



Effects of metalinguistic awareness on Chinese as a second language spelling through the mediation of reading and copying

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Abstract

This study investigated the influence of various types of Chinese metalinguistic awareness on spelling through the mediation of character reading and copying, using a path model with young Chinese as a second language (CSL) learners. A total of 221 Grade 3 Hong Kong ethnic minority students were given a range of measures including Chinese spelling, orthographic awareness, phonological awareness, morphological awareness, character reading, copying, and listening comprehension. The path model fitted well with the data and accounted for a substantial 83% of the variance in spelling. This showed that, controlling for listening comprehension, (1) both orthographic awareness and morphological awareness, but not phonological awareness, contributed to character reading, which had a dominant direct influence ($\beta = .74$) on spelling; (2) only orthographic awareness contributed to copying, which had a statistically significant, though comparatively slim, direct influence on spelling ($\beta = .10$), and (3) other than the aforementioned indirect influences, orthographic awareness also had a direct effect on spelling ($\beta = .18$). Given the complexity of Chinese orthography, Chinese spelling in CSL learners likely depends on (1) high-quality mental representations of characters and good visual–motor integration, which are reflected in good character reading and copying, and related to both orthographic awareness and morphological awareness, and (2) orthographic awareness is a critical component skill facilitating spelling directly and indirectly.

Keywords Chinese as a second language (CSL) · Metalinguistic awareness · Spelling · Chinese character reading · Copying

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Introduction

Spelling as a transcription skill is an important component skill of writing (Feng et al., 2019; Kent & Wanzek, 2016). In the case of Chinese, a language with a morpho-syllabic, orthographically complex writing system, spelling¹ has been identified as influential in the development of writing skills (Yeung et al., 2013a, 2017a, b). A body of research has found that metalinguistic awareness, which refers to the ability to reflect on and manipulate the various formal aspects of language structure (Adams, 1990; Bialystok et al., 2014), facilitates Chinese children's spelling development (Lam & McBride, 2018; Li et al., 2019). In particular, children's orthographic awareness of Chinese characters' regularity and structure; morphological awareness, including identification of the morpheme and word-compound structure; and phonological awareness at the syllabic level, have been found to contribute uniquely to both character reading and spelling. Copying has also been identified as a critical correlate of Chinese spelling related to orthographic awareness (Lam & McBride, 2018). However, comparatively few studies have investigated the spelling development of learners of Chinese as a second language (CSL), and there have not been any with a research design that considers all related metalinguistic and linguistic correlates.

While bilingual (and presumably, multilingual) learners have shown enhanced metalinguistic skills that benefit their literacy skills (Eviatar et al., 2018), CSL studies have also identified a relationship between metalinguistic and literacy skills in both young and adult learners similar to that of Chinese-speaking children (Ke, 2020; Leong et al., 2011; Zhang & Roberts, 2019). What remains unclear, however, is what roles, if any, these different skills play, as well as their relative strength of influence on CSL learners' spelling development. Adopting a componential view of spelling (Mo et al., 2018; Yeung et al., 2020) and with reference to previous literacy studies concerning both Chinese-speaking and CSL learners (Leong et al., 2018; Wong, 2018; Yeung et al., 2013a; Zhou & McBride, 2018), this study aimed at identifying the strength of the influence of these metalinguistic skills on Hong Kong ethnic minority students' CSL spelling while attending to the effects of oral language, copying skills, and character reading holistically and systematically. More precisely, we assumed that the students' spelling is predicted by character reading and copying and reflects the orthographic representation quality in their mental lexicon and visual-motor skills (Cao et al., 2013; Chang, Stafura, et al., 2015; Chang, Xu, et al., 2014; Perfetti et al., 2005), whose development is, in turn, facilitated by their metalinguistic skills. These assumptions were evaluated with a mediation model specifying the mediating role of character reading and copying in the relationship between metalinguistic skills and spelling. The findings will advance our understanding of the nature and strength of the influences of various metalinguistic skills and the linguistic component processes of Chinese spelling.

Relationships between metalinguistic awareness, reading, copying, and spelling in L1 Chinese

Chinese is a morpho-syllabic language, and its basic units are Chinese characters. The orthographic forms of the characters are complicated, as most comprise componential chunks called radicals that in turn usually consist of clusters of strokes, such as “—” (a horizontal stroke) and “丨” (a vertical stroke). It is estimated that approximately 95% of Chinese characters are multi-radical compound characters (Chen et al., 2011; Su, 2001). Each character typically represents a syllable and serves as a morpheme representing various meanings (Cheung et al., 2006). Most characters are ideo-phonetic compounds (Cheung et al., 2006; Kang, 1993; Li & Kang, 1993) composed of a semantic radical (which relates to their meaning) and a phonetic radical (which suggests their pronunciation) with various types of positional arrangement. These include, for example, left–right, top–bottom, and surrounding. For example, the compound character 河 (river, /ho4/) has a left–right structure and consists of the left semantic radical 氵 (which is a variant of 水 meaning ‘water’) and a right phonetic radical 可 (be able to, /ho2/) to cue the sound (i.e., /ho2/ to /ho4/). Another compound character 畔 (shore, /bun6/) is made up of the semantic radical 田 (field, /tin4/) and the phonetic radical 半 (half, /bun3/). It should be noted that characters do not indicate important sub-syllabic phonological features like onset (e.g., /h/, /b/), rime (e.g., /o/, /un/), or tone (e.g., tone 2 or 4), which are represented in most modern Chinese phonological encoding systems such as *Hanyu Pinyin* for Mandarin and *Jyutping* for Cantonese (Zhang & McBride-Chang, 2011). Most of the characters can function as words; however, in modern usage, words are typically made up of two or more characters that serve as simple compounds or as affixes (Shao, 2001; Su, 2001) with a relatively transparent morphological structure. For example, the combination of 河 and 畔 yields the word 河畔 (riverside, /ho4bun6/).

Metalinguistic awareness and literacy in Chinese

Chinese learners’ awareness of orthographic, morphological, and phonological forms of Chinese contributes to their early literacy development. In particular, a substantial body of research has found that orthographic awareness, which is the understanding of the orthographic conventions and rules for Chinese characters (Qian et al., 2015; Wei et al., 2014), plays an important role in Chinese children’s ability to learn to read and write. Studies have found that Chinese learners’ knowledge of the radicals and their positional regularity supports their spelling, controlling for a wide range of linguistic correlates, such as oral language and other metalinguistic competencies (Lam & McBride, 2018; Lo et al., 2018; Mo et al., 2018). Similarly, morphological awareness, the ability to analyze and manipulate morphological information (Kuo & Anderson, 2006) that is usually measured by homophone identification and word-compound construction in Chinese, has a robust and consistent contribution (like that of orthographic awareness) to spelling concurrently and longitudinally (Tong et al., 2009; Yeung et al., 2011, 2013a). On the other hand, phonological awareness, measured at both the syllabic and sub-syllabic level, plays only

a limited role: While Tong et al. (2009) found it was not uniquely associated with concurrent spelling but did predict subsequent spelling, Yeung et al. (2013b) found its predictive power was insignificant when the autoregressive effect of spelling was controlled. The researchers of both studies recognized that the findings underscored the importance of orthographic and morphological awareness for Chinese literacy.

Role of character reading and copying in the metalinguistic awareness–spelling relationship

A number of studies have also investigated the influences of character reading and copying, both of which are related to metalinguistic skills, on Chinese spelling. While studies have found a strong relationship between character reading and spelling (Chan et al., 2016; Li et al., 2019), several studies have also identified that character reading exhibits patterns of relationships with the metalinguistic skills largely similar to those found in spelling. Chinese orthographic awareness has been identified as an important correlate of Chinese character reading (Cheung et al., 2006; Yeung et al., 2013c) and reading comprehension (Ho et al., 2003; Zhang et al., 2014). Along with their literacy development, Chinese learners acquire more knowledge of the radicals and their combination rules (e.g., their positional regularity) and are more proficient in analyzing compound characters' consistent radicals and using the linguistic information of both semantic and phonetic radicals. This process in turn facilitates further reading development (Anderson et al., 2013; Wei et al., 2014). In some studies, a strong bidirectional relationship has been demonstrated between orthographic knowledge and reading development in Chinese primary school students (Li et al., 2012; Lin et al., 2019). Similarly, morphological awareness has been found to contribute to word reading (Tong et al., 2017) and to develop reciprocally with Chinese reading comprehension (Cheng et al., 2016). Chinese learners with higher morphological awareness are better at differentiating homophones, which are abundant in Chinese and often represented by different characters, as well as in reflecting on and using morphological information in words for reading comprehension. Chinese learners' phonological awareness of syllable and tone is crucial for their character reading (Li et al., 2012; Shu et al., 2008); however, its importance is comparatively small and is likely to diminish as learners become more proficient in literacy (Tong et al., 2009). In short, the learners' metalinguistic awareness develops reciprocally with character reading and facilitates the mapping of the orthographic forms to the corresponding pronunciations and meanings in their mental lexicon (Chang et al., 2014; Perfetti et al., 2005). The development of these high-quality orthographic representations is beneficial for the spelling (Li et al., 2019).

