To cite this paper:

Zhang, Q. & Reilly, R. (2016). The reading of handwriting: An evaluation of Chinese written by CFL learners. *The Twenty-Third Annual Meeting of Society for Scientific Studies of Reading (23rd SSSR)*, University of Porto, Portugal, 13-16 July, 2016.

The reading of handwriting: an evaluation of Chinese written by CFL learners

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Abstract

This paper describes two experiments that first explore the potential role of Chinese character writing in character visual recognition, and then examine different evaluative responses towards the quality of pinyin and character handwriting. Taken together, the results suggest that drawing Chinese characters privileges them in memory in a way that facilitates their subsequent visual recognition. This is true even when the congruency of the recognition response and other potential confounds are controlled for. In terms of the writing quality, the reader's empathy effect can be found for handwritten characters but not pinyin, since the handwritten characters tended to be rated more highly than pinyin. The experience of an evaluator also has an impact on the evaluation of writing quality. The pedagogical implications for Chinese as a foreign language (CFL) are highlighted at the end of the paper, in particular those relating to curriculum design and teacher training.

Keywords: Chinese characters, pinyin, reading recognition, evaluation

1. Introduction

As the second largest in the world, China's booming economy makes Chinese a popular foreign language to learn. The number of students learning Chinese in UK higher education institutions increased by 125% between 1996 and 2007 (Hu, 2010). An interesting fact is that the number of students in the UK studying Mandarin Chinese went up 38% between 2002 and 2010, during which time there was a decline in the total number of students learning modern foreign languages (Zhu & Li, 2014). A similar scenario can be found in the US. While the last decade witnessed an overall decline in the teaching of foreign languages, there has been a rush by schools across all the country to offer Chinese classes (Dillon, 2009). Chinese has been taught as a foreign language in Australian schools since as far back as the 1950s, and there are now three different pathways catering to the three main cohorts of Chinese learners in Australian schools (ACARA, 2016; Osborn, 2016). Indeed, pragmatic attitudes to the study of Chinese language can be observed among students and their parents, since they feel fluency in Chinese could lead to future work opportunities (Dillon 2009; Zhang, 2013; Zhang & Lu, 2014).

Along with the mushrooming of interest in the language, there has been a growing literature in teaching and learning Chinese as a foreign language (henceforth CFL). Since the Chinese writing system is logographic in nature, it is significantly different from European languages that use Roman-derived alphabets. For this reason, one of the main challenges for CFL learners is to learn Chinese characters (Shen, 2004, p.168; Wang et al., 2003; Everson, 1998, p.196). Among previous studies, ranging from curriculum design (He & Jiao, 2010) to the use of multimedia in the classroom (Xu et al., 2013; Zhang & Lu, 2014; Zhang, 2013), there has been a significant amount of research into the difficulty of learning Chinese characters (Zhang & Reilly, 2015; Hsiao et al., 2015).

2. A Brief Introduction to Chinese Orthography

Before we look into the relationship between writing and reading, it is necessary to provide a brief overview of Chinese orthography. There are three tiers in the orthographic structure of a Chinese character: stroke, radical and character (Shen & Ke, 2007). Usually, several strokes function as building blocks to construct a radical, and one or more radicals are used to form a character.

There are generally two kinds of Chinese characters: integral and compound (Shen & Ke, 2007; Wang et al., 2003). The former are composed using one radical only, while the latter consist of two or more radicals. For example, 女 (nǚ) means female and 马 (mǎ) means horse. When these two integral characters serve as left and right radicals, their combination becomes the compound character 妈 (mā), meaning mother. A compound character usually has a semantic radical (i.e., 女 meaning female in the character 妈) that denotes the meaning of that character, and a phonetic radical (马, pronounced mǎ) that provides insights into the pronunciation of the compound character.

