The Influence of L1 Background and Other Meta-linguistic and Background Variables on the Learning of Pinyin and Hanzi by Arabic and English Learners of Chinese as a Second Language

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Abstract

Alphabetic Pinyin and morphosyllabic Hanzi are two different writing systems used in the Chinese language. Though Pinyin and Hanzi utilize different orthographies, the development of literacy skills in both writing systems depends on phonological processing skills. Becoming aware of the phonological structure in Chinese and the orthographic structure in Hanzi are crucial for the growth of literacy skills in Pinyin and Hanzi. The present study investigated the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness, phonetic radical awareness, Pinyin spelling, Hanzi reading and Hanzi writing among adult Arabic and English CSL learners. There are five important findings from this study. First, L1 background influenced the performance in Chinese phonological awareness and Pinyin spelling, in which the English participants outperformed the Arabic participants arguably due to the greater similarities in phonology and orthography between English and Pinyin. Second, the Arabic participants' better achievements in Hanzi writing compared to the English participants might originate from their experience in using the Arabic script and in learning two different scripts. Third, the two CSL groups did not differ in phonetic radical awareness or Hanzi reading, probably due to the unique characteristics of Hanzi orthography and the far distance between Arabic, English and Hanzi. Fourth, L1 background influenced the importance of phonological awareness and phonetic radical awareness in developing Chinese literacy skills, which might relate to the different orthographies used in English and Arabic, as well as the learning contexts. Fifth, Chinese language proficiency, the length of staying in China, the number of languages previously learnt, phonological working memory and phonetic coding ability significantly predicted the Arabic and English CSL learners' performance in these measures. Theoretical implications for understanding the role of L1 transfer in L2 literacy acquisition, and educational implications for teaching Chinese as a second language were discussed.

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Author's declaration

I hereby declare that this thesis and the work presented in it are my own and have been generated by me as the result of my own original research since the official commencement of this degree program. I confirm that where I have consulted the published work of others, it is always clearly attributed. This work has not, in whole or in part, previously been published and has never been submitted for award at this, or any other, university.

Chapter One: Introduction

Different writing systems are used in various languages for the purpose of recording speech. The Chinese language has two writing systems, alphabetic Pinyin and morphosyllabic Hanzi (Chinese characters), and both are obligatory to learn for native Chinese speakers and learners of Chinese as a second language (CSL). Hanzi is commonly categorised as logographic or morphosyllabic, in which one Hanzi represents one morpheme and corresponds to one syllable. Hanzi is written using logographic script and each character is made up using different strokes, such as horizontal stroke (一), vertical stroke (丨) and left-falling stroke (丿), right-falling stroke (㇏) and dot (丶). These strokes are further used to constitute larger components called radicals, such as (十，八). Hanzi does not have a clear mapping between its orthographic unit and phonological unit in speech. For instance, the stroke or stroke patterns in 青 (qīng) does not have any link with its pronunciation <qīng>. A compound Hanzi might have a semantic radical that cues its semantic meaning and a phonetic radical that represents the phonological information of the compound Hanzi. Take 清 (qīng, feeling, emotion) for example, the left-hand radical 氵 (water) indicates the meaning of 清 and the right-hand radical 青 (qīng) stands for the pronunciation of 清. However, the correspondence between the phonetic radical and the whole Hanzi is not consistent. In some way, reading Hanzi depends on rote memory. To solve this problem, different phonetic systems have been developed for the purpose of representing the phonological properties of Hanzi. Pinyin is the most popular and an officially recognized phonetic system for Hanzi. Pinyin is made up of Roman letters and is a compulsory component in Chinese literacy education. Pinyin is typically introduced prior to the start of Hanzi learning. The primary function of Pinyin learning is to help native Chinese speakers and CSL learners acquire Chinese phonology, and learn the pronunciation of unfamiliar Hanzi. However, Hanzi is dominantly used in daily life in mainland China.

Reading, i.e. decoding the grapheme from the print to sound or semantics, and spelling, i.e. producing the grapheme by hand from the oral input, are two closely linked literacy skills in using writing systems for both native speakers and L2 learners. The successful acquisition of reading and spelling skills depends on the interplay between phonological and orthographic features in the writing system, which differs in the regularity and consistency in orthography-phonology correspondence. Phonological processing skills, phonological awareness in particular, are crucial for the development of literacy skills related to reading and spelling across different orthographies, yet specific skills might be required for some unique writing systems.

Phonological awareness "can be defined as the ability to reflect on and manipulate the phonemic segments of speech" (William & Rohl, 1991, p. 2). The role of phonological awareness in the development of reading and spelling has been explored in a large number of studies conducted among different types of writing systems. In alphabetic writing systems, like English, phonological awareness is a vital concept for reading and spelling acquisition, and significantly predicts the development of reading and spelling skills among the native speakers and the L2 learners (Adams, 1994; Bradley & Bryant, 1983; Brady & Shankweiler, 1991; Caravolas, 2004; Goswami & Bryant, 1990; Read, 1975; Wade-Woolley & Siegel, 1997; Wagner & Torgesen, 1987; Wijayathilake & Parrila, 2014). In morphosyllabic writing systems, such as Chinese Hanzi, similar grapheme-phoneme correspondence rules as in alphabetic writing systems does not exist. However, phonological awareness is still important for the growth of Hanzi reading skills, though the effect size of phonological awareness on Hanzi reading is less strong than that in alphabetic writing systems (Song, Georgiou, Su, & Hua, 2015).

Phonetic radical awareness, defined as the "insight into the structure and function of the phonetic component of semantic-phonetic compound characters" (Shu, Anderson, & Wu, 2000, p. 57), is another crucial type of meta-linguistic awareness for reading and writing

Hanzi. A major group of Chinese Hanzi contain a semantic radical that gives clues to meaning, and a phonetic radical that gives clues to pronunciation. For example, Hanzi 清 (qīng, clear liquid) is made of semantic radical 氵 (water, indicating 清 relates to water) and phonetic radical 青 (qīng, indicating the pronunciation of 清). As the only accessible phonological cue, a phonetic radical could provide essential phonological information for the pronunciation of Hanzi. Phonetic radical awareness includes two components. The first is regularity awareness. The mapping between the pronunciation of phonetic radicals and the whole Hanzi is not totally consistent. Some phonetic radicals could represent the correct pronunciation of Hanzi, such as 清 (qīng) and 青 (qīng). However, some phonetic radicals do not share any similar phonological information with the pronunciation of Hanzi, such as 马 (mǎ) and 冯 (féng). Therefore, being aware of the regularity and irregularity of phonetic radical in providing phonological information for Hanzi is essential for reading unfamiliar Hanzi. The second is position awareness. Most phonetic radicals are placed to the right in semantic-phonetic Hanzi, such as 青 (qīng) in 清 (qīng). Awareness of the positional distribution of phonetic radicals in Hanzi could aid the readers in developing better orthographic skills, which in turn facilitates Hanzi recognition skills.

Previous studies on L2 learners of alphabetic writing system such as English have revealed transfer from the learners' L1 on their phonological awareness, reading and spelling in the L2 (Chung, McBride-Chang, Cheung, & Wong, 2013; Figueredo, 2006; Luo, Chen, & Geva, 2014; Tong & McBride-Chang, 2010). In addition, learning a specific script has been found to be helpful for the development of corresponding visual-spatial skills (Kolinsky, Morais, Content, & Cary, 1987; Liow, Green, & Tam, 1999; McBride-Chang, Chow, Zhong, Burgess, & Hayward, 2005), which could further influence the script users' performance in learning L2 script and some non-linguistic tasks such as drawing (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow et al., 1999; Nachson, Argaman, & Luria, 1999; Sassoon, 1995; Shanon, 1978; Shimrat, 1973; Vaid, 1995; Vaid, Rhodes, Tosun, & Eslami, 2011). Given the effects of the L1 on L2 learning, this study looks at two groups of CSL learners, English and Arabic speakers, on their Chinese phonological awareness, phonetic radical awareness and literacy skills related to Pinyin and Hanzi. In addition, variables such as language proficiency, phonological aptitude, the length of stay in the L2-speaking country, and the number of previous languages learnt are important to account for the variation in language learning among the L2 learners. Therefore, the influence of these variables in relation to Chinese literacy skills among the CSL learners is also investigated in this study.

The reasons for selecting Arabic and English as the comparison pairs originate from the phonological and orthographic differences between the writing systems in these two languages and Chinese. Regarding phonology, Chinese and English have a large inventory of vowels and consonants, yet Arabic is a consonant-dominated language which has 28 consonants but only six vowels. Regarding orthography, Pinyin, English and Arabic are sound-based, yet Hanzi is logographic or morphosyllabic. Pinyin and English use Roman letters which are written from left to right, Hanzi is constructed mainly by strokes and stroke patterns in a rectangular layout, and it is written from left to right, while Arabic utilizes Arabic script which is written from right to left. Exploring how these two different alphabetic languages influence Chinese learning among the Arabic and English CSL learners is important for us to understand how L1 transfer impacts the development of L2 literacy skills in a more general SLA context.

This thesis comprises eight chapters. The 1st chapter is a brief introduction to this study. The 2nd chapter compares the phonologies and orthographies between Arabic, Chinese and English, and reviews the research on reading and spelling in native speakers of English and Chinese, especially the role of phonological awareness and phonetic radical awareness in the development of literacy skills in English and Chinese. The 3rd chapter focuses on the literature review of the influence of L1 on reading and spelling skills among ESL learners and CSL learners, and the impact of a range of different variables in language learning, and this chapter also presents the research questions to be addressed in the present thesis. The three research questions focus on the influence of L1 background, and other metalinguistic and background variables on (1) Chinese phonological awareness and Pinyin spelling skills, (2) phonetic radical awareness and Hanzi reading and Hanzi writing skills, and (3) the relationships between Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills (Pinyin spelling, Hanzi reading and Hanzi writing) among the Arabic and English CSL learners. The 4th Chapter deals with the first research question, i.e., the influence of L1 background and metalinguistic/background variables on Chinese phonological awareness and Pinyin spelling among the Arabic and English CSL learners. The 5th chapter sets out the results of the second research question, i.e., the influence of L1 background and other meta-linguistic and background variables on the performance in phonetic radical awareness, Hanzi reading and Hanzi writing among the Arabic and English CSL learners. The 6th chapter explores the third research question, i.e., the impact of L1 background and Chinese language proficiency on the relationships between Chinese phonological awareness, phonetic radical awareness and different Chinese literacy skills among the Arabic and English CSL learners. The 7th chapter reviews and discusses the general results of this thesis. The 8th chapter makes a conclusion of the study.

Chapter Two: Reading and Spelling in Native Speakers

In order to provide context for the study on how L1 background and other meta-linguistic and background variables influence the performance in learning the two different writing systems in the Chinese language among the Arabic and English CSL learners, this chapter starts with a general introduction to the concepts of writing systems and orthography, then continues with a comparative analysis of phonology and orthography between Arabic, Chinese and English, in order to provide a better understanding of the role L1 plays in learning Chinese. At the end, this chapter reviews research on reading and spelling in native speakers of English and Chinese, setting out the background for the development of Chinese literacy skills among the Arabic and English CSL learners.

2.1 Writing systems and orthographies

2.1.1 Writing systems

In this section, the key concepts such as *writing system*, *script* and *grapheme* are defined.

Writing systems can be defined as "the written language described in terms of linguistic units" (Joshi & Aaron, 2005, p. xiii). One language normally has one writing system, such as English, yet some languages have two writing systems, such as Pinyin and Hanzi in Chinese.

A script is a visual sign system that represents one writing system, such as Chinese Hanzi (characters), the English and the Arabic alphabetic letters. One script may be used in different writing systems. For example, Roman letters are used in many European writing systems, such as English, French, and Italian. Hanzi is utilized in Chinese and Japanese writing systems.

One language may use two different scripts in a mixed way or separately. For instance, both syllabic *kana* (adopted from the stroke or stroke patterns in Chinese characters, and each kana corresponds to a syllable) and logographic *kanji* (borrowed from Chinese characters) are used together in one Japanese sentence, such as the phrase 爱してる (I love you). 爱 is kanji, し, て and る are syllabic kana. In contrast, the Chinese language has two different writing systems: logographic Hanzi and alphabetic Pinyin, but they are used separately. Take the sentence "I love you" for example, there are three common options in Chinese.

Option 1- Hanzi only.	我爱你。
	I love you.
Option 2- Pinyin only.	Wǒ ài nǐ。
Option 3- Pinyin above Hanzi.	Wǒ ài nǐ。 我 爱 你 。

The usage of the term *grapheme* is still debated (Daniels, 1996; Sproat, 2000). In this study, grapheme refers to the basic written symbol in one script, such as each Hanzi in the Chinese writing system and each letter in the English and the Arabic alphabet.

DeFrancis (1989) classified writing systems into two types: alphabetic and graphic.

Alphabetic writing systems. Each alphabetic writing system has its own alphabet with different numbers of letters, e.g., the 26 letters in the English alphabet and 28 letters in the Arabic alphabet. One grapheme represents a corresponding phonological component of the language. Based on the phonological units that the grapheme corresponds to, alphabetic writing systems can be further classified into three types—*alphabetic*, *abjad* and *syllabic*.

In *alphabetic* writing systems, the grapheme represents one or more consonantal or vowel phoneme of the spoken language by itself or via the grapheme string. English is an alphabetic writing system. For example, the letter <a> represents the phoneme /ei/, and the letter string <ay> also represents the phoneme /ei/. Chinese Pinyin is also alphabetic. It has an alphabet with 26 Roman letters. Each letter or letter string represents a consonant or vowel.

For instance, <n> represents consonant /n/, and letter string <an> represents a rhyme /an/.

In *abjad* writing systems, most of the graphemes represent the consonantal phonemes of the spoken language. Arabic is a typical example. Most Arabic letters represent consonants, the three short vowels are often omitted or represented by diacritics (glyph added to letters to change the sound-value of the letters), and the three long vowels are represented by corresponding consonants. For example, the diacritic ـَ (top right) in بَت represents the short vowel /a/, and the diacritic ـِ (bottom right) in بِت represents the short vowel /i/. The long vowels /a:/, /i:/ and /u:/ are represented by consonant letters ا , ي, and و, respectively.

In *syllabic* writing systems, the grapheme represents a syllable rather than individual phoneme of the spoken language. Japanese kana is a typical syllabic writing system. For instance, く represents /ku/, and か represents /ka/. Each of the two graphemes represents a syllable. The sounds of く and か have the same consonant /k/, but the physical shapes of the two graphemes do not have a common component that represents /k/.

Graphic writing systems. Contrary to alphabetic writing systems, graphic writing systems do not have an alphabet. Chinese Hanzi and Japanese kanji are representative examples of this category. In fact, Japanese kanji originates from Hanzi, so only Hanzi is discussed here.

The nature of Hanzi has changed from logographic to morphosyllabic. Modern Hanzi originated from a logographic script carved on oracle bones from 14th to 11th century. The logographic nature of modern Hanzi is almost totally lost, and has become a sign system after centuries of development. For example, the Hanzi for eye has changed from  in oracle-bone-script to 目 in modern Chinese. There is no longer much resemblance between the physical representation of an eye and 目. Two-Hanzi words are the dominant type in Chinese, in which each Hanzi serves as a morpheme. Therefore, the nature of modern Hanzi is morphosyllablic, rather than logographic (DeFrancis, 1986).

Debate on the nature of Pinyin

Pinyin, literally “spelling the sounds”, is the official Romanization system for Mandarin Chinese (International Standard Organization, 1982; State Council of China, 1957). The main function of Pinyin is to represent the phonological information for Hanzi in Mandarin. For example, 一 (one), 二 (two), 三(three) are three of the simplest Hanzi in Chinese and they could be pronounced differently in different dialect areas, yet the horizontal lines in the three Hanzi are totally irrelevant to their pronunciations. However, using Pinyin could clearly represent the phonological information for these Hanzi in Mandarin, such as *yī* for 一, *èr* for 二, and *sān for* 三. For native Chinese speakers, Pinyin serves as a phonetic system for Hanzi, rather than another independent writing system, because young and adult educated native Chinese speakers dominantly use Hanzi for written communication. Nonetheless, Pinyin could be used as a writing system for learners of Chinese as a second language (CSL). This view could be supported by the following evidence.

First of all, different from native Chinese speakers, CSL learners use Pinyin in writing emails or letters or sending texting messages for the purpose of communication, due to the difficulty of inputting and recognizing Hanzi (Kupfer, 2003). CSL learners are able to successfully achieve the goal of written communication via spelling Pinyin, even without the use of tones. This is similar to the popular use of Romanized Arabic in Arabic-speaking areas (Abu Elhija, 2014).

Secondly, the nature of Pinyin is a writing system, rather than phonetic alphabet. Different from International Phonetic Alphabet, which shows a strict one-to-one correspondence between grapheme and phoneme, some alphabet letters in Pinyin could correspond to two or three phonemes, such as <i> -/i/, /ɿ/, and /ʅ/. Therefore, Pinyin could not be considered as a standard phonetic alphabet. In fact, in comparison to Hanzi, Pinyin could more clearly reflect the linguistic unit of Mandarin Chinese because the graphemes in

Pinyin match the phonemes in Chinese. Therefore, according to the definition of writing system proposed by (Joshi & Aaron, 2005, p. xiii), Pinyin might be more similar as a writing system though it is not officially used an independent writing system (Zhou, 2017).

This thesis does not aim to speak for the debate on the nature of Pinyin due to the limited space. However, Pinyin is considered as a writing system in the present thesis, and the orthography in Pinyin is also discussed in the following sections.

2.1.2 Orthography

Orthography refers to the conventions for implementing a script in a particular language. One central component of orthography is the grapheme-phoneme correspondence (GPC) rule, such as the grapheme <e> in English maps onto different phonemes like /e/ and /i/, and grapheme <l> mainly represents consonant /l/ in English. *Orthographic depth* refers to the transparency of the grapheme-to-phoneme correspondence (Katz & Frost, 1992). Based on orthographic depth, orthographies are traditionally classified as either deep or shallow. A **shallow orthography** is characterized as one with one-to-one grapheme-to-phoneme correspondence. Turkish and Finnish are considered to have shallow orthographies. A **deep orthography** is marked by complex grapheme-to-phoneme correspondence, in which graphemes map onto different sounds and phonemes are represented with different graphemes. English is commonly considered to have a deep orthography because its GPC is very sophisticated (Coulmas, 2003; Nyikos, 1987). For instance, grapheme <s> represents four different phonemes /s/, /z/, /ʃ/, /ʒ/, and grapheme <o> maps onto five different phonemes /ɔ/, /əʊ/, /ʌ/, /u:/, /ʊ/. Chinese Hanzi also has a deep orthography due to the lack of direct mapping between the orthographic units in Hanzi and phonological units in sound. Arabic orthography is also considered deep because the vowels are always omitted and only the consonants are written.

The distinction between deep and shallow orthographies is based on the relative transparency of GPC. To date, there is still no generally accepted algorithm to compute the orthographic depth across languages (Kessler & Treiman, 2001; Protopapas & Vlahou, 2009;

Van den Bosch, Content, Daelemans, & De Gelder, 1994; Ziegler, Jacobs, & Stone, 1996). Therefore, this study adopts a relativist view of orthographic depth when comparing the orthographic depth between Chinese, Arabic and English, since we cannot compute the accurate parameters of orthographic depth in each language.

Following a brief introduction to writing system and orthography, a comparative analysis of the phonologies and orthographies used in Arabic, Chinese and English is discussed in the next section.

2.2 Comparing the phonologies and orthographies of Arabic, Chinese and English

Comparing the similarities and differences between first language and second language is the basic step in exploring the influence of L1 background on second language acquisition (Lado, 1957). One of the goals of the present thesis is to explore how L1 background relates to the performance in Chinese learning (e.g. phonological awareness, Pinyin spelling, Hanzi reading and Hanzi writing) among the Arabic and English CSL learners, thus a comprehensive understanding of the similarities and differences in phonology and orthography between Chinese, Arabic and English is fundamental for the present research.

Chinese, English and Arabic are the three languages which have the largest number of speakers (Lewis, Gary, & Charles, 2014). Previous researchers have analyzed the differences and similarities in phonologies and orthographies between Chinese and English (Defense Language Institution, 1974b), and between Arabic and English (Defense Language Institution, 1974a; Smith, 2001). However, some detailed differences about the phonological and orthographic properties in the three languages are still not clear. Thus, this section compares the phonology and orthography between Arabic, Chinese and English.

2.2.1 Phonological properties of Arabic, Chinese and English

The comparative analysis of the phonological properties in Arabic, Chinese and English focuses on vowel, consonant, tone and syllable structure.

Vowels

Arabic, Chinese and English differ a great deal in terms of the number and the type of vowels (See Table 2.1). Chinese has only short vowels, whereas English and Arabic have both short and long vowels. Chinese and English have single vowels and diphthongs (sound composed of two vowels), yet Arabic has only single vowels. Chinese has 10 short vowels and four diphthongs (Beijing daxue zhongwenxi xiandai hanyu jiaoyanshi, 2006; Duanmu, 2007), English has seven short vowels, five long vowels, and eight diphthongs (Roach, 2005), whereas Arabic has only three short vowels and three long vowels(Holes, 2004). In terms of the **single vowels**, Chinese short vowels /a/, /i/ and /u/ are also present in Arabic and English, but the other seven short vowels (/ɿ/, /ʅ/, /y/, /o/, /ɤ/, /ə/, /ər/) are not observed in Arabic or English. In terms of the **diphthongs**, Chinese /ai/ is present in English but not in Arabic, and Chinese /ɘi/, /ɘu/ and /au/ are not found in either English or Arabic. In sum, Chinese and English share more similarities in vowels than Arabic and Chinese.

Table 2.1

Similarity in Vowels and Consonants in Arabic, Chinese and English

	Chinese	Arabic	English	Similarity
Vowel	10 short vowels 4 diphthongs	3 short vowels 3 long vowels	7 short vowels 4 long vowels 8 diphthongs	Chinese vs. Arabic: /a/, /i/, /u/ Chinese vs. English: /a/, /i/, /u/, /ai/
Consonant	3 nasal 6 fricative 6 affricate 1 approximant 6 stop	3 nasals 13 fricatives 1 affricate 3 approximants 7 plosives 1 trill 1 lateral approximant	3 nasals 9 fricatives 2 affricates 3 approximants 6 plosives 1 lateral	Chinese vs. English vs. Arabic: /p/, /m/, /f/, /t/, /n/, /l/, /k/, /s/, /w/, /j/. Chinese vs. English: similar consonant pairs /p/-/p^h/ vs. /p/-/b/, /k/-/k^h/ vs. /k/-/g/

Consonants

Similarities and differences exist in consonants between Arabic, Chinese and English (See Table 2.1). Chinese has 22 consonants, including three nasal consonants, six stop consonants, six affricate consonants, six fricative consonants, and one approximant consonant (Beijing daxue zhongwenxi xiandai hanyu jiaoyanshi, 2006). English has 24 consonants, including three nasals, six plosives, two affricates, nine fricatives, three approximants and one lateral consonant (Roach, 2005). Arabic has 28 consonants, including seven plosives, two nasals, one trill, 13 fricatives, one affricate, two approximants and one lateral approximant consonant (Holes, 2004). The consonants present in Chinese, English and Arabic are /p/, /m/, /f/, /t/, /n/, /l/, /k/, /s/, /w/, and /j/. Chinese and English share similar contrastive pairs, such as /p/-/p^h/ in Chinese and /p/-/b/ in English, / k/-/k^h/ in Chinese and /k/-/g/ in English. In sum, more similarities in consonants exist between Chinese and English than between Chinese and Arabic.

Tones

Tone is the use of pitch to distinguish lexical or grammatical meanings of words. Neither English nor Arabic has tones, yet Chinese has four tones. The pitch contours of the four tones in Chinese can be illustrated in a 5-level system developed by Yuanren Chao (1930) (Figure 2.1). Level 5 indicates the highest pitch, and level 1 represents the lowest pitch.

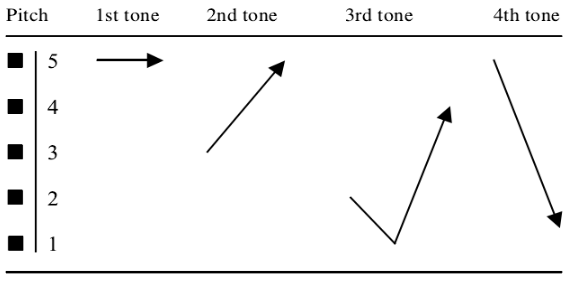

Figure 2.1 The four basic tones in Chinese (Chao, 1930)

The pitch contours of the four tones are 55 for flat tone, 35 for rising tone, 214 for falling-rising tone and 51 for falling tone. Four diacritics are utilized to represent the four corresponding tones, ˉ for flat tone, ˊ for rising tone, ˇ for falling-rising tone and ˋ for falling tone. Syllables with different tones indicate different meanings. Take the syllable <ma> for example, 妈 <mā> (flat tone) means mother, 麻<má> (rising tone) represents linen, 马<mǎ> (falling-rising tone) is horse, and 骂<mà> (falling tone) means to scold.

Syllables

Arabic, Chinese and English differ in syllable structure. The Chinese syllable is traditionally divided into two parts-initial and final, which is similar to the onset and rhyme in English (Beijing daxue zhongwenxi xiandai hanyu jiaoyanshi, 2006). The onset refers to the initial consonant phoneme of a syllable, such as “m” in the syllable “mǎ”. The onset position in Chinese syllable is optional, and a syllable with no onset is allowed in Chinese, such as <ài> (to love). All single consonants except /ŋ/ can serve as onset, and a consonant cluster is not allowed in the onset position. Rhyme refers to the segment following the onset, such as “uan” in the syllable <quan>. The rhyme includes three parts—the medial, main vowel and syllabic terminal. Both the medial and syllabic terminal parts are optional in Chinese syllables, whereas the main vowel is obligatory.

The English syllable has an onset-rhyme structure (Fudge, 1969, 1987; Kessler & Treiman, 1997; Treiman, 1983, 1985, 1986). The onset is the initial consonant or consonant cluster of a syllable. All the consonants except /ŋ/ can be used as an onset. Both single consonant and consonant clusters are allowed in the onset position, such as /p/ in <pain> and /pr/ in <pray>. The rhyme is the portion following the onset, and it includes vowel and coda part. Any vowel or diphthong may be in the vowel part in the rhyme. The coda is the consonant or consonant cluster after the vowels in the rhyme. For instance, /piɡ/ (pig) has an onset /p/ and a rhyme /iɡ/ which includes a vowel /i/ and a coda /ɡ/. Yet, /pi:/ (pea) only includes an onset /p/ and a rhyme /i:/ without any coda.

Arabic syllables are often perceived of as having a body-coda structure (Holes, 2004). In this body-coda pattern, the relationship between the initial consonant and the following vowel is closer than the relationship between the vowel and the final consonant. This has been confirmed in several studies by Saiegh-Haddad (2003, 2004, 2005, 2007). Arabic syllables start with a single consonant. Consonant clusters and vowels are not allowed to appear in the initial position. Arabic syllables end with either short or long vowel or single consonant, and consonant clusters cannot appear at the end of Arabic syllable (Haywood, 1970; Holes, 2004; Watson, 2002; Wright, 1974).

In sum, the main differences in syllables between the three languages are (1) Chinese and English syllables have an onset-rhyme structure, but Arabic syllables have a body-coda pattern; (2) the initial consonant parts in Chinese and English syllables are optional, yet obligatory in Arabic, and (3) only vowels and single consonant are allowed at the final position in Chinese syllables, whereas the final position in English and Arabic syllables are open to vowels, single consonant and consonant clusters.

Brief summary

The comparison between the three languages above reveals that the phonological properties between Chinese and English are closer than those between Arabic and Chinese (See Table 2.2). English and Chinese are similar in the large vowel repertoire, onset-rhyme syllabic structure, and certain contrastive consonant pairs. Compared with Chinese, Arabic has a smaller repertoire of vowels, a different body-coda syllabic structure and lacks some contrastive consonant pairs that are present in Chinese. However, English and Arabic are similar in that neither language has tones to differentiate lexical meanings.

Table 2.2

Summary of the Differences in Phonological Properties in Arabic, Chinese and English

	Arabic	Chinese	English
Vowel	6	14	20
Consonant	22	24	28
Tone	N/A	4	N/A
Syllable	Body-coda	Final-initial	Onset-rhyme

2.2.2 Orthographies of Arabic, Chinese and English

Following the above comparative analysis of the phonologies in Arabic, Chinese and English, this section examines the similarities and differences in orthography in the three languages. Chinese has two writing systems-alphabetic Pinyin and morphosyllabic Hanzi, and the orthographies of these two writing systems are introduced here. Therefore, this section includes a brief review of the orthographies in Hanzi, Pinyin, English and Arabic.

Hanzi orthography

Hanzi is a morphosyllabic writing system which originates from pictographs about 3000 years ago. Spoken Chinese has only about 400 syllables without tones or around 1300 syllables with tones (Lu, 2001; Su & Lin, 2006), and about 10,000 modern Hanzi are used nowadays. That is to say, one syllable corresponds to about eight different Hanzi (Su & Lin, 2006). The relationship between Hanzi and its pronunciation is quite vague because the physical components of Hanzi do not match the phonological units of its pronunciation. For instance, the pronunciation of 三 is <sān> (/san/), yet the three horizontal lines in 三 are irrelevant to the onset, rhyme or tone in its sound. Nonetheless, a majority of Hanzi are compound Hanzi carrying a phonetic radical that might provide phonological information of the whole Hanzi. The regularity of phonetic radical in cueing the pronunciation of Hanzi, and positional distribution of phonetic radical are essential aspects of Hanzi orthography, and are briefly reviewed below.

Table 2.3

Correspondence between the Phonetic Radical and Hanzi

Category	Onset	Rhyme	Tone	Percentage 1	Percentage 2	Mean
Regular	+	+	+	37.51%	31.03%	34.27%
Semi-regular	+	+	-	18.17%	17.44%	17.81%
	+	-	+	3.88%	3.1%	3.49%
	+	-	-	4.35%	3.6%	3.98%
	-	+	+	5.61%	8.1%	6.86%
	-	+	-	10.56%	15.29%	12.93%
Irregular	-	-	+	7.22%	5.15%	6.19%
	-	-	-	12.70%	16.29%	14.50%

Note. "+"=correspondence; "-" = non-correspondence. Percentage 1 and percentage 2 was cited from the studies by Li, Kang, Wei, and Zhang (1992) and Wan (2005), respectively. The mean is the average of percentage1 and percentage2.

First, the regularity of the phonetic radical in providing pronunciation of the semantic-phonetic Hanzi is briefly introduced. About 70% of modern Hanzi are semantic-phonetic Hanzi that could be decomposed into a semantic radical and a phonetic radical (Li & Kang, 1995; Li et al., 1992). The semantic radical indicates the semantic category of Hanzi, and the phonetic radical gives a clue to the pronunciation of Hanzi. Take 镜 (jìng, mirror) for example, the semantic radical 钅 (jīn, metal) indicates that 镜 is related to metal materials, and the phonetic radical 竟 (jìng) represents the pronunciation of 镜. However, the pronunciation of the phonetic radical and the Hanzi that contains it are not always matched. According to the degree of the correspondence between the phonetic radical and Hanzi, semantic-phonetic Hanzi can be divided into three types, and they are *regular*, *semiregular* and *irregular* (See Table 2.3). In the first type, *regular* Hanzi, the phonetic radical represents the accurate pronunciation of the Hanzi, such as 镜. This group of Hanzi accounts for 34.27%

of the commonly used Hanzi.

The second type is *semiregular* Hanzi, in which the phonetic radical represents partial (onset or/and rhyme) phonological information of the Hanzi, and they make up about 45.07% in commonly used Hanzi. This category could be further divided into three subcategories. The first subcategory is that the phonetic radical represents both the onset and rhyme of the Hanzi. For instance, the phonetic radical of 醒 (xǐng, to wake) is 星 (xīng), whose pronunciation differs from 醒 only in terms of the tone. The second subcategory is that the phonetic radical represents only the onset part of the Hanzi. Take 啥 (shá, what) for example, its phonetic radical is 舍 (shě), which only shares the same onset <sh> with 啥. The third subcategory is that the phonetic radical represents only the rhyme part of the Hanzi. For instance, 静 (jìng) and its phonetic radical 青 (qīng) only share the same rhyme <ing>.

In the third type, *irregular* Hanzi, the phonetic radical does not represent any phonological information of the Hanzi. For example, the phonetic radical of 猜 (cāi, to guess) is 青 (qīng), but the onsets and rhymes of 猜 and 青 are totally different. Though 猜 and 青 share the same tone, 猜 is not considered as semantic-phonetic Hanzi. Hanzi in this category are not considered as typical semantic-phonetic Hanzi.

The number of commonly used phonetic radicals in modern Hanzi ranges from 1090 to 1348 according to the scope of selected Hanzi and analysis methods (Fan, Gao, & Ao, 1984; Li et al., 1992; Zhou, 1980). Only 22.4% of the phonetic radicals fully match the pronunciation of the whole Hanzi. Among all the phonetic radicals, about 84% are independent Hanzi, which can be used as an isolated Hanzi or combined with other Hanzi as a new word (Li et al., 1992). For instance, the phonetic radical 竟 in 镜 can be used an independent word or appear in another disyllabic word such as 竟然 and 究竟.

In terms of providing phonological information, the phonetic radical has a moderate association with Hanzi. A phonetic radical is able to construct 4.25 Hanzi on average. Only

11 phonetic radicals construct more than 20 Hanzi, and 434 phonetic radicals only appear in one semantic-phonetic Hanzi (Li & Kang, 1995). In addition, one phonetic radical predicts the pronunciation of 2.5 Hanzi. That is to say, if one knows the pronunciation of a phonetic radical, then one may know the pronunciation of 2.5 Hanzi (Wen, 1987). However, the mean predictive power of phonetic radical in the pronunciation of Hanzi ranges from 0.5-0.7. If one knows the pronunciation of a phonetic radical, then there is only 50%-70% of chance that one knows the pronunciation of a Hanzi consisting of this phonetic radical (Gong, 1995; Li et al., 1992; Wen, 1987). The power of phonetic radical in predicting the pronunciation of Hanzi is not strong.

Another important feature related to phonetic radical in Hanzi is the positional distribution of phonetic radical. The distribution of phonetic radicals in semantic-phonetic Hanzi has a positional bias. The phonetic radical does not appear in random positions, and it mostly occupies a habitual position in a semantic-phonetic Hanzi: right or bottom. About two thirds (67.39%) of semantic-phonetic Hanzi places the phonetic radical on the right side, one tenth (10.50%) places the phonetic radical at the bottom, 7% of Hanzi positions phonetic radical at the top and 6% of the Hanzi places the phonetic radical on the left side (Hsiao & Shillcock, 2006; Li et al., 1992).

Pinyin orthography

The development of Pinyin is mainly due to the vague relationship between Hanzi and its pronunciation, and the consequent troubles that this vague relationship causes to Chinese literacy education (Chen, 1999). Pinyin has been developed on the basis of the Roman alphabet (See Table 2.4) and some diacritics for tones, such as "-" for the flat tone in <mā>. Among all the Roman alphabetic letters, the letter <v> is only used for foreign words or languages spoken by Chinese ethnic minorities and not used for the pronunciation of Hanzi. Pinyin is now widely used by both Chinese speakers and CSL learners. The GPC rule in Pinyin is very regular. Most of the graphemes have a one-to-one correspondence to the phonemes they represent. For instance, phoneme /k^h/ is only represented by letter <k>, yet /k/ could be represented by <c>, <k> and <ck> in English.

Table 2.4

Chinese Pinyin Alphabet and the Corresponding IPA

Pinyin Letter	IPA	Pinyin Letter	IPA	Pinyin Letter	IPA
a	/a/	j	/tɕ/	s	/s/
b	/p/	k	/k^h/	t	/t^h/
c	/ts^h/	l	/l/	v	/v/
d	/d/	m	/m/	u	/u/
e	/e/	n	/n/	w	/w/
f	/f/	o	/o/	x	/ɕ/
g	/k/	p	/p^h/	y	/j/
h	/h/	q	/$tɕ^h$/	z	/ts/
i	/i/	r	/ʐ/		

Note. IPA = International Phonetic Alphabet

In terms of single vowels, only four graphemes represent more than one phoneme. Grapheme <a> represents four similar phonemes-/a/, /ɑ/, /æ/, /A/, <e> represents four phonemes-/ɤ/, /ə/, /ɛ/, /e/, <o> represents three phonemes-/o/, /u/, /y/, and <i> represents three phonemes-/ɪ/, /ɿ/, /ʅ/. Graphemes <u>, <ü> and <er> represents /u/, /y/ and /ər/, respectively.

For most of the phoneme clusters in rhymes, the GPC is also regular. Each grapheme cluster stands for a specific phoneme, and no two grapheme clusters represent one phoneme. The number of graphemes and the number of phonemes are matched in most rhymes, and the exceptional cases are <iu> (/iou/), <ui> (/uei/) and <un> (/uən/) and the finals ending with consonant <ng> (/ŋ/). When following a consonant, each of the grapheme clusters <iu>, <ui> and <un> use two graphemes to represent three phonemes. The finals ending with /ŋ/ use two letters <ng> to represent one phoneme /ŋ/.

In terms of onsets, the general case is that one grapheme represents one phoneme. However, <zh>, <ch> and <sh> are exceptional. Each of them uses two graphemes to represent one phoneme /tʂ/, /tʂ^{h}/ and /ʂ/, respectively. In <zh>, <ch> and <sh>, the grapheme <h> is not pronounced and it is used to indicate the retroflexed articulation pattern.

English orthography

English orthography is notorious for its irregularity in GPC. The English language has a very deep orthography. The ratio of phoneme to grapheme in English ranges from 1:5.39 to 1:24 (Coulmas, 2003; Nyikos, 1987). Berndt, Reggia, and Mitchum (1987) and Gontijo, Gontijo, and Shillcock (2003) further demonstrated that the predictive power of graphemes for phonemes in English is quite weak. The opaqueness of GPC in English orthography is reflected by two facts—one grapheme represents different phonemes, and different graphemes represent one phoneme. For instance, grapheme <a> stands for several different phonemes, such as /ei/ (date), /ɑ:/ (father), /æ/ (fat) and /ɔ/ (want), and phoneme /f/ is represented by different graphemes such as <ff> (cliff), <ph> (phone), <gh> (laugh), <lf> (calf) and <ft> (often).

Arabic orthography

Arabic orthography is relatively shallow in comparison to English. Arabic belongs to the abjad writing system which is consonant-dominant. The graphemes representing consonants cannot be omitted in spelling, yet the graphemes for short vowels are substituted with diacritics or omitted (Daniels & Bright, 1996). Because there are only three short vowels, the influence of vowel omission on Arabic reading is not strong (Hermena, Drieghe, Hellmuth, & Liversedge, 2015; Salehuddin & Winskel, 2014). Despite the potential confusions caused by vowels omission, the grapheme-phoneme correspondence for consonants is very consistent and transparent. Each grapheme represents one phoneme, and vice versa.

Contrary to the case of vowel omission in the Arabic script, the vowel cannot be omitted in Romanized Arabic, which has a shallower orthography in comparison to the Arabic script. BGN/PCGN 1956 System (BGN/PCGN, 1956) is the most popular standard

Romanization system for Arabic. This system includes 22 Roman letters and some diacritics, such as short horizontal line and dot. Romanized Arabic has a one-to-one correspondence between graphemes and phonemes.

Scripts in Arabic, Chinese and English

Script is the physical medium to apply the orthography rules in languages, and it could be seen as one of the basic elements of orthography. Chinese, English and Arabic utilize different scripts differing in visual complexity and writing direction. Previous studies have demonstrated the influence of the script properties on the performance in some cognitive tasks such as handwriting and drawing (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow, Green, & Tam, 1999; Nachson, Argaman, & Luria, 1999; Sassoon, 1995; Shanon, 1978; Shimrat, 1973; Vaid, 1995; Vaid, Rhodes, Tosun, & Eslami, 2011). To understand whether the different script properties in English and Arabic affect the English and Arabic CSL learners' acquisition of Hanzi reading and Hanzi writing, comparing the differences in the script in these three languages appears to be necessary.

Arabic, Chinese and English use different scripts to record the spoken sounds. English only employs Roman alphabet for the purpose of recording speech. Arabic uses Arabic script as the main writing system, as well as the Romanized Arabic as a complementary tool. Likewise, the main script used in Chinese is Hanzi, and the supplementary script is Pinyin, which utilizes Roman alphabet to assist the teaching and learning of Hanzi. For Arabic and Chinese speakers, one purpose of using Roman letters is transliteration, that is, representing the pronunciation for Arabic words and Chinese Hanzi, respectively. Pinyin is an officially recognized phonetic system in China and normally used for marking pronunciation for Hanzi in the dictionary and Chinese language textbooks for native speakers and CSL learners and in public places in Mainland China. However, Romanized Arabic is mainly used for texting and online chatting (Abu Elhija, 2014), and its use is not observed in Arabic education for native speakers.

Different scripts differ in the visual complexity. The evaluation of the visual complexity of the script has been debated for a long time. Altmann (2004) proposed a composition method which examines script complexity by splitting a symbol into basic units, such as point, straight line and arch. In contrast, Carsten Peust (2006) suggested an intersection method, with one of the main rules being "the complexity of a sign is the maximal number of crossing points that can be achieved with a straight line" (p.11). However, Altmann and Carsten did not compare the differences in script complexity in Arabic, Chinese and English. The latest method developed by Chang (2015) evaluated the visual complexity of different scripts used in 131 orthographies in terms of perimetric complexity, the number of simple features, the number of connected points and the number of disconnected components. On the basis of this method, the overall complexity (in *z* scores) of Arabic script, English script and Chinese Hanzi was -0.50, -0.26, and 3.22. The results suggest that Chinese Hanzi is the most complex, followed by Arabic, and then English (and Pinyin), being the least visually complex.

2.2.3 Section summary

The main aim of this section was to provide a comparative analysis of the phonological and orthographic properties in Arabic, Chinese and English. The comparison found similarities and differences between the three languages in terms of vowels, consonants, tones, syllable structure, orthography and script (See Table 2.5).

In terms of **phonology**, the similarity between Chinese and English is greater than that between Chinese and Arabic. Both Chinese and English have similar number of consonants, a large inventory of vowels and rhymes and similar onset-rhyme syllable structure, whereas, Arabic and Chinese only share some consonants and three short vowels. In terms of **orthography**, English, rather than Romanized Arabic, is more similar to Chinese Pinyin. Chinese Pinyin, Romanized Arabic and English are similar in visual complexity because the three orthographies use the same Roman alphabet. However, Chinese Pinyin and English share more similarities in GPC rules in consonants and vowels. Regarding **script**, Chinese Hanzi, Arabic and English script differ in visual complexity, with Hanzi as the most complex and English script as the least complex. The differences in phonological and orthographic properties between Arabic, Chinese and English might lead to different performances in Chinese learning in terms of phonological awareness, Pinyin and Hanzi learning among the Arabic and English CSL learners, which is to be addressed in the present thesis.

Table 2.5

Summary of the Differences in Phonological and Orthographic Properties between Arabic, Chinese and English

		Arabic	Chinese	English
Phonology	Consonant & vowel	Consonant-dominant	Large inventory of consonants and vowels	Large inventory of consonants and vowels
	Syllable	Body-coda	Onset-rhyme	Onset-rhyme
	Tone	N/A	Four tones	N/A
Orthography	Depth	Romanized Arabic-shallow Arabic-Relatively deep	Pinyin-shallow Hanzi-very deep	deep
	Script complexity	Romanized Arabic-Easy Arabic-Difficult	Pinyin-Easy Hanzi-very difficult	Easy

2.3 Theories of reading and spelling

After the comparative analysis of phonological and orthographic properties in Arabic, English and Chinese, the following section reviews several theories of reading and spelling. The main purpose of inventing a writing system is for written communication, and the two skills closely related with a writing system are reading (from print to sound) and spelling (from sound to print), which are two important components of literacy abilities for both native speakers and L2 learners. The present thesis focuses on the development of Chinese literacy skills among CSL learners, and the general research on literacy skills in L2 learners is based on studies conducted with native speakers. Therefore, relevant theories of reading and spelling are reviewed in this section.

2.3.1 Theories of reading

Reading is a process that relies on an individual's cognitive abilities to decode print to sounds. There is a large volume of published studies exploring the reading process. It has been generally accepted that phonology plays an important role in the process of encoding print for the purpose of reading (Coltheart, 2006; McBride-Chang, 1995; Perfetti, Zhang, & Berent, 1992; Snowling & Hulme, 2008), even though the precise nature of phonological activation in reading is still debated (Leinenger, 2014). Several attempts have been made to propose theories to account for the reading process, such as the Dual Route Model (Coltheart, Rastle, Perry, Langdon, & Ziegler, 2001) that emphasizes the alternative activation of phonological and orthographic routes in word reading, the Universal Phonological Principle (Perfetti et al., 1992) that proposes the universal function of phonological activation in word recognition across different writing systems, Orthography Depth Hypothesis (Katz & Frost, 1992) that assumes that the strategy in decoding words differs across the depth of orthography used in the language, and the Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005) that argues for the importance of phonological awareness for the literacy skills and the developmental path of phonological awareness. One of the goals of the present thesis is to explore the development of Chinese phonological awareness and the contribution of phonological awareness to the acquisition of Pinyin and Hanzi literacy skills, therefore, the Psycholinguistic Grain Size theory is reviewed here.

The Psycholinguistic Grain Size Theory was proposed by Ziegler and Goswami (2005). Language has units of different grain sizes, the largest one is syllable, followed by onset and rhyme or body and coda, and the smallest is phoneme. Languages differ in the salient psycholinguistic grain size depending on the syllabic structure. Onset and rhyme are salient grain sizes in Chinese and English, yet body and coda are salient in Arabic.

According to this theory, there are three major problems posing a challenge to learning to read for beginning readers. The first is the **availability problem**, “not all phonological units are consciously (explicitly) accessible prior to reading” (p.3). For instance, English-speaking pre-school children have relatively good syllable awareness, yet poorer phoneme awareness. Thus, syllable awareness, not phoneme awareness, could be considered available for the English children prior to the start of formal reading education (Liberman, Shankweiler, Fischer, & Carter, 1974). The second is the **consistency problem**, not all print-sound correspondences are consistent. The grapheme-phoneme correspondence in English is such a typical example. Take <a> for example, its mapping onto phoneme is not consistent as it could represent different phonemes such as /ei/, /ə/, /æ/, /ɑ/ and /ɔ/. The third is the **granularity problem**, “there are many more orthographic units to learn when access to the phonological system is based on bigger grain sizes as opposed to smaller grain sizes” (p.3). That is to say, the number of bigger grain sizes are more than that of smaller grain sizes. For instance, there are more rhyme and onset than there are phonemes in English. The three problems are depicted in Figure 2.2.

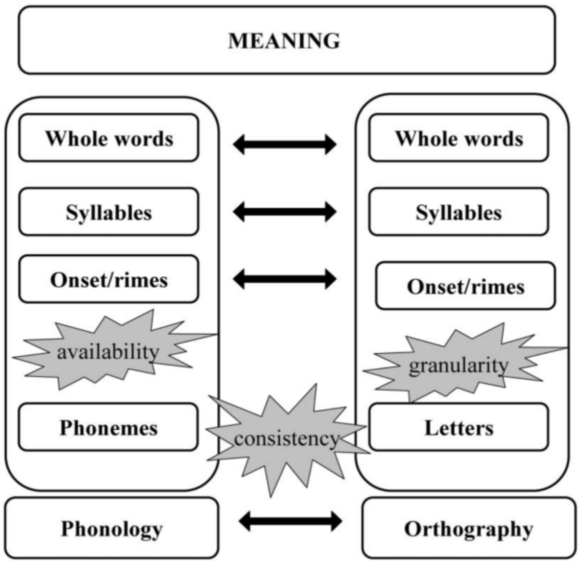

Figure 2.2 Schematic depiction of the three main problems of reading acquisition (Ziegler & Goswami, 2005, p. 4)

The degree of consistency of orthography-phonology correspondence leads to different reading strategies. Grapheme-phoneme decoding strategies at the smaller unit level are more reliable in reading orthographically consistent languages, yet recoding strategies at the larger unit level are also employed in reading orthographically inconsistent languages. Goswami et al. (2001) found a stronger effect of pseudohomophone among English children than in German children. English children demonstrated better performance in naming pseudohomophones (e.g. faik) than in orthographically control nonwords (e.g. daik), yet the German children showed similar performance in naming the two types of words, suggesting that English children using a deep orthography were more influenced by the phonological properties of whole-word in the task of reading pseudowords than their German counterparts, who use a relatively shallow orthography.

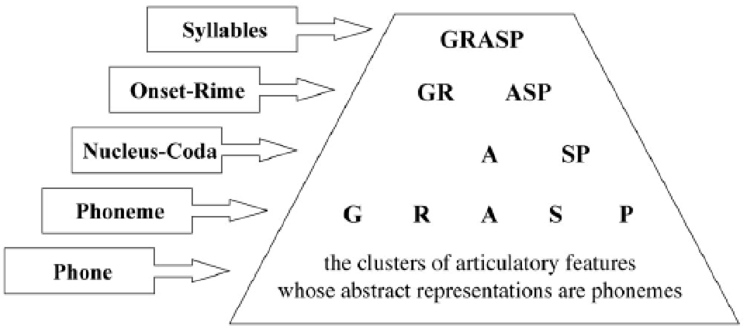

Figure 2.3 Depiction of different psycholinguistic grain sizes (Ziegler & Goswami, 2005, p. 5)

Ziegler & Goswami (2005) claimed that the development of phonological skills is essential for reading development. Phonological awareness, the ability to reflect upon and to manipulate the phonological structure of speech sounds, is an important skill in understanding the process of reading. The development of phonological awareness is supposed to follow a larger-to-smaller order (Figure 2.3). Children develop awareness of larger grain size such as the syllable before literacy, and then, after the introduction of literacy instruction, they further acquire awareness of smaller grain size units such as the phoneme. This theory has been tested in different languages and orthographies using different tasks, and has generated uniform results supporting the developmental order (Goswami, 2005), which will be illustrated in detail later.

The development of phonological awareness is likely to be influenced by orthography experience. On the one hand, prior to receiving training in using an orthography, an individual could be able to manipulate only the large grain size such as syllable, as reported in studies in non-literate people, but an individual's sensitivity to smaller grain size develops after receiving training in using an orthography (Lukatela, Carello, Shankweiler, & Liberman, 1995; Morais, Cary, Alegria, & Bertelson, 1979; Schaadt, Pannekamp, & van der Meer, 2013). On the other hand, phonological awareness performance could be influenced by the characteristics of the acquired orthography. For instance, English speakers encountered more difficulty in judging two rhyming words with different spellings (e.g. *dye-lie*) than when the rhymes share the same spelling (e.g. *die-lie*) (Seidenberg & Tanenhaus, 1979).

The importance of phonological awareness differs across different writing systems. One general acknowledgment is that phonological awareness is more important for alphabetic languages than for graphic orthography such as Hanzi (Bus & Van IJzendoorn, 1999; McBride-Chang, Cho, et al., 2005; Melby-Lervåg, Lyster, & Hulme, 2012; Song, Georgiou, Su, & Hua, 2015; Swanson, Trainin, Necoechea, & Hammill, 2003). In addition, different types of phonological awareness predict the skills in reading different languages. For example, phonemic awareness closely relate with the reading performance in alphabetic languages such as Spanish, English, Portuguese (Gottardo, Pasquarella, Chen, & Ramirez, 2015; Melby-Lervåg et al., 2012), yet syllable and tone awareness predict the performance in reading Hanzi (Li, Shu, McBride-Chang, Liu, & Peng, 2012; McBride-Chang, Chow, Zhong, Burgess, & Hayward, 2005; Shu, Peng, & McBride-Chang, 2008; Tong, 2008).

2.3.2 Theories of spelling

Compared with research on reading, the number of studies on spelling is limited, and no specific theory has been proposed about Hanzi writing. Thus the theories of spelling in alphabetic and morphosyllabic writing systems are discussed together. Spelling is an activity to transfer sound to print, and the successful spelling production could be achieved via different routes, sublexical or lexical routes. Bonin et al. (2001) and Tainturier and Rapp (2001) illustrated how the sublexical (phonology-orthography correspondence) and lexical route (whole word) work in the spelling process. The sublexcial route employs a phonology-to-orthography conversion system, and involves multiple stages in spelling unfamiliar words or regular words (Figure 2.4).

> 1. the acoustic/phonological analysis of the spoken unit, and its segmentation into smaller units (i.e., phonemes, syllables, or other functional units);
> 2. the conversion of each phonological unit into a corresponding orthographic unit;
> 3. the assembling of these orthographic units into a correctly sequenced abstract letter string. (Tainturier & Rapp, 2001, pp. 263-264)

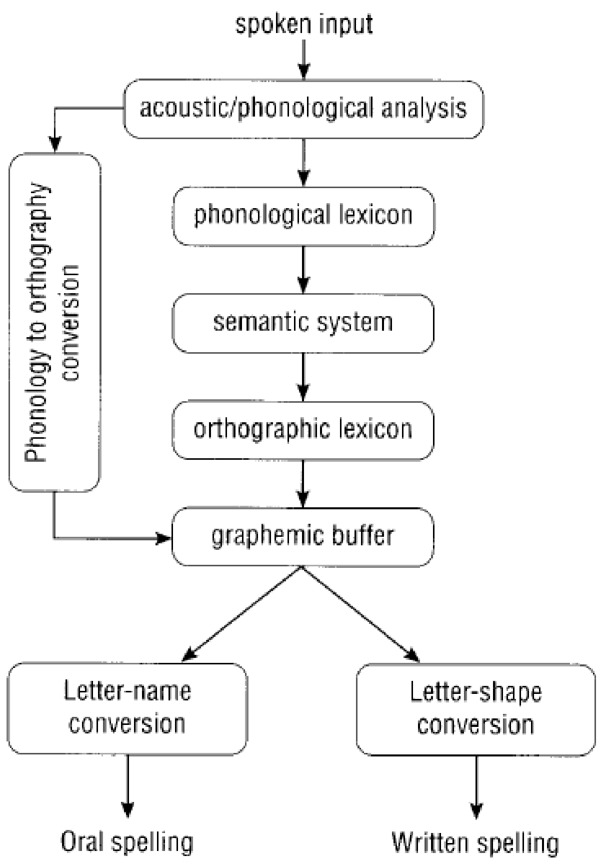

Figure 2.4 A functional architecture of the spelling system (Tainturier & Rapp, 2001, pp. 263-264)

The lexical route indicates the direct mapping between phonological lexicon to grapheme output, and it is assumed to function in the process of spelling familiar words, especially irregular words. The application of lexical route in the task of spelling might be influenced by phonological constraints, such as the homophone density of the target word.

The reliance on lexical and sublexical route differs depending on the task used to measure spelling. Bonin, Meot, Lagarrigue, and Roux (2015) compared the tasks of written naming (write down the words from the pictures), spelling to dictation (write down the words from spoken presentation) and copying (write down the words from visual presentation) among adult French speakers. The results suggested that all the three tasks involve lexical route, but the task of spelling to dictation depends more on sublexical route than the other two tasks. The homophone errors were observed only to occur in the task of spelling to dictation, indicating the influence of phonological information on the production at the grapheme level.

The role of phonology in the production of spelling is still debated, some studies have revealed the involvement of phonology in written production at the lexical and sublexical level, as illustrated in obligatory phonological median hypothesis, and this has been evidenced in a large number of studies (Rapp, Benzing, & Caramazza, 1997). This hypothesis has also been confirmed in studies involving Chinese Hanzi by Wang and Zhang (2015) in the task of writing from pictures, and by Qu, Damian, Zhang, and Zhu (2011) using priming techniques. However, research also shows that phonological information is not necessarily activated to access the orthographic code in the task of writing, termed as "orthographic autonomy hypothesis" (Rapp et al., 1997). Rapp, Benzing and Caramazza (1997) provided ample evidence regarding how orthographic activation takes place without the mediation of phonological information. Research on Hanzi writing demonstrates more supporting evidence for the independent role of orthographic information in facilitating the written production (Han, Zhang, Shu, & Bi, 2007; Law, Yeung, Wong, & Chiu, 2005; Zhang

& Wang, 2016). In sum, both phonological and orthographic information could facilitate the production of spelling.

2.3.3 Section summary

This section summarized relevant theories of reading and spelling. Phonological information appears to be more important in the task of reading, in which phonological activation is considered as a universal principle across different writing systems, than in the task of spelling, in which phonological activation is not obligatory. In addition, the importance of phonological processing skill differs across different writing systems. The approaches and theories reviewed above could provide a theoretical context for understanding the role of phonological information in learning Pinyin and Hanzi for CSL learners because Pinyin and Hanzi are different writing systems.

To understand the role of phonological awareness and phonetic radical awareness in the development of literacy skills in English and Chinese, relevant studies carried out among English- and Chinese-speaking children are reviewed. Although the present study focuses on the acquisition of alphabetic Pinyin and logographic Hanzi in Chinese among the Arabic and English CSL learners, relevant studies in children could provide insightful implications for the present study, just as the common practice of referring to literature in children by SLA researchers. It has been generally acknowledged that L2 learning could be influenced by both inter-language and intra-language factors. The developmental studies in children could help us understand the role of intra-language factors in the acquisition of literacy skills, such as the significant relationship between phonological awareness and reading skill in English and Chinese.

2.4 Previous research on phonological awareness, reading and spelling in alphabetic writing systems

One of the main goals of the present study is to explore the relationships between phonological awareness and Pinyin and Hanzi literacy skills and the influence of L1 background on these relationships among the Arabic and English CSL learners. Therefore, to provide a context for the present thesis, relevant studies that explored the roles of phonological awareness in reading and spelling alphabetic languages and Chinese among native speakers are reviewed in this section. As noted in the above sections, phonological awareness is one of the most important processing skills for the development of literacy skills in alphabetic languages for native speakers. Its power in predicting reading and spelling abilities has been documented in a large and growing volume of published studies. The development of phonological awareness, and the relationships between phonological awareness and reading and spelling skills in alphabetic languages, especially English, are reviewed below.

2.4.1 Development of phonological awareness

The theoretical framework of Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005) proposes that the development of phonological awareness follows a big-to-small trajectory. To be specific, syllable awareness develops earlier than onset-rhyme awareness, which in turn precedes phoneme awareness. The syllable is the biggest phonological unit, and is the easiest to access. The grain size smaller than the syllable is the onset and rhyme in some language such as English and Chinese, whereas the body and coda units are salient in other languages such as Arabic and Hebrew. The smallest grain size is phoneme, the basic phonological unit in alphabetic languages. This developmental path of phonological awareness has been confirmed in English. The English-speaking kindergarteners achieved higher accuracy rate in syllable awareness (48%) than in phoneme awareness (17%), so did the English-speaking first-graders (syllable awareness, 90%; phoneme awareness, 70%) (Liberman et al., 1974). Though results of phonological awareness tests might be subject to the type of task (Anthony et al., 2002; Yopp, 1988), the performance in larger phonological units is consistently found to be better than that in smaller units when the task demands are controlled for (Goswami & East, 2000; Hulme et al., 2002; Nation & Hulme, 1997). For instance, Hulme et al. (2002) administered three tasks (detection, oddity and deletion) at the onset-rhyme and phoneme level among English-speaking kindergartners. These children showed lower scores in phoneme measures (initial phoneme, 47%; final phoneme, 11%) than in onset-rhyme measures (60%) in the oddity task, and similar results were found in other two tasks. Similar results were reported in another large-scale study involving more than 1,000 English-speaking children aged between 24 to 72 months (Anthony, Lonigan, Driscoll, Phillips, & Burgess, 2003).

The development of phonological sensitivity to the smaller grain size such as phoneme relies on literacy instruction. The ability to detect the smaller grain size as a psycholinguistic unit does not develop automatically as one gets older, whereas it largely depends on explicit training, as revealed by studies comparing the performance in phoneme-level between the literate and non-literate people. Non-literate adults demonstrate poorer performance in tasks at the phonemic level such as phoneme counting, phoneme deletion and phoneme discrimination (Lukatela et al., 1995; Morais et al., 1979; Schaadt et al., 2013). For example, Morais et al. (1979) found that the literate group significantly outperformed the non-literate group in the tasks of addition and deletion (addition, 91% vs. 46%; deletion, 87% vs. 26%). Children's ability to manipulate phonemes increases greatly from kindergarten to first grade, largely due to the beneficial effect of formal literacy instruction in primary school, as reported in different languages, such as Turkish, Italian, Greek, French and English (Cossu, Shankweiler, Liberman, Katz, & Tola, 1988; Demont & Gombert, 1996; Durgunoğlu & Öney, 1999; Harris & Hatano, 1999; Liberman et al., 1974). For instance, Durgunoğlu & Öney (1999) measured Turkish-speaking children's performance in syllable and phoneme awareness. The kindergartener and first-graders performed similarly in syllable awareness measured by the task of tapping (93.50% vs. 97.50%), but the first-graders achieved higher scores in phoneme awareness in the task of phoneme tapping (94% vs. 67.23%) and initial phoneme deletion (92.50% vs. 43.08%) than did the kindergarteners.

Readers using different orthographies tend to perform differently in specific levels of phonological awareness because of the influence of syllable structures and orthography depth. For example, Italian children outperform English children in syllable and phoneme awareness (Cossu et al., 1988). Turkish (94%), Italian (80%) and Greek (85%) kindergartners showed much better performance in syllable awareness than their English (69%) and French (48%) counterparts (Ziegler & Goswami, 2005). The results are in line with the syllable structure and the consistency of grapheme-phoneme correspondence in L1 orthography. Turkish, Italian and Greek have a simple syllable structure and shallow orthography, in which the grapheme-phoneme mapping is consistent. In contrast, French and English have a relatively complex syllable structure, and the grapheme-phoneme relationship is very inconsistent.

To sum up, the development of the subcomponents of phonological awareness follows a big-to-small pattern, and readers of different languages are likely to demonstrate different performance at specific levels of phonological awareness depending on the salient grain size in the language. The transition from shallow awareness of bigger grain size to deep awareness of smaller grain size could be facilitated by formal literacy education, as evidenced in studies involving first-graders vs. kindergarteners. Based on these studies reviewed above, it could be inferred that the normal adult English CSL learners have developed awareness of syllable, onset, rhyme and phoneme, yet their Arabic counterparts demonstrate awareness of syllable, body, coda and phoneme because English and Arabic differ in syllabic structure.

2.4.2 Phonological awareness and reading

The close relationship of phonological awareness with word recognition skills has been widely acknowledged across different sound-based writing systems in previous research (Adams, 1994; Bradley & Bryant, 1983; Brady & Shankweiler, 1991; Goswami & Bryant, 1990; Wagner & Torgesen, 1987; Wagner, Torgesen, & Rashotte, 1994; Wijayathilake &

Parrila, 2014; Ziegler et al., 2010). The importance of phonological awareness lies in its predictive role in reading ability among the children learning their mother tongues. In general, it is widely believed that better phonological awareness leads to easier access to the rudimentary phonological units of a language, which in turn makes the learning of the orthography-phonology mapping possible and efficient.

