Which is More Powerful for Investigating Phonological Awareness in Second Language Learners ff Chinese: Pinyin Invented Spelling vs. Oddity Test?

**Abstract** The importance of phonological awareness for the acquisition of literacy skills has been widely recognized. Phonological awareness is commonly examined using oddity test across different languages, yet Pinyin invented spelling is recommended as being more powerful for investigating phonological awareness in Chinese-speaking children. However, it is still unclear whether this holds true for learners of Chinese as a second language (CSL). To address this issue, we administered an oddity test and a Pinyin invented spelling task to explore Chinese phonological awareness in 43 Arabic and 40 English CSL learners at pre-intermediate and intermediate levels who studied at their home countries. The results of independent samples t-tests, multiple regression analysis and path analysis generated two major findings. First, Pinyin invented spelling revealed more significant cross-group differences in Chinese phonological awareness between the Arabic and English CSL learners than the oddity test did. Second, the participants’ performance in Pinyin invented spelling was a stronger predictor of character-reading and character-writing skills than their performance in oddity test. The overall findings suggest that Pinyin invented spelling could be a more powerful measurement of Chinese phonological awareness for CSL learners in comparison to the conventional oddity test, in line with the findings reported for Chinese-speaking children. The theoretical implications for understanding the role of phonological skills in the growth of Chinese literacy skills and practical suggestions for measuring Chinese phonological awareness are proposed.

**Keywords** Chinese as a second language·Phonological awareness·Oddity test·Pinyin invented spelling

# **Introduction**

The development of literacy skills is essential for achieving academic success for both native speakers and second language learners. Reading and writing are two important types of literacy skills, and have attracted numerous researchers to carry out studies from different perspectives. Reading involves accessing meaning via decoding the printed words, while writing involves producing printed words via phonological and/or semantic representation. Although reading and writing are two different cognitive activities, it has been commonly believed that phonological skills are essential for the growth of both reading and writing competency, as evidenced in several theory frameworks, such as the Universal Phonological Principle (Perfetti, 2003; Perfetti et al., 1992), the Psycholinguistic Grain Size Theory (Ziegler and Goswami, 2005) and the Obligatory Phonological Mediation Hypothesis in Spelling (Rapp and Caramazza, 1997). For instance, the Universal Phonological Principle claims that “contact with printed words in any writing system automatically arouses phonological properties associated with the words” (Perfetti et al., 1992, p227). Phonological skills are universally required for reading in any language because correct mapping between phonology and orthography is essential for the successful decoding of printed words. In addition, the strong association between phonological processing skills and spelling ability in alphabetic orthographies has been well documented (al Mannai and Everatt, 2005; Caravolas, 2004; Moll et al., 2014). At the phonological level, phonological awareness, the ability to perceive and manipulate phonological structure in spoken language, is an essential meta-linguistic skill for reading and writing, and it has been investigated by numerous researchers across different languages.

Various measures, such as the oddity test, syllable or phoneme deletion task and invented spelling task, have been administered to examine phonological awareness in English and Chinese (Ding et al., 2014, 2018; Lin et al., 2010; Song et al., 2015; Stanovich et al., 1984; Yopp, 1988). In Chinese, Pinyin (an official Roman writing system in Chinese) invented spelling is recommended as a more powerful task to measure Chinese-speaking children’s phonological awareness (Ding et al., 2014, 2018; Lin et al., 2010), yet it is unclear whether Pinyin invented spelling is also a robust tool for investigating phonological awareness in learners of Chinese as a second language (CSL). Thus, the present study aims to investigate the power of different measurements in tapping Chinese phonological awareness among CSL learners. Before reporting the details of the experiment, in the following sections we first set out the background to the study, covering the relevant studies of phonological awareness among Chinese children and CSL learners, in order to identify the research gaps in the field that this study aims to address.

## **Chinese Children’s Phonological Awareness**

Similar to English phonological awareness (Stanovich et al., 1984; Yopp, 1988), Chinese children’s phonological awareness has been examined using different tasks, such as oddity test, deletion task and Pinyin invented spelling (Ding et al., 2014, 2018; Lin et al., 2010; Song et al., 2015). These tasks might differ in the power to tap phonological awareness. In comparison to the deletion task, Pinyin invented spelling has been recommended as an optical measure for Chinese phonological awareness (Ding et al., 2014, 2018; Lin et al., 2010). The researchers’ bias towards Pinyin invented spelling is based on the following evidence.

First, Pinyin invented spelling could be better able to distinguish students with different literacy competencies. Ding et al. (2014) reported that although both Pinyin invented spelling and the deletion task significantly correlated with Chinese character recognition, yet Pinyin invented spelling was more powerful for differentiating the poor from the average readers and good readers, and the average from the good readers, while the deletion task only differentiated the good readers from the poor readers.

Another crucial reason is that Pinyin invented spelling was found to be a stronger predictor of Chinese character reading and writing skills. It has been widely acknowledged that phonological awareness plays a critical role in the development of reading and spelling skills in the L1 (Bradley and Bryant, 1983; Swanson et al., 2003; Ziegler et al., 2010; Hulme and Snowling, 2013; Goswami and Bryant, 2016) and the L2 (McBride and Kail, 2002; Keung and Ho, 2009; Uchikoshi and Marinova-Todd, 2012; Yeung and Chan, 2013). Phonological awareness significantly correlates with character-reading skills among Chinese-speaking children, as shown in a meta-analysis study (Song et al., 2015). Studies found that Pinyin invented spelling might outweigh conventional tasks such as deletion tasks in tapping Chinese phonological awareness. For example, Lin et al. (2010) measured Chinese phonological awareness using both syllable deletion and Pinyin invented spelling among 296 kindergarten children. The results showed that, compared to syllable deletion (β=.14), invented Pinyin spelling was a stronger longitudinal predictor of Chinese word-reading ability (β=.20). Similarly, Ding et al. (2018) observed that children’s performance in Pinyin invented spelling accounted for a significant amount of the variances in children’s performance in reading characters, but their performance in the tasks of syllable deletion and phoneme deletion was not a significant predictor in character reading.