Copying skills, which entail both orthographic awareness and visual-motor integration, also facilitate reading and spelling in Chinese (Cao et al., 2013; Chang et al., 2015; Guan et al., 2011; Tan et al., 2005). Using a character copying task in their studies, Guan et al., (2011) and Tan et al. (2005) showed that the process of copying, in which a character's subcomponents are deconstructed and recomposed, facilitates learners' awareness of characters' internal structures for a better orthographic awareness, which strengthens orthographic representations

and the formation of long-term motor memory to enhance the visual-motor integration. Similarly, Mo et al. (2018) found that the delayed character copying, in which the participants had to reproduce characters from memory following a brief presentation, constituted Chinese children's orthographic working memory and was the sole predictor of spelling from a range of linguistic-related knowledge. In addition to using the delayed copying task to investigate learners' orthographic awareness, McBride-Chang et al. (2011) and Wang et al. (2014) also used the tasks of copying unfamiliar scripts (Vietnamese, Korean, and Hebrew), which do not require orthographic knowledge and evaluated relatively pure visual-motor integration skills in relation to Tan et al.'s motor functioning. In both studies, each of the two copying measures predicted a unique proportion of variance in the Chinese spelling. Lam and McBride (2018) further established that visual-motor integration was a unique correlate of spelling after controlling for the orthographic representations supported by orthographic, morphological, and phonological skills.

While studies concerning the role of copying in the Chinese spelling have focused on the effects of orthographic awareness and visual-motor integration, studies on the relationship between character reading and spelling (Chan et al., 2016; Li et al., 2019) have focused on evaluating whether metalinguistic skills serve as a third variable to account for the relationship. These studies established a strong reading-spelling relationship, which was accounted for by orthographic and phonological awareness among other cognitive and linguistic variables (Chan et al., 2016) or by orthographic awareness and word-compound morphological awareness (Li et al., 2019). The results suggested that reading facilitates the development of high-quality orthographic representations in readers' mental lexicon that are beneficial to spelling and that there are reciprocal influences between literacy and metalinguistic skills, as found by studies of Chinese literacy development (Cheng et al., 2016; Lin et al., 2019).

However, few studies have investigated the role of metalinguistic awareness in Chinese spelling with regard to both reading and copying. The present study aimed to fill this research gap by evaluating the strengths of the various metalinguistic awareness influences on spelling through the mediation of reading and copying. As the literature review showed, orthographic, morphological, and phonological awareness all facilitate the development of high-quality orthographic representations in readers' mental lexicons for reading, whereas the orthographic awareness is reflected in learners' copying skills, along with the visual-motor integration. We thus assumed that the quality of learners' orthographic representations and their visual-motor skills as reflected in character reading and copying will predict their spelling ability and mediate the effects of metalinguistic awareness. These hypotheses were evaluated by a path model specifying the indirect effects of metalinguistic awareness on spelling with both character reading and copying as mediators in a sample of young CSL learners. To date, there have been comparatively few studies concerning young CSL learners' literacy development and we believe that, as shown below, understanding the Chinese literacy development of this group can help broaden our knowledge of Chinese literacy development across learners with different linguistic backgrounds.

CSL learners' metalinguistic awareness and literacy development

Studies have shown that bilingual learners have higher metalinguistic awareness than their monolingual counterparts, as the bi- and multi-lingual context may cause them to be more sensitive to the structural dimension of language (Adesope et al., 2010; Bialystok et al., 2014; Eviatar et al., 2018). Studies have also found that the enhanced metalinguistic awareness of bilingual learners is beneficial to their L2 literacy skills of reading and spelling (Eviatar et al., 2018; Harrison et al., 2016). In their meta-analysis comparing bilingual to monolingual learners on English spelling, Zhao et al. (2016) found that bilingual learners were able to master constrained skills and actually outperformed their monolingual counterparts on spelling. The L2 learners' enhanced metalinguistic awareness could facilitate research exploring its influences on literacy development.

There have been far fewer studies investigating Chinese L2 learners compared to those examining English L2 learners. However, given the idiosyncratic and complex Chinese writing system, literacy acquisition is a major challenge for CSL learners (Everson, 2002; Liu, 2002) and thus constitutes a major topic for CSL research. Usually, the participants in CSL research are adult learners (Shen, 2013; Shen & Ke, 2007; see the review by Ma et al., 2017). The research findings have generally identified similar patterns of relationships between metalinguistic awareness and literacy skills to those found in native Chinese-speaking children. As for the role of orthographic awareness in CSL literacy, research shows that explicit instruction on Chinese orthography facilitates learners' orthographic awareness and benefits their literacy learning (see the review by Ke, 2020). Zhang and Roberts (2019) found that phonological awareness predicted character reading and spelling in adult Arabic and English CSL learners. In studies with English-speaking Chinese heritage language learners, who had learned Chinese as L1 in the home but with limited exposure and formal instruction (which resulted in restricted competencies and bears resemblance to CSL learners), it was found that their morphological awareness was closely related to their oral vocabulary (Luo et al., 2018) and contributed to reading comprehension (Zhang & Koda, 2018). In general, the findings of CSL studies that various metalinguistic awareness types support literacy development were similar to those in Chinese L1.

These patterns of relationships between metalinguistic awareness and literacy development were also observed in Hong Kong's ethnic minority CSL students who are non-native, young learners of different native languages who learn Chinese throughout the primary and secondary grades in a Chinese-speaking society. It should be noted that the linguistic context of Hong Kong, an international city with both Chinese and English as its official languages, has specific characteristics for Chinese literacy acquisition that differ from other Chinese-speaking areas. In most local schools, Cantonese, the dialect prevalent in Guangdong Province and Macau close to Hong Kong, serves as the oral language that is used and taught, and the traditional script is used for written Chinese, which differs from the simplified script used in mainland China and Singapore. However, most schools teach standard oral Chinese, Mandarin, or Putonghua as a subject (with much less class time than the

Chinese class taught in Cantonese). The simplified script is not taught in either Chinese language or Mandarin lessons. The teaching of Putonghua is facilitated by a phonological coding system called *Hanyu Pinyin* (a romanization system for Putonghua), while no phonological coding is provided for Cantonese learning (Zhang & McBride-Chang, 2011). As for ethnic minority students, it has been found that Chinese learning is important for their academic and career expectations (Cheung et al., 2015), but these students often perform unsatisfactorily in Chinese language attainment tests (Tsung et al., 2010; Wong, 2018) and tend to have a low opinion of their own Chinese proficiency (Ku et al., 2005; Li & Chuk, 2015; Loper, 2004).

Studies of these students have found that their Chinese orthographic knowledge and componential awareness are important for the development of their Chinese reading (Leong et al., 2011; Wong, 2017, 2019) and writing skills (Leong et al., 2018). Wong (2018) found that copying partially mediated the influence from reading to sentence writing, and they attributed the mediation effect to the orthographic representations developed through reading, which were carried through to copying and supported writing. Moreover, Wong (2021) observed a strong CSL reading–listening comprehension relationship, which aligns with the findings in literacy research that (1) reading development partly depends on oral language understanding as measured by listening comprehension (Language & Reading Research Consortium, 2015), and (2) reading promotes linguistic knowledge and awareness (such as high lexical-quality vocabulary), which facilitate listening comprehension (Kim & Philips, 2014). As in Chinese L1 learners, reading was found to promote morphological awareness (Cheng et al., 2016), which in turn contributed to oral vocabulary knowledge (Tong et al., 2017). The findings highlight the reciprocal nature of language–literacy relations in both Chinese-speaking and CSL learners.