Several meta-analytic studies have been conducted to explore the effect size of phonological awareness on English reading skills. One meta-analytic study addressing the effects of phonological awareness training on reading skills found that phonological awareness accounted for about 12% of the variance in word recognition (Bus & Van IJzendoorn, 1999). Another study by Swanson et al. (2003) used the results obtained from 35 independent samples and concluded that the correlation between phonological awareness and real-word reading is moderate (r=.51). Existing studies reveal that phonological awareness is undoubtedly important to English reading (Hulme & Snowling, 2013), yet its power in explaining the variance in English reading skills is not so strong. As Swanson et al. (2003) stated that "the importance of…phonological awareness measures in accounting for reading performance has been overstated" (p.407) because other cognitive skills such as rapid naming exert similar influence in reading. As for the effect size of different levels of phonological awareness on English reading, Melby-Lervåg et al. (2012) found that phonological awareness at phoneme level showed the highest correlation with English reading (r=0.57), and that the effect size of rhyme awareness on reading was moderate (r=0.43). To conclude, the association between phonological awareness and English word reading is moderately strong, and the different levels of phonological awareness show different effect sizes for reading performance.

The relationship between phonological awareness and reading has also been investigated among Arabic readers. The performance in Arabic phonological awareness predicts the achievements in reading Arabic words and non-words among students from kindergarten to high school (Al Ghanem & Kearns, 2014). Phonological awareness measured by different tasks such as phoneme deletion, oddity, isolation and deletion, and phoneme counting remarkably related with the performance in reading vowelized Arabic word and non-word, with a correlation coefficient ranging from 0.40 to 0.85 (Abu-Rabia, 1995; Tibi, Park, Ho, & Lombardino, 2013). The highest correlation coefficient (r=0.85) was observed between a phoneme segmentation task and the word reading skills. The results of regression analyses further revealed that phonological awareness tasks predicted about 25% of the variances in vowelized word reading, with visual processing and rapid automatic naming skills statistically controlled for (Smythe et al., 2008). Similar results were observed in the studies examining unvowelized word and non-word reading (Elbeheri & Everatt, 2007; Ibrahim, Eviatar, & Aharon-Peretz, 2007).

Supporting evidence for the significance of phonological awareness for the development of reading skills has also been reported in other sound-based writing systems, such as French (Plaza & Cohen, 2007), Spanish (Manrique & Signorini, 1994), Greek (Aidinis & Nunes, 2001), Thai (Wei, 2005), Japanese Kana (Yoshida, 2005), Korean (McBride-Chang, Cho, et al., 2005) and Indonesian (Winskel & Widjaja, 2007). In sum, the importance of phonological awareness for the development of reading abilities is general across various alphabetic languages.

2.4.3 Phonological awareness and spelling

Apart from reading skills, the development of spelling capabilities is also observed to be influenced by phonological awareness. The positive contribution of phonological awareness to spelling performance was first studied among users of alphabetic writing systems. One of the pioneering studies conducted by Read (1975) pointed out that children's knowledge of the categorization of speech sounds was the basis for their invented spellings. For instance, one common error type in children's invented spellings was using a letter with similar pronunciation as the target vowel to substitute the vowel, such as using letter <e> for vowel /i/ in spelling <ship> as <sep>. Wade-Woolley and Siegel (1997) found that the correlation between phoneme awareness and real word spelling (*r*=0.67) was significantly strong among English-speaking children. Niolaki and Masterson (2012) further reported that phonological awareness accounted for 15% of the variance in spelling among English-speaking children.

Supporting evidence for the strong association between phonological awareness and spelling skill comes from several cross-language studies. Caravolas (2004) compared the spelling development among Czech-, English- and French-speaking children, and found that phonological awareness was one common core component underlying the development of spelling skill in all three languages. Moll et al. (2014) explored the correlation between phonological awareness and literacy skills among children using different alphabetic orthographies, such as English, German, Hungarian and Finnish. The results revealed that children's performance on phonological awareness accounted for significant amounts of the variances in spelling performance (4.1%-8.9%). A study conducted among Arabic-speaking children provided further evidence. Phonological awareness measured by the task of word and non-word rhyming accounted for about 8.6% of the variance in Arabic spelling performances among the children from grade 1 to 3 (al Mannai & Everatt, 2005). Similar findings were observed in Persian-speaking children (Rahbari, Sénéchal, & Arab-Moghaddam, 2007). These results suggest that the importance of phonological awareness holds across different alphabetic writing systems.

To conclude, the success in reading and spelling tasks in sound-based writing systems heavily depends on the readers' perception of the segmental properties of the languages. One of the crucial stages in reading and spelling processes in alphabetic languages is the conversion between grapheme and phoneme, which is closely linked with the phonological structure of the spoken syllable. Success in perceiving and manipulating the phonological units contributes to the understanding of orthography-phonology mapping, which in turn leads to better performance in the task of decoding the print and writing-to-dictation.

2.4.4 Section summary

Based on the studies reviewed above on the development of phonological awareness, and the contributions of phonological awareness to reading and spelling skills in alphabetic writing systems, it could be inferred that the normal adult English and Arabic speakers could have developed phonological awareness at both large and small grain size levels, and might have realized the contribution of phonological awareness to reading and spelling in their native languages prior to the start of Chinese language learning, which might influence their perception of the relationship between phonological awareness and Pinyin and Hanzi learning in the process of Chinese language learning, which is to be addressed in the present thesis.

After reviewing studies on phonological awareness, reading and spelling in alphabetic writing systems, next section will turn to the development of reading and spelling skills in Hanzi, and the relevant cognitive factors such as phonological awareness and phonetic radical awareness.

2.5 Previous research on phonological awareness, phonetic radical awareness and Chinese literacy skills

As mentioned above, the links between phonological awareness and literacy skills have been explored in different languages, and the strong predictive power of phonological awareness in the development of reading and spelling in alphabetic writing systems has been widely accepted. It is known that Chinese Hanzi is traditionally considered as a logographic writing system, with huge differences from the alphabetic orthographies. The question as to what cognitive correlates determine the development of Hanzi reading skills has attracted a large number of researchers to conduct studies to answer this question. The general answer is that Chinese phonological awareness is important for Hanzi reading, yet its predictive power is less strong (Song et al., 2015). More importantly, awareness of the phonetic radical is crucial for Hanzi reading. Pinyin is also a widely used writing system in Chinese, and it is a must-learn component before starting formal literacy education for Chinese-speaking children in mainland China. Thus, in this section, research on phonological awareness, phonetic radical awareness as well as the literacy skills in Hanzi and Pinyin among Chinese-speaking children is briefly reviewed.

2.5.1 Phonological awareness and Chinese literacy skills

Similar to English phonological awareness, Chinese phonological awareness also includes different levels. The largest level is the syllable, followed by onset-rhyme, and the smallest level is the phoneme. However, Chinese phonological awareness includes another suprasegmental level different from English phonological awareness, and that is lexical tone. Therefore, Chinese phonological awareness consists of syllable awareness, onset awareness, rhyme awareness, phoneme awareness and tone awareness.

Development of Chinese phonological awareness

This section focuses on two issues, one is about the developmental order of the different levels of Chinese phonological awareness, and another one is about the role of Pinyin learning in the development of Chinese phonological awareness.

Developmental order of the subcomponents of Chinese phonological awareness

According to the Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005), the development rate of the subcomponents of phonological awareness is different. The larger unit develops earlier than the smaller unit. The developmental path for Chinese phonological awareness appears to be consistent with this theory, i.e., syllable awareness develops earlier than onset-rhyme awareness and phoneme awareness, yet the results of the development of tone awareness are not consistent (McBride-Chang et al., 2008; Shu et al., 2008; Tong, 2008; Yeh, 2012). Hong Kong children with an average age of 61.24 months performed much better in the task of syllable deletion (75.07%) and tone detection(73.04%) than in onset deletion (4.06%) (McBride-Chang et al., 2008). Kindergartners (aged between 39 and 71 months) in Beijing consistently demonstrated higher accuracy rate in the task of syllable detection (0.74 to 0.89) than in the task of onset and rhyme detection (0.28 to 0.64), with the performance in the task of tone detection lying in between (0.37 to 0.55) (Shu et al., 2008). Similar results were found in Taiwan children (aged 6;7), who showed better performance in syllable awareness than onset, rhyme, tone and phoneme awareness in both detection (83% vs. 59%, 65%, 47%, 45%) and production tasks (78% vs. 48%, 57%, 56%, 29%). However, Tong (2008) found that kindergartners (mean age = 5.89 years) and second graders (mean age=8.09 years) in Hong Kong performed better in the measures of tone detection (51.65%; 82.99%) than in syllable and onset (46.94%; 70.37%), and rhyme deletion (18.56%; 53.06%). Likewise, the first, second and fifth graders in a primary school in Beijing developed tone awareness (0.78, 0.87, 0.88) earlier than onset (0.55, 0.80, 0.85), rhyme (0.51, 0.66, 0.76) and phoneme awareness (0.47, 0.60, 0.73) (Xu, Dong, Yang, & Wang, 2004). The earlier development of tone skills was highlighted in a study by Zhu and Dodd (2000) who administered a picture-naming and picture-description task among children aged from 1;6 to 4;6 in Beijing. The analysis of the children's errors suggested that tones were acquired first, followed by rhymes, and onsets. These conflicting results suggest that the general development of syllable, onset, rhyme and phoneme awareness in Chinese follows the large-to-small path, yet the development rate of tone awareness is still unclear.

Table 2.6

Phonological Saliency Analysis of the Components of Chinese Syllable

	Status in the syllable	Ability to distinguish lexical meaning	Number of permissible choices
Tone	Compulsory	Strong	4
Rhyme	Compulsory	Strong	39
Onset	Optional	Strong	21
Phoneme	Compulsory	Weak	28

The earlier development of tone than onset and rhyme in Chinese could be accounted for by another theory in relation to phonological saliency (See Table 2.6) (Zhu & Dodd, 2000). The phonological saliency of a phonological component is determined by its status in the syllable structure, its ability to distinguish lexical meaning and the number of permissible choices within a component. For example, tone has the highest phonological saliency in Chinese because it is compulsory for each syllable. Same syllable with different tones represent different meanings, and it has only four alternative choices. In terms of the status in a Chinese syllable, onset is optional, but tone, rhyme and phoneme are compulsory. In terms of the ability to differentiate the lexical meaning, tone is the strongest, followed by rhyme and onset, and phoneme. Tone is the most salient feature in Chinese and different tones convey different meanings. Tone cannot be pronounced alone and has to be attached to a rhyme, making the rhyme more salient than the onset. The phoneme is the smallest unit in distinguishing the lexical meaning and its ability to do so is also the weakest. As for the number of permissible options, tone has only four, rhyme has 39, onset has 23 and phoneme has 28 options. Therefore, it could be said that tone has the most phonological saliency, followed by rhyme, onset and phoneme, which might relate with the developmental order of the subcomponents of Chinese phonological awareness.

Chinese phonological awareness and Pinyin

Although Chinese speakers use Hanzi as the dominant writing system, they are still required to learn Pinyin before starting to learn Hanzi. Pinyin is a must-learn subject in kindergarten and primary school. The main role of Pinyin in Chinese reading is to help children learn Chinese phonology and pronunciation of unfamiliar Hanzi. Some studies have focused on the role of Pinyin in the development of phonological awareness. Pinyin learning is generally considered to be an advantage for developing phonological awareness among the Chinese-speaking children.

Pinyin learning experience could lead to good performance in phonological processing skills. An early study compared the segmentation performance in spoken words among

Chinese adults who knew only Hanzi and those who knew both Hanzi and Pinyin (Read, Yun-Fei, Hong-Yin, & Bao-Qing, 1986). The participants heard a Chinese syllable and then were asked to add or delete a single consonant at the beginning of the syllable. Adults literate only in Hanzi performed much less well than those literate in both Hanzi and Pinyin. The experience of Pinyin learning was proposed to account for the differences in performing phonological tasks. The positive role of learning Pinyin in performing phonological tasks is also observed among children. Pinyin skills (Pinyin dictation and writing Hanzi according to Pinyin) uniquely accounted for 46% of the variance in Chinese phonological awareness among primary school students at grades 1, 3 and 5. (Xu & Ren, 2004). Lin et al. (2010) found that early Pinyin spelling skills (β=0.20) significantly predicted later performance in vocabulary reading among the kindergarteners aged 77 months in Beijing. Ding, Liu, McBride, and Zhang (2014) also reported a significant correlation between the performance in invented spelling and Chinese phonological awareness test such as syllable and phoneme deletion (r=0.43). It is not surprising to find that Pinyin spelling skills demonstrate a close relationship with Chinese phonological awareness, given that Pinyin is an alphabetic writing system, and that phonological awareness is a good predictor in spelling skills in alphabetic languages, as reviewed in earlier sections.

The experience of Pinyin learning significantly contributes to the development of phonological awareness. Shu et al. (2008) compared the phonological awareness among children in kindergarten (aged between 39 to 71 months) and first grade (aged between 72 to 90 months). They found that first-grade students achieved better performance on onset and tone awareness than kindergarteners did, but first-graders and kindergarteners did not differ in syllable and rhyme awareness. The researchers attributed the first-graders' advantage in onset and tone awareness to the formal Pinyin instruction they received from the first grade. Similar results were reported in a teaching experiment (Ren, Xu, & Zhang, 2006), in which the experimental group learned Pinyin, while the control group did not.

Phonological awareness tests were administered at the beginning of the term and at the end of the academic year. The Pinyin group outperformed the control group in onset and rhyme awareness in the second test, further confirming that Pinyin learning is beneficial for the growth of Chinese phonological awareness.

More evidence comes from cross-area studies among children who were instructed in Pinyin for literacy and those who did not learn Pinyin. In mainland China, literacy education in kindergartens and primary schools is carried out in both Pinyin and Hanzi, while literacy teaching in Hong Kong is administered via Hanzi, not Pinyin. It has been found that children receiving Pinyin instruction achieve better performance in phonological tasks than those without Pinyin learning experience. One study compared the children from Xi'an (Mainland China) and Hong Kong, Hong Kong children consistently performed better in Chinese word recognition than children from Xi'an, yet Xi'an children outperformed Hong Kong children in the tasks of syllable and onset phoneme deletion (McBride-Chang, Bialystok, Chong, & Li, 2004). Another study compared the children from Beijing and Hong Kong, the Beijing group outperformed the Hong Kong group on pseudo-word reading and on all the measures of phonological awareness such as rhyme detection, initial, medial and final phoneme deletion. The Pinyin advantage in Chinese phonological awareness was also observed among Guangzhou children, who speak the same language (Cantonese) as Hong Kong children, but they also speak Mandarin and learn Pinyin (Cheung, Chen, Lai, Wong, & Hills, 2001). Both Hong Kong kindergarteners with a mean age of 48.8 months and Guangzhou kindergarteners with a mean age of 50.8 months achieved similar performance at each level of Chinese phonological awareness, but Guangzhou children performed better in phonological awareness at onset and coda levels than Hong Kong counterparts. In conclusion, the experience of learning Pinyin has significantly positive effects on the development of Chinese phonological awareness at different levels.

Chinese phonological awareness, Hanzi reading and Hanzi writing skills

Since the early studies on Chinese phonological awareness (Ho, 1989; Huang & Hanley, 1995, 1997), observations of significant and non-significant correlations between phonological awareness tasks and Hanzi reading performances have been reported (Chung, McBride-Chang, Cheung, & Wong, 2013; Ho, 2006; Huang & Hanley, 1995; Keung & Ho, 2009; Li, Shu, McBride‐Chang, Liu, & Peng, 2012; McBride-Chang et al., 2008; Siok & Fletcher, 2001; So & Siegel, 1997). Some studies have not found a significant relationship between phonological awareness and Chinese reading ability. Instead, morphological awareness and visual-orthographic skills (Tong & McBride-Chang, 2010), visual skills (Huang & Hanley, 1995; Siok & Fletcher, 2001) appear to be uniquely associated with Hanzi reading. Some research (Huang & Hanley, 1995, 1997; Yeh, 2012) finds that phonological awareness is related to Hanzi reading, but its importance becomes weaker or even nonsignificant when relevant variables such as IQ, visual ability and pre-reading ability are controlled in regression analyses. For example, Huang and Hanley (1995) investigated the relationship between phonological awareness and Chinese reading among students aged between 8 and 9 years in primary school in Hong Kong and Taiwan. Scores in Hanzi naming and Chinese vocabulary were significantly correlated with phonological awareness, with the correlation ranging from 0.40 to 0.55. However, phonological awareness lost its power in predicting Hanzi reading when vocabulary scores were included in the regression analyses. Huang and Hanley (1995, 1997) concluded that phonological awareness was not primary source for the development of Hanzi reading skills. The observed weak or non-significant relationship between phonological awareness and Hanzi reading skills was mainly explained from the perspective of the deep orthography of Hanzi, which does not utilize clear orthography-phonology correspondence for the phonological representation.

A large number of studies still have reported significant correlation between phonological awareness and Hanzi reading among Chinese-speaking children. Siok and Fletcher (2001) carried out a cross-grade study in primary school children (aged 6;5 to 11;0).

A regression analysis test revealed that the odd-man-out task in phonological awareness was the only significant predictor of single Hanzi and word reading skills after controlling for intelligence. However, the positive contribution of the oddity test to Chinese reading was only observed among 2^{nd} (aged 7;10) and 5^{th} grade (aged 11;0). Shu et al. (2008) examined the role of phonological awareness in Hanzi recognition among children from K1 (aged between 40 and 47 months) to K3 in kindergarten (aged between 60 to 78 months). They found that children's performance in tone detection and syllable deletion tasks independently accounted for variances in Hanzi recognition. In both models, syllable deletion and tone detection contributed unique 7%, 3% of the variance in Hanzi recognition, respectively.

The relationship between the different levels of phonological awareness and Hanzi reading skills might be mediated by age. Li et. al (2012) found a significant correlation between syllable awareness and Hanzi recognition (r=.45) among kindergarteners (aged between 4.84 and 5.76 years), and a significant correlation between rhyme awareness and Hanzi recognition (r=.32) among primary school children (aged between 6.91 and 8.90 years). Another longitudinal study found that the predictive power of Chinese children's performance in syllable deletion in Hanzi recognition and dictation gradually increases with children' age from 7- to 10-years-old (Pan et al., 2011). It seems that the importance of phonological awareness in Hanzi reading varies according to the readers' age or maturity, which could relate to the children's better performance in phonological awareness and Hanzi reading skills as they receive more literacy instruction, or the children's development of phonetic radical awareness that is supposed to link the phonological awareness and Hanzi reading (Ho & Bryant, 1997b).

A recent study (Song et al., 2015) explored the effect size of phonological awareness on Chinese reading using a meta-analysis method. This study included 51 independent samples from 35 studies, and reported a coefficient of 0.36 between phonological awareness and Hanzi reading, which was not influenced by any moderator, including age/grade, test complexity or dialect. The weak correlation between phonological awareness and Hanzi reading mainly depends on the nature of Hanzi orthography. An individual Hanzi corresponds to a syllable, yet the strokes or radicals in Hanzi do not map onto the phonological units of a syllable, such as onset, rhyme or tone.

Unlike the importance of phonological awareness for spelling skills in alphabetic languages, phonological awareness is not essential for Hanzi writing. The relationship between phonological awareness and Hanzi writing skills has not been widely investigated. Yeung et al. (2011) measured the role of Chinese phonological awareness in Hanzi writing to dictation among first-graders with a mean age of 6;7 in Hong Kong. Their results showed that though phonological awareness correlated with Hanzi writing (r=0.21), its predictive power was not significant in the model that included orthographic skills and morphological awareness. Similar results were reported in a recent study by Liu, Chen, and Wang (2016) in the Hong Kong children. The weak correlation between phonological awareness and Hanzi writing skills largely lies in the lack of grapheme-phoneme mapping in Chinese Hanzi. In the task of writing Hanzi to dictation, the transformation from phonological input to orthographic output does not depend on the conversion from phoneme to grapheme because no orthographic unit in Hanzi corresponds to the phonological unit in speech. Therefore, the ability to manipulate the phonological structure of Chinese syllable appears to be less important than orthographic awareness for the production of Hanzi writing.

To conclude, the development of Chinese phonological awareness appears to follow a large-to-small pattern, and the experience of learning Pinyin is beneficial for the growth of phonological sensitivity to the smaller grain size. In addition, phonological awareness is important for the acquisition of Chinse literacy skills, yet it is more important for Hanzi reading than for Hanzi writing.

A majority of Hanzi are composed of a semantic radical and a phonetic radical. Being aware of the relationship between phonetic radical and Hanzi is also very important for the development of Hanzi reading skill. Therefore, next section continues to review some studies on phonetic radical awareness.

2.5.2 Phonetic radical awareness and Chinese literacy skills

Phonetic radical awareness is another important type of skills for Hanzi recognition for native Chinese speakers and CSL learners. One goal of the present study is to investigate the relationships between phonetic radical awareness and Hanzi reading and Hanzi writing skills, and the influence of L1 background on these relationships. Therefore, the review in this section focuses on the contribution of phonetic radical awareness to Hanzi reading and Hanzi writing among native Chinese speakers.

Phonetic radical awareness

Different from phonological awareness which operates on the level of phonological structure of spoken language, phonetic radical awareness in Hanzi means the knowledge of and the ability to manipulate the functional and positional information of phonetic radical in Hanzi, known as phonetic awareness (Shu, Anderson, & Wu, 2000) or phonetic principle (Anderson, Li, Ku, Shu, & Wu, 2003) in other studies. Phonetic radical awareness is used in the current research, as it directly indicates the issue to be addressed in the present study, and it corresponds to the term "phonological awareness". Phonetic radical awareness in Hanzi includes several different levels, and regularity awareness and position awareness are reviewed in this study.

First, regularity awareness of phonetic radical is introduced. As discussed in the earlier section on Hanzi orthography, not all phonetic radicals represent the full phonological information of Hanzi, and there are three categories of semantic-phonetic Hanzi: regular, semiregular and irregular. It has generally been agreed that regular semantic-phonetic Hanzi are easier for recognition than semi-regular and irregular ones, termed as regularity effect. Studies have reported significantly different performance in processing these three types of Hanzi. In the task of Hanzi naming, the accuracy rate is higher and the reaction time is shorter in naming regular Hanzi than semi-regular and irregular Hanzi (Cai, Qi, Chen, & Zhong, 2012; Ho & Bryant, 1997a; Shu & Anderson, 1999; Shu, Bi, & Wu, 2003).

Regularity awareness means being aware of the limited role phonetic radical plays in providing the pronunciation of Hanzi. Becoming aware of the regularity effect of phonetic radicals is essential for the development of Hanzi recognition skills. Shu and her colleagues explored this issue in a series of studies (Shu & Anderson, 1999; Shu, Anderson, et al., 2000; Shu & Zeng, 1996; Shu, Zhou, & Wu, 2000). They found that phonetic-radical awareness developed as children gained more exposure to Hanzi learning. For instance, in the task of writing down the pronunciation for Hanzi (Shu, Anderson, et al., 2000), a robust familiarity by type (regular vs. irregular) interaction was found in the primary school students. The difference in the accuracy rates in reading regular vs. irregular Hanzi was smaller when the stimuli were familiar Hanzi than that when the stimuli were unfamiliar, indicating that participants might make use of phonetic radical to access the phonological information of both regular and irregular Hanzi. In addition, the fourth- (accuracy rate = .25) and sixth-grade (accuracy rate =.26) children showed greater differences in accuracy rates in reading regular vs. irregular Hanzi than the second-grade children (accuracy rate =.14), suggesting that the children in higher grades were more influenced by the phonetic radical in reading Hanzi. In another task, the participants were required to judge whether a pair of Hanzi were homophones (tone not included) (Shu, Zhou, & Wu, 2000). The university students (accuracy rate =.26, .57) showed higher accuracy rates when a pair of Hanzi had the same phonetic radical and the same pronunciation, as well as when a pair of Hanzi had the same phonetic radical but different pronunciations, in comparison to the fourth (accuracy rate =.34, .40), sixth (accuracy rate =.36, .44) and the eighth (accuracy rate =.28, .41) graders. Shu and her colleagues concluded that Chinese readers developed and got refined sensitivity to the functional properties of phonetic radical in reading Hanzi as they got more literacy instruction, and gradually realized the limited role phonetic radical played in retrieving the phonological representation of Hanzi.

Chinese children’s reliance on phonetic radicals to access the pronunciation of Hanzi could be reflected by the errors in Hanzi recognition. Two types of common errors are identified in Hanzi naming (Shu & Anderson, 1999; Shu & Zeng, 1996). The first type is **regularity errors**. Some Chinese readers use the phonetic radical to name the pronunciation of the irregular Hanzi. For example, the pronunciation of 琼 is < qióng >, and the pronunciation of its phonetic radical 京 is < jīng >. Some children read 琼 as 京. The second type is **analogy errors**. Some Chinese readers use the pronunciation of a familiar Hanzi with the same phonetic radical to represent the pronunciation of the target Hanzi. For example, 陪 (<péi >, to accompany) and 掊 (<póu >, to dig with hand) share the same phonetic radical but have different pronunciations. Some children read 掊 as < péi > because 陪 is more frequently used than 掊. Shu and Zeng (1996) reported that the dominant errors in second graders were random errors, yet the regularity errors and analogy errors increased among the older children. In sixth graders, 33% of the errors were regularity errors and 19% were analogy errors. The change of error types in different grades clearly shows that the children rely more on the phonetic radical as they learn more Hanzi. The Chinese children’s sensitivity to the function of phonetic radicals leads to their dependence on phonetic radical to retrieve the phonological representation of Hanzi.

Another important part of phonetic radical awareness is the position awareness. In semantic-phonetic Hanzi, the general tendency is that a phonetic radical appears on the right-hand side. Thus, position awareness of Hanzi means being aware of the bias of positional distribution of the phonetic radical in Hanzi. Research has found that Chinese readers are sensitive to radicals in specific positions in recognizing Hanzi. The sensitive positions include the right-side radical in Hanzi with left-right structure (Shen, Pan, & Chen, 1998; Yu, 1998; Yu, Cao, Feng, & Li, 1990), and the phonetic radicals on the right-side may provide more sensitive phonological cues for Hanzi readers. Taft et al. (1999) found that response times in naming Hanzi whose radicals could be repositioned to form another Hanzi (杏-呆) were longer than in those whose radicals cannot be repositioned (寻), confirming the existence of activation of the positional features of phonetic radical in Hanzi recognition. Another study used priming technique to explore this issue (Ding, Peng, & Taft, 2004). The priming effect took place when the Hanzi prime and the target Hanzi had the same phonetic radical in the same position, for example 种 (zhǒng)-钟 (zhōng). However, the priming effect disappeared when the same phonetic radical was placed at different positions, such as 钟 (zhōng)-衷 (zhōng). The results suggest that the position of phonetic radicals is embedded in the mental representation of Hanzi, and the unique positional information of the phonetic radical plays an important part in the processing of Hanzi recognition.

Chinese children as young as five years old start to develop their sensitivity to the positional information of the phonetic radical in Hanzi. Yin and McBride (2015) found that Chinese pre-school children's awareness of the positions of radicals in Hanzi emerged in 5-years-old. They assessed the children's sensitivity to phonetic radicals using a character-learning task that included pseudo-Hanzi and non-Hanzi with phonetic cues. The kindergarteners with a mean age of 5;5 reached the criterion of making five consecutive correct responses in learning these two groups of Hanzi, yet the children at the second year failed. The result suggests that Chinese children can make use of positional knowledge of phonetic radicals in reading Hanzi from the final stage of kindergarten (around 5 years old). As they advance in grades, their knowledge of the positional information of phonetic radicals improves (Ho, Ng, & Ng, 2003).

Chen, Shu, Wu, and Anderson (2003) proposed a model for the development of phonetic radical awareness in Hanzi recognition. They stated that "the pronunciation of a character is represented at two levels: at the sublexical level by the phonetic, and at the level of the phonetic family by the characters sharing the same phonetic" (p.121). For example, the pronunciation of 清 (qīng) is influenced not only by its phonetic radical 青 (qīng), but also other Hanzi that contain 青, such as 静 (jìng) and 情 (qíng). Children's awareness of phonetic radical develops in different stages. At the initial stage, children begin to know that the phonetic radical can represent the pronunciation of regular semantic-phonetic Hanzi, and may treat all semantic-phonetic Hanzi as regular ones. At a later stage, children overgeneralize the function of phonetic radicals in regular semantic-phonetic into irregular semantic-phonetic Hanzi, and use the partial information that the phonetic radicals provide to represent the pronunciation of Hanzi or to read unfamiliar Hanzi by analogy with familiar Hanzi with same phonetic radicals (e.g. reading 清, 静, 情 as 青). In the next stage, as children gain more experience in Hanzi, they gradually realize the limitations of phonetic radicals in representing the phonological information of Hanzi, and the differences between regular between regular and irregular semantic-phonetic Hanzi.

Phonetic radical awareness and Hanzi reading

Radicals have been acknowledged as one of the processing units in Hanzi recognition (Chen, Allport, & Marshall, 1996; Peng & Wang, 1997; Tsang & Chen, 2009; Zhou & Marslen-Wilson, 1999). As the only available phonological cue in Hanzi, the phonetic radical is crucial for retrieving the pronunciation of Hanzi. In the Interactive Constituency Model of Chinese Character Identification (Perfetti & Tan, 1999), both the phonology arising from Hanzi and the phonetic radical are important for activating the phonological representation of Hanzi. The influence of radical phonology depends on the phonological links between the Hanzi and the phonetic radical. If the phonetic radical and the whole Hanzi share the same pronunciation, then facilitation occurs. If the phonetic radical and the whole Hanzi have different pronunciations, then competition rather than facilitation is evident.

Several studies have investigated the correlation between phonetic radical awareness and Hanzi recognition skills. Ho et al. (2003) examined the relationship between various types of knowledge of phonetic radicals and Chinese word reading proficiency among the primary schoolchildren aged between 7;2 to 11;0. The radical position judgment task was used to measure children's explicit positional knowledge of phonetic radicals, the phonological-relatedness judgment task tested the children's knowledge of the function of phonetic radicals, and pseudo-Hanzi naming task explored the children's overall knowledge of phonetic radicals. These tasks, apart from the radical position judgement task, were found to be significantly associated with Chinese word reading skills, with correlation coefficients ranging from 0.32 to 0.70. However, significant correlations were found between general radical position awareness and Hanzi readings skills among Chinese-speaking in Mainland China and those in Canada (Luo, Chen, Deacon, & Li, 2011). A subsequent study by Yin and McBride (2015) among Mandarin-speaking kindergartners aged between 4;1 and 5;5 further revealed that the children's sensitivity to the functional and positional properties of phonetic radicals tested at an early time explained unique variances in Chinese word reading skills tested one year later. Yeung, Ho, Chan, and Chung (2016)further found that the second graders' (Mean age=8.09 years) performance in phonetic radical awareness (measured by pseudo-Hanzi naming) significantly predicted the scores in Hanzi reading and Hanzi writing in second grade (reading: β=0.25; writing: β=0.19) and fourth grade (reading: β=0.11; writing: β=0.11) in Hong Kong.

To sum up, the significance of phonetic radicals lies in the link between their phonological properties and the sound of Hanzi. Although such links are often vague and cannot be relied upon under all circumstances, the phonetic radical is still a vital orthographic unit in processing Hanzi and of great importance for the teaching and learning of Hanzi.

As mentioned above, Hanzi reading depends on phonological awareness and phonetic radical awareness. The question then arises as to the relationship between phonological awareness and phonetic radical awareness in Hanzi recognition. One possible path be the phonetic radical, which is the only phonological cue in Hanzi. Ho and Bryant (1997b) explored this issue among Hong Kong children aged between 3;4 and 5;3, and found that rhyme-tone detection measures significantly predicted pseudo-Hanzi reading (evidence for children's use of phonetic radicals), and pseudo-Hanzi reading significantly correlated with Chinese word reading. When the pseudo-Hanzi reading was controlled for, children's performance in word reading was still predicted by rhyme-tone detection measures ($\triangle F$=5.32, $\triangle r^2$ = .082, p < .05), yet its predictive power appeared weaker compared with that when pseudo-Hanzi reading was not controlled. The researchers concluded that "at least to some extent, the link between phonological skills and reading Chinese is through the use of the character's phonetic component in reading" (p.950). Similarly, another study by Ho and Bryant (1997a) in Hong Kong children found that the correlation between rhyme detection and Hanzi reading disappeared in the regression model where the pseudo-Hanzi reading ability was controlled for. These findings suggest that phonetic radical could be the possible bridge that links phonological awareness with the performance in reading compound Hanzi among the native Chinese speakers.

Radical awareness and Hanzi writing

Compared with the numerous studies on Hanzi reading carried out among the Chinese speakers, the amount of research on Hanzi writing is limited. One of the central issues in investigating Hanzi writing is to explore the cognitive predictors related to Hanzi production skills, similar to the topic of the predictors in Hanzi reading. The strong association between orthographic skills and Hanzi writing has been observed in several studies. Yeung et al. (2011) and Yeung, Ho, Chan, and Chung (2013) carried out a study among Hong Kong children aged between 7.08 and 9.94 years old to explore the predictors related to Hanzi writing. They measured orthographic skills using a pseudo-Hanzi meaning judgement task that was adapted to test the children's overall knowledge of semantic radicals. The orthographic skills contributed a significant amount of unique variance to Hanzi writing performance. Another study conducted by Wang, Yin, and McBride (2015) extended the study to kindergartners with a mean age of 5;2 years in Mainland China. Wang et al. reported that semantic radical knowledge tested at about 5 years old was predictive of the Hanzi writing skills one year later. Yin and McBride (2015) further demonstrated that Mandarin-speaking kindergartners' sensitivity to the functional and positional properties of phonetic radicals uniquely accounted for a significant amount of variance (4%) in word writing skills. Similarly, Shi, Li, Zhang, and Shu (2011) measured orthographic awareness using pseudo-Hanzi judgement among Chinese children in Beijing. Their study found that radical awareness strongly related to the performance in Hanzi writing at the time when the study was conducted, as well as the writing skills tested one year later. Yet, position awareness was not a significant predictor. However, a recent study by Liu, Chen and Wang (2016) did not find the significant prediction of orthographic knowledge in Hanzi writing among Hong Kong children with an average of 9.03 years. Taken together, most of the concurrent and longitudinal studies reveal that Hanzi writing skills are mainly associated with the abilities in processing the orthographic structure of Hanzi and radical knowledge.

2.5.3 Section summary

This section reviewed relevant studies on the development of Chinese phonological awareness and the contribution of Pinyin learning to Chinese phonological awareness, and the different importance of Chinese phonological awareness for Hanzi reading and Hanzi writing among native Chinese speakers. It could be inferred from these studies that Arabic and English CSL learners might show a similar bigger-to-smaller pattern in the developmental order of the subcomponents of Chinese phonological awareness as the Chinese-speaking children, and phonological awareness might demonstrate different strength in the correlations with Hanzi reading and Hanzi writing among the CSL learners. In addition, relevant research on phonetic radical awareness and its importance for Hanzi reading and Hanzi writing among the native Chinese speakers was summarized. It could be inferred from the above studies that the Arabic and English CSL learners could develop sensitivity to the functional and positional properties of phonetic radical in Hanzi as they are exposed to more Hanzi, and might rely on the phonetic radical to retrieve the phonological representation of Hanzi, and to aid the production of Hanzi writing.

2.6 Chapter summary

This chapter started with a brief introduction to writing systems and orthography, and the second section analyzed the similarities and differences in phonology and orthography between Chinese, Arabic and English, laying a foundation for our understanding of the three languages in the present thesis. The comparative analysis revealed more similarities between Chinese and English than between Chinese and Arabic, which might influence the performance in Chinese learning (e.g. phonological awareness and phonetic radical awareness, Pinyin and Hanzi literacy skills) in the Arabic and English CSL learners.

In the third section, theories of reading and spelling were briefly summarized. The Psycholinguistic Grain Size Theory on reading, the role of phonological information in reading Hanzi, and the phonological and orthographic routes in the process of spelling were reviewed, laying the theoretical foundation for our understanding of how phonological information works differently in reading and spelling in different writing systems.

The fourth section summarized research on the development of phonological awareness, and the contribution of phonological awareness to reading and spelling among the users of alphabetic writing systems. This section provided a context for how phonological awareness develops and how it facilitates the development of literacy skills in L1 among the Arabic and English CSL learners, helping us get insight into how Chinese phonological awareness relates to the spelling skills in alphabetic Pinyin among the CSL learners.

The fifth section focused on the development of Chinese phonological awareness and phonetic radical awareness in Hanzi, and how these two skills contribute to the acquisition of Hanzi reading and Hanzi writing among the native Chinese-speaking children. The studies reviewed in this section could cast light on the development of Chinese phonological awareness and phonetic radical awareness, and their relationships with Hanzi literacy skills among the Arabic and English CSL learners.

Chapter Three: Reading and Spelling in L2 Learners

The main goal of the present study is to explore how L1 background and other meta-linguistic and background variables influence the development of phonological awareness, phonetic radical awareness, and the literacy skills in Pinyin and Hanzi among the Arabic and English CSL learners. Therefore, to further set out the background for the present thesis, the review in this chapter focuses on the development of reading and spelling skills in L2 learners, ESL and CSL learners in particular. Relevant studies on ESL learners, especially Arabic and Chinese ESL learners, could provide insightful evidence for how L1 background influences the acquisition of L2 literacy skills and the interplay between Arabic, English and Chinese in the acquisition of second language. This chapter begins with an introduction about the influence of L1 on L2 learning and non-linguistic skills such as handwriting and drawing, then reviews research on L1 transfer to the acquisition of literacy skills in English and Chinese, and the role of other meta-linguistic and background variables in SLA. The research gap and research questions are set out at the end of the section.

3.1 Influence of L1 on L2 learning and non-linguistic skills

It is uncontroversial that there is an influence of L1 background at all linguistic levels in learning second language(see Odlin, 2013 for an overview). A learner’s L1 also influences some non-linguistic skills like handwriting and drawing, which are discussed separately below.

3.1.1 Influence of L1 on L2 learning

The influence of L1 on L2 learning has been well documented in extensive studies. The influence of L1 on acquiring a second language is referred as transfer. Transfer is a very important concept in the SLA research. In the 1950s, the concept of transfer was closely related to the theory of Contrastive Analysis (Lado, 1957), which placed the systematic comparison between L1 and L2 at the central part of language learning. Transfer from the

L1 may be positive or negative. Positive transfer occurs when the L1 and L2 are similar at certain linguistic levels, and L1 is beneficial for L2 learning. Negative transfer indicates the case where the L1 and L2 are different and the L1 is likely to cause difficulty and error in L2 learning. Though the distinction between positive and negative transfer is limited in explaining the L2 acquisition process, language transfer is still a resonant topic, and has been studied extensively. Irrespective of the debate regarding the role of L1 transfer in second language learning, "language transfer is indeed a real and central phenomenon that must be considered in any full account of the second language acquisition process" (Gass & Selinker, 1992, p. 7).

Language transfer from L1 to L2 occurs in learning spoken language as well as written language. As for the spoken language, the influence of the L1 has been observed in different aspects, such as phonological awareness (Chen, 2006; Durgunoğlu, Nagy, & Hancin-Bhatt, 1993; Luo, Chen, & Geva, 2014; Melby-Lervåg & Lervåg, 2011; Sun-Alperin & Wang, 2011), and reading strategies (Keung & Ho, 2009; Koda, 1988; Melby-Lervåg & Lervåg, 2011; Wang, Park, & Lee, 2006; Wang, Perfetti, & Liu, 2005). The influence of L1 orthography has also been reported in research on spelling and handwriting, such as how the orthographic depth in L1 affects the spelling skills in L2 (Bebout, 1985; Brown, 1970; Cook, 1997; Figueredo, 2006; Ibrahim, 1978; James, 1993; Wang & Geva, 2003b).

As for multilingual individuals who speak three or more languages, the transfer from L1 as well as L2 influence the acquisition of the target language. Phonology is a topic of interest for researchers in third language acquisition. Studies have found the influence of both L1 and L2 on the acquisition of L3 phonology (Hamarberg, 2001; Ringbom, 1987), yet whether L2 transfer occurs depends on the achievement of a threshold level of L2 proficiency (Tremblay, 2006).

Koda (2008) proposed a Transfer Facilitation Model to account for the influence of L1 transfer on L2 reading. This model comprises four main tenets. First, the development of L2 reading skills may be facilitated by language-independent metalinguistic awareness and abilities developed in L1. Second, the development of meta-linguistic awareness and subcomponents in L2 reading could be achieved with less amount of input and print exposure than those required in L1. Third, language distance influences how the transfer from meta-linguistic awareness and reading skills in L1 works in L2. Fourth, different L1 backgrounds lead to cross-language variations in L2 reading skills. Though this model only focuses on the role of L1 transfer in L2 reading, it is helpful for us to understand how L1 contributes to or inhibits the development of other literacy skills in L2, such as spelling.

The physical feature of the script used in L1 orthography is also likely to exert influence in the process of L2 handwriting (Nachshon, 1983; Shanon, 1979). For example, when writing lowercase “t” and uppercase “H”, American participants wrote the horizontal line from left to right, and the Israeli participants wrote from right to left (Shanon, 1979). In the task of writing uppercased letters “M”, “V”, “W” and “X”, Arabic and Hebrew users exhibited stronger right-to-left bias than English readers (Nachson, 1983). These findings suggest that the ESL learners transfer their handwriting habits in line direction in L1 to writing English alphabet letters.

To sum up, the transfer from L1 or other languages previously learnt to L2 has been observed at different levels, and the script used in L1 could also influence the L2 writing. The Transfer Facilitation Model on reading could provide implication for the L1-to-L2 transfer in other areas in SLA. In addition to L2 learning, the influence of L1 transfer has also been observed in the performance in non-linguistic tasks, which will be reviewed in the next section.

3.1.2 Influence of L1 on non-linguistic tasks

Hanzi is traditionally considered a logographic writing system, and users of alphabetic writing systems tend to process Hanzi as a picture (Yoon, Chung, Kim, Song, & Park, 2006). CSL learners, especially at the beginning stage, are more likely to construct Hanzi like drawing a picture. Meanwhile, L1 script has been reported to influence some non-linguistic tasks such as drawing, and the development of visual-spatial skills. Given that writing Hanzi is demanding in terms of visual-spatial skills (Liu et al., 2016; McBride-Chang, Chow, et al., 2005; Tavassoli, 2002), and English and Arabic scripts differ in visual complexity, differences in reading and writing Hanzi between the Arabic and English CSL learners might exist. Therefore, studies on how L1 script affects the performance in drawing and visual-spatial skills are reviewed.

Learning to read in different orthographies affects the development of visual-spatial skills. First, receiving formal literacy training is crucial for the development of visual-spatial skills. For example, Kolinsky, Morais, Content, and Cary (1987) explored the performance in the task of finding parts within figures among the non-literate adults, the pre-school kindergarteners aged between 50 and 70 months and the primary school students aged between 72 and 103 months in Belgium. The non-literate adults and the kindergarteners achieved similar performance, yet the primary school students who just started formal literacy education tended to achieve higher accuracy rate than the non-literate adults and the pre-school kindergarteners (Kolinsky et al., 1987), indicating the importance of literacy education for the growth of visual-spatial skills. Second, users of different orthographies tend to perform differently in visual-spatial tasks. Japanese speakers performed better in discriminating abstract figures than did the Spanish and Arabic participants (Brown & Haynes, 1985). Chinese students' better performance in the task of visual-spatial tasks in comparison to their Greek counterparts (Demetriou et al., 2005) was further corroborated in a study comparing users of four orthographies (McBride-Chang et al., 2011). Both the Hong Kong and Korean students outperformed the Spanish and Israeli students in the tasks of visual-spatial relationships test, yet no significant differences in the visual-spatial relationship test were found between the Hong Kong and Korean students or between the Spanish and Israeli students. It is believed that "the experience of learning to read different orthographies may differentially shape some aspects of visual spatial processing" (p.260). These findings suggest that users of alphabetic writing systems might demonstrate similar visual-spatial skills, irrespective of the writing directions in L1, such as left-to-right Spanish and right-to-left Israeli.

Contrary to the results of the study by McBride-Chang et al. (2011), script direction might influence its users' performance in drawing. In the task of drawing, the users of different scripts are likely to demonstrate a directional tendency corresponding to the direction in L1 script (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow et al., 1999; Shimrat, 1973; Vaid, 1995; Vaid et al., 2011). For instance, Arabic speakers are more likely to start drawing from the right side on the paper and draw the horizontal line from the right to left, whereas users of the Roman script such as English, French show the opposite pattern.

In summary, L1 script learning relates to the development of visual-spatial capabilities, which could further influence the behavior in drawing. Given the differences in visual complexity in Arabic and English scripts, and the similarity in perceiving Hanzi and picture for CSL learners with sound-based L1 background (Yoon et al., 2006), it could be inferred that the Arabic and English CSL learners might demonstrate differences in learning Hanzi, which is considered as a picture for the beginning CSL learners speaking alphabetic L1s.

3.1.3 Section summary

The above section briefly summarized studies on the influence of L1 transfer on spoken and written language in L2, and drawing and visual-spatial processing skills, laying a foundation for how L1 transfer influences learning Chinese among the Arabic and English CSL learners. The Transfer Facilitation Model (Koda, 2008) could serve as the framework for accounting for the role of L1 transfer in learning Chinese as a second language. In the light of the differences in phonological and orthographic properties in English and Arabic, these studies might indicate different performances in Chinese learning among the English and Arabic CSL learners.

3.2 Previous research on cross-language transfer in ESL learning

The influence of cross-language transfer on ESL learning has been extensively documented in numerous studies. The relationship between phonological awareness and literacy skills among ESL learners, and the impact of language transfer on English phonological awareness, reading and spelling are briefly reviewed here, to set out a background for the present thesis.

3.2.1 Phonological awareness and literacy skills among ESL learners

A large amount of research has explored the relationship between phonological awareness and literacy skills among ESL learners with different L1 backgrounds. The close correlations between phonological awareness and English literacy skills have been reported among ESL learners speaking different L1s. McBride-Chang and Kail (2002), Keung and Ho (2009), Uchikoshi and Marinova-Todd (2012) and Yeung and Chan (2013) carried out studies among Cantonese-speaking children (aged between 3 to 6 years old) in Hong Kong, and they found that English phonological awareness measured at the levels of syllable, rhyme and phoneme, significantly correlated with the performance in English word reading. Sun, Zhou, and Zhu (2013) reported that English phonological awareness explained 59% and 40% of the variance of English non-word reading and English spelling among Mandarin-speaking students with a mean age of 6.6 years in Guangzhou. Furthermore, Gottardo et al. (2015) found that English phonological awareness significantly predicted the performance in English word reading at different time points, among ESL learners who spoke Chinese, Spanish or Portuguese as an L1. Zhao (2011) further revealed that the general models of the metalinguistic capabilities predicting English spelling performance were remarkably similar among the Chinese ESL learners and the native English speakers. These findings suggest that the awareness of and manipulation skills in relation to different levels of phonological structure in English are vital for the acquisition of English literacy skills for native speakers as well as the ESL learners. The unique features of the language to be learnt may determine the metalinguistic skills to be required.

The L1 background might influence the relationship between phonological awareness and English literacy skills. Zhao (2011) explored the predictive power of meta-linguistic awareness (phonological awareness, orthographic awareness and morphological awareness) in English spelling among Chinese ESL learners and native English speakers. The Chinese ESL learners demonstrated weaker reliance on phonological awareness in comparison to orthographic awareness in English spelling, yet the native English speakers showed opposite pattern. Zhao attributed this finding to the influence of Hanzi among the Chinese ESL learners, who might rely more on orthographic information, rather than phonology-orthography correspondence rule, in reading and writing Hanzi. However, the study by Gottardo et al. (2015) among the ESL learners who spoke Chinese, Spanish or Portuguese as an L1 did not find a clear influence of L1 background on the contribution of phonological awareness to English word reading. Therefore, more studies are needed to explore whether the predictive power of phonological awareness in literacy skills remains stable across L2 learners with different L1 backgrounds.

The studies mentioned above imply that Chinese phonological awareness could also be important for the CSL learners to acquire Pinyin literacy skills because both Pinyin and English are alphabetic, and they are relatively similar in terms of phonology and orthography. It could also be inferred that Chinese phonological awareness is crucial for the development of Hanzi reading skills among the Arabic and English CSL learners, as shown by the similar patterns of phonological awareness and English literacy skills observed in native English speakers and ESL learners, as well as the significant correlation between phonological awareness and Hanzi reading among the native Chinese speakers. In addition, the importance of phonological awareness for Pinyin and Hanzi learning might be different across the English and Arabic CSL learners because English and Arabic differ in orthographic properties.

Although the influence of L1 background on the relationship between phonological awareness and literacy skills among the ESL learners is still unclear, studies have revealed that ESL learners speaking different L1s are likely to demonstrate differences in English phonological awareness, which will be reviewed below.

3.2.2 Cross-language transfer in English phonological awareness

A large and growing body of literature has reported the influence of L1 transfer on the development of English phonological awareness among ESL learners with different L1 backgrounds. Here the influence of transfer from Arabic and Chinese on learning English phonological skills are briefly reviewed. The Arabic and Chinese ESL learners are selected because studies involving Arabic speakers could help us understand how Arabic CSL learners acquire Pinyin due to the similarity in Pinyin and English, and, likewise, the research in Chinese speakers might be useful for our understanding of how English CSL learners learn Pinyin.

Arabic ESL learners

To the best of the author's knowledge, no studies have explored how transfer from Arabic may influence the development of the subcomponents of English phonological awareness among Arabic ESL learners. However, research dealing with the influence of Arabic on the acquisition of English phonology may provide insights into how Arabic ESL learners learn English phonological skills. One of the main findings is that Arabic ESL learners achieve poor performance in the tasks of vowel acquisition (Ryan & Meara, 1991; Saigh & Schmitt, 2012). In one study conducted by Ryan and Meara (1991), Arabic-speaking participants were presented with a word (e.g. *department*) for a short time and then presented with the same word (e.g. *department*) or an altered word with one vowel removed from the word displayed before (e.g. *dpartment*), and then they were required to make same-different judgment about the two words. The Arabic ESL learners made more errors (17.23% vs.

5.26%) and spent more time (3916 vs. 1815 milliseconds) on making same-different decisions compared with speakers of non-Arabic languages, and the Arabic ESL learners' poor performance was attributed to their limited exposure to vowels in their native language.

In another study by Saigh and Schmitt (2012), the materials used in the task were sentences, containing a correct target word (e.g. *department*), or a target word with a missing vowel (e.g. *dpartment*) or misspelt letter (e.g. *debartment*). The Arabic ESL learners were asked to judge whether the target word was correct; if the target word was wrong, they were required to write the correct spelling. The participants performed better on long vowels than on short vowels, and the effects of vowel length on the tasks of noticing and recalling were significant. The results were explained in terms of the transfer from Arabic phonology and orthography. Arabic has only six vowels. The short vowels are always omitted, but the long vowels are kept in written Arabic. However, neither short nor long vowels in English can be omitted. In sum, the limited exposure to vowels in L1 could be the main reason for the Arabic ESL learners' poor development of the sensitivity to English vowels.

Contrary to Arabic, the Chinese language has a large vowel repertoire, similar to English. Chinese ESL learners' performance in English phonological awareness has also been observed to be influenced by the phonological characteristics in Chinese.

Chinese ESL learners

Chinese ESL learners' performance in English phonological awareness has been found to be influenced by the unique phonological features of Chinese. As outlined in earlier sections, Chinese has a simple onset-rhyme syllabic structure, and syllable, not phoneme, is a salient grain size in Chinese. In contrast, English has a very complex onset-rhyme syllabic structure and the sensitivity to phonemes is essential for the development of English literacy skills. Chinese ESL learners tend to demonstrate better performance in tasks of syllable awareness and rhyme awareness than in phoneme awareness. This finding has been reported in studies involving Hong Kong children who do not learn any alphabetic writing system in native language (Cheung et al., 2001; Keung & Ho, 2009; McBride-Chang et al., 2004; McBride-Chang, Cheung, Chow, Chow, & Choi, 2006; Yeung & Chan, 2013), Taiwan children who use Zhuyin Fuhao (Yang, 2009) and Mainland children who use alphabetic Pinyin to learn Chinese (Chen, Xu, Nguyen, Hong, & Wang, 2010; McBride-Chang et al., 2004; Sun et al., 2013). Chinese ESL learners' poor performance in phoneme awareness was corroborated in a study that reported the Korean (alphabetic) ESL learners' better performance in phoneme deletion than that of Chinese ESL learners (Wang, Koda, & Perfetti, 2003). These results indicate that the insalient status of phoneme in Chinese could be the main reason leading to the Chinese ESL learners' poorer performance in the ability to distinguish and manipulate English phonemes.

The influence of Chinese on Chinese ESL learners' phonological awareness, syllable and onset awareness in particular, has also been found in two experimental studies by Chen et al. (2010) and Sun et al. (2013). These two empirical studies revealed that the training on English phonological awareness was more helpful for the development of syllable and phoneme awareness, not rhyme awareness, for Chinese ESL learners, indicating the difficulty in processing English syllable and phoneme, which are more complex than those in Chinese.

To summarize, Chinese ESL learners are likely to demonstrate different performance at different levels of English phonological awareness, influenced by the similarities and differences between Chinese and English, and syllable and phoneme awareness pose greater challenges for Chinese ESL learners than does rhyme awareness. Based on the reviewed studies above on the performance in English phonological awareness among the Arabic and Chinese ESL learners, it could be implied that the Arabic CSL learners could encounter similar problems in learning the vowels and rhymes in Chinese, yet the English CSL learners might have fewer difficulties in acquiring Chinese phonological awareness due to the similarity in phonological properties between Chinese and English and the simple structure of Chinese syllable.

Following the review of the influence of cross-language transfer on the development of English phonological awareness, the next section turns to how L1 background influences English reading among ESL learners.

3.2.3 Cross-language transfer in English reading

The orthography in different languages has been found to influence the ESL learners' performance in English word reading. Numerous studies have been carried out among ESL learners speaking a variety of first languages. Relevant research that compared the ESL learners using logographic languages and alphabetic languages is briefly reviewed here. The general finding of these studies is that ESL learners from logographic language backgrounds depend more on the orthographic or visual route to access English words, whereas those from alphabetic language backgrounds rely more on phonological information in English word naming.

Different reading strategies in English have been found among the Japanese, Spanish and Arabic ESL learners. Brown and Haynes (1985) found that Spanish and Arabic ESL learners were faster in processing pseudo words that could be regularly prounceable than their Japanese counterparts. Koda (1988) examined the performance in lexical decision making between these ESL learners using two types of words (real word vs. pseudohomophone (e.g. *rain* and *rane*), and pseudohomophone vs. nonsense yet pronounceable word (e.g. *rane* and *tane*). The Japanese ESL learners showed significantly greater differences in processing speed across the two types of words than the Arabic and Spanish ESL learners. A subsequent study by Koda (1989) reported that the Japanese participants demonstrated better performance in the task of recalling unpronounceable words than phonologically similar words, whereas the opposite pattern was observed in the Spanish and Arabic participants. These findings suggest ESL learners with L1 morphosyllabic writing system (Hanzi/Kanji) background may rely more on visual strategy in English word reading, and they are more influenced by the visual information in the words. On the contrary, ESL learners with alphabetic L1 background demonstrate heavier dependence on phonological information in processing English words.

The studies reviewed above involving Spanish and Arabic ESL learners did not report significant differences in English word reading between the two groups. This implies that the Arabic and English CSL learners might not differ in Hanzi reading because both Arabic and English are alphabetic, yet Hanzi is morphosyllabic.

English spelling has also been found to be influenced by L1 background among the ESL learners, and this will be reviewed among the Arabic and Chinese ESL learners to provide background for the tests with Arabic and English CSL learners' performance in Pinyin spelling.

3.2.4 Cross-language transfer in English spelling

Cross-language transfer, either positive or negative, from the L1 has been found to influence the spelling in L2. According to a review of 27 studies, both positive and negative transfer were found in 15 studies, only positive transfer was found in eight studies, only negative transfer was found in three studies, and one study reported no transfer (Figueredo, 2006). The influence of L1 transfer on spelling has been reported among ESL learners using similar alphabet writing systems, such as Welsh (James, 1993), Spanish (Bebout, 1985; Ferroli & Shanahan, 1992; Raynolds, Uhry, & Brunner, 2013) and German (Luelsdorff, 1986). The influence of transfer from L1 on L2 learning could come from differences in phonological features as well as orthographic depth. The influence of L1 transfer from Arabic and Chinese to English spelling is briefly reviewed below.

Arabic ESL learners

Transfer from Arabic to English spelling is observed to occur at both consonants and vowels. In terms of consonants, one common error made by Arabic ESL learners is substituting /p/ with /b/. This is because only /b/ exists in Arabic while both /b/ and /p/ are present in English. Ibrahim (1978) found that Arabic ESL learners tended to use <b> to <p> in spelling English words like <play> and caused errors like <blay>. Allaith (2009) and Allaith and Joshi (2011) further compared young Arabic ESL learners' and English-speaking children's spelling performance in /b/-/p/, and found that more substitution errors arose in the Arabic group. The confusion between /b/ and /p/ was confirmed in another study among Arabic ESL learners studying in a British university (Saigh & Schmitt, 2012). Another difficulty with English consonant spelling among Arabic ESL learners is consonant clustering at the end of the word (Ibrahim, 1978; Saigh & Schmitt, 2012). As noted earlier, Arabic phonology does not allow final consonant clusters, thus Arabic-speakers may often insert a vowel between the last two consonants to make it sound more like a syllable, such as <communisem> for <communism>, <partener> for <partner>.

The errors in vowels mainly arise from the fact that Arabic has a small inventory of vowels, as noted in Chapter 2. Many English vowels are not present in Arabic, and they are likely to cause confusion with some similar phonemes such as /i/-/e/, /u:/-/ɔ:/, and /u/-/o/-/ɔ/ (Saigh & Schmitt, 2012; Thompson-Panos & Thomas-Ružić, 1983). For Arabic speakers, /o/ and /ɔ/ sound like allophones or phoneme variants of /u/. In addition, some Arabic dialects only have /o/, yet English has /ou/ and /ɔ/. This may account for the fact that Arabic ESL learners have difficulties in writing <hall> in place of <whole>, or wrote <coast> to substitute <cost> (Ibrahim, 1978). The small number of vowels in Arabic appears to make Arabic ESL learners rely more on consonants in English spelling, and this leads to random choice of vowels in English spelling, such as the errors <hobet>, <hapet>, <hibet> for spelling <habit> (Saigh & Schmitt, 2012).

The relatively shallow orthography of Arabic and the deep orthography in English may also account for spelling errors with English vowels (Saigh & Schmitt, 2012; Thompson-Panos & Thomas-Ružić, 1983). Arabic has a one-to-one GPC in consonants and vowels, therefore, Arabic ESL learners may tend to rely on one-to-one sound-letter correspondence in English spelling, leading to errors like <absolotly>, <captin>, <regon> in which Arabic speakers omitted vowels that are used to represent the target phoneme (Saigh & Schmitt, 2012).

In sum, the influence of transfer from Arabic on English spelling could take place on consonant and vowel, and the Arabic ESL learners' poor performance in English spelling is related to the differences in phonological and orthographic properties between Arabic and English. It could be inferred from these findings that the Arabic CSL learners might encounter similar problems in spelling Chinese Pinyin, given the similarity between Pinyin and English.

Chinese ESL learners

Similar to the influence of Arabic on English spelling, the impact of Chinese on English spelling among Chinese ESL learners has also been found in spelling consonant and vowel.

Errors are observed in the spelling of English consonants that are not present in Chinese, such as /θ/, /ʃ/ and /ð/. Cantonese-speaking ESL children in Canada were found to demonstrate difficulties in spelling words with these phonemes such as <ship>, <thick> and <teeth> (Wang & Geva, 2003a), and they were likely to use <s> or <z> to replace <θ>. Similarly, He (2001) found confusion between /ʃ/ and /ð/ among adult ESL learners in mainland China, and substitution errors between /s/-/ʃ/, /d/-/ð/. Errors in consonant spelling also happen at the final position of English syllable, largely due to the different endings of the syllable in Chinese and English. In Chinese, only /n/ and /ŋ/ can occur at the final position following the main vowel, yet more consonants are allowed in the same position in English. This might lead to Chinese ESL learners' omission of the consonant at the end of a syllable, such as <caugh> for <caught>, <offen> for <offend> (He, 2001).

One common type of error in vowel spelling is the omission of the silent letter <e> (He, 2001). The potential explanation is that every letter representing a vowel in Chinese Pinyin matches a sound, and one-to-one correspondence exists between the grapheme and the vowel. That is to say, letter <e> is always pronounced, and silent <e> does not exist in Chinese Pinyin. Chinese ESL learners' dependence on the spelling strategy in Chinese Pinyin may be the main reason for the error of omitting silent letter <e> in English.

Chinese ESL learners might use more visual strategies in spelling English, arguably because of the influence of Hanzi. Using visual strategy, Chinese ESL learners tend to process English words as a whole orthographic unit rather than different phonological units. Wang and Geva (2003b) observed that Chinese ESL learners performed less well in spelling pseudo words than the native English speakers, yet the Chinese ESL learners outperformed the English speakers in the task involving visual presentation of orthographically legitimate and illegitimate letter strings, indicating that Chinese ESL learners rely more on visual strategy in spelling English words. Furthermore, Zhao (2011) reported that the relationship between orthographic awareness and English spelling was stronger in Chinese ESL learners (R^2=0.732) than it was in native English speakers (R^2=0.493). That is to say, Chinese ESL learners are likely to be influenced by the orthographic characteristics of Hanzi, and tend to rely on visual strategy, not phonological strategy, to process English spelling.

To conclude, the Chinese ESL learners' performance in English spelling relates to the phonological differences between English and Chinese, as well as the deep orthography of Hanzi. Considering Chinese ESL learners' reliance on orthographic skills in spelling English words, the Arabic and English CSL learners might rely on phonological information to achieve success in writing Hanzi due to the influence of alphabetic L1 background.

ESL learners' performance in English spelling is influenced not only by L1 background, but also the internal characteristics of English. Relevant studies comparing cross-language transfer and intra-lingual influence are reviewed below.

Cross-language transfer and intra-lingual influence

To determine whether the spelling performance of ESL learners is affected by cross-language transfer or by intra-lingual factors such as similarity in phonological perception, researchers have conducted studies among different L1 speakers.