Turning to spelling, phonological awareness is a significant predictor of spelling in alphabetic languages (Caravolas, 2004; Moll et al., 2014), but findings about its contribution to character writing are inconsistent. Using conventional tasks (i.e., deletion tasks and oddity test) to measure phonological awareness, Yeung et al. (2011) and Liu et al. (2016) found that although phonological awareness significantly correlated with character writing, yet its predictive power was not significant in the regression model that included orthographic skills and morphological awareness. Likewise, relying on the task of Pinyin invented spelling, Wang et al. (2014) did not observe a significant correlation between phonological awareness and character writing. In contrast, Ding et al. (2018) observed that phonological awareness measured using deletion tasks did not significantly predict children’s performance in character writing, yet children’ performance in Pinyin invented spelling significantly explained 5.1% of the variances in character writing. The unstable relationship between phonological awareness and character writing largely lies in the vagueness of grapheme-phoneme mapping in characters. The transformation from phonological input to orthographic output in writing characters does not depend on the conversion from phoneme to grapheme, because no orthographic unit in characters corresponds to a phonological unit in speech. Thus, the ability to manipulate the phonological structure of Chinese might not be critical for character writing. Nonetheless, the tasks administered for investigating phonological awareness might be another critical underlying reason, and more studies are still needed for understanding this topic.

As for the reasons underlying the observed advantage of Pinyin invented spelling over the deletion tasks in measuring Chinese phonological awareness, it is assumed that Pinyin invented spelling explores Chinese phonological awareness at both the segmental (i.e., onset, rime and syllable) and suprasegmental (i.e., tone) levels. In contrast, deletion tasks only focus on syllable or phoneme, ignoring the suprasegmental feature. It is known that Chinese is a tonal language, and Chinese character is morphosyllabic, therefore, tone awareness ( Hao and Zhou, 2019; Siok and Fletcher, 2001; McBride et al., 2008; Li and Ho, 2010) and syllable awareness (McBride-Chang et al., 2005; Shu et al., 2008; Tong, 2008) are critical for the recognition of Chinese characters. More importantly, the deletion tasks have been found to be relatively easy for Chinese children to manipulate, and even struggling readers perform well on deletion tasks ( Ding et al., 2014, 2018; Lin et al., 2010), and this might be related to the unique characteristics of Chinese language. Each character corresponds to a syllable and a morpheme; thus, deleting a syllable from a multisyllable word/phrase is like deleting a character from a set of characters, which is a common and easy task for Chinese children. Furthermore, the structure of Chinese syllables is simple, and a Chinese syllable has a maximum of four phonemes. Finally, Pinyin learning could help an individual understand the phonological structure in Chinese and achieve good performance in phonological awareness tasks (Charles et al., 1986; Cheung et al., 2001; McBride-Chang et al., 2004)

The power of invented spelling in exploring phonological awareness has also been documented in earlier studies concerning English speakers (Morris, 1983; Read, 1978; Zifcak, 1977, cited from Yopp, 1988). Knowledge of phonemes can be assessed using invented spelling tasks (Tangel and Blachman, 1992) and invented spelling may be a proxy for phonological awareness (Mann et al., 1987; McBride and Ho, 2005). The significant predictive power of invented spelling in reading and spelling skills has been found in both concurrent and longitudinal studies (Mehta et al., 2018; Ouellette and Sénéchal, 2017). Ouellette and Sénéchal (2017) contend that invented spelling is not just a mere proxy for phonological awareness; instead, “the analytic processs of invented spelling invokes other cognitive capabilities pertinent to literacy acquisition and potentially improves the quality of phonological and orthgraphic representation” (p.77). These results indicate that invented spelling could be used to explore meta-linguistic awareness and cognitive skills beyond phonological awareness.

Another commonly used task in measuring phonological awareness is the oddity test, which is also termed the *odd-man-out* task. This test requires participants to detect the odd one in a set of three or four items. For instance, to examine onset awareness in English, a set of three words, “*good*, *guy*, *fight*”, could be used, and *fight* is the odd word because it has a different onset from the other two words. The nature of the oddity test is auditory discrimination, which is one of the least difficult tests for phonological awareness and easier than tasks such as blending, isolation and deletion, and has a weak prediction in word reading skills (Yopp,1988). The oddity test has also been widely used to examine phonological awareness in Chinese children (Huang and Hanley, 1995; 1997; Liow and Poon, 1998; Shu et al., 2008; Song et al., 2008; Xu et al., 2004). Similar to the differences between deletion tasks and Pinyin invented spelling, the oddity test concentrates on a specific aspect of the phonological structure, such as onset, rime, phoneme or tone. Considering the rational underlying the advantage of Pinyin invented spelling over deletion tasks, it is reasonable to assume that Pinyin invented spelling might also outperform oddity test in tapping Chinese phonological awareness, which yet needs further empirical evidence.

## **CSL Learners’ Phonological Awareness**

Compared with the numerous studies on phonological awareness in Chinese-speaking children, research on CSL learners’ phonological awareness is scant. Different from the various tasks used in studies concerning Chinese-speaking children, measurements to tap CSL learners’ phonological awareness focus on the oddity test, and Pinyin invented spelling has not been administered among CSL learners.

Mixed results have emerged from different studies using the oddity test. For instance, Zhang and Wu (2007) found that the participants’ phonological awareness was above the chance level (M=.52) after the first week of the first semester among 25 beginner CSL learners from Indonesia. Similarly, Zhang and Roberts (2019) observed that first-year CSL learners achieved above-chance level performance (M=.80) in phonological awareness among English and Arabic participants. In contrast, Gao and Gao (2005) found that the participants’ accuracy rate in the oddity test was significantly below chance level (M=.21) among 22 beginning and 16 intermediate CSL learners with mixed L1 backgrounds. These mixed results might be caused by the different L1 backgrounds and L2 proficiencies of the participants and the materials used in the oddity test, and also suggest that more research is needed to explore the power of oddity test in exploring CSL learners’ phonological awareness.