By comparing these young CSL students with their Chinese-speaking counterparts, Zhou and McBride (2018) and Zhou et al. (2018) further found that while similar linguistic correlates of Chinese literacy acquisition were identified in both groups of students, the CSL students relied more heavily on their Chinese phonological awareness skills than their orthographic and morphological skills. The participating Grade 3 and 4 CSL students in Zhou and McBride (2018) were studying in Hong Kong's international schools, where Chinese is taught in Mandarin with the aid of *Hanyu Pinyin* and with relatively limited lesson time compared to the mainstream local schools. Particularly relevant to the present study, Zhou et al. (2018), in which the participating students were in Grades 2 and 3 and learned CSL in local primary schools, found that while the native Chinese-speaking children's morphological awareness, visual-spatial skills, and copying skills were related to their spelling, the only significant predictor of the CSL children's spelling was phonological awareness. The researchers attributed this result to the CSL children's under-developed Chinese orthographic knowledge, which led them to rely more heavily on their phonological skills for Chinese literacy tasks. Wang et al. (2018) experimented to evaluate the effectiveness of Chinese literacy acquisition by the native Chinese-speaking and CSL children in Grades 2 and 3 under four conditions: Copying, look-say, radical knowledge, and phonological information. They found that copying skills facilitated the writing of both groups of children, but that the CSL children did not benefit from radical knowledge instruction (the researchers speculated that this

might be related to the children's limited Chinese learning experience and competence). This finding did not align with the findings of Leong et al (2011) and Wong (2017, 2019). More research is needed to determine the contribution of various metalinguistic skills to CSL learners' literacy development.

The present study

Little is understood about young CSL learners' Chinese spelling, which is an important skill for their writing development, especially through a research design that considers all related metalinguistic and linguistic correlates identified in previous studies holistically. To address this gap, the present study was conducted with the following overarching question: What are the relative strengths of various metalinguistic awareness skills, including orthographic, phonological, and morphological processing, on CSL spelling with regard to both character reading and copying? As stated above, the effects of metalinguistic awareness were evaluated with a proposed mediation model, specified with reference to previous studies, and are illustrated in Fig. 1 with character reading and copying as mediators. In this model, all three metalinguistic awareness skills contribute to the character reading, thus representing the learners' character knowledge and the quality of their orthographic representations. In contrast, only orthographic skills contribute to copying, which reflect orthographic awareness and visual-motor integration skills that are critical to Chinese spelling. Given the findings of previous studies, we expected that orthographic awareness would have a more dominant effect on spelling than morphological and phonological awareness, indirectly through the character reading and copying of

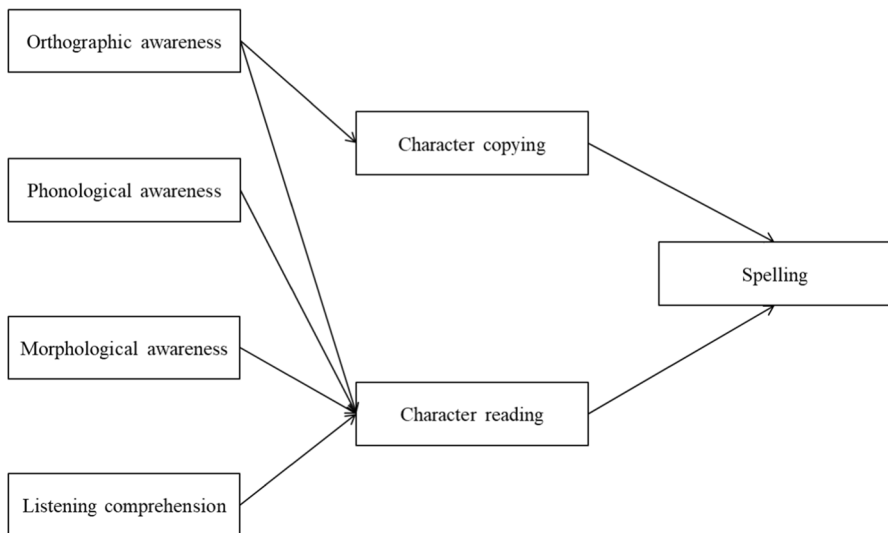


Fig. 1 Proposed path model for CSL spelling

the participating CSL students who have been learning Chinese for some years. The software used for path analysis was IBM® SPSS® Amos.

The study included a listening comprehension measure as a control variable for the CSL learners' Chinese oral language competence. A substantial body of research found that oral language provides a critical foundation for early literacy skills and later reading development (Language & Reading Research Consortium, 2015; NICHID, 2005), which is particularly important for second-language learners as they generally have inferior L2 oral proficiency to support literacy (Bialystok, 2007). Therefore, without proper control of its influences, it would be difficult to determine the unique contribution of the various metalinguistic skills to character reading and spelling. For this reason, the young learners' oral competency in Chinese was measured by a listening comprehension test consisting of vocabulary and comprehension items, and it was included as an immediate predictor of character reading with an indirect effect on spelling. This was an important general measure of verbal skills for controlling effect. It served a different purpose than vocabulary knowledge, which is often included in studies concerning its reciprocal influences with orthographic and/or morphological awareness in Chinese language studies (e.g., Luo et al., 2018; Tong et al., 2017).

Methods

Participants

The participants comprised 221 primary ethnic minority students in Hong Kong, whose families had origins in South Asian countries; they were recruited from five government-aided schools with a substantial proportion of ethnic minority students of low to moderate socioeconomic status (SES). No further specific SES and family background information was collected from the students, nor were students' general cognitive abilities, like intelligence, evaluated. However, their teachers reported that there were no students with special educational needs. The students had been learning both English and Chinese as second languages (both are official languages in Hong Kong and compulsory school subjects), but they had attained a higher proficiency in English than in Chinese because, as is common across Hong Kong schools that enroll many ethnic minority students (Tsung et al., 2010), all of the schools adopt English as the medium of instruction except in Chinese lessons. Chinese was taught as a core subject in Cantonese using the traditional script with no accompanying phonological coding system. Some of the schools also taught Mandarin as a subject but with very limited lesson times (one lesson per week). Most of the students had attended their respective schools starting in Grade 1, and, by the time of testing, all students were at the end of their Grade 3 school year. The present study required participating students to be equipped with a certain degree of Chinese competency, which is why students about to complete their junior-primary schooling were chosen as participants, as they had been learning CSL in school for some years.

By the time of testing, the students, on average, were 9.27 years old (*SD*: 0.04, Range: 7.39–11.49). The difference in students' ages was limited, but for better

control, age was entered in the subsequent analyses as a control variable. Most had been born in Hong Kong (161 or 72.85%) and had started education in kindergarten (176 or 79.64%). Their ethnic distribution was as follows: 91 (41.18%) Pakistani, 83 (37.56%) Nepalese, 26 (11.76%) Indian, 8 (3.62%) Filipino, 5 (2.26%) Indonesian, and 8 (3.62%) of other ethnicities. It is noted that the students constituted a heterogenous linguistic group speaking their different mother tongues at home and may have had different degrees of L1 literacy competency. However, it was beyond the research team's capacity to consider the whole range of linguistic diversity of the participants. To evaluate the potential L1 influences on the students' CSL learning, one-way ANOVAs were conducted to see if there were significant performance differences in Chinese literacy skills among students of different ethnicities. The results showed no statistically significant group differences in character reading ($F(5, 215) = 0.26, p = 0.94$) or spelling ($F(5, 215) = 1.03, p = 0.40$).

Measures

A range of Chinese language assessments was administered to evaluate the students' metalinguistic awareness, listening comprehension, Chinese character reading, copying, and spelling, as follows:

Orthographic awareness

The orthographic awareness test was developed with reference to those adopted by Ho et al. (2003) and Shen and Ke (2007), and used in Wong (2017, 2019). The orthographic awareness test consists of two parts: Assessing the students' visual-orthographic sensitivity to Chinese characters and their awareness of the semantic radicals' representational functions. Part 1 comprised a radical perception test that requires the students to divide a compound character into two immediate component radicals; for example, to divide character 攔 (clutch, /ak1/) into the semantic radical 扌 (indicating hand-related motions) and the phonetic radical 凵 (adversity, /ak1/). Part 2 assesses participants' skill in using the information provided by the semantic radical to decode a novel character. The participants were shown a picture (provided with an English illustration) and were required to choose the novel character with the meaning that best matched the picture from three options. For example, from the three options of 持 (hold, /ci4/), 峙 (stand up, /ci5/), and 侍 (waiter, /si6/), which all share the same phonetic radical 寺 (temple, /zi6/), they should have chosen 侍 to match the picture of a waiter (as its semantic radical 亻 indicates people). All of the characters were novel to the participants, since they are at the Grade 6 level, according to Pan and Kang's (2003) study, and their Chinese teachers confirmed that none of the words had been covered in their Chinese lessons. There were 12 and 20 items in Parts 1 and 2, respectively, for a total of 32 items, and each correct response was awarded one mark. The test had a good reliability, with a Cronbach's alpha of 0.82.

