**Influence of L1 script directionality and L2 proficiency on Hanzi learning among the Arabic and English learners** **of L2 Chinese**

**Abstract:** The present research investigates the role L1 script directionality and L2 proficiency on the learning of Hanzi (Chinese characters) by pre-intermediate and intermediate adult Arabic (right to left) and English (left to right) learners of L2 Chinese who studied at their home country. The tasks included reading Hanzi for pronunciation, writing Hanzi according to Pinyin and meaning, and naming pseudo-Hanzi to examine phonetic radical application skills. The results showed that (1) L1 script background only predicted the performance in Hanzi writing, (2) L2 proficiency was a significant predictor in Hanzi reading and Hanzi writing, and (3) L2 proficiency interacted with L1 script background in phonetic radical application skills. These findings suggest that L1 script background and L2 proficiency play different roles in the development of Hanzi literacy skills and orthographic awareness. The theoretical implications for the influence of L1 writing system on L2 learning and the threshold level for the development of orthographic awareness in Hanzi, and the practical implications for Hanzi instruction are discussed.

**Keywords:** Writing system transfer; Hanzi learning; phonetic radical; Chinese as a second language

# 1 Introduction

Research on learning Chinese as a second language (CSL) has become a topic of interest in recent years due to a rapidly increasing number of CSL learners (Ke 2018; Shei et al. 2020). According to the status of Hanzi (Chinese characters) in CSL learners’ own countries, CSL learners can broadly be categorized into two groups. One typically includes CSL learners from Korea, Japan and Singapore where Hanzi is in popular use (the Hanzi group). A second group includes CSL learners from the countrie where alphabetic writing systems are widely used, such as English- and Arabic-speaking regions. A number of problems have arisen given this situation, one is that CSL learners from alphabetic backgrounds have generally been treated as a homogeneous group in the classroom and are most often assumed to perform and develop similarly in their learning of Hanzi (in reading, writing and orthographic awareness) (Zhang & Ke 2018). This assumption ignores the potential influence of the learners’ native writing system (L1WS) background as well as theirs learning experience of second writing systems (L2WSs). An example of this can be found forArabic and English CSL learners. One common problem observed among elementary Arabic CSL learners is that of writing Hanzi from right to left, given that Arabic is written the different directionalities in Arabic (right to left) and English (left to right) are assumed to be main cause (Zhang, 2014). Regarding the L2WS background of CSL learners, English learners are most likely to be mono-script users before learning Chinese as they tend to learn foreign languages that use a similar script as English (e.g. French, Spanish) (American Academy of Arts & Sciences 2017; Bianco & Slaughter 2009; Early 2008; Early et al. 2017; Met 2008; Parrish 2020). In contrast, most Arabic CSL learners are bi-script users due to the requirement of English learning in the Arabic world (Ahmad 2014; Bailey & Damerow 2014).

Different groups of multi-competent L2WS users also may perform differently in tasks measuring non-linguistic skills such as visual-spatial perception (Demetriou et al. 2005; Kolinsky et al. 1987; McBride-Chang et al. 2011) as well as in linguistic skills such as reading (Brown & Haynes 1985; Cook & Bassetti 2005; Koda 1988), writing (Oller & Ziahosseiny 1970) and orthographic awareness (Li et al. 2014; Xu & Maries 2019). Considering that Hanzi is highly dependent on visual-spatial skills (Liu et al. 2016; McBride-Chang et al. 2005; Tavassoli 2002) it is possible that Arabic and English CSL learners may show differences in the acquisition Hanzi acquisition, and this has yet to be systematically explored.

In comparison to the massive amount of research on language transfer, less attention has been paid to writing system transfer. In the area of CSL acquisition, most studies have concentrated on the comparison between Hanzi group and alphabetic group learners (Zhang & Ke 2018), neglecting any differences among CSL learners using different L1WSs within the alphabetic group, such as English and Arabic. To fill in this gap, and also in response to Cook & Bassetti’s (2005) call for more research on multi-competent L2WS users, the present study aims to explore the influence of L1 script directionality on phonetic radical application skills, Hanzi reading and Hanzi writing in Arabic and English CSL learner with different L2 proficiency levels. Such research has the potential to deepen our understanding of the role that L1WS features may play in the acquisition of literacy skills and orthographic awareness in the L2 and can enrich research on writing system transfer and the development of literacy skills in SLA, as well as providing empirical evidence for Hanzi instruction.

Before reporting the experiment, we first set out relevant background to this study, providing a brief introduction to Hanzi and phonetic radicals, as well as a review of the literature on L2 script directionality, L2 proficiency and L2 learning.

## **1.1 Hanzi and phonetic radicals**

Hanzi has a morphosyllabic orthography, in which one Hanzi corresponds to one syllable, and the orthographic unit of Hanzi does not map onto its phonological units. For instance, the two lines in 十 (ten) are totally irrelevant to its pronunciation *shí*. Of the 7,000 commonly used modern Hanzi, 70.53% are semantic-phonetic Hanzi (Li & Kang 1995; Li et al. 1992), which comprise a semantic radical giving a clue to its meaning, and a phonetic radical indicating its pronunciation. Take 枫 (fēng, maple tree) for example, the left-hand radical木 (mù, wood) indicates 枫 semantically relates to wood, and the right-hand radical 风 (fēng, wind) represents its pronunciation. The percentage of semantic-phonetic Hanzi required to be learnt by Chinese children is 72% (Shu et al. 2003) and that by learners of Chinese as a second language (CSL) ranged from 66.1% (Feng 1998) to 87% (Zhang et al. 2021), suggesting the importance of semantic-phonetic Hanzi for the acquisition of Chinese literacy skills.