The contribution of phonological awareness to the development of CSL learners’ literacy skills has also been examined. To the best of our knowledge, only two studies explored this issue among CSL learners, yet with different research findings. Using the task of oddity test, Zhang and Roberts (2018) observed that the total effect of phonological awareness measured using oddity test on character reading (β= 0.30) and character writing (β= 0.28) was significant among English and Arabic CSL learners at pre-intermediate and intermediate levels, yet the direct effect of phonological awareness was only significant on character reading. In contrast, Hao and Zhou (2019) did not find the significant contribution of phonological awareness to character reading among beginner CSL learners. The task used by Hao and Zhou (2019) was similar to the oddity test and requires the participants to judge whether the syllables they heard include the target onset or rime, involving the auditory discrimination ability. However, it is unknown how Pinyin invented spelling influences the contribution of phonological awareness to Chinese literacy skills. Therefore, more studies are necessary to explore whether measuring phonological awareness using different tasks would yield different findings about the relationship between phonological awareness and Chinese literacy skills among CSL learners.

# **The Current Study**

There are several research gaps in previous studies concerning Chinese phonological awareness. First, previous studies only compared the power of Pinyin invented spelling and deletion tasks in tapping Chinese phonological awareness, yet the differences between Pinyin invented spelling and the classical method-oddity test in measuring Chinese phonological awareness have not be examined. Second, most previous studies focus on Chinese-speaking children, paying little attention to CSL learners. Third, inconsistent results about the contribution of phonological awareness to character writing warrant more relevant research. Thus, the current study aims to explore whether Pinyin invented spelling outperforms conventional oddity test in measuring Chinese phonological awareness among CSL learners.

Carrying out such a study among CSL learners is important. First, the fast growing number of CSL learners around the world and the unique characteristics of Chinese characters have attracted attention from researchers concerning second language acquisition and more studies are needed to explore the uniqueness of CSL learning. Second, evidence from CSL learners could deepen our understanding of the influence of different measurements on researching phonological awareness and of the similarities and differences in cognitive processing of Chinese characters among the native Chinese speakers and CSL learners.

The current study selected Arabic and English CSL learners as participants mainly because of the unique characteristics of phonological properties across Chinese, English and Arabic. In terms of vowels, Chinese has 10 short vowels and four diphthongs; English has seven short vowels, five long vowels, and eight diphthongs; and Arabic has three short vowels and three long vowels. With regard to consonants, Chinese has 22 consonants, English has 24 and Arabic has 28. Chinese has four tones, yet neither English nor Arabic has tones. More importantly, Chinese Pinyin and English utilize the same Roman writing system, which differs greatly from the Arabic writing system. Thus, Chinese Pinyin and English are more similar in terms of phonological and orthographic properties than Chinese Pinyin and Arabic.

The differences and similarities between the three languages might lead to English and Arabic CSL learners’ different performances in Chinese phonological awareness. Previous studies have found the influence of L1 background on phonological awareness (Durgunoğlu et al., 1993) and spelling (Figueredo, 2006) tasks. In particular, Arabic ESL learners achieved unsatisfactory performance in tasks involving vowel manipulation in English (Ryan and Meara, 1991; Saigh and Schmitt, 2012) and in spelling the vowels (Thompson and Thomas, 1983; Saigh and Schmitt, 2012) and some consonants of English words (Ibrahim, 1978; Allaith, 2009; Allaith and Joshi, 2011). Considering the comparisons between the three languages and the above findings, it would be reasonable to expect the English CSL learners to outperform their Arabic counterparts in Chinese phonological awareness, offering us a very good chance to examine the influence of different tasks on measuring Chinese phonological awareness.

To be specific, the present study has two research questions.

The first is whether cross-group differences in Chinese phonological awareness between Arabic and English CSL learners vary across the tasks of oddity test and Pinyin invented spelling. Considering the features in phonological and orthographic properties across Arabic, Chinese and English, it is hypothesized that the English group would outperform the Arabic group in Chinese phonological awareness, especially for rimes which are composed mainly by vowels, and that Pinyin invented spelling would reveal more cross-group differences between the Arabic and English groups than the oddity test.

The second research question is whether the contribution of phonological awareness to character reading and character writing skills differs across the tasks of oddity test and Pinyin invented spelling. Considering that Pinyin invented spelling tasks may invoke additional cognitive skills beyond phonological sensitivity, it is hypothesized that phonological awareness measured via Pinyin invented spelling would contribute more to character reading and character writing than that measured via oddity test.

# **Material and Methods**

## **Participants**

The 83 L2 participants comprised two groups, English and Arabic learners of Chinese as a second language, all living in their native countries (the UK or Egypt) and studying Chinese as a major subject at university (Table 1). The participants were recruited from among 2nd-year and 3rd-year learners. The 3rd-year English group studied in China for about one year due to the requirement of course policy in the UK and some participants in 2nd-year English group stayed in China for some time due to tourism or volunteer work or other reasons. However, the Arabic groups did not have such experience.

Table 1 Demographic information of the Arabic and English participants

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Group  | N | Age(SD) | Male | Female | 2nd year | 3rd year | Length of stay in China (SD) |
| Arabic | 43 | 19.58(0.79) | 4 | 39 | 23 | 20 | n/a  |
| English  | 40 | 20.55(1.32) | 17 | 23 | 20 | 20 | .84(1.41) |

As described above, the Arabic and English groups differed in learning context and experience of staying in China, therefore, to make sure the two groups were comparable in global CSL proficiency, the participants’ Chinese proficiency was examined using the standardized HSK (Hanyu Shuiping Kaoshi) test. There has been no consensus about the most suitable test to examine CSL learners’ proficiency. According to Zhang (2018), HSK is recommended as a powerful Chinese proficiency test. A simplified version of HSK test designed by Zhang (2018) was administered in the present study, which included listening and reading comprehension. Speaking and writing section were excluded mainly due to the time limit. Nonetheless, Zhang (2018) claims that this simplified HSK test was valid in investigating CSL learners’ overall proficiency to some extent. There were eight questions in each section, which were randomly selected from HSK level 3 and HSK level 4, corresponding to pre-intermediate and intermediate levels, respectively, according to the syllabus of HSK test[[1]](#footnote-1). It was administered in a paper-and-pencil format and took approximately 20 minutes. One score was assigned to a correct answer and zero to an incorrect or unanswered item. The maximum score was 16, and the Cronbach’s alpha reliability was .80. The Arabic and English groups did not differ significantly in terms of their overall scores, and the effect size was small[[2]](#footnote-2), *t*(81)=1.27, *p*=.21, Cohen’s d=.28, Hedge’s g=.28. The results suggest that the two groups were comparable in overall Chinese language proficiency irrespective of their different background and experiences.