Phonological awareness

The phonological awareness test was developed with reference to the measures adopted in Li et al. (2012) and Tong and McBride-Chang (2010). The test has two sections assessing the participants' phonological sensitivity at the syllabic and sub-syllabic (i.e., onset/rime/tone) levels. In Part 1, the participants were required to reproduce a Chinese word/phrase minus one of the syllables, for example, removing the syllable /luk6/ (綠, green) from the word /hung4 luk6 dang1/ (紅綠燈, traffic light) and reproducing /hung4 dang1/. The Part 2 items had an "odd-man-out" format, with students required to identify a syllable with a systematic difference from the rest, among four options. For example, in the four options of /fung1/ (風, wind), /faa1/ (風, flower), /fui1/ (風, ash), and /gan1/ (風, a unit of weight), the correct answer is /gan1/, as it has a different onset /g/ (while all four options have the same tone, 1, and different rimes). There were 18 items in each of Parts 1 and 2, for a total of 36 items, and each correct response was awarded one mark. The test had a good reliability, with a Cronbach's alpha of 0.90.

Morphological awareness

The morphological awareness test was developed with reference to Li et al. (2012), McBride-Chang et al. (2008), and Zhou et al. (2018). The test has two sections. Part 1 has 12 homophone judgment items in the "odd-man-out" format. The students were required to identify a homophone with a different meaning from among three options; for example, to identify that /bui3/ of /bui3 hok3/ (貝殼, seashell) is different from that of /bui3 zek3/ (背脊, backbone) and /bui3 min6/ (背面, back side). Part 2 is a morphological construction task with seven items. In each item, the students were presented with a simple morphological analysis of a word compound, that is, the compound's constituent morpheme, and were then required to construct a new compound with the acquired morphological structure. For example, the word compound /cing1 zuk1 se4/ (青竹蛇, a kind of snake) was elaborated as "a snake (蛇, /se4/) that is green (青, /cing1/) and looks like bamboo (竹, /zuk1/)," and the students were required to construct a new compound for "a snake that is red (紅, /hung4/) and looks like a belt (帶, /daai3/)" (the correct answer is /hung4 daai3 se4/ 紅帶蛇). There was a total of 19 items, and each correct response was awarded one mark, resulting in a satisfactory reliability, with a Cronbach's alpha of 0.75.

Listening comprehension

The listening comprehension test was taken from a local standardized test, namely the Hong Kong Attainment Test (HKAT; Educational Research Section of the Hong Kong Education Department, 1989a, b, 1999a, b), and a school-based Chinese language listening test developed by the Curriculum Development Institute of the Hong Kong Education Bureau (2011) for junior-primary ethnic minority students. As the HKAT was developed to assess local Chinese-speaking children's abilities in Chinese, the items adopted by this study were of a lower grade level (i.e., Grade 1) to compensate for the lower Chinese competence of the participating ethnic minority

students. The test consists of two parts. Part 1 consisted of an oral vocabulary test with 24 items, in which the students were required to match a picture with a targeted word that was given in a simple context, for example, “Tom is a teacher. What does Tom do for a living?” Part 2 comprised 16 multiple-choice questions on listening material content to assess the students’ comprehension ability. There was a total of 40 items and each correct response was awarded one mark. The test had a good reliability, with a Cronbach’s alpha value of 0.87.

Chinese character copying

The character copying test was developed with reference to Tan et al. (2005) and used in Wong (2018). The test required that students copy as many of the presented Chinese characters as possible in one minute. The presented characters were a mix of common (e.g., 天 ‘sky’ /tin1/) and relatively uncommon characters (e.g., 晶 ‘crystal’ /zing1/), and of simple (e.g., 上 ‘above’ /soeng6/) and compound characters (e.g., 湖 ‘lake’ /wu4/). The students were first given some practice items and instructed (1) to write clearly and at their normal pace, and (2) that incorrect, unclear, or incomplete copied characters would not be scored. There were two test sets and their correlation was 0.84, indicating good test–retest reliability.

Chinese character reading

The Chinese character reading test was used in Wong (2017, 2019). It consists of test items as single characters or two-character words. Chinese characters at the Grade 1 level were selected with reference to Pan and Kang’s (2003) study of the use of Chinese characters in Hong Kong primary schools. All items were also verified against a list of basic Chinese words; the list was prepared for Hong Kong primary students (Chinese Language Education Section of the Hong Kong Education Bureau, 2008) to ensure that the words are at the junior-primary level. Among the 100 character items that were chosen in total, 50 were single characters and 25 were two-character words. The test was designed as an individual test, and the students were required to read out the characters one by one and follow the test administrator’s instructions. Each correct pronunciation was awarded one point. The test had a good reliability, with a Cronbach’s alpha of 0.98.

Chinese spelling

A dictation test was used to assess the students’ Chinese spelling. The students were required to write down single characters, two-character words, and four-character phrases. As facilitation, both single-character and two-character word items were presented with corresponding pictures, and each of the four-character phrases was presented in a sentence to provide context. All target items and sentences were read aloud to the students. The target items were also verified against the list of basic Chinese words that was prepared for Hong Kong primary students (Chinese Language Education Section of the Hong Kong Education Bureau, 2008) to ensure that

Table 1 Alpha values and descriptive statistics for all measures used in the study ($N=221$)

Measures (max score)	Alpha	Range	Mean (%)	<i>SD</i>	Skewness	Kurtosis
Orthographic awareness (32)	.82	5–31	19.66 (61.44)	5.62	.02	–.64
Phonological awareness (36)	.90	0–32	20.95 (58.19)	7.46	–1.12	.63
Morphological awareness (19)	.75	0–17	6.88 (36.18)	3.77	.41	–.33
Listening comprehension (40)	.87	10–38	26.09 (65.23)	7.61	–.76	.05
Character copying (---)	.84 [#]	5–29	11.88 (---)	4.32	.38	.92
Character reading (100)	.98	0–96	28.76 (28.76)	22.57	.88	–.05
Spelling (41)	.95	0–41	11.08 (27.02)	9.60	.94	.23

[#] Test–retest reliability

Table 2 Partial correlations among all measures after controlling for age ($N=221$)

Variables	1	2	3	4	5	6	7
1. Orthographic awareness	–						
2. Phonological awareness	.39**	–					
3. Morphological awareness	.45**	.37**	–				
4. Listening comprehension	.59**	.51**	.52**	–			
5. Character copying	.33**	.25**	.23**	.34**	–		
6. Character reading	.65**	.41**	.55**	.73**	.28**	–	
7. Spelling	.70**	.44**	.49**	.69**	.37**	.89**	–

** $p < .01$

the words were at the junior-primary level. Each correctly identified character was awarded one mark. The test had a good reliability, with a Cronbach's alpha of 0.95.

Data were collected by the research team (comprising university students at the researchers' affiliated institutes) on-site with the assistance of respective school-teachers for logistical arrangements. All written test items/instructions were presented in traditional Chinese script and oral test items/instructions, for example, those in listening comprehension and dictation tests, were provided in Cantonese (clarifications in English were also provided if needed). The tests were administered from June to July and took about 2 h at each school.

Results

The alpha values and descriptive statistics for all measures are presented in Table 1. All measures' Cronbach's alpha values for reliability were acceptable to good, with a range of 0.75 to 0.98. The majority of the absolute values of skewness and kurtosis were less than or close to one, showing that the measures had no severe violations of the normal distribution. Correlations among the measures controlling for age are presented in Table 2. Controlling for age, all correlations were statistically significant, with the lowest between orthographic and phonological awareness ($r=0.38$) and the highest between character reading and spelling ($r=0.89$). As for the rather

high value of the reading–spelling correlation, we evaluated it with reference to previous Chinese L1 and CSL studies with the reading–spelling correlation values reported: The average value of the nine Chinese L1 studies was 0.58 (ranging from 0.30 to 0.75), while only one CSL study was found (Zhou et al., 2018), in which the value was 0.84. It was noted that CSL learners’ character reading and spelling showed higher correlations, which aligns with our findings here.