Phonetic-semantic Hanzi can be roughly categorized into three types according to the degree of regularity in which the phonetic radical provides phonological information for the whole Hanzi. The *first* type is regular Hanzi, in which the phonetic radical and the whole Hanzi have the same pronunciation, such as 清 (qīng) and 青 (qīng). The *second* type is semiregular, in which the phonetic radical and the whole Hanzi share partial phonological similarity such as same syllable with different tones, like青(qīng) and 请 (qǐng), or same onset or rhyme such as青(qīng) and 倩 (qiàn) and 精 (jīng). The *third* type is irregular Hanzi, whose pronunciation totally differs from that of its phonetic radical, such as 己 (jǐ) and 妃 (fēi). Researchers have different viewpoints as to whether the last type should be counted as semantic-phonetic Hanzi (Li et al. 1992; Shu et al. 2003), the present study adopted Shu et al.’s (2003) standpoint and categorized it as irregular group.

A phonetic radical has a positional bias in Hanzi. About 67.39% of compound Hanzi place the phonetic radical on the right-hand side (青 vs. 请), 10.50% at the bottom (青 vs. 菁), 7% at the top (太 vs. 态) and 6% on the left-hand side (青 vs. 靓) (Hsiao & Shillcock 2006; Li et al. 1992). A phonetic radical on the right-hand side carries more sensitive phonological information than those in other positions (Shen et al. 1998; Yu 1998; Yu et al. 1990). The positional information of the phonetic radical is embedded in the mental representation of Hanzi, and is critical for Hanzi recognition (Ding et al. 2004; Taft et al. 1999).

Phonetic radical awareness is defined as the ’insight into the structure and function of the phonetic component of semantic-phonetic compound characters’ (Shu, Anderson, & Wu, 2000, p. 57) and is crucial for Hanzi learning. Several studies have observed significant correlations between phonetic radical awareness and Hanzi reading ability (Ho et al. 2003; Luo et al. 2011; Yeung et al. 2016; Yin & McBride 2015) and Hanzi writing skills (Shi et al. 2011; Yin & McBride 2015) among Chinese-speaking children. However, the contribution of phonetic radical awareness to Hanzi literacy skills might not work among CSL learners with low Hanzi recognition skills (Zhang & Roberts 2019).

## **1.2 L1 script directionality and L2 learning**

Script directionality is one of the physical properties of orthography, and it is commonly categorized into three groups: (1) left to right, such as Chinese and English; (2) right to left, such as Arabic and Hebrew; and (3) top to bottom, such as Japanese. The influence of L1WS transfer on L2 learning has been documented in several theoretical frameworks such as Orthographic Depth Hypothesis (Katz & Frost 1992) and Transfer Facilitation Model (Koda 2008). By contrast, the influence of L1 script directionality on L2 learning has been received scant attention (Cook & Bassetti 2005). Existing literature about this topic finds mixed results about how the L1 script directionality influences the performance in L2 writing and reading.

L1 script could lead to different performance in L2 handwriting, as evidenced in English letters (Cook 2001; Nachshon 1983; Shanon 1979; Zhang 2015) and Hanzi (Thaveewatanaseth & Jiang 2015; Zhang 2014; Zhang 2015; Zhang 1990). For example, in the task of writing uppercased letters “M”, “V”, “W” and “X”, Arabic and Hebrew speakers who use right-to-left L1 script exhibited stronger right-to-left bias in comparison to native English readers (Nachson, 1983). Influenced by the habit of stroke order in writing Hanzi, Chinese learners of English are likely to write letter “t” in the sequence of horizontal line before the vertical line (Cook 2001). As for Hanzi writing, Zhang (2015) found that the Arabic speakers tended to write the horizontal line from right to left in copying Hanzi, yet the English speakers showed an opposite bias. The English speakers showed stronger bottom-right-to-top-left tendency in writing left-falling stroke, yet the Arabic group’s bias for top-left-to-bottom-right was similar as the Chinese speakers’. These differences might be related with the different script directionalities in Arabic and English, such as the right-to-left preference in writing horizontal line by the Arabic speakers whose script directionality is from right to left. However, these studies focus on the fine-grained level of Hanzi writing, it is still unknown how the script directionality influences the general performance in Hanzi writing, such as accuracy rate.

L1 script directionality has been found to affect the directional scanning tendency, such as Hebrew speakers’ right-to-left tendency in scanning Hebrew letters and non-linguistic items such as circle and bar patterns (Nachshon et al. 1977) and right-to-left directional scanning effects in Arabic and Urdu readers in the task of picture array naming and recall task (Padakannaya et al. 2002). However, these different directional scanning effects might not lead to differences in L2 reading performance. Naghdipour (2015) administered different tasks of English reading comprehension to the Arabic and Turkish ESL learners. Although the Arabic group showed slightly slower reading rate and lower accuracy rate, the two groups did not differ significantly in any measure of English comprehension. To the best of our knowledge, there is still no research on the influence of L1 directionality on the performance in L2 Chinese reading or Hanzi orthographic awareness.