## **Measures**

*The Oddity test*

There is not yet a standardized test for Chinese phonological awareness, and the questionnaires used to test phonological awareness in L2 Chinese are not available. Thus, we developed an oddity test based on the comparison of the phonological properties of Arabic, Chinese and English. The test comprised four subtests on syllable, onset, rime and tone awareness, with eight questions for each subtest. A subtest for phoneme awareness was not included because it is not a salient psycholinguistic grain size for Chinese reading (Li et al., 2012).

The oddity test was administered in the form of a paper-and-pencil test. For each subtest, the participants were required to listen to a set of three items and then to detect the odd one. Disyllabic words were used for syllable awareness and single-syllable words for onset, rime and tone awareness. For example, among “pāo, bīng, pū”, the odd word was “bīng”. 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* (The State Language Affairs Commission, 2010) and were recorded by an adult female native Chinese speaker in a professional sound-proof language lab. The audio was played only once and the participants had five seconds to answer each question. The accuracy rate on each subtest was calculated by dividing the number of correct answers by 8. The Cronbach’s alpha reliability of the oddity test was .72.

*Pinyin invented spelling*

A list of 15 pseudo disyllable words was used for the Pinyin spelling task. The selected syllables covered most of the onsets and rimes in Chinese. The distribution of the four tones was balanced across the disyllables. The participants were required to write down the disyllable words in Pinyin after hearing the stimulus twice and had ten seconds to write each one. The timing limit of 10 seconds was adopted according to the results of a polit study, in which 90% of the participants (n=10) was able to write down the disyllables within ten seconds. All the stimuli were recorded by an adult female native Chinese speaker in a professional sound-proof language lab. The task was administered in the form of a paper-and-pencil test. The Cronbach’s alpha reliability of the Pinyin invented spelling task was .87.

The scoring of syllable spelling focused on the accuracy of the spelling of the 30 single syllables. One point was assigned to a correctly spelled syllable, and a score of zero was assigned to a syllable with error(s) in onset, rhyme or tone. The scoring of the onset, rhyme and tone spelling focused on the individual unit. For instance, to calculate the accuracy rate for onset spelling, one point was assigned if the onset of one syllable was correct, regardless of whether there were errors in rhyme or tone. The accuracy rate for the syllable, onset, rhyme and tone was calculated by dividing the number of correct responses by 30.

*Character reading and writing tests*

The tests for character reading and writing tests were adopted from Zhang and Roberts (2019).

 Character reading test includes 108 characters, which were balanced in difficulty, stroke order, frequency and phonetic regularity. The 108 characters were displayed on one A4 paper from high to low frequency. The task was asking the participants to read out the pronunciation of the displayed characters. 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 characters in a row in this study according to Zhang and Roberts’s practice (2019). The time limit was three minutes. One score was assigned if the syllable was pronounced correct, and 0 if the pronounced syllable was wrong or missed. Tone was not analyzed because of its difficulty and this is also a common practice in CSL research area. The Cronbach’s alpha reliability of character reading was .93.

Character writing test includes 24 target characters, which were also balanced in frequency, storke number and frequency. This task was administered using a paper-and-pencil test. The task was to write the target character according to the pronunciation and translated meaning of the displayed words. The Pinyin of the target character was printed in bold and italic. For instance, the target character for “***dōu*** lái le (all came)”is都. One score was assigned to a correct answer, and zero to a wrong answer or unanswered item. The Cronbach’s alpha reliability of character writing was .80.

*The LLAMA test*

To control for the participants’ language-learning aptitude, in particular their phonological working memory (PWM) and phonetic coding ability (PCA), sections D and E of the LLAMA tests were administered (Meara, 2005). LLAMA tests have been used in previous studies (Bokander and Bylund, 2019; Granena, 2013; Granena and Long, 2013; Xiang et al., 2012; Yi, 2018), 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.

Section D is a sound recognition task that tests PWM, and includes two phases. 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. 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 participants were tasked with distinguishing the words they had learned and those they had not after hearing the words one by one.

Section E is a sound-symbol correspondence task that tests PCA. There were two phases in this section. In the learning phase, the participants had two minutes to learn the sound-symbol correspondence rules of an artificial language. A list of 24 spellings in an artificial writing system was then displayed on the screen. The participants were required to click each spelling to hear the sounds and to determine how these spellings correspond to the sounds in the artificial language. In the test phase, the participants first heard a word and then saw two possible spellings on the screen, and they were required to select the correct spelling. There were 21 items in the test phase. Although the LLAMA test manual did not mention time limit for the test phase, most participants completed this section within 10 minutes.

Both the Section D and Section E of LLAMA tests were administered on a laptop. Although the LLAMA test manual did not mention time limit for the test phase in Section D and Section E, all the participants completed section D within 10 minutes and Section E within 15 minutes, including the learning phase.

## **Procedure**

This study was approved by the Education Ethics Committee in the Department of Education in University of York where the first author undertook PhD studies. 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. 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. The participants completed the measures in the following order to prevent potential priming effect: LLAMA test, phonological awareness, Pinyin invented spelling and HSK test, and then background information questionnaire. All the participants were tested individually, and were given a small amount of cash after completing the test. Most of the participants completed the four measures within 40 minutes.

# **Results**

The English and Arabic groups’ performance on the oddity test, Pinyin invented spelling task and other measures are presented in Table 2.

## **Question 1: The Effect of the Oddity Test and Pinyin Invented Spelling on Cross-Group Differences**

The first research question concerns whether Pinyin invented spelling reveals more cross-group differences between Arabic and English CSL learners than the oddity test does. To answer this question, a series of independent samples *t*-tests were carried out for the oddity test and Pinyin invented spelling task between the English and Arabic groups. The results of the independent *t*-tests of the performance on the oddity test and Pinyin invented spelling task of the English and Arabic groups are summarized in Table 3.

In the task of oddity test, the Arabic and English groups differed significantly only in syllable discrimination and onset discrimination, both effect sizes are big, and the English group outperformed the Arabic group in syllable and onset discrimination. The two groups did not differ significantly in rime or tone discrimination.