Addressing the research question regarding the relationship between metalinguistic awareness and spelling among CSL learners, a path model, as specified in Fig. 1 and with age as a control variable, was evaluated, and the resulting fit indices were not good: $\chi^2(8)=34.35$, $p=0.00$, CFI=1, SRMR=0.04, RMSEA=0.12, 90%CI [0.08, 0.17], PCLOSE=0.00. Model modification indices showed that orthographic awareness had a strong direct influence on spelling, while listening comprehension had a strong direct influence on copying. These results indicated, as suggested by the literature review, a strong and pervasive oral language influence on all literacy acquisition and development (Language & Reading Research Consortium, 2015; NICHID, 2005), and that in Chinese, the learners’ orthographic awareness (i.e., their knowledge of the characters’ internal structures and regularities) has a substantial direct influence on spelling (Lam & McBride, 2018; Lo et al., 2018; Mo et al., 2018), which goes beyond the indirect influences exerted via character reading and copying. Accordingly, the model was re-specified with the direct routes from orthographic awareness to spelling and from listening comprehension to copying.

The modified model, as presented in Fig. 2, differed significantly from the original model as shown by the χ^2 -difference test results: $\chi^2(2)=2$ 8.43, $p=0.00$, and a remarkable improvement was observed in the model fit indices: $\chi^2(6)=5.92$, $p=0.43$, CFI=1, SRMR=0.01, RMSEA=0.00, 90%CI [0.00, 0.09], PCLOSE=0.72. A substantial portion of the variance in spelling (83%) was explained by the model. A bootstrap estimation approach was adopted

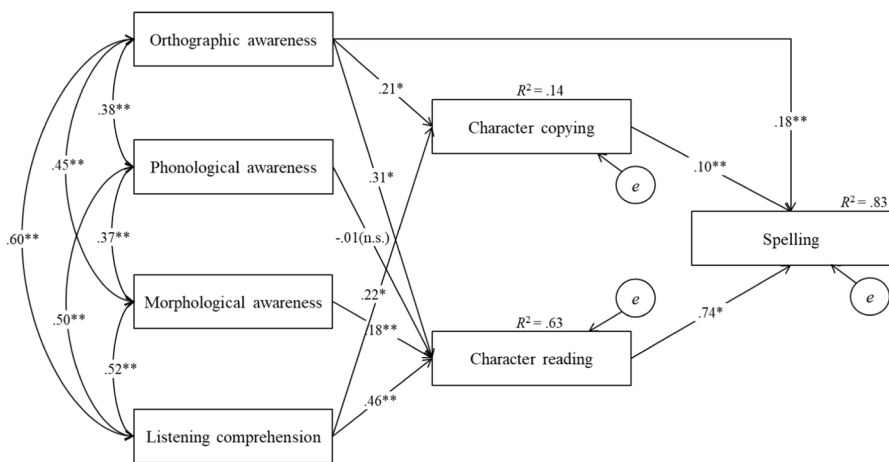


Fig. 2 Results of the revised path model for CSL spelling. Note Age was entered as a control variable in the model. ** $p < .01$. * $p < .05$

to evaluate the direct, indirect, and full effects in the model (Shrout & Bolger, 2002). The results of the bootstrapping method with 500 samples are presented in Table 3. Here, character reading had a direct, dominant effect (standardized regression coefficient $\beta=0.74$) on Chinese spelling, while copying's direct effect was comparatively slight, although still statistically significant ($\beta=0.10$). Both character reading and copying were under the direct influence of listening comprehension and orthographic awareness and mediated their effects on spelling fully (in the case of listening comprehension) or partially (in the case of orthographic awareness). Morphological awareness, but not phonological awareness, also affected character reading, indicating that sensitivity to morphemic structure facilitates CSL learners' Chinese reading at this stage. Orthographic awareness played a significant role in CSL learners' spelling, as it exerted a direct effect ($\beta=0.18$), in addition to the indirect effects through reading and copying. Among the three metalinguistic awareness skills, orthographic awareness had the largest total effect on spelling, 0.43, in terms of β -value, compared to that of morphological awareness at 0.13, phonological awareness at -0.01 (which was statistically non-significant), and listening comprehension, the controlling variable for oral language competence, at 0.37.

Table 3 Standardized regression weights of the direct, indirect, and total effects in the revised path model for CSL spelling

Path	β	SE	95%CI	P
Direct effect				
OA \rightarrow CR	.31	.08	.11, .42	.02
PA \rightarrow CR	-.01	.05	-.14, .06	.63
MA \rightarrow CR	.18	.05	.08, .27	.00
LC \rightarrow CR	.46	.07	.34, .63	.00
OA \rightarrow CC	.21	.07	.07, .35	.01
LC \rightarrow CC	.22	.07	.07, .35	.01
OA \rightarrow SP	.18	.06	.07, .30	.00
CR \rightarrow SP	.74	.05	.61, .83	.01
CC \rightarrow SP	.10	.03	.04, .18	.00
Indirect effect				
OA \rightarrow CR, CC \rightarrow SP	.25	.06	.11, .35	.02
PA \rightarrow CR, CC \rightarrow SP	-.01	.04	-.10, .05	.62
MA \rightarrow CR, CC \rightarrow SP	.13	.04	.05, .20	.01
L \rightarrow CR, CC \rightarrow SP	.37	.05	.27, .46	.00
Total effect ^a				
OA \rightarrow SP; OA CR, CC \rightarrow SP	.43	.05	.32, .53	.01

OA orthographic awareness, PA phonological awareness, MA morphological awareness, LC listening comprehension, CR character reading, CC character copying, SP spelling

^aThe total effect of phonological awareness, morphological awareness, and listening comprehension on spelling was equal to their indirect effects, as there were total mediations by character reading and copying

Discussion

This study evaluated the effects of related metalinguistic and linguistic correlates, particularly character reading and copying, as identified in previous CSL and Chinese L1 studies (Leong et al., 2018; Yeung et al., 2013a, b; Zhou & McBride, 2018), on CSL spelling by generating a mediation model. The finalized model explained a substantial portion of the variance in CSL spelling (83%) with contributions from orthographic awareness, morphological awareness, and listening comprehension, which were largely mediated by character reading and copying, reflecting their orthographic representations and visual-motor integration. Learners' orthographic knowledge played a pivotal role, as it contributed to spelling both directly and indirectly through the mediator variables. Comparatively, the contribution of morphological awareness was indirect and small, whereas that of phonological awareness was not significant. These results support the hypotheses that metalinguistic awareness facilitates learners' orthographic representation quality and visual-motor skills, which are critical for their spelling. They also underscore oral language as an important foundation for CSL literacy acquisition: The students' listening comprehension strongly directly influenced both their character reading and copying and indirectly influenced spelling itself.

The results provide strong evidence for the importance of orthographic awareness for CSL learners' spelling. This finding aligns with those of studies conducted with Chinese-speaking children concerning their spelling (Lam & McBride, 2018; Lo et al., 2018; Mo et al., 2018). A more nuanced analysis with our model (Fig. 2) suggested that similar to their Chinese-speaking counterparts, the CSL learners' knowledge and sensitivity to orthographic conventions and regularities, including the composite radicals and their positional regularity and linguistic information, contribute to their character knowledge and mental representations, which facilitates character reading (Yeung et al., 2011, 2013c) and copying (Mo et al., 2018). These in turn contribute to spelling ability. Our findings further suggest that orthographic awareness facilitates the encoding process of spelling, over and beyond the influences of character reading and copying, as shown by its direct effect on spelling. Given the orthographic complexity of Chinese characters, learners' orthographic awareness is important for retention, visual-motor integration, decoding, and encoding. Learners' knowledge of semantic and phonetic radicals, as a composite of orthographic awareness, may also facilitate their use of morphological and phonological information for character reading, copying, and spelling.

As shown in the study's adopted mediation model, morphological awareness was found to have a statistically significant indirect effect via character reading on spelling. Learners' sensitivity to the morpheme (which is mostly represented by a character) and the word-compound structure helps facilitate better character reading/memory and, therefore, spelling. Again, the findings were similar to those found in Chinese-speaking children (Tong et al., 2017; Yeung et al., 2011). Unlike orthographic awareness, however, morphological awareness did not have a direct influence on spelling over and beyond reading and copying. This finding

suggests that the contribution of morphological awareness to spelling is through high-quality orthographic representations in learners' mental lexicons and reflected in their character reading, as shown by Li et al. (2019).