## **1.3 L2 proficiency and L2 learning**

L2 proficiency closely relates to L2 literacy skills. For instance, Hanzi recognition ability is a good predictor of L2 Chinese proficiency (Wong 2016; Wu et al. 2017; Zhang et al. 2020). This is also reflected in *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other Languages* (The State Language Affairs Commision 2010), in which the number of Hanzi required to be learnt progresses from 900 at the beginner level to 2,700 at the advanced level, indicating that the number of Hanzi that CSL learners are able to recognize and to write increases in conjunction with their L2 Chinese proficiency.

L2 orthographic awareness may develop quickly after a short period of time in L2 learning for adult L2 learners. According to the Transfer Facilitation Model (Koda, 2008), with the assistance from L1 meta-linguistic awareness and general cognitive competencies, an adult learner’s meta-linguistic awareness in L2 may be achieved with less input exposure in comparison to that required in L1. Similar findings have been reported in adult CSL learners, whose sensitivity to the functional and positional information of radicals in Hanzi develops soon after being exposed to Hanzi learning (Li et al. 2014; Nguyen et al. 2016; Shen & Ke 2007; Wang et al. 2004; Wang et al. 2003). For instance, Shen and Ke (2007) found that English CSL learners showed above-chance-level performance in radical perception tests within the first-month of Chinese learning. However, learners’ radical application skills and L2 proficiency may not develop simultaneously. Shen and Ke (2007) observed that the first- and second-year English CSL learners’ radical application skills (using semantic radicals to retrieve the meanings of unfamiliar Hanzi) did not differ significantly. This finding implies that radical application skills and L2 proficiency may not progress in parallel.

L2 proficiency may interact with L1 script background in influencing Hanzi acquisition. It has been commonly found that the achievement gap in Hanzi learning between Hanzi and alphabetic group learners tends to decrease as the CSL learners’ proficiency increases, such as in Hanzi reading ((Jiang 2000; Li et al. 2014; Xu & Maries 2019; Zhang et al. 2021). Li et al. (2014) further found that L1 script background did not significantly influence orthographic awareness among CSL learners from a Hanzi background and those from an alphabetic background when the participants’ Chinese proficiency was matched, yet the Hanzi group still outperformed the alphabetic group in Hanzi writing. However, the influence of L2 proficiency and the interaction between L1 script background and L2 proficiency on Hanzi learning has not been explored among CSL learners using different alphabetic L1WSs.

## **1.4 The current study**

As discussed above, previous research on Hanzi learning in CSL learners has not investigated the different performance in Hanzi learning among Arabic and English CSL learners, whose L1WSs differ a great deal from Hanzi, as well as from each other, in terms of visual properties (Chang 2015). First, Hanzi is the most visually complex, followed by Arabic, with English being the least visually complex. Second, the three scripts differ in writing direction, with English and Hanzi written from left to right and Arabic from right to left. In addition, as mentioned in the introduction section, English and Arabic CSL learners might differ in L2WS background before learning Chinese. Considering the findings reviewed in the earlier sections, it could be inferred that Arabic and English CSL learners with different proficiencies might perform differently in various aspects of Hanzi learning, such as Hanzi reading, Hanzi writing and phonetic radical application skill. Therefore, the present study aimed to explore the following questions among Arabic and English CSL learners with different L2 Chinese levels.

RQ 1. How does L1 script directionality influence Hanzi reading, Hanzi writing and phonetic radical application skills?

Hypothesis 1. Compared with the English group, the Arabic learners may be better at detecting the positional and functional properties of phonetic radicals in Hanzi because of the influence of the right-to-left directionality in Arabic script, and thus they may perform better in Hanzi reading, Hanzi writing phonetic and radical application, skills.

RQ 2. How does L2 proficiency influence Hanzi reading, Hanzi writing and phonetic radical application skills?

Hypothesis 2. The Arabic and English groups’ phonetic radical application skills, Hanzi reading and Hanzi writing skills may develop along with L2 proficiency, irrespective of L1 background.

RQ 3. Is there an interaction effect between L1 script directionality and L2 proficiency on Hanzi reading, Hanzi writing and phonetic radical application skills?

Hypothesis 3. There may be an interaction effect between L1 script directionality and L2 proficiency in Hanzi learning, and the effect of L1 script directionality in Hanzi reading, Hanzi writing and phonetic radical application skills decreases as the English and Arabic CSL learners’ L2 Chinese proficiency increases.

# 2. Method

## **2.1 Participants**

The Arabic and English-speaking participants lived in their native countries at the time of data collection (the UK or Egypt) and all studied Chinese as a major subject at university. All the participants were recruited from the second- and third-year learners. The learners’ Chinese proficiency was tested using a short-version standard HSK test (Hanyu Shuiping Kaoshi, Chinese proficiency test). The HSK test comprises listening and reading sections, with eight questions in each. It was administered in the form of a paper-and-pencil task, and took no longer than 20 minutes to complete. The Cronbach’s alpha reliability of the HSK test was .80. According to their HSK scores, the L2 learners were divided into pre-intermediate (below the overall mean scores in HSK test) and intermediate (above the overall mean scores in HSK test) groups. This led to four L2 groups. In the Arabic group, there were 24 pre-intermediate participants (24 females; mean age=19.26, SD=.69; HSK score=6.17, SD=2.12) and 20 intermediate participants (16 females and 4 males; mean age =19.95, SD=.76; HSK score=12.25, SD=1.55). In the English group, there were 17 pre-intermediate participants (11 females and 6 males; mean age =21.06, SD=1.6; HSK score=6.65, SD=2.18) and 23 intermediate participants (12 females and 11 males; mean age =20.17, SD=.94; HSK score=12.43, SD=1.58). The intermediate group significantly outperformed the pre-intermediate group in the HSK test within the Arabic (*t*(41)=10.57, *p*<.0001, *d*=3.22) and English (*t*(38)=9.73, *p*<.0001, *d*=3.18) learners, indicating the validity of the short-version HSK test. The Arabic and English groups did not differ in the overall scores or the reading section of the HSK test.