Although the Chinese writing system has a pictographic origin, it also uses a Romanised form – pinyin – to represent its phonology (Shen & Ke, 2007; Bassetti, 2005; Wang et al., 2003). Each Chinese character can be transcribed into pinyin, including onset, rime and tone (Wang et al., 2004). As shown in Table 1 below, 女 is represented by pinyin nǚ. 'n' is the onset, 'ǚ' is the rime, and the symbol above it indicates the tone.

Table 1. An example of a Chinese compound character.

	integral character / semantic radical	integral character / phonetic radical	compound character
	女	马	妈

Pinyin	nǚ	mǎ	mā
English	female	horse	mother

2.1 Write to Read in Chinese

The sharply contrasting differences between the phonology and orthography of Chinese present a challenge to adult CFL learners with an alphabetic first language. For alphabetic languages, a number of orthographic units such as letters can be mapped onto phonemes and recombined to form written words. The phonological representations of words are usually strengthened when learning to read an alphabetic writing system. This is based on the assumption that 'orthographic knowledge is intimately tied to the phonological constituent of a word' (Guan et al., 2011; Cao et al., 2013b). Reading proficiency can therefore be improved through success in establishing the phonological connections to orthography (Tan et al., 2005). In this case, alphabetic reading can be helped by learning orthographic representations, which in turn contribute to the development of writing skills. On the other hand, the contribution of writing to reading development may be moderate in English or any alphabetic language, compared to Chinese (Cao et al., 2013b; Guan et al., 2011).

However, the Chinese logographic writing system does not provide systematic and reliable grapheme-phoneme correspondences (Xu et al., 2013; Shu et al., 2003). Specifically, the basic Chinese writing units (i.e., strokes) are not mapped to phonemes (Guan et al., 2011). Although the phonetic radical of a compound character can be connected to the phonological awareness of this character in Chinese, the connection is much less intimate than in alphabetic languages (Cao et al., 2013b). As can be seen in the example of the character 妈, the connection of the phonetic radical 马 (mǎ) is associated with the phonological representation of 妈 (mā) at the syllabic level rather than the phoneme level. In addition,

Chinese has a large number of homophones, which allows a syllable to correspond to many different characters with various meanings. Therefore, phonological information is unlikely to be as reliable as the orthographic form of a character in reading achievement (Cao et al., 2013a; Tan et al., 2005). Consequently, writing characters could be a more critical component of learning to read.

In addition, Chinese writing is different from alphabetic writing. Chinese characters 'are packed into a square configuration, possessing a high, nonlinear visual complexity' (Tan et al., 2005). Guan et al. (2011) point out that Chinese orthography 'involves the coupling of writing related visual and motor systems'. This coupling may help establish the spatial configuration of strokes and radicals which, along with a temporal sequence of motor movements associated with stroke composition, completely defines the shape of the character (Cao et al., 2013b; Guan et al., 2011). Therefore, significant spatial analysis combined with highly organised motor activity appear to be involved in writing a Chinese character (Tan et al., 2005).

Cao et al. (2013b) state that writing Chinese characters might facilitate the development of a visual-spatial memory, which also has a motor memory trace. Since motor memories can last for a very long period of time (Shadmehr & Holcomb, 1997), this writing-related motor information can be additional assistance for the activation of visual information in the process of Chinese character recognition. In other words, handwriting may pair the movement patterns, usually stroke sequencing through well-practised writing (Parkinson et al., 2010), with the language stimuli, namely characters. This pairing can help establish long-lasting motor memories of Chinese characters which are exploited in the orthographic recognition process. This language-specific proposal is based on the concept of embodied cognition. That is to say, a person must 'internally "run" or "simulate" the corresponding production process' when understanding a physical stimulus (Bi et al., 2009). In the case of

writing-on-reading effects in Chinese, learners might automatically activate the corresponding motor programs for writing characters, which in turn assist in reading them.

The study by Tan et al. (2005) gives supporting evidence that motor programming contributes to the formation of long-term motor memory of characters among Chinese children. In other words, for native speakers who are exposed to Chinese in daily life and so develop the phonology-to-semantics link before formal schooling, development in writing is a more significant contributing factor to reading fluency than phonological awareness. Most relevant to the current study, Cao et al. (2013b) show that character-writing training plays a crucial role for adult CFL learners learning the visual-spatial aspects of characters. That is to say, handwriting can establish more precise visual-orthographic representations and therefore contribute to orthographic recognition in adult CFL beginners (Cao et al., 2013b; Guan et al., 2011).