The influence of both intra-language and cross-language factors have been found in previous studies. An earlier study by Oller and Ziahosseiny (1970) explored the error types in English spelling among users of Roman writing systems (such as Spanish, German and Slavic language) and users of Non-Roman writing systems (such as Chinese, Japanese and Arabic). The most frequent errors among the two groups could be accounted for by intra-lingual misperceptions. For instance, a typical error of this sort was <since> spelt as <sence> by speakers of Hebrew, Spanish, French, Japanese, etc., and this error could be caused by the phonological similarity in the pronunciations of the two words, rather than the influence of L1 background. There is still evidence indicating the influence of L1 transfer. On the one hand, the Roman group produced more spelling errors than the non-Roman group, probably due to the interference between English and other similar Roman writing systems such as Spanish and German. On the other hand, some errors were only observed among specific language speakers. For instance, <sens> for <since> by French speakers, <reiches> for <riches> by German speakers. Similarly, Cook (1997) found that the percentages and categories of the spelling errors were similar in English L1 children, English L1 adults and English L2 adults speaking different L1s, indicating the dominance of some universal processing problems in English spelling, such as vowel and consonant substitution, omission, insertion and transposition. However, the existence of cross-language transfer was still observed. For instance, confusion between /r/ and /l/ was only found among Japanese-speaking ESL learners.

The close relationship between English spelling performance and L1 transfer is clearly revealed in the study by Dixon, Zhao, and Joshi (2010). They compared the English spelling performance among young ESL learners (aged between 66 to 79 months) with logographic Chinese L1, alphabetic Malay L1 and syllabic Tamil L1 backgrounds, and found significant between-group differences. Tamil-speaking children produced the most errors in “major consonant omission and illegal substitution”, Malay-speaking children made the most errors in “vowel omission and substitution” and Chinese-speaking children committed most errors in “real-word substitution”. It is suggested that Chinese-speaking children’s experience in Hanzi leads to their reliance on visual processing strategies, making them less sensitive to phonological processing cues, while Malay-speaking children’s errors may reflect the fact that Malay only has a small inventory of simple vowels, and Tamil-speaking children’s dominant errors in consonants might relate to the fact that each consonant in Tamil contains an inherent vowel /a/. It is the unique features of L1 that might relate with the dominant errors in English spelling.

The influence of L1 transfer on English spelling has also been found in one study involving native speakers of Cantonese, Mandarin and Vietnamese. Holm and Dodd (1996) found that the Cantonese-speaking ESL learners made more errors in the task of nonword spelling than the Vietnamese and Mandarin ESL learners. The between-group differences were explained in terms of the phonological skills in L1 literacy. Cantonese speakers from Hong Kong with no experience of learning an L1 alphabetic writing system showed the poorest phonological awareness, and this could have caused their poor performance in nonword spelling. In contrast, Vietnamese and Chinese groups were exposed to an alphabetic writing system since childhood and had better phonological awareness, which in turn led to better performance in spelling tasks.

In conclusion, both similarities and differences have been found in ESL spelling performance among ESL learners with different L1 backgrounds. The similarities may be explained by the intra-lingual factors, and the differences could be caused by the transfer from L1. These studies indicate that the Arabic and English CSL learners might demonstrate both similarities and differences in Hanzi writing and Pinyin spelling. Similarities could be expected in tone spelling, and the difficulties are likely to take place in rhyme and onset spelling.

3.2.5 Section summary

This section summarized relevant research on the contribution of phonological awareness to English literacy skills, and the influence of cross-language transfer on phonological awareness, reading and spelling among ESL learners speaking Arabic, Chinese and other L1s. Phonological awareness has been found to demonstrate a close relationship with English literacy skills among ESL learners with different L1 backgrounds, which might be influenced by the nature of L1 writing system. The reading and spelling performance in English could be influenced by the L1 transfer at phonological level (e.g. consonant and vowel), orthographic level (e.g. orthography depth), as well as intra-language factors such as similar pronunciation. These studies imply that (1) Chinese phonological awareness might demonstrate significant correlations with Pinyin spelling and Hanzi reading among the Arabic and English CSL learners, and the effect size of these correlations might differ across the CSL learners' L1 backgrounds, and (2) the Arabic and English CSL learners might demonstrate similarities in Chinese phonological awareness and Chinese literacy skills such as Pinyin spelling, Hanzi reading and Hanzi writing due to the unique features of Chinese writing systems (e.g. tone and Hanzi), as well as differences owing to the dissimilarities in phonological and orthographic properties between Arabic and English.

After reviewing the influence of cross-language transfer on English learning, the following section will turn to the impact of L1 transfer on Chinese learning, with an aim to review relevant studies on Chinese phonological awareness, Pinyin spelling, phonetic radical awareness, Hanzi reading and Hanzi writing in CSL learners.

3.3 Previous research on cross-language transfer in CSL learning

In recent years, some researchers have turned their attention to learners of Chinese as a second language to explore how L1 background influences the acquisition of this logographic language. Though the number of relevant studies is still limited, the influence of L1 impact on Chinese language learning has been found at different levels, such as phonological awareness, Pinyin spelling, phonetic radical awareness, and Hanzi reading and Hanzi writing. Most of the research has been conducted between the CSL learners with Hanzi background and those with no Hanzi background. According to the existence of or contact with Hanzi, the L1 orthographies of CSL learners are traditionally classified into two groups. One is labelled as Hanzi group, including Japanese, Korean, Thai, Singaporean or Vietnamese where Hanzi are in common use in the mainstream writing system or once utilized as a writing system. Another is labelled as non-Hanzi group, in which Hanzi does not exist in the writing system, such as Indo-European languages. However, no study has investigated how transfer from two different scripts used in alphabetic languages such as Arabic and English works differently in Chinese learning. The goals of the present thesis are to explore the influence of L1 background on phonological awareness, Pinyin spelling, phonetic radical awareness and Hanzi learning among the Arabic and English CSL learners, therefore, relevant studies on these research areas are reviewed.

3.3.1 Chinese phonological awareness in CSL learners

The issue of Chinese phonological awareness among CSL learners is an under-studied area. Previous studies focused on the influence of L1 on the development of Chinese phonological awareness among CSL learners. However, the influence of L1 on the development of Chinese phonological awareness among the Arabic and English CSL learners and the relationship between Chinese phonological awareness and Chinese literacy skills among CSL learners have not been addressed. Therefore, relevant studies on these two topics are reviewed here.

Chinese phonological awareness and literacy skills in CSL learners

As reviewed in earlier sections, it has been widely acknowledged that phonological awareness closely relates with literacy skills in both alphabetic and morphosyllabic writing systems. However, few studies have explored the relationship between phonological awareness and Chinese literacy skills among the CSL learners. Tian (2003) investigated the relationship between phonological awareness and short-term memory of single Hanzi, and found that only syllable awareness significantly correlated with the performance in short-memory of Hanzi strings (r=.27). Zhang (2006) explored the contribution of training on phonological awareness to CSL learners' listening and reading skills. The training focused on syllable, onset, rhyme, phoneme and tone. The experimental group outperformed the control group in the task of Pinyin dictation, indicating the importance of phonological awareness for Pinyin dictation skills.

The contribution of phonological processing skills to Chinese literacy skills might vary across the CSL learners' language backgrounds. Jiang (2003) explored the influence of L1 background on the relationship between phonological skills and the knowledge of Hanzi meaning among CSL learners with Hanzi and non-Hanzi backgrounds. The learners' phonological skills were assessed by the task of writing Pinyin for Hanzi, and the knowledge of Hanzi meaning was measured using the task of translating Hanzi into English. The strong association of knowing pronunciation and knowing meaning was only found in non-Hanzi CSL learners, consistent with the finding observed among the English-speaking CSL learners (Everson, 1998). Jiang concluded that CSL learners with sound-based writing system backgrounds might rely on the phonological route to encode the meaning of Hanzi, being influenced by the phonological nature of their native writing system. In contrast, Japanese and Korean CSL learners possibly depended on orthographic route to access the semantics of Hanzi due to their large amount of exposure to Hanzi in their L1 orthographies.

Taken together, it still remains unknown how CSL learners' phonological awareness contributes to the learning of Pinyin and Hanzi, which is an important issue that has been extensively studied among native speakers of English and Chinese, and ESL learners. Understanding how Chinese phonological awareness associates with the acquisition of Pinyin and Hanzi and the influence of L1 background on these associations is important as they could help us gain insight into whether the importance of phonological awareness remains stable across native speakers and L2 learners. Thus, the importance of phonological awareness for Pinyin and Hanzi learning and the influence of L1 background on their relationships among the Arabic and English CSL learners are two of the problems to be addressed in the present thesis.

Although the influence of L1 background on the contribution of Chinese phonological awareness to the acquisition of literacy skills has not been found among CSL learners, yet it has been observed that L1 background might impact the development of Chinese phonological awareness, which will be reviewed in next section.

Developmental order of the subcomponents of Chinese phonological awareness

Whether CSL learners with different L1 backgrounds demonstrate similar developmental trajectory in Chinese phonological awareness is still unclear. Some studies find a similar developmental pattern among CSL learners speaking different L1s. Using different methods such as oddity test, rhyming and alliteration, the developmental path of different levels of Chinese phonological awareness appears to follow the order of "tone > rhyme > onset > phoneme". This has been found among CSL learners with different L1s, such as Korean and non-Korean (Gao & Gao, 2005; Gao, 2001; Shao, 2007).

Some studies demonstrate that the developmental path of Chinese phonological awareness varies according to L1 background. Japanese and Southeast-Asian CSL learners showed similar patterns (onset/rhyme > phoneme > syllable), while European-American learners had a different path (syllable/phonemic > onset/rhyme awareness) (Tian, 2003). In addition, "onset > rhyme > tone" path was found among Thai samples, "onset/rhyme> tone" path emerged from the non-Thai group (Wu, 2008), "onset > tone > rhyme" pattern was observed in Indonesian samples (Shao, 2007). Another interesting finding is that no differences were found between different levels of phonological awareness among Russian samples (Shao, 2007). Yet, it still remains unknown how the different development patterns of Chinese phonological awareness demonstrated by the CSL learners relate to their native language background because a comprehensive comparative analysis of Chinese and the CSL learners' first languages was not carried out. Based on the analysis of phonological and orthographic properties in Arabic, English and Chinese, the present thesis aims to explore this issue by examining the developmental order of the subcomponents of phonological awareness among the Arabic and English CSL learners.

Cross-language transfer in Chinese phonological awareness

The development of Chinese phonological awareness is found to be influenced by the CSL learners' L1 background. Below I discuss this according to different levels of Chinese phonological awareness-syllable, onset and rhyme, and tone awareness.

Syllable awareness. The status of the syllable in the L1 may affect CSL learners' performance in Chinese syllable awareness. For instance, a syllable disadvantage in phonological awareness was found among Japanese CSL learners (Gao, 2001; Tian, 2003). In a same-different syllable judgment task, the participants were required to decide whether a pair of audibly presented two-Hanzi words contained the same syllable. The Japanese group tended to produce more errors than European-American group (Tian, 2003). In the syllable judgment task the participants were required to judge whether a visually presented syllable was a real Chinese syllable or not, and the Japanese participants again consistently achieved poorer performance than the European-American and Southeast Asian groups (Gao, 2001; Tian, 2003) or the English and Korean groups (Gao, 2001). The Japanese CSL learners' disadvantage in syllable awareness may be due to the dominance of syllable in Japanese in comparison to the European-American group whose L1s demonstrate an onset-rhyme syllabic structure.

Onset and rhyme awareness. The CSL learners' performance in onset and rhyme awareness may also be influenced by the availability of onset-rhyme in L1 orthography and the phonological similarity between Chinese and their L1 backgrounds. The lack of onset-rhyme units in Japanese led to Japanese CSL learners' poor performance in onset and rhyme tasks (Gao, 2001, 2004). However, on the other hand, having a similar onset-rhyme phonological structure between L1 and Chinese might also cause confusions for other CSL learners. Tian (2003) observed that European-American CSL participants produced more errors in alliteration and rhyming judgment tasks than the Japanese and Southeast Asian participants among the beginner CSL learners. This could be accounted for by the fact that Pinyin and most European-American languages use the same Roman alphabet and have similar onset-rhyme syllabic structure. Likewise, Gao and colleagues (2005) found the influence of cross-language differences on onset and rhyme awareness tests among the Korean and the non-Korean groups. The Korean group outperformed the Indonesian group, probably due to the relatively stronger similarities in phonological properties between Korean and Chinese. Whether the results of these studies relate to the phonological features in the CSL learners' L1s is still not clear because detailed comparative analysis between Chinese and the CSL learners' L1s was not carried out.

Tone awareness. CSL learners from tonal L1 backgrounds are likely to achieve better performance scores than those from non-tonal language backgrounds. For instance, Thai CSL learners demonstrated an advantage in Chinese tone awareness due to their reference to the tones in Thai (Wu, 2008). Studies further corroborated that differences in tone awareness were not found among CSL learners speaking various non-tonal languages, such as Japanese, Korean and English (Gao & Gao, 2005; Gao, 2001, 2004), Indonesian and Russian or Indonesian and Korean (Shao, 2007). These results point to similar performance in tone awareness among the CSL learners speaking non-tonal languages.

The reviewed studies above reveal that the influence of L1 transfer on the acquisition of Chinese phonological awareness takes place at different levels, such as syllable, onset-rhyme and tone. However, no studies have explored how L1 transfer works similarly or differently in Chinese phonological awareness among the Arabic and English CSL learners whose languages differ hugely in phonological and orthographic properties. These findings imply that Arabic and English CSL learners might show both similarities in tone awareness and differences in syllable, onset and rhyme awareness.

Following the review of Chinese phonological awareness among the CSL learners, the next section will review the role of L1 transfer in Pinyin spelling among CSL learners.

3.3.2 Pinyin spelling in CSL learners

The influence of L1 background on English spelling has been documented in a large number of studies, seen in Section 3.2.4. However, little research has investigated Pinyin spelling among CSL learners speaking different L1s, which is one of the goals of the present study. Two available studies explored the performance in Pinyin spelling between native Chinese-speaking children and CSL learners, and they are briefly reviewed here.

Lin (2009) examined the performance in Pinyin spelling between Indonesian CSL learners and third graders (aged between 8 to 9 years) in a primary school in southern China. The participants were presented with a list of two-Hanzi words and asked to write down the pronunciation in Pinyin. The results showed both similarities and differences among the two groups. The similarity in onset spelling errors was that both groups had difficulty in distinguishing z-zh, c-ch and s-sh. The reason is that such pairs are not present in either Indonesian language or Min dialect spoken by Chinese children. The differences were that Indonesian CSL learners produced more errors in p-b, d-t, and g-k, and the confusion in spelling n-r-l were the frequent errors among Chinese children. In terms of vowels, one of the common difficulties for both groups was to distinguish i-u-ü and er-e. The differences were that Indonesian CSL learners tended to replace <e> with <i> in spelling syllables such as <zhe>, <ze>, <she>, <se>, and the Chinese children were likely to substitute the diphthong <ou> with single vowel <o>. Hu (2010) compared Pinyin spelling skills between Chinese-speaking children and young English-speaking CSL learners in Singapore. The English-speaking CSL learners produced the most errors in consonants that are not present in English phonology, such as /tɕ/, /tɕʻ/, /ɕ/, /tʂ/, /tʂʻ/ and /ʂʻ/, and the most common errors in the English-speaking group were committed in vowels that do not exist in English, such as /ʅ/, /ʅ/ and /y/.

To summarize, though the amount of the research related to Pinyin spelling is limited, yet the available studies demonstrate that CSL learners' performance in Pinyin spelling was influenced by the cross-language differences between their L1 and Chinese. However, it remains unclear how L1 background affects the performance in Pinyin spelling among the Arabic and English CSL learners, whose native languages demonstrate greater differences in phonology and orthography. The studies reviewed above imply that the Arabic and English CSL learners will demonstrate similarities in tone spelling and differences in onset and rhyme spelling.

The Chinese language uses two writing systems, one is Pinyin and another is Hanzi. Studies have found the influence of L1 background on not only Pinyin, but also Hanzi. The next section will review studies on phonetic radical awareness and Hanzi reading among CSL learners.

3.3.3 Phonetic radical awareness and Hanzi reading in CSL learners

Influenced by the extensive studies on Hanzi among the native Chinese-speaking children, and the need to help CSL learners to develop Hanzi proficiency, CSL researchers have spent a lot of effort on exploring how CSL learners acquire the orthographic structure of Hanzi and how they use the phonetic radicals to access the pronunciation of Hanzi. One of the goals of the present study is to investigate how L1 background influences the development of phonetic radical awareness and Hanzi literacy skills and their relationships, therefore, relevant research on phonetic radical awareness among CSL learners are reviewed.

Regularity effect and position effect of phonetic radical in reading Hanzi

Similar to the regularity effect in Chinese children's performance in reading Hanzi as noted in earlier sections, CSL learners' skills in recognizing Hanzi are also impacted by the consistency between the phonetic radical and the whole Hanzi. CSL learners achieved better performance scores in reading regular Hanzi than in semiregular and irregular Hanzi. In the task of writing Pinyin for Hanzi, CSL participants achieved the highest scores in writing Pinyin for regular Hanzi, and this result was found among CSL learners with different writing system backgrounds, such as Japanese, Korean, English and French (Chen & Wang, 2001; Feng, 2002; Jiang, 2001; Xing, 2001). Similar results have been observed in studies using Hanzi-Pinyin matching (Rong, 2005) and priming tasks (Wang & Gao, 2006). The effect of Hanzi regularity could be reflected by CSL learners' errors in Hanzi naming. Similar to the Chinese-speaking children, CSL learners make regularity errors and analogy errors in naming Hanzi. Chen (2001) found that regularity errors accounted for 43.1% and 35% of the total errors among beginner and intermediate-level CSL learners respectively, and Xie (2007) reported that regularity errors accounted for 20% of the total errors among the Thai CSL learners, yet the percentage of analogy errors ranged from 4% to 9.9%. CSL learners made fewer analogy errors when their Chinese language proficiency increased (Chen, 2001; Xie, 2007), reflecting their better awareness of the irregularity of phonetic radical in cuing the pronunciation of Hanzi. However, whether the regularity effect in reading Hanzi remains stable among the Arabic and English CSL learners is still not clear because Arabic and English differ in the consistency of grapheme-phoneme correspondence.

The positional effect of phonetic radical on Hanzi naming has not been explored systematically among the CSL learners. Feng (2002) measured the French CSL learners' Hanzi recognition performance by asking the participants to write Pinyin for Hanzi and to make a word using the target Hanzi. She found that the French CSL learners performed better in Hanzi with top-bottom structure than in those with left-right structure, and the accuracy rate in recognizing Hanzi with phonetic radical on the top, bottom, right and left was 85%, 78%, 69.9% and 51.7%, respectively. However, this study only provided descriptive data, it is unclear whether the French CSL learners' Hanzi recognition skills differed significantly across the four types of Hanzi. In addition, whether this finding could be generalized to CSL learners speaking other L1s needs further study, and the present thesis makes an effort to answer this question by exploring this issue among the Arabic and English CSL learners.

Phonetic radical awareness and Hanzi reading in CSL learners

CSL learners' sensitivity to the functional and positional information of radicals in Hanzi develops soon after being exposed to Hanzi instruction. CSL learners in Vietnam demonstrated strong radical awareness after three months' of Hanzi learning (Nguyen, Li, Wu, & Sun, 2016), and their performance in copying pseudo-Hanzi with legal radical was better than the single-radical Hanzi with low frequency, indicating they had become sensitive to the frequently used radicals in Hanzi. Similar findings were reported for English-speaking adult CSL learners (Wang, Liu, & Perfetti, 2004; Wang, Perfetti, & Liu, 2003). Furthermore, English CSL learners become aware of the positional information of the radical as their exposure to Hanzi increases. Tong and Yip (2014) tested CSL learners' position awareness of Hanzi radicals using a picture-character mapping task. They observed that the participants demonstrated a stronger tendency to select the correct radicals in correct positions, compared with those with correct radicals in incorrect positions. However, the CSL learners' knowledge of Hanzi radicals and radical application skills may not develop in parallel. Shen and Ke (2007) found that English-speaking CSL learners' radical application skills (using semantic radicals to retrieve the meanings of unfamiliar Hanzi) lagged behind their perception skills of Hanzi radical (decomposing compound Hanzi into radical units and producing compound Hanzi using radical units). In addition, radical awareness significantly correlated with Hanzi literacy skills (Shen & Ke, 2007; Tong & Yip, 2014; Zhao & Jiang, 2002). Therefore, processing Hanzi by radicals for the purpose of learning Hanzi is a commonly used strategy by CSL learners (Jiang & Zhao, 2001; Shen, 2005, 2010; Zhao & Jiang, 2002) and an efficient teaching method for instructors (Shen, 2004; Shen, Tsai, Xu, & Zhu, 2011).

As the only orthographic unit that carries phonological information, the phonetic radical plays an important role in Hanzi recognition. Williams and Bever (2010) used two tasks to test whether CSL learners used phonetic radicals as a reliable means to identify Hanzi. In the task of homonym recognition, it was found that CSL learners responded fastest and made the fewest errors in the condition where the pair of Hanzi shared the same pronunciation and the same phonetic radical, such as 安 (ān, safe) and 氨 (ān, Ammonia). In a lexical decision task, the blurring technique was used. This technique was used to make the phonetic or semantic radical of one Hanzi less visible by blurring. A significant increase in error rate was observed when the phonetic radical was blurred. In addition, the response time in pseudo-Hanzi and the error rate both increased in the blurred phonetic radical condition. The results indicate that CSL learners use phonetic radicals as an important route to Hanzi recognition. Tong and Yip (2014) further revealed that the CSL learners' sensitivity to phonetic radicals measured by the task of picture-character mapping moderately correlated with single Hanzi recognition (r=.37) and two-Hanzi word recognition (r=.39). Regression analyses models revealed that 19% and 24% of the variance of recognition performance in single Hanzi and two-Hanzi word were predicted by phonetic radical sensitivity. The available evidence reviewed above points to the close relationship between phonetic radical awareness and Hanzi recognition skills. However, Tong and Yip's study only tested the CSL learners' perception skills in phonetic radical awareness, rather than application skills which appear to be more difficult to be acquired as revealed in Shen and Ke's research (2007). Tong and Yip (2014) explored this issue only among English CSL learners, and it remains unknown whether their finding could be generalized into CSL learners using different scripts, such as Arabic.

As noted earlier, the CSL learners are generally categorized into Hanzi and non-Hanzi group. The influence of cross-language transfer on phonetic radical awareness has been found between the Hanzi and non-Hanzi CSL learners, and the next section reviews relevant studies on how Hanzi and non-Hanzi CSL learners perform differently in phonetic radical awareness.

Cross-language transfer in phonetic radical awareness

The influence of the L1 on the use of phonetic radicals to access the pronunciation and meaning of Hanzi among CSL learners of various language backgrounds has been reported. Xing (2001) observed that the performance in marking Pinyin for semantic-phonetic Hanzi between the CSL learners from non-Hanzi backgrounds (Indo-European) and those from Hanzi backgrounds (such as Japanese and Korean). The Hanzi and non-Hanzi groups performed equally well in regular Hanzi, but the Hanzi group performed much better in naming irregular Hanzi than the non-Hanzi group did. Xing concluded that the CSL learners from non-Hanzi backgrounds tended to rely more on phonetic radicals to name irregular Hanzi. Similar results were reported in a study conducted by Zhang (2007), who used a proofreading task which required the participants to search for Hanzi errors in shape or sound. The beginning CSL learners from alphabetic L1 backgrounds performed better in searching for Hanzi with shape errors than in locating sound errors, and this difference disappeared among the intermediate-level learners. However, the Japanese CSL learners at different levels performed better in searching for Hanzi with sound errors. The results imply that the CSL learners from alphabetic L1 backgrounds rely more on sound at the beginning stages of learning, then gradually shift to both sound and shape, whereas Japanese CSL learners predominantly rely on the shape, rather than the sound across levels. Lin and Collins (2012) found similar results among Japanese and English CSL learners. The Japanese CSL learners' dominant reliance on phonetic radicals and their use of visual strategy in processing Hanzi could be accounted for by the existence of a large inventory of Kanji (borrowed from ancient Hanzi) and the common use of Kanji in Japanese writing system. Japanese CSL learners could be considered as native users of Hanzi to some extent, thus their dominant use of phonetic radical in processing Hanzi is not surprising.

These Hanzi and non-Hanzi groups of CSL learners have also been found to differ in their sensitivity to radical positions in naming Hanzi. Feng, Lu, and Xu (2005) administered the task of Hanzi identification in the Hanzi and non-Hanzi CSL learners. The non-Hanzi CSL learners were more sensitive to the radicals on the right side and the bottom, while their counterparts with Hanzi background relied more on the structure of the whole Hanzi, rather than radicals in specific positions. Taken together, the data in previous studies point to a common finding that the dominant strategy used to decode Hanzi by the CSL learners depends on the relationship between Hanzi and their L1 orthography. This finding is consistent with the research on Kanji learning among the learners of Japanese as a second language (Matsumoto, 2013). However, previous studies categorized the Arabic and English CSL learners to the same group, ignoring the script differences in Arabic and English. Thus, whether the differences in writing direction and visual complexities in Arabic and English impact the development of phonetic radical awareness and Hanzi reading is still unknown.

Similar to the influence of L1 background on Hanzi reading among CSL learners with Hanzi and with non-Hanzi backgrounds, these two groups of CSL learners tend to demonstrate different performances in Hanzi writing.

3.3.4 Hanzi writing in CSL learners

Hanzi writing is a difficult task for the CSL learners, especially for those speaking alphabetic languages. Relevant studies on Hanzi writing among CSL learners have focused on the analysis of errors in learners' Hanzi writing (Guo, 2008; Jiang & Liu, 2004; Xiao, 2002; Zhang, 2014). These studies have revealed an influence of the L1 script on Hanzi writing. CSL learners of different L1 backgrounds have been found to show different performance in writing Hanzi. You (2003) analyzed the Hanzi writing in a CSL corpus among English, French and Arabic CSL learners. She reported that these CSL learners with non-Hanzi backgrounds demonstrated poor performance in producing Hanzi with left-right structure. However, Nguyen et al. (2016) observed that the Vietnamese CSL learners with

Hanzi background performed better in writing Hanzi with left-right structure than those with top-bottom structure in the task of delay copying (write down the target Hanzi after seeing it for two seconds). These two studies suggest that CSL learners with Hanzi background are likely to perform better in Hanzi with left-right structure than do their counterparts with no Hanzi background.

The directionality of the L1 script has been found to affect the performance in Hanzi writing. Thaveewatanaseth and Jiang (2015) investigated the influence of Thai script on the handwriting of Hanzi among Thai CSL learners. It was found that the Thai CSL learners were likely to write the horizontal line in Hanzi <口> from right to left, which was assumed to be influenced by the directionality in writing the horizontal line in Thai vowel <ิ> [i]. However, the Thai CSL learners wrote the horizontal line from left to right in Hanzi <十>, which was supposed to originate from the influence of writing English alphabetic letter<t>. The experience of using both L1 and L2 scripts appears to influence the behavior in Hanzi writing.

The above studies focused on the influence of L1 script on the stroke directionality in Hanzi, and did not explore whether writing direction in L1 script exerts influence on writing Hanzi with phonetic radicals at different positions such as left and right. Considering the influence of writing direction in L1 script on drawing among the users of Arabic and English scripts as reviewed in the earlier section, and that writing Hanzi is similar to drawing for CSL learners, thus the Arabic and English CSL learners might perform differently in writing semantic-phonetic Hanzi with left-right structure.

3.3.5 Section summary

This section summarized relevant studies on the influence of L1 background on the development of phonological awareness, phonetic radical awareness, Pinyin spelling, Hanzi reading and Hanzi writing among the CSL learners, pointing to the existence of the influence of L1 transfer on learning Chinese. The main research gap is the lack of comparative studies in Chinese language learning between the Arabic and English CSL learners whose first languages differ in phonological properties as well as orthographic features, lending themselves to tap the impact of L1 background on Chinese language acquisition among CSL learners speaking two different alphabetic L1s and using two different scripts.

3.4 Previous research on other meta-linguistic and background variables in SLA

The present thesis focuses on the influence of L1 background on learning Chinese between the Arabic and English CSL learners who are studying Chinese in their home country, United Kingdom and Egypt. The CSL learners in these two countries might differ a great deal in some meta-linguistic and background variables, such as phonological aptitude, L2 Chinese proficiency and previous language learning experience, which could interact with L1 in Chinese learning. Therefore, relevant meta-linguistic and background variables are also explored in the present study to generate a clearer picture of how L1 background interacts with these variables in the acquisition of the Chinese language among the Arabic and English CSL learners. The relevant meta-linguistic and background variables of interest in the present study include L2 proficiency, foreign language aptitude, previous language learning experience and the experience of staying abroad in an L2-speaking country.

3.4.1 L2 language proficiency

L2 learners' language proficiency in the target language influences the development of their meta-linguistic awareness and literacy skills in the L2, and this has been well established in studies involving different languages. The Arabic and English CSL learners might differ in Chinese language proficiency considering the different learning contexts in Egypt and the United Kingdom. For instance, most English CSL learners study the Chinese language as well as another subject in the university, yet most Arabic CSL learners only learn the Chinese language as a major subject. In addition, the English CSL learners are required to study abroad in China for one year, yet only few Arabic CSL learners have such chance. Moreover, the English CSL learners have more opportunities to interact with Chinese speakers due to the huge number of Chinese students studying in the UK, yet the Arabic CSL learners have fewer chances because the number of Chinese students in Egypt is limited. Therefore, relevant research on the influence of Chinese language proficiency on Chinese learning among CSL learners is reviewed.

Chinese language proficiency is closely associated with Chinese literacy skills related to Hanzi. CSL learners of a higher proficiency perform better in reading Hanzi than do those with lower proficiency in cross-level research (Kim, Packard, Christianson, Anderson, & Shin, 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001) and longitudinal studies (Ke, 1996). It is not surprising to find the strong relationship between Chinese language proficiency and the performance in Hanzi reading. Hanzi is one of the most important parts of Chinese language learning, and most Chinese language proficiency tests are administered via the print of Hanzi, not Pinyin. Therefore, the ability to recognize Hanzi could be considered as the basis of Chinese language proficiency, which in turn reflects the performance in Hanzi reading.

The influence of Chinese language proficiency has been reported in the development of Chinese phonological awareness in CSL learners. Gao and Gao (2005) revealed that the intermediate CSL learners outperformed the pre-intermediate CSL learners in phonological awareness and its subcomponents, indicating the strong relationship between Chinese language proficiency and the ability to manipulate Chinese phonological units. Zhang and Wu (2007) observed that the development rate of Chinese phonological awareness differed across the CSL learners' Chinese language proficiency level. The pre-intermediate CSL learners' pattern in phonological awareness was "onset/rhyme/tone > phoneme", and the pattern in intermediate CSL learners was "tone/rhyme > onset > phoneme" and the advanced CSL learners showed a pattern of "tone > rhyme > onset > phoneme". These findings suggest that the development of Chinese phonological awareness relates with their Chinese language proficiency.

Chinese language proficiency influences the acquisition of radical awareness in reading Hanzi among the CSL learners. Jiang (2001) reported that the regularity errors and analogy errors accounted for 47.5% of all errors among the intermediate CSL learners, whereas these errors only accounted for 19.3% among the pre-intermediate CSL learners. It suggests that the CSL learners with higher proficiency depend more on phonetic radicals to retrieve the pronunciation of Hanzi than did those with lower proficiency because CSL learners with higher proficiency are more likely to realize how phonetic radical represents the phonological information of Hanzi. Xing (2001) demonstrated that the difference between reading regular and irregular Hanzi among the CSL learners of higher Chinese proficiency was smaller than that in those of lower proficiency, indicating that the CSL learners become more aware of the irregularity and inconsistency of phonetic radicals in cueing the sound of Hanzi as their Chinese language proficiency increases. Shen and Ke (2007) further observed that successful application of semantic radical knowledge only happened in the English CSL learners with high Chinese language proficiency. In sum, Chinese language proficiency highly predicts the growth of CSL learners' sensitivity to the functional properties of orthographic units in Hanzi.

To conclude, the CSL learners' Chinese language proficiency influences their performance in meta-linguistic awareness as well as Chinese literacy skills. Nonetheless, what is still unknown is how Chinese language proficiency influences the development of phonological awareness and phonetic radical awareness in the Arabic and English CSL learners, whose native languages demonstrate salient differences in phonological properties, visual complexity and writing direction in L1 script.

3.4.2 Foreign language aptitude

Although no studies have revealed differences in foreign language aptitude (FLA) between the Arabic and English speakers, the close relationship between foreign language aptitude and the achievements in second language acquisition has been confirmed in previous studies. FLA refers to "the natural ability to learn a language, not including intelligence, MOTIVATION, interest, etc." (Richards & Schmidt, 2013). The commonly used instruments for testing FLA include the Modern Language Aptitude Test (MLAT) (Carroll & Sapon, 1959), The Pimsleur Language Aptitude Battery (PLAB) (Pimsleur, 1966), the Defense Language Aptitude Battery (Dlab) (Petersen & Al-Haik, 1976) and the LLAMA language aptitude tests (Meara, 2005). Significant correlations between FLA and L2 learning have been found in L2 performance (Carroll, 1964; Matheus, 1937; Winke, 2013), grammar (Gisela, 2014; Li, 2014), writing (Wistner, 2014), and pronunciation (Granena & Long, 2013; Hu et al., 2013; Smemoe & Haslam, 2013; Winke, 2013).

It is generally believed that FLA comprises four components: phonemic coding ability, grammatical sensitivity, inductive language learning ability and rote learning ability (Carroll, 1958). As the present thesis focuses on the development of phonological awareness and phonetic radical awareness among CSL learners, research about the phonological aptitude is reviewed here. Two important parts of phonological aptitude are phonological working memory and phonetic coding ability (Meara, 2005).

Phonological working memory (PWM) refers to the short-term capability of storing and retrieving phonological information. PWM can be tested by the task of non-word repetition (Gathercole, Willis, Baddeley, & Emslie, 1994). The importance of PWM for the acquisition of vocabulary and syntax has generally been acknowledged (Ellis, 1996). Phonetic coding ability refers to the ability to encode the correspondence between written symbol and sounds. Phonological working memory and phonetic coding ability are two separate sections measured in LLAMA aptitude tests (Meara, 2005). Phonetic coding ability was found to be a good predictor in pronunciation skills in advanced L2 learners (Hu et al., 2013). Phonetic coding scores on the PLAB test has also been found to show significant correlations with improvement in global foreign accent, fluency and accuracy among both ESL learners in China and in America (Smemoe & Haslam, 2013).

The relationship between FLA and Chinese language proficiency among CSL learners has not been well documented in previous research. How language learning aptitude relates to the Chinese language acquisition was studied in 1950s-1960s to explore the general effect of language aptitude on language learning. Harding (1956) (Cited in Carroll, 1964) reported a correlation of 0.45 between the language aptitude and the final grade scores among 135 airmen learning the Chinese language. Harding suggested that different abilities may be required for Chinese learning as Hanzi is a unique script. Similar results were reported in another study investigating the different predictors in nine languages including Chinese and Arabic (Asher, 1972). In contrast, the study by Carroll (1964) did not support the notion of language-specific aptitude. However, a recent study by Winke (2013) found that English CSL learners' L2 aptitude (measured by MLAT) did not predict the performance in Chinese language proficiency.

To summarize, the contribution of FLA to the Chinese language acquisition is still unclear, especially the relationship between phonological aptitude and phonologically related awareness (phonological awareness and phonetic radical awareness) has not been explored. The present thesis makes an effort to uncover the association between phonological aptitude and meta-linguistic awareness and literacy skills in Chinese among the Arabic and English CSL learners.

3.4.3 Languages previously learnt

The Arabic and English CSL learners might differ in the number of languages previously learnt. The UK has a high percentage of immigrants (13.1%)[1], yet immigrants only make up 0.3% of the population in Egypt[2]. The huge differences in the number of immigrants indicate that English speakers in the UK could have more opportunities to learn a foreign language than their Arabic counterparts. In addition, the UK government provides a variety of foreign language courses since high school, yet similar policy is not observed in

1 http://www.migrationobservatory.ox.ac.uk/resources/briefings/migrants-in-the-uk-an-overview/
2 http://www.migrationpolicycentre.eu/docs/migration_profiles/Egypt.pdf

Egypt. It is quite possible that the two groups of CSL learners could have different experiences in foreign language learning before the start of Chinese course in the university. Therefore, relevant studies on the influence of previous language learning on the target language acquisition are reviewed in this section.

Before starting learning a foreign language, an individual may often have experience of learning other languages. Both the first language and the foreign languages previously learnt can influence the acquisition of the target language. Previous research mainly focuses on how the characteristics of the languages previously learnt influence the acquisition of grammar, vocabulary or phonology of the target languages. However, a small yet very interesting question has not been well documented, that is how the number of languages previously learnt relates with the learning of the target language. It appears to be common sense that if an individual who can speak many languages is more likely to succeed in learning another foreign language. To the best of the author's knowledge, this issue was documented in only one study. Ehrman and Oxford (1995) analyzed the data from 855 officials in 34 foreign language training programs in the United States, and they found that the number of previous languages significantly correlated with speaking (r=0.34) and reading (r=0.32) proficiency after training. The more languages one could speak, the better one performs in foreign language learning. They further found that the performance in previous languages did not relate to the performance in the target language, in contrast, "number of previous languages-breath of exposure rather than depth-was an important factor" (p.81). That is to say, the more languages an individual learnt, the better performance s/he achieves in learning another foreign language. Yet, the relationship between the number of previous languages and the performance in Chinese learning in the CSL learners has not been addressed in previous studies, which will be addressed in the Arabic and English CSL learners in the present thesis.

3.4.4 Study abroad in the L2-speaking country

The Arabic CSL learners in Egypt and the English CSL learners in the UK differ in the experience of studying abroad in China. As mentioned earlier, most Arabic CSL learners in Egypt study the Chinese language only in their home country, but the English CSL learners have at least one-year's studying in China. The differences in studying abroad in China between the two groups might influence the development of meta-linguistic awareness and Chinese literacy skills. Therefore, studies about the influence of studying abroad in the L2 country are reviewed here.

The popular belief is that studying abroad is beneficial for improving language proficiency. A pioneering study by Carroll (1967) found a significant relationship between the length of stay in L2 country and language proficiency among foreign language learners in colleges. The superior performance by the learners who study abroad has been mainly found in speaking and listening skills. Brecht and Davidson (1991) found better performance in speaking skills among the learners of Russian as a second language in Russia in comparison with those who studied in the home country. Freed's (1995b) and Lafford's (1995) studies reported that the abroad group outperformed the home group in terms of speed and quantity of speaking skills. Meara (1994) analyzed self-report data from language learners who studied abroad, and observed more significant progress in listening and speaking skills and less in reading and writing. Freed (1995b) found better performance in oral fluency in the abroad group, but no significant differences in writing fluency between the abroad group and the home group (Freed, 1998). One major reason accounting for the advantages of studying abroad is proposed to be the large amount of input and interaction with native speakers in the L2-speaking country (Collentine, 2009).

The advantage of studying abroad in the L2 country is not always found in the learners with study abroad experience. In one study involving learners of Japanese as a second language (Huebner, 1995), two groups were recruited, one group studied in Japan and another group in America. The two groups used the same materials, had instructors with equal teaching capabilities and the same length of study. The two groups did not differ in listening comprehension, Kanji (Japanese character) recognition or reading comprehension, though the abroad group performed slightly better in listening and reading comprehension. Likewise, Dewey (2004) did not find differences in the measures of free-recall and vocabulary knowledge between the learners of Japanese as a second language in a study-abroad program in Japan and those in an intensive immersion program in the United States.

To summarize, the effect of studying abroad on L2 learning is still not clear-cut. Just Cohen and Shively (2007) stated, “the study-abroad students do not necessarily achieve greater language gains than their peers who stay home and study the target language” (p.189). In addition, the effect of studying abroad on language learning may be domain-specific, more helpful for listening and speaking skills (Collentine, 2009). However, it remains unknown how studying abroad in China contributes to the development of the meta-linguistic awareness such as phonological awareness and phonetic radical awareness, and the achievement in literacy skills in Pinyin and Hanzi among the CSL learners, which is to be addressed in the present thesis.

3.4.5 Section summary

This section reviewed relevant research on the relationships between some meta-linguistic and background variables and second language learning, with a focus on the second language proficiency, foreign language aptitude, the languages previously learnt and the experience of studying abroad in the L2 country. The Arabic and English CSL learners are assumed to demonstrate great differences in these variables, which could influence their performance in Chinese learning, yet this issue still remains unknown and needs further exploration.

3.5 Research gap, research questions and hypotheses

Chinese utilizes two different writing systems, alphabetic Pinyin and morphosyllabic Hanzi, and these two systems are must-learn contents for both native Chinese-speaking children and CSL learners. The previous studies reviewed above have focused on one-to-one transfer in SLA, such as Chinese or Arabic to English. Few studies have explored the issue of one-to-two transfer such as how transfer from one writing system influences the acquisition of two writing systems used in L2. Learning Chinese lends itself to this issue. The central topic of the present thesis is to investigate the cross-linguistic influence of English and Arabic on the acquisition of two types of meta-linguistic awareness (phonological awareness and phonetic radical awareness) and literacy skills in Pinyin (spelling) and Hanzi (reading and writing).

In terms of L1 transfer to phonological awareness and spelling in L2, previous studies have not compared the influence of transfer from English and Arabic on Chinese phonological awareness and Pinyin spelling. Compared with Chinese, English and Arabic are similar in that neither language has tone, but they differ in terms of syllable structure and the vowel repertoire. Thus, English and Arabic are highly suitable for research exploring how the similarities and differences function in learning Chinese phonological awareness and Pinyin spelling.

Previous research on Hanzi acquisition among the CSL learners has not investigated the influence of Arabic and English orthographies, both of which are traditionally categorized as non-Hanzi background. Though both Arabic and English are sound-based, yet Arabic script is more visually complex, and English has a deeper orthography. In addition, the Arabic script is written from right to left, whereas English is from left to right. Considering the unreliable regularity of the phonetic radical in representing the sound of Hanzi and the positional bias of the phonetic radical in Hanzi structure, together with the impact of script learning experience on visual-spatial skills, it is still unclear how Arabic and English CSL learners acquire the skills in manipulating phonetic radicals, and how they achieve success in reading and writing Hanzi.

Though a large amount of literature has documented the role of phonological awareness and phonetic radical awareness in Hanzi reading skills among the native Chinese speakers, no study has yet explored these issues among CSL learners. In addition, few studies have investigated the relationships between phonological awareness, phonetic radical awareness and Pinyin spelling, Hanzi reading and Hanzi writing among CSL learners. Moreover, it remains unknown whether L1 background influences the way in which phonological awareness and phonetic radical awareness work in the development of different Chinese literacy skills.

The impact of some meta-linguistic and background variables on SLA has been well documented in the literature. The most common background variable that has been addressed in previous research is Chinese language proficiency. However, other relevant variables in terms of phonological aptitude, previous language learning experience and the experience of staying in China has not yet been explored. It remains unclear how these factors may affect the development of meta-linguistic awareness and the acquisition of literacy skills in Chinese such as phonological awareness and phonetic radical awareness, Pinyin and Hanzi-related skills.

Therefore, the three general questions to be addressed in this thesis are as follows:

Question 1. What is the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling skills among the Arabic and English CSL learners?

Question 2. What is the influence of L1 background and other meta-linguistic and background variables on phonetic radical awareness and Hanzi reading and Hanzi writing skills among Arabic and English CSL learners?

Question 3. What is the influence of L1 background and other meta-linguistic and background variables on the relationships between Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills (Pinyin spelling, Hanzi reading and Hanzi writing) among the Arabic and English CSL learners?

Chapter Four: Influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling among CSL learners

This chapter presents the results of an investigation into the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling skills among Arabic and English CSL learners. The sub-questions to be addressed in this chapter are listed below.

Research question 1: How do L1 background and other meta-linguistic and background variables influence the performance on the subcomponents (syllable, onset, rhyme and tone) of Chinese phonological awareness among the Arabic and English CSL learners?

Research question 2: How do L1 background and other meta-linguistic and background variables influence the developmental order of the subcomponents (syllable, onset, rhyme and tone) of Chinese phonological awareness among the Arabic and English CSL learners?

Research question 3: How do L1 background and other meta-linguistic and background variables influence the performance on the subcomponents (syllable, onset, rhyme and tone) of Pinyin spelling skills among Arabic and English-speaking CSL learners?

Research question 4: How do L1 background and other meta-linguistic and background variables influence the developmental order of the subcomponents (onset, rhyme and tone) of Pinyin spelling skills among Arabic and English-speaking CSL learners?

4.1 Method

4.1.1 Participants

The participants included both CSL learners and groups of English and Arabic native speaker controls (See Table 4.1). The CSL learner participants comprised four groups, two pre-intermediate and two intermediate groups of English and Arabic CSL learners, all living in their native countries and studying Chinese as a major subject at the universities. The CSL participants were recruited from the 2nd-year and 3rd-year learners. The Arabic CSL group comprised 44 participants, with 23 2nd-year and 21 3rd-year learners, and the English CSL group had 40 participants, with 20 2nd-year and 20 3rd-year learners. The Arabic CSL learners were recruited from a university in Egypt, and the English CSL learners from England. The mean age of the Arabic CSL learners and the English CSL learners were 19.59 years old (SD=0.79, min=18, max=21), and 20.55 years old (SD=1.32, min=18, max=26), respectively.

It is no doubt flawed to define the participants' language level only by the length of study due to the individual variations in L2 proficiency. To overcome this problem, the classification of Chinese proficiency level in this study was assessed using the participants' scores in a Chinese language test (HSK, see Appendix 2). The overall mean of HSK scores among the CSL learners was 9.46 (SD=3.52, maximum=16). The participants who scored below the overall mean were assigned into the pre-intermediate group, and those above the overall mean were assigned into the intermediate group. The number of the participants in the pre-intermediate and intermediate Arabic and English CSL group was 24 (M=5.96, SD=2.33), 20 (M=12.25, SD=1.55), 17 (M=6.65, SD=2.18) and 23 (M=12.43, SD=1.59), respectively. The results of independent-samples T-tests showed that the intermediate L2 learners outperformed their pre-intermediate counterparts in the Arabic group ($t(42)=10.31$, $p<0.0001$), in the English group ($t(38)=9.73$, $p<0.0001$) and in the whole CSL group ($t(82)=14.45$, $p<0.0001$). The significant differences between the pre-intermediate and intermediate L2 learners point to the validity of using HSK scores to divide the CSL learners into groups with different proficiency levels. The Arabic and the English CSL learners did not differ in the overall HSK scores or the reading section of HSK test, however the English CSL learners outperformed the Arabic CSL learners in the listening section of HSK test, $t(81)=2.32$, $p=0.02$. This result indicates better listening skills among the English group.

Table 4.1

Details of the Arabic and English CSL Participants, and the Native Speakers of Arabic and English

		CSL		Native	
		Arabic	English	Arabic	English
Total number		44	40	20	20
Age (SD)		19.59(0.79)	20.55(1.32)	33.60(6.92)	24.11(4.8)
Gender	Male	4	17	7	13
	Female	40	23	10	10
Academic year	2nd year	23	20	N/A	N/A
	3rd year	21	20	N/A	N/A
Number of participants	Level 1	24	17	N/A	N/A
	Level 2	20	23	N/A	N/A
HSK test scores	Level 1	5.96(2.33)	6.65 (2.18)	N/A	N/A
	Level 2	12.25 (1.55)	12.43 (1.59)	N/A	N/A
Years of Chinese learning	Level 1	1(0)	2.66(2.66)	N/A	N/A
	Level 2	2(0)	2.70(1.49)	N/A	N/A
Years of staying in China	Level 1	N/A	1.07(1.95)	N/A	N/A
	Level 2	N/A	0.66(0.82)	N/A	N/A
Number of previous languages	Level 1	3.05(0.21)	3.24(0.66)	N/A	N/A
	Level 2	3(0)	3.30(0.63)	N/A	N/A

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

The two groups of native speakers were recruited for the control purposes. Because the native speakers did not have any experience of Chinese learning, thus their response in Chinese phonological awareness could be seen as the pure influence of L1 background. The Arabic and English native speakers were recruited from universities in England. The Arabic-speaking group came from different Arabic-speaking countries, such as Oman, Egypt and Saudi Arabia, but all the participants spoke Arabic as first language and English as a second language, and they did not have any experience in learning Chinese or other East Asian languages. The English-speaking participants were British, and spoke English as a first language, and did not have experience in learning Arabic or Chinese or other East Asian languages. There were 20 participants in the native English group (male=10, female=10) and the native Arabic group (male=7, female=13), respectively. The average age wase 33.6 years old (SD=6.92) in the Arabic group, and 24.1 years old (SD=4.8) in the English group.

The average years of learning Chinese in the Arabic CSL group was 1 year for the pre-intermediate samples (SD=0), 2 years for the intermediate samples (SD=0), and 1.48 years for the whole Arabic group (SD=0.51, min=1, max=2). The average years of learning Chinese in the English CSL group were 2.6 years for the pre-intermediate samples (SD=2.66, min=1, max=8), 2.7 years for the intermediate group (SD=1.49, min=2, max=7), and 2.65 years for the whole English group (SD=2.13, min=1, max=8). The Arabic and English CSL group differed significantly in the years of Chinese language learning, $t(82)=-3.54$, $p=.0007$. This significant difference was caused mainly by the fact that some English participants started Chinese learning from an early age, such as preparing for A-level Chinese test at high school or GCSE Chinese test at secondary school. In contrast, all Arabic participants started to learn Chinese at the start of their undergraduate studies.

Years of living in China

No Arabic CSL participants reported that they lived in China. However, the English CSL participants had an average of 0.84 years of living in China (SD=1.41, min=0, max=7). This difference could be accounted for by two facts. First, some English participants lived in China at an early age due to parents' work in China. Second, according to the university requirements in England, the English CSL learners have one-year compulsory course in China after the first-year undergraduate study in the UK. However, a similar study-abroad policy was not observed in the university in Egypt. These two factors lead to the English CSL group's longer years of living in China than the Arabic CSL group.

The number of languages previously learnt

The number of languages previously learnt in the Arabic and English CSL learners were 3.05 (SD=0.21) and 3.30 (0.65), respectively. The results of *t*-tests showed that the English group spoke more languages than the Arabic group, $t(46.46)=2.37$, $p=0.02$. Two possible explanations for this result may relate to the different language policies and the immigration environment in the two countries. First, a large number of foreign languages have been included for the A-level tests in the UK[3], yet similar policy was not observed in Egypt. Second, the UK is famous for its immigrants from other countries and its variety in languages spoken. People living in the UK are more likely to be exposed to different languages. In contrast, Egypt is an Arabic-dominant country, where English is the most popular foreign language. The lack of foreign language environment in Egypt might bring fewer chances to learn other foreign languages. In addition, most of the previous languages the participants reported were alphabetic, such as French, German and Spanish. In the English group, only two participants reported that they had experience in learning Japanese as a third language.

4.1.2 Instruments

In the present study, phonological aptitude was measured using LLAMA tests (Meara, 2005), Chinese language proficiency was examined by HSK test, Chinese phonological awareness and Pinyin spelling were measured using self-developed tests.

Phonological aptitude

Tests related to phonological aptitude are an indispensable part of modern language learning aptitude tests, such as Modern Language Aptitude Test (MLAT) (Carroll & Sapon, 1959), Pimsleur Language Aptitude Battery (PLAB) (Pimsleur, 1966), the Defense Language Aptitude Battery (Dlab) (Petersen & Al-Haik, 1976) and the LLAMA language aptitude tests (Meara, 2005). Phonological aptitude normally includes two parts-phonological working memory and phonetic coding ability. This study used LLAMA tests

[3] http://www.cie.org.uk/programmes-and-qualifications/cambridge-advanced/cambridge-international-as-and-a-levels/subjects/#

to explore the participants' phonological aptitude. LLAMA Language Aptitude Tests were developed by a team led by Meara (2005). LLAMA tests have been used in previous studies (Granena, 2013; Granena & Long, 2013; Xiang et al., 2012), and showed good reliability and validity. In addition, LLAMA software is compatible with laptops, and it is convenient for administering. For instance, the scores of each section were displayed automatically after the participants finished the tests. Moreover, the LLAMA tests were easily accessible as they could be downloaded and used free of charge. The LLAMA tests included several sections to examine different language aptitudes. Section D and Section E are designed to test the phonological aptitude.

Section D was a sound recognition task to test phonological working memory (Figure 4.1) (see Appendix 1). There were two phases in administering this section. In the learning phase, the participants first heard a string of 10 words spoken in an artificial language, and they were asked to remember these words. During the first phase, they were not required to take any notes. In the test phase, the participants heard another string of words including the 10 words they had heard before in the learning phase and 20 words they had not heard before. The task in the test phase for the participants was to distinguish the words they had learnt and those they had not after hearing the words one by one. They were required to click the "smile face" icon on the software screen if they thought one word was one of the words they heard in the first phase, otherwise they were required to click the "plain face" icon. During the test phase, the software provided feedback to the participants' answers. The software played a "ding" sound for a correct answer, and a "bleep" for a wrong answer right after choosing a smile/plain face icon. The scores appeared automatically on the panel when the participants completed the task. There was no time limit in the test phase. The test was administered on a laptop, and most of the participants completed this section within 10 minutes.

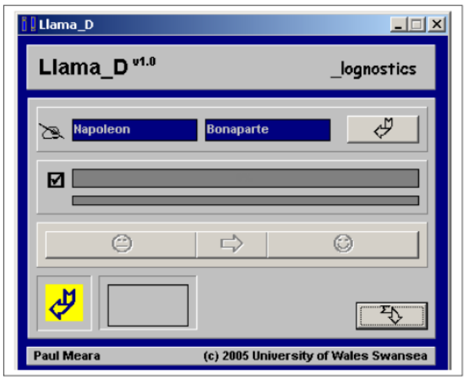

Figure 4.1 Section D of LLAMA tests (Meara, 2005, p. 8)

Section E was a sound-symbol correspondence task to test phonetic coding ability (Figure 4.2) (see Appendix 1). There were two phases in administering this section. In the learning phase, the participants had two minutes to learn the sound-symbol correspondence rules in an artificial language. A list of 24 spellings in an artificial writing system were displayed on the panel. The participants were required to click each spelling to hear the sounds, and to work out how these spellings correspond to the sounds in the artificial language. The participants were not allowed to take any note using pen and paper. In the test phase, the participants first heard a word and then saw two possible spellings on the panel, and they were required to select the correct spelling. There were 21 items in the test phase. The scores appeared automatically on the panel when the participants completed the task. There was no time limit in the test phase. The test was administered on a laptop, and most of the participants took about 15 minutes to complete.

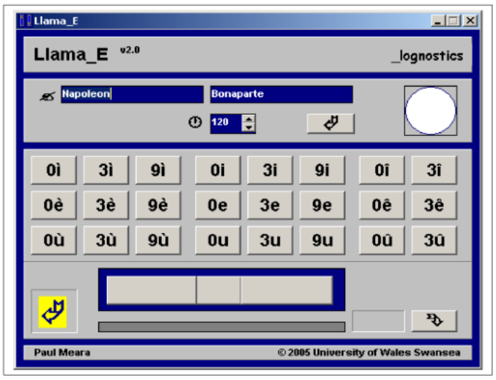

Figure 4.2 Section E of LLAMA tests (Meara, 2005, p. 11)

Chinese language proficiency test

The CSL learners' Chinese proficiency was tested by the standard Chinese language proficiency test-HSK (Hànyǔ Shuǐpíng Kǎoshì) (see Appendix 2), which is the official examination for testing Chinese language proficiency for the CSL learners. HSK could be regarded as Chinese "TOEFL" or "IELTS". The HSK test includes six levels, with level 6 as the highest and level 1 as the lowest. Level 3 and level 4 correspond to the pre-intermediate level and intermediate level. An individual learning Chinese as a major subject is supposed to achieve level 3 in one year, and level 4 in two years. Therefore, all the questions used in testing Chinese language proficiency in this study were extracted from level 3 and level 4.

The Chinese language proficiency test used in this study included listening and reading section. Both the listening and reading section included eight items, with four questions from level 3 and four questions from level 4. In the **listening** section, the participants first heard a short dialogue and one or two questions after the dialogue, and then they were required to answer the questions by selecting the correct answer out of four possible ones. The participants had 10 seconds to answer each question. In the **reading** section, the participants first read a short paragraph and one or two questions after the paragraph, and then they were required to answer the questions by selecting the correct answer out of four possible choices. The time limit for the reading section was 10 minutes. The Chinese language proficiency test was administered in the form of pen-and-paper, and it took approximately 20 minutes.

The maximum score of the Chinese language proficiency test was 16. One point was assigned to one correct answer, and zero point was assigned to one incorrect answer or unanswered question. The Cronbach's alpha reliability of the HSK test was 0.80.

Chinese phonological awareness

A large number of tasks and questionnaires have been developed to investigate Chinese phonological awareness, yet there is still no generally accepted questionnaire. The most common task used in testing Chinese phonological awareness is the oddity test (Gao, 2001; Huang & Hanley, 1995, 1997; Liow & Poon, 1998; Shu et al., 2008; Xu et al., 2004; Zhang

& Wu, 2007). The oddity task, also termed as odd-man-out test, requires the participants to detect the odd one after hearing a set of three or four items. The Chinese phonological awareness test in this study used a self-developed oddity test (see Appendix 3), and it included four subtests: syllable awareness, onset awareness, rhyme awareness and tone awareness.

In the oddity test for Chinese syllable awareness, the participants were presented with three disyllabic words, one having a different syllable from the other two words, and they were required to detect the odd one. For example, among "zhōngguó, guójiā, chīfàn", the odd one was "chīfàn" because the other two words had the same syllable "guó". The syllables used in the syllable awareness test covered most of the onsets and rhymes in Chinese. There were eight sets in this section.

In the oddity test for Chinese onset awareness, the participants were presented with three single syllables, one having a different onset from other two syllables, and they were required to detect the odd one. For example, among "bān, báo, pēng", the odd one was "pēng". This section included four pairs of onsets where the Arabic and English CSL learners were supposed to commit errors (the last four sets) and four pairs that were easy to be distinguished (the first four sets). The eight sets in this section included the following comparison onset pairs--"n-s", "b-d", "l-g", "m-n", "b-p", "z-c", "j-zh", and "ch-q".

In the oddity test for rhyme awareness, the participants were presented with three single syllables, one having a different rhyme from other two syllables, and then they were required to detect the odd one. For example, among "liǎn, jiǎn, lǎng", the odd one was "lǎng". The rhyme awareness test mainly focused on the rhymes where Arabic and English CSL learners were supposed to make errors. There were eight sets in this section, including the following comparison pairs, "i-ü", "o-e", "uo-ou", "ui-ei", "ue-ie", "ao-ou", "in-ing" and "un-en".

In the oddity test for tone awareness, the participants were presented with three single syllables, one having a different tone from other two syllables, and then they were required to detect the odd one. For example, among “jiǎn, qiān, miǎn”, the odd one was “qiān”. In the tone awareness test, all of the four tones were included. There were eight sets in this section, and the three items shared the same rhymes and different onsets in each set.

In each section, there were two items for practice before the test started. Therefore, there were eight practice questions and 32 test questions in Chinese phonological awareness test. All the stimuli were selected from *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other Languages* (Guojia yuwei, 2010) and were recorded by an adult female native Chinese speaker in a professional sound-proof language lab. The participants had ten seconds to answer each question. The Chinese phonological awareness test was administered in the form of paper-and-pencil and it took approximately 15 minutes.

Because a standard test for Chinese phonological awareness for native Chinese-speaking children or CSL learners is not available, given that this test in the study was a new task, a pilot study was run. The Chinese phonological awareness test was piloted among 3 English CSL learners, 4 native Chinese, 4 native Arabic and 4 native English speakers, and revealed a reliability of 0.65. In the main study, the reliability of phonological awareness test was 0.72.

The accuracy rate in each section and the overall phonological awareness was calculated for the analysis. One point was assigned to one correct answer, and zero point was assigned to one incorrect answer or unanswered item. The accuracy rate in each subsection was calculated by dividing the number of correct answers by 8, and the accuracy rate in the overall Chinese phonological awareness was calculated by dividing the total number of correct answers by 32.

Pinyin spelling

Similar to the dictation task used for English spelling test, dictation was also used to measure Pinyin spelling skills. However, there is not standard Pinyin spelling test for native

Chinese speakers or CSL learners. Thus, the present study developed a new test for Pinyin spelling. Given that this was a new task, a pilot study was run. In the pilot study, a list of 12 frequent single syllables was used to test Chinese Pinyin spelling skills among 3 English CSL learners and 4 native Chinese speakers. The syllables were selected from *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other Languages* (Guojia yuwei, 2010). Half of the syllables were with high frequency and half were with low frequency. All the syllables did not share same onset or rhyme, and the distribution of the four tones was balanced. The stimuli were recorded by an adult female native Chinese speaker in a professional sound-proof language lab. After hearing each syllable, the participants had ten seconds to spell, and they were required to write out the onsets, rhymes and tones. The Cronbach's alpha reliability of Chinese phonological awareness test in the pilot study was 0.72. However, the pilot study did not find significant difference in Pinyin spelling skills between the English CSL learners and native Chinese speakers. The results indicated the ceiling effect in the task of Pinyin spelling among the English CSL leaners, and suggested that the single syllables might be too simple and not suitable for the test of Pinyin spelling for the CSL learners.

In order to make the test more appropriate to investigate the CSL learners' Pinyin spelling skills, therefore, the single syllables in the pilot study were replaced with disyllabic words in the main study. The task of Pinyin spelling in the main study included 15 disyllable words, all of which were selected from modern Chinese syllables with low frequency (See Appendix 4). The selected syllables covered most of the common onsets and rhymes in Chinese. The 30 single syllables in the 15 disyllable words were different in terms of onset, rhyme and tone. The frequencies of the four tones in the syllables were balanced (Institute of Big Data and Language Education, 2010). The participants were required to write down the disyllable words in Pinyin after hearing the stimulus. The participants had ten seconds to write each disyllabic word. All the stimuli were recorded by an adult female native Chinese speaker in a professional sound-proof language lab. The task of Pinyin spelling was administered in the form of pen-and-paper and it took about 5 minutes. The Cronbach's alpha reliability of the Pinyin spelling test was 0.87.

The accuracy rates in syllable, onset, rhyme and tone in Pinyin spelling were calculated for analysis. The 30 single syllables in the 15 disyllabic words were analyzed separately. The analysis of the single syllable focused on the accuracy of the whole syllable. Thus, one point was assigned to a correctly spelt syllable, and zero point was given to a syllable with an error in onset, rhyme or tone. The analysis of the onset, rhyme and tone only focused on the individual unit. For instance, one point was assigned if the onset of one syllable was correct, regardless of the error in spelling rhyme or tone. The accuracy rate of the syllable, onset, rhyme and tone was calculated by dividing the correct number by 30.