In terms of Pinyin invented spelling, significant cross-group differences were observed in syllable, onset and rime spelling, and the effect sizes range from medium to big. The English group performed better than the Arabic group in syllable, onset and rime spelling. The two groups did not differ significantly in tone spelling.

Table 2 The participants’ performance on the measured variables

|  |  |  |  |
| --- | --- | --- | --- |
| Measures | Arabic |  | English |
| N | Mean | SD | Min | Max | N | Mean | SD | Min | Max |
| HSK | 43 | 9 | 3.59 | 1 | 15 |  | 40 | 9.98 | 3.43 | 2 | 16 |
| PWM | 43 | 24.53 | 14.47 | 0 | 55 |  | 40 | 32.88 | 10.97 | 5 | 60 |
| PCA | 43 | 33.02 | 23.14 | 0 | 90 |  | 40 | 69.5 | 27.78 | 10 | 100 |
| Reading | 43 | .21 | .12 | .02 | .45 |  | 40 | .27 | .16 | .02 | .65 |
| Writing | 43 | .30 | .16 | 0 | .63 |  | 40 | .25 | .15 | .04 | .75 |
| Oddity test |  |  |  |  |  |  |  |  |  |  |  |
| Syllable  | 43 | 0.65  | 0.23  | 0.13  | 1.00  |  | 40 | 0.93  | 0.15  | 0.25  | 1.00  |
| Onset | 43 | 0.73  | 0.19  | 0.25  | 1.00  |  | 40 | 0.87  | 0.13  | 0.50  | 1.00  |
| Rime | 43 | 0.68  | 0.19  | 0.13  | 1.00  |  | 40 | 0.74  | 0.12  | 0.50  | 1.00  |
| Tone | 43 | 0.90  | 0.13  | 0.63  | 1.00  |  | 40 | 0.92  | 0.11  | 0.63  | 1.00  |
| Average | 43 | 0.74  | 0.11  | 0.50  | 0.94  |  | 40 | 0.87  | 0.08  | 0.56  | 1.00  |
| Pinyin invented spelling |  |  |  |  |  |  |  |  |  |
| Syllable | 43 | 0.44  | 0.19  | 0.00  | 0.77  |  | 40 | 0.58  | 0.22  | 0.07  | 0.90  |
| Onset | 43 | 0.86  | 0.08  | 0.60  | 0.97  |  | 40 | 0.93  | 0.06  | 0.77  | 1.00  |
| Rime  | 43 | .74 | .12 | .30 | .93 |  | 40 | .87 | .09 | .60 | 1.00 |
| Tone  | 43 | 0.63  | 0.20  | 0.00  | 0.90  |  | 40 | 0.68  | 0.20  | 0.23  | 0.97  |

Note. PWM=phonological working memory, PCA=phonetic coding ability, Reading= character reading, Writing= character writing.

Table 3 Summary of the *t*-tests for the oddity test and Pinyin invented spelling task

|  |  |  |
| --- | --- | --- |
| Task | *t*-test | Effect size |
| Cohen’s d | Hedge’s g |
| Oddity test | Syllable  | *t*(81)=6.60, *p*<.0001 | 1.45 | 1.44 |
| Onset | *t*(81)=3.95, *p*=.0002 | .87 | .86 |
| Rime | *t*(81)=1.90, *p*=.06 | .42 | .41 |
| Tone | *t*(81)=.79, *p*=.43 | .17 | .17 |
|  | Average | *t*(81)=.79, *p*<.0001 | 1.33 | 1.32 |
| Pinyin invented spelling | Syllable  | *t*(81)=3.01, *p*=.004 | .66 | .65 |
| Onset | *t*(81)=4.61, *p*<.0001 | 1.01 | 1.00 |
| Rime | *t*(81)=5.51, *p*<.0001 | 1.21 | 1.20 |
| Tone | *t*(81)=1.03, *p*=.30 | .23 | .23 |

## **Question 2: The Effect of the Oddity Test and Pinyin Invented Spelling on Character Literacy Skills**

The second research question is whether Pinyin invented spelling contributes more to character reading and character writing skills than the oddity test does. Correlation, multiple regression and path analyses were carried out to investigate the second question. Correlation and multiple regression analysis were conducted to provide evidence for path analysis.

### Multiple Regression

The average of the scores for syllable, onset, rime and tone awareness represented the overall performance on the oddity test. The syllable spelling accuracy was considered to represent the overall performance on the Pinyin invented spelling task because it took onset, rime and tone into account.

The correlation matrix between measured variables and the results of the multiple regression analyses are summarized in Table 4 and Table 5, respectively. The VIF indexes of the two multiple regressions indicate that high multicollinearity does not exist. Pinyin invented spelling significantly predicted the participants’ character-reading and character-writing performance, and the L1 background was a significant predictor of character writing, both with big effect sizes. The oddity test did not significantly predict either character reading or character writing, and its effect sizes were very small.

### Path Analysis

To further investigate the relations of the oddity test and Pinyin invented spelling task with character literacy skills among the CSL learners, path analysis was carried out using AMOS 23.0.

Table 4 Correlation matrix between the participants’ background and measured variables

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1 | L1 | 1.00  |  |  |  |  |  |  |  |  |  |
| 2 | Age | 0.41\* | 1.00  |  |  |  |  |  |  |  |  |
| 3 | Gender | 0.38\* | 0.31\* | 1.00  |  |  |  |  |  |  |  |
| 4 | China years | 0.40\* | 0.29\* | 0.32\* | 1.00  |  |  |  |  |  |  |
| 5 | PWM | 0.31\* | 0.13  | 0.23\* | 0.37\* | 1.00  |  |  |  |  |  |
| 6 | PCA | 0.57\* | 0.03  | 0.27\* | 0.13  | 0.37\* | 1.00  |  |  |  |  |
| 7 | OT | 0.56\* | 0.17  | 0.33\* | 0.13  | 0.27\* | 0.51\* | 1.00  |  |  |  |
| 8 | PIS | 0.32\* | 0.03  | 0.21  | -0.06  | 0.18  | 0.34\* | 0.39\* | 1.00  |  |  |
| 9 | Reading | 0.20  | 0.15  | 0.23\* | 0.03  | 0.12  | 0.20  | 0.30\* | 0.60\* | 1.00  |  |
| 10 | Writing | -0.15  | -0.05  | 0.13  | -0.10  | -0.01  | -0.05  | 0.10  | 0.47\* | 0.71\* | 1.00  |

Note. PWM=phonological working memory; PCA=phonetic coding ability; OT=oddity test; PIS=Pinyin invented spelling; Reading=character reading; Writing=character writing. \**p*<.05.