In fact, it is traditional for native Chinese-speaking children to invest a great deal of time and energy in learning characters (Lam, 2011). This traditional approach is noticeable for the separation between the teaching of reading and writing. Even in this digital era, there have been calls to enhance the teaching of handwriting for Chinese children in the formal schooling system (Liu, 2015).

In the same vein, CFL learners whose native language is English or another alphabetic language also have to face the challenge of identification and accumulation of Chinese characters, in order to lay the foundation for Chinese reading proficiency. Due to familiarity with alphabetic-like phonological representation of Chinese, they tend to develop an unbalanced acquisition of phonology and orthography. Typically, this involves a faster acquisition of phonology than of orthography (Everson, 1998). Therefore, there have been various attempts in exploring innovative methods in teaching and learning Chinese characters

for native (e.g. Tian et al., 2010; Tse et al., 2007) and non-native learners (Qian, Own & Bax, 2018; Zhang & Lu, 2014; Dummitt, 2008).

Some groups of researchers emphasise character writing practice for beginners learning Chinese (Tso et al., 2012), whereas others advocate focusing on the teaching of pinyin (Everson, 1998). In fact, the main difference between these two instructional approaches lies in the timing of introducing pinyin to learners and the relative amount of time allocated to oral practice and character writing (Ye, 2013). They can consequently be generally translated into three different curricula used in CFL classrooms (Zhang & Lu, 2014; He & Jiao, 2010).

The first one is a 'unity' curriculum which aims to simultaneously develop all four skills (listening, speaking, reading and writing) of speakers. In order to achieve the same proficiency in four skills, far more contact hours have to be spent on learning to write. The 'delay' curriculum focuses on introducing pinyin and oral development while delaying learning to read and write (Parkard, 1990). This curriculum disadvantages CFL ab initio learners in that they are unable to read or write Chinese after a certain period of studying. The 'lag' curriculum prioritises oral development, with some Chinese writing taught at the early stage. However, this may lead to a discrepancy between listening/speaking and reading/writing skills at a later stage.

Moreover, concerns have been raised about the usefulness of handwriting characters in an era of increasing reliance on electronic communication (Zhang & Lu, 2014; Allen, 2008). It might be an inefficient use of learners' time to practise handwriting, as it is common to type the pinyin of a character and subsequently select the intended character from a list of computer-generated possibilities. Furthermore, with regard to theories of embodied cognition, typing can also be considered a process of associating a pointing movement on keyboards to form a character, though this 'visuomotor association involved in typewriting

should […] have little contribution to its visual recognition' (Longcamp et al., 2008). Tan et al. (2013) examine Chinese children's reading development by comparing the reading performance of frequent users of pinyin typing on e-devices with that of those spending more time on handwriting. Interestingly, they discover that children's reading scores are negatively correlated with the use of the pinyin input method, while reading performance is significantly positively correlated with handwriting. As a result, their study suggests that heavy use of the pinyin input method and e-tools may interfere with the learning of visual-spatial properties of characters, at least among Chinese children.

In this context, the intention of the current study is to scrutinise whether orthographic knowledge acquired through writing significantly contributed to reading performance in a group of Irish adult beginning CFL learners, all with an alphabetic first language background. Moreover, it will also investigate the quality of handwritten characters and pinyin from the perspective of readers. As stated in the next section, an evaluation of handwriting in Chinese will provide valuable information regarding the reading of two systems of Chinese.