In contrast, phonological awareness was found to have no statistically significant effects on either reading or spelling. This may be related to the fact that, as shown in Chinese-speaking learners (Tong et al., 2009), the syllabic awareness required for character reading is relatively easy to attain and to automatize for most learners over time. On the other hand, a more fine-grained awareness at the sub-syllabic level was not facilitative for the participating students' character reading as they have not been taught with any phonological encoding system (which shows sub-syllabic phonological units in writing) to aid literacy acquisition. Therefore, it is likely that these factors limited the contribution of phonological awareness to their literacy development. This also explains why the phonological awareness of these CSL learners, who were completing their Grade 3 school year and had already been learning Chinese for years, did not influence their spelling, as found in Zhou and McBride (2018) and Zhou et al. (2018). In Zhou and McBride (2018), the participants learned Chinese with the aid of *Hanyu Pinyin*, which encouraged them to use the skill, while the younger Grades 2 and 3 participants in Zhou et al. (2018) had under-developed Chinese orthographic knowledge and had to rely more heavily on their phonological skills. Similarly, Zhang and Roberts' (2019) adult learners, who had studied the language for only one or two years and had limited Chinese competences, also leaned on their phonological skills for literacy tasks. The lack of exposure to any Chinese phonological encoding system might also have compromised the present study's students' capability in using phonological information like the participants in Wang et al.'s (2018) study.

The path model adopted in this study sheds light on the component processes of Chinese spelling in CSL learners, specifying the mediating effects of character reading and copying. As postulated, the learners' character reading and copying reflected their Chinese orthographic representation quality and visual-motor skills and largely mediated the effects of metalinguistic awareness, and both reading and copying contributed directly to spelling. Beyond phonological awareness, which had no significant effect, orthographic and morphological awareness together and orthographic awareness alone facilitated the learners' character reading and copying, respectively. The mediation model advances our understanding of the contributions of metalinguistic skills to copying, reading, and spelling in CSL learners.

Aside from identifying the relative strengths of influences of metalinguistic awareness skills, the results also yielded some interesting findings concerning the role of oral language in CSL literacy, underscoring the importance of oral language for CSL literacy development. The learners' listening comprehension was found to have a substantial influence on their literacy skills: It was moderately to strongly related to all metalinguistic awareness, had the largest direct contribution to both character reading and copying, and also had a substantial indirect effect on spelling through their mediation. It should be noted that the copying task used in the present study was with Chinese character items, not using unfamiliar scripts as in McBride-Chang et al. (2011) and Wang et al. (2014), which may be a factor for the relationship. Research on alphabetic language learners has found that oral language

provides a critical foundation for early literacy skills and later reading development, especially in second language learners (Bialystok, 2007; Language & Reading Research Consortium, 2015; NICHID, 2005). The findings of this study indicate that similar relationships were found in CSL learners learning a foreign language with a morpho-syllabic writing system. As found by previous CSL studies (Wong, 2019, 2021), the CSL learners' Chinese oral language played a significant role in their literacy development.

Educational implications

These findings hold some key educational implications for CSL learning and instruction. The findings suggest that fluent CSL spellers are those with good character knowledge and visual-motor integrated skills, which in turn are facilitated by both orthographic and morphological awareness. It is recommended that teachers help their students acquire character knowledge by building up orthographic and morphological knowledge with instructional practices such as analyzing word compounds and characters' orthographic structure, explicit teaching of radical knowledge, and combination regularities. Teachers may also make use of character copying at a reasonable level to consolidate students' character knowledge and facilitate their spelling. Acquiring literacy is likely to help CSL learners recognize syllables in Chinese naturally (most characters represent syllables); however, for those lagging behind, teachers may facilitate their learning by making the point explicit. Finally, it should be noted that Chinese listening comprehension is highly related to the various metalinguistic awareness types and has a substantial influence on all literacy abilities; thus, oral language should be a core component of the CSL curriculum. Furthermore, efforts should be made to identify relevance to literacy learning; for example, pointing out the one-to-one character-syllable and character-morpheme relationships, in addition to using different characters to differentiate homophones and homographs.

Conclusions

This study has highlighted the importance of orthographic and morphological awareness for CSL spelling with considerations of critical linguistic correlates, character reading, and copying. In particular, orthographic processing was uniquely associated in our model with Chinese spelling, both directly and indirectly through character reading and copying. These findings are similar to previous work on both CSL and Chinese-speaking learners, suggesting that similar types of metalinguistic awareness matter to Chinese literacy at this stage of learning. The importance of oral language in CSL literacy is also clear. Thus, CSL teachers can facilitate students' literacy acquisition by teaching and consolidating orthographic and morphological knowledge based on a firm oral language foundation.

Several limitations should also be highlighted from this research. First, Hong Kong's ethnic minority students learn CSL within an idiosyncratic context

characterized by, for example, the use and learning of Cantonese as the oral language and traditional script as the written form and with no phonological coding provided for characters to facilitate language learning. Therefore, generalizations of the present study's findings to other populations of CSL learners should be made with caution. Second, it would be useful to compare native Chinese-speaking learners' performances with those of the CSL group. Lacking such a comparative design, the present study relied on the body of literature on Chinese-speaking children's literacy development for reference. Building on the study's findings of unique metalinguistic awareness correlates of CSL literacy, future studies may continue to explore CSL development with such a research design. Third, the correlation between character reading and spelling indicates that both skills may rely on similar underlying knowledge and/or cognitive processes, as found by Chan et al. (2010) and Li et al. (2019) in native Chinese-speaking learners. Given the rather high correlation value ($r=0.89$) discovered in this study, the reading-spelling relationship may be stronger in CSL learners. Future CSL studies may examine further the underlying factor structures of the two skills to account for their relationship. It should be noted that the study did not include the variables of the participants' L1s, SES, family backgrounds, and general cognitive abilities in the analyses, so readers should be cautious in interpreting the results, and researchers might examine these factors in future studies.

Notes.

1 As a morpho-syllabic writing system, spelling in Chinese involves a process of writing the character(s) of a word rather than writing the letter(s) of a word, as in alphabetic languages. We retain the term "spelling" to align with the large body of research concerning alphabetic languages, although some researchers use the terms "dictation" or "character writing" instead for differentiation.

2. Each Chinese character's Cantonese pronunciation is Romanized (according to the *Jyutping* system) and translated into English in brackets.

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Data availability The authors are not authorized to make the data and material for public view/use.

Declaration

Conflicts of interest There are no conflicts of interests/competing interests to declare.

References

Adams, M. J. (1990). *Beginning to read: Thinking and learning about print*. MIT Press.