Path analysis is confirmatory and should be theory-based or evidence-based. However, there is no available theoretical framework for our research questions; thus, the selection of the variables and paths in the model was mainly based on the correlation matrix between the measured variables (Table 4) and the results of multiple regression analysis (Table 5).

Table 5 Summary of the results of the multiple regression analysis

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Predictor | *F* | *p* | *R2* | *Adjusted*  *R2* | VIF | *b* | SE | *t* | *p* | β | η2 | ω2 |
| Reading | Model | 6.05 | <.0001 | .395 | .33 |  |  |  |  |  |  |  |  |
|  | L1 |  |  |  |  | 2.49 | -.04 | .04 | -.94 | .35 | -.13 | .01 | 0 |
|  | Age |  |  |  |  | 1.38 | .02 | .01 | 1.31 | .19 | .14 | .02 | .01 |
|  | Gender |  |  |  |  | 1.33 | .03 | .03 | .74 | .46 | .08 | .01 | 0 |
|  | China years |  |  |  |  | 1.49 | .01 | .02 | .44 | .66 | .05 | .002 | 0 |
|  | PWM |  |  |  |  | 1.34 | -.0003 | .001 | -.28 | .78 | -.03 | .001 | 0 |
|  | PCA |  |  |  |  | 1.89 | .00004 | .001 | .07 | .94 | .01 | .0001 | 0 |
|  | OT |  |  |  |  | 1.71 | .11 | .15 | .72 | .47 | .08 | .01 | 0 |
|  | **PIS** |  |  |  |  | **1.30** | **.40** | **.07** | **5.79** | **<.001** | **.60** | **.31** | **.30** |
| Writing | Model | 5.24 | <.0001 | .362 | .293 |  |  |  |  |  |  |  |  |
|  | **L1** |  |  |  |  | **2.49** | **-.13** | **.05** | **-2.87** | **.005** | **-.42** | **.10** | **.09** |
|  | Age |  |  |  |  | 1.38 | .004 | .01 | .29 | .77 | .03 | .001 | 0 |
|  | Gender |  |  |  |  | 1.33 | .05 | .04 | 1.33 | .19 | .14 | .02 | .01 |
|  | China years |  |  |  |  | 1.49 | .01 | .02 | .53 | .60 | .06 | .004 | 0 |
|  | PWM |  |  |  |  | 1.34 | -.001 | .001 | -.40 | .69 | -.04 | .002 | 0 |
|  | PCA |  |  |  |  | 1.89 | -.0004 | .001 | -.66 | .51 | -.08 | .006 | 0 |
|  | OT |  |  |  |  | 1.71 | .14 | .16 | .84 | .41 | .10 | .01 | 0 |
|  | **PIS** |  |  |  |  | **1.30** | **.42** | **.08** | **5.43** | **<.001** | **.58** | **.29** | **.28** |

Note. PWM=phonological working memory, PCA=phonetic coding ability, OT=oddity test, PIS=Pinyin invented spelling

PCA (phonetic coding ability) did not significantly correlate with character writing in the correlation matrix or predict character writing in the multiple regression analysis, thus the path from PCA to character writing was not depicted in the path analysis. Age and length of stay in China did not correlate with either the oddity test, Pinyin invented spelling, character reading or character writing; thus, the two variables were excluded from path analysis. Gender, L1, PCA and PWM are the participants’ background and meta-cognitive variables, and they are assumed to contribute to participants’ performance on the oddity test and Pinyin invented spelling task, which in turn contribute to character reading and character writing. Considering the consensus on the role of phonological awareness in spelling skills, a direct path from the oddity test to Pinyin invented spelling was added. Additionally, based on the strong relationship between character reading and character writing in the correlation matrix and the possible contribution of reading to writing, a direct effect of character reading on character writing was depicted (Figure 1). This model shows adequate goodness-of-fit indices (Table 6).

Table 6 Summary of the goodness-of-fit indices

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| χ2 | *df* | *p* | GFI | RMSEA |  | NFI | RFI | IFI | TLI | CFI |  | PGFI | AIC |
| 2.62 | 7 | .92 | .99 | 0 |  | .99 | .96 | 1.02 | 1.09 | 1.00 |  | .19 | 60.62 |



Note. PA=phonological awareness; PCA=phonetic coding ability; PWM=phonological working memory; OT=oddity test; PIS=Pinyin invented spelling; reading=character reading; writing=character writing.

Figure 1. Model depicting the effects of the measured variables on character reading and character writing

Table 7 Decomposition of the effects in the path analysis model

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Direct effects | Indirect effects | Total effects | *R2/adjusted R2* |
| B | β | B | β | B | β |
| PA | Gender | .03 | .12 | 0 | 0 | .32 | .12 | .38/.35\*\*\* |
| L1 | .08 | .35\* | 0 | 0 | .08 | .35\* |  |
| PWM | 0 | .03 | 0 | 0 | 0 | .03 |  |
| PCA | .001 | .27\* | 0 | 0 | .001 | .27\* |  |
| PIS | Gender | 0 | 0 | .02 | .03 | .02 | .03 | .19/.14\*\* |
|  | L1 | .03 | .07 | .04 | .10\* | .07 | .17 |  |
|  | PWM | 0 | 0 | 0 | .01 | 0 | .01 |  |
|  | PCA | .001 | .16 | 0 | .07\* | .002 | .23 |  |
|  | OT | .51 | .28\* | 0 | 0 | .51 | .28\* |  |
| Reading | Gender | .04 | .11 | .01 | .03 | .04 | .14 | .38/.33\*\*\* |
|  | L1 | 0 | 0 | .03 | .12 | .03 | .12 |  |
|  | PWM | 0 | 0 | 0 | .01 | 0 | .01 |  |
|  | PCA | 0 | -.06 | .001 | .15\* | 0 | .09 |  |
|  | OT | .08 | .06 | .20 | .16\* | .27 | .22\* |  |
|  | PIS | .38 | .57\* | 0 | 0 | .38 | .57\* |  |
| Writing | Gender | 0 | 0 | .04 | .10 | .04 | .10 | .36/.31\*\*\* |
| L1 | -.11 | -.36\* | .04 | .12 | .-.07 | -.24 |  |
| PWM | 0 | 0 | 0 | .01 | 0 | .01 |  |
| PCA | 0 | 0 | .001 | .11 | .001 | .11 |  |
|  | OT | .04 | .03 | .27 | .20\* | .31 | .23\* |  |
|  | PIS | .13 | .18 | .28 | .38\* | .41 | .56\* |  |
|  | Reading | .72 | .67\* | 0 | 0 | .72 | .67\* |  |