2.2 Evaluation of Handwriting in Chinese

The impact of technology seems to be the main reason for the decreasing use of handwriting in our daily life and the reduced pedagogical focus on handwriting in language classrooms. In the particular case of Chinese, handwriting requires more attention from writers in terms of character composition than does writing using a word processor. However, like other current alphabetic input methods, digitised Chinese input methods employ a fuzzy matching technique on the e-device. Even if the pinyin or the character is not fully or correctly written, the system will still be able to find the most similar pronunciation or character according to the text input. As a result, the action of writing with word processors tends not to require memorising whole character composition.

On the other hand, digitised writing modes embedded in word processors should not be "the only factor behind the current plight [of] the Chinese handwriting" (Liu, 2015). Due to a pragmatic mindset, traditional culture is less valued and respected in Chinese society, which has led to the general public's growing alienation from the traditional art of Chinese handwriting (ibid.).

Indeed, the use of word processors may allow people to concentrate on what to write rather than how to write. According to Li (2006), learners of English writing on a computer tended to focus more on higher order thinking activities, make more revisions and receive higher scores in argumentation than those using paper and pen.

In contrast, Powers et al. (1994) find a scoring discrepancy between handwritten and word-processed essays in English. Better evaluations tended to be given to handwritten ones. Similar findings are reported in the study of Bridgement and Cooper (1998). In the case of Chinese, despite the value of handwriting in learning to read characters, previous research suggests that word-processed Chinese tends to have higher scores than texts produced with paper and pencil (Zhu et al., 2016). Reasons for this result could be the ease of typing pinyin and then selecting the intended character from a list of homophones (ibid.). Writing a Chinese character by hand is similar to building a construction by using strokes to form radicals and eventually a character, which requires harmony, symmetry and equilibrium (Chang & Yu, 2005). It indeed involves much more cognitive thinking and physical movement than writing using a word processor. In addition, Chinese handwriting is closely linked with traditional Chinese arts such as calligraphy, and is one of the symbols of Chinese culture. Therefore, a number of provinces and cities in mainland China have implemented policies and measures for primary and secondary school students in order to promote Chinese handwriting (Liu, 2015). As Zhu et al. (2016) note, raters admitted to having an instinctive sympathy for CFL

learners who write legibly and tastefully, especially when the learners are not from the Sinosphere.

Interestingly, an effective way to reduce the evaluation discrepancy was to train essay readers with extra emphasis on essay quality rather than the method used to write an essay, i.e., using word processor or handwriting, as well as to inform the readers of the empathy effect (Powers et al., 1994). However, previous research has focused on a comparison between word-processed and handwritten texts. There seems to be no study on the evaluation of handwriting of two systems of one language. It consequently remains unknown whether reader empathy towards handwriting is also applicable to pinyin. Under these circumstances, the handwritten characters and pinyin produced in the experiment of the current study were presented to four raters in order to investigate the extent that the reader empathy effect could have on each system. The hope was that this would shed light on the training that CFL teachers might need when evaluating learners' writing quality.

3. The present study

There were two main phases to the present study. It first investigated the performance of a group of CFL beginners, in order to examine the effectiveness of training in character writing on subsequent character recognition. Apart from character handwriting, participants' training also incorporated a pinyin writing task. The point of this task was to act as a control; both pinyin and character drawing involve motor movements, and both are effortful in rather similar ways. So if there is an effect due to character drawing as opposed to pinyin transcription, it should therefore be related to the inherent features of character writing.

Characters and pinyin written by the participants in the first phase of the study were then evaluated by CFL teachers to study the potential effect of empathy on handwriting in Chinese. More interestingly, rather than comparing handwritten and word-processed texts,

the current study analysed the evaluation of handwritten characters and pinyin. This design allowed us to scrutinise whether the empathy effect was for handwriting in general or for characters in particular. Also, the teaching experience of each rater was taken into consideration, to examine if this factor contributed to the evaluation of writing quality.