The two groups differed in some aspects of their exposure to Chinese. First, the English-speaking participants were required to study at a Chinese university for one year according to the course policy in the UK, therefore, the third-year English group spent one year in China during their second year of study. However, the Arabic participants only studied Chinese in Egypt. Second, the two groups differed in language learning history. The Arabic participants had learnt English prior to learning Chinese, and most of the English participants had learned an Indo-European foreign language before learning Chinese. Although both groups learned Chinese as a third language, the Arabic group had acquired Arabic and Roman scripts, yet the English group only acquired the Roman script before learning Hanzi. Third, the two groups differed in learning hours per week. The Arabic group learned Chinese for about 20 hours per week. In contrast, the second-year English group spent 10-12 hours on learning Chinese, and the third-year English group studied more than 20 hours per week when they were in China. However, they were still matched in L2 Chinese proficiency.

## **2.2 Measures**

To answer the research questions, three tests were designed to collect data, including one Hanzi reading test and Hanzi writing test to measure participants’ capabilities in reading and writing Hanzi, respectively, and one task of pseudo-Hanzi naming to measure phonetic radical application skill.

### *Hanzi reading test*

The Hanzi reading test required the participants to read aloud the pronunciations of a list of Hanzi. The materials included 108 compound Hanzi balanced in regularity and position of phonetic radicals (Table 1). In terms of the regularity of the phonetic radical, three types of Hanzi were included (regular, semiregular and irregular), with 36 for each type. In terms of the position of the phonetic radical, two types of Hanzi were included: those with the phonetic radical on the right side (RPR, ‘right-side phonetic radical’) and those with phonetic radical on the left side (LPR, ‘left-side phonetic radical’), with 54 for each type. All the materials 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 balanced for learning difficulty, frequency and stroke number (Institute of Big Data and Language Education 2011). ANOVAs showed that the selected regular, semiregular and irregular Hanzi did not differ significantly in stroke number(*F*(2, 105)=.50, *p*=.61, η²=.01) or frequency(*F*(2, 105)=.88, *p*=.42, η²=.02). Similarly, the selected LPR and RPR Hanzi did not differ significantly from each other in the stroke number(*t*(106)=1.05, *p*=.30, *d*=.20) or frequency (*t*(106)=-1.31, *p*=.19, *d*=.22).

Table 1 Details of the selected Hanzi in the task of Hanzi reading and Hanzi writing

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Task | Type |  | | | N | | Stroke number (SD) | Frequency (SD) |
| Reading | Regularity | Regular | | | 36 | | 9.53 (2.77) | .0002 (.0002) |
|  |  | Semiregular | | | 36 | | 9.57 (2.50) | .0002 (.0003) |
|  | Irregular | | | 36 | | 9.03 (2.51) | .0005 (.0015) |
| Position | LPR | | | 54 | | 9.63(2.92) | .0002(.0002) |
|  |  | RPR | | | 54 | | 9.11(2.18) | .0004(.0013) |
| Writing | Regularity | | Regular | 8 | | 8.00(1.31) | | .0004(.0007) |
|  | | Semiregular | 8 | | 8.00(1.51) | | .0004(.0005) |
|  | | Irregular | 8 | | 9.13(1.46) | | .0005(.0009) |
| Position | | LPR | 12 | | 8.08(1.62) | | .0005(.0008) |
|  |  | | RPR | 12 | | 8.67(1.30) | | .0003(.0006) |

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

The 108 Hanzi, from low to high frequency, were printed on one A4 sheet of paper. The participants were asked to read aloud the Hanzi according to the numeric order. They were required to say “I don’t know” in Chinese if they did not know the target Hanzi. The test stopped if the participant made five errors or no response to five Hanzi consecutively. One point was given if the syllable was pronounced correctly. Only the first attempt counted. The time limit for this task was three minutes. The accuracy rate in reading LPR and RPR Hanzi was calculated by dividing the number of accurate answers by 108. The Cronbach’s alpha reliability of Hanzi reading test was .93.

### *Hanzi writing test*

The participants’ Hanzi writing skills were examined in a task which required them to write Hanzi according to Pinyin (official Romanization phonetic system for Mandarin)[[1]](#footnote-1) and the meaning presented in their L1s. Because one of the most significant differences between Arabic and English scripts lies on the directionality and most phonetic radicals appear in the Hanzi with left-right structure, therefore only LPR and RPR Hanzi are selected for this task. This test included 24 Hanzi balanced in the regularity (8 regular, 8 semi-regular and 8 irregular) and position (12 LPR and 12 RPR) of phonetic radicals (Table 1). As with Hanzi reading test, all the materials were selected from the same syllabus, and were balanced in frequency and stroke number (Institute of Big Data and Language Education 2011). ANOVAs showed that the selected regular, semiregular and irregular Hanzi did not differ significantly in stroke number(*F*(2, 21)=1.65, *p*=.22, η²=.14) or frequency (*F*(2, 21)=.14, *p*=.88, η²=.01). Similarly, the selected LPR and RPR Hanzi did not differ from each other in the stroke number(*t*(22)=-.97, *p*=.34, *d*=.41) or frequency (*t*(22)=.79, *p*=.44, *d*=.29).