4.1.3 Procedure

This study was approved by the Education Ethics Committee in the Department of Education in University of York. All participants were given informed consent which was printed in their native languages, Arabic or English. The informed consents mainly informed them of the aim and the main tasks in the study, and the relevant ethic issues involved (See Appendix 9).

The Arabic and English CSL learners undertook the tasks of phonological aptitude, Chinese language proficiency test, Chinese phonological awareness test and Pinyin spelling. The native Arabic and English speakers were tested on the measures of Chinese phonological awareness. The instructions of the tests were translated into English or Arabic by native speakers of English or Arabic who were PhD students in second language acquisition. All the participants were tested individually, and were given a small amount of cash after completing the tests.

4.2 Results

The questions discussed in this chapter were how L1 background and other meta-linguistic and background variables influenced the performance in (1) Chinese phonological awareness and (2) Pinyin spelling among the Arabic and English CSL learners. The analysis of the results is organized as follows. Firstly, the participant's accuracy rate in Chinese phonological awareness and Pinyin spelling are presented. Secondly, in order to explore the influence of L1 background and Chinese language proficiency level on the performance in Chinese phonological awareness and Pinyin spelling, as well as the developmental order of the subcomponents of phonological awareness and Pinyin spelling, between-group and within-group ANOVAs were carried out among the Arabic and English groups. Thirdly, in order to investigate the influence of other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling, and their subsets, stepwise regression analyses tests were conducted based on the results of ANOVAs. The results of Chinese phonological awareness and Pinyin spelling are presented separately.

The Chinese phonological awareness test included subtests on syllable, onset, rhyme and tone awareness. The mean accuracy rates, standard deviation in each subtest and the overall Chinese phonological awareness among the pre-intermediate and intermediate Arabic and English CSL learners and the native speakers of Arabic and English are displayed in Table 4.2.

4.2.1 Influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness

The influence of L1 background and Chinese language proficiency level on phonological awareness was explored prior to the influence of other meta-linguistic and background variables among the Arabic and English CSL learners.

Influence of L1 background and Chinese language proficiency level

The influence of L1 background and Chinese language proficiency level were examined in both the between-group differences in Chinese phonological awareness, and the within-group differences in the subcomponents of Chinese phonological awareness among the pre-intermediate and intermediate Arabic and English CSL earners.

Table 4.2

Summary of the Accuracy Rates in Chinese Phonological Awareness Test in the Arabic and English CSL Learners and the Native Speakers of Arabic and English

		CSL Learners						Native Speakers			
		Arabic		English		Total		Arabic		English	
Measures	Level	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Syllable awareness	Level1	0.57	0.22	0.89	0.21	0.70	0.27				
	Level2	0.73	0.21	0.96	0.09	0.86	0.19				
		0.64	0.23	0.93	0.15			0.57	0.18	0.70	0.16
Onset awareness	Level1	0.68	0.19	0.82	0.15	0.74	0.19				
	Level2	0.79	0.16	0.91	0.10	0.85	0.14				
		0.73	0.18	0.87	0.13			0.65	0.12	0.78	0.11
Rhyme awareness	Level1	0.66	0.18	0.70	0.11	0.68	0.15				
	Level2	0.70	0.19	0.78	0.13	0.74	0.16				
		0.68	0.18	0.74	0.12			0.67	0.17	0.70	0.10
Tone awareness	Level1	0.88	0.13	0.91	0.12	0.89	0.13				
	Level2	0.94	0.10	0.94	0.10	0.94	0.11				
		0.90	0.12	0.92	0.11			0.83	0.24	0.93	0.10
Overall phonological awareness	Level1	0.70	0.11	0.83	0.09	0.75	0.12				
	Level2	0.79	0.09	0.90	0.06	0.85	0.09				
		0.74	0.11	0.87	0.08			0.68	0.11	0.78	0.06

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

Between-group differences in phonological awareness

The native Arabic- and English-speaking groups were recruited as controls. By looking at native speakers' scores on these tasks, it was possible to extrapolate from the native speaker findings, CSL learners' perception of Chinese phonological awareness before starting Chinese learning. To test the development of Chinese phonological awareness from the beginning stage to the intermediate level, ANOVAs were carried out in phonological awareness and its subsets among the native speakers (level 0), and the pre-intermediate (level 1) and intermediate (level 2) CSL learners (See Table 4.3).

The results of ANOVAs (Table 4.3) revealed that the main effect of L1 was significant in syllable awareness, $F(1, 118)=47.86$, $p<0.0001$, onset awareness, $F(1, 118)=25.34$, $p<0.0001$, and overall phonological awareness, $F(1, 118)=51.28$, $p<0.0001$. In addition, the main effect of Chinese language proficiency level was significant in syllable awareness, $F(2, 118)=13.92$, $p<0.0001$, onset awareness, $F(2, 118)=10.05$, $p=0.0001$, and overall Chinese phonological awareness, $F(2, 118)=19.05$, $p<0.0001$. The results of the pairwise comparison tests revealed that the English group performed better than the Arabic group in syllable and onset awareness, and overall Chinese phonological awareness, and that the intermediate CSL learners outperformed the pre-intermediate CSL learners and the native speakers.

Following the tests examining the between-group differences in Chinese phonological awareness between the Arabic and English CSL learners and the native speakers of Arabic and English, the next section explored the within-group differences in the subsets of Chinese phonological awareness in the Arabic and English CSL learners.

Within-group differences across the subsets of Chinese phonological awareness

This section explored the developmental order of the subsets of Chinese phonological awareness by examining the within-group differences across the subsets of Chinese phonological awareness. Therefore, four within-group repeated-measure ANOVAs were run in the pre-intermediate and intermediate Arabic and English CSL groups (See Table 4.4).

Table 4.3

Summary of ANOVAs of the Performance in Chinese Phonological Awareness in the Arabic and English CSL Learners and the Native Speakers of Arabic and English

Subtest	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Syllable	**L1**	**1**	**1.62**	**1.62**	**47.86**	**<.0001*** **	**English > Arabic**
	CSL level	**2**	**0.94**	**0.47**	**13.92**	**<.0001*** **	**Level 2 > Level 0 &1**
	L1& CSL level	2	0.19	0.10	2.84	0.06	
	Residuals	118	3.98	0.03			
Onset	**L1**	**1**	**0.52**	**0.52**	**25.34**	**<.0001*** **	**English > Arabic**
	CSL level	**2**	**0.42**	**0.21**	**10.05**	**.0001*** **	**Level 2 > Level 0 &1**
	L1& CSL level	2	0.002	0.001	0.05	0.95	
	Residuals	118	2.44	0.02			
Rhyme	L1	1	0.08	0.08	3.38	0.07	
	CSL level	2	0.09	0.05	2.02	0.14	
	L1& CSL level	2	0.01	0.01	0.24	0.79	
	Residuals	118	2.73	0.02			
Tone	L1	1	0.05	0.05	2.73	0.10	
	CSL level	2	0.07	0.04	1.82	0.17	
	L1& CSL level	2	0.06	0.03	1.41	0.25	
	Residuals	118	2.36	0.02			
Overall Phonological awareness	**L1**	**1**	**0.39**	**0.39**	**51.28**	**<.0001*** **	**English > Arabic**
	CSL level	**2**	**0.29**	**0.15**	**19.05**	**<.0001*** **	**Level 2 > Level 0 &1**
	L1& CSL level	2	0.01	0.003	0.42	0.66	
	Residuals	118	0.91	0.01			

Note. Level 0 = native speakers; Level 1 = pre-intermediate level; Level 2 = intermediate level.

****p<.001*

Table 4.4

Summary of the Repeated Measures ANOVAs of the Subsets of Chinese Phonological Awareness among the Arabic and English CSL Learners

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	23	1.08	0.05	1.55	0.08	
	PA subtest	**3**	**1.22**	**0.41**	**13.51**	**<0.0001*****	**Tone>syllable, onset, rhyme onset>syllable**
	Residual	69	2.08	0.03			
Arabic level 2	Subjects	19	0.60	0.03	1.10	0.37	
	PA subtest	**3**	**0.66**	**0.22**	**7.64**	**0.0002*****	**Tone>syllable, onset, rhyme**
	Residual	57	1.64	0.03			
English level1	Subjects	16	0.49	0.03	1.55	0.12	
	PA subtest	**3**	**0.44**	**0.15**	**7.39**	**0.0004*****	**Syllable>rhyme Onset>rhyme Tone>rhyme**
	Residual	48	0.96	0.02			
English level2	Subjects	22	0.27	0.01	.18	0.30	
	PA subtest	**3**	**0.46**	**0.15**	**14.41**	**<0.0001*****	**Syllable>rhyme Onset>rhyme Tone>rhyme**
	Residual	66	0.70	0.01			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level; PA = phonological awareness. Chinese phonological awareness test includes four subtests: syllable, onset, rhyme and tone.

*** $p<.001$

The results of ANOVAs (Table 4.4) revealed that the differences in the subcomponents of Chinese phonological awareness were significant in the pre-intermediate ($F(3, 69)=13.51$, $p<0.0001$) and intermediate ($F(3, 57)=7.64$, $p=0.0002$) Arabic CSL group. The pre-intermediate and intermediate Arabic CSL learners performed better in tone awareness than in syllable, onset and rhyme awareness.

The results of ANOVAs (Table 4.4) revealed that the differences in the subcomponents of Chinese phonological awareness were significant in the pre-intermediate ($F(3, 48)=7.39$, $p=0.0004$) and intermediate ($F(3, 66)=14.41$, $p<0.0001$) English CSL group. The pre-intermediate and intermediate CSL learners performed better in syllable, onset and tone awareness than rhyme awareness.

The results of the between-group (Table 4.3) and within-group (Table 4.4) ANOVAs revealed the main effects of L1 background and Chinese language proficiency level on the performance in overall phonological awareness, syllable and onset awareness, not rhyme or tone awareness, among the Arabic and English CSL learners. In addition, the two groups differed in the developmental order of the subcomponents of Chinese phonological awareness.

The next section focused on the influence of other meta-linguistic and background variables on the performance in Chinese phonological awareness among the Arabic and English CSL learners.

Influence of other meta-linguistic and background variables

To further explore the influence of other meta-linguistic and background variables on the performance in Chinese phonological awareness, a series of stepwise regression analyses (forward, $pe=.05$) were carried out among the Arabic and English CSL learners. Four stepwise regression analyses were carried out among the pre-intermediate and intermediate Arabic and English CSL learners in overall Chinese phonological awareness, syllable and onset awareness, respectively, because the main effects of L1 background and Chinese language proficiency level were found. Only one stepwise regression analysis was run among all the CSL learners in rhyme awareness or tone awareness because the main effect of neither L1 background nor Chinese language proficiency level was found in the two variables. The length of stay in China, Chinese language test scores, phonological working memory, phonetic coding ability and the number of languages previously learnt were included in the regression model. The length of stay in China was excluded from the models in the Arabic groups because of the lack of such data.

Table 4.5

Summary of Stepwise Regression Analyses for Variables Predicting the CSL Learners' Performance in Phonological Awareness

Hanzi	Group	Predictor variable	R^2	Adj. R^2	F	*p*	B	SE	*t*	*p*	β
Tone awareness	Whole CSL group	Model	.05	.04	4.21	.04					
		Phonetic coding ability					.001	<.001	2.05	.04	.24
Rhyme awareness	Whole CSL group	Model	.09	.08	7.94	.01					
		Phonetic coding ability					.001	<.001	2.82	.01	.31
Onset awareness	Arabic level 2	Model	.21	.17	4.82	.04					
		Phonological working memory					-.01	.003	-2.20	.04	-.46
Syllable awareness	Arabic level 1	Model	.19	.15	5.03	.04					
		Number of previous languages					.34	.15	2.24	.04	.43
	English level 2	Model	.20	.16	5.20	.03					
		Chinese language test scores					-.02	.01	-2.28	.03	-.45

Note. Level 1= pre-intermediate level; level 2 = intermediate level.

Seen from Table 4.5, a significant model (F(1, 82)=4.21, p=.04) predicted 5% of the variance in tone awareness in the whole CSL group, and only phonetic coding ability (β=.24, t=2.05, p=.04) was entered into the final model. In addition, a significant model (F(1, 82)=7.94, p=.01) predicted 9% of the variance in rhyme awareness in the whole CSL group, and only phonetic coding ability (β=.31, t=2.82, p=.01) was entered into the final model. Moreover, a significant model (F(1, 17)=4.82, p=.04) predicted 21% of the variance in onset awareness in the intermediate Arabic CSL group, and only phonological working memory (β=-.46, t=-2.20, p=.04) was entered into the final model. As for syllable awareness, a significant model (F(1, 22)=5.03, p=.04) predicted 19% of the variance in syllable awareness in the pre-intermediate Arabic CSL group, and only the number of previous languages (β=.43,

t=2.24, p=.04) was entered into the final model; a significant model (F(1, 21)=5.20, p=.03) predicted 20% of the variance in syllable awareness in the intermediate English CSL group, and only Chinese language test scores (β=-.45, t=-2.28, p=.03) was entered into the final model.

Brief summary: phonological awareness

The above section examined the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness, and the main results are presented in Table 4.6.

Table 4.6

Summary of the Results of Phonological Awareness in the Arabic and English CSL Learners

Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Overall	English > Arabic	Level 2 > Level 1	N/A
Syllable	English > Arabic	Level 2 > Level 1	Arabic level 1: number of previous languages English level 2: Chinese language test scores (-)
Onset	English > Arabic	Level 2 > Level 1	Arabic level 2: Phonological working memory(-)
Rhyme	✕	✕	Whole CSL group: Phonetic coding ability
Tone	✕	✕	Whole CSL group: Phonetic coding ability
Developmental order	Arabic: Tone> syllable, onset, rhyme; English: Tone, syllable, onset> rhyme		

Note. “>” = better than; “✕” = non-significant main effect; Level 1 = pre-intermediate level; Level 2 = intermediate level; (-) = negative beta value.

The main effects of L1 background and Chinese language proficiency level were found in syllable and onset awareness, and the overall Chinese phonological awareness among the Arabic and English CSL learners. The English CSL learners outperformed the Arabic CSL learners, and the intermediate CSL group outperformed the pre-intermediate CSL group. The two CSL groups did not differ in rhyme awareness or tone awareness. In addition, the Arabic (tone > syllable, onset, rhyme) and English (tone, syllable, onset > rhyme) CSL groups showed different within-group performance across the four subsets of Chinese phonological awareness. Significant predictors of other meta-linguistic and background variables included phonetic coding ability, phonological working memory, number of languages previously learnt and Chinese language test scores.

Following the tests that examined the influence of L1 background and Chinese language proficiency level on the performance in Chinese phonological awareness, next section presents the results of the Pinyin spelling among the two CSL groups.

4.2.2 Influence of L1 background and other meta-linguistic and background variables on Pinyin spelling

The CSL learners' Pinyin spelling skills were tested using the task of dictation using disyllabic words. The analysis of the participants' performance in Pinyin spelling included syllable, onset, rhyme and tone spelling, which are summarized in Table 4.7.

Influence of L1 background and Chinese language proficiency level

The influence of L1 background and Chinese language proficiency level were examined in the between-group differences in Pinyin spelling, and the within-group differences in the subcomponents of Pinyin spelling among the Arabic and English CSL earners.

Between-group differences in Pinyin spelling

To explore the influence of L1 background and Chinese language proficiency level on the performance in Pinyin spelling and its subsets, a series of ANOVAs and pairwise comparison tests were carried out among the pre-intermediate and intermediate Arabic and English CSL learners (See Table 4.8).

Syllable spelling **(**Table 4.8)**.** The main effect of L1 background on syllable spelling was significant, $F(1, 80)=8.71$, $p=0.004$, as was the main effect of Chinese language proficiency level, $F(1, 80)=25.17$, $p<0.001$, and the interaction effect between L1 background and Chinese language proficiency level was also significant, $F(1, 80)=4.27$, $p=0.04$. Pairwise comparisons tests showed that the English group outperformed the Arabic group, and the intermediate group outperformed the pre-intermediate group. In addition, the intermediate group performed better than the pre-intermediate in each of the Arabic and English CSL groups, and the intermediate English group performed better than the pre-intermediate and intermediate Arabic group.

Onset spelling **(**Table 4.8)**.** The main effect of L1 background on onset spelling was significant, $F(1, 80)=21.10$, $p<0.001$, as was the main effect of Chinese language proficiency level, $F(1, 80)=15.70$, $p=0.0002$. The results of pairwise comparison tests showed that the English group outperformed the Arabic group, and the intermediate group outperformed the pre-intermediate group.

Rhyme spelling **(**Table 4.8)**.** The main effect of L1 background on rhyme spelling was significant, $F(1, 80)=30.32$, $p<0.001$, as was the main effect of Chinese language proficiency level, $F(1, 80)=15.28$, $p=0.0002$. The results of pairwise comparison tests showed that the English group outperformed the Arabic group, and the intermediate group outperformed the pre-intermediate group.

Tone spelling **(**Table 4.8)**.** Only the main effect of Chinese language proficiency level on tone spelling was significant, $F(1, 80)=17.52$, $p=0.0001$. The results of pairwise comparison tests showed that the intermediate group outperformed the pre-intermediate group.

In conclusion, the English CSL learners outperformed the Arabic CSL learners in the measures of syllable, onset and rhyme spelling, and the two groups showed similar performances in tone spelling. The intermediate CSL group consistently performed better than the pre-intermediate CSL group in the measures of syllable, onset, rhyme and tone spelling.

Table 4.7

Summary of the Accuracy Rates in Chinese Pinyin Spelling and the Subtests in the Arabic and English CSL Learners

Measures	CSL level	Arabic		English		Total	
		Mean	SD	Mean	SD	Mean	SD
Syllable spelling	Pre-intermediate	0.38	0.17	0.42	0.19	0.40	0.17
	Intermediate	0.50	0.20	0.70	0.16	0.61	0.21
		0.44	0.19	0.58	0.22		
Onset spelling	Pre-intermediate	0.84	0.10	0.89	0.06	0.86	0.09
	Intermediate	0.88	0.05	0.96	0.04	0.92	0.06
		0.86	0.08	0.93	0.06		
Rhyme spelling	Pre-intermediate	0.71	0.13	0.81	0.09	0.75	0.13
	Intermediate	0.78	0.10	0.91	0.06	0.85	0.10
		0.74	0.12	0.87	0.09		
Tone spelling	Pre-intermediate	0.58	0.17	0.55	0.17	0.57	0.17
	Intermediate	0.69	0.23	0.78	0.15	0.73	0.19
		0.63	0.20	0.68	0.20		

Table 4.8

Summary of ANOVAs of the Performance in Pinyin Spelling in the Arabic and English CSL Learners

Measures	Source	*df*	*SS*	*MS*	*F*	*p*	*Pairwise comparison*
Syllable spelling	**L1**	**1**	**0.28**	**0.28**	**8.71**	**0.004****	**English > Arabic**
	CSL level	**1**	**0.80**	**0.80**	**25.17**	**<0.001*****	**Level2 > level1**
	L1*CSL level	**1**	**0.14**	**0.14**	**4.27**	**0.04***	**English level2 > English level1, Arabic level 1&level2 Arabic level2>Arabic level1**
	Residuals	80	3.89	0.05			
Onset spelling	**L1**	**1**	**0.10**	**0.10**	**21.10**	**<0.001*****	**English > Arabic**
	CSL level	**1**	**0.07**	**0.07**	**15.70**	**0.0002*****	**Level2 > level1**
	L1*CSL level	1	0.005	0.005	1.00	0.32	
	Residuals	80	0.37	0.005			
Rhyme spelling	**L1**	**1**	**0.30**	**0.30**	**30.32**	**<0.001*****	**English>Arabic**
	CSL level	**1**	**0.15**	**0.15**	**15.28**	**0.0002*****	**Level2 >Level 1**
	L1*CSL level	1	0.003	0.003	0.37	0.54	
	Residuals	80	0.79	0.01			
Tone spelling	L1	1	0.02	0.02	0.48	0.49	
	CSL level	**1**	**0.57**	**0.57**	**17.52**	**0.0001*****	**Level2 > level1**
	L1*CSL level	1	0.08	0.08	2.36	0.13	
	Residuals	80	2.61	0.03			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** p<.01; *** p<.001*

Table 4.9

Summary of the Repeated Measures ANOVAs of the Subsets of Pinyin Spelling in the Arabic and English CSL Learners

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	23	0.93	0.04	5.67	<.0001	
	Subset	**2**	**0.78**	**0.39**	**54.56**	**<.0001*** **	**onset>rhyme>tone**
	Residual	46	0.33	0.01			
Arabic level 2	Subjects	19	0.61	0.03	2.00	0.03	
	Subset	**2**	**0.37**	**0.19**	**11.64**	**0.0001*** **	**onset>rhyme>tone**
	Residual	38	0.61	0.02			
English level1	Subjects	16	0.33	0.02	1.86	0.07	
	Subset	**2**	**1.09**	**0.54**	**49.77**	**<.0001*** **	**onset>rhyme>tone**
	Residual	32	0.35	0.01			
English level2	Subjects	22	0.30	0.01	1.95	0.03	
	Subset	**2**	**0.43**	**0.22**	**30.77**	**<.0001*** **	**onset>rhyme>tone**
	Residual	44	0.31	0.01			

Note. ****p*<.001*

The next section examined the within-group differences in the subsets of Pinyin spelling among the Arabic and English CSL groups.

Within-group differences across the subsets of Pinyin spelling

Four separate within-group repeated measure ANOVAs and pairwise comparison tests were carried out in Arabic and English CSL group, respectively (See Table 4.9). Because Pinyin syllable spelling encompassed onset, rhyme or tone, thus syllable spelling was not included in the repeated-measures ANOVA tests. The results of within-group repeated-measure ANOVA tests revealed that the differences between the three subsets of Pinyin spelling were significant in the pre-intermediate ($F(2, 46)=54.56$, $p<0.0001$) and intermediate ($F(2, 38)=11.64$, $p=0.0001$) Arabic CSL learners, and in the pre-intermediate ($F(2, 32)=49.77$, $p<0.0001$) and intermediate ($F(2, 44)=30.77$, $p<0.0001$) English CSL learners. The results of pairwise comparison tests showed that the four groups showed a similar pattern, and they performed the best in onset spelling, less well in rhyme spelling, and the worst in tone spelling.

Following the above section examining the influence of L1 background on the between-group and within-group differences in Pinyin spelling among the Arabic and English CSL learners, the next section examined the influence of other meta-linguistic and background variables on Pinyin spelling.

Influence of other meta-linguistic and background variables

To further explore the influence of other meta-linguistic and background variables on the performance in Pinyin spelling, a series of stepwise regression analyses (forward, pe=.05) were carried out among the Arabic and English CSL learners. Four stepwise regression analyses were carried out among the pre-intermediate and intermediate Arabic and English CSL learners in syllable, onset and rhyme spelling, respectively, because the main effects of both L1 background and Chinese language proficiency level were observed. Two stepwise regression analyses in tone spelling were run among the pre-intermediate and intermediate CSL learners because only the main effect of Chinese language proficiency level was found in tone spelling. The length of stay in China, Chinese language test scores, phonological working memory, phonetic coding ability and the number of languages previously learnt were included in the regression models. The length of stay in China was excluded from the regression models in the Arabic groups because of the lack of such data. The results are summarized in Table 4.10.

A significant model ($F(1, 41)=7.63$, $p=.01$) predicted 16% of the variance in tone spelling in the intermediate CSL group, and only Chinese language test scores ($\beta=.40$, $t=2.76$, $p=.01$) was entered into the final model. A significant model ($F(1, 21)=5.18$, $p=.03$) predicted 20% of the variance in rhyme spelling in the intermediate English CSL group, and only Chinese language test scores ($\beta=.44$, $t=2.28$, $p=.03$) was entered into the final model. As for onset spelling, a significant model ($F(1, 22)=8.38$, $p=.01$) predicted 28% of the variance in onset spelling in the pre-intermediate Arabic CSL group, and only Chinese language test scores ($\beta=.53$, $t=2.89$, $p=.01$) was entered into the final model; a significant model ($F(1, 15)=7.64$, $p=.01$) predicted 33% of the variance in onset spelling in the pre-intermediate English CSL group, and only the length of stay in China ($\beta=.58$, $t=2.76$, $p=.01$) was entered into the final model. In terms of syllable spelling, a significant model ($F(2, 21)=7.79$, $p=.003$) predicted 43% of the variance in syllable spelling in the pre-intermediate Arabic CSL group, and two predictors were entered into the final model: Chinese language test scores ($\beta=.54$, $t=3.28$, $p=.004$), and phonetic coding ability ($\beta=.42$, $t=2.51$, $p=.02$); a significant model ($F(1, 18)=5.46$, $p=.03$) predicted 23% of the variance in syllable spelling in the intermediate Arabic CSL group, and only phonetic coding ability ($\beta=.48$, $t=2.34$, $p=.03$) was entered into the final model; a significant model ($F(1, 15)=8.27$, $p=.01$) predicted 36% of the variance in syllable spelling in the pre-intermediate English CSL group, and only the length of stay in China ($\beta=.60$, $t=2.88$, $p=.01$) was entered into the final model.

Table 4.10

Summary of Stepwise Regression Analyses for Variables Predicting the CSL Learners' Performance in Pinyin Spelling

Hanzi	Group	Predictor variable	R^2	Adj. R^2	F	*p*	B	SE	*t*	*p*	β
Tone	Level 2	Model	.16	.14	7.63	.01					
		Chinese language test scores					.05	.02	2.76	.01	.40
Rhyme	English level 2	Model	.20	.16	5.18	.03					
		Chinese language test scores					.02	.01	2.28	.03	.44
Onset	Arabic level 1	Model	.28	.24	8.38	.01					
		Chinese language test scores					.02	.01	2.89	.01	.53
	English level 1	Model	.33	.29	7.64	.01					
		Length of stay in China					.08	.03	2.76	.01	.58
Syllable	Arabic level 1	Model	.43	.37	7.79	.003					
		Chinese language test scores					.04	.01	3.28	.004	.54
		Phonetic coding ability					.003	.001	2.51	.02	.42
	Arabic level 2	Model	.23	.19	5.46	.03					
		Phonetic coding ability					.004	.002	2.34	.03	.48
	English level 1	Model	.36	.31	8.27	.01					
		Length of stay in China					.24	.08	2.88	.01	.60

Brief summary: Pinyin spelling

The influence of L1 background and other meta-linguistic and background variables on Pinyin spelling among the Arabic and English CSL learners were examined in the above section, and the main results are summarized in Table 4.11. The main effects of L1 background and Chinese language proficiency level were found in syllable, onset and rhyme spelling. The English CSL learners outperformed the Arabic CSL learners, and the intermediate CSL learners outperformed the pre-intermediate CSL learners. However, only the main effect of Chinese language proficiency level was found in tone spelling, in which the intermediate group showed better performance. In addition, the two CSL groups demonstrated similar pattern (onset>rhyme>tone) in the performance in the three subsets of Pinyin spelling. The observed significant predictors of other meta-linguistic and background variables in Pinyin spelling included Chinese language test scores, the length of stay in China and phonetic coding ability.

Table 4.11

Summary of the Results of Pinyin Spelling in the Arabic and English CSL Learners

Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Syllable	English > Arabic	Level 2 > Level 1	Arabic level 1: Chinese language test scores; phonetic coding ability
			Arabic level 2: phonetic coding ability
			English level 1: length of stay in China
Onset	English > Arabic	Level 2 > Level 1	Arabic level 1: Chinese language test scores
			English level 1: length of stay in China
Rhyme	English > Arabic	Level 2 > Level 1	English level 2: Chinese language test scores
Tone	✕	Level 2 > Level 1	Level 2: Chinese language test scores
Developmental order			Arabic/English: onset > rhyme > tone

Note. “>” = better than; “✕” = non-significant main effect; Level 1 = pre-intermediate level; Level 2 = intermediate level.

4.2.3 Summary

This chapter explored the influence of L1 background and other meta-linguistic and background variables on the acquisition of Chinese phonological awareness and Pinyin spelling among the Arabic and English CSL learners and the results are summarized in Table 4.12.

Table 4.12

Summary of the Findings in Chinese Phonological Awareness and Pinyin Spelling

	Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Differences	Overall PA	English>Arabic	Level2>Level1	N/A
	Syllable awareness	English>Arabic	Level2>Level1	Arabic level 1: number of previous languages English level 2: Chinese language test scores (-)
	Onset awareness	English>Arabic	Level2>Level1	Arabic level 2: Phonological working memory(-)
	Syllable spelling	English>Arabic	Level2>Level1	Arabic level 1: Chinese language test scores; phonetic coding ability Arabic level 2: phonetic coding ability English level 1: length of stay in China
	Onset spelling	English>Arabic	Level2>Level1	Arabic level 1: Chinese language test scores English level2: length of stay in China
	Rhyme spelling	English>Arabic	Level2>Level1	English level 2: Chinese language test scores
Similarities	Rhyme awareness	✕	✕	Whole CSL group: Phonetic coding ability
	Tone awareness	✕	✕	Whole CSL group: Phonetic coding ability
	Tone spelling	✕	Level2 > Level1	Level 2: Chinese language test scores

Note. “>” = better than; “✕” = non-significant main effect; PA = phonological awareness; Level 1 = pre-intermediate level; Level 2 = intermediate level.

Influence of L1 background. The influence of L1 background among the Arabic and English CSL learners was found on the measures of Chinese phonological awareness (overall PA, syllable, onset) and Pinyin spelling (syllable, onset and rhyme), and the English CSL learners consistently outperformed the Arabic CSL learners in these measures. The influence of L1 background among the two groups of CSL learners was not found in rhyme awareness, or tone awareness/spelling. In addition, the two CSL groups showed different patterns in the development order of the subcomponents of Chinese phonological awareness (Arabic: tone > syllable, onset, rhyme, English: tone, syllable, onset > rhyme), but similar pattern in the development order of the subcomponents of Pinyin spelling (onset > rhyme > tone).

Influence of Chinese language proficiency level. The influence of Chinese language proficiency level were observed in most measures of phonological awareness and Pinyin spelling except rhyme awareness and tone awareness. The intermediate CSL learners performed better than the pre-intermediate CSL learners in these measures.

Influence of other meta-linguistic and background variables. Five variables were found to be significant predictors of the performance in Chinese phonological awareness and Pinyin spelling. **Chinese language test scores** predicted syllable awareness (negative) and rhyme spelling in the intermediate English CSL group, tone spelling in the intermediate CSL group, onset and syllable spelling in the pre-intermediate Arabic CSL group. **The length of stay in China** predicted the performance in syllable spelling in the pre-intermediate English CSL group and onset spelling in the intermediate English CSL group. **The number of languages previously learnt** predicted the performance in syllable awareness in the pre-intermediate Arabic CSL group. **Phonological working memory** negatively predicted the performance in onset awareness in the intermediate Arabic CSL group. **Phonetic coding ability** predicted the performance in tone awareness, rhyme awareness in the whole CSL group, syllable spelling in the pre-intermediate and intermediate Arabic CSL groups.

4.3 Discussion

The influence of L1 background and other meta-linguistic and background variables on second language acquisition have been well documented in previous studies, yet studies have not compared the performance in Chinese language learning among Arabic and English CSL learners. This chapter explored the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling among the Arabic and English CSL learners. It was found that the two CSL groups consistently performed differently in most measures of Chinese phonological awareness and Pinyin spelling, as well as the developmental order of the subcomponents of Chinese phonological awareness. The subsets of Chinese phonological awareness and Pinyin spelling included the same subcomponents, and the two CSL groups showed similar results in most measures of these subsets, so these two general measures are discussed together. The influence of L1 background is discussed first, followed by the influence of other meta-linguistic and background variables.

4.3.1 Influence of L1 background on Chinese phonological awareness and Pinyin spelling

Influence of L1 background was observed in both phonological awareness and Pinyin spelling among the Arabic and English CSL learners in this study. However, the two CSL groups also showed similarities in some measures such as tone awareness/spelling. Thus, both group differences and similarities between Arabic and English CSL learners are discussed here.

Group differences in Chinese phonological awareness and Pinyin spelling between the Arabic and English CSL learners

Numerous studies have documented the influence of L1 background on phonological awareness and spelling skills, especially among ESL learners and CSL learners. The impact of L1 transfer has been observed on different levels of phonological awareness and spelling skills, such as consonant and vowel learning among ESL learners (Allaith, 2009; Allaith &

Joshi, 2011; Figueredo, 2006; Ibrahim, 1978; Ryan & Meara, 1991; Saigh & Schmitt, 2012), and onset-rhyme awareness (Gao, 2001, 2004; Tian, 2003), syllable awareness (Gao, 2001; Tian, 2003), onset and rhyme spelling (Hu, 2010; Lin, 2009) among CSL learners. Consistent with previous studies, the present research found significant between-group differences in onset awareness/spelling, rhyme spelling and syllable awareness/spelling in the Chinese language among the Arabic and English CSL learners.

Onset awareness and onset spelling

Previous studies have revealed the influence of L1 transfer on onset spelling, such as the confusion between /b/ and /p/ in English for the Arabic ESL learners (Allaith, 2009; Allaith & Joshi, 2011; Ibrahim, 1978; Saigh & Schmitt, 2012) and the errors in spelling /θ/, /ʃ/ and /ð/ for Chinese ESL learners (He, 2001; Wang & Geva, 2003b). Considering the differences in consonants and onsets between Arabic, English and Chinese, it was hypothesized that the two CSL groups would differ in onset awareness and spelling. The results were in line with the hypothesis. The English group performed better in onset awareness and spelling than did the Arabic group. Two general reasons may account for the observed differences, one is related to the cross-language similarities and differences, and another is related to the different listening skills in the two CSL groups.

English and Chinese Pinyin are similar in terms of syllable structure, onset structure, articulation method and orthographic representation, in which the Arabic and Chinese demonstrate huge differences. These similarities and differences might lead to the significant between-group differences in the measures of onset awareness/spelling between the Arabic and English CSL learners.

First, English and Chinese syllables have a similar onset-rhyme structure, yet Arabic syllable has a body-coda structure. Take the C_1VC_2 syllable structure for example, C_1V is perceived more cohesive in Arabic (Saiegh-Haddad, 2007), yet VC_2 is perceived more cohesive in Chinese (Wang & Gao, 2011) and English (Fudge, 1969, 1987; Kessler &

Treiman, 1997; Treiman, 1983, 1985, 1986). Different syllable structures in L1 might influence the perception of onset in L2. For instance, a set of three syllables testing onset awareness in this study were “chōng-qiū-qī”, in which <chōng> was the target odd syllable. The accuracy rate in this set in the Arabic CSL group (M=0.52, SD=0.51) was the lowest among the eight sets, yet the accuracy rate in the English CSL group was much higher (M=0.80, SD=0.41). One may assume that the errors originated from the common confusion between <ch> (/ʈʂ^h/) and <q> (/tɕ^h/) among the Arabic CSL learners. However, in the task of onset spelling, the error of replacing <q> with <ch> or vice versa was rare, and it was only found in three cases. Therefore, it could be the different syllable structures in Arabic and Chinese that led the Arabic CSL learners to perceive <qiū> and <qī> as two syllables with different onsets.

Second, the acquired English onset awareness by English CSL learners might facilitate their acquisition of onset awareness/spelling in Chinese. The English CSL learners might have developed advanced onset awareness in English due to the intensive input in English orthography, as explained by the Psycholinguistic Grainsize Theory (Ziegler & Goswami, 2005), which claims that the development of the awareness of smaller grain size such as onset is speeded by the initiation of formal literacy education. As the English CSL learners were adults, thus they could have possessed the ability to distinguish and to manipulate the onsets in English. The Transfer Facilitation Model (Koda, 2008) argues that the development of meta-linguistic awareness competency in L2 is facilitated by the corresponding available meta-linguistic awareness in L1. Therefore, it might be easier for the English CSL learners to acquire the onset awareness/spelling in Chinese, in comparison with the Arabic CSL learners, who, in contrast, might possess a body awareness, rather than onset awareness.

Third, Chinese and English share more similarities in consonants used in onsets in terms of articulation methods. On the one hand, the voicing consonant pairs /p/-/p^h/, /t/-/t^h/ and /k/-/k^h/ in Chinese have similar corresponding consonant pairs in English /p/-/b/, /t/-/d/, and /k/-

/g/, yet only /t/-/d/ exists in Arabic. Take the syllable <bàng> for example, the English CSL group's accuracy rate in spelling the onset <b> was 1.00, yet the Arabic CSL group's accuracy rate was only 0.66. The most common error in spelling the onset of syllable <bàng> committed by the Arabic CSL learners was substituting <b> with <p>, similar to the error of replacing /p/ with /b/ by Arabic ESL learners (Figueredo, 2006; M. H. Ibrahim, 1978; Ryan & Meara, 1992; Saigh & Schmitt, 2012; Allaith, 2009; Allaith & Joshi, 2011). On the other hand, some of the Chinese consonants are not present in Arabic, yet similar consonants exist in English. Take the consonant <q> (/tɕʰ/, voicing alveolo-palatal sibilant affricate) for instance, Arabic does not have a similar consonant, yet English has a similar consonant /tʃ/ (voiceless palate-alveolar sibilant affricate). The Arabic CSL group's accuracy rate in spelling the onset of <qiū> was only 0.55, yet the accuracy rate in English CSL group reached 0.88. However, the similarities between Chinese and English do not guarantee positive transfer, and negative transfer could also occur. For example, the English CSL group's accuracy rate in spelling the onset of <zhǎ> was only 0.55, yet the accuracy in the Arabic CSL group was 0.88. The most common error observed in the English CSL learners was substituting <zh> (/ʈʂ/, voiceless retroflex sibilant affricate) with <j>(/tɕ/, voiceless alveolo-palatal sibilant affricate), which is similar to the English consonant /dʒ/ (voiceless palato-alveolar sibilant affricate). Although negative transfer from English to Chinese was found, the general similarities in consonants between English and Chinese could still account for the English CSL group's better performance in onset awareness and onset spelling.

Fourth, the orthographic representations of the similar phonemes in Chinese and English are similar. Chinese and English use the same Roman alphabet to represent the phonemes, but Arabic mainly use Arabic script. For instance, the graphic representations of the phoneme /m/ are <m> in Chinese, <m> in English and <م> in Arabic. Though the Romanized Arabic is in use in daily life, yet it is still an auxiliary script for Arabic language. Therefore, compared with the Arabic CSL learners, the English CSL learners' extensive exposure to Roman script that is also utilized in Chinese Pinyin could facilitate the better development of onset awareness and onset spelling.

Another general reason accounting for the English CSL group's higher achievement in Chinese onset may link with their better listening skills in Chinese. In the Chinese language proficiency test (HSK), the English CSL group outperformed the Arabic CSL group in the listening section, indicating that the English participants demonstrated better listening skills. This may be largely due to the fact that a majority of English CSL learners had experience of staying in China, yet the Arabic participants did not have a similar experience. Staying in the L2-speaking country brings intensive exposure to listening, which is essential for the development of listening skills. The large amount of input in listening and output in speaking in China is of great advantage for the CSL learners in improving listening skills, as reported in studies which showed a robust contribution of studying abroad in a L2-speaking country to the development of listening skills (Brecht & Davidson, 1991; Freed, 1995b; Lafford, 1995; Meara, 1994).

To summarize, the similarities in syllable structure, consonant articulation and orthographic representation between Chinese and English, the English CSL learners' English onset awareness, and the English CSL group's better listening skills may have led to better performance in onset awareness/spelling in the English CSL learners in comparison to the Arabic CSL learners.

Rhyme spelling

The main component of rhyme is vowel, which differs across languages. Different language speakers are more likely to show unique patterns in rhyme awareness or rhyme spelling due to the influence of L1 transfer, which has been well documented in a large amount of literature involving ESL learners (Ibrahim, 1978; Ryan & Meara, 1991; Saigh & Schmitt, 2012) and CSL learners (He, 2001). Both English and Chinese have a large inventory of vowels, yet Arabic has only six vowels, therefore, it was hypothesized that the

English CSL learners would perform better in rhyme spelling than Arabic CSL learners. The results were in agreement with the hypothesis. The English CSL group's superiority in rhyme spelling may relate to four reasons.

The first reason relates to the similar rhyme structures in Chinese and English. The syllables in Chinese and English are made up of onset and rhyme. The position of rhyme allows for both vowels and consonants in Chinese and English, though Chinese rhyme allows for only a limited number of consonants, such as /n/ and /ŋ/. However, Arabic syllable has a body-coda structure. The coda position in Arabic syllable is mainly composed of consonants, different from the Chinese and English rhymes. This could be reflected in the Arabic CSL group's poor performance in spelling rhymes <uai> and <ia>, in which the dominant error pattern was replacing the target rhymes with <uan> and <ian>, respectively. The Arabic CSL learners' reliance on consonant in L1 might have led to their tendency to end a Chinese syllable with a consonant.

The second reason is associated with the similarity in vowels between Chinese and English. Chinese and English have a large inventory of vowels, and share certain common vowels, yet Arabic has only six single vowels. The three languages only share three common vowels: /a/, /i/ and /u/. In addition, Chinese and English share some similar diphthongs and vowel cluster. Thus, Chinese rhymes may pose more difficulty for the Arabic CSL learners, similar to the difficulty of learning English vowels for the Arabic ESL learners (M. H. Ibrahim, 1978; Ryan & Meara, 1992; Saigh & Schmitt, 2012). For instance, /u/ is a common vowel in the three languages, and the English and Arabic CSL group's accuracy rate in spelling the single rhyme <u> of <chū> was 1.00 and 0.91, respectively. However, the two CSL groups differed in spelling Chinese complex rhymes. Take <uai> in <guài> for example, the accuracy rate was 0.90 for the English CSL group, yet the Arabic CSL group showed poorer performance (0.36). However, just like the case with onsets, the similarities in vowels between English and Chinese do not necessarily lead to positive transfer, which is consistent with the finding that the users of Roman scripts produced more spelling errors than the users of non-Roman script (Oller & Ziahosseiny, 1970). In the task of Pinyin spelling, the Arabic group outperformed the English group in spelling the single rhymes in two syllables-<mò> (Arabic, M=0.86; English, M=0.65) and <zhǎ> (Arabic, M=0.77; English, M=0.48). In the English CSL learners, the most common error in spelling the rhyme of <mò> was substitution of <o> with <uo>, and the most common error in <zhǎ> was replacing <a> with <ia>, yet these errors were rarely observed in the Arabic CSL learners. However, the large vowel repertoire in English might be a big advantage for English CSL learners to develop perception and production skills required in the task of rhyme spelling, in comparison to the Arabic CSL learners.

The third reason is that Chinese Pinyin and English alphabet use the same 26 Roman letters, and have similar orthographic representation of similar vowels, yet Arabic has different graphic representations for the same phonemes. For instance, the two common single vowels /a/ and /i/ have same graphic representations in Chinese and English-<a> and <i>, yet their graphic representations in Arabic are two diacritics < َ > for /a/ and < ِ > for /i/. The common script used in Pinyin and English is probably another advantage for English CSL learners. This finding is similar to the results of the study by Cook (1997) who found that Arabic and Hebrew speakers committed more English spelling errors than did the users of Roman scripts.

The last potential reason is that English group had better listening skills. As discussed in the onset section, a majority of the English CSL learners stayed in China for about one year, and might have been intensively exposed to Chinese listening. The better listening skills may be an advantage for the English CSL learners' skills in perceiving and producing Chinese rhymes.

To summarize, the English group's better performance in spelling Chinese rhymes may be accounted for by the typological similarities in rhyme structure, vowels, and orthographic representation in both English and Chinese Pinyin, as well as the English CSL group's better listening skills.

Syllable awareness and syllable spelling

As noted in the literature review section above, different languages have different syllable structures, which influences the performance in syllable learning in L2, such as the Japanese CSL learners' poor performance in Chinese syllable awareness (X. Gao, 2001; Tian, 2003) and Chinese ESL learners' potential difficulty in perceiving English syllables (Chen, 2011; Chen et al., 2010; Sun et al., 2013). English and Chinese have similar onset-rhyme syllabic structure, yet Arabic syllable has a body-coda structure, thus it was hypothesized that English CSL group would outperform the Arabic CSL group in syllable awareness and syllable spelling. The results were in line with this hypothesis. Considering English CSL participants' better performance in onset awareness/spelling, and rhyme spelling, it is not surprising to find English CSL learners' better achievements in syllable awareness/spelling. In addition to the better listening skills in the English CSL group and the similar orthographic representation used in English and Chinese Pinyin mentioned above, the two CSL groups' different performances in syllable awareness/spelling may also relate to the syllabic structure in the three languages.

As discussed above in the onset and rhyme sections, Chinese and English syllables include an onset part and a rhyme part, and Arabic syllable includes a body part and a coda part. Previous studies have found that the preference in processing subsyllablic units in L2 was influenced by the syllable structure in L1(Chen, 2006; Yoon, Bolger, Kwon, & Perfetti, 2002). For instance, young Chinese ESL learners tended to perceive an English syllable as a core syllable plus appendices (Chen, 2006, 2011), which was assumed to be influenced by Chinese syllable structure which typically consists only of a consonant and a vowel. Thus, the similarities and differences in the syllable structures in the three languages may be a potential reason for the different performance in perceiving and producing Chinese syllables in the Arabic and English CSL learners.

The developmental order of the subcomponents of Chinese phonological awareness

The impact of L1 background on the development of the subcomponents of phonological awareness has been reported in Chinese ESL learners (Catherine McBride-Chang et al., 2004; Sun et al., 2013; X. Chen, Xu, Nguyen, Hong, & Wang, 2010) and CSL learners speaking different languages (Gao & Gao, 2005; Gao, 2001; Shao, 2007; Tian, 2003; Zhang & Wu, 2007). Given that Arabic, Chinese and English differ in syllabic structure, consonants and vowels, it was hypothesized that the Arabic and English CSL groups would demonstrate different patterns in the developmental order of the subcomponents of Chinese phonological awareness. The results were partially in line with the hypothesis. On the one hand, the two CSL groups did not differ in the relative development rate of tone and rhyme awareness (discussed later). On the other hand, the two CSL groups differed in the development of onset and syllable awareness. The Arabic CSL group developed tone awareness earlier than syllable, onset and rhyme awareness, yet the English CSL group developed the syllable, onset and tone awareness earlier than rhyme awareness.

The observed development trajectory in the Arabic and English CSL learners are different from those in the previous studies conducted in CSL learners with different L1 backgrounds (L. Gao & Gao, 2005; X. Gao, 2001; Shao, 2007; J. Zhang & Wu, 2007; Tian, 2003), and also in disagreement with the large-to-small pattern in development of phonological awareness in the Psycholinguistic Grain Size Theory proposed by Zielger & Goswami (2005). The difference in the development patterns of Chinese phonological awareness in the Arabic and English CSL learners lies in the onset and syllable awareness, and this between-group difference might relate to the extent to which the Arabic and English languages are similar to the Chinese language in terms of phonological properties. As discussed above, the typological distance between English and Chinese is much closer that that between Arabic and Chinese. According to the Transfer Facilitation Model (Koda, 2008), the meta-linguistic competency in English could be more beneficial for the growth of meta-linguistic capabilities in learning Chinese for the English CSL learners, in comparison to the Arabic CSL learners. Therefore, the English CSL learners might have developed awareness of syllabic structure and onset in Chinese earlier than did their Arabic counterparts. This could be the main reason for the higher accuracy rates in onset and syllable awareness in the English CSL learners. In contrast, the similar performance in onset, syllable and rhyme awareness in the Arabic CSL learners indicates that they have relatively low competency at both large and small levels in Chinese phonological awareness.

The Arabic and English CSL learners demonstrated differences as well as similarities in phonological awareness and Pinyin spelling. Following the discussion on the differences, the next section focuses on the similarities.

Group similarities in Chinese phonological awareness and Pinyin spelling between the Arabic and English CSL learners

L2 learning is influenced by cross-language differences as well as the intra-language characteristics. In line with previous studies that reported similar performances in English spelling among ESL learners speaking various L1s (Cook, 1997; Dixon et al., 2010; Holm & Dodd, 1996; Oller & Ziahosseiny, 1970), the present study found that the Arabic and English CSL groups did not differ in some parts of Chinese phonological awareness and Pinyin spelling, which could be explained by the intra-language features in the Chinese language. Group similarities were observed in rhyme awareness, tone awareness/spelling, the development of rhyme and tone awareness and the development of the subcomponents in Pinyin spelling.

Rhyme awareness

Rhyme is the core part in English and Chinese syllables, and it is compulsory. The primary unit in a rhyme is a vowel, which differs greatly in English, Chinese and Arabic. Studies have revealed the influence of L1 background on vowel and rhyme in learning

English as a second language (He, 2001; Oller & Ziahosseiny, 1970; Ryan & Meara, 1991; Saigh & Schmitt, 2012) and Chinese as a second language (Gao, 2001, 2004; Tian, 2003). It was hypothesized that the English CSL group would perform better in rhyme awareness than the Arabic CSL group. However, the results were in conflict with this hypothesis. The differences in rhyme awareness between the Arabic and English CSL groups were not significant. This unexpected observation could be attributed to the difficulty of rhyme learning, negative transfer from English, and the Arabic CSL group's exposure to rhyme structures.

First, Chinese rhymes are more difficult to learn, in comparison to onset. The Chinese language has 39 rhymes, which have greater phonological saliency than onsets (Zhu & Dodd, 2000). Rhymes are essential in Chinese syllables as no Chinese syllable can exist without a rhyme. The difficulty of the rhyme acquisition could be reflected by the relatively lower accuracy rates in rhyme awareness (Arabic, 0.68; English, 0.74) and rhyme spelling (Arabic, 0.74; English, 0.87), compared with onset awareness (Arabic, 0.73; English, 0.87) and onset spelling (Arabic, 0.86; English, 0.93) among the Arabic and English CSL learners in the present study.

Second, English and Chinese share a small number of same or similar rhymes and vowels, and have a large inventory of different rhymes and vowels. On the one hand, the similar vowels and rhymes may cause confusion for English CSL learners, a problem that Arabic CSL learners were less likely to face due to the limited number of vowels in Arabic. For instance, in the set of <līn>-<xīn>-<dīng> in which <dīng> was the target item, the Arabic CSL group (M=0.80) outperformed the English CSL group (M=0.46). That is to say, the transfer from English vowels and rhymes may be negative in learning Chinese rhymes for the English CSL learners, yet the interference from Arabic vowels is unlikely to happen. On the other hand, the different vowels and rhymes may pose similar difficulty for both Arabic and English CSL learners. For instance, in the set of <dùn>-<fèn>-<gùn> in which

<fèn> was the odd one, both the Arabic and English CSL learners showed similar accuracy rates (Arabic, M=0.59, SD=0.50; English, M=0.58, SD=0.50).

The third reason may be related to the Arabic CSL group's exposure to vowel/rhyme learning. The Arabic group has learnt English prior to learning the Chinese language, and they used English-medium Chinese language textbooks. Therefore, the Arabic CSL group could have been exposed to a certain amount of input of English rhymes. Considering the studies that reported the significant influence of L2 on L3 (Hamarberg, 2001; Ringbom, 1987), the experiences in using English could be helpful for the perception skills of Chinese rhymes for the Arabic CSL learners.

To conclude, the unexpected nonsignificant difference in rhyme awareness among the Arabic and English CSL groups may relate to the difficulty of rhyme perception, negative transfer from English vowel/rhyme, and the Arabic CSL learners' exposure to rhymes in English and Chinese.

Tone awareness and tone spelling

Tone is a suprasegmental feature in Chinese, and it is used to distinguish the meanings of the morphemes that otherwise have the same syllable. Influence of L1 background on tone learning has been reported between the CSL learners with and those without tonal background (Wu, 2008). Because neither Arabic nor English has tones, it was hypothesized that English and Arabic CSL groups would not differ in tone awareness or tone spelling. The results were in line with this hypothesis. This could be explained by the lack of tones in Arabic and English, as well as by the task of measuring tone awareness.

Similar performance in tone learning among the CSL learners with no tonal language background has been documented in previous research with CSL learners speaking Japanese, Korean and English as a native language (Gao & Gao, 2005; Gao, 2004). The main difference in learning Chinese tones for these CSL learners is that their first languages do not have similar phonological units as the Chinese tone. According to the Transfer

Facilitation Model (Koda, 2008), the available meta-linguistic competency in L1 is beneficial for the development of corresponding meta-linguistic competency in L2, such as L1 transfer to L2 in phonological awareness. However, for CSL learners with no tonal language background, similar tone awareness is not available in their L1s, thus their skills in perceiving and discriminating different Chinese tones mainly depends on the amount of exposure to tones in Chinese learning, rather than on L1 transfer. Considering that the Arabic and English demonstrated similar performance in the Chinese language proficiency test, it is not surprising to find the similar performance in tone awareness between the Arabic and English CSL learners in the present study.

Another potential reason may relate to the task. The tone awareness was measured in the form of the oddity test, which required the participants to detect the odd item among a set of three items. In each set, the three items had the same rhyme. The same rhyme was chosen because tone is closely attached to rhyme, and the pitch of the same tone may differ in different rhymes (Duanmu, 2007). Thus, the practice of selecting same rhymes was to make the impact of rhyme minimal. The Chinese language has only four tones, it is relatively easy to perceive and distinguish the differences of the four tones, compared with the onsets and rhymes. This may explain the high accuracy rates in tone awareness in the Arabic and English CSL groups. It is worthy to note that the accuracy rates in tone awareness in the two groups of native speakers were as high as 0.83 in the Arabic group and 0.93 in the English group. Thus, the results at least showed that the oddity test in tone awareness was relatively easy for the native speakers of Arabic and English and the Arabic and English CSL learners, leading to the ceiling effect. This finding was consistent with the studies by Yopp (1988) and Stanovich, Cunningham, and Cramer (1984), which revealed that the rhyming task was the easiest in testing phonological awareness.

The developmental order of the subcomponents of Chinese phonological awareness and Pinyin spelling

The development of the different units in phonological awareness has been discussed in the framework of Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005), which claims that phonological awareness progresses from large level (syllable) to small level (onset, rhyme and phoneme). Previous studies involving native Chinese-speaking children (McBride-Chang et al., 2008; Shu et al., 2008; Tong, 2008; Yeh, 2012) and CSL learners (Gao & Gao, 2005; X. Gao, 2001; Shao, 2007; Tian, 2003; Zhang &Wu, 2007) reported different results. In this study, the developmental order of the subcomponents of Chinese phonological awareness across the Arabic and English CSL groups showed both similar and different patterns. The different patterns have been discussed above, thus this section focuses on the similar aspect. Furthermore, the Arabic and English CSL groups demonstrated a uniform tendency in the developmental order of the subcomponents of Pinyin spelling.

The similar pattern in the development of tone awareness and rhyme awareness is discussed first. Previous research in native Chinese-speaking children revealed similar pattern with regard the development of syllable, onset, rhyme and phoneme awareness, which followed a large-to-small pathway (Ziegler & Goswami, 2005), yet the results of the development of tone awareness were inconsistent (McBride-Chang et al., 2008; Shu et al., 2008; Tong, 2008; Yeh, 2012). In addition, different results on the developmental order of tone and rhyme awareness were reported in the CSL learners, yet the common pattern is that rhyme and tone developed synchronically, which might result from the close link between tone and rhyme (L. Gao & Gao, 2005; X. Gao, 2001; Shao, 2007; Zhang &Wu, 2007). However, the present study found that tone awareness developed earlier than rhyme awareness in the CSL learners, which could be interpreted from the status of tone and rhyme in Chinese phonological awareness.

The perception skills of Chinese tones appear to emerge very early among the CSL learners. The superior performance in tone awareness by CSL learners in this study was in line with the finding reported among Chinese-speaking children (Chen, Ku, Koyama, Anderson, & Li, 2008; Xu et al., 2004). There are several reasons accounting for this phenomenon. In addition to the lack of tone in Arabic and English, and the odd-man-out test in measuring tone awareness, there are other two reasons related to the nature of the tone. One reason relates to the phonological saliency of tone in Chinese (Zhu & Dodd, 2000). Tone is proposed to possess the strongest phonological saliency compared to rhyme and onset. There are only four tones in Chinese, and the tones are compulsory and are used to distinguish different lexical or grammatical meanings. Another reason is associated with the unique nature of tone in Chinese phonological awareness. The role of tone in Chinese phonological awareness is still not clear (Branum-Martin, Tao, & Garnaat, 2015; Chen et al., 2004; Chen et al., 2008). In the various tasks of Chinese phonological awareness, tone awareness appears to demonstrate a different relationship with the single ability of Chinese phonological awareness, yet onset, rhyme and syllable awareness represent the same underlying construct in Chinese. Therefore, tone awareness may be "a different construct from onset-rime awareness with Mandarin" (Chen et al., 2008, p. 416). In a nutshell, the phonological saliency and the suprasegmental nature of tones may lead to the most rapid development of tone awareness in the Arabic and English CSL learners.

Of the four components of Chinese phonological awareness, rhyme awareness developed very slowly, as demonstrated by the low accuracy rate in rhyme awareness in the two CSL groups. This finding is in line with previous research (Shao, 2007), yet contrary to some studies that reported the earlier development of rhyme awareness than onset awareness (Gao & Gao, 2005; Wu, 2008). The slow development of rhyme awareness in Arabic and English CSL learners might be linked with the learning difficulty of Chinese rhymes. The Chinese language has a larger number of rhymes in comparison with tones and onsets. In addition, some rhymes have similar pronunciations and are difficult to distinguish, even for native Chinese-speaking children (Chen, Li, Li, Wang, & Wu, 2013), such as the distinction between /in/ and /iŋ/. Chinese rhymes may pose greater difficulties for the Arabic CSL learners with consonant-dominant L1 background. Although the earlier development of rhyme awareness observed in previous studies was mainly explained by the phonological saliency of rhymes (Zhu & Dodd, 2000), the results in the present study indicate that the development of rhyme awareness among the CSL learners may also be affected by its learning difficulty. For the Arabic and English CSL learners, the learning difficulty might override the phonological saliency of rhymes, leading to a less good performance in the task of distinguishing between different rhymes.

Next, the similar pattern in the development of the subcomponents of Pinyin spelling is discussed. Previous studies involving CSL learners paid little attention to Pinyin spelling (Hu, 2010; Lin, 2009). It was hypothesized that the Arabic and English CSL learners would demonstrate different patterns in the development of Pinyin spelling because English and Arabic differ in syllabic structure and the vowel repertoire. The results in the present study are in disagreement with the hypothesis. The two groups of CSL learners performed best in onset spelling, less well in rhyme spelling, and worst in tone spelling. The findings are contrary to the theory of phonological saliency (Zhu & Barbara, 2000), and they might be caused by the relative learning difficulty.

As mentioned above, rhyme spelling is more difficult than onset spelling. First, The Chinese language has 39 rhymes, but only 22 onsets. Second, only six Chinese rhymes are made up by single graphemes, and other rhymes are constituted by two or three graphemes, whereas only three onsets are constituted by two graphemes, and other rhymes are single-grapheme onset. Third, most of the Chinese rhymes are not present in Arabic or English, yet Arabic, Chinese and English share common onsets. These three reasons may explain the participants' better performance in spelling onsets and poorer performance in spelling rhymes. In addition, the low accuracy rate in rhyme spelling in this study is consistent with the observed high percentage of vowel errors in spelling among English-speaking children (Bebout, 1985; Wyatt, 1973).

As for the poorest performance in tone spelling, it might be related to three possible factors. Although there are only four tones in Chinese, tones are the most difficult in the task of spelling, similar to the highest error rate in tone in Pinyin typing in English CSL learners (Guan, Liu, Chan, Ye, & Perfetti, 2011). The first reason could be the lack of tone in the Arabic and English CSL learners' L1s. Tone is a suprasegmental feature in Chinese, its role in distinguishing lexical meaning works via the different pitch contours. Because neither Arabic nor English has a similar phonological unit to tone, the Arabic and English learners might encounter a great challenge in tone learning. Another reason could be due to its close link with Chinese rhymes. It is known that Chinese rhymes are difficult for the CSL learners to acquire. Given the fact that tones are marked above rhymes in Chinese Pinyin, the difficulty in tone spelling might also be associated with rhyme learning. The third reason might relate to the procedure of Pinyin spelling. The common practice in Pinyin spelling is to write tone after onset and rhyme. As the short-term memory is limited, thus the storing of the tonal information in the working memory may be restricted. The CSL learners had less time and less working memory to process the tone in the spelling, resulting in less good performance in spelling tones.

To conclude, the Arabic and English CSL groups' better performance in tone awareness and worse performance in rhyme awareness is associated with the nature of tone and rhyme in Chinese phonological awareness and the task of odd-man-out test, yet the two CSL groups' similar tendency in the development order of the subcomponents of Pinyin spelling might be related to the relative learning difficulty of the subcomponents of Pinyin syllable and the process of Pinyin spelling.

Following the above discussion on the Arabic and English CSL learners' different and similar performance in phonological awareness and Pinyin spelling, the next section discusses the influence of other meta-linguistic and background variables on these measures among the two groups.

4.3.2 Influence of other meta-linguistic and background variables on Chinese phonological awareness and Pinyin spelling

The impact of other meta-linguistic and background variables on second language learning has been well documented in previous studies (Dörnyei, 2005), such as language proficiency (Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001), language aptitude (Hu et al., 2013; Li, 2015; Smemoe & Haslam, 2013; Winke, 2013), previous language learning experience (Ehrman & Oxford, 1995) and studying abroad in L2-speaking country (Aveni, 2005; Brecht, Davidson, & Ginsberg, 1995; Carroll, 1967; Collentine, 2009; Freed, 1995a; Freed, 1998; Meara, 1994). Five significant variables were found in the measures of phonological awareness and Pinyin spelling, and they were Chinese language proficiency, the length of stay in China, the number of languages learnt, phonetic coding ability and phonological working memory.

Chinese language proficiency has been found to be the most common predictor in phonological awareness and Pinyin spelling. Firstly, the main effect of Chinese language proficiency level was found in most measures of phonological awareness (syllable and onset) and Pinyin spelling (syllable, onset, rhyme and tone), in which the intermediate CSL learners outperformed their pre-intermediate counterparts. Secondly, Chinese language proficiency as a significant predictor was observed in syllable awareness and rhyme spelling in the intermediate English CSL group, tone spelling in the intermediate CSL group, onset and syllable spelling in the pre-intermediate Arabic CSL group. The results are consistent with previous research that reported similar findings among CSL learners (Gao & Gao, 2005; Gao, 2011; Tian, 2003; Zhang & Wu, 2007). L2 Chinese language proficiency and the performance in phonological awareness and Pinyin spelling are closely related. Pinyin is generally introduced at the beginning stage of Chinese learning as the main medium writing system in the classroom. It is known that Pinyin is phonemic and its structure corresponds to the syllable structure in Chinese. Therefore, more experience in using Pinyin could lead to better awareness of the phonological structure in Chinese and better skills in Pinyin spelling, which in turn contributes to the learning of Hanzi whose pronunciation is represented using Pinyin. Thus, these findings are not surprising. However, an unexpected finding is that Chinese language test scores negatively predicted syllable awareness in the intermediate English CSL group. One possible reason might relate with the intermediate English CSL learners' experience of studying abroad in China. Their experience of staying in China could lead them to rely more on Hanzi rather than Pinyin for the purpose of communication due to the dominant status of Hanzi in mainland China. Thus, the intermediate English CSL learners might activate the orthographic features of corresponding Hanzi on hearing the disyllables, which could interfere with their performance in detecting the differences between the displayed syllables. More evidence is needed to account for this assumption.