3.1 Write-to-read Experiment 1

Twenty-three participants were recruited from a pool of CFL students in Ireland who had completed seven weeks (approximately 45 hours) of previous instruction in Chinese in the first-year Chinese language course at both authors' universities. Heritage learners and learners whose native language was other than English were excluded from the experiment. The 23 participants reported having no substantial experience learning Chinese prior to enrolling in their current language programme. They were all taught from a similar curriculum employing the same textbook and instruction. Listening and speaking skills were developed simultaneously with reading and writing skills. Copying characters was regularly assigned as homework. Writing characters or pinyin from memory was also required for dictation quizzes. Before taking part in this experiment, the participants had prior knowledge of pinyin and the general rules of stroke order, and knew approximately 200 characters. Consequently, the effect of prior exposure to certain characters used in the current experiment was controlled for statistically in the data analyses.

The training session consisted of learning thirty-two integral characters. Of these characters, half were novel and half had been taught to the participants in class. The stroke count for the characters ranged from 1 to 7, with a median of 4.

During the experiment, participants were seated in front of a desktop computer. The PsychoPy presentation software system (Pierce, 2007) was used to display the materials and record participant responses. Following an initial presentation of a prompt character ("+"),

there was a five-second exposure of both a character's form and its sound (a female native speaker spoke the character). The screen then displayed either a large C, instructing the participant to draw the displayed character, or a large P, instructing the participant to write the pinyin representation of the sound. Fifty percent of the time the participant had to write pinyin, and fifty percent of the time the participant had to draw the character. Choice of response mode and sequencing of the characters was random, and the usual counterbalancing measures were taken.

During the testing phase of Experiment 1, the stimuli were presented to the participants either as a character or as a sound. Participants had to decide whether a stimulus shown on a screen or played as audio was one of those taught to them in the training session. They were asked to make a decision quickly and accurately by pressing the appropriate key on the keyboard to indicate their decision. The structure of the presentation of the materials was designed such that for half of the test items, the mode of presentation was congruent with the mode in which the item had been learned.

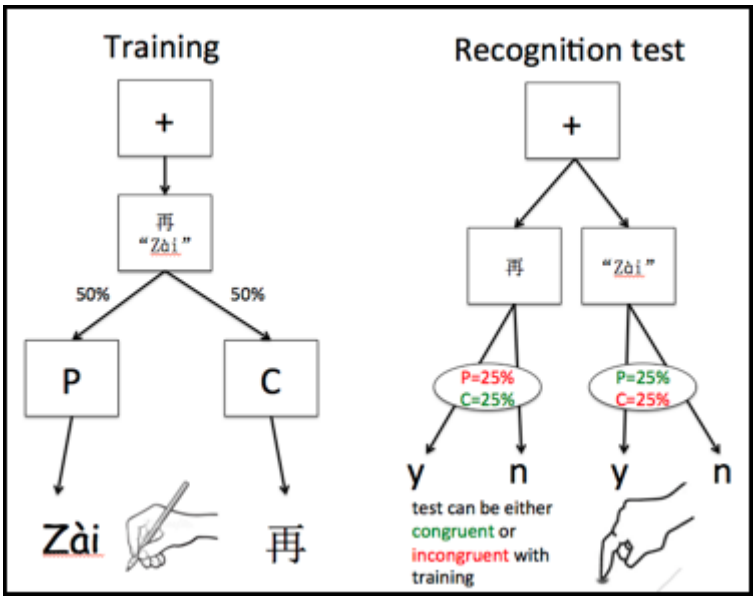

Figure 1. Schematic representation of training and testing in Experiment 1.

Recognition data was again analysed using linear mixed model logistic regression (Jaeger, 2008). The dependent measure was the correctness of the recognition decision, the fixed factors were mode of training (character drawing versus pinyin transcription), congruency of recognition, and whether the participant had learned the character in class. A congruent recognition item involved the presentation of the character during training and the soliciting of a response during testing in the same modality (e.g., character drawing in training followed by character recognition as the test). The number of strokes comprising each character was entered into the model as a covariate, to determine if the stroke count had an effect on correct responding.

3.2 Results of Experiment 1

Table 2 presents the results of the regression analysis. Note that the fixed factors (learn, train and test) are coded as contrasts that test the difference in probability of responding for the two levels of each factor. The direction of the contrast is indicated by the labels: y-n, p-c and ic-c. These represent respectively "yes – no", "pinyin – character" and "incongruent – congruent".