Note. PA=phonological awareness; PCA=phonetic coding ability; PWM=phonological working memory; OT=oddity test; PIS=Pinyin invented spelling; reading=character reading; writing=character writing. \**p*<.05, \*\**p*<.01, \*\*\**p*<.001.

As shown in Table 7, the total effects of Pinyin invented spelling on character reading and character writing were significant, as were the total effects of oddity test on character reading and character writing. However, the direct effect of Pinyin invented spelling on character reading was significant, and its direct effect on character writing was marginally significant. In contrast, the direct path from oddity test to character reading or character writing was not significant. The indirect effects of oddity test on character reading and character writing were significant, as was the indirect effect of Pinyin invented spelling on character writing.

# **Discussion**

The present study compared the power of two different measures, the oddity test vs. Pinyin invented spelling, for exploring Chinese phonological awareness in English and Arabic CSL learners. Two main findings emerged. First, it is found that Pinyin invented spelling uncovered more cross-group differences in phonological awareness than the oddity test among the two CSL groups. Second, Pinyin invented spelling, rather than the oddity test, significantly predicted character-reading and character-writing skills. The overall results suggest that Pinyin invented spelling could be a more robust tool than the oddity test for exploring phonological awareness in CSL learners.

## **The Effect of the Oddity Test and Pinyin Invented Spelling on Cross-Group Differences**

In the current study, Pinyin invented spelling appears to be better able to uncover the cross-group differences among English and Arabic CSL learners. In line with our hypothesis, the English group outperformed the Arabic group in Chinese phonological awareness measured using the oddity test and Pinyin invented spelling task. Although the effect size of L1 background on syllable discrimination was larger than that on syllable spelling, the effect sizes of L1 background on onset spelling and rime spelling were larger than those on onset and rime discrimination. More importantly, the two groups’ differences in rime discrimination was not statistically significant, in contrast to those for rime spelling. These findings align with previous research that has observed poorer performance in vowel perception or manipulation by Arabic ESL learners (Ryan and Meara, 1991; Saigh and Schmitt, 2012; Thompson and Thomas, 1983). The major reason for this result may relate to the cognitive loads required for the two different tasks.

On the oddity test, perception skills and short-term working memory are essential for detecting the odd one out of the three items (Yopp, 1988). Our CSL participants were educated university students and possessed full-fledged perception skills and working memory; therefore, the oddity test might be a relatively easy task for them. In fact, we also administered the oddity test to a group of native Arabic speakers and a group of native English speakers who did not have any experience with learning Chinese. The results showed that the two groups’ overall performance on the oddity test was above the chance level: Arabic (syllable=.57, SD=.18; onset=.65, SD=.12; rime=.67, SD=.17; tone=.83, SD=.24; mean=.68, SD=.11), *t*(42)=10.73, *p*<.0001; English (syllable=.70, SD=.16; onset=.78, SD=.11; rime=.70, SD=.10; tone=.93, SD=.10; mean=.78, SD=.06), *t*(39)=10.73, *p*<.0001. This finding is similar to struggling Chinese children’s fairly good phonological awareness performance as measured by syllable deletion and phoneme deletion (Ding et al., 2014). In addition, the subtest of oddity test focuses on a specific component of Chinese syllables, such as onset, rime or tone. These results suggest that the oddity test is an easy task for adult CSL learners because of their cognitive maturity and ample experience with language learning.

Unlike oddity test, both perception and production skills are required for the Pinyin invented spelling task. In addition to correct perception of the syllable structure, the Pinyin invented spelling task involves the transition from phonological processing to orthographic processing, in which awareness of and the ability to master the phonology-orthography correspondence play an important role (Tainturier and Rapp, 2001). Moreover, the Pinyin invented spelling task requires the participants to concentrate on onset, rime and tone simultaneously (Ding et al., 2014, 2018; Lin et al., 2010). Pinyin invented spelling is a more comprehensive and difficult task that imposes a greater cognitive load than the oddity test for adult CSL learners, and might invoke other cognitive abilities pertinent to literacy acquisition beyond phonological awareness (Ouellette and Sénéchal, 2017).

## **The Effect of the Oddity Test and Pinyin Invented Spelling on Character Literacy Skills**

The finding that the effects of phonological awareness measured via oddity test and Pinyin invented spelling on character reading and character writing were significant is in accord with theories such as Universal Phonological Principle (Perfetti, 2003), the Psycholinguistic Grain Size Theory (Ziegler and Goswami, 2005) and the Obligatory Phonological Mediation Hypothesis in Spelling (Rapp and Caramazza, 1997), and the results of previous studies in Chinese children (Ding et al., 2014, 2018; Lin et al., 2010; Song et al., 2015) and CSL learners (Zhang and Roberts, 2019). Additionally, Pinyin invented spelling appears to be a much stronger predictor than the oddity test, as seen in the results of multiple regression analysis and path analysis, and the results are in line with previous studies (Ding et al., 2014, 2018; Lin et al., 2010). There are three possible reasons accounting for the relatively stronger effect of Pinyin invented spelling on character literacy skills.