- Adesope, O. O., Lavin, T., Thompson, T., & Ungerleider, C. (2010). A systematic review and meta-analysis of the cognitive correlates of bilingualism. *Review of Educational Research, 80*(2), 207–245.
- Anderson, R. C., Ku, Y., Li, W., Chen, X., Wu, X., & Shu, H. (2013). Learning to see the patterns in Chinese characters. *Scientific Studies of Reading, 17*(1), 41–56.
- Bialystok, E. (2007). Acquisition of literacy in bilingual children: A framework for research. *Language Learning, 57*, 45–77.
- Bialystok, E., Peets, K. F., & Moreno, S. (2014). Producing bilinguals through immersion education: Development of metalinguistic awareness. *Applied Psycholinguistics, 35*, 177–191.
- Cao, F., Rickles, B., Vu, M., Zhu, Z., Chan, D. H. L., Harris, L. N., Stafura, J., Xu, Y., & Perfetti, C. A. (2013). Early stage visual-orthographic processes predict long-term retention of word form and meaning: A visual encoding training study. *Journal of Neurolinguistics, 26*, 440–461.
- Chan, D. W., Ho, C.S.-H., Tsang, S.-M., Lee, S.-H., & Chung, K. K. H. (2016). Exploring the reading-writing connection in Chinese children with dyslexia in Hong Kong. *Reading and Writing, 19*, 543–561.
- Chang, L.-Y., Stafura, J. Z., Rickles, B., Chen, H.-C., & Perfetti, C. A. (2015). Incremental learning of Chinese orthography: ERP indicators of animated and static stroke displays on character form and meaning acquisition. *Journal of Neurolinguistics, 33*, 78–95.
- Chang, L.-Y., Xu, Y., Perfetti, C. A., Zhang, J., & Chen, H.-C. (2014). Supporting orthographic learning at the beginning stage of learning to read Chinese as a second language. *International Journal of Disability, Development and Education, 61*(3), 288–305.
- Chen, H.-C., Chang, L.-Y., Chiou, Y.-S., Sung, Y.-T., & Chang, K.-E. (2011). 中文部件組字與形構資料庫之建立及其在識字教學的應用 [Chinese orthography database and its application in teaching Chinese characters]. *Bulletin of Educational Psychology, 43*, 269–290.
- Cheng, Y., Zhang, J., Wu, X., Liu, H., & Li, H. (2016). Cross-lagged relationships between morphological awareness and reading comprehension among Chinese children. *Frontiers in Psychology, 7*, 1379.
- Cheung, F., Lai, B. P. Y., Wu, A. M. S., & Ku, L. (2015). Academic and career expectations of ethnic minority youth in Hong Kong. *The Journal of Early Adolescence, 35*(8), 1092–1107.
- Cheung, H., McBride-Chang, C., & Chow, B.W.-Y. (2006). Reading Chinese. In R. M. Joshi & P. G. Aaron (Eds.), *Handbook of orthography and literacy* (pp. 421–438). Lawrence Erlbaum Associates.
- Chinese Language Education Section of the Hong Kong Education Bureau. (2008). *Lexical items with English translations for fundamental Chinese learning in Hong Kong schools*. Hong Kong: Education Bureau of the Government of the Hong Kong Special Administration Region.
- Curriculum Development Institute of the Hong Kong Education Bureau (2011) 中國語文校內評估工具 (非華語學生適用) [School-based Chinese language assessment tool (applicable to non-Chinese-speaking students)]. Hong Kong: Government of the Hong Kong Special Administration Region.
- Educational Research Section of the Hong Kong Education Department. (1989a). 香港學科測驗第三輯: 中文 (小學一年級) [The third series of the Hong Kong attainment test: Chinese (Grade 1)]. Hong Kong: Government of the Hong Kong Special Administration Region.
- Educational Research Section of the Hong Kong Education Department. (1989b). 香港學科測驗第三輯: 中文 (小學二年級) [The third series of the Hong Kong attainment test: Chinese (Grade 2)]. Hong Kong: Government of the Hong Kong Special Administration Region.
- Educational Research Section of the Hong Kong Education Department. (1999a). 香港學科測驗第五輯: 中文 (小學一年級) [The fifth series of the Hong Kong attainment test: Chinese (Grade 1)]. Hong Kong: Government of the Hong Kong Special Administration Region.
- Educational Research Section of the Hong Kong Education Department. (1999b). 香港學科測驗第五輯: 中文 (小學二年級) [The fifth series of the Hong Kong attainment test: Chinese (Grade 2)]. Hong Kong: Government of the Hong Kong Special Administration Region.
- Eviatar, Z., Taha, H., & Shwartz, M. (2018). Metalinguistic awareness and literacy among Semitic-bilingual learners: A cross-language perspective. *Reading and Writing, 31*, 1869–1891.
- Everson, M. E. (2002). Theoretical developments in reading Chinese and Japanese as foreign languages. In J. H. Sullivan (Ed.), *Literacy and the second language learner* (pp. 1–16). Information Age Publishing.
- Feng, L., Lindner, A., Ji, X. R., & Joshi, R. M. (2019). The roles of handwriting and keyboarding in writing: A meta-analytic review. *Reading and Writing, 32*, 33–63.
- Guan, C. Q., Liu, Y., Chan, D. H., Ye, F., & Perfetti, C. A. (2011). Writing strengthens orthography and alphabetic-coding strengthens phonology in learning to read Chinese. *Journal of Educational Psychology, 106*(3), 779–798.

- Harrison, G. L., Goegan, L. D., Jalbert, R., McManus, K., Sinclair, K., & Spurling, J. (2016). Predictors of spelling and writing skills in first- and second-language learners. *Reading and Writing, 29*, 69–89.
- Ho, C.S.-H., Ng, T.-T., & Ng, W.-K. (2003). A “radical” approach to reading development in Chinese: The role of semantic radicals and phonetic radicals. *Journal of Literacy Research, 35*(3), 849–878.
- Kang, J. S. (1993). 現代漢語形聲字形符研究 [Analysis of semantics of semantic-phonetic compound characters in modern Chinese]. In Y. Chen (Ed.), *Information analysis of usage of characters in modern Chinese* (pp. 71–83). Shanghai Education Publisher.
- Ke, S. E. (2020). Review of research on learning and instruction with specific reference to reading Chinese as an additional language (1976–2018). *Frontiers of Education in China, 15*, 14–38.
- Kent, S. C., & Wanzek, J. (2016). The relationship between component skills and writing quality and production across developmental levels: A meta-analysis of the last 25 years. *Review of Educational Research, 86*(2), 570–601.
- Kim, Y.-S., & Phillips, B. (2014). Cognitive correlates of listening comprehension. *Reading Research Quarterly, 49*(3), 269–281.
- Ku, H.-B., Chan, K.-W., & Sandhu, K. K. (2005). *A research report on the education of South Asian ethnic minority groups in Hong Kong*. Hong Kong: Centre for Social Policy Studies, Department of Applied Social Sciences, Hong Kong Polytechnic University.
- Kuo, L. J., & Anderson, R. C. (2006). Morphological awareness and learning to read: A cross-language perspective. *Educational Psychologist, 41*, 161–180.
- Lam, S.S.-Y., & McBride, C. (2018). Learning to write: The role of handwriting for Chinese spelling in kindergarten children. *Journal of Educational Psychology, 110*(7), 917–930.
- Language and Reading Research Consortium. (2015). Learning to read: Should we keep things Simple? *Reading Research Quarterly, 50*(2), 151–169.
- Leong, C. K., Shum, M. S. K., Tai, C. P., Ki, W. W., & Zhang, D. (2018). Differential contribution of psycholinguistic and cognitive skills to written composition in Chinese as a second language. *Reading and Writing, 32*, 439–466.
- Leong, C. K., Tse, S. K., Loh, K. Y., & Ki, W. W. (2011). Orthographic knowledge important in comprehending elementary Chinese text by users of alphasyllabaries. *Reading Psychology, 32*(3), 237–271.
- Li, D. C. S., & Chuk, J. Y. P. (2015). South Asian students’ needs for Cantonese and written Chinese in Hong Kong: A linguistic study. *International Journal of Multilingualism, 12*(2), 210–224.
- Li, H., Shu, H., McBride-Chang, C., Liu, H., & Peng, H. (2012). Chinese children’s character recognition: Visuo-orthographic, phonological processing and morphological skills. *Journal of Research in Reading, 35*(3), 287–307.
- Li, L., Wu, X., Cheng, Y., & Nguyen, T. P. (2019). The relationship of character reading and spelling: A longitudinal study in Chinese. *Journal of Research in Reading, 42*(1), 18–36.
- Li, Y., & Kang, J. S. (1993). 現代漢語形聲字聲符研究 [Analysis of phonetics of semantic-phonetic compound characters in modern Chinese]. In Y. Chen (Ed.), *Information analysis of usage of characters in modern Chinese* (pp. 84–98). Shanghai Education Publisher.
- Lin, D., Mo, J., Liu, Y., & Li, H. (2019). Developmental changes in the relationship between character reading ability and orthographic awareness in Chinese. *Frontiers in Psychology, 10*, 1–10.
- Liu, X. (2002). 漢語作為第二語言教學簡論 [Teaching of Chinese as a second language: A brief introduction]. Beijing Language and Culture University Press.
- Lo, J. C. M., Ye, Y., Tong, X., McBride, C., Ho, C.S.-H., & Wayne, M. M. Y. (2018). Delayed copying is uniquely related to dictation in bilingual Cantonese–English–speaking children in Hong Kong. *Writing Systems Research, 10*(1), 26–42.
- Loper, K. (2004). *Race and equality: A study of ethnic minorities in Hong Kong’s education system*. Hong Kong: Centre for Comparative and Public Law, Faculty of Law, University of Hong Kong.
- Luo, Y. C., Koh, P. W., Deacon, S. H., & Chen, X. (2018). The roles of metalinguistic skills in Chinese–English biliteracy development. *Reading and Writing, 31*, 1721–1740.
- Ma, X., Gong, Y., Gao, X., & Xiang, Y. (2017). The teaching of Chinese as a second or foreign language: A systematic review of the literature 2005–2015. *Journal of Multilingual and Multicultural Development, 38*(9), 815–830.
- McBride-Chang, C., Chung, K. K. H., & Tong, X. (2011). Copying skills in relation to word reading and writing in Chinese children with and without dyslexia. *Journal of Experimental Child Psychology, 110*, 422–433.