Table 2. Estimates from the logistic LMM predicting correct responses on the basis of stroke count, learning mode, testing congruency, prior learning in class, and the interactions between the last three terms.

	estimate	**SE**	**z**	**pr(>|z|)**
intercept	-2.260	0.165	-13.69	< 0.001
strokes	-0.004	0.060	-0.063	0.950
learn:y-n	-0.882	0.255	-3.460	**< 0.001**
train:p-c	-0.277	0.246	-1.125	0.261
test:ic-c	0.533	0.273	1.954	**0.051**

learn x train	-0.562	0.496	-1.134	0.257
learn x test	0.162	0.507	0.320	0.749
train x test	-1.539	0.493	-3.125	**0.002**
learn x train x test	1.755	0.992	1.770	0.078

The overall correct recognition rate was just over 85%. The results presented in Table 2 indicate that stroke count and training mode had no significant effect on correct responding. However, if a participant had already encountered a character in class, as one would hope, this had a significant effect on recognition ($|z| = 3.46$; $p < 0.001$). The overall effect of congruency marginally improved recognition ($|z| = 1.954$; $p = 0.05$). There was, however, a significant interaction between congruency and training mode ($|z| = 6.7$; $p < 0.001$). This interaction is graphed in Figure 2 and suggests that congruency played a greater role in improving performance when participants had to draw the character during training rather than transcribe its pinyin form. In fact, planned comparisons reveal that the source of the significant training-by-testing interaction is the difference between congruent and incongruent conditions in the character drawing condition ($|z| = 3.822$; $p < 0.001$). This can also be seen in the relative differences in the congruency effect between training modes in Figure 2.

Another effect of note is the marginally significant three-way interaction between prior learning, training mode and testing mode ($|z| = 1.77$; $p = 0.08$). The source of this effect is that the training-by-testing interaction just discussed is eliminated for those items to which

participants had some prior exposure in class. Effectively, the participants responded significantly more accurately to the learned characters, giving rise to a ceiling effect in performance.

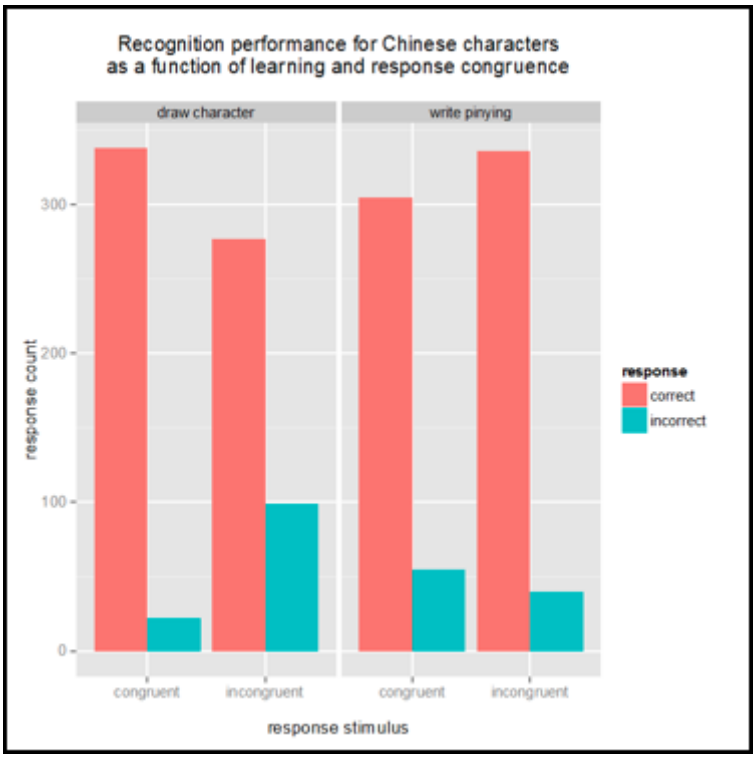

Figure 2. Correct recognition of Chinese characters as a function of congruency of learning and testing modes.