The length of stay in China as a significant predictor was found in the performance in syllable spelling in the pre-intermediate English CSL group and onset spelling in the intermediate English CSL group. This finding is consistent with previous research that demonstrated a positive contribution of studying abroad in an L2-speaking country to the development of listening skills (Brecht & Davidson, 1991; Freed, 1995b; Lafford, 1995; Meara, 1994). Listening skills are the basis of correct spelling, as the first stage of spelling requires correct perception and segmentation of the spoken words (Tainturier & Rapp, 2001). Generally speaking, living or studying in an L2-speaking country brings forth extensive exposure to L2 and intensive interaction with L2 speakers, the huge amount of input is beneficial for the development of listening skills, which further facilitates spelling performance. In the English CSL group, some learners had experience of staying or studying in China, which might bring them an advantage in listening skills in comparison to their counterparts who did not have similar experience.

The number of languages previously learnt predicted the achievement in syllable awareness in the pre-intermediate Arabic CSL group. This finding accords with the results in the study conducted by Ehrman and Oxford (1995) which found the positive contribution of the number of previous languages to language learning. These results suggest that learning more languages is beneficial for the success in acquiring another language, as well as the development of meta-linguistic awareness such as syllable awareness in the target language. That is to say, more experience in learning different languages could help an individual gain better sensitivity to the phonological structure in a novel language.

Phonetic coding ability was found to contribute to the performance in tone awareness, rhyme awareness in the whole CSL group, syllable spelling in the pre-intermediate and intermediate Arabic CSL groups. This accords with earlier studies, which reported the strong relationship between phonetic coding ability and phonologically related skills (Hu et al., 2013; Smemoe & Haslam, 2013). The phonetic coding ability tested in this study was the capability to detect the grapheme-phoneme correspondence rules in an artificial language. Stronger phonetic coding ability might guide the CSL learners to detect the grapheme-phoneme corresponding rules in alphabetic Pinyin, which further contributes to the performance in Pinyin spelling. This study extends the close link between phonetic coding ability with language learning to Pinyin in the CSL learners speaking alphabetic L1s.

The present thesis found that phonological working memory negatively predicted the performance in onset awareness in the intermediate Arabic CSL learners. This finding is contrary to the general finding about the positive role of working memory in foreign language learning (Ellis, 1996). A possible reason might relate to the artificial language used in the task of measuring phonological working memory. In the section of LLAMA-D for phonological working memory in LLAMA tests (Meara, 2005), the artificial language was based on an aboriginal language in Northern America, which might show greater differences to Arabic in comparison to English. Detailed analysis of the artificial language could reveal stronger evidence for this explanation.

4.4 Conclusion

The purposes of the current study were to examine how L1 background and other meta-linguistic and background variables influenced the acquisition of Chinese phonological awareness and Pinyin spelling skills. The following conclusions can be drawn from the present study.

First, L1 background influenced most measures of Chinese phonological awareness (syllable, onset, rhyme), Pinyin spelling (syllable, onset, rhyme) and the general development order of the subcomponents of Chinese phonological awareness among the Arabic and English CSL learners. The observed between-group differences in these measures may be related to the extent to which Arabic and English are similar to Chinese in terms of phonological characteristics, as well as the different Chinese listening skills among the two CSL groups.

Second, L1 background did not influence tone awareness/spelling and the developmental order of the subcomponents of Pinyin spelling among the Arabic and English CSL learners. The non-significant difference in tone-related skills might be associated with the lack of tone in Arabic and English, and the similar developmental order of the subcomponents of Pinyin spelling could be associated with the relative difficulty in learning these phonological units.

Third, in terms of other meta-linguistic and background variables, Chinese language proficiency, the length of stay in China, phonetic coding ability, and the number of languages previously learnt were found to be significant predictors in different measures of Chinese phonological awareness and Pinyin spelling. However, phonological working memory and Chinese language proficiency negatively predicted the performance in some measures.

Chapter Five: Influence of L1 background and other meta-linguistic and background variables on phonetic radical awareness and Hanzi literacy skills among CSL learners

Chinese uses two different writing systems, Pinyin and Hanzi. The previous chapter explored the influence of L1 background and other meta-linguistic and background variables on phonological awareness and Pinyin spelling among the Arabic and English CSL learners. However, it remains unclear as to how these two CSL groups performed in learning Hanzi. To answer this question, this chapter explores the influence of L1 background and other meta-linguistic and background variables on phonetic radical awareness, Hanzi reading and Hanzi writing skills among the Arabic and English CSL learners. The questions to be addressed in this chapter are as follows:

Research question 1. How do L1 background and other meta-linguistic and background variables influence the development of phonetic radical awareness among the Arabic and English CSL learners?

Research Question 2. How do L1 background and other meta-linguistic and background variables influence the reading skills of Arabic and English CSL learners in different types of Hanzi (regular, semiregular, irregular, LPR and RPR)?

Research Question 3. How do L1 background and other meta-linguistic and background variables influence writing skills of Arabic and English CSL learners in different types of Hanzi (regular, semiregular, irregular, LPR and RPR)?

5.1 Method

5.1.1 Participants

The participants included both CSL learners and native Chinese speaker controls (See Table 5.1). Eighty-three of the Arabic and English CSL participants in Chapter Four took part in this study. Using the same method in Chapter Four, the participants were assigned into pre-intermediate or intermediate CSL group according to their HSK scores. The Arabic group comprised 43 participants, with 23 pre-intermediate and 20 intermediate CSL learners, and the English group had 40 participants, with 17 pre-intermediate and 23 intermediate CSL learners. The results of independent-samples T-tests showed that the intermediate L2 learners outperformed their pre-intermediate counterparts in the Arabic group ($t(41)=10.57$, $p<0.0001$), in the English group ($t(38)=9.73$, $p<0.0001$) and in the whole CSL group ($t(81)=14.65$, $p<0.0001$). The mean age of the Arabic and English CSL participants were 19.58 years old (SD=0.70, min=18, max=21), and 20.55 years old (SD=1.32, min=18, max=26), respectively.

The average length of learning Chinese in the Arabic CSL group was 1 year for the pre-intermediate group (SD=0), 2 years for the intermediate group (SD=0), and 1.48 years for the whole Arabic group (SD=0.51, min=1, max=2). The average length of learning Chinese in the English group were 2.66 years for the pre-intermediate samples (SD=2.66, min=1, max=8), 2.7 years for the intermediate group (SD=1.49, min=2, max=7), and 2.65 years for the whole English group (SD=2.13, min=1, max=8).

Native Chinese speakers were recruited for control purposes. The Chinese group included 22 native Chinese speakers (male=10, female=12, average age=27.18, SD=4.98) recruited from a university in England. All the Chinese participants spoke Chinese as first language and English as a second language. The native Chinese speakers were recruited for the purpose of providing a standard in the performance in phonetic radical awareness. Whether the CSL learners have developed awareness of the functional and positional properties of phonetic radical could be examined by comparing the performance in phonetic radical awareness between the CSL learners and the native Chinese speakers.

Table 5.1

Details of the Arabic and English CSL Participants, and the Native Chinese Speakers

		Arabic	English	Chinese
Total number		43	40	22
Age (SD)		19.58(0.79)	20.55(1.32)	27.18(4.98)
Gender	Male	4	17	10
	Female	39	23	12
Academic year	2nd year	23	20	N/A
	3rd year	20	20	N/A
Number of participants	Level 1	23	17	N/A
	Level 2	20	23	N/A
HSK test scores (SD)	Level 1	6.17 (2.12)	6.65 (2.18)	N/A
	Level 2	12.25 (1.55)	12.43 (1.59)	N/A
Years of Chinese learning (SD)	Level 1	1(0)	2.66(2.66)	N/A
	Level 2	2(0)	2.70(1.49)	N/A
Years of staying in China (SD)	Level 1	N/A	1.07(1.95)	N/A
	Level 2	N/A	0.66(0.82)	N/A
Number of previous languages (SD)	Level 1	3.09(0.29)	3.24(0.66)	N/A
	Level 2	3(0)	3.30(0.63)	N/A

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

Years of living in China

No Arabic CSL participants reported that they had experience of living in China. In the English CSL group, the average length of staying in China was 1.07 years for the pre-intermediate group (SD=1.95, min=0, max=7), 0.66 year for the intermediate group (SD=0.82, min=0, max=4), and 0.84 year for the whole English group (SD=1.41).

The number of languages previously learnt

In the Arabic CSL group, the average number of languages previously learnt was 3.09 (SD=0.29, min=3, max=4) for the pre-intermediate group, 3 (SD=0, min=3, max=3) for the intermediate group, and 3.05(SD=0.21) for the whole Arabic group. In the English group, the average number of languages previously learnt was 3.24 (SD=0.66, min=2, max=5) for the pre-intermediate group and 3.30 (SD=0.63, min=2, max=5) for the intermediate group, and 3.30 (SD=0.65) for the whole English group. Most of the previous languages the participants reported were alphabetic, such as French, German and Spanish. In the English group, only two participants reported that they had experience in learning Japanese as a third language.

5.1.2 Instruments

In the present study, phonological aptitude was measured using LLAMA tests (Meara, 2005), Chinese language proficiency was examined by HSK test, phonetic radical awareness was measured using a task of pseudo-Hanzi naming, Hanzi reading and Hanzi writing skills were examined using self-developed tasks.

Phonological aptitude

The LLAMA tests used to measure phonological aptitude were the same as in Chapter Four (see Appendix 1).

Chinese language proficiency test

The test used to measure Chinese language proficiency was the same as in Chapter Four (See Appendix 2). The same method of redefining the pre-intermediate and the intermediate level in Chapter Four was used here. The Arabic and the English CSL learners did not differ in the overall HSK scores or the reading section of HSK test.

Phonetic radical awareness

To investigate the CSL learners' phonetic radical awareness, a task of pseudo-Hanzi naming was used in the present thesis. Similar tasks have been employed by researchers to explore the Chinese readers' and CSL learners' sensitivity to Hanzi radical (Ho et al., 2003; Shen et al., 1998; Tong & Yip, 2014; Yu, 1998; Yu et al., 1990). However, the selected Hanzi in previous studies are not suitable for the present study because the CSL learners in the present thesis came from different learning contexts and might demonstrate different proficiency in Hanzi recognition. Thus, new pseudo-Hanzi were invented (See Appendix 5).

In the task of pseudo-Hanzi naming, the participants were presented with 10 pseudo-Hanzi, and they were required to guess and to write down the pronunciation of the pseudo-Hanzi using Pinyin. Each pseudo-Hanzi was constructed as left-right structure by a pair of single Hanzi, which were selected from the most frequent Hanzi. Ten frequent single Hanzi that can be used as phonetic radical in Hanzi were selected. Two of the ten Hanzi frequently occur at the top position as phonetic radical, and the other eight Hanzi are commonly used in left-right structured Hanzi. The mean accuracy rate in reading the ten single Hanzi was 0.89 (SD=0.02, min=0.50, max=1.00) in the Arabic CSL group and 0.88 (SD=0.09, min=0.60, max=1.00) in the English CSL group, respectively. The Arabic and English CSL groups did not show significant differences in reading the single Hanzi, $t(81)=0.41$, $p=0.69$.

Each pair of single Hanzi was selected randomly to construct two pseudo-Hanzi that only differed in the positions of the radicals. Take 不 (bù, not) and 力 (lì, power) for example, they were used to construct two pseudo-Hanzi  and , which only differed in the positions of the single Hanzi. In , 不 was on the left side, and 力 was on the right side, yet the positions of these two single Hanzi were opposite in . In addition to the pseudo-Hanzi, five real Hanzi with low frequency were added as distractors. The time limit for this task was three minutes.

The analysis of the participants' performances in the task of pseudo-Hanzi naming focused on the use of the Hanzi on the right side because a majority of phonetic radicals appear on the right side in compound Hanzi. The participant's response in using the right-side single Hanzi could be generally categorized into three types. The first type was using single Hanzi to directly name the pseudo-Hanzi, termed as direct naming strategy, such as naming  as 也 <yě>. The second type was using another Hanzi with similar orthographic features as the right-side Hanzi to name the pseudo-Hanzi, labelled as similar Hanzi naming strategy. For instance, one might name  as <wáng>, as 主 (zhǔ) in the pseudo-Hanzi is very similar to 王 (wáng). The third type was using another Hanzi containing the right-side Hanzi to name the pseudo-Hanzi, labelled as family Hanzi naming strategy. Take  for example, one might name it as < tā > due to the influence of 他 (tā) or 她(tā) that share the radical 也 with the target pseudo-Hanzi.

Hanzi reading

The task of Hanzi reading required the CSL participants to read aloud the pronunciation of a list of Hanzi. The materials included 108 semantic-phonetic Hanzi (See Appendix 6). The selected Hanzi were balanced in regularity and position of phonetic radicals. In terms of the regularity of the phonetic radical, three types of semantic-phonetic Hanzi (regular, semiregular and irregular) were included in the task of reading, with 36 Hanzi for each type. In terms of the position of the phonetic radical, two types of Hanzi were included. One type was Hanzi with phonetic radical on the right side (RPR, right-side phonetic radical) and another type was that with phonetic radical on the left side (LPR, left-side phonetic radical). There were 54 LPR and 54 RPR Hanzi in the task of reading. All these Hanzi were selected from the beginner, intermediate and advanced levels in *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other*

Languages (Guojia yuwei, 2010), and they were balanced in frequency and stroke number (Institute of Big Data and Language Education, 2011). The details of the selected Hanzi was summarized in Table 5.2. ANOVAs showed that neither the three types of Hanzi with different degrees of regularity nor the two types of Hanzi with different positional structures differed in stroke number or frequency.

The selected Hanzi were printed on one A-4 paper, and were arranged from low frequency to high frequency. The participants were required to read aloud the Hanzi according to the numeric order. If they did not know, they were required to say "I don't know". The test stopped if the participant made five errors or did not respond to five Hanzi in a row. The time limit was three minutes. One point was given if the syllable was pronounced correctly, and 0 was given if the pronounced syllable was wrong or missed. Only the first attempt counted. The accuracy rate in reading each type of Hanzi was calculated by dividing the number of accurate answers by 108. The Cronbach's alpha reliability of Hanzi reading was 0.93.

Table 5.2

Details of the Selected Hanzi in the Task of Hanzi Reading

Type		N	Stroke number (SD)	Frequency (SD)
Regularity	Regular	36	9.53 (2.77)	0.0002 (0.0002)
	Semiregular	36	9.57 (2.50)	0.0002 (0.0003)
	Irregular	36	9.03 (2.51)	0.0005 (0.0015)
Position	LPR	54	9.63(2.92)	0.0002(0.0002)
	RPR	54	9.11(2.18)	0.0004(0.0013)

Note. LPR = left-side phonetic radical; RPR = right-side phonetic radical

Hanzi writing

The task of Hanzi writing required the CSL participants to write Hanzi according to the displayed Pinyin and the meaning presented in their L1. The materials included 24 Hanzi (See Appendix 7). The selected Hanzi were balanced in the regularity and position of phonetic radicals. In terms of the regularity of the phonetic radical, three types of semantic-phonetic Hanzi (regular, semiregular and irregular) were included in the tasks of reading, with 8 Hanzi for each type. In terms of the position of the phonetic radical, two types of Hanzi were included. There were 12 LPR (left-side phonetic radical) and 12 RPR (right-side phonetic radical) Hanzi in the task of writing. All these Hanzi were selected from the beginner, intermediate and advanced levels in *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other Languages* (Guojia yuwei, 2010), and they were balanced in frequency and stroke number (BLCU-IBDLE, 2011). The details of the selected Hanzi for writing are displayed in Table 5.3. ANOVAs showed that neither the three types of Hanzi with different degrees of regularity nor the two types of Hanzi with different positional structures differed in the stroke number or frequency.

Table 5.3

Details of the Selected Hanzi in the Task of Hanzi Writing

Type		N	Stroke number (SD)	Frequency (SD)
Regularity	Regular	8	8.00(1.31)	0.0004(0.0007)
	Semiregular	8	8.00(1.51)	0.0004(0.0005)
	Irregular	8	9.13(1.46)	0.0005(0.0009)
Position	LPR	12	8.08(1.62)	0.0005(0.0008)
	RPR	12	8.67(1.30)	0.0003(0.0006)

Note. LPR = left-side phonetic radical; RPR = right-side phonetic radical

Hanzi writing was measured using a paper-and-pencil test. The participants were required to write the target Hanzi according to the displayed words in Pinyin and the translation. The Pinyin of the target Hanzi was bolded and italic. For example, the target Hanzi for "***dōu*** lái le, All came" is 都. One point was given for a correct Hanzi, and zero point was assigned to a wrong answer or unanswered item. The accuracy rate in writing each type of Hanzi was calculated by dividing the number of correct answers by 24. The Cronbach's alpha reliability of Hanzi writing was 0.80.

5.1.3 Procedure

This study was approved by the Ethics Committee in the Department of Education at the University of York. All participants were given informed consent which was printed in their native languages, Arabic, Chinese or English. The informed consents mainly informed them of the aim and the main tasks in the study, and the relevant ethic issues involved (See Appendix 9).

The Arabic and English CSL learners completed the tasks of phonological aptitude, Chinese language proficiency test, phonetic radical awareness, Hanzi reading and Hanzi writing. The native Chinese speakers were only tested on the measure of phonetic radical awareness. The instructions of the tests were presented in the participants' native language—Arabic, Chinese or English. All the participants were tested individually, and were given a small amount of cash or a small gift after successfully completing the test.

5.2 Results

The research questions in this chapter were how L1 background and other meta-linguistic and background variables influence the performance in (1) phonetic radical awareness in Hanzi, (2) Hanzi reading skills and (3) Hanzi writing skills among the Arabic and English CSL learners. The analysis of the results was organized as follows. Firstly, the accuracy rates in phonetic radical awareness, Hanzi reading and Hanzi writing are presented. Secondly, to understand the influence of L1 background on phonetic radical awareness, Hanzi reading and Hanzi writing skills among the Arabic and English CSL learners, a series of ANOVA tests were carried out. In addition, within-group repeated-measure ANOVAs were administered to examine the performance across the subsets of phonetic radical awareness and Hanzi reading and Hanzi writing skills among the two CSL groups. Thirdly, to explore the influence of other meta-linguistic and background variables on phonetic radical awareness, Hanzi reading and Hanzi writing skills among the Arabic and English CSL learners, a series of stepwise regression analyses (forward, *pe*=.05) were carried out. The results of phonetic radical awareness, Hanzi reading and Hanzi writing are presented separately.

5.2.1 Phonetic radical awareness

In order to examine the CSL learners' knowledge of the functional and positional properties of the phonetic radical in Hanzi, a task of pseudo-Hanzi naming was administered. The percentages of different naming strategies in using the right-side Hanzi to name the pseudo-Hanzi among the native Chinese speakers and the CSL learners were summarized in Table 5.4.

Influence of L1 background and Chinese language proficiency level

To explore the influence of L1 background and Chinese language proficiency level, a series of ANOVAs were carried out among the native Chinese speakers, the Arabic and English CSL learners. Firstly, ANOVAs were run among the native Chinese speakers and the two groups of CSL learners to explore whether the CSL learners had developed phonetic radical awareness. Secondly, ANOVAs were conducted among the pre-intermediate and intermediate Arabic and English CSL learners to investigate the influence of L1 background and Chinese language proficiency on the development of phonetic radical awareness.

Between-group differences among the native Chinese speakers and the CSL learners

ANOVAs were carried out in the three types of strategies in using the right-side Hanzi to encode the pseudo-Hanzi (See Table 5.5). The results showed that the main effect of L1 background was significant in the direct naming strategy, $F(2, 102)=4.03$, $p=0.02$, the family Hanzi naming strategy, $F(2, 102)=9.95$, $p=0.0001$, and the general strategy to utilize the right-side Hanzi to name the pseudo-Hanzi, $F(2, 102)=6.64$, $p=0.002$, but not in the strategy of similar Hanzi naming.

Table 5.4

Summary of the Performance in the Task of Pseudo-Hanzi Naming among the Chinese Speakers, the Arabic and English CSL Learners

Strategy	CSL level	Arabic		English		Chinese	
		Mean	SD	Mean	SD	Mean	SD
Direct naming	Pre-intermediate	0.36	0.33	0.25	0.26		
	Intermediate	0.25	0.23	0.57	0.34		
		0.31	0.29	0.44	0.34	0.52	0.24
Similar Hanzi naming	Pre-intermediate	0.04	0.06	0.04	0.06		
	Intermediate	0.04	0.07	0.04	0.05		
		0.04	0.06	0.04	0.05	0.04	0.05
Family Hanzi naming	Pre-intermediate	0.04	0.06	0.05	0.07		
	Intermediate	0.03	0.07	0.05	0.08		
		0.03	0.06	0.05	0.08	0.13	0.12
General strategy	Pre-intermediate	0.44	0.38	0.34	0.67		
	Intermediate	0.31	0.26	0.32	0.36		
		0.38	0.33	0.53	0.37	0.69	0.20

Note. General strategy = sum of the direct naming, similar Hanzi naming and family Hanzi naming

Table 5.5

Summary of ANOVAs of the Performance in the Task of Pseudo-Hanzi Naming among the Chinese Speakers, the Arabic and English CSL Learners

Strategy	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Direct naming	**L1**	**2**	**0.74**	**0.37**	**4.03**	**0.02***	**Chinese>Arabic** **English>Arabic**
	Residuals	102	9.31	0.09			
Similar Hanzi naming	L1	2	0.001	0.0003	0.09	0.91	N/A
	Residuals	102	0.33	0.003			
Family Hanzi naming	**L1**	**2**	**0.13**	**0.07**	**9.95**	**0.0001*****	**Chinese>Arabic** **Chinese>English**
	Residuals	102	0.68	0.01			
General	**L1**	**2**	**1.42**	**0.71**	**6.64**	**0.002****	**Chinese>Arabic** **English>Arabic**
	Residuals	102	10.94	0.11			

Note. *$p<.05$; ** $p<.01$; *** $p<.001$

The results of pairwise comparison tests revealed the detailed between-group differences (See Table 5.5). In terms of the **direct naming strategy**, the native Chinese speakers and the English CSL learners relied more on this strategy than did the Arabic CSL learners, but no difference was found between the native Chinese speakers and the English CSL learners. As for the strategy of **using family Hanzi**, the native Chinese speakers demonstrated stronger preference, but no significant difference was found between the two groups of CSL learners. In the **general strategy** of using the right-side Hanzi to name the pseudo-Hanzi, the Chinese speakers and the English CSL learners achieved similar performance, who showed stronger tendency than the Arabic CSL learners.

A further t-test was conducted to examine whether the three groups' performance in phonetic radical awareness was at chance level. The Chinese speakers' performance was above chance level ($t(21)=4.46$, $p=0.0002$), the English group's achievement was at chance level ($t(39)=0.51$, $p=0.61$), and the Arabic group's performance was below the chance level ($t(42)=-2.38$, $p=0.02$).

The results of ANOVAs (See Table 5.5) revealed that the native Chinese speakers and the English CSL learners showed stronger reliance on the right-side Hanzi (direct naming strategy and general strategy) in the task of pseudo-Hanzi naming than the Arabic CSL learners. However, only the native Chinese speakers performed above chance level, and the performance of English and Arabic CSL learners was at or below chance level, indicating the CSL learners' poorer achievements in phonetic radical awareness. In addition, the CSL learners' Chinese language proficiency was not controlled in the above tests. Therefore, ANOVA tests including Chinese language proficiency level were further conducted to explore the interplay between L1 background and Chinese language proficiency level in phonetic radical awareness among the two CSL groups.

Between-group differences among the Arabic and English CSL learners

ANOVAs were carried out in the percentage of the three strategies among the pre-intermediate and intermediate Arabic and English CSL learners (See Table 5.6). The results did not find a main effect of L1 background or Chinese language proficiency level in any strategy, but the interaction effect between L1 background and Chinese language proficiency level was found in the direct naming strategy, $F(1, 79)=11.05$, $p=0.001$, and in the general strategy of using right-side Hanzi, $F(1, 79)=9.28$, $p=0.003$. The results of pairwise comparison tests revealed that the intermediate English group showed stronger tendency in the direct naming strategy and the general strategy of using right-side Hanzi than the pre-intermediate English group, and the pre-intermediate and intermediate Arabic groups.

Table 5.6

Summary of ANOVAs of the Performance in the Task of Pseudo-Hanzi Naming among the Arabic and English CSL Learners

Strategy	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Direct naming	L1	1	0.25	0.25	2.83	0.10	**English level2>Arabic level1** **English level2>Arabic level2** **English level2>English level1**
	CSL level	1	0.21	0.21	2.44	0.12	
	L1*CSL level	**1**	**0.97**	**0.97**	**11.05**	**0.001****	
	Residuals	79	6.97	0.09			
Similar Hanzi naming	L1	1	0.001	0.001	0.16	0.69	N/A
	CSL level	1	0.00002	0.00002	<0.01	0.94	
	L1*CSL level	1	0.0002	0.0002	0.06	0.81	
	Residuals	79	0.28	0.004			
Family Hanzi naming	L1	1	0.003	0.003	0.71	0.40	N/A
	CSL level	1	0.0004	0.0004	0.07	0.79	
	L1*CSL level	1	0.001	0.001	0.10	0.75	
	Residuals	79	0.38	0.005			
General	L1	1	0.34	0.34	2.99	0.09	**English level2>Arabic level1** **English level2>Arabic level2** **English level2>English level1**
	CSL level	1	0.19	0.19	1.72	0.19	
	L1*CSL level	**1**	**1.05**	**1.05**	**9.28**	**0.003****	
	Residuals	79	8.92	0.11			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** p<.01*

Table 5.7

Summary of the Repeated Measures ANOVAs of the Performance in the Task of Pseudo-Hanzi Naming among the Chinese Speakers, the Arabic and English CSL Learners

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	22	1.06	0.05	1.44	0.15	**direct naming>similar Hanzi naming, family Hanzi naming**
	Strategy	**2**	**1.59**	**0.79**	**23.60**	**<0.0001*** **	
	Residual	44	1.48	0.03			
Arabic level 2	Subjects	19	0.43	0.02	1.20	0.31	**direct naming>similar naming, family Hanzi naming**
	Strategy	**2**	**0.60**	**0.30**	**16.10**	**<0.0001*** **	
	Residual	38	0.71	0.02			
English level1	Subjects	16	0.54	0.03	1.67	0.10	**direct naming>similar Hanzi naming, family Hanzi naming**
	Strategy	**2**	**0.49**	**0.25**	**12.26**	**0.0001*** **	
	Residual	32	0.65	0.02			
English level2	Subjects	22	0.94	0.04	1.04	0.44	**direct naming>similar naming, family Hanzi naming**
	Strategy	**2**	**4.28**	**2.14**	**51.89**	**<0.0001*** **	
	Residual	44	1.81	0.04			
Chinese	Subjects	21	0.27	0.01	0.42	0.98	**direct naming>similar Hanzi naming, family Hanzi naming**
	Strategy	**2**	**2.85**	**1.42**	**46.66**	**<.0001*** **	
	Residual	42	1.28	0.03			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level. Strategy was classified into three types: direct naming, similar Hanzi naming and family Hanzi naming.

****p*<.001

Within-group differences in phonetic radical awareness

To further explore whether each of the Chinese speakers, the Arabic and English CSL learners differed across the use of the three naming strategies in decoding the pseudo-Hanzi, five repeated-measures ANOVAs were carried out (See Table 5.7). The ANOVAs revealed significant differences across the percentages of the three strategies in the task of pseudo-Hanzi naming in each of the five groups: the native Chinese speakers, $F(2, 42)=46.66$, $p<0.0001$; the pre-intermediate Arabic CSL learners, $F(2, 44)=23.60$, $p<0.0001$; the intermediate Arabic CSL learners, $F(2, 38)=16.10$, $p<0.0001$; the pre-intermediate English CSL learners, $F(2, 32)= 12.26$, $p<0.0001$; the intermediate English CSL learners, $F(2, 44)=51.89$, $p=0.0001$. The results of pairwise comparison tests showed that the five groups showed a similar pattern, and they relied more on the direct naming strategy, and less on the strategies of similar Hanzi naming and family Hanzi naming.

To conclude, the results of the ANOVAs (See Table 5.6 and Table 5.7) showed that neither L1 background nor Chinese language proficiency level influenced the performance in phonetic radical awareness among the Arabic and English CSL learners. However, the intermediate English CSL group showed the strongest tendency in using right-side Hanzi to name the pseudo-Hanzi, indicating the influence of other meta-linguistic and background variables because most of the intermediate English CSL learners had experiences of studying abroad in China. Therefore, a series of stepwise regression analyses were conducted to explore the influence of other meta-linguistic and background variables on the development of phonetic radical awareness.

Influence of other meta-linguistic and background variables

A series of stepwise regression analyses (forward, *pe*=.05) were carried out in the three types of strategies used in the task of pseudo-Hanzi naming among the Arabic CSL group, the pre-intermediate and the intermediate English CSL group because the main effect of L1 background was not significant yet interaction effect between L1 background and Chinese language proficiency level was found. The length of stay in China, Chinese language test scores, phonological working memory, phonetic coding ability and the number of languages previously learnt were included in the regression model. The length of stay in China was excluded from the regression models in the Arabic groups because of the lack of such data. No significant models were found in either of the three naming strategies in the Arabic or the pre-intermediate English CSL group. Three significant models were found in the intermediate English CSL group (see Table 5.8). A significant model (F(1, 21)=5.79, p=.03) predicted 22% of the variance in direct naming strategy, and only the number of previous languages (β=-.46, t=-2.41, p=.03) was entered into the final model, a significant model (F(1, 21)=8.73, p=.01) predicted 29% of the variance in similar Hanzi naming strategy, and only phonetic coding ability (β=.54, t=2.95, p=.01) was entered into the final model, and a significant model (F(1, 21)=6.64, p=.02) predicted 24% of the variance in general naming strategy, and only the number of previous languages (β=-.49, t=-2.58, p=.02) was entered into the final model.

Brief summary: phonetic radical awareness

This section examined the performance in phonetic radical awareness among the Arabic and English CSL learners, and the main findings are presented in Table 5.9. First, the main effect of neither L1 background nor Chinese language proficiency level in phonetic racial awareness among the Arabic and English CSL learners was significant, yet the intermediate English CSL learners showed relatively better achievements in phonetic radical awareness. In addition, the two CSL groups similarly demonstrated stronger reliance on the strategy of direct naming than on the other two strategies. Second, of the five meta-linguistic and background variables, the number of previous languages negatively predicted the CSL learners' performance in phonetic radical awareness, yet phonetic coding ability positively contributed to phonetic radical awareness.

Table 5.8

Summary of Stepwise Regression Analyses for Variables Predicting the intermediate English CSL Learners' Performance in the Task of Pseudo-Hanzi Naming

Strategy	Predictor variable	R^2	Adj. R^2	F	p	B	SE	t	p	β
Direct naming	Model	.22	.18	5.79	.03					
	Number of previous languages					-.25	.10	-2.41	.03	-.46
Similar Hanzi naming	Model	.29	.26	8.73	.01					
	Phonetic coding ability					.001	<.001	2.95	.01	.54
General naming strategy	Model	.24	.20	6.64	.02					
	Number of previous languages					-.28	.11	-2.58	.02	-.49

Table 5.9

Summary of the Results of Phonetic Radical Awareness in the Arabic and English CSL Learners

Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Direct naming	✕	English level 2 > English level 1, Arabic level 1&2	English level 2: number of previous languages (-)
Similar Hanzi naming	✕	✕	English level 2: phonetic coding ability
Family Hanzi naming	✕	✕	N/A
General strategy	✕	English level 2 > English level 1, Arabic level 1&2	English level 2: number of previous languages (-)
Within-group differences	Arabic & English: direct naming > similar Hanzi naming/ family Hanzi naming		

Note. "✕" = non-significant main effect; ">" = better than; Level 1 = pre-intermediate level; Level 2 = intermediate level; (-) = negative beta value.

Following the tests that examined the influence of L1 background and other meta-linguistic and background variables on phonetic radical awareness in Hanzi among the Arabic and English CSL learners, ANOVAs and stepwise regression analyses tests were conducted to explore the impact of L1 background and other meta-linguistic and background variables on the performance in Hanzi reading skills.

5.2.2 Hanzi reading

The Arabic and English CSL learners' Hanzi reading skills were measured using the task of reading Hanzi for pronunciation. The stimuli included regular, semiregular and irregular Hanzi, and LPR (left-side phonetic radical) and RPR (right-side phonetic radical) Hanzi. The Arabic and English CSL learners' accuracy rates in reading Hanzi are displayed in Table 5.10.

Influence of L1 background and Chinese language proficiency level

The influence of L1 background and Chinese language proficiency level were examined in between-group differences and within-group differences in reading different types of Hanzi.

Between-group differences in Hanzi reading

The between-group differences among the Arabic and English CSL learners were examined in the overall performance in Hanzi reading, reading Hanzi with different degrees of regularity (regular, semiregular and irregular), and Hanzi with different positional structures (LPR and RPR).

Overall performance in Hanzi reading

The results of ANOVA in overall Hanzi reading are displayed in Table 5.11. Only the main effect of Chinese language proficiency level on reading Hanzi was significant, $F(1, 79)=32.42$, $p<0.0001$, and the intermediate group outperformed the pre-intermediate group.

Table 5.10

Summary of the Accuracy Rates in Reading Hanzi in the Arabic and English CSL Learners

Measures	CSL level	Arabic		English		Total	
		Mean	SD	Mean	SD	Mean	SD
Regular Hanzi	Pre-intermediate	0.06	0.04	0.07	0.04	0.06	0.04
	Intermediate	0.11	0.05	0.14	0.06	0.13	0.06
		0.08	0.05	0.11	0.06		
Semiregular Hanzi	Pre-intermediate	0.04	0.03	0.05	0.03	0.05	0.03
	Intermediate	0.08	0.04	0.11	0.05	0.09	0.05
		0.05	0.03	0.08	0.05		
Irregular Hanzi	Pre-intermediate	0.05	0.03	0.04	0.03	0.04	0.03
	Intermediate	0.08	0.04	0.10	0.05	0.09	0.04
		0.06	0.03	0.07	0.05		
LPR Hanzi	Pre-intermediate	0.07	0.04	0.06	0.05	0.06	0.04
	Intermediate	0.12	0.07	0.16	0.08	0.14	0.08
		0.09	0.06	0.12	0.09		
RPR Hanzi	Pre-intermediate	0.09	0.05	0.09	0.05	0.09	0.05
	Intermediate	0.15	0.06	0.18	0.07	0.17	0.07
		0.12	0.06	0.14	0.08		
Total	Pre-intermediate	0.16	0.09	0.16	0.10	0.16	0.09
	Intermediate	0.27	0.12	0.35	0.15	0.31	0.14
		0.21	0.12	0.27	0.16		

Note. LPR = left-side phonetic radical; RPR = right-side phonetic radical

Table 5.11

Summary of the ANOVAs of the Performance in Overall Hanzi Reading in the Arabic and English CSL Learners

Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
L1	1	0.03	0.03	2.29	0.13	
CSL level	**1**	**0.47**	**0.47**	**32.42**	**<0.0001*** **	**Level2>Level1**
L1*CSL level	1	0.03	0.03	2.35	0.13	
Residuals	79	1.14	0.01			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** *p<.001*

The next section examined the performance in reading Hanzi with different degrees of regularity (regular, semiregular and irregular) among the Arabic and English CSL learners.

Regular, semiregular and irregular Hanzi

The results of ANOVAs in reading Hanzi with different degrees of regularity are presented in Table 5.12. Only the main effect of Chinese language proficiency level was significant in reading **regular Hanzi**, $F(1, 79)=35.68$, $p<0.0001$, and **semiregular Hanzi**, $F(1, 79)=26.21$, $p<0.0001$. The intermediate group outperformed the pre-intermediate group in these two measures. The main effect of Chinese language proficiency level on reading **irregular Hanzi** was significant, $F(1, 79)=29.14$, $p<0.0001$, as was the interaction effect between L1 background and Chinese language proficiency level, $F(1, 79)=4.70$, $p=0.03$. Within each of the two CSL groups, the intermediate learners outperformed the pre-intermediate learners. Moreover, the intermediate English CSL group performed better than the pre-intermediate Arabic CSL group, and the intermediate Arabic CSL group performed better than the pre-intermediate English CSL group.

Table 5.12

Summary of the ANOVAs of the Performance in Reading Hanzi with Different Degrees of Regularity in the Arabic and English CSL Learners

Strategy	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Regular Hanzi	L1	1	0.01	0.01	3.66	0.06	**Level2> Level1**
	CSL level	**1**	**0.08**	**0.08**	**35.68**	**<0.0001*** **	
	L1*CSL level	1	0.003	0.003	1.36	0.25	
	Residuals	79	0.18	0.002			
Semiregular Hanzi	L1	1	0.06	0.06	3.90	0.06	**Level2> Level1**
	CSL level	**1**	**0.04**	**0.04**	**26.21**	**<0.0001*** **	
	L1*CSL level	1	0.002	0.002	1.53	0.22	
	Residuals	79	0.11	0.001			
Irregular Hanzi	L1	1	0.0002	0.0002	0.14	0.71	**Level2>Level1 Arabic level2>Arabic level1 Arabic level2>English level1 English level2>English level1 English level2>Arabic level1**
	CSL level	**1**	**0.04**	**0.04**	**29.14**	**0.0001*** **	
	L1*CSL level	**1**	**0.01**	**0.01**	**4.70**	**0.03***	
	Residuals	79	0.11	0.001			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

**p<.05; *** p<.001*

The next section examined the performance in reading Hanzi with different positional structures (LPR and RPR) among the Arabic and English CSL learners.

LPR and RPR Hanzi

The results of ANOVAs in reading Hanzi with different positional structures are presented in Table 5.13. The main effect of Chinese language proficiency level was significant in reading LPR Hanzi, $F(1, 79)=33.88$, $p<0.0001$, and RPR Hanzi, $F(1, 79)=28.53$, $p<0.0001$, yet neither the main effect of L1 background nor the interaction effect between L1 background and Chinese proficiency level was found. The results of the pairwise comparison tests revealed that the intermediate group outperformed the pre-intermediate group in reading LPR and RPR Hanzi.

Table 5.13

Summary of the ANOVAs of the Performance in Reading LPR and RPR Hanzi in the Arabic and English CSL Learners

Type	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
LPR Hanzi	L1	1	0.10	0.10	2.35	0.13	
	CSL level	**1**	**0.13**	**0.13**	**33.88**	**<0.0001*** **	**Level2>Level1**
	L1*CSL level	1	0.01	0.01	2.58	0.11	
	Residuals	79	0.31	0.004			
RPR Hanzi	L1	1	0.01	0.01	2.05	0.16	
	CSL level	**1**	**0.10**	**0.10**	**28.53**	**<0.0001*** **	**Level2>Level1**
	L1*CSL level	1	0.01	0.01	1.96	0.17	
	Residuals	79	0.28	0.004			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level; LPR = left-side phonetic radical; RPR = right-side phonetic radical.

*** *p<.001*

Within-group differences in Hanzi reading

The within-group differences among the Arabic and English CSL learners were examined in reading Hanzi with different degrees of regularity (regular, semiregular and irregular), and reading Hanzi with different positional structures (LPR and RPR).

Regular, semiregular and irregular Hanzi

The results of the four repeated-measure ANOVAs exploring within-group differences in reading Hanzi with different degrees of regularity are presented in Table 5.14. The results of the ANOVAs revealed that the differences in reading the three types of Hanzi were significant in the pre-intermediate ($F(2, 44)=10.54$, $p=0.0002$) and intermediate ($F(2, 38)=27.42$, $p<0.0001$) Arabic CSL group, The results of pairwise comparison tests showed that the two Arabic CSL groups showed similar pattern, and they performed better in reading regular Hanzi than in semiregular and irregular Hanzi.

The results of the ANOVAs (Table 5.14) revealed significant differences in reading the three types of Hanzi in the pre-intermediate English CSL group ($F(2, 32)=37.14$, $p<0.0001$) and in the intermediate English CSL group ($F(2, 44)=95.08$, $p<0.0001$). The results of pairwise comparison tests showed a similar pattern in the two English CSL groups. The English CSL learners performed best in reading regular Hanzi, less well in semiregular Hanzi and worst in irregular Hanzi.

LPR and RPR Hanzi

The results of the four repeated-measure ANOVAs exploring within-group differences in reading Hanzi with different positional structures (LPR and RPR) are presented in Table 5.15. The results of the ANOVAs revealed that the differences in the accuracy rates in reading the two types of Hanzi were significant for the pre-intermediate ($F(1, 22)=34.00$, $p<0.0001$) and intermediate ($F(1, 19)=18.25$, $p=0.0004$) Arabic CSL group. The results of pairwise comparison tests showed that the two Arabic CSL groups showed a similar pattern, and the accuracy in reading RPR Hanzi was higher than that in reading LPR Hanzi.

Table 5.14

Summary of the Repeated Measures ANOVAs of the Performance in Reading Regular, Semiregular and Irregular Hanzi

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	22	0.06	0.003	18.62	<0.0001***	
	Regularity	**2**	**0.003**	**0.002**	**10.54**	**0.0002*** **	**Regular>semiregular, irregular**
	Residual	44	0.01	0.0002			
Arabic level 2	Subjects	19	0.10	0.01	19.00	<0.0001***	
	Regularity	**2**	**0.02**	**0.01**	**27.42**	**<0.0001*** **	**Regular>semiregular, irregular**
	Residual	38	0.01	0.003			
English level1	Subjects	16	0.05	0.003	25.54	<0.0001***	
	Regularity	**2**	**0.10**	**0.005**	**37.14**	**<0.0001*** **	**Regular>semiregular>irregular**
	Residual	32	0.004	0.0001			
English level2	Subjects	22	0.17	0.01	53.86	<0.0001***	
	Regularity	**2**	**0.03**	**0.01**	**95.08**	**<0.0001*** **	**Regular>semiregular>irregular**
	Residual	44	0.006	0.0001			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.
***p<.001

Table 5.15

Summary of the Repeated Measures ANOVAs of the Performance in Reading LPR and RPR Hanzi

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	22	0.09	0.004	15.27	<0.0001***	
	Position	**1**	**0.01**	**0.01**	**34.00**	**<0.0001*** **	**RPR>LPR**
	Residual	22	0.01	0.0003			
Arabic level 2	Subjects	19	0.15	0.01	27.71	<0.0001***	
	Position	**1**	**0.01**	**0.01**	**18.25**	**0.0004*** **	**RPR>LPR**
	Residual	19	0.01	0.0003			
English level 1	Subjects	16	0.08	0.005	25.39	<0.0001***	
	Position	**1**	**0.01**	**0.008**	**41.23**	**<0.0001*** **	**RPR>LPR**
	Residual	16	0.003	0.0002			
English level 2	Subjects	22	0.25	0.01	31.73	<0.0001***	
	Position	**1**	**0.003**	**0.003**	**9.11**	**0.006*** **	**RPR>LPR**
	Residual	22	0.008	0.0004			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level; LPR = left-side phonetic radical; RPR = right-side phonetic radical

***p<.001

The results of the ANOVAs (Table 5.15) revealed that the differences in the accuracy rates in reading the two types of Hanzi were significant for the pre-intermediate ($F(1, 16)=41.23$, $p<0.0001$) and intermediate ($F(1, 22)=9.11$, $p=0.006$) English CSL group. The results of pairwise comparison tests showed a similar pattern in the two English CSL groups, who performed better in reading RPR Hanzi than in LPR Hanzi.

Taken together, the above results (Table 5.11, 5.12, 5.13, 5.14, and 5.15) did not find the main effect of L1 background on any measure of Hanzi reading among the Arabic and English CSL learners. Only the main effect of Chinese language proficiency level was significant, and the intermediate CSL group performed better in Hanzi reading than the pre-intermediate CSL learners. In addition, the Arabic and English CSL groups showed a similar pattern in reading regular, semiregular and irregular Hanzi, as well as in reading LPR and RPR Hanzi. Since the influence of L1 background on Hanzi reading was not found, then the question arose as to what factors, besides Chinese language proficiency level, might impact the Hanzi reading performance among the Arabic and English CSL learners. Therefore, the section below examined the influence of other meta-linguistic and background variables on Hanzi reading.

Influence of other meta-linguistic and background variables

The influence of other meta-linguistic and background variables on Hanzi reading was examined in the overall performance in Hanzi reading, regular, semiregular and irregular Hanzi reading, and LPR and RPR Hanzi reading using a series of stepwise regression tests (forward, $pe=.05$) (See Table 5.16). The length of stay in China, Chinese language test scores, phonological working memory, phonetic coding ability and the number of languages previously learnt were included in the regression model. The length of stay in China was excluded from the regression models in the Arabic groups because of the lack of such data.

Table 5.16

Summary of Stepwise Regression Analyses for Variables Predicting the CSL Learners' Performance in Hanzi Reading

Hanzi	Group	Predictor variable	R^2	Adj. R^2	F	*p*	B	SE	*t*	*p*	β
Overall	Level 1	Model	.10	.08	4.27	.05					
		Chinese language test scores					.01	.01	2.07	.05	.32
	Level 2	Model	.36	.33	11.14	<.001					
		Chinese language test scores					.05	.01	4.09	<.001	.52
		Length of stay in China					.07	.03	2.53	.02	.32
Regular	Level 2	Model	.34	.31	10.41	.0002					
		Chinese language test scores					.02	.001	3.81	<.001	.49
		Length of stay in China					.03	.01	2.67	.01	.34
Semiregular	Level 2	Model	.34	.30	10.10	.0003					
		Chinese language test scores					.02	.003	4.01	<.001	.52
		Length of stay in China					.02	.01	2.19	.03	.28
Irregular	Arabic level 1	Model	.21	.18	5.75	.03					
		Chinese language test scores					.01	.003	2.40	.03	.46
	Arabic level 2	Model	.25	.21	6.14	.02					
		Chinese language test scores					.01	.01	2.48	.02	.50
	English level 2	Model	.26	.23	7.41	.01					
		Chinese language test scores					.02	.01	2.72	.01	.51
LPR	Level 1	Model	.13	.11	5.65	.02					
		Chinese language test scores					.01	.003	2.38	.02	.36
	Level 2	Model	.38	.34	12.1	.0001					
		Chinese language test scores					.03	.01	4.11	<.001	.51
		Length of stay in China					.04	.01	2.84	.01	.36
RPR	Level 2	Model	.32	.29	9.48	.0004					
		Chinese language test scores					.02	.01	3.91	<.001	.51
		Length of stay in China					.03	.01	2.09	.04	.27

Overall performance in Hanzi reading.

Two stepwise regression tests were carried out in the overall performance in Hanzi reading within the pre-intermediate and intermediate CSL groups because only the effect of Chinese language proficiency level was found in overall performance in Hanzi reading. A significant model ($F(1, 38)=4.27$, $p=.05$) predicted 10% of the variance in Hanzi reading in the pre-intermediate CSL group, and only Chinese language test scores ($\beta=.32$, $t=2.07$, $p=.05$) was entered into the final model. A significant model ($F(2, 40)=11.14$, $p<.001$) predicted 36% of the variance in Hanzi reading in the intermediate CSL group, and two predictors were entered into the final model: Chinese language test scores ($\beta=.52$, $t=4.09$, $p<.001$) and the length of stay in China ($\beta=.32$, $t=2.53$, $p=.02$).

Regular, semiregular and irregular Hanzi reading

Two stepwise regression tests were carried out within the pre-intermediate and intermediate CSL groups in reading regular and semiregular Hanzi, respectively, because only the effect of Chinese language proficiency level was found in these two measures. A significant model ($F(2, 40)=10.41$, $p=.0002$) predicted 34% of the variance in reading regular Hanzi in the intermediate CSL group, and two predictors were entered into the final model: Chinese language test scores ($\beta=.49$, $t=3.81$, $p<.001$) and the length of stay in China ($\beta=.34$, $t=2.67$, $p=.01$). Similarly, a significant model ($F(2, 40)=10.10$, $p<.001$) predicted 34% of the variance in reading semiregular Hanzi in the intermediate CSL group, and two predictors were entered into the final model: Chinese language test scores ($\beta=.52$, $t=4.01$, $p<.001$) and the length of stay in China ($\beta=.28$, $t=2.19$, $p=.03$).

Four stepwise regression tests were carried out in reading irregular Hanzi among the pre-intermediate and intermediate Arabic and English CSL groups because the interaction effect between L1 background and Chinese language proficiency level was found. A significant model ($F(1, 21)=5.75$, $p=.03$) predicted 21% of the variance in reading irregular Hanzi in the pre-intermediate Arabic CSL group, and only Chinese language test scores

(β=.46, t=2.40, p=.03) was entered into the final model. A significant model (F(1, 18)=6.14, p=.02) predicted 25% of the variance in reading irregular Hanzi in the intermediate Arabic CSL group, and only Chinese language test scores (β=.50, t=2.48, p=.02) was entered into the final model. A significant model (F(1, 21)=7.41, p=.01) predicted 26% of the variance in reading irregular Hanzi in the intermediate English CSL group, and only Chinese language test scores (β=.51, t=2.72, p=.01) was entered into the final model.

LPR and RPR Hanzi reading

Two stepwise regression tests were carried out within the pre-intermediate and intermediate CSL groups in reading LPR and RPR Hanzi because only the effect of Chinese language proficiency level was found in these two measures. A significant model (F(1, 38)=5.65, p=.02) predicted 13% of the variance in reading LPR Hanzi in the pre-intermediate CSL group, and only Chinese language test scores (β=.36, t=2.38, p=.02) was entered into the final model. A significant model (F(2, 40)=12.10, p<.001) predicted 38% of the variance in reading LPR Hanzi in the intermediate CSL group, and two predictors were entered into the final model: Chinese language test scores (β=.51, t=4.11, p<.001) and the length of stay in China (β=.36, t=2.84, p=.01). Likewise, a significant model (F(2, 40)=9.48, p<.001) predicted 32% of the variance in reading RPR Hanzi in the intermediate CSL group, and two predictors were entered into the final model: Chinese language test scores (β=.51, t=3.91, p<.001) and the length of stay in China (β=.27, t=2.09, p=.04).

Brief summary: Hanzi reading

The above section examined how L1 background and other meta-linguistic and background variables influenced Hanzi reading skills among the Arabic and English CSL learners, and the main results are displayed in Table 5.17. First, the main effect of L1 background on reading any type of Hanzi (regular, semiregular, irregular, LPR and RPR Hanzi) was not significant among the two groups of CSL learners. In addition, the two groups of CSL learners demonstrated similar pattern in reading Hanzi with different degrees of regularity (regular > semiregular, irregular) and Hanzi with different positional structure (RPR > LPR). Second, the main effect of Chinese language proficiency level was significant among the Arabic and English CSL learners, and the intermediate learners outperformed the pre-intermediate learners. Other meta-linguistic and background variables that significantly predicted Hanzi reading included Chinese language test scores and the length of stay in China.

Table 5.17

Summary of the Results of Hanzi Reading in the Arabic and English CSL Learners

Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Overall Hanzi reading	✕	Level 2 > Level 1	Level 1: Chinese language test scores level2: Chinese language test scores, length of stay in China
Regular Hanzi	✕	Level 2 > Level 1	Level2: Chinese language test scores, length of stay in China
Semiregular Hanzi	✕	Level 2 > Level 1	Level2: Chinese language test scores, length of stay in China
Irregular Hanzi	✕	Level 2 > Level 1	Arabic level 1, Arabic level 2,English level 2: Chinese language test scores
Within-group differences	Arabic/English: regular > semiregular, irregular		
LPR Hanzi	✕	Level 2 > Level 1	Level1: Chinese language test scores level2: Chinese language test scores, length of stay in China
RPR Hanzi	✕	Level 2 > Level 1	Level 2: Chinese language test scores, length of stay in China
Within-group differences			Arabic / English: RPR > LPR

Note. "✕" = non-significant main effect; ">" = better than; LPR = left-side phonetic radical; RPR = right-side phonetic radical; Level 1 = pre-intermediate level; Level 2 = intermediate level.

After the tests examining the performance in phonetic radical awareness and Hanzi reading, the following section investigates the Arabic and English CSL learners' achievement in writing different types of Hanzi.

5.2.3 Hanzi writing

The Arabic and English CSL learners' Hanzi writing skills were measured using a task of writing Hanzi according to the displayed Pinyin and meaning. The stimuli used in the task of Hanzi writing included regular, semiregular and irregular Hanzi, and LPR (left-side phonetic radical) and RPR (right-side phonetic radical) Hanzi. The CSL learners' performances in writing different types of Hanzi are displayed in Table 5.18.

Influence of L1 background and Chinese language proficiency level

The influence of L1 background and Chinese language proficiency level was examined in between-group differences, and within-group differences in reading different types of Hanzi among the Arabic and English CSL learners.

Between-group differences in Hanzi writing

The between-group differences among the Arabic and English CSL learners were carried out in the overall performance in Hanzi writing, writing Hanzi with different degrees of regularity (regular, semiregular and irregular), and Hanzi with different positional structures (LPR and RPR).

Overall performance in Hanzi writing

ANOVA was carried out to explore the influence of L1 background and Chinese language proficiency level on the overall performance in writing Hanzi (See Table 5.19). The main effect of L1 background, $F(1, 79)=4.31$, $p=0.04$, as was the main effect of Chinese language proficiency level, $F(1, 79)=22.32$, $p<0.0001$. The results of the pairwise comparison tests revealed that the Arabic group outperformed the English group, and the intermediate group outperformed the pre-intermediate group.

Table 5.18

Summary of the Accuracy *Rates in Writing Hanzi in the Arabic and English CSL Learners*

Measures	CSL level	Arabic		English		Total	
		Mean	SD	Mean	SD	Mean	SD
Regular Hanzi	Pre-intermediate	0.08	0.05	0.06	0.05	0.07	0.05
	Intermediate	0.14	0.07	0.13	0.07	0.13	0.07
		0.11	0.07	0.10	0.07		
Semi-regular Hanzi	Pre-intermediate	0.08	0.06	0.03	0.03	0.06	0.06
	Intermediate	0.12	0.06	0.08	0.06	0.10	0.06
		0.10	0.06	0.06	0.06		
Irregular Hanzi	Pre-intermediate	0.07	0.04	0.07	0.04	0.07	0.04
	Intermediate	0.11	0.06	0.11	0.06	0.11	0.06
		0.09	0.06	0.09	0.06		
LPR Hanzi	Pre-intermediate	0.06	0.06	0.07	0.04	0.06	0.05
	Intermediate	0.15	0.11	0.16	0.10	0.15	0.10
		0.10	0.10	0.12	0.09		
RPR Hanzi	Pre-intermediate	0.18	0.09	0.09	0.07	0.14	0.09
	Intermediate	0.22	0.08	0.17	0.07	0.19	0.08
		0.20	0.09	0.13	0.08		
Total	Pre-intermediate	0.24	0.13	0.16	0.09	0.21	0.12
	Intermediate	0.37	0.17	0.32	0.15	0.34	0.16
		0.30	0.16	0.25	0.15		

Table 5.19

Summary of ANOVAs of the Performance in Overall Writing Hanzi in the Arabic and English CSL Learners

Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
L1	**1**	**0.08**	**0.08**	**4.31**	**0.04***	**Arabic>English**
CSL level	**1**	**0.43**	**0.43**	**22.32**	**<.0001*****	**Level 2>Level 1**
L1*CSL level	1	0.01	0.01	0.33	0.57	
Residuals	79	1.53	0.02			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

**p<.05; *** p<.001.*

The next section examined the performance in writing Hanzi with different degrees of regularity (regular, semiregular and irregular) among the Arabic and English CSL learners.

Regular, semiregular and irregular Hanzi

The results of ANOVAs testing the influence of L1 background and Chinese language proficiency level on writing regular, semiregular and irregular Hanzi are presented in Table 5.20. The main effect of Chinese language proficiency level was significant in writing **regular** Hanzi, $F(1, 79)=18.94$, $p<0.0001$, and **irregular** Hanzi, $F(1, 79)=15.23$, $p=0.0002$. The results of the pairwise comparison tests revealed that the intermediate group outperformed the pre-intermediate group in writing regular and irregular Hanzi. The main effect of L1 background on writing **semiregular** Hanzi was significant, $F(1, 79)=16.30$, $p=0.0001$, as was the main effect of Chinese language proficiency level, $F(1, 79)=13.97$, $p=0.0003$. The results of the pairwise comparison tests showed that the Arabic group performed better than the English group, and the intermediate group outperformed the pre-intermediate group.

Table 5.20

Summary of ANOVAs of the Performance in Writing Hanzi with Different Degrees of Regularity in the Arabic and English CSL Learners

Type	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Regular Hanzi	L1	1	0.01	0.01	2.11	0.15	
	CSL level	**1**	**0.07**	**0.07**	**18.94**	**0.0001*** **	**Level2> Level1**
	L1*CSL level	1	0.001	0.001	0.25	0.62	
	Residuals	79	0.28	0.004			
Semiregular Hanzi	**L1**	**1**	**0.05**	**0.05**	**16.30**	**0.0001*** **	**Arabic>English**
	CSL level	**1**	**0.04**	**0.04**	**13.97**	**0.0003*** **	**Level2>Level1**
	L1*CSL level	1	0.003	0.003	0.87	0.35	
	Residuals	79	0.24	0.003			
Irregular Hanzi	L1	1	0.0003	0.0003	0.12	0.73	
	CSL level	**1**	**0.04**	**0.04**	**15.23**	**0.0002*** **	**Level2>Level1**
	L1*CSL level	1	<0.0001	<0.0001	0.00	0.99	
	Residuals	79	0.20	0.003			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** *p<.001*

The next section examined the performance in writing Hanzi with different positional structures (LPR and RPR) among the Arabic and English CSL learners.

LPR and RPR Hanzi

The results of ANOVAs testing the influence of L1 background and Chinese language proficiency level on writing LPR and RPR Hanzi are presented in Table 5.21. The main effect of Chinese language proficiency level on writing **LPR** Hanzi was significant, *F*(1, 79)=22.34, *p*<0.001, and the intermediate group outperformed the pre-intermediate group. The main effect of L1 background on writing **RPR** Hanzi was significant, *F*(1, 79)=20.22, *p*<0.001, as was the main effect of Chinese language proficiency level, *F*(1, 79)=11.56, *p*<0.01, and the Arabic group outperformed the English group, and the intermediate group outperformed the pre-intermediate group.

Table 5.21

Summary of ANOVAs of the Performance in Writing LPR and RPR Hanzi in the Arabic and English CSL Learners

Type	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
LPR Hanzi	L1	1	0.00	0.00	0.30	0.59	
	CSL level	**1**	**0.16**	**0.16**	**22.34**	**<0.001*****	**Level 2>Level 1**
	L1*CSL level	1	0.00	0.00	0.02	0.88	
	Residuals	79	0.58	0.01			
RPR Hanzi	**L1**	**1**	**0.11**	**0.11**	**20.22**	**<0.001*****	**Arabic>English**
	CSL level	**1**	**0.06**	**0.06**	**11.56**	**<0.01****	**Level 2>Level 1**
	L1*CSL level	1	0.01	0.01	1.53	0.22	
	Residuals	79	0.44	0.01			

Note. LPR = left-side phonetic radical; RPR = right-side phonetic radical; Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** p<.01; *** p<.001*

Following the tests that examined the between-group differences in Hanzi writing among the Arabic and English CSL learners, within-group differences in writing different types of Hanzi were explored in the two CSL groups in the next section.

Within-group differences in Hanzi writing

The within-group differences among the Arabic and English CSL learners were carried out in writing Hanzi with different degrees of regularity (regular, semiregular and irregular), and writing Hanzi with different positional structures (LPR and RPR).

Regular, semiregular and irregular Hanzi. The results of the four repeated-measure ANOVAs exploring within-group differences in writing Hanzi with different degrees of regularity (regular, semiregular and irregular) are presented in Table 5.22. The differences in the accuracy rates in writing the three types of Hanzi were not significant in the pre-intermediate or the intermediate Arabic CSL group. The differences in the accuracy rates in writing the three types of Hanzi were significant in the pre-intermediate ($F(2, 32)=9.61$, $p=0.0005$) and intermediate ($F(2, 44)=7.79$, $p=0.001$) English CSL group. The results of pairwise comparison tests showed that the English CSL learners performed better in writing regular and irregular Hanzi than in semiregular Hanzi.

LPR and RPR Hanzi. The results of the four repeated-measure ANOVAs exploring within-group differences in writing LPR and RPR Hanzi are presented in Table 5.23. The differences in the accuracy rates in writing the two types of Hanzi were significant in the pre-intermediate ($F(1, 22)=66.97$, $p<0.0001$) and intermediate ($F(1, 19)=9.36$, $p=0.006$) Arabic group, who performed better in RPR Hanzi than in LPR Hanzi. The differences in the accuracy rates in writing the two types of Hanzi were not significant in either the pre-intermediate or intermediate English group.

Summary

This section examined the between-group differences and within-group differences in writing different types of Hanzi in the Arabic and English CSL learners. The two CSL groups differed in the overall Hanzi writing performance, writing semiregular and RPR Hanzi, in which the Arabic group outperformed the English group. In addition, the two CSL groups demonstrated different patterns in writing Hanzi with different degrees of regularity and Hanzi with different positional structures. The Arabic CSL learners did not differ in writing regular, semiregular or irregular Hanzi, yet the English CSL learners performed better in writing regular and irregular Hanzi than in semiregular Hanzi. The Arabic CSL learners performed better in writing RPR Hanzi than in LPR Hanzi, yet the English CSL learners did not differ in the performance in writing LPR or RPR Hanzi. The section below examined the influence of other meta-linguistic and background variables on Hanzi writing.