This task was administered in the form of paper-and-pencil test. The Pinyin of the target Hanzi was bolded and italicized, such as “***dōu***lái le (Pinyin), All came (meaning) Hanzi:\_\_\_\_\_\_\_”. One point was given for a correct Hanzi. The accuracy rate in writing LPR and RPR Hanzi was calculated by dividing the number of correct answers by 24. The Cronbach’s alpha reliability of Hanzi writing was .80.

### *Phonetic radical application test*

The task of pseudo-Hanzi naming has been used to measure learner’s overall knowledge of phonetic radical (Ho & Bryant 1997; Ho et al. 2003; Tong & Yip 2014). Phonetic radical application skill was defined as the ability to use phonetic radical to name unfamiliar Hanzi in the present study. The perception skills of phonetic radicals were not explored independently in this study because application skills could reveal more information about whether the participants have fully realized the role of phonetic radical in representing the phonological information of Hanzi (Shen & Ke, 2007). In this task, the participants were presented with 10 pseudo-Hanzi, and they were required to write down the pronunciation of the pseudo-Hanzi using Pinyin. As with Hanzi reading test, the single Hanzi were selected from the same syllabus to control as far as possible for familiarity. Ten single Hanzi were selected, including two Hanzi (such as 人 and太) commonly occurring at the top position as phonetic radical, and eight Hanzi (such as 中and 也) usually used in left-right structured Hanzi. The two pre-intermediate L2 groups did not differ significantly in the accuracy rate in reading the ten single Hanzi (Arabic: M=.89, SD=.12; English: M=.84, SD=.11, *t*(39)=1.37, *p*=.18, *d*=.43), neither did the two intermediate L2 groups (Arabic: M=.88, SD=.08; English: M=.90, SD=.06, *t*(41)=-1.14, *p*=.26, *d*=.29).

A pair of single Hanzi constructed two pseudo-Hanzi with left-right structure in which the positions of the single Hanzi differed. For instance, 不 (bù, not) and力 (lì, power) were used for  and . In addition to the ten pseudo-Hanzi, five low-frequency real Hanzi were added as distractors. The time limit for this task was five minutes. The analysis of the participants’ performance in the pseudo-Hanzi naming task focused on the use of the right-side Hanzi because the majority of phonetic radicals in Chinese appear in this position. Participants’ responses were categorized into three types. The *first* involved the use of a single Hanzi to directly name the pseudo-Hanzi, or a ‘direct naming strategy’, such as naming  as <yě> (也). The *second* type was using another Hanzi with similar orthographic features as the right-side Hanzi to name the pseudo-Hanzi, which we labelled as ‘similar Hanzi naming strategy’. For instance, one might name  as <wáng> because 主 (zhǔ) is orthographically similar to 王 (wáng). The *third* type was using another Hanzi containing the right-side Hanzi to name the pseudo-Hanzi (labelled ‘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.

One score was given to an answer that could be categorized into one of the three strategies mentioned above, and zero score was given to other strategies used. To make the rating more reliable, the results of the first author’s preliminary analysis were judged by another Chinese-speaking PhD student who majored in second language acquisition. The two raters achieved 92% agreement over the scoring and the debated answers were solved after further analysis by the two raters. The Cronbach’s alpha reliability of the pseudo-Hanzi naming task was .89 among the CSL learners.

The task of pseudo-Hanzi naming was also administered among native Chinese speakers to examine its reliability and validity. Twenty-two Chinese native speakers (female=10, male=12; mean age=27.18, SD=4.98), all speaking L1 Chinese and L2 English and studying at a university in the UK, were recruited. The Chinese group’s percentage of using right-side radical to name pseudo Hanzi was .69 (SD=.20), consistent with the fact that phonetic radical dominates the right-side in compound Hanzi, and this result suggests that this task was valid in testing phonetic radical application skills. The results of one-way ANOVA test among the Chinese group and the four CSL groups revealed a significant effect of group in phonetic radical application test, *F*(4, 101)=4.92, *p*=.001, η2*=*.16. The results of post-hoc comparisons found that the Chinese group did not differ significantly from the English intermediate CSL group, yet outperformed the other three CSL groups.

## **2.3 Procedure**

All participants were given informed consent forms printed in their native languages. The Arabic and English CSL learners completed the tasks of pseudo-Hanzi naming, Hanzi reading and Hanzi writing. The instructions of the tests were presented in the participants’ L1. All the participants were tested individually, and were given a small amount of money or a small gift after successfully completing the test.

## **2.4 Data analysis**

First, a series of two-way ANOVAs were carried out to explore the main effect of L1 script directionality and L2 proficiency as well as the interaction effect on Hanzi reading, Hanzi writing and phonetic radical application skills. Second, a series of multiple regression analyses were administered to further examine the role of L1 script and L2 proficiency in the performance in Hanzi reading, Hanzi writing and phonetic radical application skills controlling for the participants’ demographic variables.

# 3. Results

The participants’ scores in the tasks of Hanzi reading, Hanzi writing and phonetic radical application skills test are displayed in Table 2.