- McBride-Chang, C., Tardif, T., Cho, J.-R., Shu, H., Fletcher, P., Stokes, S., Wong, A., & Leung, K. (2008). What's in a word? Morphological awareness and vocabulary knowledge in three languages. *Applied Psycholinguistics*, 29(3), 437–462.
- Mo, J., McBride, C., & Yip, L. (2018). Identifying the unique role of orthographic working memory in a componential model of Hong Kong kindergarteners' Chinese written spelling. *Reading and Writing*, 34, 1083–1108.
- NICHID Early Child Care Research Network. (2005). Pathways to reading: The role of oral language in the transition to reading. *Developmental Psychology*, 41(2), 428–442.
- Pan, H. R., & Kang, B. W. (Eds.). (2003). 小學中文科常用字研究 [A study of the Chinese characters recommended for the subject of Chinese language in primary school]. Hong Kong Baptist University Language Centre.
- Perfetti, C. A., Liu, Y., & Tan, L. H. (2005). The lexical constituency model: Some implications of research on Chinese for general theories of reading. *Psychological Review*, 112(1), 43–59.
- Qian, Y., Song, Y.-W., Zhao, J., & Bi, H.-Y. (2015). The developmental trend of orthographic awareness in Chinese preschoolers. *Reading and Writing: an Interdisciplinary Journal*, 28(4), 571–586.
- Shao, J. M. (2001). 現代漢語通論 [An outline of modern Chinese]. Shanghai Education Press.
- Shen, H. H. (2013). Chinese L2 literacy development: Cognitive characteristics, learning strategies, and pedagogical interventions. *Language & Linguistics Compass*, 7, 371–387.
- Shen, H. H., & Ke, C. R. (2007). Radical awareness and word acquisition among non-native learners of Chinese. *The Modern Language Journal*, 91(i), 90–111.
- Shrout, P. E., & Bolger, N. (2002). Mediation in experimental and nonexperimental studies: New procedures and recommendations. *Psychological Methods*, 7(4), 422–445.
- Shu, H., Peng, H., & McBride-Chang, C. (2008). Phonological awareness in young Chinese children. *Developmental Science*, 11(1), 171–181.
- Su, P. C. (2001). 現代漢字學綱要 (修訂版) [Modern Chinese orthography (revised ed.)]. Peking University Press.
- Tan, L., Spinks, J., Eden, G., Perfetti, C., Siok, W., & Desimone, R. (2005). Reading depends on writing, in Chinese. *Proceedings of the National Academy of Sciences of the United States of America*, 102(24), 8781–8785.
- Tong, X., & McBride-Chang, C. (2010). Developmental models of learning to read Chinese words. *Developmental Psychology*, 46(6), 1662–1676.
- Tong, X., McBride-Chang, C., Shu, H., & Wong, A.M.-Y. (2009). Morphological awareness, orthographic knowledge, and spelling errors: Keys to understanding early Chinese literacy acquisition. *Scientific Studies of Reading*, 13(5), 426–452.
- Tong, X., Tong, X., & McBride, C. (2017). Unpacking the relation between morphological awareness and Chinese word reading: Levels of morphological awareness and vocabulary. *Contemporary Educational Psychology*, 48, 167–178.
- Tsung, L., Zhang, Q., & Cruickshank, K. (2010). Access to majority language and educational outcomes: South Asian background students in postcolonial Hong Kong. *Diaspora, Indigenous, and Minority Education*, 4(1), 17–32.
- Wang, Y., McBride-Chang, C., & Chan, S. F. (2014). Correlates of Chinese kindergarteners' word reading and writing: The unique role of copying skills? *Reading and Writing*, 27, 1281–1302.
- Wang, Y., McBride, C., Zhou, Y., Joshi, R. M., & Farver, J. (2018). Becoming literate in Chinese: A comparison of native-speaking and non-native-speaking children. *Journal of Research in Reading*, 41(3), 511–524.
- Wei, T.-Q., Bi, H.-Y., Chen, B.-G., Liu, Y., Weng, X.-C., & Wydell, T. N. (2014). Developmental changes in the role of different metalinguistic awareness skills in Chinese reading acquisition from preschool to third grade. *PLoS ONE*, 9(5), 1–11.
- Wong, Y. K. (2017). The role of radical awareness in Chinese-as-a-second-language learners' Chinese character reading development. *Language Awareness*, 26(3), 211–225.
- Wong, Y. K. (2018). Exploring the reading-writing relationship in young Chinese language learners' sentence writing. *Reading and Writing*, 31, 945–964.
- Wong, Y. K. (2019). Role of decoding competence in the Chinese reading comprehension development of ethnic minority students in Hong Kong. *International Journal of Bilingual Education and Bilingualism*, 22(8), 1016–1029.

- Wong, Y. K. (2021). Developmental relations between listening and reading comprehension in young Chinese language learners: A longitudinal study. *Journal of Psycholinguistic Research*, *50*, 261–273.
- Yeung, P., Ho, C.S.-H., Chan, D.W.-O., & Chung, K.K.-H. (2013a). Modeling the relationships between cognitive-linguistic skills and writing in Chinese among elementary grades students. *Reading and Writing*, *26*, 1195–1221.
- Yeung, P., Ho, C.S.-H., Wong, Y.-K., Chan, D.W.-O., Chung, K.K.-H., & Lo, L.-Y. (2013b). Longitudinal predictors of Chinese word reading and spelling among elementary grade students. *Applied Psycholinguistics*, *34*, 1245–1277.
- Yeung, P., Ho, C.S.-H., Chan, D.W.-O., & Chung, K.K.-H. (2017a). The role of transcription skills and oral language skills in Chinese writing among children in upper elementary grades. *Applied Psycholinguistics*, *38*, 211–231.
- Yeung, P., Ho, C.S.-H., Chan, D.W.-O., & Chung, K.K.-H. (2017b). A simple view of writing in Chinese. *Reading Research Quarterly*, *52*(3), 333–355.
- Yeung, P.-S., Ho, C.S.-H., Chan, D.W.-O., Chung, K.K.-H., & Wong, Y.-K. (2013c). A model of reading comprehension in Chinese elementary school children. *Learning and Individual Differences*, *25*, 55–66.
- Yeung, P.-S., Ho, C.S.-H., Chik, P.P.-M., Lo, L.-Y., Luan, H., Chan, D.W.-O., & Chung, K.K.-H. (2011). Reading and spelling Chinese among beginning readers: What skills make a difference? *Scientific Studies of Reading*, *15*(4), 285–313.
- Yeung, S. S., Liu, Y., & Lin, D. (2020). Growth of phonemic awareness and spelling in a second language. *International Journal of Bilingual Education and Bilingualism*, *23*(6), 754–768.
- Zhang, H., & Koda, K. (2018). Vocabulary knowledge and morphological awareness in Chinese as a heritage language (CHL) reading comprehension ability. *Reading and Writing*, *31*, 53–74.
- Zhang, H., & Roberts, L. (2019). The role of phonological awareness and phonetic radical awareness in acquiring Chinese literacy skills in learners of Chinese as a second language. *System*, *81*, 163–178.
- Zhang, J., & McBride-Chang, C. (2011). Diversity in Chinese literacy acquisition. *Writing System Research*, *3*(1), 87–102.
- Zhang, J., McBride-Chang, C., Wong, A.M.-Y., Tardif, T., Shu, H., & Zhang, Y. (2014). Longitudinal correlates of reading comprehension difficulties in Chinese children. *Reading and Writing: an Interdisciplinary Journal*, *27*, 481–501.
- Zhao, J., Quiroz, B., Dixon, L. Q., & Joshi, R. M. (2016). Comparing bilingual to monolingual learners on English spelling: A meta-analytic review. *Dyslexia*, *22*, 193–213.
- Zhou, Y., & McBride, C. (2018). The same or different: An investigation of cognitive and metalinguistic correlates of Chinese word reading for native and non-native Chinese speaking children. *Bilingualism: Language and Cognition*, *21*(4), 765–781.
- Zhou, Y., McBride, C., Leung, J. S. M., Wang, Y., Joshi, R. M., & Farver, J. (2018). Chinese and English reading-related skills in L1 and L2 Chinese-speaking children in Hong Kong. *Language, Cognition and Neuroscience*, *33*(3), 300–312.

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