Table 5.22

Summary of the Repeated Measures ANOVAs of the Performance in Writing Hanzi with Different Degrees of Regularity in the Arabic and English CSL Learners

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level 1	Subjects	22	0.12	0.005	4.22	<0.0001***	N/A
	Regularity	2	0.006	0.003	2.37	0.10	
	Residual	44	0.06	0.001			
Arabic level 2	Subjects	19	0.17	0.01	6.41	<0.0001***	N/A
	Regularity	2	0.01	0.004	2.63	0.09	
	Residual	38	0.05	0.001			
English level1	Subjects	16	0.05	0.003	2.00	0.004**	
	Regularity	**2**	**0.02**	**0.01**	**9.61**	**0.0005*** **	**regular, irregular>semiregular**
	Residual	32	0.03	0.001			
English level2	Subjects	22	0.17	0.01	5.69	<0.0001***	
	Regularity	**2**	**0.02**	**0.01**	**7.79**	**0.001** **	**regular, irregular>semiregular**
	Residual	44	0.06	0.001			

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

*** p<.01; *** p<.001*

Table 5.23

Summary of the Repeated Measures ANOVAs of the Performance in Writing LPR and RPR Hanzi in the Arabic and English CSL Learners

Group	Source	*df*	*SS*	*MS*	*F*	*p*	Pairwise comparison
Arabic level1	Subjects	22	0.18	0.01	3.03	0.006	
	Position	**1**	**0.18**	**0.18**	**66.97**	**<0.0001*****	**RPR>LPR**
	Residual	22	0.06	0.003			
Arabic level2	Subjects	19	0.26	0.01	2.70	0.02	
	Position	**1**	**0.05**	**0.05**	**9.36**	**0.006****	**RPR>LPR**
	Residual	19	0.96	0.005			
English level1	Subjects	16	0.07	0.004	2.79	0.02	N/A
	Position	1	0.003	0.003	1.64	0.22	
	Residual	16	0.02	0.002			
English level2	Subjects	22	0.26	0.01	3.58	0.002	N/A
	Position	1	0.001	0.001	0.18	0.67	
	Residual	22	0.07	0.003			

Note. LPR = left-side phonetic radical; RPR = right-side phonetic radical; Level 1 = pre-intermediate level; Level 2 = intermediate level.

** $p<.01$; *** $p<.001$

Influence of other meta-linguistic and background variables

A series of stepwise regression analyses (forward, *pe*=.05) were carried out to explore the influence of other meta-linguistic and background variables on the overall performance in Hanzi writing, writing regular, semiregular and irregular Hanzi, and LPR and RPR Hanzi. The length of stay in China, Chinese language test scores, phonological working memory, phonetic coding ability and the number of languages previously learnt were included in the regression model. The length of stay in China was excluded from the regression models in the Arabic groups because of the lack of such data.

Overall performance in Hanzi writing

Four stepwise regression tests were carried out in writing Hanzi among the Arabic and English CSL groups (See Table 5.24) because the main effects of L1 background and Chinese language proficiency level were significant. A significant model ($F(2, 14)=7.59$, $p=.01$) predicted 52% of the variance in Hanzi writing in the pre-intermediate English CSL group, and two predictors were entered into the final model: Chinese language test scores ($\beta=.55$, $t=2.82$, $p=.01$) and the number of previous languages ($\beta=.25$, $t=3.79$, $p=.002$). A significant model ($F(1, 21)=5.48$, $p=.03$) predicted 21% of the variance in Hanzi writing in the intermediate English CSL group, and only Chinese language test scores ($\beta=.45$, $t=2.34$, $p=.03$) was entered into the final model.

Regular, semiregular and irregular Hanzi

Two stepwise regression tests were carried out in writing **regular** and **irregular** Hanzi within the pre-intermediate and intermediate CSL learners because only the main effect of Chinese language proficiency level was found in these two types of Hanzi. However, no significant models were found in either of the two measures. Four stepwise regression tests were carried out in writing **semiregular** Hanzi in the pre-intermediate and intermediate Arabic and English CSL groups (See Table 5.24) because the main effects of L1 background and Chinese language proficiency level were significant in writing semiregular Hanzi.

Table 5.24

Summary of Stepwise *Regression Analyses for Variables Predicting the CSL Learners' Performance in Hanzi Writing*

Hanzi	Group	Predictor variable	R^2	Adj. R^2	F	*p*	B	SE	*t*	*p*	β
Overall	English Level 1	Model	.52	.45	7.59	.01					
		Chinese language test scores					.03	.01	2.82	.01	.55
		Number of previous languages					.12	.03	3.79	.002	.25
	English level 2	Model	.21	.17	5.48	.03					
		Chinese language test scores					.04	.02	2.34	.03	.45
Semiregular	English level 2	Model	.19	.15	4.88	.04					
		Chinese language test scores					.02	.01	2.21	.04	.43
LPR	Level 1	Model	.10	.08	4.35	.04					
		Number of previous languages					.04	.02	2.08	.04	.32
	Level 2	Model	.14	.12	6.64	.01					
		Chinese language test scores					.03	.01	2.58	.01	.37

A significant model (F(1, 21)=4.88, p=.04) predicted 19% of the variance in writing semiregular Hanzi in the intermediate English CSL group, and only Chinese language test scores (β=.43, t=2.21, p=.04) was entered into the final model.

LPR and RPR Hanzi

Two stepwise regression tests were carried out in LPR Hanzi in the pre-intermediate and intermediate CSL groups (See Table 5.24) because only the main effect of Chinese language proficiency level was found in writing LPR Hanzi. A significant model (F(1, 38)=4.35, p=.04) predicted 10% of the variance in writing LPR Hanzi in the pre-intermediate CSL group, and only the number of previous languages (β=.32, t=2.08, p=.04) was entered into the final model. Likewise, a significant model (F(1, 41)=6.64, p=.01) predicted 14% of the variance in writing LPR Hanzi in the intermediate CSL group, and only Chinese language test scores (β=.37, t=2.58, p=.01) was entered into the final model.

Four stepwise regression tests were carried out in writing RPR Hanzi within the pre-intermediate and intermediate Arabic and English CSL group because the main effects of both L1 background and Chinese language proficiency level were significant. However, no significant models were found in any of the four CSL groups.

To conclude, this section examined the influence of other meta-linguistic and background variables on the performance in writing Hanzi among the Arabic and English CSL learners. Of the five variables included in the stepwise regression analyses models, two variables predicted the performance in writing Hanzi. **Chinese language test scores** predicted the performance in overall Hanzi writing, writing semiregular Hanzi and LPR Hanzi. **The number of languages previously learnt** predicted the performance in overall Hanzi writing, writing irregular and LPR Hanzi.

Brief summary: Hanzi writing

The above section examined how L1 background and other meta-linguistic and background variables influenced Hanzi writing skills among the Arabic and English CSL learners, and the main results are shown in Table 5.25. First, between-group differences among the Arabic and English CSL learners were observed in the overall Hanzi writing performance, writing semiregular and RPR Hanzi, and the Arabic CSL learners outperformed the English CSL learners in these measures. In addition, the two CSL groups showed different patterns in the writing performance across regular, semiregular and irregular Hanzi (Arabic: no differences; English: regular, irregular > semiregular), and across LPR and RPR Hanzi (Arabic: RPR> LPR; English: no differences). Second, the main effect of Chinese language proficiency level was significant on writing any type of Hanzi among the Arabic and English CSL learners, and the intermediate group outperformed the pre-intermediate group. Other meta-linguistic and background variables that predicted Hanzi writing included Chinese language test scores and the number of languages previously learnt.

Table 5.25

Summary of the Results of Hanzi Writing in the Arabic and English CSL Learners

Measures	L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Overall Hanzi writing	**English < Arabic**	Level 2 > Level 1	English level 1: number of previous languages, Chinese language test scores English level2: Chinese language test scores
Regular Hanzi	✕	Level 2 > Level 1	N/A
Semiregular Hanzi	**English < Arabic**	Level 2 > Level 1	English Level2: Chinese language test scores
Irregular Hanzi	✕	Level 2 > Level 1	N/A
Within-group differences	Arabic: regular ≈ irregular ≈ semiregular; English: regular, irregular >semiregular		
LPR Hanzi	✕	Level 2 > Level 1	Level 1: number of previous languages; Level 2: Chinese language test scores
RPR Hanzi	**English < Arabic**	Level 2 > Level 1	N/A
Within-group differences	Arabic: RPR>LPR; English: RPR ≈ LPR		

Note. "✕" = non-significant main effect; "<" = less well than; ">" = better than; "≈" = similar to; LPR = left-side phonetic radical; RPR = right-side phonetic radical; Level 1 = pre-intermediate level; Level 2 = intermediate level.

5.2.4 Summary

This chapter examined the role of L1 background and Chinese language proficiency level in the development of phonetic radical awareness, Hanzi reading and Hanzi writing skills among the Arabic and English CSL learners. The main results are displayed in Table 5.26.

Table 5.26

Summary of the Results of Performance in Phonetic Radical Awareness, Hanzi Reading and Hanzi Writing among the Arabic and English CSL Learners

Measures		L1 Effect	CSL Level Effect	Stepwise Regression (group: predictor)
Phonetic radical awareness	Direct naming	✕	✕	English level 2: number of previous languages (-)
	Similar Hanzi	✕	✕	English level 2: phonetic coding ability
	Family Hanzi	✕	✕	N/A
	General strategy	✕	✕	English level 2: number of previous languages (-)
	Within-group differences		Arabic & English: direct naming > similar Hanzi naming/ family Hanzi naming	
Hanzi reading	Overall reading	✕	Level 2>Level 1	Level 1: Chinese language test scores Level2: Chinese language test scores, length of stay in China
	Regular	✕	Level 2>Level 1	Level2: Chinese language test scores, length of stay in China
	Semiregular	✕	Level 2>Level 1	Level2: Chinese language test scores, length of stay in China
	Irregular	✕	Level 2>Level 1	Arabic level 1, Arabic level 2,English level 2: Chinese language test scores
	Within-group differences		Arabic: regular>semiregular, irregular;	English: regular>semiregular>irregular
	LPR	✕	Level 2>Level 1	Level1: Chinese language test scores Level2: Chinese language test scores, length of stay in China
	RPR	✕	Level 2>Level 1	Level2: Chinese language test scores, length of stay in China
	Within-group differences			Arabic / English: RPR > LPR
Hanzi writing	Overall writing	English<Arabic	Level 2>Level 1	English level 1: number of previous languages, Chinese language test scores; English level2: Chinese language test scores
	Regular	✕	Level 2>Level 1	N/A
	Semiregular	English<Arabic	Level 2>Level 1	English Level2: Chinese language test scores
	Irregular	✕	Level 2>Level 1	N/A
	Within-group differences		Arabic: regular ≈ irregular ≈ semiregular;	English: regular, irregular >semiregular
	LPR	✕	Level 2>Level 1	Level 1: number of previous languages; Level 2: Chinese language test scores
	RPR	English<Arabic	Level 2>Level 1	N/A
	Within-group differences			Arabic: RPR>LPR; English: RPR ≈ LPR

Note. "✕" = non-significant main effect; "<" = less good than; ">" = better than; "≈" = similar to; Similar Hanzi = similar Hanzi naming; Family Hanzi = Family Hanzi naming; (-) = negative beta value; Level 1 = pre-intermediate level; Level 2 = intermediate level; LPR = left-side phonetic radical; RPR = right-side phonetic radical

Influence of L1 background. Between-group differences between the Arabic and English CSL learners were observed in overall Hanzi writing, writing semiregular and RPR Hanzi, and within-group performances in writing Hanzi with different degrees of regularity and Hanzi with different positional structures. The Arabic CSL learners outperformed the English CSL learners in overall Hanzi writing, writing semiregular and RPR Hanzi. In terms of writing regular, semiregular and irregular Hanzi, the Arabic CSL learners did not differ in writing these three types of Hanzi, yet the English CSL learners performed better in writing regular and irregular Hanzi than in semiregular Hanzi. In terms of writing Hanzi with different positional structures, the Arabic CSL learners performed better in writing RPR Hanzi than in LPR Hanzi, yet the English CSL learners did not differ in writing the two types of Hanzi.

Influence of Chinese language proficiency level. The influence of Chinese language proficiency level was observed in the measures of Hanzi reading and Hanzi writing, in which the intermediate CSL learners outperformed the pre-intermediate CSL learners. However, no influence of Chinese language proficiency level was found in phonetic radical awareness.

Influence of other meta-linguistic and background variables. Four meta-linguistic and background variables predicted the performance in phonetic radical awareness, Hanzi reading and Hanzi writing among the Arabic and English CSL learners. With regard to **phonetic radical awareness**, phonetic coding ability remarkably contributed to the use of similar Hanzi naming strategy in the intermediate English CSL group. However, the number of languages previously learnt negatively correlated with the naming strategies in the English CSL learners. In terms of **Hanzi reading**, Chinese language test scores and the length of stay in China uniquely accounted for the variance in Hanzi reading scores. As for **Hanzi writing**, Chinese language test scores and the number of languages previously learnt predicted Hanzi writing performance.

5.3 Discussion

The research questions in this chapter were how L1 background and other meta-linguistic and background variables influenced the performance in phonetic radical awareness, and Hanzi reading and Hanzi writing skills among the Arabic and English CSL learners. The influence of L1 background and other meta-linguistic and background variables on Hanzi learning has been reported in literature involving CSL learners with and without Hanzi background. However, no studies have compared the performance in Hanzi learning among the Arabic and English CSL learners who use two scripts differing in visual complexity and writing direction. Learning a specific script influences the development of visual-spatial skills (Kolinsky et al., 1987; Liow et al., 1999), which is important for the successful acquisition of logographic Hanzi (McBride-Chang, Chow, et al., 2005; Tavassoli, 2002). Considering the differences in Arabic and English scripts, the Arabic and English speakers might develop unique visual-spatial skills specific to the L1 script, which could further impact the perception of the orthographic structure of Hanzi. In the present study, a significant influence of L1 background was found on the measures of Hanzi writing, and on within-group differences in writing different types of Hanzi. Other meta-linguistic and background variables that significantly predicted the performance in Hanzi learning included Chinese language proficiency, the length of stay in China, phonetic coding ability and the number of languages learnt. The influence of L1 background is discussed first, then followed by the influence of other meta-linguistic and background variables.

5.3.1 Influence of L1 background on phonetic radical awareness, Hanzi reading and Hanzi writing skills

Chinese Hanzi differs greatly from Arabic and English in terms of scripts and orthography. Hanzi is logographic or morphosyllabic, and each Hanzi is composed of stroke, radicals or recurrent stroke patterns in a rectangular layout. The salient differences between the Arabic and English orthographies lie in the script complexity and the writing direction. It was hypothesized that the Arabic and English CSL learners would not differ in reading and writing Hanzi with different degrees of regularity, but the Arabic CSL learners would perform better in reading and writing LPR and RPR Hanzi, and develop better awareness of phonetic radical in Hanzi. The hypothesis was based on the fact the Arabic script is written from right to left and phonetic radical is dominantly at right-hand side in Hanzi. The results were partially in line with the hypothesis. Congruent with this hypothesis, the significant influence of L1 background was found in writing RPR Hanzi, in which the Arabic CSL learners outperformed their English counterparts. However, in disagreement with the hypothesis, the Arabic CSL learners showed advantage in overall Hanzi writing and irregular Hanzi writing. In addition, the two CSL groups did not differ in reading LPR or RPR Hanzi, or writing LPR Hanzi, or the phonetic radical awareness. Moreover, the two linguistic groups differed in the within-group differences in reading and writing different types of Hanzi. The possible reasons for the observed performances in phonetic radical awareness, Hanzi reading and Hanzi writing among the Arabic and English CSL learners were discussed separately below.

Phonetic radical awareness

Radical is an important orthographic unit in Hanzi processing for native Hanzi users and CSL learners. As the only component that might carry crucial phonological information for the whole Hanzi, phonetic radical plays a vital role in accessing the pronunciation of the semantic-phonetic Hanzi. Although phonetic radical in not consistent in providing phonological information, relying on phonetic radical to store the phonological representation of Hanzi and to read unfamiliar Hanzi is a commonly used strategy by native Chinese speakers (Ho et al., 2003; Luo et al., 2011; Shu & Anderson, 1997; Taft et al., 1999; Yin & McBride, 2015; Zhang, Li, Dong, Xu, & Sholar, 2015) and CSL learners (Shen & Ke, 2007; Tong & Yip, 2014; Wang et al., 2004; Wang, Perfetti, et al., 2003; Zhao & Jiang, 2002).

The development of phonetic radical awareness does not relate to the CSL learners' sound-based language background. Considering the influence of L1 script on some visual-spatial tasks such as handwriting and drawing (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow et al., 1999; Nachshon, 1983; Shanon, 1979; Shimrat, 1973; Vaid, 1995; Vaid et al., 2011), and that most phonetic radicals occur on the right-side in Hanzi, it was hypothesized that the L2 proficiency-matched Arabic CSL learners would perform better in phonetic radical awareness than their English counterparts. However, the results were contrary to the hypothesis. The Arabic and the English CSL learners did not differ in phonetic radical awareness, suggesting that CSL learners' sensitivity to the functional and positional regularity of phonetic radicals in Hanzi does not relate to the L1 background.

One possible explanation for the similar performance in phonetic radical awareness in the Arabic and English CSL learners is the distance between Hanzi orthography and the two alphabetic orthographies. Hanzi is traditionally considered as logographic, and grapheme-phoneme correspondence does not exist in Hanzi. A majority of Hanzi are semantic-phonetic, in which the phonetic radical could provide phonological cues for pronunciation. However, the phonetic radical is not reliable in aiding the pronunciation because of its varying functional regularity and positional distribution. Therefore, the mapping between phonetic radical and Hanzi, and the grapheme-phoneme correspondence in Arabic and English are different and cannot be equated. On the one hand, the print-sound mapping in Arabic and English takes place at the phonemic level and the graphemic level, yet the function of phonetic radical lies in its correspondence with the syllable level. On the other hand, the graphemes in Arabic and English only appear in horizontal structure, yet the phonetic radical could be arranged at different positions in a rectangular layout. The orthographic distance between Hanzi and Arabic and English is too far, thus the meta-linguistic awareness in these two alphabetic L1 orthographies might not contribute to the development of phonetic radical awareness in Hanzi, as implied in the theoretical framework of Transfer Facilitation Model (Koda, 2008).

The right-to-left writing direction in Arabic script and the dominance of right-side phonetic radical in Hanzi might not be comparable or transferrable. Even though most phonetic radical appears on the right-side in Hanzi layout, and the Arabic script is written from right to left, this similarity did not help the Arabic CSL learners develop better phonetic radical awareness. One possible reason might be related to the different natures of the visual-spatial information of phonetic radical in Hanzi and the writing direction in Arabic. The positional information of phonetic radical in Hanzi has phonological implications, but the right-to-left direction in Arabic script is not phonologically related. The layout of phonetic radical per se involves the relationship between the orthographic units (such as semantic radical and phonetic radical) in Hanzi. In contrast, the right-to-left direction in Arabic only governs the writing sequence of letters in a word or words in a sentence, and it does not indicate any phonological information. Another alternative reason is that the phonetic radical could occur at different positions, left, right, top, bottom or even the middle, but the writing direction in Arabic can only move from right to left. The positional variation of phonetic radical in Hanzi is much more complex than the right-to-left direction in writing Arabic, which may not be directly related to the Arabic CSL learners' perception of phonetic radical in Hanzi.

Compared with the previous research that reported a significant influence of writing system with different writing directions on some cognitive tasks, such as handwriting and drawing (Benny Shanon, 1979; Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow, Green, & Tam, 1999; Nachshon, 1983; Sassoon, 1995; Shimrat, 1973; Vaid, 1995; Vaid, Rhodes, Tosun, & Eslami, 2011), this study did not support this idea. It might be because the current study focused on the CSL learners' performance in a phonologically related task, yet the tasks used in previous studies were not based on phonological properties. These conflicting results indicate that the influence of script direction in L1 on the L2 learning might be domain-specific.

The results in this study further suggest that the Arabic and English CSL learners had not developed sensitivity to the functional and the positional properties of the phonetic radical in Hanzi. **First**, compared with Chinese speakers' stronger reliance on the right-side Hanzi in naming pseudo-Hanzi, the Arabic and English CSL learners showed weaker tendency to use the right-side Hanzi to decode the pseudo-Hanzi. The CSL learners' performance in phonetic radical awareness was not above the chance level, indicating the underdevelopment of phonetic radical awareness in either CSL group. **Second**, the CSL learners' poor phonetic radical awareness was also reflected in the within-group differences in the naming strategies. The three groups demonstrated more reliance on direct naming strategy than on other two strategies (similar Hanzi naming and family Hanzi naming). Nonetheless, the native Chinese speakers showed a much higher percentage of direct naming strategy and family Hanzi naming strategy than the two CSL groups. Considering the CSL learners' limited Hanzi repertoire, using either of the two single Hanzi to name the pseudo-Hanzi could be the most effective strategy, yet they still showed a low percentage of direct Hanzi naming strategy involving the right-side Hanzi. This further indicates that the CSL learners in this study had not become aware of the role the phonetic radical plays in Hanzi.

If the CSL learners' writing system background in L1 did not relate to their phonetic radical awareness, then the question arises as to the potential factors related to the development of the sensitivity to the phonetic radical in the Arabic and English CSL learners. The amount of exposure to Hanzi and the explicit instruction might be two reasons.

The Arabic and English CSL learners' phonetic radical awareness appears to be more related to the amount of exposure to Hanzi, rather than Chinese language proficiency. **First**, the results of the stepwise regression analyses in phonetic radical awareness did not find Chinese language test scores as a significant predictor in the Arabic and English CSL learners. Thus, the positive effect of Chinese language proficiency on the development of phonetic radical awareness might not exist among the pre-intermediate and intermediate CSL learners. **Second**, the interaction effect between L1 background and Chinese language proficiency level revealed the strongest tendency to use the right-side Hanzi to name pseudo-Hanzi in the intermediate English CSL learners. Considering that a majority of the intermediate English CSL learners studied abroad in China for one year, and the insignificant difference in Chinese language proficiency test between the intermediate learners in the Arabic and English groups, the stronger reliance on right-side Hanzi in the intermediate English CSL learners could be due to their larger amount of exposure to Hanzi. One year's experience of studying in China could bring more chances in reading and writing Hanzi, which in turn might improve their implicit awareness of the orthographic structure of Hanzi and the positional properties of phonetic radicals. In contrast, all the Arabic CSL learners or the majority of pre-intermediate English CSL learners did not have similar experience, and their contact with Hanzi was limited to the classroom and textbook. The relatively small amount of exposure to Hanzi might not be enough to activate the CSL learners' sensitivity to the phonetic radical in Hanzi. This explanation is consistent with studies carried out among native Chinese-speaking children (Shu, Anderson, et al., 2000; Shu, Zhou, et al., 2000; Wu, Zhou, & Shu, 1999), and CSL learners (Shen & Ke, 2007; Xing, 2001), whose radical awareness develops as they acquire more Hanzi.

The development of phonetic radical awareness might also depend on explicit instruction. The Arabic CSL learners' performance in the phonetic radical awareness was a good example. In this study, the pre-intermediate Arabic group outperformed the intermediate Arabic group in using the direct naming strategy and the general naming strategy. One possible reason for this finding might relate to the Hanzi instruction method. The second-year and third-year learners in the Arabic group were instructed by the same teacher at the time of data collection, yet the third-year learners were instructed by a different teacher than in their first and second year. The third-year group did not receive any instruction about the functional and positional regularity of the phonetic radical in Hanzi, yet the second-year group was explicitly drawn attention to such knowledge at the beginning of the second year. Moreover, during the process of data collection, I interviewed some CSL learners after the task of pseudo-Hanzi naming about whether they had been informed about the relationship between phonetic radical and Hanzi. The CSL learners who had been informed about this rule tended to show stronger right-side preference. This explanation is in line with previous research that found the importance of explicit instruction for developing the CSL learners' sensitivity to the functional and positional properties of the radicals in Hanzi (Nguyen et al., 2016; Wang et al., 2004; Wang, Perfetti, et al., 2003).

Taken together, the CSL participants in this study did not show phonetic radical awareness measured in the task of pseudo-Hanzi naming. The Arabic and English CSL learners' performance in phonetic awareness test was not influenced by the script direction in L1. In contrast, the amount of exposure to Hanzi and the classroom instruction in Hanzi could be two potential reasons accounting for the CSL learners' achievement in phonetic radical awareness.

Although the Arabic and English CSL learners did not differ in phonetic radical awareness, they demonstrated significant differences in the task of Hanzi writing, which is discussed in following section.

Hanzi writing

Hanzi writing is a very difficult task for the CSL learners, especially for those with an alphabetic L1 background. Previous studies focused on the error analysis in Hanzi writing, and the influence of L1 background on the performance in Hanzi writing (Guo, 2008; Jiang & Liu, 2004; Xiao, 2002; Zhang, 2014; Zhang & Huang, 2010). The present study examined the influence of L1 background on Hanzi writing among the Arabic and English CSL learners. Based on the fact that right-to-left Arabic script is more complex than the English script, and that most phonetic radicals occur on the right side in Hanzi, it was hypothesized that the Arabic CSL learners would perform better in writing RPR Hanzi than the English CSL learners, and the two CSL groups would not differ in writing other types of Hanzi. The results found a main effect of L1 background on the overall Hanzi performance, writing semiregular and RPR Hanzi, in which the Arabic group outperformed the English group. The results were partially consistent with the hypothesis in terms of the Arabic group's better achievement in RPR Hanzi, but other results were in conflict with the hypothesis.

The Arabic CSL learners' higher scores in writing RPR Hanzi, and the different patterns of the within-group performances across writing regular, semiregular, irregular Hanzi and LPR and RPR Hanzi among the Arabic and English CSL groups might not be influenced by the writing directions in L1 script. The Arabic group's better performance in writing RPR Hanzi was supposed to relate with their better sensitivity to the functional and positional properties of phonetic radical in Hanzi, being influenced by the right-to-left direction in Arabic script. However, the results in phonetic radical awareness revealed that the Arabic CSL learners showed poorer performance in phonetic radical awareness, indicating that the right-to-left direction in Arabic did not contribute to their acquisition of phonetic radical awareness. Hence, the phonetic radical awareness could not account for their better writing skills in the Arabic CSL learners, and then the two CSL groups' different performance in writing Hanzi might not relate to the script direction in L1. This result is not in line with previous studies on the influence of L1 script on L2 handwriting. One possible explanation could be associated with the different measures of writing. This study only measured the general accuracy rate in writing Hanzi, yet previous research measured smaller orthographic units such as stroke direction (Shanon, 1979) or stroke order (Sassoon, 1995) or radical (Thaveewatanaseth & Jiang, 2015). These different results indicate that the influence of L1 script on L2 handwriting might occur only at smaller orthographic levels.

The question then arises as to the possible factors linked to the different performance in writing Hanzi between the Arabic and English groups. There are at least two possible reasons.

The **first** reason may relate to the different visual complexities of the Arabic and Roman scripts and the Arabic CSL group's experience in learning two different scripts. According to the methods proposed by Carsten Peust (2006) and Chang (2015) to measure the script complexity, the Arabic script is more complex than the English script, indicating that Arabic script is more difficult to write. In addition, most of the Arabic CSL learners had learnt both Arabic and Roman scripts (English script) prior to learning Chinese Hanzi, yet the English CSL learners only learnt Roman script (English or French) before initializing Chinese learning at the university. Therefore, the Arabic CSL group's exposure to a difficult script and their experience in using two different scripts might be helpful for the acquisition of a third script type, i.e. Hanzi. This explanation is in line with previous studies that showed different performance in visual-spatial tasks among users of different orthographies (Demetriou et al., 2005; Kolinsky et al., 1987; McBride-Chang et al., 2011), and that learning a new script is beneficial for the task of visual-spatial processing (Liow et al., 1999). Especially, considering Hanzi writing is demanding in visual-spatial skills and memory (McBride-Chang, Chow, et al., 2005; Tavassoli, 2002), therefore, the Arabic CSL learners' Hanzi writing might benefit from their experience in using a more difficult script and in learning two different scripts.

Second, the two CSL groups' different performance in Hanzi writing might be related to the learning contexts, such as course modules and textbooks. In terms of course modules, most of the English CSL learners studied Chinese (about 10 hours per week) as well as another subject, yet the Arabic CSL learners only studied Chinese as the main subject (about 20 hours per week). The different amount of time spent on Chinese learning might be a potential reason for the two CSL groups' different performance in Hanzi writing. As for the textbooks, the two CSL groups used different textbooks. The Arabic CSL learners used *Boya Chinese* (Li, 2004), and the second-year English CSL learners used *Chinese in Steps* (Zhang & Li, 2006). These textbooks differed in the contents, the frequencies of selected Hanzi and the requirement for Hanzi writing, which could lead to the different achievements in Hanzi writing among the Arabic and English CSL groups.

In conclusion, the Arabic and English CSL learners' different performances in writing Hanzi might not relate to the writing direction of L1 script. In contrast, L1 script complexity and experience in script learning, and different contexts of Chinese language learning may be potential reasons for the Arabic CSL group's better performance in writing Hanzi.

Unlike the significant group differences in Hanzi writing between the Arabic and English CSL learners, the two groups demonstrated similar performance in Hanzi reading.

Hanzi reading

Hanzi reading is another difficult task for the CSL learners with non-Hanzi background. The difficulty lies in the lack of reliable phonological information in cueing the sound of Hanzi. Previous studies have revealed the advantage in reading Hanzi for the CSL learners with Hanzi background (such as Japanese and Korean) compared to those without (Jiang, 2003; Ke, 1998; Lin & Collins, 2012), yet it remains unclear about how varying L1 background influences Hanzi reading among the CSL learners both with non-Hanzi background. As mentioned above, the Arabic CSL learners were predicted to develop better phonetic radical awareness because of the right-to-left writing direction in Arabic script, thus they were assumed to perform better in reading RPR Hanzi. In addition, the two CSL groups would perform similarly in reading Hanzi with different degrees of regularity. However, the results were in disagreement with the hypothesis. The main effect of L1 background was not found in any measure of Hanzi reading. The results suggest that Hanzi reading skills among the Arabic and English CSL learners are influenced by Chinese proficiency level, not L1 background.

Analogously, the regularity effect in reading Hanzi was similar in the Arabic and English CSL learners. The regularity effect indicates that the ease in reading Hanzi differs depending on the correspondence between the phonetic radical and the Hanzi. Reading regular Hanzi is the easiest, followed by semiregular Hanzi, and the irregular Hanzi is the most difficult. The two CSL groups' reading performances in these three types of Hanzi are consistent with the regularity effect reported in the younger native Chinese speakers (Cai et al., 2012; Ho & Bryant, 1997b; Shu & Anderson, 1999) and the CSL learners (Chen & Wang, 2001; Feng, 2002; Jiang, 2001; Wang & Gao, 2006; Xing, 2001). Regular Hanzi has the most reliable phonetic radical, which could provide clear phonological clues for reading Hanzi. Semiregular Hanzi has partially reliable phonetic radical, which could only offer limited phonological clues of syllable, onset or rhyme. In contrast, the phonetic radical in the irregular Hanzi could not provide any useful phonological information for cuing Hanzi. Therefore, the Arabic and English CSL learners' reading achievements are similarly influenced by the regularity effect in Hanzi.

The two CSL groups performed better in reading RPR Hanzi than in LPR Hanzi. This result is in line with the previous studies (Hsiao & Liu, 2010; Shen et al., 1998; Yu, 1998; Yu et al., 1990). This might relate to the relative frequency of LPR and RPR Hanzi. RPR Hanzi are dominant and frequent in modern Chinese (Li & Kang, 1995). Though the frequencies of LPR and RPR Hanzi had been balanced in the study, yet the frequencies were calculated based on the natural written Chinese database, rather than the CSL database. The frequent RPR Hanzi are more likely to appear in the CSL textbooks, thus the CSL learners tend to be more familiar with them and to achieve better performance in reading RPR Hanzi. However, the frequencies of the selected Hanzi in the CSL learner's textbooks were not computed, and this question needs further exploration.

The two CSL groups' similar performance in reading LPR and RPR Hanzi indicates that script directionality does not influence the skills in reading Hanzi. Although previous studies have reported the influence of script directionality in visual scanning, handwriting and drawing (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow et al., 1999; Shimrat, 1973; Vaid, 1995; Vaid et al., 2011), the directionality in L1 script does not seem to affect the general performance in reading Hanzi with different positional structures.

The fact that Arabic and English writing systems do not have similar positional effect, as shown by the phonetic radical in Chinese Hanzi, could be the main reason. The grapheme-phoneme correspondence rules in Arabic and English are totally different from the phonetic-radical-Hanzi mapping forms. The print-sound rules in alphabetic L1 might not contribute to the development of phonetic radical awareness in Hanzi for the Arabic and English CSL learners, as suggested by the Transfer Facilitation Model (Koda, 2008) because the distances between Arabic, English and Hanzi orthographies are very far. Another explanation might be associated with the measures. This study only examined the accuracy rate in reading LPR and RPR Hanzi among the CSL learners, and it may be hard to capture the influence of the L1 script directionality on the level of whole Hanzi. Reaction time or eye-tracking techniques could be more useful to detect the influence of script directionality at a fine-grained level.

To conclude, the Arabic and English CSL learners' similar performance in reading Hanzi indicates that Hanzi reading may not be influenced by the writing direction in L1 script, and that the development of Hanzi reading skills may be influenced by the internal characteristics of Hanzi, such as regularity effect and position effect.

Following the above discussion on the Arabic and English CSL learners' performance in phonetic radical awareness, Hanzi reading and Hanzi writing, the next section discusses the influence of other meta-linguistic and background variables on these measures among the two groups.

5.3.2 Influence of other meta-linguistic and background variables on phonetic radical awareness, Hanzi reading and Hanzi writing skills

A large and growing body of literature has investigated the influence of other meta-linguistic and background variables on second language learning, such as language proficiency (Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001), language aptitude (Hu et al., 2013; Li, 2015; Smemoe & Haslam, 2013; Winke, 2013), previous language learning experience (Ehrman & Oxford, 1995) and studying abroad in L2-speaking country (Aveni, 2005; Brecht et al., 1995; Carroll, 1967; Collentine, 2009; Freed, 1995a; Freed, 1998; Meara, 1994). The present study found four variables that significantly predicted the performance in measures of phonetic radical awareness, Hanzi reading and Hanzi writing in the Arabic and English CSL learners, and they were Chinese language proficiency, number of languages previously learnt, length of stay in China and phonetic coding ability.

Chinese language proficiency was the most common predictor. Firstly, the main effect of Chinese language proficiency level was found in most measures of Hanzi reading and Hanzi writing, in which the CSL learners' performance improved as their Chinese proficiency level increased. Secondly, the positive contribution of Chinese language proficiency was found in most measures of Hanzi reading and Hanzi writing among the two CSL groups, consistent with previous findings (Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001), but Chinese language proficiency was not a significant predictor in the measures of phonetic radical awareness. This finding indicates that the CSL learners' awareness of the functional and positional properties of phonetic radical in Hanzi might be independent from Chinese language skills. This result is similar to that in a study by Shen and Ke (2007) who reported that radical application skills lagged behind the knowledge of radicals in Hanzi among the CSL learners in America, which was interpreted from the perspectives of knowledge types (declarative knowledge, procedural knowledge and strategic knowledge) and cognitive restructuring.

Another common predictor was the length of stay in China, which was found in reading Hanzi in the intermediate group, but not in the pre-intermediate group. This could be explained by the different experience of studying abroad in China in these two groups. The Arabic CSL learners and most of the pre-intermediate English CSL learners did not have any experience of studying in China, meanwhile most intermediate English CSL learners studied at Chinese universities for one academic year as required by their degree specifications. Thus, the differences in the length of staying in China appeared to be greater in the intermediate CSL learners than in the pre-intermediate learners. However, this result is in disagreement with previous finding in learners of Japanese as a second language (Huebner, 1995; Dewey, 2004), which did not find significant differences in Kanji learning between the students who studied in Japan and those who studied at their home country. The main reason could be due to the different length of staying in L2 country. The learners of Japanese in Japan in Huebner's and Dewey's studies participated in a summer program, yet the third-year English CSL learners in the present thesis studied in China for one academic year and received more L2 input. Another important finding is that the length of staying in China did not predict any measure of phonetic radical awareness, indicating that staying in China might be more helpful for the development of Hanzi reading skills than for the meta-cognition of the orthographic structure of Hanzi, corroborating with the finding that the CSL learners' radical application skills lagged behind their Hanzi knowledge (Shen & Ke, 2007).

The number of languages previously learnt predicted writing Hanzi in the pre-intermediate English CSL group, and phonetic radical awareness in the intermediate English CSL group. The predictive power of the number of previous languages was positive for Hanzi writing, similar to the finding reported by Ehrman and Oxford (1995) who observed that more experience in learning foreign languages led to better performance in speaking and reading skills. However, the number of languages previously learnt negatively predicted the phonetic radical awareness among the English CSL learners. The fact that most English CSL learners only learnt European languages before starting learning Chinese might be one possible reason. Grapheme-phoneme correspondence governs the reading and spelling convention in alphabetic languages, but phonetic radical awareness only exists in Hanzi. Heavily influenced by the exposure to alphabetic languages, the English CSL learners might find it hard to map the phonetic radical onto the pronunciation of Hanzi. This finding is similar to previous studies that showed Chinese ESL learners' poor performance in English phoneme awareness (Bialystok, Majumder, & Martin, 2003; McDowell & Lorch, 2008) and Hong Kong children' less good achievement in phoneme deletion task (McBride-Chang et al., 2004), indicating the difficulty in acquiring the target phonological unit that only exists in L2, such as the English phoneme for Chinese ESL learners and the phonetic radical in Hanzi for CSL learners speaking alphabetic L1s.

Phonetic coding ability predicted the performance in phonetic radical awareness in the intermediate English CSL group. The result indicates that stronger phonetic coding ability related to higher percentage of right-preference strategy in naming pseudo-Hanzi. Phonetic coding ability was examined using LLAMA-E test (Meara, 2005) and it was tested by the capability to detect the symbol-sound correspondence rules in an artificial language in this study. The symbols used in the LLAMA-E test were Roman letters, numbers and diacritics. This result suggests that phonetic coding ability tested in an alphabetic orthography is also important for the development of orthographic awareness in Hanzi, indicating that the aptitude to decode the orthographic structure of Chinese Hanzi is similar to that in learning alphabetic writing systems, and pointing to language-universal aptitude (Carrol, 1964). Phonetic coding ability might reveal an underlying universal cognitive construct that is crucial for the successful detection of the corresponding rules between print and sound in learning a language.

5.4 Conclusion

The influence of L1 background and other meta-linguistic and background variables on phonetic radical awareness and Hanzi literacy skills were explored among the Arabic and English CSL learners in this study. The general results suggest that L1 background is not an important factor contributing to the development of phonetic radical awareness, Hanzi reading and Hanzi writing skills for the Arabic and English speaking CSL learners.

The phonetic radical awareness was examined using the task of pseudo-Hanzi naming.

The Arabic and English groups demonstrated poor phonetic radical awareness in comparison to the native Chinese speakers, indicating that the CSL learners had not developed awareness of the functional and positional properties of phonetic radical in Hanzi, and that L1 background did not influence the growth of phonetic radical awareness in the two CSL groups. In contrast, phonetic coding ability was found to predict the strategy of using the right-side Hanzi to name the pseudo-Hanzi. Furthermore, Chinese language proficiency and the number of languages previously learnt demonstrated interference with the CSL learners' sensitivity to the phonetic radical in Hanzi.

L1 background did not contribute to Hanzi reading or writing skills. The development of the Arabic and English CSL learners' reading skills could be more motivated by the internal structure of Hanzi such as the functional and positional properties of phonetic radical. Chinese language proficiency and the length of stay in China significantly correlated with Hanzi reading. In the task of Hanzi writing, the Arabic group's better achievement did not link with the right-to-left writing direction in Arabic script, and it might relate to the visual complexity in Arabic script, the Arabic group's experience in learning different scripts, and Chinese learning contexts. Furthermore, Chinese language proficiency and the number of languages previously learnt uniquely contributed to the writing performance in Hanzi.

The general results in this study demonstrated that the far distance in orthographies between Hanzi, Arabic and English did not result in the influence of L1 background on Hanzi acquisition (Koda, 2008), and further confirms the traditional belief that CSL learners with non-Hanzi background tend to show similar performance in Hanzi learning.

Chapter Six: Influence of L1 background and L2 Chinese language proficiency on the relationships between phonological awareness, phonetic radical awareness and Chinese literacy skills among CSL learners

This chapter aims to explore the influence of L1 background and L2 Chinese language proficiency on the relationships between phonological awareness, phonetic radical awareness and different types of Chinese literacy skills (Pinyin spelling, Hanzi reading and Hanzi writing) among the Arabic and English CSL learners.

The previous two chapters explored the influence of L1 background and other meta-linguistic and background variables on phonological awareness and Pinyin spelling, and phonetic radical awareness and Hanzi literacy skills among the Arabic and English CSL learners, respectively. The main effects of L1 background and Chinese language proficiency level were observed in phonological awareness, Pinyin spelling and Hanzi writing, not in Hanzi reading or phonetic radical awareness. The English CSL learners achieved better performance in Chinese phonological awareness and Pinyin spelling, and the Arabic CSL learners demonstrated higher accuracy rates in Hanzi writing. The main results are summarized in Table 6.1.

As discussed earlier in Chapter 2 and Chapter 3, the significant correlations between phonological awareness and literacy skills in reading and spelling have been well established among native users and L2 learners of alphabetic languages such as English. For users of logographic Hanzi, phonological awareness and radical awareness are two important skills that closely correlate with the performance in Hanzi reading, and radical awareness also contributes to the acquisition of Hanzi writing skills. The results in the previous two chapters appeared to be inconsistent with previous studies that reported close relationships between phonological awareness and phonetic radical awareness and Chinese literacy skills. On the one hand, English CSL learners demonstrated better performance in Chinese phonological awareness and Pinyin spelling skills, consistent with the importance of phonological awareness for spelling skills observed in alphabetic orthographies. On the other hand, the between-group differences in phonological awareness and the group similarity in Hanzi reading, as well as the group similarity in phonetic radical awareness and the between-group differences in Hanzi writing were contradictory with the positive correlations between phonological awareness and radical awareness with Chinese literacy skills. Given that the relationship between phonological processing skills and literacy skills might differ across the L2 learners' L1 background (Jiang, 2003; Zhao, 2011), the results in the previous two chapters imply that the relationships between Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills in Pinyin and Hanzi might be dependent on the Arabic and English CSL learners' L1 background and Chinese language proficiency level.

Table 6.1

Summary of the Between-group Differences in Phonological Awareness, Pinyin Spelling, Phonetic Radical Awareness, Hanzi Reading and Hanzi Writing in the Arabic and English CSL Learners

Measures	Group comparison
Phonological awareness	English > Arabic
Pinyin spelling	English > Arabic
Phonetic radical awareness	English ≈ Arabic
Hanzi reading	English ≈ Arabic
Hanzi writing	English < Arabic

Note. ">" = better than; "≈" =similar to; "<" = less well than.

This chapter, therefore, explores the influence of L1 background and Chinese language proficiency level on the relationships between phonological awareness, phonetic radical awareness and different types of Chinese literacy skills among the Arabic and English CSL learners. The questions to be addressed in this chapter are as follows:

Research question 1. How do L1 background and L2 Chinese language proficiency influence the importance of Chinese phonological awareness for Pinyin spelling among the Arabic and the English CSL learners?

Research question 2. How do L1 background and L2 Chinese language proficiency influence the importance of Chinese phonological awareness and phonetic radical awareness for Hanzi reading among the Arabic and the English CSL learners?

Research question 3. How do L1 background and L2 Chinese language proficiency influence the importance of Chinese phonological awareness and phonetic radical awareness for Hanzi writing among the Arabic and English CSL learners?

6.1 Method

6.1.1 Participants

The 83 Arabic and English CSL learners recruited in Chapter Five participated in this study.

6.1.2 Instruments

Chinese phonological awareness

The measures of Chinese phonological awareness were the same as used in Chapter Four (See Appendix 3).

Pinyin spelling

The measures of Pinyin spelling were the same as used in Chapter Four (See Appendix 4).

Phonetic radical awareness

The measures of pseudo-Hanzi naming in Chapter Five was used to examine phonetic radical awareness in this study (See Appendix 5).

Hanzi reading and Hanzi writing

The tasks of reading Hanzi for pronunciation (See Appendix 6) and writing Hanzi according to Pinyin and meaning (See Appendix 7) were the same as used in Chapter Five.

6.1.3 Procedure

This study was approved by the Ethics Committee in the Department of Education at the University of York. All participants were given informed consent which was printed in their native languages, Arabic or English. The informed consents mainly informed them of the aim and the main tasks in the study, and the relevant ethic issues involved (See Appendix 9).

All the participants were tested individually, and were given a small amount of cash or a small gift after successfully completing the test. The instructions of the tests were presented in the participants' native language-Arabic or English.

6.2 Results

The research questions were to explore the influence of L1 background and Chinese language proficiency level on the correlations between phonological awareness, phonetic radical awareness and Chinese literacy skills among the Arabic and English CSL learners. The results were organized as follows. Firstly, the accuracy rates in the four tasks are presented. Secondly, to understand the general correlations between phonological awareness, phonetic radical awareness, Pinyin Spelling, Hanzi reading and Hanzi writing, a series of correlation analysis tests were run among all the CSL participants. Thirdly, in order to explore the influence of L1 background and Chinese language proficiency level, a series of correlation analysis tests were carried out between the Arabic and English CSL learners.

The Arabic and English CSL participants' performances in the four tasks are summarized in Table 6.2.

Table 6.2

Summary of the Arabic and English CSL Learners' Accuracy Rates in Chinese Phonological Awareness, Phonetic Radical Awareness, Pinyin Spelling, Hanzi Reading and Hanzi Writing

Measures		Level	Arabic		English	
			Mean	SD	Mean	SD
Phonological awareness	Syllable awareness	Level1	0.57	0.22	0.89	0.21
		Level2	0.73	0.21	0.96	0.09
			0.64	0.23	0.93	0.15
	Onset awareness	Level1	0.68	0.19	0.82	0.15
		Level2	0.79	0.16	0.91	0.10
			0.73	0.18	0.87	0.13
	Rhyme awareness	Level1	0.66	0.18	0.70	0.11
		Level2	0.70	0.19	0.78	0.13
			0.68	0.18	0.74	0.12
	Tone awareness	Level1	0.88	0.13	0.91	0.12
		Level2	0.94	0.10	0.94	0.10
			0.90	0.12	0.92	0.11
	Overall phonological awareness	Level1	0.70	0.11	0.83	0.09
		Level2	0.79	0.09	0.90	0.06
			0.74	0.11	0.87	0.08
Phonetic radical awareness	Direct naming strategy	Level1	0.36	0.33	0.25	0.26
		Level2	0.25	0.23	0.57	0.34
			0.31	0.29	0.44	0.34
	Similar Hanzi naming strategy	Level1	0.04	0.06	0.04	0.06
		Level2	0.04	0.07	0.04	0.05
			0.04	0.06	0.04	0.05
	Family Hanzi naming strategy	Level1	0.04	0.06	0.05	0.07
		Level2	0.03	0.07	0.05	0.08
			0.03	0.06	0.05	0.08
Pinyin spelling		Level1	0.38	0.17	0.42	0.19
		Level2	0.50	0.20	0.70	0.16
			0.44	0.19	0.58	0.22
Hanzi reading		Level1	0.16	0.09	0.16	0.10
		Level2	0.27	0.12	0.35	0.15
			0.21	0.12	0.27	0.16
Hanzi writing		Level1	0.23	0.13	0.16	0.09
		Level2	0.27	0.17	0.32	0.15
			0.30	0.16	0.25	0.15

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level.

6.2.1 Overall correlation between phonological awareness, phonetic radical awareness and Chinese literacy skills

The overall correlation matrix between Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills (Pinyin spelling, Hanzi reading and Hanzi writing) were examined among the CSL participants in this study (Table 6.3). It can be seen that Pinyin spelling significantly correlated with syllable awareness (r=0.29), onset awareness (r=0.26), tone awareness (r=0.33) and overall Chinese phonological awareness (r=0.39), Hanzi reading significantly correlated with syllable awareness (r=0.22) and overall Chinese phonological awareness (r=0.30). Hanzi writing did not significantly relate with any measure of phonological awareness or phonetic radical awareness.

6.2.2 Influence of L1 background and Chinese language proficiency level on the correlations between phonological awareness, phonetic radical awareness and Chinese literacy skills

To explore whether L1 background and Chinese language proficiency level affected the relationships between phonological awareness, phonetic radical awareness and Chinese literacy skills, a series of correlation analyses were carried out in the whole Arabic group and the whole English group (Table 6.4), the pre-intermediate and intermediate Arabic (Table 6.5) and English group (Table 6.6), and the pre-intermediate and intermediate groups (Table 6.7). The following significant correlations were observed: Pinyin spelling and tone awareness (r=0.40), Pinyin spelling and phonological awareness (r=0.39) in the whole English group; Pinyin spelling and tone awareness (r=0.46) in the intermediate English group; Pinyin spelling and phonological awareness (r=0.35) in the intermediate group; Hanzi reading and syllable awareness (r=0.33), Hanzi reading and phonological awareness (r=0.30) in the whole Arabic group; Hanzi reading and rhyme awareness (r=0.45) in the intermediate Arabic group; Hanzi reading and direct naming strategy (r=0.33) in the whole English group; Hanzi writing and onset awareness (r=0.43) in the pre-intermediate Arabic group.

Table 6.3

Correlation Matrix between Pinyin Spelling, Hanzi Reading, Hanzi Writing, Phonetic Radical Awareness, and Phonological Awareness among the Whole CSL Group

	Spelling	Reading	Writing	Direct	Similar	Family	PRA	Syllable	Onset	Rhyme	Tone	PA
Spelling	1.00											
Reading	0.60*	1.00										
Writing	0.47*	0.71*	1.00									
Direct	0.10	0.18	-0.01	1.00								
Similar	-0.01	0.03	-0.09	0.38*	1.00							
Family	0.00	-0.06	-0.15	0.07	0.01	1.00						
PRA	0.09	0.16	-0.06	0.97*	0.51*	0.26*	1.00					
Syllable	**0.29***	**0.22***	-0.02	0.01	0.06	0.00	0.02	1.00				
Onset	**0.26***	0.21	0.13	0.18	0.13	0.10	0.20	0.43*	1.00			
Rhyme	0.17	0.19	0.11	-0.07	0.16	0.15	−0.01	0.29*	0.11	1.00		
Tone	**0.33***	0.13	0.10	0.18	0.18	0.21	0.23*	0.19	0.12	0.04	1.00	
PA	**0.39***	**0.30***	0.10	0.10	0.18	0.14	0.14	0.84*	0.67*	0.55*	0.42*	1.00

Note. Spelling = Pinyin spelling; Reading = Hanzi reading; Writing = Hanzi writing; Direct = direct naming strategy; Similar = similar Hanzi naming strategy; Family = family Hanzi naming strategy; PRA = phonetic radical awareness; Syllable = syllable awareness; Onset = onset awareness; Rhyme = rhyme awareness; Tone = tone awareness; PA = phonological awareness.

*$p<.05$

Table 6.4

Correlation Matrix between Pinyin Spelling, Hanzi Reading, Hanzi Writing, Phonetic Radical Awareness and Phonological Awareness in the Arabic CSL Group (Below the Diagonal) and the English CSL Group (Above the Diagonal)

	Spelling	Reading	Writing	Syllable	Onset	Rhyme	Tone	PA	Direct	Similar	Family	PRA
Spelling	-	0.65*	0.58*	0.06	0.25	0.27	**0.40***	**0.39***	0.18	-0.01	0.07	0.18
Reading	0.48*	-	0.78*	-0.10	0.26	0.12	0.15	0.16	**0.33***	0.04	-0.08	0.29
Writing	0.53*	0.77*	-	0.02	0.23	0.17	0.05	0.19	0.10	-0.12	-0.17	0.04
Syllable	0.19	0.33*	0.12	-	0.38*	0.17	0.01	0.71*	-0.14	-0.29	-0.13	-0.20
Onset	0.09	0.07	0.20	0.21	-	0.40*	0.01	0.76*	0.19	0.11	-0.05	0.18
Rhyme	0.00	0.19	0.13	0.23	-0.13	-	-0.18	0.58*	-0.08	0.18	0.17	-0.01
Tone	0.24	0.09	0.16	0.26	0.15	0.13	-	0.30	0.18	-0.02	0.22	0.21
PA	0.21	**0.30***	0.25	0.78*	0.51*	0.52*	0.54*	-	0.04	-0.03	0.07	0.05
Direct	-0.15	-0.12	-0.08	-0.15	0.05	-0.15	0.15	-0.08	-	0.40*	-0.03	0.97*
Similar	-0.05	0.01	-0.06	0.22	0.14	0.14	0.33*	0.32*	0.37*	-	0.00	0.51*
Family	-0.16	-0.09	-0.11	-0.03	0.16	0.12	0.19	0.16	0.17	0.03	-	0.17
PRA	-0.17	-0.12	-0.10	-0.09	0.10	-0.08	0.23	0.02	0.97*	0.51*	0.34*	-

Note. Spelling = Pinyin spelling; Reading = Hanzi reading; Writing = Hanzi writing; Direct = direct naming strategy; Similar = similar Hanzi naming strategy; Family = family Hanzi naming strategy; PRA = phonetic radical awareness; Syllable = syllable awareness; Onset = onset awareness; Rhyme = rhyme awareness; Tone = tone awareness; PA = phonological awareness.

*p<.05

Table 6.5

Correlation Matrix between Pinyin Spelling, Hanzi Reading, Hanzi Writing, Phonetic Radical Awareness and Phonological Awareness in the Pre-intermediate (Below the Diagonal) and the Intermediate (Above the Diagonal) Arabic CSL Group

	Spelling	Reading	Writing	Syllable	Onset	Rhyme	Tone	PA	Direct	Similar	Family	PRA
Spelling	-	0.42	0.54*	-0.12	-0.03	0.09	0.25	0.04	-0.06	-0.30	-0.15	-0.17
Reading	0.40	-	0.77*	0.14	-0.21	**0.45***	0.03	0.25	-0.02	0.07	-0.03	0.00
Writing	0.39	0.63*	-	-0.10	-0.27	0.37	0.07	0.04	-0.10	-0.12	-0.12	-0.15
Syllable	0.33	0.26	0.06	-	-0.30	0.34	0.09	0.67*	-0.12	0.33	-0.15	-0.06
Onset	0.05	0.06	**0.43***	0.39	-	-0.13	0.00	0.20	0.13	-0.01	0.33	0.20
Rhyme	-0.17	-0.22	-0.23	0.10	-0.21	-	0.08	0.71*	-0.45*	0.09	0.28	-0.29
Tone	0.11	-0.13	0.05	0.25	0.12	0.13	-	0.41	-0.04	0.31	0.09	0.07
PA	0.15	0.03	0.14	0.80*	0.60*	0.40	0.53*	-	-0.26	0.34	0.24	-0.08
Direct	-0.14	-0.03	0.09	-0.07	0.11	0.06	0.34	0.14	-	0.34	-0.10	0.94*
Similar	0.28	-0.03	0.02	0.17	0.28	0.20	0.39	0.41	0.41*	-	-0.01	0.55*
Family	-0.15	-0.11	-0.05	0.13	0.08	-0.02	0.32	0.19	0.34	0.06	-	0.17
PRA	-0.10	-0.05	0.07	-0.01	0.15	0.08	0.41	0.21	0.98*	0.52*	0.46*	-

Note. Spelling = Pinyin spelling; Reading = Hanzi reading; Writing = Hanzi writing; Direct = direct naming strategy; Similar = similar Hanzi naming strategy; Family = family Hanzi naming strategy; PRA = phonetic radical awareness; Syllable = syllable awareness; Onset = onset awareness; Rhyme = rhyme awareness; Tone = tone awareness; PA = phonological awareness.

*p<.05

Table 6.6

Correlation Matrix between Pinyin Spelling, Hanzi Reading, Hanzi Writing, Phonetic Radical Awareness and Phonological Awareness in the Pre-intermediate (Below the Diagonal) and the Intermediate (Above the Diagonal) English CSL Group

	Spelling	Reading	Writing	Syllable	Onset	Rhyme	Tone	PA	Direct	Similar	Family	PRA
Spelling	-	0.34	0.34	-0.09	0.11	-0.11	**0.46***	0.17	-0.28	-0.17	0.13	-0.26
Reading	0.66*	-	0.73*	-0.31	0.23	-0.25	0.21	-0.05	-0.03	-0.16	-0.15	-0.09
Writing	0.49*	0.47	-	-0.26	-0.01	-0.16	0.10	-0.14	-0.20	-0.28	-0.17	-0.27
Syllable	-0.15	-0.45	-0.08	-	-0.09	0.16	-0.13	0.38	-0.17	0.01	0.03	-0.15
Onset	0.03	-0.13	0.21	0.51*	-	0.32	0.14	0.66*	0.11	0.49*	0.08	0.19
Rhyme	0.38	0.30	0.41	0.08	0.37	-	-0.18	0.68*	-0.44*	0.25	0.27	-0.32
Tone	0.36	-0.13	-0.27	0.02	-0.18	-0.32	-	0.38	0.14	0.13	0.19	0.19
PA	0.16	-0.27	0.08	0.83*	0.77*	0.40	0.18	-	-0.19	0.42*	0.28	-0.06
Direct	0.01	0.36	-0.17	-0.47	-0.03	0.08	0.12	-0.22	-	0.52*	-0.22	0.98*
Similar	0.11	0.38	0.06	-0.48	-0.18	0.10	-0.17	-0.39	0.37	-	-0.32	0.56*
Family	0.04	0.01	-0.30	-0.26	-0.20	0.03	0.28	-0.13	0.33	0.38	-	-0.03
PRA	0.04	0.36	-0.19	-0.53*	-0.10	0.09	0.13	-0.28	0.95*	0.58*	0.57*	-

Note. Spelling = Pinyin spelling; Reading = Hanzi reading; Writing = Hanzi writing; Direct = direct naming strategy; Similar = similar Hanzi naming strategy; Family = family Hanzi naming strategy; PRA = phonetic radical awareness; Syllable = syllable awareness; Onset = onset awareness; Rhyme = rhyme awareness; Tone = tone awareness; PA = phonological awareness.

*p<.05

Table 6.7

Correlation Matrix between Pinyin Spelling, Hanzi Reading, Hanzi Writing, Phonetic Radical Awareness and Phonological Awareness in the Pre-intermediate (Below the Diagonal) and the Intermediate (Above the Diagonal) CSL Group

	Spelling	Reading	Writing	Syllable	Onset	Rhyme	Tone	PA	Direct	Similar	Family	PRA
Spelling	-	0.45*	0.32*	0.21	0.22	0.13	0.30	**0.35***	0.10	-0.18	0.06	0.08
Reading	0.52*	-	0.66*	0.15	0.12	0.17	0.13	0.25	0.12	-0.02	-0.07	0.09
Writing	0.37*	0.53*	-	-0.20	-0.21	0.11	0.08	-0.11	-0.21	-0.20	-0.17	-0.26
Syllable	0.13	-0.03	-0.19	-	0.08	0.37*	0.01	0.74*	0.22	0.23	0.02	0.24
Onset	0.06	-0.01	0.20	0.54*	-	0.12	0.05	0.50*	0.30	0.19	0.23	0.35*
Rhyme	0.02	-0.05	-0.12	0.15	-0.02	-	-0.03	0.69*	-0.22	0.16	0.28	-0.12
Tone	0.23	-0.13	-0.09	0.21	0.07	0.02	-	0.30*	0.06	0.22	0.14	0.12
PA	0.17	-0.07	-0.09	0.87*	0.71*	0.40*	0.41*	-	0.15	0.34*	0.27	0.25
Direct	-0.09	0.11	0.07	-0.27	0.00	0.04	0.24	-0.08	-	0.40*	-0.09	0.97*
Similar	0.20	0.15	0.03	-0.07	0.11	0.16	0.16	0.10	0.38*	-	-0.15	0.50*
Family	-0.05	-0.05	-0.16	0.00	0.00	0.01	0.30	0.08	0.31*	0.22	-	0.09
PRA	-0.05	0.11	0.04	-0.24	0.01	0.06	0.28	-0.03	0.97*	0.53*	0.48*	-

Note. Spelling = Pinyin spelling; Reading = Hanzi reading; Writing = Hanzi writing; Direct = direct naming strategy; Similar = similar Hanzi naming strategy; Family = family Hanzi naming strategy; PRA = phonetic radical awareness; Syllable = syllable awareness; Onset = onset awareness; Rhyme = rhyme awareness; Tone = tone awareness; PA = phonological awareness.

*p<.05

To summarize, there were three main findings (See Table 6.8). First, among all the CSL participants, phonological awareness significantly correlated with Pinyin spelling and Hanzi reading, not Hanzi writing, and the overall phonetic radical awareness did not correlate with any Chinese literacy skill. Second, the link between phonological awareness and Pinyin spelling was only observed in the English group, the close association between phonological awareness and Hanzi reading only occurred in the Arabic group, and the strategy of direct naming in the test of phonetic radical awareness only correlated with Hanzi reading in the English group. Third, the correlation between Pinyin spelling and phonological awareness was only reported in the intermediate learners.

Table 6.8

Summary of the Significant Correlations with Pinyin Spelling, Hanzi Reading and Hanzi Writing in the Arabic and English CSL Learners

Literacy skills	Group	Significant correlations
Pinyin spelling	Arabic and English	Syllable awareness, onset awareness and tone awareness, phonological awareness
	English	Tone awareness, phonological awareness
	English level2	Tone awareness
	Level 2	phonological awareness
Hanzi reading	Arabic and English	Syllable awareness, phonological awareness
	Arabic	Syllable awareness, phonological awareness
	Arabic level2	Rhyme awareness
	English	Direct naming strategy
Hanzi writing	Arabic level1	Onset awareness

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level

6.3 Discussion

Significant relationships between phonological awareness and reading and spelling skills in alphabetic languages as well as non-alphabetic languages have been well documented in the literature involving native speakers of English and Chinese (Bus & Van IJzendoorn, 1999; Song et al., 2015; Swanson et al., 2003). The importance of phonetic radical awareness for Hanzi reading and Hanzi writing has also been observed in Chinese-speaking children. However, how phonological awareness and phonetic radical awareness contribute to the development of Chinese literacy skills has not been investigated in CSL learners. This chapter investigated the associations of Chinese phonological awareness and phonetic radical awareness for Pinyin spelling, Hanzi reading and Hanzi writing in CSL learners, and the influence of L1 background and Chinese language proficiency level on these relationships among the Arabic and English CSL learners. The results suggest that phonological awareness was important for Pinyin spelling and Hanzi reading, and that the importance of phonological awareness differed across the CSL learners' L1 background and Chinese language proficiency level. In addition, the strategy of direct naming in the task testing phonetic radical awareness correlated with Hanzi reading only in the English CSL learners. The relationships between phonological awareness, phonetic radical awareness and different Chinese literacy skills (Pinyin spelling, Hanzi reading and Hanzi writing) are discussed separately.