Table 2 Summary of the accuracy rates in the tasks of pseudo-Hanzi naming, Hanzi reading and Hanzi writing

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Measures | Arabic | | English | | Chinese |
| pre-intermediate | intermediate | pre-intermediate | intermediate |
| Pseudo Hanzi  naming | .44(.38) | .31(.26) | .34(.37) | .66(.36) | .69(.20) |
| Hanzi reading | .16(.09) | .27(.12) | .16(.10) | .35(.15) | NA |
| LPR Hanzi reading | .07(.04) | .12(.07) | .06(.05) | .16(.08) | NA |
| RPR Hanzi reading | .09(.05) | .15(.06) | .09(.05) | .18(.07) | NA |
| Hanzi writing | .24(.13) | .37(.17) | .16(.09) | .32(.15) | NA |
| LPR Hanzi writing | .06(.06) | .15(.11) | .07(.04) | .16(.10) | NA |
| RPR Hanzi writing | .18(.09) | .22(.08) | .09(.07) | .17(.07) | NA |

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

## **3.1 Hanzi reading**

The results of two-way ANOVA tests showed that only the main effect of L2 proficiency was significant in overall Hanzi reading (*F*(1, 80)=32.42, *p*<.001, η2=.29), LPR Hanzi reading (*F*(1, 80)=33.88, *p*<.0001, η2=.30) and RPR Hanzi reading (*F*(1, 80)=28.53, *p*<.0001, η2=.27), and that the intermediate groups outperformed the pre-intermediate groups, irrespective of L1 background.

The multiple regression model, including age, gender, L1 script background, years of study in China, and L2 proficiency, accounted for 55.3%, 58.5% and 49.2% of the variance in overall Hanzi reading, LPR and RPR Hanzi reading, respectively (Table 3). Years of study in China and L2 proficiency significantly predicted the performance in overall Hanzi reading, LPR Hanzi reading and RPR Hanzi reading.

Table 3 Results of multiple regression analysis of the Arabic and English L2 participants’ performance in Hanzi reading and Hanzi writing

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Type | Predictor | Hanzi reading | | |  | Hanzi writing | | |
|  |  | *b* | *△R2* | *△F* |  | *b* | *△R2* | *△F* |
|  | age | -.01 | .02 | 3.80 |  | -.01 | - | .22 |
|  | gender | .01 | .04 | 7.08 |  | .04 | .03 | 2.97 |
| Overall  performance | China years | .21\*\*\* | .32 | 56.74 |  | .11\* | .04 | 4.46 |
| L1 background | -.06 | .03 | 5.68 |  | -.12\*\* | .10 | 11.13 |
|  | L2 proficiency | .11\*\*\* | .13 | 23.36 |  | .13\*\* | .14 | 15.13 |
|  | Model | *F*=19.33, *R2*=.553\*\*\* | | |  | *F*=6.79, *R2*=.303\*\*\* | | |
|  | age | - | .03 | 4.94 |  | -.01 | - | .25 |
|  | gender | .01 | .04 | 8.01 |  | .03 | .06 | 6.84 |
| LPR  Hanzi | China years | .11\*\*\* | .34 | 64.73 |  | .06\* | .08 | 9.02 |
| L1 background | -.03 | .04 | 7.62 |  | -.02 | .01 | 1.53 |
|  | L2 proficiency | .06\*\*\* | .13 | 24.72 |  | .07\*\*\* | .14 | 14.99 |
|  | Model | *F*=22, *R2*=.585\*\*\* | | |  | *F*=6.53, *R2*=.295\*\*\* | | |
|  | age | - | .02 | 2.5 |  | .02 | .02 | 1.94 |
|  | gender | - | .04 | 5.56 |  | .01 | - | .05 |
| RPR  Hanzi | China years | .10\*\*\* | .29 | 44.06 |  | .05 | - | .25 |
| L1 background | -0.02 | .02 | 3.59 |  | -.10\*\*\* | .2 | .21 |
|  | L2 proficiency | .05\*\*\* | .13 | 19.73 |  | .05\*\* | .06 | 7.53 |
|  | Model | *F*=15.09, *R2*=.492\*\*\* | | |  | *F*=6.25, *R2*=.286\*\*\* | | |

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

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

## **3.2 Hanzi writing**

The results of two-way ANOVA tests revealed a significant effect of L1 script background (*F*(1, 80)=4.31, *p*=.04, η2=.05), and a significant effect of L2 proficiency (*F*(1, 80)=22.32, *p*<.0001, η2=.22) in the overall scores for Hanzi writing. The results of the pairwise comparisons revealed that the Arabic group outperformed the English group, and the intermediate group outperformed the pre-intermediate group.

For the scores in writing LPR Hanzi, there was a significant effect of L2 proficiency (*F*(1, 80)=22.34, *p*=.0001, η2=.22), and the intermediate learners outperformed the pre-intermediates. The main effect of L1 script background on writing RPR Hanzi was significant (*F*(1, 80)=20.22, *p*=.0001, η2=.20), as was the main effect of L2 proficiency (*F*(1, 80)=11.56, *p*=.0006, η2=.13), with the Arabic group outperforming the English learners, and the intermediate learners outperforming the pre-intermediate learners.

The results of multiple regression model accounted for 30.3%, 29.5% and 28.6% of the variance in overall Hanzi writing, LPR Hanzi writing and RPR Hanzi writing, respectively (Table 3). L2 proficiency was the common predictor in overall Hanzi writing, LPR Hanzi writing and RPR Hanzi writing. Years of study in China significantly predicted the performance in overall Hanzi writing and LPR Hanzi writing, so did the L1 script background in overall Hanzi writing and RPR Hanzi writing.