Firstly, Pinyin invented spelling task suits the unique characteristics of Chinese language. Chinese is a morphosyllabic and tonal language, thus the ideal measurement of Chinese phonological awareness should be comprehensive and tap an individual’s abilities to manipulate at the syllable, onset, rime and tone levels. The traditional tasks such as syllable deletion, phoneme deletion or oddity test concentrate on a specific part instead of the holistic structure of Chinese phonology. The task of Pinyin invented spelling moves beyond the level of syllable and phoneme awareness and examines the awareness of phonological structure, and corresponds to the features of Chinese as a syllable-based and tonal language (Ding et al., 2018).

Secondly, Pinyin is utilized as an aid for learning characters. For both CSL learners and Chinese-speaking children, introduction to Pinyin routinely appears prior to the introduction of characters in classroom practice and textbooks. Pinyin is mainly used to represent the pronunciation of Chinese characters because transparent phonological clues are not available in the orthographic units of the characters. More importantly, Pinyin normally appears above or near each character in the textbooks or dictionaries, and character writing skills are normally examined by asking the learners to write out characters according to the displayed Pinyin or vice versa, these practices might reinforce the mapping between Pinyin and Chinese character reading and writing (Ding et al., 2018). Therefore, mastery of Pinyin may greatly boost CSL learners’ confidence and ability to learn new characters.

Pinyin learning might be particularly useful for the acquisition of Chinese literacy skills for CSL learners speaking alphabetic L1s, because they rely heavily on phonological skills to achieve success in character learning (Everson, 1998; Jiang, 2003). Everson (19998) and Jiang (2003) found a strong correlation between knowing pronunciation and knowing meaning among CSL learners speaking alphabetic L1s, rather than their counterparts with Chinese-character background such as Korean and Japanese CSL learners. These findings are similar to those reported in ESL learners who speak alphabetic L1s rely more on phonological information in English word naming in comparison to those speaking non-alphabetic L1s (Brown and Haynes, 1985; Koda, 1988; 1989; Zhao, 2011).

Thirdly, Pinyin learning may enhance the development of phonological awareness. The benefit of learning Pinyin for improving phonological awareness has been observed in studies of Chinese-speaking children (Cheung et al., 2001; McBride-Chang et al., 2004; Ren et al., 2006; Shu et al., 2008). Lin et al. (2010) argued that Pinyin practice helps Chinese children manipulate the phonological units of Chinese syllables in both top-to-bottom (such as by segmenting a Pinyin syllable into its onset and rime) and bottom-to-top (such as by combining an onset and rime into a Pinyin syllable) ways, which in turn strengthens the children’s sensitivity and ability to manipulate the structure of Chinese syllables.

It is further observed that the effect of Pinyin invented spelling on character writing was mediated by character reading, aligning with the finding reported by Zhang and Roberts (2019). An individual can successfully write a Chinese character without knowing its pronunciation, and the independent role of orthographic processing in character writing has been observed in previous research (Law et al., 2005; Han et al., 2007; Zhang and Wang, 2016). The mediation effect of character reading on the relationship between Pinyin invented spelling and character writing might be due to the strong correlation between Pinyin invented spelling and character reading, which in turn significantly predicts character writing. The significant contribution of Pinyin knowledge or Pinyin invented spelling to Chinese character reading and the significant prediction of character reading in character writing have been found in studies involving Chinese children (Ding et al., 2014, 2018; Lin et al., 2010; Siok and Fletcher, 2001) . Additionally, reading intervention might facilitate the development of spelling skills, with its beneficial effect being maintained over time (Graham et al., 2017). Therefore, it seems reasonable that character reading bridges the effect of Pinyin invented spelling on character writing, but more research is needed to explore the underlying mechanism.

This study has several theoretical and practical implications. Theoretically, the overall findings provide evidence from CSL learners for the theories that argue for the contribution of phonological skills to the growth of literacy skills across different languages, such as Universal Phonological Principle (Perfetti, 2003), the Psycholinguistic Grain Size Theory (Ziegler and Goswami, 2005) and the Obligatory Phonological Mediation Hypothesis in Spelling (Rapp and Caramazza, 1997). Moreover, the present study confirms the close relationship between reading and writing, and, in particular, the facilitating effect of reading on writing might be universal across different languages (Ding et al., 2018; Graham et al., 2017). From a practical perspective, the results of this study demonstrate that different tasks differ in the power to tap phonological awareness (Stanovich et al., 1984; Yopp, 1988). Also, it provides further support for the proposed advantage of Pinyin invented spelling over conventional tasks such as deletion tasks or oddity test among Chinese children (Ding et al., 2014, 2018; Lin et al., 2010;). The results imply that researchers and instructors are recommended to use Pinyin invented spelling alongside the conventional measurement s to measure Chinese phonological awareness among native Chinese speakers and learners of Chinese as a second language.

# **Limitations and Conclusion**

We are aware of a number of limitations in the present study. Firstly, using tasks such as syllable deletion or phoneme deletion alongside oddity test and Pinyin invented spelling might have led to a comprehensive understanding of the influence of different tasks on the measurements of Chinese phonological awareness. Secondly, the total score, timing limit and the times played for each item in oddity test and Pinyin invented spelling differed, which might lead to the different reliabilities of each test and further influence the research findings. Thirdly, only English and Arabic CSL learners were recruited for the present study, and they were studying Chinese in a Chinese-as-a-foreign-language context; thus, whether the findings can be generalized to CSL learners speaking other languages or in a Chinese-as-a-second-language context should be researched further. Also, the two groups of participants differed in the experience of studying Chinese in China, and this might influence the research findings. Future research could recruit participants with more homogeneous characteristics and experience. Finally, our study recruited only 83 CSL participants, and the samples might not be suitable for path analysis, which requires large sample sizes (Stage et al., 2004; Klein, 2010). Although the present study is limited in several ways, to the best of our knowledge, this is the first study to explore the influence of different tools on the measurement of phonological awareness among CSL learners. The results are of theoretical and practical significance, and shed light on our understanding of how findings might differ depending on the assessments administered and of the role phonological awareness plays in the acquisition of Chinese literacy skills.

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1. <http://www.chinesetest.cn/userfiles/file/dagang/HSK1.pdf> [↑](#footnote-ref-1)
2. The present study adopts the criteria for effect size proposed by Cohen (1988) and Cohen’s benchmarks are .40 = small, .70 = medium and 1.00 = big. [↑](#footnote-ref-2)