6.3.1 Phonological awareness and Pinyin spelling

Prior studies have documented the importance of phonological awareness in the development of spelling skills in alphabetic languages among native speakers (Caravolas, 2004; Caravolas et al., 2012; Moll et al., 2014; Niolaki & Masterson, 2012; Rahbari et al., 2007; Read, 1975; Wade-Woolley & Siegel, 1997) and L2 learners (Sun et al., 2013; Yeung, 2006; Zhao, 2011). However, no support was found for the association between Chinese phonological awareness and Pinyin spelling among the CSL learners or the influence of L1 background on the relationship between phonological awareness and spelling skills among L2 learners. Thus, the present study examined the relationship between Chinese phonological awareness and Pinyin spelling among CSL learners with different alphabetic L1 backgrounds. The hypothesis was that Chinese phonological awareness would be important for spelling Pinyin, and the correlation between phonological awareness and Pinyin spelling was similar across the Arabic and English CSL learners. As expected, the results in the present study showed that the correlation between Chinese phonological awareness (syllable, onset and tone awareness) and Pinyin spelling was significant. However, it is surprising to observe that the correlation between phonological awareness and Pinyin spelling was only found in the English group, not in the Arabic group.

The observed significant correlation between Chinese phonological awareness and Pinyin spelling in the current study is consistent with other research that reported the importance of phonological awareness in spelling in alphabetic languages (Caravolas, 2004; Caravolas et al., 2012; Moll et al., 2014; Niolaki & Masterson, 2012; Rahbari et al., 2007; Read, 1975; Wade-Woolley & Siegel, 1997). The overall Chinese phonological awareness was found to exert moderate influence in Pinyin syllable spelling, and the reported coefficient was similar to the results reported in research in native users of different alphabetic orthographies (Caravolas, 2004; Moll et al., 2014) and learners of English as a second language (Leong, Tan, Cheng, & Hau, 2005; Wade-Woolley & Siegel, 1997). This is largely due to the alphabetic nature of Pinyin.

Pinyin is phonemic, and utilizes similar Roman alphabet as used in English. Pinyin orthography is very shallow, in which the grapheme-phoneme correspondence is quite consistent. According to the three stages in the spelling process proposed by Tainturier and Rapp (2001), the spelling task first requires segmentation of the spoken sounds into smaller units such as syllable, onset-rhyme and tone, in which the abilities of perception, discrimination and segmentation of the syllable structure are essential. The second stage involves converting the segmented phonological unit into the corresponding orthographic unit, and the awareness of the phoneme-grapheme correspondence rules are extremely important. In these two stages, awareness of the phonological structure of the spoken sounds is crucial, as incorrect perception or segmentation of the syllable structure directly leads to the application of wrong phoneme-grapheme mapping forms. Therefore, it is not surprising to find a strong relationship between phonological awareness and spelling in alphabetic orthographies. This study extends the literature in demonstrating that Chinese phonological awareness is also a significant variable related with Pinyin spelling for the Arabic and English CSL learners, and provides more supporting evidence for the Psycholinguistic Grain Size Theory (Zielger & Goswami, 2005) that argues for the significance of phonological awareness for the development of literacy skills.

It is interesting to find that the importance of Chinese phonological awareness for Pinyin spelling differed across the CSL learners' L1 background and Chinese language proficiency level. Chinese phonological awareness correlated with Pinyin spelling in the English CSL learners, and the intermediate CSL learners. These findings might be related with the influence of L1 orthography. English and Chinese have a similar syllabic structure. English and Pinyin use the same Roman alphabetic letters. Therefore, the English CSL learners may be better able to develop awareness of phonological structure in Chinese and to realize the importance of phonological awareness for Pinyin spelling. As for the Arabic CSL learners, the main difficulty lies in that Arabic differs from Chinese in terms of its body-coda syllabic structure, the dominant status of consonant, lack of compound vowel and rhyme, and the script used in the orthography. The distance between Pinyin and Arabic is further than that between Pinyin and English. According to the Transfer Facilitation Model proposed by Koda (2008), the development of the subsets of Chinese phonological awareness in the English CSL learners could be easier as they have already demonstrated phonological awareness at corresponding levels in English, and the positive transfer from English might benefit the growth of Chinese phonological awareness, which further leads to better skills in Pinyin spelling. In contrast, it could be more difficult for the Arabic CSL learners to develop Chinese phonological awareness. In particular, the limited number of vowels in Arabic could result in longer time for the growth of Chinese rhyme awareness. This is similar to the case with Arabic ESL learners' relatively slow development in acquiring English phonological awareness (Saiegh-Haddad & Geva, 2008). Thus, the slow development of Chinese phonological awareness among the Arabic CSL learners might be the main reason leading to the weak correlations between phonological awareness and Pinyin spelling in the Arabic group.

As for the different correlation coefficients between phonological awareness and Pinyin spelling in the pre-intermediate and intermediate groups, this result is consistent with some studies conducted in native Chinese-speaking children (Li et al., 2012; Pan et al., 2001), yet conflicting with the result in a meta-linguistic study which reported that age or grade did not moderate the effect size of phonological awareness (Song et al., 2015). The unbalanced development rate of phonological awareness and Pinyin spelling skills might account for this result in the present study. Though there has not been a consensus, phonological awareness might develop earlier than spelling skills. This is because phonological awareness mainly involves the ability to reflect on and to manipulate the phonological structure in speech, but the acquisition of spelling skills depends on the correct perception of phonological structure and the successful application of grapheme-phoneme correspondence rules, as well as the motor skills to produce the spelling by hand. Especially for the CSL learners, it might be time-consuming to achieve success in Pinyin spelling because Pinyin has tones that are not present in their L1s and they are also required to learn Hanzi. Therefore, the intermediate CSL learners could demonstrate better performance in phonological awareness and Pinyin spelling skills than the pre-intermediate CSL learners, which led to a stronger association between phonological awareness and Pinyin spelling. However, this result should be interpreted with caution, and more studies are needed to explore whether the effect size of phonological awareness on Hanzi reading is mediated by Chinese language proficiency among CSL learners.

To conclude, the phonemic nature of Pinyin orthography determines that Chinese phonological awareness and its subcomponents are crucial for the development of Pinyin spelling skills for the Arabic and English CSL learners. However, the similarities and closer distance in orthographies between English and Pinyin could have led to stronger correlation between Chinese phonological awareness and Pinyin spelling in the English CSL learners, and the dissimilarities and further distance in orthographies between Arabic and Pinyin might explain the weak relationship between phonological awareness and Pinyin spelling in the Arabic CSL learners.

Following the discussion on the relationship between phonological awareness and Pinyin spelling, the next section turns to the association between phonological awareness, phonetic radical awareness and Hanzi reading.

6.3.2 Phonological awareness, phonetic radical awareness and Hanzi reading

The relationships between Chinese phonological awareness, orthographic awareness and Hanzi reading is a resonant topic in research involving native Chinese speakers. Numerous studies have reported that phonological awareness is a good predictor in reading skills not only in languages with alphabetic writing systems (Adams, 1994; Bradley & Bryant, 1983; Brady & Shankweiler, 1991; Goswami & Bryant, 1990; Wagner & Torgesen, 1987; Wagner et al., 1994; Ziegler et al., 2010), but also in languages using logographic script such as Chinese (Ho & Bryant, 1997b; Huang & Hanley, 1997; McBride-Chang & Ho, 2000; Shu et al., 2008; Zhou, McBride-Chang, Fong, Wong, & Cheung, 2012), though its predictive power in reading skills is not as powerful as expected (Melby-Lervåg et al., 2012; Song et al., 2015; Swanson et al., 2003). In addition to phonological awareness, phonetic radical awareness is another important skill for Hanzi reading for the native speakers of Chinese. Becoming aware of the functional and positional information of phonetic radical in Hanzi is crucial for the development of Hanzi recognition skills for Chinese children (Cai et al., 2012; Ding et al., 2004; Ho & Bryant, 1997a; Ho et al., 2003; Shu & Anderson, 1999; Shu et al., 2003; Taft et al., 1999; Yeung et al., 2016; Yin & McBride, 2015; Yu, 1998; Yu et al., 1990) and CSL learners (Feng, 2002; Feng et al., 2005; Kim et al., 2016; Lin & Collins, 2012; Nguyen et al., 2016; Shen, 2010; Shen & Ke, 2007; Taft & Chung, 1999; Xing, 2001; You, 2003).

The relationship between Chinese phonological awareness and Chinese literacy skills has not been examined among CSL learners. The present research extends the study into CSL learners, and investigates the influence of L1 background on the correlation between Chinese phonological awareness, phonetic radical awareness and Hanzi recognition. The hypothesis was that phonological awareness and phonetic radical awareness would be important for Hanzi recognition, and that L1 background and Chinese language proficiency level wound affect the relationship between phonological awareness, phonetic radical awareness and Hanzi reading. The results were partially in line with the hypothesis. As expected, syllable awareness and Chinese phonological awareness significantly correlated with Hanzi reading in all the CSL participants, which was further found in the Arabic group, but not in the English group. However, the phonetic radical awareness did not show correlation with Hanzi reading, only the direct naming strategy demonstrated significant correlation with Hanzi reading in the English CSL group. In addition, neither phonological awareness nor phonetic radical awareness correlated with Hanzi reading in the pre-intermediate or intermediate CSL learners.

The overall correlation coefficient (r=.30) between Chinese phonological awareness and Hanzi reading in all the CSL learners in the present study was similar to the finding in Chinese-speaking children (r=0.35), as reported in a meta-analytic study (Song et al., 2015).

These results suggest that the importance of phonological awareness for Hanzi reading is similar for both Chinese-speaking children and CSL learners. The finding is consistent with the theoretical framework of universal phonological principle proposed by Perfetti et al. (1992), who argue that the mapping between the graphic units and the phonological units in speech sounds is universal in all writing systems, yet the universal phonological principle is mediated by the writing systems. As for the link between phonological awareness and Hanzi reading, one possible bridge is phonetic radical (Ho & Bryant, 1997a, 1997b), which is the only orthographic unit that could cue the phonological information of the Hanzi. However, it still remains unclear how phonetic radical works in linking Chinese phonological awareness and Hanzi reading.

The present study found that syllable awareness significantly associated with Hanzi reading. Syllable is the largest unit of phonological awareness across different languages, and its importance for reading is universal across orthographies, as supported by previous research (Bialystok, McBride-Chang, & Luk, 2005; McBride-Chang & Kail, 2002) and predicted by the Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005). The nature of Hanzi is morphosyllabic, and one individual Hanzi corresponds to a syllable. The orthographic units of Hanzi do not map onto any small unit of the phonological structure of spoken words, such as onset or rhyme. Therefore, it is predictable that syllable awareness strongly associates with Hanzi reading among the CSL learners.

This study found that the importance of Chinese phonological awareness and phonetic radical awareness for Hanzi reading among the Arabic and English CSL learners was affected by the different alphabetic L1 backgrounds. The relationship between phonological awareness and Hanzi recognition was significant only in the Arabic CSL learners, but the significant correlation between the direct naming strategy, also the dominant strategy, in phonetic radical awareness and Hanzi reading was only found in the English CSL group. This finding might be accounted for by the different orthography depth in Arabic and English, and the different performance in phonetic radical awareness in Hanzi between these two CSL groups.

First, influenced by the characteristics of L1 orthography, the Arabic and English CSL learners might develop different strategies to decode Hanzi. Hanzi reading could be accessed via dual route, phonological route through phonetic radical or orthographic route via holistic memorization. The different transparency of the script-sound relationship in Arabic and English may lead the CSL learners to adopt different strategies to access Hanzi. As mentioned above, the orthographies in both Hanzi and English are deep. It may be the common inconsistency in the grapheme-phoneme correspondence rules in English and in the match between phonetic radical and Hanzi that guide the English CSL learners to adopt a holistic strategy in reading Hanzi, rather than solely relying on the unreliable phonetic radical. This explanation is in line with the Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005), which claims that English speakers develop strategies at both small and large phonological units to decode English words, via phonological route or orthographic route. In contrast, Arabic orthography is relatively shallow, which may lead to the dominance of phonological route in reading Hanzi among the Arabic group because of the comparative consistency and regularity in grapheme-phoneme correspondence in Arabic.

Second, the Arabic and English CSL learners' different phonetic radical awareness could be another reason. The present study did not find an association between phonetic radical awareness and Hanzi reading in the Arabic and English CSL learners, and one possible reason is due to the CSL learners' underdeveloped phonetic radical awareness. As discussed in Chapter Five, the two CSL groups' performance in phonetic radical awareness was at or below chance level, and appeared to be poorer in comparison to the native Chinese speakers. It is worth noting that the English CSL learners demonstrated slightly better performance in phonetic radical awareness, but the intermediate Arabic CSL group demonstrated poorer phonetic radical awareness than the pre-intermediate Arabic group. On the contrary, the intermediate English CSL learners outperformed the pre-intermediate English learners in phonetic radical awareness, in line with the common belief that phonetic radical awareness develops as the amount of exposure to Hanzi increases (Ho et al., 2003; Shu, Anderson, et al., 2000). Therefore, the English CSL learners might have developed slightly better phonetic radical awareness to some extent, which might guide them to rely on phonetic radical to access the pronunciation of Hanzi.

In sum, the positive contribution of phonological awareness and its subcomponents to Hanzi reading is similar across the native Chinese speakers and the CSL learners, yet the CSL learners' L1 orthography and Chinese language proficiency level may influence their relative reliance on the phonological route to access Hanzi. Unlike the important role of phonetic radical awareness in reading Hanzi among the native Chinese speakers, the underdeveloped phonetic radical awareness might not contribute to Hanzi reading skills in the CSL learners.

Following the above section that discussed the relationship between phonological awareness, phonetic radical awareness and Hanzi reading, next section focuses on Hanzi writing and its correlation with phonological awareness and phonetic radical awareness.

6.3.3 Phonological awareness, phonetic radical awareness and Hanzi writing

The relationship between phonological awareness and spelling in sound-based writing systems has been investigated in a large number of studies (Caravolas, 2004; Caravolas et al., 2012; Moll et al., 2014; Niolaki & Masterson, 2012; Rahbari et al., 2007; Read, 1975; Wade-Woolley & Siegel, 1997), yet this issue has been studied in only few studies in Hanzi writing (Yeung et al., 2011). Radical awareness, rather than phonological awareness is more important for Hanzi writing for Chinese-speaking children (Shi et al., 2011; Wang et al., 2015; Yeung et al., 2016; Yeung et al., 2011; Yeung, Ho, Wong, et al., 2013; Yin & McBride, 2015), yet the relationship between phonetic radical awareness and Hanzi writing is an understudied topic in the CSL learners. One goal of the present study was to explore how L1 background and other meta-linguistic and background variables impact the relationships between phonological awareness, phonetic radical awareness and Hanzi writing among the Arabic and English CSL learners. It was hypothesized that phonetic radical awareness, rather than phonological awareness, would demonstrate a strong relationship with Hanzi writing, and that the relationship between phonetic radical awareness and Hanzi writing would differ across the CSL learners' L1 backgrounds and Chinese language proficiency level. The results were inconsistent with the hypothesis. Neither phonological awareness nor phonetic radical awareness significantly correlated with Hanzi writing among the Arabic or English CSL learners, or among the pre-intermediate or intermediate CSL learners.

The non-significant correlation between phonological awareness and Hanzi writing in the present study further corroborates a previous study by Yeung et al. (2011). The relationship between phonological awareness and Hanzi writing was very weak in Yeung et al.'s study in Hong Kong children, and this correlation disappeared in the model in which orthographic skills were included. The present study and Yeung et al.'s research suggest that phonological awareness does not play an important part in the production of Hanzi writing for native Chinese-speaking children as well as for CSL learners with alphabetic L1 background. These results are in disagreement with prior research in alphabetic writing systems that reported significant correlations between phonological awareness and spelling performance (Caravolas, 2004; Caravolas et al., 2012; Moll et al., 2014; Niolaki & Masterson, 2012; Wade-Woolley & Siegel, 1997; Rahbari et al., 2007; Read, 1975). One of the main reasons is related to the unique characteristics of Hanzi and the alphabetic scripts. As discussed above, Hanzi is traditionally categorized as a logographic or morphosyllabic script, in which the phonological information is only restricted to the phonetic radical, which in turn only appears in semantic-phonetic Hanzi that makes up about 70% of modern Hanzi (Li & Kang, 1995; Li et al., 1992). The essential characteristic that distinguishes Hanzi from alphabetic script is that the orthographic unit in Hanzi does not map onto the segmental unit of speech, such as phoneme, rhyme and onset. One individual Hanzi only corresponds to the syllable level. Therefore, the perception skills of the sound structure in Chinese might not provide help in activating the orthographic representation of Hanzi during the process of Hanzi writing. Although onset awareness was found to show a strong relationship with Hanzi writing in the Arabic CSL learners, it remains unclear as to how onset awareness links with Hanzi writing, and this needs further investigation.

This study failed to find a significant correlation between phonetic radical awareness and Hanzi writing among the CSL learners, contrary to the hypothesis and in disagreement with previous research that observed a strong relationship between orthographic skills and Hanzi writing (Shi et al., 2011; Wang et al., 2015; Yeung et al., 2011; Yeung, Ho, Wong, et al., 2013; Yin & McBride, 2015). Studies involving Chinese-speaking children reported a significant correlation between Hanzi writing and various orthographic skills, such as semantic radical awareness (Wang et al., 2015), sensitivity to the functional and positional properties of phonetic radical (Yin & McBride, 2015), and orthographic awareness (Shi et al., 2011). The CSL learners' underdeveloped phonetic radical awareness in this study might be the main reason for the weak effect size of phonetic radical awareness for Hanzi writing. As discussed in Chapter Five, the Arabic and English CSL learners demonstrated a weaker preference to use the right-side Hanzi to name the pseudo-Hanzi, indicating a lack of awareness of phonetic radical. Therefore, the function of phonetic radical in activating the orthographic representation of Hanzi in the process of Hanzi writing might not work in the CSL learners, further leading to a very weak correlation between phonetic radical awareness and Hanzi writing.

An alternative interpretation of the weak predictive power of phonological awareness and phonetic radical awareness in Hanzi writing may lie in the nature of Hanzi writing process. Different to the spelling process in English (Tainturier & Rapp, 2001), the process of segmenting the sound to smaller units and matching the phonological units to the orthographic units might not be important in Hanzi writing. Writing Hanzi could rely on either phonological route or semantic route or both (Weekes, Su, Yin, & Chen, 2006). On the one hand, production of Hanzi may be independent of pronunciation. The Hanzi writing task in this study required the CSL learners to write Hanzi according to the displayed Pinyin and meaning. Therefore, the participants had two ways to access the target Hanzi, phonological route or semantic route. An individual could successfully retrieve the physical shape of one Hanzi via semantic route, without the aid of phonological information. This case is very common where a native Chinese speaker can only write the Hanzi, yet does not know its pronunciation, especially for some Hanzi with special structures such as <卍>(wàn) and <犇>(bēn). One the other hand, phonological awareness and Chinese Hanzi is assumed to be linked with phonetic radical (Ho & Bryant, 1997b), which may only work in reading Hanzi, rather than in writing Hanzi. Even if the phonetic radical was activated in the process of writing Hanzi, then only the orthographic representation of phonetic radical is produced, yet the semantic radical is still not activated, which still means the incomplete production of Hanzi. Therefore, the importance of phonetic radical in activating the orthographic representation of the whole Hanzi might be limited, resulting in a weak relationship between phonetic radical awareness and Hanzi writing among the CSL learners.

To sum up, the non-significant correlations between phonological awareness, phonetic radical awareness and Hanzi writing might be largely determined by the nature of Hanzi and the Hanzi writing process, and the CSL learners' weak performance in phonetic radical awareness.

6.4 Conclusion

The goals of this study were to examine the importance of phonological awareness and phonetic radical awareness for the development of Chinese literacy skills in the Arabic and English CSL learners and the influence of L1 background and Chinese language proficiency level on these relationships. There are three main findings.

First, L1 background and Chinese language proficiency influenced the relationships between Chinese phonological awareness and Pinyin spelling. Pinyin spelling significantly correlated with Chinese phonological awareness in the English CSL learners, not in the Arabic group, which could be due to the closer orthographic distance between English and Chinese Pinyin and the Arabic CSL learners' inferior performance in Chinese phonological awareness caused by the further distance between Arabic and Chinese Pinyin. The significant correlation between Chinese phonological awareness and Pinyin spelling was only observed in the intermediate CSL learners, and this result might result from the unbalanced development rate of Chinese phonological awareness and Pinyin spelling skills.

Second, L1 background influenced the relationship between Chinese phonological awareness, phonetic radical awareness and Hanzi reading. Hanzi reading skills correlated with Chinese phonological awareness in the Arabic CSL learners and with the direct naming strategy in phonetic radical awareness in the English CSL learners. This result could be caused by the different L1-modulated strategies in decoding Hanzi, influenced by the different orthographic depth in Arabic and English, as well as by the relatively different performance in phonetic radical awareness between the Arabic and English CSL learners.

Third, neither Chinese phonological awareness nor phonetic radical awareness correlated with Hanzi writing, which could be due to the limited role of phonological information in the process of Hanzi writing and the CSL learners' underdeveloped phonetic radical awareness.

Chapter Seven: General discussion

7.1 Overview

Phonological information in the writing system is at the heart of our understanding of the development of literacy skills, such as reading and spelling. In alphabetic languages, phonological awareness is an important factor in the development of literacy skills among the native speakers (Adams, 1994; Bradley & Bryant, 1983; Brady & Shankweiler, 1991; Goswami & Bryant, 1990; Wagner & Torgesen, 1987; Wagner et al., 1994; Wijayathilake & Parrila, 2014; Ziegler et al., 2010) and L2 learners (Baek, 2007; Gottardo et al., 2015; Keung & Ho, 2009; McBride-Chang & Kail, 2002; Sun et al., 2013; Uchikoshi & Marinova-Todd, 2012; Yeung, 2006; Yeung & Chan, 2013), and its important role in contributing to the growth of reading and spelling capabilities has been well established in the literature. As a typical non-alphabetic language, there has been an increasing interest in the relationship between phonological awareness and Hanzi reading in Chinese. The importance of phonological awareness for Hanzi reading has generally been acknowledged in previous studies involving children with and without experience in learning Pinyin or Zhuyin fuhao (Chung et al., 2013; Ho, 2006; Huang & Hanley, 1995; Keung & Ho, 2009; Li, Shu, McBride‐Chang, et al., 2012; McBride-Chang et al., 2008; Siok & Fletcher, 2001; So & Siegel, 1997; Song et al., 2015). In addition to phonological awareness, awareness of phonetic radicals is another key variable for Hanzi recognition. Young and adult readers of Hanzi (Cai et al., 2012; Ding et al., 2004; Ho & Bryant, 1997a; Ho et al., 2003; Shu & Anderson, 1999; Shu et al., 2003; Taft et al., 1999; Yin & McBride, 2015; Yu, 1998; Yu et al., 1990), as well as CSL learners (Feng, 2002; Feng et al., 2005; Kim et al., 2016; Lin & Collins, 2012; Nguyen et al., 2016; Shen, 2010; Shen & Ke, 2007; Taft & Chung, 1999; Xing, 2001; You, 2003) rely on the functional properties of phonetic radicals to read unfamiliar Hanzi. Other meta-linguistic and background variables such as Chinese language proficiency play an important role in learning Chinese as a second language (Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001). So far, however, there has been little discussion about the influence of L1 background and other meta-linguistic and background variables on Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills, and on the relationships between these variables among CSL learners speaking alphabetic L1s. Therefore, the objectives of the present thesis were to examine how L1 background and other meta-linguistic and background variables influenced the performance in phonological awareness, phonetic radical awareness, Chinese literacy skills and their associations among CSL learners speaking different alphabetic L1s. The present thesis examined these questions in the pre-intermediate and intermediate Arabic and English CSL learners. The main findings are summarized in Table 7.1.

First, significant between-group differences between the Arabic and English CSL learners were observed in phonological awareness, Pinyin spelling and Hanzi writing. The English group performed better in phonological awareness (syllable, onset, overall PA) and Pinyin spelling (syllable, onset, rhyme), but the Arabic group did better in Hanzi writing (overall, semiregular and RPR). In addition, between-group differences were observed in some within-group measures, such as the developmental order of the subcomponents of Chinese phonological awareness (English: tone, syllable, onset>rhyme; Arabic: tone>syllable, onset, rhyme), writing different types of Hanzi (English: regular, irregular > semiregular; Arabic: no differences; Arabic: RPR>LPR; English: no differences). Group similarities were found in rhyme awareness, tone awareness/spelling, phonetic radical awareness, reading Hanzi, writing regular, irregular, LPR Hanzi, and the within-group differences in Pinyin spelling (onset > rhyme > tone), and in reading different types of Hanzi (regular> semiregular, irregular; RPR > LPR).

Table 7.1

Summary of the Results of Phonological Awareness, Pinyin Spelling, Phonetic Radical Awareness, Hanzi Reading and Hanzi Writing among the Arabic and English CSL Learners

Measures		L1	Level	Stepwise Regression (group: predictor)
Phonological awareness	Overall	✓ E>A	✓	N/A
	Syllable	✓ E>A	✓	Arabic level 1: number of previous languages English level 2: Chinese language test scores (-)
	Onset	✓ E>A	✓	Arabic level 2: Phonological working memory(-)
	Rhyme	✕	✕	Whole CSL group: Phonetic coding ability
	Tone	✕	✕	Whole CSL group: Phonetic coding ability
	Developmental order	✓		Arabic: tone> syllable, onset, rhyme; English: syllable, onset, tone> rhyme
Pinyin spelling	Syllable	✓ E>A	✓	Arabic level 1: Chinese language test scores; phonetic coding ability; Arabic level 2: phonetic coding ability; English level 1: length of stay in China
	Onset	✓ E>A	✓	Arabic level 1: Chinese language test scores English level1: length of stay in China
	Rhyme	✓ E>A	✓	English level 2: Chinese language test scores
	Tone	✕	✓	Level 2: Chinese language test scores
	Developmental order	✕		Arabic/English: Onset> rhyme > tone
Phonetic radical awareness	Direct naming	✕	✕	English level 2: number of previous languages (-)
	Similar Hanzi naming	✕	✕	English level 2: phonetic coding ability
	Family Hanzi naming	✕	✕	N/A
	General strategy	✕	✕	English level 2: number of previous languages (-)
	Within-group differences	✕		Arabic/English: Direct naming > similar Hanzi naming/ family Hanzi naming
Hanzi reading	Overall	✕	✓	Level 1: Chinese language test scores; Level2: Chinese language test scores, length of stay in China,
	Regular	✕	✓	Level2: Chinese language test scores, length of stay in China,
	Semiregular	✕	✓	Level2: Chinese language test scores, length of stay in China,
	Irregular	✕	✓	Arabic level 1, Arabic level 2, English level 2: Chinese language test scores
	Within-group differences	✕		Arabic/English: regular>semiregular, irregular
	LPR	✕	✓	Level1: Chinese language test scores; Level2: Chinese language test scores, length of stay in China
	RPR	✕	✓	Level 2: Chinese language test scores, length of stay in China,
	Within-group differences	✕		Arabic/English: RPR > LPR
Hanzi writing	Overall	✓ E<A	✓	English level 1: number of previous languages, Chinese language test scores; English level 2: Chinese language test scores
	Regular	✕	✓	N/A
	Semiregular	✓ E<A	✓	English Level2: Chinese language test scores
	Irregular	✕	✓	N/A
	Within-group differences	✓		Arabic: regular ≈ irregular ≈ semiregular; English: regular, irregular >semiregular
	LPR	✕	✓	Level 1: number of previous languages; Level 2: Chinese language test scores
	RPR	✓ E<A	✓	N/A
	Within-group differences	✓		Arabic: RPR>LPR; English : RPR ≈ LPR

Note. "✓"= significant effect; "✕" = non-significant effect; "≈"= similar to; ">" = better than; "<" = less good than; E = English CSL; A = Arabic CSL; Level 1 = pre-intermediate level; Level 2 = intermediate level; LPR = left-side phonetic radical; RPR = right-side phonetic radical; (-) = negative beta value.

Second, the importance of phonological awareness and phonetic radical awareness differed for different types of Chinese literacy skills across L1 background and Chinese language proficiency level in the Arabic and English CSL learners. Chinese phonological awareness significantly correlated with Pinyin spelling and Hanzi reading. However, the significant relationship between phonological awareness and Pinyin spelling was only found in the English CSL group and the intermediate CSL group, and the close association between phonological awareness and Hanzi reading was only observed in the Arabic CSL group. The moderate association between direct naming strategy and Hanzi reading was reported in the English CSL group. Neither phonological awareness nor phonetic radical awareness significantly correlated with Hanzi writing skills among the two CSL groups.

Third, other meta-linguistic and background variables predicted the measures of phonological awareness, phonetic radical awareness and Chinese literacy skills. **Chinese language proficiency** was the most common predictor and was observed in syllable awareness (intermediate English CSL group, negative), tone spelling (intermediate CSL group), rhyme spelling (intermediate English CSL group), onset and syllable spelling (pre-intermediate Arabic CSL group), overall Hanzi reading and LPR Hanzi reading (pre-intermediate and intermediate CSL group), reading regular, semiregular and RPR Hanzi (intermediate CSL group), reading irregular Hanzi (pre-intermediate and intermediate Arabic group, intermediate English group), overall Hanzi writing (pre-intermediate and intermediate English CSL group) and semiregular Hanzi writing (intermediate English CSL group) and LPR Hanzi writing (intermediate CSL group). **The number of languages previously learnt** was found as a significant predictor in syllable awareness (pre-intermediate Arabic CSL group), direct naming strategy and general naming strategy (intermediate English CSL group, negative), overall Hanzi writing (pre-intermediate English CSL group), LPR Hanzi writing (pre-intermediate CSL group). **Phonetic coding ability** predicted the performance in tone awareness and rhyme awareness (whole CSL group), syllable spelling (pre-intermediate and intermediate Arabic CSL group), and similar Hanzi naming strategy (intermediate English CSL group)**. Phonological working memory** was a significant predictor in the performance in onset awareness (intermediate Arabic CSL group, negative). **The length of stay in China** predicted onset and syllable spelling (pre-intermediate English CSL group) and most of the measures in Hanzi reading except irregular Hanzi (intermediate CSL group).

The following general discussion section starts with the influence of L1 background on Chinese language learning, then continues to the influence of other meta-linguistic and background variables, and ends with theoretical and pedagogical implications, as well as the limitations of the present thesis.

7.2 The influence of L1 background on phonological awareness, phonetic radical awareness and Chinese literacy skills among CSL learners

The influence of L1 background on the second language learning has been a debated topic. Numerous studies have documented supporting and opposing evidence. Previous research has investigated the influence of L1 background on the learning of another language with a similar nature, such as how Spanish affects English learning (Sun-Alperin, 2007; Sun-Alperin & Wang, 2011), and the impact of L1 background on learning another language with different nature, such as the influence of Chinese on English learning (Keung & Ho, 2009; Li, McBride-Chang, Wong, & Shu, 2012). The current study revealed the influence of two alphabetic languages on Chinese phonological awareness and Pinyin spelling skills, not on phonetic radical awareness in Hanzi and Hanzi literacy skills, in the Arabic and English CSL learners. To make it clear how L1 background influenced the two different writing systems, Pinyin and Hanzi, in Chinese among the Arabic and English CSL learners, the following discussion begins with the impact of L1 background on phonological awareness and phonetic radical awareness, then goes on to the influence of L1 background on literacy skills in Pinyin and Hanzi, and the associations between the two types of meta-linguistic awareness and Chinese literacy skills, and ends with the similar performance in tone and Hanzi reading among the Arabic and English CSL learners.

7.2.1 L1 influence on phonological awareness and phonetic radical awareness

The influence of L1 background on the development of meta-linguistic awareness among second language learners is an important issue. Studies have documented the impact of native language on the acquisition of phonological awareness among the ESL learners and CSL learners (Gao & Gao, 2005; Gao, 2001, 2004; Shao, 2007; Tian, 2003; Wu, 2008). The current study demonstrated that phonological awareness, not phonetic radical awareness, was heavily influenced by the CSL learners' alphabetic L1 background. The influence of L1 background on phonological awareness were observed at different levels, such as syllable and onset, in which the English group outperformed the Arabic group. This result is consistent with the Japanese CSL learners' poor performance in onset and rhyme awareness due to the lack of onset-rhyme in Japanese (Gao, 2001). The English participants' better performances in these measures could be attributed to the similarities shared by English and Chinese in terms of onset-rhyme syllable structure, some common onsets, and a large inventory of vowels/rhymes. However, the Arabic language has a different body-coda syllabic structure and is consonant-dominant. The Arabic CSL learners' poor performance in Chinese phonological awareness is similar to the Arabic ESL learners' inferior achievement in learning English vowels and consonants (Flege & Port, 1981; Gao, 2004; Ibrahim, 1978; Ryan & Meara, 1991; Saigh & Schmitt, 2012). The available sensitivity to English onset-rhyme syllabic structure in the English CSL learners is an advantage for them to develop better Chinese phonological awareness, which, however, poses a great challenge for the Arabic CSL learners. This interpretation is consistent with Transfer Facilitation Model (Koda, 2008), which proposes that the degree of adjustment of L1 metalinguistic competency in L2 is determined primarily by the typological distance between L1 and L2. The close distance between L1 and L2 in the area of phonological and orthographic properties indicates less effort in adjustment, and further distance implies more adjustment required. Thus, it might take more effort and time for the Arabic CSL learners to develop the sensitivity to and the ability to manipulate the phonological structure in Chinese in comparison to the English CSL learners.

Contrary to the obvious influence of L1 background on Chinese phonological awareness, the development of phonetic radical awareness in Hanzi did not show a clear association with L1 background in the Arabic and English CSL learners. The main effect of L1 background was not found in any measure of phonetic radical awareness, and the Arabic and English CSL learners both demonstrated weak performance in phonetic radical awareness. The similar performance in phonetic radical awareness in the two groups of CSL learners might stem from the lack of corresponding orthographic awareness in Arabic and English. Hanzi is a totally different writing system from Arabic and English, and has its own unique orthography. For the Arabic and English CSL learners, the development of phonetic radical awareness mainly depends on the exposure to Hanzi because there is no corresponding orthographic unit they could refer to. According to the developmental model of phonetic radical awareness (Chen et al., 2003), the Arabic and English CSL learners might have not achieved the native-like competence in Hanzi, and they have not fully realized the functional and positional regularity of phonetic radical in representing the pronunciation of Hanzi. In addition, the results of stepwise regression analyses indicate that phonetic coding ability and a large amount of exposure to Hanzi might be more essential for the growth of phonetic radical awareness for the Arabic and English CSL learners.

Another reason accounting for the different influence of L1 background on phonological awareness and phonetic radical awareness might relate with the nature of these two types of meta-linguistic awareness. The nature of phonological awareness is the ability to reflect on and to manipulate the segmental structure of speech sounds, and it pertains to the level of phonology. Phonological awareness is measured using auditory material, and it is general across literate and illiterate people, who might differ in terms of the psycholinguistic grain size that can be manipulated (Ziegler & Goswami, 2005). A literate individual with orthographic skills is able to develop better phonological awareness at the fine-grain sized level (Mann, 1986; Read et al., 1986; Serniclaes, Ventura, Morais, & Kolinsky, 2005). However, even though phonetic radical awareness relates to the phonological information of Hanzi to some extent, it is a component of orthographic awareness restricted to Hanzi. Phonetic radical awareness is the sensitivity to and the ability to manipulate the functional and positional properties of phonetic radical in Hanzi, and it is measured using visual materials. Contrary to the generalization of phonological awareness across the literate and illiterate populations, phonetic radical awareness can be only possessed by literate people who have learnt a large amount of Hanzi (Yeh, Li, Takeuchi, Sun, & Liu, 2003). Therefore, the CSL learners' performance in phonological awareness could be affected by the phonological characteristics in L1, their experience in learning L1 orthography. In contrast, their awareness of the function of phonetic radical might only be influenced by the amount of the contact with Hanzi because the sound-based orthography previously learnt is different from Hanzi. In sum, the phonological nature of phonological awareness and the orthographic nature of phonetic radical awareness might result in the different influence of L1 background on their development by the Arabic and English CSL learners.

Following the discussion about how L1 background influenced the development of phonological awareness and phonetic radical awareness, next section discusses the impact of L1 background on Pinyin spelling and Hanzi writing.

7.2.2 L1 influence on Pinyin spelling and Hanzi writing skills

Influence of L1 background on Pinyin and Hanzi literacy skills has been reported in previous studies involving CSL learners with and without Hanzi background (Feng, 2002; Hu, 2010; Jiang, 2003; Ke, 1998; Lin & Collins, 2012; Lin, 2009; Xing, 2001). The present thesis explored this issue in the Arabic and English CSL learners in order to explore the different ways in which alphabetic L1 background impacts the acquisition of Pinyin and Hanzi. The significant effect of L1 background was observed in Pinyin spelling and Hanzi writing, not in Hanzi reading. The English CSL participants' better performances in Pinyin spelling could be attributed to the similarities shared by English and Pinyin, just as the contribution of English to the performance in Chinese phonological awareness. In addition to the phonological similarities between Chinese and English, English and Pinyin use a similar Roman alphabet, and share certain similarities in grapheme-phoneme mappings. In contrast, Arabic utilizes a unique script and a different orthography, in which vowels are always omitted. Therefore, the greater differences between Pinyin and Arabic orthographies could be an obstacle for the Arabic group to acquire Pinyin spelling skills.

Different from the clear influence of L1 background on Pinyin spelling in the Arabic and English CSL learners, the dissimilar performances in Hanzi writing skills between the two groups of CSL learners could not be explained by the writing directions in L1 script as hypothesized. The Arabic group outperformed the English group in overall Hanzi writing, writing semiregular and RPR Hanzi, which was in conflict with their poor performance in phonetic radical awareness, and these results were in disagreement with the hypothesis that right-to-left direction in Arabic would lead to better achievement in phonetic radical awareness. The Arabic CSL group's better performance in Hanzi writing might be related to the visual complexity of Arabic script and their experience in learning two different scripts (Arabic and English) because learning a new script could enhance the development of visual spatial skills (Demetriou et al., 2005; Kolinsky et al., 1987; McBride-Chang et al., 2011). The different learning contexts for the Arabic and English CSL learners could also have contributed to the between-group differences because the textbooks and classroom instruction might differ in the efforts devoted to Hanzi writing. To sum up, the Arabic and English CSL learners' different performance in Hanzi writing could not be attributed to the different writing directions in Arabic and English writing systems, but might relate with the visual complexity in L1 script, script learning experience and Chinese learning contexts.

The main cause of the different influence of L1 background on Pinyin and Hanzi learning could be accounted for by the Psycholinguistic Grain Size Theory (Zielger & Goswami, 2005) and the Transfer Facilitation Model (Koda, 2008). Zielger and Goswami claim that the availability of phonological units, the grapheme-phoneme consistency and the granularity of orthographic units and phonological units are the main reasons for reading problems. In terms of **availability**, before learning Chinese, the adult Arabic and English CSL learners have acquired sensitivity to different phonological units, such as syllable, phoneme, onset-rhyme or body-coda, which is closely related with the phonological structure of Pinyin. However, they did not have any knowledge related to phonetic radical awareness in Hanzi because there is no corresponding orthographic unit as phonetic radical in Arabic or English. As for **consistency**, alphabetic Pinyin has a much more consistent orthography based on grapheme-phoneme correspondence that is similar to that in English and Arabic, but the orthography in Hanzi is inconsistent and deep. Though phonetic radical could provide help in activating the phonological representation of Hanzi to some extent, yet the functional and positional regularity of phonetic radical are not always reliable. Closely related to the consistency problem, Pinyin and Hanzi differs hugely in the **granularity**. Pinyin is represented at phoneme level, yet Hanzi operates at the syllable level. Taken together, the consistency and the granularity in Pinyin are roughly in line with the available psycholinguistic grain size in L1s in the Arabic and English CSL learners, but the consistency and the granularity in Hanzi are uniquely different from that in Arabic and English. In a nutshell, Pinyin is closer to Arabic and English than is Hanzi. In addition, the Transfer Facilitation Model (Koda, 2008) implies that adjustment of L1 meta-linguistic awareness competency in L2 is more likely to occur between close orthographies. Therefore, the transfer from L1 orthography could be adjusted more easily in Pinyin, but not in Hanzi.

The results in this thesis further corroborate with the traditional method of categorizing the CSL learners into Hanzi group and non-Hanzi group.

Although the Arabic and English learners demonstrated significant between-group differences in phonological awareness, Pinyin spelling and Hanzi writing, they demonstrated similar performance in tone and Hanzi reading, which is discussed below.

7.2.3 Non-significant influence of L1 on tone and Hanzi reading

No influence of L1 background among the Arabic and English CSL learners was found on tone awareness/spelling and Hanzi reading, in which only Chinese language proficiency level demonstrated the main effect. That is to say, the CSL learners' performance in tone and Hanzi closely relates with Chinese language proficiency, and is not subject to the impact of L1 background. The unique characteristics of tone and Hanzi might be the principal reason.

The Arabic and English CSL learners' similar achievements in tone awareness and tone spelling are mainly related to the lack of tone in Arabic and English. Tone is a significant phonological feature that distinguishes Chinese from Arabic and English. Chinese is a tonal language and has four different lexical tones that are used to differentiate syllables. However, neither Arabic nor English has tones. Thus, the CSL learners' skills in perceiving different tones mainly depend on their exposure to tones because there is no similar phonological property that they could refer to in their first languages. This result is in line with previous research that observed similar performance in tone awareness in the CSL learners speaking non-tonal languages (Gao & Gao, 2005; Gao, 2001, 2004; Shao, 2007; Wu, 2008).

Hanzi reading is another skill that is not found to be influenced by the Arabic and English CSL learners' alphabetic L1 background. Although the differences in reading regular and semiregular Hanzi between the two CSL groups reached marginal significance, a main effect of L1 background on Hanzi reading was not found. One possible explanation for this could be due to the orthographic differences between Hanzi and the two sound-based writing systems. It is known that Hanzi is morphosyllabic and it does not have any orthographic unit corresponding to the phonological unit in a syllable. As the only component that carries phonological information, phonetic radical is not transparent and not consistent in providing help in the pronunciation of Hanzi. Although orthographic analogy using phonetic radical could be utilized to read unfamiliar Hanzi, it is not always reliable. The grapheme-phoneme correspondence norms in Arabic and English could not be relied on to facilitate the development of Hanzi reading skills. Chinese language proficiency and the length of stay in China were found as two frequent predictors in Hanzi reading achievement. These two factors are closely associated with the exposure to Hanzi, indicating that the development of Hanzi reading skills is more driven by the amount of contact with Hanzi for the Arabic and English CSL learners, rather than the L1 background. This result in the present study is line with the traditional belief that CSL learners with no Hanzi background are likely to perform similarly in Hanzi learning.

The Arabic and English CSL groups differed in both phonological awareness and Pinyin spelling, yet they differed in Hanzi writing, but not in phonetic radical awareness. These results indicate that the relationships between phonological awareness, phonetic radical awareness and Chinese literacy skills might differ in the two groups of CSL learners, which is discussed in next section.

7.2.4 L1 influence on relationships between phonological awareness, phonetic radical awareness and Chinese literacy skills

There has been a large volume of published studies describing the important role of phonological awareness in the development of reading and writing skills in alphabetic languages (Melby-Lervåg et al., 2012; Swanson et al., 2003) as well as in non-alphabetic languages such as Chinese (Song et al., 2015). Moreover, a large and growing body of literature has investigated the importance of radical for Hanzi acquisition among native speakers of Chinese (Anderson et al., 2013; Ho, Wong, & Chan, 1999; Shu & Anderson, 1997; Shu, Anderson, et al., 2000) and CSL learners (Nguyen et al., 2016; Shen, 2000; Shen

& Ke, 2007; Tong & Yip, 2014; Wang et al., 2004). One goal of the present thesis was to assess the importance of Chinese phonological awareness and phonetic radical awareness for different Chinese literacy skills, and to examine the potential impact of L1 background on this issue among the Arabic and English CSL learners. The current study revealed two interesting findings. The first finding was that the predictive power of phonological awareness and phonetic radical awareness varied across different Chinese literacy skills. Another important finding was that the relationships between phonological awareness, phonetic radical awareness and Chinese literacy skills were influenced by L1 background among the Arabic and English CSL learners.

The importance of Chinese phonological awareness varied across different literacy skills among the Arabic and English CSL learners. **First,** similar to the different effect sizes of phonological awareness for alphabetic and non-alphabetic writing systems (Leong, Tan, Cheng, & Hau, 2005; Niolaki & Masterson, 2012; Read, 1975; Song et al., 2015; Wade-Woolley & Siegel, 1997), Chinese phonological awareness appears to be more predictive in Pinyin than Hanzi, as revealed by the correlation coefficients. This is because Pinyin is a phonemic writing system with a shallow orthography, but Hanzi has a very deep orthography and inconsistent relationship between phonetic radical and Hanzi. According to the psycholinguistic grain size theory (Ziegler & Goswami, 2005), the development of phonological awareness is essential for reading skills, yet the role of phonological awareness varies across different writing systems. These findings in the present thesis corroborate the claim of Ziegler & Goswami (2005) that the importance of phonological awareness for literacy skills is mediated by the nature of orthography, and extend such research into two different writing systems in one language among the second language learners. **Second**, across the different literacy skills in Hanzi, Chinese phonological awareness is more pivotal for reading than writing. This finding supports previous research that reported the significant role of phonological awareness in Hanzi reading (Huang, 1993; McBride & Wang, 2015;

Pan et al., 2015; Song et al., 2015) as well as its nonsignificant prediction in Hanzi writing (Yeung et al., 2011). The reason for the weak association between phonological awareness and Hanzi writing might be due to the nature of Hanzi as well as the process of Hanzi writing (Weekes, Su, Yin, & Chen, 2006). The process of writing Hanzi is to convert the sounds or semantics to orthographic representation. Because the direct mapping between the orthographic units in Hanzi and the phonological units in language does not exist, the ability to perceive and to manipulate the sound structure might not assist the production of Hanzi by hand. Hence, it could be concluded that the contribution of phonological awareness to spelling skills varies across different writing systems.

The importance of phonetic radical awareness differed for Hanzi reading and Hanzi writing. The overall results did not find a significant link between phonetic radical awareness and Hanzi reading or writing. However, the direct naming strategy, also the dominantly used strategy, in phonetic radical awareness showed a moderate association with Hanzi reading, not with Hanzi writing. The results, in fact, suggest that the CSL learners in the present study had not acquired phonetic radical awareness. The different associations between direct naming strategy and Hanzi reading and Hanzi writing might lie in the different cognitive processes that underlie these two activities. Reading Hanzi for pronunciation is a process of converting the orthographic representation to phonological representation by mouth, while Hanzi writing is a process of producing the orthographic representation of Hanzi by hand via phonological or semantic representation. The importance of phonetic radical awareness in Hanzi reading lies in its function of providing phonological information for the whole Hanzi. However, the phonological properties of phonetic radical might not be useful for Hanzi writing, as most Hanzi have both semantic and phonetic radicals. Even though the phonological route could facilitate the production of phonetic radical, the semantic radical might not be activated, still leading to failure in Hanzi writing. Therefore, phonetic radical might play different roles in reading and writing Hanzi for the CSL learners, yet this idea still needs further confirmation in future research.

The relationships between Chinese phonological awareness and Pinyin spelling, and Hanzi reading, and that between phonetic radical awareness and Hanzi reading differ across the CSL learners' L1 background. This finding is very important, as this issue has not been investigated in previous studies. The significant correlation between Chinese phonological awareness and Pinyin reading, and that between direct naming strategy and Hanzi reading was only found in the English CSL learners, yet the significant link between Chinese phonological awareness and Hanzi reading was only observed in the Arabic CSL group. The different relationships between Chinese phonological awareness and literacy skills in the Arabic and English CSL groups are assumed to come from the cross-language differences in orthography in Arabic, English and Chinese. Firstly, the similarities between English and Pinyin orthographies help the English CSL learners develop better Chinese phonological awareness, which in turn leads to better spelling skills in Pinyin. However, the huge differences between Arabic and Pinyin orthographies may not be helpful for the development of Chinese phonological awareness among the Arabic CSL learners, which restrains the development of Pinyin spelling skills. Secondly, the deep orthography in English encourages the English CSL learners to use both phonological and orthographical strategies to encode Hanzi (Ziegler & Goswami, 2005), yet the shallow orthography in Arabic might entice the Arabic CSL learners to mainly rely on phonological route to access Hanzi. In addition, the different learning contexts and the length of staying in China could influence the development of phonological awareness and phonetic radical awareness, which may lead to the different relationships between the two types of meta-linguistic competencies and Chinese literacy skills among the Arabic and English CSL learners.

The above section discussed how L1 background influenced the development of the two types of meta-linguistic awareness and different Chinese literacy skills and their relationships among the Arabic and English CSL learners. In addition to L1 transfer, other meta-linguistic and background variables also impacted Chinese language learning among the CSL learners. The next section discusses how individual characteristics in Chinese language proficiency, phonological aptitude, the experience of studying abroad in China and the number of previous languages influenced the Arabic and English CSL learners' performance.

7.3 The influence of other meta-linguistic and background variables on phonological awareness, phonetic radical awareness and Chinese literacy skills

Literature has documented a large amount of evidence for the impact of other meta-linguistic and background variables on second language acquisition. In this thesis, five significant variables were found to predict the performance in different measures of Chinese phonological awareness, phonetic radical awareness, Pinyin and Hanzi literacy skills among the Arabic and English CSL learners, and they were Chinese language proficiency, phonological aptitude (phonetic coding ability and phonological working memory), the length of stay in China and the number of languages previously learnt, which were discussed in detail below.

7.3.1 Chinese language proficiency

Influence of Chinese language proficiency on phonological awareness and Hanzi processing skills has been reported in CSL learners in previous studies (Gao & Gao, 2005; Ke, 1996; Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001). In this study, the impact of Chinese language proficiency among the Arabic and English CSL learners was observed in both meta-linguistic awareness and Chinese literacy skills. The intermediate CSL learners outperformed the pre-intermediate CSL learners in most measures except rhyme awareness and tone awareness and phonetic radical awareness. In addition, the contribution of Chinese language proficiency to phonological awareness, Pinyin and Hanzi literacy skills was positive in most measures. However, the most surprising result is that Chinese language proficiency did not show significant prediction in the measure of phonetic radical awareness, indicating that the CSL learners' phonetic radical awareness does not develop automatically as their Chinese language proficiency increases. Explicit classroom instruction on how phonetic radical contributes to or inhibits the cueing of phonological information of the Hanzi could be essential for the growth of phonetic radical awareness (Shen, 2004; Taft & Chung, 1999). In addition, the negative prediction of Chinese language test scores in the syllable awareness in the intermediate English CSL learners point to the potential interference of the activation of the orthographic information of Hanzi with their performance in syllable awareness.

7.3.2 Phonological aptitude

Foreign language aptitude is a significant predictor in language acquisition (Carroll, 1958; Gardner & Lambert, 1965; Li, 2014; Reynolds, 1999; Smemoe & Haslam, 2013; Winke, 2013). Phonological aptitude is a part of foreign language aptitude, and it was operationalized as a synthesis of phonological working memory and phonetic coding ability in the present thesis (Meara, 2005). Contrary to the general consensus on the contribution of working memory to language learning (Ellis, 1996), phonological working memory negatively predicted the performance in onset awareness in the intermediate Arabic CSL group. This result might relate to the potential influence of the artificial language used in the LLAMA-D test (Meara, 2005). Phonetic coding ability was a significant predictor in measures of onset awareness, syllable spelling, and phonetic radical awareness (direct naming strategy and similar Hanzi strategy), similar to previous studies in which the CSL learners' achievement relates with language learning aptitude (Asher, 1972; Carroll, 1964; Winke, 2013).

The results in the present study suggest that phonetic coding ability might be more strongly related with meta-linguistic awareness than with literacy skills. Phonetic coding ability was only correlated with syllable spelling skills, but showed strong relationships with rhyme, tone awareness and phonetic radical awareness. The phonetic coding ability in the present study was tested by an artificial language and an artificial script that was made up of three numbers, three English alphabetic letters and three diacritics. The results indicate that stronger ability to decode the sound-based script was closely linked with the capability to decode pseudo-Hanzi in the CSL learners. A CSL learner with higher phonetic coding ability is more likely to discover the functional and positional properties of the phonetic radicals in Hanzi. This finding also provides support for the notion of language-universal aptitude (Carroll, 1964) for foreign language learning.

7.3.3 The length of stay in China

Studying abroad in an L2-speaking country is traditionally considered as an advantage for the development of L2 proficiency. However, the contribution of studying abroad to the growth of L2 competency might be domain-specific (Collentine, 2009). The present thesis found that the length of stay in China predicted the performance in measures of Pinyin spelling and Hanzi reading in the Arabic and English CSL learners. A majority of the intermediate English CSL learners had experience of staying or studying abroad in China for a period of time, and this could have helped them improve listening skills due to a large amount of input caused by interaction with Chinese speakers and other CSL learners. Listening skills are closely related with Pinyin spelling performance. This explanation is in line with the findings in prior research that showed greater gains in listening skills for learners studying abroad (Brecht & Davidson, 1991; Freed, 1995b; Lafford, 1995; Meara, 1994). The contribution of staying in China to reading Hanzi is in agreement with a study that found that learners of Japanese as a second language in Japan gained slightly more improvement in Kanji recognition than those who studied Japanese in America (Huebner, 1995). In the present study, although the differences in reading Hanzi between the Arabic and English CSL learners did not reach significance, the English group showed higher accuracy rate in the task of Hanzi recognition. For the CSL learners, staying in China is predicted to bring forth a larger amount of input and output in Hanzi, which is essential for the development of Hanzi literacy skills.

It is worth noting that the effect of staying in China might be domain-specific (Collentine, 2009). One of the significant differences between the Arabic and English CSL learners in this study is that the latter group had experience of staying in China. The English group outperformed the Arabic group in the listening section, not the reading comprehension section of Chinese language proficiency test, and in phonological awareness and Pinyin spelling, not in reading and writing. These results suggest that staying in China might be more beneficial for the development of listening skills, as reported in previous research (Brecht & Davidson, 1991; Freed, 1995b; Lafford, 1995; Meara, 1994) than for reading comprehension. This finding is consistent with results found in learners of Japanese as a second language whose performance in reading comprehension did not differ across the contexts of studying abroad and studying in home country (Dewey, 2004; Huebner, 1995).

7.3.4 The number of languages previously learnt

The impact of previous experience in language learning on the target language learning is a very interesting topic, but few studies explored the influence of the breadth of language learning on the achievement in target language (Ehrman & Oxford, 1995). In this study, the number of languages previously learnt meant how many languages the participant had learnt prior to starting learning Chinese at the university. The number of languages previously learnt was a significant predictor in measures of syllable awareness and writing Hanzi in the Arabic and English CSL learners, extending the effect of previous language learning experience into Hanzi writing skills in learning Chinese as a second language (Ehrman & Oxford, 1995). However, it still remains unclear why and how the breadth of language learning benefits the writing performance in Hanzi. One possible reason might be that one individual who has more experience in language learning is more likely to realize the importance of writing skills, such as the contribution of writing to reading (Berninger, Abbott, Abbott, Graham, & Richards, 2002; Guan et al., 2011; Tan et al., 2005).

It is surprising to find that the number of previous languages showed negative beta values in phonetic radical awareness (direct naming strategy and general right-side naming strategy), indicating the negative influence of the number of previous languages on the development of this meta-linguistic awareness competency. This result is not consistent with the study by Ehrman and Oxford (1995) who found that the number of previous languages demonstrated positive correlations with speaking and reading measures. The negative influence of the number of previous languages could be caused by the interference effect of previously learnt languages (Allaith & Joshi, 2011; He, 2001; Ibrahim, 1978; Wang & Geva, 2003a). The negative effect of the number of previous languages on phonetic radical awareness may relate to the distance between Hanzi orthography and the sound-based orthographies the CSL participants had learnt. Neither the Arabic nor English CSL learners had learnt other East Asian languages such as Japanese and Korean prior to learning Chinese. The previous languages they had learnt all utilize sound-based writing systems, which are totally different from Hanzi. Therefore, it is possible that the experience in learning sound-based orthographies strengthens the CSL learners' reliance on the phonological route to decode Hanzi, which further leads to poor sensitivity to the functional and positional properties of the phonetic radical in Hanzi, as implied by the Transfer Facilitation Model (Koda, 2008).

7.4 Theoretical implications

The main purpose of the present thesis was to explore how L1 background and other meta-linguistic and background variables influenced the development of Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills among the Arabic and English CSL learners. The theoretical significance of this research is multi-fold.

First, this research is the first of its kind to explore the different influence of L1 background on Pinyin and Hanzi among the CSL learners speaking alphabetic L1s. The general finding in this study is that the influence of L1 background on learning L2 writing system largely depends on the orthographic distance, providing more supporting evidence for the Transfer Facilitation Model (Koda, 2008). The distance between the orthographies in Pinyin, Arabic and English is closer than that between Hanzi, Arabic and English. Therefore, more between-group differences in Chinese phonological awareness and Pinyin spelling were reported among the Arabic and English CSL learners, yet phonetic radical awareness and Hanzi literacy skills were less influenced by the CSL learners' shared sound-based orthography background in the two L1s concerned.

Second, this research has demonstrated that the contributions of phonological awareness and phonetic radical awareness not only varied across different Chinese literacy skills, but also differed across the CSL learners' L1 backgrounds. This finding is important as it revealed the varying roles of phonological awareness and phonetic radical awareness in the acquisition of different Chinese literacy skills among the CSL learners. Furthermore, the influence of L1 background on the relationships between the two types of meta-linguistic awareness and Chinese literacy skills points out that L1 background impacts how the meta-linguistic awareness contributes to the growth of Chinese literacy skills.

Third, this research did not find an influence of the directional features of L1 script on the sensitivity to the functional and positional properties of phonetic radical in Hanzi among the Arabic and English CSL learners. This result suggests that the influence of the physical features in L1 writing system on the acquisition of handwriting in L2 might be limited to the fine-grained level, such as stroke order and starting position. Furthermore, the findings in this study point to the close relationship between the development of phonetic radical awareness and the amount of exposure to Hanzi and phonetic coding ability.

Fourth, the present study provides more evidence for several general theories of reading and spelling. The significant correlations between Chinese phonological awareness and Pinyin and Hanzi literacy skills further corroborate the Psycholinguistic Grainsize Theory (Ziegler & Goswami, 2005). The different effect sizes Chinese phonological awareness showed on Pinyin and Hanzi are consistent with the claim that the role phonological information plays in reading and spelling is mediated by the nature of writing system, which is a main tenet of Orthography Depth Hypothesis (Katz & Frost, 1992). The different relationships between the subcomponents of Chinese phonological awareness and Pinyin, and that between the components of Chinese phonological awareness and Hanzi, as well as the development of the components of Chinese phonological awareness in the CSL learners assist in our understanding of the Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005). In addition, Chinese phonological awareness remarkably contributed to Pinyin spelling, but not Hanzi writing, and this finding suggest the varying importance of phonological awareness for the spelling skills in alphabetic language and logographic language.

Finally, this research provides new understandings of the role of different meta-linguistic and background variables in second language learning. It replicated and extends the studies on how meta-linguistic and background variables contributed to the second language acquisition among the CSL learners with different first language background. In addition, it further provides evidence that meta-linguistic and background variables work differently in a domain-specific way in the Chinese language. Such results may be important in further establishing the different contributions of meta-linguistic and background variables to the development of meta-linguistic awareness and literacy skills in second language learning.

7.5 Pedagogical implications

This research found that both similarities and differences occurred in Chinese phonological awareness, phonetic radical awareness, Pinyin spelling and Hanzi learning in the Arabic and English CSL learners, thus it has a number of important implications for the practice of Pinyin and Hanzi teaching and learning for the Arabic and English CSL learners.

First, this research found that the Arabic and English CSL learners differed greatly in

Chinese phonological awareness and Pinyin spelling, indicating that different strategies could be utilized in teaching Chinese phonology and Pinyin for the two groups of CSL learners. For the Arabic CSL learners, more effort could be made to promote their sensitivity to Chinese rhymes, and refined perception of Chinese syllables and onsets due to the differences in Arabic and Chinese. For the English CSL learners, emphasis could be put on how to prevent the negative transfer from English to Chinese, especially at the rhyme level, such as the confusion between similar rhymes like /a/ and /ia/, as revealed in the low accuracy rate in spelling <zhǎ> in English CSL learners in section 4.3.1.

The two CSL groups did not differ in tone awareness or tone spelling, indicating that they might face similar difficulties in learning tones, and that similar strategy could be used in teaching tones for these two groups of CSL learners. For instance, one commonly used strategy in facilitating the perception of Chinese tones is using hand gestures. Take the 1^{st} and 4^{th} tone for example, flat hand is moved across the body at chest height to represent the high and flat pitch contour of the 1^{st} tone, and flat hand is moved from up-left to bottom-right in front of the body to signify the falling pitch contour of the 4^{th} tone. In addition, software such as Praat has been found to be helpful to assist in the CSL learners' perception of Chinese tones (Song, 2009). Visualizing the phonological characteristics of the tones using a multi-sensory approach could benefit the development of CSL learners' tone awareness.

Second, the finding that the Arabic and English CSL learners did not differ in Hanzi reading or phonetic radical awareness suggests that similar teaching strategy could be used in teaching Hanzi for the two groups of CSL learners. Hanzi is specific to Chinese, and the acquisition of Hanzi largely depends on its internal characteristics, such as the regularity effect and positional effect of phonetic radical in Hanzi. Furthermore, the weak phonetic radical awareness in the two groups of CSL learners indicates the necessity of explicit instruction on the functional and positional properties of phonetic radical in learning Hanzi since phonetic radical awareness appears not to develop automatically as Chinese language proficiency increases. Various measures could be taken to facilitate the development of phonetic radical awareness, such as grouping Hanzi with the same phonetic radical together and classifying Hanzi according to the regularity and the position of phonetic radical. For instance, 清(qīng), 请(qǐng), 情(qíng), 晴(qíng), 倩(qiàn), 靓(liàng), and 静(jìng) could be classified into three groups based on the regularity of 青(qīng): regular, 清; semiregular, 请, 情, 晴, 倩, 静; irregular, 靓. These Hanzi could also be classified into two groups based on the position of 青: left-side, 清, 请, 情, 晴, 倩; right-side, 静 and 靓. This method could assist in the CSL learners' understanding of the mechanisms in which phonetic radical represents the pronunciation of compound Hanzi. In addition, training CSL learners to develop effective strategies in learning Hanzi is beneficial for the development of orthographic awareness and Hanzi recognition skills (Jiang & Zhao, 2001; Shen et al., 2011; Zhao & Jiang, 2002).

The Arabic CSL learners outperformed the English CSL learners in writing Hanzi, which might be influenced by the visual complexity in L1 script. This finding suggests that the English CSL learners might need more training to achieve success in Hanzi writing in comparison to the Arabic CSL learners. Thus, more exercises and tasks in writing Hanzi could be incorporated in the textbooks and classroom instruction targeting English CSL learners in order to help them develop competency in writing Hanzi.