## **3.3 Phonetic radical application skill**

The results of two-way ANOVA tests did not find the main effect of L1 script background or L2 proficiency in pseudo-Hanzi naming, but there was a significant interaction effect between L1 script background and L2 proficiency, *F*(1, 80)=9.74, *p*=.003, η2=.11. The results of pairwise comparisons revealed that the intermediate English group showed a stronger preference for the right-side Hanzi than the pre-intermediate English group, the pre-intermediate and intermediate Arabic groups.

The multiple regression model accounted for 9.7% of the variance in the performance in pseudo-Hanzi naming, and the years of study in China was the only significant predictor (Table 4).

Table 4 Results of the multiple regression analysis in the Arabic and English L2 participants’ performance in pseudo Hanzi naming

|  |  |  |  |
| --- | --- | --- | --- |
| Predictor | *b* | *△R2* | *△F* |
| age | -.03 | - | .02 |
| gender | -.08 | - | .002 |
| China years | .26\* | .09 | 8.10 |
| L1 background | .02 | - | .05 |
| L2 proficiency | .04 | - | .21 |
| Model | *F*=1.68, *R*2=.097 | | |

*Note.* \**p*<.05.

# 4. Discussion

The present research investigated how the L1 script directionality and L2 proficiency influenced the development of Hanzi reading, Hanzi writing, and phonetic radical application skills among pre-intermediate and intermediate Arabic and English CSL learners. There were two main findings. First, the influence of L1 script directionality was significant on Hanzi writing, but not on Hanzi reading or phonetic radical application skills. Second, L2 proficiency was a common predictor in Hanzi reading and Hanzi writing, yet the interaction effect between L1 directionality and L2 proficiency was only significant in phonetic radical applications.

## **4.1 The influence of L1 script directionality**

The Arabic and English CSL learners did not differ significantly in Hanzi reading performance or phonetic radical application skills, which is contrary to Hypothesis 1. This finding partially supports the common practice that CSL learners using different alphabetic L1WSs are categorized into alphabetic group in classroom instruction and research (Jiang 2003; Ke 1998; Zhang & Ke 2018). The results can be explained from the perspective of the Transfer Facilitation Model (Koda, 2008), in which orthography distance is vital for L1 transfer to work in the development of meta-linguistic awareness competencies and literacy skills in L2. Although Arabic is more visually complex than English (Chang 2015), the Arabic-Hanzi or English-Hanzi orthographic distance might not be unique enough to trigger the influence of L1WS transfer on Hanzi reading or phonetic radical awareness, which was observed mainly among Hanzi group vs. alphabetic group (Lin & Collins 2012; Zhang & Ke 2018).

Second, it is interesting to find that the influence of L1 script background was significant on Hanzi writing, partially in line with Hypothesis 1. This finding deepens our understanding of the role of L1WS in L2 acquisition (Cook & Bassetti, 2005), and, together with previous findings (Li et al. 2014; Nachshon 1983; Shanon 1979; Thaveewatanaseth & Jiang 2015; Zhang 2014; Zhang 2015; Zhang 1990), suggests that L1 script background influences both the micro level (e.g. stroke directionality and stroke order) and macro level (e.g. general accuracy rate) of handwriting. The present study might be the first to reveal the significant differences in general performance in Hanzi writing among the Arabic and English CSL learners who are commonly considered as homogeneous. This finding indicates that CSL learners using different alphabetic L1WSs may differ in Hanzi writing, and that the influence of L1 script background should not be overlooked in future research.

Next question is to find the reason underlying the significant effect of L1WS on Hanzi writing among the Arabic and English groups. The Arabic group’s better Hanzi writing skills were hypothesized to be linked with their better phonetic radical application skills, arguably influenced by the right-to-left directionality in Arabic, which was yet underdeveloped and less good than the English group. Thus, the L1 script directionality might not be the answer. One possible reason relates to the Arabic participants’ unique visual-spatial processing abilities because of their extensive exposure to a more visually complex script than English (Chang, 2015) and the experience of learning both Arabic and Roman scripts prior to learning Chinese. Considering the benefit of learning a different script for visual-spatial processing skills (Cook & Bassetti 2005; Liow et al. 1999), and the significance of visual-spatial skills for the acquisition of Hanzi writing skills (McBride-Chang et al. 2005; Tavassoli 2002), the contribution of Arabic script properties to acquiring Hanzi writing seems reasonable. However, this explanation needs more empirical evidence for validation.

## **4.2 The influence of L2 proficiency**

The results about the influence of L2 proficiency and the interaction between L1 script background and L2 proficiency on the measured variables were partially in line with Hypothesis 2 and Hypothesis 3. The significant influence of L2 proficiency on Hanzi reading and writing was not surprising, similar to the role of L2 proficiency in vocabulary size among learners of English as a second language (Drummond 2018; Miralpeix & Muñoz 2018; Zhao & Ji 2018). Hanzi per se is the goal as well as the medium of Chinese learning for CSL learners, and Hanzi literacy skills, in particular Hanzi reading, could be good predictors of the L2 learners’ proficiency to some extent (Wong 2016; Wu et al. 2017; Zhang 2018; Zhang et al. 2020).

It was surprising to find that L2 proficiency was not a significant predictor in phonetic radical application skills and that the interaction effect between L2 proficiency and L1 script background was only significant in phonetic radical application skills. These results suggest that orthographic processing skills might develop later than L2 proficiency, in line with previous study (Shen & Ke, 2007). Upon further speculation, Hanzi reading ability might relate more with phonetic radical application skills than does L2 proficiency. Although the English and Arabic intermediate L2 learners were proficiency-matched, the English group outperformed the Arabic group in Hanzi reading probably because most English intermediate L2 learners studied in China for one year, which brought them a large amount of exposure to Hanzi. Similar to the driving force of Hanzi reading ability for the growth of orthographic processing skills for Chinese children (Luo et al. 2011), a larger Hanzi repertoire is likely to help L2 learners have a better chance of abstracting the positional bias and function of phonetic radicals, consistent with the claim about the close relationship between orthographic processing skills and word reading capabilities (Castles & Nation 2006; Ehri 2005). That is, for both L1 and L2 learners, more reading input and higher reading ability could generate better orthographic processing skills.