Third, the significant influence of other meta-linguistic and background variables on Chinese language learning indicates that CSL learners' individual characteristics in some variables should perhaps be taken into account in teaching Chinese as a second language. For instance, the experience of previous language learning might interfere with the acquisition of Chinese phonology and phonetic radical awareness for the Arabic and English CSL learners. Thus, having a track of the history in previous language learning might be helpful for the instructors to take measures to prevent the interferences from happening. In addition, the domain-specific influence of studying abroad in China suggests that studying abroad is more beneficial for the development of speaking skills than for reading skills, thus, future program targeting studying abroad in China could devote more time to improve the skills in Hanzi recognition and Chinese reading comprehension, contributing to a balanced progress of listening and reading skills. For instance, CSL learners studying in China could be encouraged to use online chatting tools such as WeChat and QQ (similar to WhatsApp and Messengers) to communicate with native Chinese speakers, which might increase the amount of exposure to Hanzi and improve Hanzi reading skills.

To conclude, this research found that the influence of L1 background on Chinese learning varied depending on the distance between L1 and Chinese in the area of phonology and orthography. Although Arabic and English CSL learners are generally categorized into a non-Hanzi background group, this categorization method tends to exaggerate the similarities between the Arabic and English CSL learners, ignoring the differences in the acquisition of phonological skills and Pinyin spelling. Therefore, strategies employed in teaching the Arabic and English CSL learners could vary depending on Pinyin or Hanzi. Other meta-linguistic and background variables should also be taken into account in the classroom instruction to make the teaching more effective and productive.

7.6 Limitations

Several limitations to the present research need to be acknowledged.

First, the present study investigated phonological awareness using the odd-man-out form, which only tested the perception skills, thus a design including the tasks of syllable deletion test, rhyming production or phoneme deletion test that examines both perception and production skills might produce different results in phonological awareness. The different performance in rhyme in the tasks of odd-man-out and Pinyin spelling suggested that different tasks might lead to different results, further pointing to the importance of task in measuring phonological awareness (Yopp, 1988).

Second, the items used in testing tone awareness were single syllables with the same rhyme in each set, and two of the three stimuli in each set had the same tone, making it easy to detect the odd one. The accuracy rates in tone awareness in native Arabic- and English-speaking groups demonstrated a ceiling effect, indicating that the test in tone awareness was relatively easy. Future research using a more difficult task such as syllable deletion and oral onset/rhyme production could be better able to detect the CSL learners' performance in Chinese tone.

Third, the CSL participants were only required to read Hanzi for pronunciation, thus it is not clear whether they knew the meaning of the Hanzi. Making words using the Hanzi or translating Chinese Hanzi to Arabic/English may help us tap into whether the participants really know the Hanzi.

Fourth, using the mean of the CSL participants' HSK scores as the standard to judge their L2 Chinese proficiency level could be limited. Although significant differences were observed between the pre-intermediate and intermediate CSL learners among the Arabic and English groups, the participants with highest pre-intermediate score might not differ from those with lowest intermediate score. Due to the small sample size in this study, the participants scoring around the mean were not removed. One possible solution for future study could be assigning the top 10% into intermediate L2 group and the bottom 10% into the pre-intermediate L2 group, which could reveal more insightful results about the influence of L2 Chinese proficiency level on CSL learning.

Fifth, the present study is limited in using different methods to explore the research questions. Only quantitative methods, rather than qualitative techniques, were employed in this study, which might limit our understanding of the influence of L1 background and other meta-linguistic and background variables on Chinese learning in the Arabic and English CSL learners. For example, whether the CSL participants received explicit training on the role of phonetic radical in reading Hanzi and their beliefs about the learning difficulty of the different parts of Chinese syllable structure were unknown. Conducting an interview about the CSL learners' classroom instruction and their views about Chinese learning could deepen our understanding of other factors that might potentially influence the acquisition of the phonological and orthographic properties in Chinese.

Lastly, this study has a small and an unequal sample size in the pre-intermediate and intermediate CSL learners. The main reason lies at the difficulty in collecting data from Egypt and the UK within limited time. Future studies with a larger and equal sample size in different proficiency levels, in particular the advanced level, could be more helpful for understanding how L1 influences Chinese language learning among learners of different Chinese proficiencies. In addition, the recruited CSL participants came from different countries and the contexts in which they learnt Chinese differed hugely. Thus, the findings in this study are limited by the CSL learners with great variations in other meta-linguistic and background variables. Further research involving CSL learners with more various L1 backgrounds yet with similar learning experience including comparable time spent abroad in L2 context could lead to more insightful results.

Chapter Eight: Conclusions

Phonological processing skills are crucial for developing literacy skills in different languages, and phonological activation is considered as a universal route in reading and spelling/writing in various writing systems, as shown in several theoretical models of reading, such as Dual-rout Model (Coltheart et al., 2001), Universal Phonological Principle (Perfetti et al., 1992) and Psycholinguistic Grain Size Theory (Ziegler & Goswami, 2005). However, the importance of phonological skills for reading is mediated by the characteristics of orthography (Katz & Frost, 1992), and different types of phonological skills are required in reading alphabetic writing systems such as English and non-alphabetic writing system such as Chinese Hanzi.

There is a consensus as regards the significant role phonological awareness plays in the development of reading and spelling skills in English and other alphabetic languages (Brady & Shankweiler, 1991; Caravolas et al., 2012; Goswami & Bryant, 1990; Seymour, Aro, & Erskine, 2003; Wade-Woolley & Siegel, 1997). Phonological awareness is the ability to reflect on and to manipulate the phonological structure of languages, and it includes syllable, onset-rhyme and phoneme awareness in English (Treiman & Zukowski, 1991). Its important link with English word learning lies in the print-sound correspondence in English orthography, in which the grapheme in print maps onto the phoneme in sound. Therefore, better phonological awareness allows easier access to the phonological units in languages, which in turn makes the correspondence between orthography and phonology efficient in reading and spelling. However, the importance of phonological awareness appears to less strong in reading and writing Hanzi in comparison to reading and writing English (McBride-Chang, Cho, et al., 2005; Song et al., 2015). Hanzi has a deep orthography, in which an individual Hanzi corresponds to a syllable, and the orthographic unit (stroke or radical) in Hanzi does not correspond to a smaller phonological unit such as onset and rhyme. Therefore, the capability to manipulate the phonological structure in Chinese could not directly facilitate the access to Hanzi. Observations of significant correlation between the measures of Chinese phonological awareness and the task of Hanzi recognition have been reported in a large number of studies, yet the average effect size of phonological awareness for Hanzi reading is smaller than that in English word recognition (Song et al., 2015). However, phonological awareness does not predict the performance in Hanzi writing (Yeung et al., 2011).

Apart from phonological awareness, awareness of phonetic radical is another crucial type of meta-linguistic skill for the development of Hanzi literacy skills (Shen, 2010; Shu & Anderson, 1997; Shu, Anderson, et al., 2000; Shu, Zhou, et al., 2000). A majority of Hanzi are constituted by a semantic radical that cues its meaning and a phonetic radical that cues its pronunciation. According to the regularity of phonetic radical in cueing the sound of Hanzi, semantic-phonetic Hanzi are generally categorized into three types, regular, semiregular and irregular. On the basis of the positional distribution at the horizontal level, the semantic-phonetic Hanzi are divided into two types, LPR (left-side phonetic radical) and RPR (right-side phonetic radical), of which the RPR Hanzi are dominant. Sensitivity to the functional and positional properties of phonetic radical is essential for the native Chinese-speaking children and CSL learners to develop Hanzi recognition skills.

The influence of L1 background on the development of phonological processing abilities in L2 has been explored in numerous studies. The phonological features and the orthography depth in L1 are found to affect the phonological processing abilities in L2 (Katz & Frost, 1992; Koda, 2008; Zielgler & Goswami, 2005). L1 transfer influences L2 learning, as well as some non-linguistic tasks, such as drawing (Dennis, 1958; Dennis & Raskin, 1960; Green & Meara, 1987; Liow et al., 1999; Nachson et al., 1999; Sassoon, 1995; Shanon, 1978; Shimrat, 1973; Vaid, 1995; Vaid et al., 2011) because learning a specific script works differently in the development of visual-spatial skills (Kolinsky et al., 1987; Liow et al., 1999; McBride-Chang, Chow, et al., 2005). In addition, other meta-linguistic and background variables are another important factor in the process of L2 acquisition. Previous studies have reported that different types of meta-linguistic and background variables are associated with the achievements in L2, such as L2 proficiency (Jiang, 2001; Kim et al., 2016; Lin & Collins, 2012; Shen & Ke, 2007; Xing, 2001), the experience of studying abroad in L2-speaking country (Collentine, 2009; Freed, 1995b; Huebner, 1995; Meara, 1994;), previous language learning experience (Ehrman & Oxford, 1995) and language learning aptitude (Carroll, 1964; Li, 2014; Winke, 2013).

It has long been the goals of the researchers and instructors to decipher the acquisition of Chinese language and Hanzi among the CSL learners. A lot of effort has been spent on exploring the influence of L1 backgrounds on Chinese language learning. The general consensus is that CSL learners with various L1 backgrounds tend to perform differently in the process of acquiring Pinyin and Hanzi (Jiang, 2001, 2003; Jiang & Liu, 2004; Machida, 2013; Xiao, 2002). However, previous studies mainly focus on the different achievements between the CSL learners with- and without- Hanzi background, paying little attention to the potential differences between the CSL learners with different alphabetic language backgrounds. In addition, far too little attention has been paid to the influence of L1 background on meta-linguistic awareness and Chinese literacy skills among the Arabic and English CSL learners, who use different orthographies. Moreover, there has so far been no data on the relationship between meta-linguistic awareness (phonological awareness, phonetic radical awareness) and different types of Chinese literacy skills in the CSL learners. Furthermore, other meta-linguistic and background variables such as phonological aptitude, previous language learning experience, the length of staying in China have not been taken into account in previous research. Therefore, the present study was designed to examine the influence of L1 background and other meta-linguistic and background variables on the development of phonological awareness, phonetic radical awareness and literacy skills related to Pinyin and Hanzi among the Arabic and English learners of Chinese as a second language. To be specific, the main questions of this study were how L1 background and other meta-linguistic and background variables impacted (1) the performance in Chinese phonological awareness and Pinyin spelling, (2) phonetic radical awareness, Hanzi reading and Hanzi writing, and (3) the contribution of phonological awareness and phonetic radical awareness to different types of Chinese literacy skills among the Arabic and English CSL learners.

To answer these questions, two pre-intermediate and two intermediate groups of English and Arabic CSL learners were recruited from the universities in the United Kingdom and Egypt, respectively. In addition, native speakers of Arabic, Chinese and English were also recruited for the control purpose. The CSL participants were tested in phonological aptitude using LLAMA tests (phonological working memory and phonetic coding ability), Chinese language proficiency test using HSK examination (listening and reading), Chinese phonological awareness using odd-man-out test (syllable, onset, rhyme and tone), Pinyin spelling using the task of dictation (disyllabic Chinese words), phonetic radical awareness using a task of pseudo-Hanzi naming, Hanzi reading for pronunciation and Hanzi writing according to Pinyin and meaning. The two groups of native Arabic and English speakers were assessed in Chinese phonological awareness and the native Chinese speakers were tested in phonetic radical awareness.

The effect of L1 background on most measures of Chinese phonological awareness and Pinyin spelling were significant in the Arabic and English CSL learners. The English CSL learners outperformed the Arabic CSL learners in syllable awareness/spelling, onset awareness/spelling, overall phonological awareness and rhyme spelling. In terms of the developmental order of the subcomponents of Chinese phonological awareness, the two CSL groups showed different patterns in phonological awareness. The greater similarity in phonological and orthographic properties between Pinyin and English than those between

Pinyin and Arabic, as well as the English CSL learners' better listening skills could be the main reasons leading to the significant between-group differences. English and Chinese are similar in terms of onset-rhyme syllabic structure, articulation of some consonants, a large inventory of vowels and rhymes, and the Roman alphabet, yet Arabic differs from these two languages in terms of its body-coda syllabic structure, consonant-dominant phonological properties and the right-to-left script. The close relationship between Pinyin and English might give the English CSL learners an advantage in developing phonological perception and manipulation skills and Pinyin production abilities. Furthermore, the English CSL group demonstrated better achievements in the test of Chinese listening proficiency than did the Arabic CSL learners, and the possible reason could be the English CSL learners' overall more experience of studying abroad or staying in China.

The two CSL groups did not differ in rhyme awareness or tone awareness/spelling, and they showed a similar path in the development pattern of the subcomponents of Pinyin spelling skills (onset>rhyme>tone). The Arabic and English CSL learners' similar performance in tone awareness/spelling might link with the fact that Arabic and English are not tonal languages. The likely explanation for the two groups' insignificant differences in rhyme and tone awareness and the similar developmental order of the subcomponents of Pinyin spelling might relate to the relative difficulty in learning different phonological units of the Chinese language. Onset could be the easiest, rhyme could be difficult and tone might be the most difficult for the CSL learners. Chinese has 22 onsets, which are made up of consonants, while consonants exist in Arabic, Chinese and English, thus onset learning could be the easiest. In contrast, there are 39 rhymes in Chinese, and most rhymes are constituted by vowels. The large number of rhymes in Chinese pose difficulties to the English CSL learners due to the interference from English rhymes, as well as to the Arabic CSL learners because of the lack of compound vowels and rhymes in Arabic. Therefore, rhymes are more difficult than onsets. The most difficult phonological unit in Chinese to learn might be tone, which is not possessed by either Arabic or English. Furthermore, tones are attached to the rhymes in Pinyin spelling, adding more difficulty to the perception and production of tones. In sum, the relative learning difficulty in different phonological units of Pinyin might lead to the similar pattern in the development of Pinyin spelling between the Arabic and English CSL learners.

Contrary to the influence of L1 background on phonological awareness and Pinyin spelling, more similarities were observed in phonetic radical awareness and Hanzi literacy skills among the Arabic and English CSL learners. In terms of the phonetic radical awareness, the two CSL groups showed a weaker tendency to use the right-side Hanzi to name the pseudo-Hanzi in comparison to the native Chinese speakers. In addition, neither a main effect of L1 background nor the main effect of Chinese language proficiency level was found. These results indicate that the two groups of CSL learners have not developed phonetic radical awareness and that the development of phonetic radical awareness did not relate with the writing direction in the CSL learners' L1 script or their Chinese language proficiency. The amount of exposure to Hanzi and the explicit instruction about the functional and positional properties of phonetic radical in Hanzi could be the main factors contributing to the development of phonetic radical awareness.

As for the test of Hanzi reading skills, only the main effect of Chinese language proficiency level was found among the Arabic and English CSL learners. Moreover, the regularity effect and position effect of phonetic radical in reading Hanzi were similar for the two groups of CSL learners, who performed better in reading regular Hanzi than in semiregular and irregular Hanzi, and better in reading RPR Hanzi than in LPR Hanzi. The findings imply that Chinese language proficiency, rather than L1 background, relates more closely to the development of Hanzi reading skills that could be primarily driven by the internal characteristics of Hanzi orthography.

Significant between-group differences were found in Hanzi writing between the Arabic and English CSL learners. The Arabic CSL learners outperformed the English CSL learners in the performance in overall Hanzi writing, writing semiregular and RPR Hanzi. The Arabic CSL learners' better skills in Hanzi writing were in conflict with their inferior performance in phonetic radical awareness, which was hypothesized to be facilitated by the right-to-left writing direction in Arabic script. Thus, the Arabic CSL group's superior Hanzi writing skills appeared not to result from the right-to-left direction in L1 script. In contrast, the visual complexity of Arabic script and the experience of learning two different scripts (Arabic and Roman scripts) might be the potential reasons.

The importance of phonological awareness and phonetic radical awareness differed for the development of different types of Chinese literacy skills across the Arabic and English CSL learners. Chinese phonological awareness significantly correlated with Pinyin spelling among the English CSL learners, and with Hanzi reading among the Arabic CSL learners, but not with Hanzi writing in either group. Phonetic radical awareness (direct naming strategy) was found to demonstrate a significant relationship with Hanzi reading in the English CSL group, but it did not significantly correlate with Hanzi writing. The different effect sizes of Chinese phonological awareness on Pinyin spelling and Hanzi reading across the two CSL groups might be linked with the CSL learners' L1 orthography background. Both Pinyin and English are phonemic and use the same Roman alphabet. Grapheme-phoneme correspondence rules are important for the production of spelling in Pinyin and English, which share certain similarities in the mapping norm between print and sound. The English CSL learners' reliance on print-sound mapping to spell English words might help them become better aware of the importance of Chinese phonological awareness for Pinyin spelling. In contrast, the Arabic CSL learners may have not developed efficient competency to reflect on the sound structure in Chinese due to the lack of tone and vowels/rhymes in Arabic, which in turn leads to a poor correlation between phonological awareness and Pinyin spelling.

As for the different correlations with Hanzi reading in the Arabic (phonological awareness) and English (phonetic radical awareness) CSL learners, the orthography depth in Arabic and English and the different performance in phonetic radical awareness might explain these results. English orthography is deep, and the English readers might have developed multiple strategies such as phonological and orthographical routes to access reading rather than sole reliance on phonological information. The opaqueness of grapheme-phoneme mapping in English is comparable to the inconsistent correspondence between phonetic radical and Hanzi. Hence, the English readers may use both phonological and orthographic clues to read Hanzi. Contrary to the deep orthography in English, Arabic has a relatively transparent grapheme-phoneme mapping rule, which might lead to the Arabic readers' dominant reliance on phonological information in the activity of reading. Consequently, the Arabic CSL learners could depend more on phonological clue in Hanzi recognition, resulting in the strong association between the task of phonological awareness and Hanzi reading skills. In addition, the English CSL learners showed slightly better phonetic radical awareness. The English CSL group's experience of staying or studying in China might assist them to gain a deeper understanding of the orthographic structure and the knowledge of the functional and positional properties of phonetic radicals. However, the Arabic CSL learners only studied Chinese in their home country, and they might have had a smaller amount of exposure to Hanzi. Given that orthographic awareness is more crucial than phonological awareness for Hanzi recognition, it is not surprising to find the significant role of phonetic radical awareness in reading in the English CSL group, but not in the Arabic CSL group.

Other meta-linguistic and background variables were found to relate with the performances in Chinese learning among the Arabic and English CSL learners. Chinese language proficiency, the length of staying in China, the number of languages previously learnt and phonological aptitude (phonetic coding ability and phonological working memory) were significant predictors in specific measures. Phonetic coding ability showed significant relationships with phonological awareness and phonetic radical awareness, suggesting that the ability to detect the relationship between print and sound and these two types of Chinese meta-linguistic awareness might reveal certain common cognitive structure related to language learning. The number of languages previously learnt were found to demonstrate a negative association with phonetic radical awareness and positive relationship with syllable awareness and Hanzi writing, indicating that the previous language learning experience might vary in different aspects of language learning. Chinese language proficiency was the most common predictor and it contributed to most of the measures in phonological awareness, Pinyin spelling, Hanzi reading and Hanzi writing, rather than phonetic radical awareness. These results point to the slower development of phonetic radical awareness in Hanzi in CSL learners. In addition, the length of staying in China only predicted the performance in literacy skills such as Pinyin spelling and Hanzi reading, not in meta-linguistic awareness competencies and Hanzi writing, suggesting the domain-specific contribution of studying abroad in L2-speaking country to L2 learning. The findings in this study indicate that the importance of other meta-linguistic and background variables might differ for meta-linguistic awareness and Chinese literacy skills among the Arabic and English CSL learners.

This research is theoretically and practically important. Theoretically speaking, this study contributes to the existing knowledge of the influence of L1 background and other meta-linguistic and background variables on L2 learning by providing evidence for how Arabic and English impact the development of Chinese phonological awareness, phonetic radical awareness and Chinese literacy skills in learners of Chinese as a second language. This research is the first of its kind to explore how the first language affects the acquisition of two different writing systems used in the Chinese language. This is also the first study reporting the influence of Arabic and English on Chinese phonological awareness and Pinyin spelling skills among the CSL learners. In addition, this study extends previous research about the importance of phonological awareness for Pinyin spelling and the contribution of phonological awareness and phonetic radical awareness to Hanzi recognition among the CSL learners. More importantly, this research further points out that the relationship between phonological awareness, phonetic radical awareness, Pinyin spelling and Hanzi reading could be affected by the CSL learners' L1 background. Finally, the present study adds substantially to our understanding of how other meta-linguistic and background variables affect the development of meta-linguistic awareness and literacy skills L2 learning. In particular, the domain-specific effect of the experience of staying in L2-speaking country, the interference of the number of languages previously learnt, the strong association of phonetic coding ability with Chinese phonological awareness and phonetic radical awareness, and the mixed effect of Chinese language proficiency are insightful for future research on the role of other meta-linguistic and background variables in second language learning.

The findings of this study have a number of important implications for Chinese teaching. First, considering that more influence of L1 background were found in Chinese phonological awareness and Pinyin than in phonetic radical awareness and Hanzi, more targeting instructions could be provided in Pinyin learning for the CSL learners with different sound-based orthography backgrounds, and similar teaching strategies for Hanzi learning. Second, the achievements in rhyme and tone appeared to be two of the lowest in the Arabic and English CSL learners, therefore more attention could be paid to the teaching and learning of these two phonological units in Chinese. Another important practical implication is that explicit instructions are needed to develop the CSL learners' sensitivity of the functional and positional properties of phonetic radical in Hanzi.

Appendices

Appendix 1. Instructions for phonological aptitude test

English

Instructions for phonological working memory test (LLAM-D)

You start the program by clicking the arrow button at the bottom left in the start panel, then you will hear a set of 10 words in a language that are unfamiliar to you.

Your task is to listen carefully to these words. All the words will be read only once.

When program times out, you will hear a bleep to signal that you are entering the test phase.

In the test phase, you will hear these words alongside other words that you have not heard before.

If you think it is a word that you have already heard, click the smiling face button.

If you think that is a word you have not heard before in this test, click the plain face button.

Click the arrow button to hear the next word.

The program gives you feedback in the form of a ding for a correct answer, and a bleep for a wrong answer.

Instructions for phonetic coding ability test (LLAM-E)

You start the program by clicking the arrow button at the top right in the start panel.

Your task is to learn how the spelling system of this language works. You do this by clicking on the small buttons in the main panel. Each button plays a short sound file. The text on the button tells you how that particular sound is written in the language.

You have **two minutes** for this phase.

When program times out, you will hear a bleep to signal that you are entering the test phase.

Click the blank button between two spellings to start testing.

Each time you click the blank button the program will play a new word for you. At the same time, it displays two possible spellings for this word. One spelling is correct, the other is wrong. Click on the spelling that you think is correct.

The program will give you feedback in the form of a ding for a correct answer, and a bleep for an incorrect answer.

Arabic

Instructions for phonological working memory test (LLAM-D)

**يبدأ تشغيل البرنامج بالضغط على الزر، ثم ستستمع الى مجموعة مكونة من ١٠ كلمات بلغة غير مألوفة بالنسبة لك.
ان مهمتك هي الاستماع بعناية الى هذه الكلمات. ستتم قراءة كل الكلمات لمرة واحدة فقط.**

عندما يتوقف البرنامج، سوف تسمع تنبيها يُشير الى دخولك الى مرحلة الاختبار. في مرحلة الاختبار، سوف تسمع هذه الكلمات الى جانب كلمات لم تسمعها من قبل.

اذا كنت تعتقد انك سمعت الكلمة مسبقا اضغظ الزر.

اذا كنت تعتقد انك لم تسمع الكلمة مسبقا خلال هذا الاختبار اضغظ الزر.

**اضفط الزر لسماع الكلمة التالية.
يُظهر لك البرنامج نتيجة اجاباتك: الجرس عند الإجابة الصحيحة، والصفير عند الإجابة الخاطئة.**

Instructions for phonetic coding ability test (LLAM-E)

يبدأ تشغيل البرنامج بالضغط على الزر في قائمة البداية.

**ان مهمتك هي تعلم كيفية عمل نظام التهجئة لهذه اللغة. يمكنك القيام بذلك بالضغط على الأزرار الصغيرة في القائمة الرئيسية، كل زر يقوم بتشغيل ملف صوتي قصير،
إن النص المكتوب على الزر يحدد لك كيفية كتابة صوت معين في اللغة.**

لديك دقيقتين لهذه المرحلة ويمكنك كتابة أي ملاحظات تحتاجها.

عندما يتوقف البرنامج، سوف تسمع تنبيها يشير الى دخولك مرحلة الاختبار. انقر على الزر الفارغ\الأبيض بين التهجئتين(الكلمتين) لتبدأ الاختبار.

في كل مرة تضغط على الزر الفارغ سيشغل لك البرنامج كلمة جديدة. وفي نفس الوقت سيُظهر لك احتمالين اثنين لتهجئة الكلمة: واحدة منهما صحيحة وأخرى خاطئة. اضغط على التهجئة التي تعتقد انها صحيحة.

سيُظهر لك البرنامج نتيجة اجاباتك: الجرس عند الإجابة الصحيحة، والصفير عند الإجابة الخاطئة.

Appendix 2. Chinese language proficiency test

Listening section

Instructions

English

Listen and answer. Please answer following questions according to what you hear. You have 5 seconds to answer each question. Each conversation or paragraph will be read only once.

Arabic

استمع وأجب. الرجاء الإجابة على الأسئلة التالية وفقا لما تسمع. لديك ٥ ثواني فقط للإجابة على كل سؤال. إن كل محادثة أو قطعة ستُقرأ لمرة واحدة فقط.

Materials

Level 3

1. 男：刚才还是大太阳，这会儿就下雨了。

   女：是，这天气一会儿晴一会儿阴的。

   男：你怎么知道带雨伞？

   女：早上我妈把它放我包里了。

   ★问：谁把雨伞放包里的？

   A 服务员　B 她妈妈　C 她的学生

2. 女：电影票多少钱一张？

   男：八十。

   女：好，我买三张。

   男：对不起，您要买几点的？

   ★问：女的要买几张电影票？

   A 3 张　B 8 张　C 10 张

3. 男：经常吃甜的东西容易变胖。

   女：我同意，所以我不吃糖。

   男：那你怎么还敢吃那么多蛋糕？

   女：没关系，这种蛋糕不甜，没放糖。

   ★问：女的为什么不吃糖？

   A 吃饱了　B 口渴了　C 不愿意变胖

4. 女：你听一下，这是什么声音？

男：像是空调的声音？

女：是不是坏了？应该找人检查一下了。

男：这个周末我们去买个新的吧，这个空调太旧了。

★问：男的认为空调怎么了？

A 坏了　B 该换了　C 放得太低了

Level 4

1-2 许多人都有过后悔的经历，其实，只要我们按照自己的想法去做了，就没什么后悔的，因为我们不可能把所有的事情全部做对。另外，让我们走向成功的，往往是我们从过去做错的事情中得到的经验。

★许多人都有过怎样的经历？

A 后悔　B 得意　C 紧张　D 激动

★什么能帮助我们走向成功？

A 理想　B 努力工作　C 正确的方法　D 失败的经验

3-4 今天，你们终于完成了大学四年的学习任务，马上就要开始新的生活了。我代表学校向同学们表示祝贺！祝你们在今后取得更大的成绩，也希望你们以后有时间多回学校来看看。

★说话人最可能是谁？

A 导游　B 校长　C 记者　D 服务员

★这段话最可能是在什么时候说的？

A 访问　B 开学　C 毕业　D 放寒假

Reading section

Instructions

English

Read and answer. The time limit for the reading section is 10 minutes.

Arabic

اقرأ وأجب. ان المهلة المحددة لقسم القراءة هي ١٠ دقائق

Materials

Level 3

1. 猫和人不同，它们不怕黑，因为它们的眼睛在晚上更容易看清楚东西。我们家的那只猫就总是习惯白天睡觉，晚上出来走动。

★ 关于那只猫，可以知道什么？

A 害怕晚上　　B 喜欢换环境　　C 喜欢白天休息

2. 茶是我的最爱，花茶、绿茶、红茶，我都喜欢，天冷了或者你工作累了的时候，喝杯热茶，真是舒服极了。

★ 关于他，可以知道：

A 口渴了　　B 没完成工作　　C 很喜欢喝茶

3. 你好，我今天早上才发现，昨天从你们这儿拿回去的衣服不是我的，衬衫和裤子都不是我的，这条裤子太长了，你帮我看一下，是谁拿错了。

★ 根据这段话，可以知道他：

A 非常生气　　B 是卖衣服的　　C 拿错了衣服

4. 孩子在学会说话以前，就已经懂得了哭和笑，他们借这样的办法来告诉别人自己饿了、生气了、不舒服或者很高兴、很满意。慢慢大一点以后，他们就开始用一些简单的词语来表示自己的意思了。

★ 孩子笑可能表示：

A 很难过　　B 很好吃　　C 不想玩了

Level 4 (41004:79, 82-85)

5-6 每个人的生命中都会遇见一件重要的事情，那就是结婚，选择与自己爱的人在一起生活。在结婚之前，我们都要弄清楚自己想要的是什么，而不要被别人对

幸福的看法影响，因为没有人能够代替你获得幸福，真正的幸福是你和你爱的人在一起，共同生活，并且从心底里感到幸福与快乐。

★ 结婚之前，我们应该：

A 休息好　B 学会表达　C 与父母商量　D 知道自己要什么

★ 根据这段话，婚后幸福的条件是：

A 互相信任　B 相互尊重　C 有责任心　D 找到你爱的人

7-8. 一个年轻人问富人怎么才能赚更多的钱。富人拿出 3 块大小不同的西瓜说："如果西瓜的大小代表钱的多少，你选哪块？"年轻人想都没想就拿了最大的一块。而富人自己吃了最小的一块。很快富人就吃完了，又拿起最后一块西瓜吃起来，一边吃一边说："还是我吃得多吧。"年轻人突然明白了，只看眼前一定会输掉更多。

★ 富人为什么选小块西瓜？

A 他饱了　B 他懂礼貌　C 离他最近　D 有机会吃到第 3 块

★ 这个故事想说明什么？

A 先苦后甜　B 别羡慕富人　C 别只看到眼前　D 速度是最重要的

Appendix 3. Chinese phonological awareness test

Syllable awareness

Instructions

English

You will hear a list of disyllabic Chinese words. In each set, two words have the same syllable, which is not included in the third word. The same syllable may appear in different positions of each disyllabic word. Your task is to detect the odd word by circling the corresponding number. Each word will be read only once. After the audio, you will have 5 seconds to answer each question. Now, let us have a bit of training:

Arabic

في هذا القسم، سوف تستمع الى قائمة من الكلمات الصينية ذات جزئين لفظيين (المقصود بالجزء اللفظي هو في كل مجموعة كلمتين لهما نفس الجزء اللفظي، بينما الثالثة ليست كذالك. قد يظهر نفس الجزء في أماكن مختلفة في الكلمة ذات الجزئين اللفظيين. مهمتك هي الكشف عن الكلمة الغربية بوضع دائرة حول الرقم المطابق. سيتم قراءة كل كلمة لمرة واحدة فقط. بعد انتهاء الصوت، سيكون لديك ٥ ثواني للإجابة على كل سؤال. لنتدرب قليلا الان:

Materials

1.	jīngcăi	căiqŭ	méitĭ	2.	dàgē	hăoxiàng	gēmí
3.	duìhuà	jìsuàn	huàjiā	4.	mùbiāo	zàijiàn	jiànshè
5.	gănjué	juédìng	kăoshēng	6.	guāngmíng	shíxiàn	míngchēng
7.	cuòwù	zăoyĭ	yĭqián	8.	gāozhōng	zhōngyú	fúwù

Onset awareness

Instructions

English

You will hear a list of Chinese syllables. In each set, two syllables have the same initial sound, which is not included in the third syllable. Your task is to detect this odd syllable by circling the corresponding number. Each syllable will be read only once. After the audio, you will have 5 seconds to answer each question. Now, let us have a bit of training:

Arabic

في هذا القسم، سوف تستمع الى قائمة من الأجزاء اللفظية في اللغة الصينية (syllables). في كل مجموعة جزئين يبتدآن بنفس الصوت، بينما الجزء الثالث لٰيس كذالك. مهمتك هي الكشف عن المقطع الغريب بوضع دائرة حول الرقم المطابق. سيتم قراءة كل مقطع لمرة واحدة فقط. بعد انتهاء الصوت، سيكون لديك ٥ ثواني للإجابة على كل سؤال. لنتدرب قليلا الان:

Materials

1.	nán	suí	nuó	2.	běi	bǎo	děng
3.	lù	gùn	guài	4.	móu	mí	nín
5.	pāo	bīng	pū	6.	zuì	cèng	zì
7.	jiǎo	jǔ	zhǎng	8.	chōng	qiū	qī

Rhyme awareness

Instructions

English

You will hear a list of Chinese syllables. In each set, two syllables share the same final sound, which is not included in the third syllable. Your task is to detect this odd syllable by circling the corresponding number. Each syllable will be read only once. After the audio, you will have 5 seconds to answer each question. Now, let us have a bit of training:

Arabic

في هذا القسم، سوف تستمع الى قائمة من الأجزاء اللفظية في اللغة الصينية. في كل مجموعة جزئين ينتهيان بنفس الصوت، بينما الجزء الثالث ليس كذالك. مهمتك هي الكشف عن المقطع الغريب بوضع دائرة حول الرقم المطابق. سيتم قراءة كل مقطع لمرة واحدة فقط. بعد انتهاء الصوت، سيكون لديك ٥ ثواني للإجابة على كل سؤال. لنتدرب قليلا الان:

Materials

1.	lǐ	bǐ	nǚ	2.	bō	hē	gē
3.	zuò	dòu	ròu	4.	zuǐ	shuǐ	fěi
5.	xué	jié	qué	6.	yáo	sháo	lóu
7.	līn	xīn	dīng	8.	dùn	fèn	gùn

Tone awareness

Instructions

English

In this section, you will hear a list of Chinese syllables. In each test, two syllables share the same tone, which is not included in the third syllable. Your task is to detect this odd syllable by circling the corresponding number. Each syllable will be read only once. After the audio, you will have 5 seconds to answer each question. Now, let us have a bit of training:

Arabic

في هذا القسم، سوف تستمع الى قائمة من الأجزاء اللفظية في اللغة الصينية. في كل مجموعة مقطعين يتشاركان في نفس النغمه ، بينما المقطع الثالث ليس كذلك. ان مهمتك هي الكشف عن المقطع الغريب بوضع دائرة حول الرقم المطابق. سيتم قراءة كل جزء لفظي لمرة واحدة فقط. بعد انتهاء الصوت، سيكون لديك ٥ ثواني للإجابة على كل سؤال. لنتدرب قليلا الان:

Materials

1.	chē	shé	hé	2.	jiǎo	tiào	niǎo
3.	táng	láng	pàng	4.	tóu	shǒu	hóu
5.	shā	tǎ	wā	6.	xié	jié	tiě
7.	mèng	pèng	gēng	8.	bāo	cǎo	pǎo

Appendix 4. Disyllabic words used Chinese Pinyin spelling test

Instructions

English

You will hear a list of disyllabic Chinese words. Your task is to write the words in Pinyin, including tones. Each word will be read twice. After the audio, you will have 10 seconds to answer each question:

Arabic

إملاء. في هذا القسم، سوف تستمع الى قائمة من الكلمات الصينية ذات جزئين لفظيين (المقصود بالجزء اللفظي هو . مهمتك هي كتابة الكلمات ب والنغمات . سيتم قراءة كل كلمة لمرة واحدة فقط. بعد انتهاء الصوت، سيكون لديك ١٥ ثانية للإجابة على كل سؤال.

Materials

No.	Disyllable word	Single syllable	Frequency
1	ruò duàng	ruò	0.0004665435
		duàng	0.0000000000
2	shān diāo	shān	0.0009676683
		diāo	0.0000452344
3	sǔn guā	sǔn	0.0001948046
		guā	0.0000690743
4	píng guài	píng	0.0014572158
		guài	0.0002419288
5	bàng huǐ	bàng	0.0000803089
		huǐ	0.0010327814
6	jiā kěn	jiā	0.0014036021
		kěn	0.0002489634
7	hēng lào	hēng	0.0000688614
		lào	0.0000116084
8	zǎi mò	zǎi	0.0000331744
		mò	0.0007449122
9	cì pín	cì	0.0012936388
		pín	0.0001577729
10	jiè qīu	jiè	0.0023411488
		qīu	0.0001860048

Continue on next page

Continued

11	xióng qū	xióng	0.0001971356
		qū	0.0010799316
12	chū róu	chū	0.0042251508
		róu	0.0000769188
13	nián tóng	nián	0.0031519164
		tóng	0.0001795153
14	fĕi xué	fĕi	0.0001185711
		xué	0.0024506086
15	yuán zhă	yuán	0.0036162795
		zhă	0.0000228067

Appendix 5. Phonetic radical awareness test

Instructions

Below are some Hanzi you have not learnt, please try to guess their pronunciations by using Pinyin, including tones. The time limit is 3 minutes.

Arabic

٨) فيما يلي بعض ال اللتي لم تكن قد تعلمتها. يرجى محاولة أن تكتب نطقها باستخدام ال بما في ذلك النغمات.

Materials

Distractors

夶 (bǐ), 叴 (qiú), 垚 (yáo), 牸 (zì), 対 (duì)

Test items

No.	Hanzi 1	Pinyin1	Hanzi 2	Pinyin2	Pseudo-Hanzi 1	Pseudo-Hanzi 2
1	人	rén	己	jǐ		
2	也	yě	太	tài		
3	不	bú	力	lì		
4	生	shēng	中	zhōng		
5	主	zhǔ	可	kě		

Appendix 6. Hanzi used in the task of reading

Instructions

English

Please read aloud following Hanzi according to the order of the numbers. If one Hanzi has two or more pronunciations, it is acceptable to say either one. Only the first pronunciation you produce counts. If you do not know, just say “I don’t know”. If you do not know five Hanzi in a row, the test will stop. The time limit is 3 minutes.

Arabic

يرجى قراءة ال التالية بصوت عال وفقا لترتيب الأرقام.

في حالة وجود أكثر من نطقين لل فيسمح باختيار أي منهما. سيتم احتساب اللفظ الأول الذي ستقدمه فقط. اذا لم تعرف، فقط قل "لا أعرف".

اذا لم تعرف أو أسات قراءة خمسة على التوالي، فسوف يتوقف الاختبار. المهلة هي ٣ دقائق.

Materials

No.	Level	Hanzi	Structure	Regularity	Strokes	Frequency
1	1	她	RPR	irregular	6	0.0095878936
2	1	动	RPR	irregular	6	0.0015448504
3	1	拉	RPR	semiregular	8	0.0014877059
4	1	像	RPR	regular	13	0.0014288623
5	1	让	RPR	semiregular	5	0.0012534643
6	1	理	RPR	regular	11	0.0009601030
7	1	放	LPR	semiregular	8	0.0008293902
8	1	部	LPR	irregular	10	0.0007667204
9	1	机	RPR	regular	6	0.0006119453
10	1	欢	LPR	irregular	6	0.0005731721
11	1	期	LPR	semiregular	12	0.0005217600
12	1	刚	LPR	regular	6	0.0004835117
13	1	形	LPR	irregular	7	0.0004067940
14	1	够	LPR	irregular	11	0.0003766540
15	1	钟	RPR	regular	9	0.0003608242
16	1	领	LPR	semiregular	11	0.0003266646
17	1	数	LPR	irregular	13	0.0003082518
18	1	群	LPR	semiregular	13	0.0002375429
19	1	致	LPR	regular	10	0.0002334680
20	1	骑	RPR	regular	11	0.0002321834
21	1	河	RPR	semiregular	8	0.0002264924
22	1	政	LPR	regular	9	0.0002038943
23	1	救	LPR	semiregular	11	0.0001836996
24	1	腿	RPR	semiregular	13	0.0001808818
25	1	价	RPR	semiregular	6	0.0001738095

Continue on next page

Continued

26	1	功	LPR	regular	5	0.0001569161
27	1	彩	LPR	regular	11	0.0001542502
28	1	较	RPR	semiregular	10	0.0001531590
29	1	油	RPR	regular	8	0.0001399675
30	1	凉	RPR	irregular	10	0.0001090816
31	1	创	LPR	semiregular	6	0.0001026309
32	1	鸡	RPR	irregular	7	0.0000962355
33	1	项	LPR	irregular	9	0.0000928374
34	1	净	RPR	irregular	8	0.0000906412
35	1	邮	LPR	regular	7	0.0000417568
36	1	绩	RPR	irregular	11	0.0000210234
37	2	给	RPR	irregular	9	0.0016571366
38	2	战	LPR	regular	9	0.0004825309
39	2	强	LPR	irregular	12	0.0004273755
40	2	则	LPR	irregular	6	0.0003066909
41	2	呼	RPR	regular	8	0.0002703764
42	2	顶	LPR	semiregular	8	0.0002504857
43	2	怜	RPR	semiregular	8	0.0002273350
44	2	胡	LPR	semiregular	9	0.0001762406
45	2	伴	RPR	regular	7	0.0001664057
46	2	欺	LPR	regular	12	0.0001487941
47	2	翻	LPR	regular	18	0.0001487941
48	2	附	RPR	regular	7	0.0001387658
49	2	触	RPR	semiregular	13	0.0001004622
50	2	攻	LPR	regular	7	0.0000904202
51	2	裤	RPR	regular	12	0.0000812759
52	2	敏	LPR	semiregular	11	0.0000707504
53	2	肚	RPR	semiregular	7	0.0000696177
54	2	劝	LPR	irregular	4	0.0000658606
55	2	邻	LPR	semiregular	7	0.0000602939
56	2	挡	RPR	semiregular	9	0.0000565230
57	2	饮	RPR	irregular	7	0.0000550588
58	2	割	LPR	irregular	12	0.0000507077
59	2	胁	RPR	irregular	8	0.0000502518
60	2	豫	LPR	regular	15	0.0000487877
61	2	刮	LPR	irregular	8	0.0000414806
62	2	跨	RPR	semiregular	13	0.0000392843
63	2	洒	RPR	irregular	9	0.0000357620
64	2	偿	RPR	regular	11	0.0000355686
65	2	顽	LPR	irregular	10	0.0000321153
66	2	傍	RPR	semiregular	12	0.0000311760
67	2	袜	RPR	irregular	10	0.0000268664
68	2	填	RPR	irregular	13	0.0000239518
69	2	郊	LPR	regular	8	0.0000228468

Continue on next page

Continued						
70	2	胶	RPR	regular	10	0.0000198079
71	2	鸭	LPR	semiregular	10	0.0000122107
72	2	巩	LPR	semiregular	6	0.0000027764
73	3	雅	LPR	semiregular	12	0.0002394352
74	3	盯	RPR	regular	7	0.0001154494
75	3	郁	LPR	semiregular	8	0.0000769801
76	3	飘	LPR	semiregular	15	0.0000747147
77	3	怖	RPR	regular	8	0.0000592718
78	3	倦	RPR	semiregular	10	0.0000579181
79	3	狼	RPR	semiregular	10	0.0000569788
80	3	颇	LPR	semiregular	11	0.0000498374
81	3	媚	RPR	semiregular	12	0.0000475721
82	3	脉	RPR	irregular	9	0.0000400993
83	3	泄	RPR	irregular	8	0.0000399888
84	3	邪	LPR	irregular	6	0.0000378754
85	3	剂	LPR	semiregular	8	0.0000348503
86	3	叙	LPR	semiregular	9	0.0000339386
87	3	勋	LPR	irregular	9	0.0000337729
88	3	劫	LPR	irregular	7	0.0000310932
89	3	颠	LPR	irregular	16	0.0000307340
90	3	狮	RPR	regular	9	0.0000303887
91	3	鹅	LPR	irregular	12	0.0000290626
92	3	搅	RPR	semiregular	12	0.0000274465
93	3	削	LPR	regular	9	0.0000255403
94	3	刹	LPR	regular	8	0.0000239518
95	3	鸦	LPR	regular	9	0.0000228053
96	3	颂	LPR	semiregular	10	0.0000154154
97	3	涛	RPR	irregular	10	0.0000147109
98	3	歧	RPR	irregular	8	0.0000109676
99	3	讼	RPR	semiregular	6	0.0000108985
100	3	郑	LPR	irregular	8	0.0000107051
101	3	翔	LPR	irregular	12	0.0000085641
102	3	栖	RPR	semiregular	10	0.0000082464
103	3	坝	RPR	semiregular	7	0.0000048622
104	3	缔	RPR	regular	12	0.0000045169
105	3	浏	RPR	regular	9	0.0000045031
106	3	彰	LPR	regular	14	0.0000026797
107	3	抠	RPR	irregular	7	0.0000025002
108	3	钙	RPR	regular	9	0.0000007597

Note. Level 1 = pre-intermediate level; Level 2 = intermediate level; level 3 = advanced level; LPR = left-side phonetic radical, RPR = right-side phonetic radical; Strokes = the number of strokes of Hanzi; Frequency = Hanzi frequency.

Appendix 7. Hanzi used in the task of writing

Instructions

English

Please write the target Hanzi according to the bold and italic Pinyin and the translation.

Arabic

يرجى كتابة ال بين الأقواس وفقا للكتابة الداكنة والمائلة والترجمة .

Materials

No.	Level	Hanzi	Structure	Regularity	Strokes	Frequency	Pinyin	English translation	Arabic translation
1	1	都	LPR	irregular	10	0.0027260449	***dōu*** lái le	All came	جميعهم أتوا
2	1	但	RPR	regular	7	0.0020702846	***dàn*** shì	but, however	لكن
3	1	此	LPR	semiregular	6	0.0013002215	yīn ***cǐ***	so, therefore	لهذا السبب
4	2	却	LPR	semiregular	7	0.000897875	tā ***què*** zǒu le	but he went away	لكنه ذهب
5	1	海	RPR	irregular	10	0.0005146186	dà ***hǎi***	ocean, sea	البحر، المحيط
6	2	战	LPR	regular	9	0.0004825309	***zhàn*** zhēng	war, battle	الحرب
7	2	则	LPR	irregular	6	0.0003066909	fǒu ***zé***	otherwise	وإلا
8	1	试	RPR	regular	8	0.0002221275	***kǎo*** shì	test, examination	إمتحان
9	1	读	RPR	irregular	10	0.000218868	***dú*** shū	to read	قراءة كتاب
10	1	顾	LPR	irregular	10	0.0002070575	***gù*** kè	customer	عميل
11	1	政	LPR	regular	9	0.0002038943	***zhèng*** zhì	politic	سياسي
12	2	胡	LPR	semiregular	9	0.0001762406	***hú*** zi	mustache	شنب
13	2	徒	RPR	irregular	10	0.000168657	***tú*** dì	apprentice	مبتدئ
14	2	诚	RPR	regular	8	0.0001616264	zhēn ***chéng***	honest, sincere	صادق
15	1	洗	RPR	semiregular	9	0.0001515291	***xǐ*** shǒu	to wash hands	غسل اليدين
16	1	创	LPR	semiregular	6	0.0001026309	***chuàng*** zào	to create	خلق
17	2	贴	RPR	irregular	9	0.0001025204	***tiē*** zhǐ	sticker	ملصق
18	2	脏	RPR	semiregular	10	0.0000910141	***zāng*** yīfu	dirty clothes	الملابس القذرة
19	1	绍	RPR	semiregular	8	0.0000677806	jiè ***shào***	introduce	عرّف ب
20	2	肌	RPR	regular	6	0.0000470472	***jī*** ròu	muscle	عضلة
21	2	诞	RPR	semiregular	9	0.0000466328	shèng ***dàn*** jié	Christmas	عيد الميلاد
22	1	邮	LPR	regular	7	0.0000417568	***yóu*** jú	post office	مكتب البريد
23	2	刮	LPR	irregular	8	0.0000414806	***guā*** liǎn	shave the face	حلق الوجه
24	2	郊	LPR	regular	10	0.0000228468	***jiāo*** wài	suburb, outskirts	ضواحي

Note. Level 1 = pre-intermediate level; Level2 = intermediate level; level 3 = advanced level; LPR = left-side phonetic radical, RPR = right-side phonetic radical; Strokes = the number of strokes of Hanzi; Frequency = Hanzi frequency.

Appendix 8. Participants' background questionnaire

Arabic CSL learners

سنة الولادة:____
الجنسية:____
الجنس : ____
اللغة الأم:____
أعلى درجة حققتها في اختبار كفاءة اللغة الصينيه(HSK) : _______________
عدد السنوات في تعلم الصينية:_________________________________
عدد الشهور في المعيشة في الصين:__________________________
أسباب المعيشة في الصين:_____________________________________

		مبتدئ	مبتدئ متوسط	متوسط	متوسط متقدم	متقدم
اللغة الأجنبية الأولى	الكفاءة الشفوية	1	2	3	4	5
_________	الكفاءة الكتابية	1	2	3	4	5
اللغة الأجنبية الثانية	الكفاءة الشفوية	1	2	3	4	5
________	الكفاءة الكتابية	1	2	3	4	5

English CSL learners

Year of birth: ________________________
Gender: _____________________________
Nationality: __________________________
Native language: ______________________
Years of Chinese learning: _____________
Highest HSK level you passed: __________
Months of living in China: ______________
Reasons for living in China: _____________

		beginner	beginner-intermediate	intermediate	intermediate-advanced	advanced
1st foreign language ______	Oral proficiency	1	2	3	4	5
	Written proficiency	1	2	3	4	5
2nd foreign language ______	Oral proficiency	1	2	3	4	5
	Written proficiency	1	2	3	4	5

Native speakers of Arabic

سنة الولادة
الجنس
الجنسية
الـ تخ صص\ ألمادة
حالـ يا الدرا سة ق يد ف يها بـ ما (درا سـ ية شهادة اعـلي)

متقدم	متوسط متقدم	متوسط	مبتدئ متوسط	مبتدئ		
5	4	3	2	1	الكفاءة الشفوية	اللغة الأجنبية الأولى
5	4	3	2	1	الكفاءة الكتابية	________
5	4	3	2	1	الكفاءة الشفوية	اللغة الأجنبية الثانية
5	4	3	2	1	الكفاءة الكتابية	_______

Native speakers of Chinese

出生年份：________________
性别：____________________
国籍：____________________
在读专业：________________
最高学历（含在读学历）:_____

		初级	初中级	中级	中高级	高级
第一外语：_________	听说能力：	1	2	3	4	5
	读写能力：	1	2	3	4	5
第二外语：_________	听说能力：	1	2	3	4	5
	读写能力：	1	2	3	4	5

Native speakers of English

Year of birth: ______________________________
Gender: __________________________________
Nationality: ______________________________
Subject: _________________________________
Highest education (including current program):_______

		beginner	beginner-intermediate	intermediate	intermediate-advanced	advanced
1st foreign language ______	Oral proficiency	1	2	3	4	5
	Written proficiency	1	2	3	4	5
2nd foreign language ______	Oral proficiency	1	2	3	4	5
	Written proficiency	1	2	3	4	5

Appendix 9. Informed Consent

Arabic CSL learners

كلية التربية
جامعة يورك

اسم الباحث
هاي وي ز هانق

عنوان الدراسة
تأثيرات نظام الكتابة للغة الأم على اكتساب الصينية البينين والهانزي

وصف ملخص الدراسة
تهدف الدراسة لاكتشاف أثر نظام الكتابة للغة الأم على اكتساب اللغة الصينية البينين والصينية الهانزي.

الوظيفة الرئيسية تكمن في الإجابة على الاسئلة عقب الاستماع لمقطع صوتي، كتابة هانزي بحسب بينين وكتابة بينين لهانزي.

لديك كامل الحرية لإيقاف الدراسة في أي وقت والمغادرة بدون إعطاء أي أسباب أو تبريرات.

سيتم الإحتفاظ بالبيانات بلا أسماء وبسرية كاملة وستخزن بكل أمان في جهاز كمبيوتر محمي ولن يستطيع الوصول لهذه البيانات إلا المختصين من الباحثين في هذه الدراسة. وفي حالة استخدامنا لبعض تلك البيانات في المستقبل لأغراض النشر العلمي فلن يصرح بأي معلومات خاصة بك.

عند وجود أي أسئلة أو استفسارات عن هذه الدراسة أو في حالة الرغبة في الحصول على ملخص الدراسة بعد نهايتها فتفضل بمراسلة:
hz756@york.ac.uk

للمشاركة في دراسة مسبقة موافقة
لقد قرأت البيان المتعلق بالدراسة الحالية والتي سأشارك فيها وانني علي دراية تامة بها. وانا ادرك بأنني استطيع الانسحاب منها في أي وقت أوخلال خمسة عشر يوماً بعد إكمال جمع البيانات وإن حدث ذلك فإن البيانات التي اعطيتها سيتم التخلص منها بالشكل المناسب. وادرك ايضا ان البيانات التي سأعطيها ستعامل بسرية تامة. و عليه فأنا موافق لأشارك في هذه الدراسة.

اسم المشارك:　　　　　　التوقيع:　　　　　　التاريخ:

اسم الباحث: هاي وي ز هانق　　　　　　التوقيع:　　　　　　التاريخ:

English CSL learners

Department of Education

University of York

Name of Researcher

Haiwei Zhang

Title of Study

Influences of writing system background on the acquisition of Chinese Pinyin and Hanzi

Brief Description of Study

The aim of this study is to explore the influences of native writing systems on the acquisition of Chinese Pinyin and Hanzi.

The main tasks include making judgments after listening to audios, writing Hanzi according to pinyin and writing pinyin for Hanzi. The tasks will take you approximately 50 minutes.

You are free to stop your participation at any point, without giving any specific reason, without your rights affected.

All the data that we collect during the experiment will be fully anonymized, and they will be securely stored in a password-protected computer / locked office, and only researchers involved in this study will have access to these data. If we used your individual data in future presentations or publications, you will not be identified.

If you have any further questions about the study, or would like a debrief after the study is completed, please write to hz756@york.ac.uk.

INFORMED CONSENT

I have read the statement concerning the research that I am being asked to take part in, and I have had the opportunity to ask questions. I understand that I may withdraw at any time during data collection time, and within 15 days after the completion of data collection completion, and if I decided to do so my data will be safely disposed of. I understand that my data will be kept confidential. I am happy to take part in the research.

(Participant) Printed Name:	Signature:	Date:
(Researcher) Printed Name:	Signature:	Date:

Native speakers of Arabic

كلية التربية
جامعة يورك

اسم الباحث
هاي وي ز هانق

عنوان الدراسة
تأثيرات نظام الكتابة للغة الأم على اكتساب الصينية البينين والهانزي

وصف ملخص الدراسة
تهدف الدراسة لاكتشاف أثر نظام الكتابة للغة الأم على اكتساب اللغة الصينية البينين والصينية الهانزي.

سيطلب منك الاستماع لمادة صوتية واجابة أسئلة حولها. قد تستغرق هذه المهمة حوالي خمسة عشر دقيقة.

لديك كامل الحرية لإيقاف الدراسة في أي وقت والمغادرة بدون إعطاء أي أسباب أو تبريرات.

سيتم الإحتفاظ بالبيانات بلا تسمية وبسرية كاملة وستخزن بكل أمان في جهاز كمبيوتر محمي ولن يستطيع الوصول لهذه البيانات إلا المختصين من الباحثين في هذه الدراسة. وفي حالة استخدامنا لبعض تلك البيانات في المستقبل لأغراض النشر العلمي فلن يصرح بأي معلومات خاصة بك.

عند وجود أي أسئلة أو استفسارات عن هذه الدراسة أو في حالة الرغبة في الحصول على ملخص الدراسة بعد نهايتها فتفضل بمراسلة:
hz756@york.ac.uk

موافقة مسبقة في دراسة للمشاركة

لقد قرأت البيان المتعلق بالدراسة الحالية والتي سأشارك فيها وانني علي دراية تامة بها. وانا ادرك بأنني استطيع الانسحاب منها في أي وقت أوخلال خمسة عشر يوماً بعد إكمال جمع البيانات وإن حدث ذلك فإن البيانات التي اعطيتها سيتم التخلص منها بالشكل المناسب. وادرك ايضا ان البيانات التي سأعطيها ستعامل بسرية تامة. وعليه فأنا موافق لأشارك في هذه الدراسة.

اسم المشارك:　　　　　　التوقيع:　　　　　　التاريخ:

اسم الباحث: هاي وي ز هانق　　　　　　التوقيع:　　　　　　التاريخ:

Native speakers of Chinese

约克大学教育学院

研究人员：

张海威

研究项目：

不同母语文字书写系统对汉语二语学习者汉字习得的影响

研究简介：

该研究旨在探讨不同母语文字书写系统在汉语二语学习者习得汉字过程中的作用。

该研究中的任务主要是为汉字注音。在研究过程中，如果您因故不能完成任务，您可以随时退出研究。

我们所收集的数据将会全部匿名处理，而且数据将会保存在带有密码保护的电脑或有锁的柜子中，密码或钥匙只有研究者本人知道或保存。如果在以后的文章或报告中我们使用您的个人数据，您的身份也将会做匿名处理。

如果您对本研究还有进一步的疑问，或者想得知研究的基本结果，请邮件联系 hz756@york.ac.uk.

知情同意书

我已经阅读了上述有关该研究的介绍，而且有机会就该研究与研究人员讨论。

我知道在数据收集过程中或数据收集完成的半个月之内，我可以随时退出该项研究。

我知道我的信息和数据将会受到保密处理。

最后我决定同意参加该项研究。

姓名：

签名：

日期：______________年________月________日

Native speakers of English

Department of Education
University of York

Name of Researcher

Haiwei Zhang

Title of Study
Influences of writing system background on the acquisition of Chinese Pinyin and Hanzi

Brief Description of Study

The aim of this study is to explore the influences of native writing systems on the acquisition of Chinese Pinyin and Hanzi.

You will be asked to listen to some audio materials and to make judgments, and to do a phonological aptitude test using a specific software. The tasks will take you approximately 30 minutes.

You are free to stop your participation at any point, without giving any specific reason, without your rights affected.

All the data that we collect during the experiment will be fully anonymized, and they will be securely stored in a password-protected computer / locked office, and only researchers involved in this study will have access to these data. If we used your individual data in future presentations or publications, you will not be identified.

If you have any further questions about the study, or would like a debrief after the study is completed, please write to hz756@york.ac.uk.

INFORMED CONSENT

I have read the statement concerning the research that I am being asked to take part in, and I have had the opportunity to ask questions. I understand that I may withdraw at any time during data collection time, and within 15 days after the completion of data collection completion, and if I decided to do so my data will be safely disposed of. I understand that my data will be kept confidential. I am happy to take part in the research.

(Participant) Printed Name: Signature: Date:

(Researcher) Printed Name: Signature: Date:

List of abbreviations and symbols

β	standardized regression coefficient
B	unstandardized regression coefficient
BCE	before Common Era
BGN	United States Board on Geographic Names
BLCU	Beijing Language and Culture University
CSL	Chinese as a Second Language
df	degree of freedom
Dlab	The Defense Language Aptitude Battery (Dlab)
ERP	Event-related potential
ESL	English as a Second Language
F	F test statistic, calculated by dividing the between group variance by the within group variance
FLA	foreign language aptitude
GCSE	General Certificate of Secondary Education
GPC	grapheme-phoneme correspondence
HSK	Hànyǔ Shuǐpíng Kǎoshì, Standard Chinese language proficiency test for learners of Chinese as a second language
IBDLE	Institute of Big Data and Language Education
IELTS	International English Language Testing System
IPA	International Phonetic Alphabet
IQ	Intelligence Quotient
L1	first language
L2	second language
LLAMA	The Swansea Language Aptitude Tests

LPR	left-side phonetic radical
MLAT	Modern Language Aptitude Test
M	Mean
MS	Mean Square
N	Number
N/A	not applicable
PA	phonological awareness
PCGN	Permanent Committee on Geographical Names
PLAB	The Pimsleur Language Aptitude Battery (PLAB)
PRA	phonetic radical awareness
PWM	phonological working memory
r	Pearson's correlation coefficient
R^2	the coefficient of determination
RPR	right-side phonetic radical
SD	Standard Deviation
SE	Standard Error
SLA	Second Language Acquisition
SS	Sum of Square
TOEFL	Test of English as a Foreign Language
/ /	phonological representation
< >	orthographic representation
>	better than, earlier than
<	less well than
≈	similar to
—	flat tone, as in <xīng>
／	rising tone, as in <shá>

ˇ falling-rising tone, as in <shě>

ˋ falling tone, as in <jìng>

Glossary

alphabetic writing system	the writing system that use alphabet letter to map onto the phonological units in speech, such as English and Arabic
body	the part of a syllable that includes the initial consonant and the nucleus
coda	the final part of a syllable that comes after the nucleus
consonant	a sound that is pronounced with the flow of air obstructed at some point in the mouth, throat or larynx
cross-language transfer	the influence of the knowledge and skills in an acquired language such as L1 on the learning of the target language such as L2, also known as cross-linguistic influence
deep orthography	the orthography that utilizes irregular and inconsistent orthography-phonology correspondence rules, such as English and Chinese Hanzi
foreign language aptitude	the natural ability to learn a language, not including intelligence, MOTIVATION, interest, etc.
diacritics	the glyph added to letters to change the sound-value of the letters, such as Chinese tone marks
grapheme	the basic written symbol in one script, such as individual English alphabetic letter

graphic writing system	the writing system that does not have its own alphabet, and each grapheme corresponds to a morpheme, such as Hanzi
Hanzi	Chinese characters
Kana	a syllabic script adopted from stroke or stroke patterns in Japanese writing system
Kanji	Chinese characters used in Japanese writing system
onset	the initial part of a syllable that comes before the nucleus
orthography depth	the degree to which grapheme corresponds to phoneme
orthography	the conventions for implementing a script in a particular language
phoneme	the smallest distinct sound unit in a given language
phonetic radical awareness	insight into the structure and function of the phonetic component of semantic-phonetic Chinese characters
phonetic radical	the radical that gives phonological cues of the pronunciation of Chinese characters
phonological awareness	the ability to reflect on and manipulate the phonological segments of speech
phonology	the sound systems of individual language
Pinyin	an alphabetic writing system using Roman alphabet letters to represent the pronunciation of Chinese characters, mainly used in Mainland China
radical	an orthographic component that is larger than stroke and often indicates semantic or phonological properties of Hanzi

reading	the activity of retrieving the phonological representation from a print word
rhyme	the part that follows the onset of a syllable, often including the nucleus and coda
script	a visual sign system that represents one writing system
semantic radical	the radical that gives semantic cues of the meaning of Chinese Hanzi
shallow orthography	the orthography that utilizes regular and consistent orthography-phonology correspondence rules, such as Turkish
spelling	the activity of producing the orthographic representation by hand from phonological or semantic input
stroke	the basic orthographic unit in Hanzi, including horizontal line (㇐), vertical line (丨), left-falling line (丿), right-falling line (㇏), dot (丶) and upward line (㇀)
syllable	a phonological unit consisting of a vowel or other unit that can be produced in isolation
tone	the use of pitch to distinguish lexical or grammatical meanings of words
vowel	a sound that is pronounced with open approximation
writing system	the written language described in terms of linguistic units
Zhuyin Fuhao	a syllabic writing system using stroke or stroke pattern to represent the pronunciation of Chinese characters, mainly used in Taiwan area

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