## **4.3 Implications**

The overall findings of the present study have important theoretical implications. First, as an echo to the call for more research on multi-competent writing system users and the influence of L1WS transfer on L2WS learning (Cook & Bassetti 2005), the present study enriches this research area by exploring the performance in Hanzi acquisition among users of two scripts with opposite directionalities. The significant prediction of L1 script background in the holistic performance in Hanzi writing extends the influence of L1WS to the macro level of L2WS learning, and sheds light on the influence of different alphabetic L1WSs on Hanzi acquisition among different groups of multi-competent L2WS users (Cook & Bassetti, 2005).

Second, this study is important for understanding the threshold level for the development of phonetic radical application skills (Ho et al. 2003; Ke 1998; Shu et al. 2003). Take the English intermediate L2 group as an example, whose performance in pseudo-Hanzi naming was above the chance level and did not differ significantly from the native Chinese group. The English intermediate L2 group was estimated to recognize 1,050 Hanzi[[2]](#footnote-2). Similarly, Chinese children at grade 1 are generally able to recognize about 1,000 Hanzi (Wen et al. 2015; Zeng et al. 2019) and their orthographic processing skills are above the chance-level (e.g. Li & Shu 2009; Luo et al. 2011). According to the Transfer Facilitation Model (Koda, 2008) and relevant studies (Ke 1998; Nguyen et al. 2016; Wang et al. 2003), the adult L2 learners’ awareness of Hanzi orthography may grow within a short period of time in light of their mature cognitive skills and rich (in)formal meta-linguistic knowledge due to the large amount of exposure to languages. Thus, 1,000 Hanzi might be a foundation for CSL learners to develop proper orthographic awareness. However, this suggestion is tentative, and more studies are needed to address this question.

The present study also has several practical implications. First, as mentioned in the introduction section, the commonly used dichotomous method that generally categorizes CSL learners into either Hanzi or alphabetic groups may well overlook the influence of different alphabetic L1WSs on Hanzi learning. Therefore, to overcome the limitation of this method, instructors are advised to take the unique characteristics of different L1WSs into account and to design tailored materials and strategies for Chinese teaching, rather than using the same instruction method. For instance, comparing the physical features of Hanzi and Arabic scripts in terms of directionality and stroke order could help facilitate Arabic CSL learners’ understanding of Hanzi orthography. Second, the general underdeveloped phonetic radical application skills among the CSL learners in the present study points to the importance of explicit instruction. As the L2 learners’ phonetic radical application skills may not develop simultaneously with L2 proficiency, explicit training on the relationship between phonetic radicals and the whole Hanzi appears to be necessary. This suggestion is in line with the studies revealing the benefits of explicit training in developing orthographic awareness competency in CSL learners (Taft & Chung 1999; Wang et al. 2004), as well as the L2 learners’ self-report strategy of using radical to learn Hanzi (Jiang & Zhao 2001; Sung & Wu 2011).

# 5. Conclusion

In conclusion, the present study found that L1 script background influenced Hanzi writing more than Hanzi reading and phonetic radical application skills, L2 proficiency influenced Hanzi reading and Hanzi writing more than phonetic radical application skills, and that phonetic radical application skills were influenced by both L1 script background and L2 proficiency among the Arabic and English CSL learners. These findings suggest that L1 script background and L2 proficiency play different roles in various levels of Hanzi acquisition for L2 learners, and that classroom instruction should be tailored to different groups of L2 learners taking the influence of L1WSs on Hanzi learning into account.

We are aware that this study has a number of limitations. The first concerns the measures used to capture Hanzi reading and writing skills. Only the accuracy rate was analyzed and the detailed errors in reading and writing were not taken into account. Future research could compare the performance of learners at other levels in reading Hanzi (such as examining eye-movements) and writing Hanzi (such as stroke direction and stroke order) between the Arabic and English L2 learners, which might reveal more insightful findings about the influence of L1 script directionality on L2 learning. In addition, the stroke order of the target Hanzi used in the writing task was not taken into account because of the difficulty in defining the relative complexity of stroke order and recording of the dynamic process of Hanzi writing (Zhang 2014), and this issue could be addressed in future studies. Secondly, although the Arabic and English learners were proficiency-matched, there were individual differences among them, such as their experience of study in China. Future research including CSL learners matched for both proficiency level and individual differences in amount and type of exposure in L2 will generate a clearer picture of how L1 background impacts Hanzi learning.

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1. Learners of Chinese as a second language are required to learn Pinyin from the very beginning of Chinese learning. Thus, writing Pinyin for Hanzi is a very common task for CSL learners. [↑](#footnote-ref-1)
2. 1050=.35\*108/(108/3000), where .35 is the accuracy rate in Hanzi reading, 108 is the total number of Hanzi selected from the pool and 3,000 is the total number of Hanzi in the pool *The Graded Chinese Syllables, Characters and Words for the Application of Teaching Chinese to the Speakers of Other Languages*. [↑](#footnote-ref-2)