3.3 Evaluation of Writing Quality

Four CFL teachers in Ireland were recruited to participate in the evaluation study. They were all native Chinese speakers and had various levels of experience in teaching Mandarin Chinese to English-speaking students. When the study was conducted, they were involved in teaching Irish CFL beginner learners who had the same profile as the participants in Experiment 1. J, L, W and X were used to represent four raters, in order to ensure the anonymity of participants.

Since 23 CFL learners were trained to handwrite 32 characters three times in Experiment 1, three training sessions generated 2,208 Chinese characters and pinyin equivalents in total: 23 x 32 x 3 = 2,208. These handwritten characters and pinyin equivalents

were scanned and cropped to the same size in order to present them on a computer screen for the evaluation. A character or pinyin word was shown on the screen, and four CFL teachers were asked to rate each one on a three-point scale: incorrect, okay and good. As soon as a rating was entered, the next character was displayed.

All four raters had been teaching Chinese to CFL learners for at least a year. The overall teaching experience varied, with L being the most experienced, followed by J, W and X in descending order.

3.4 Results of Writing Quality Evaluation

Figure 3 below shows that there was a significant increase in positive rating of the handwriting over three training sessions ($|z| = 7.57$, $p < 0.001$). The more a student had practised handwriting, the better his/her handwriting could be read and assessed by the readers.

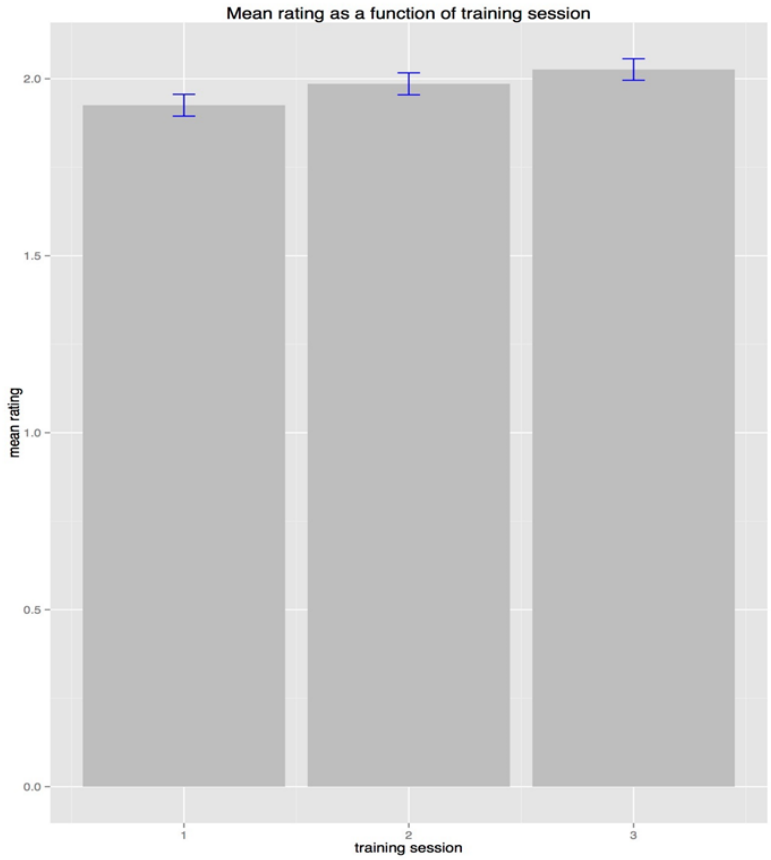

Figure 3: Ratings of handwriting in three training sessions.

The results were further analysed with a division between the ratings for handwritten characters and those for handwritten pinyin. There was a highly significant difference between these ratings ($|z| = -14.4$, $p < 0.001$). It seems that writing practice chiefly improved the quality of handwritten characters rather than the quality of handwritten pinyin.

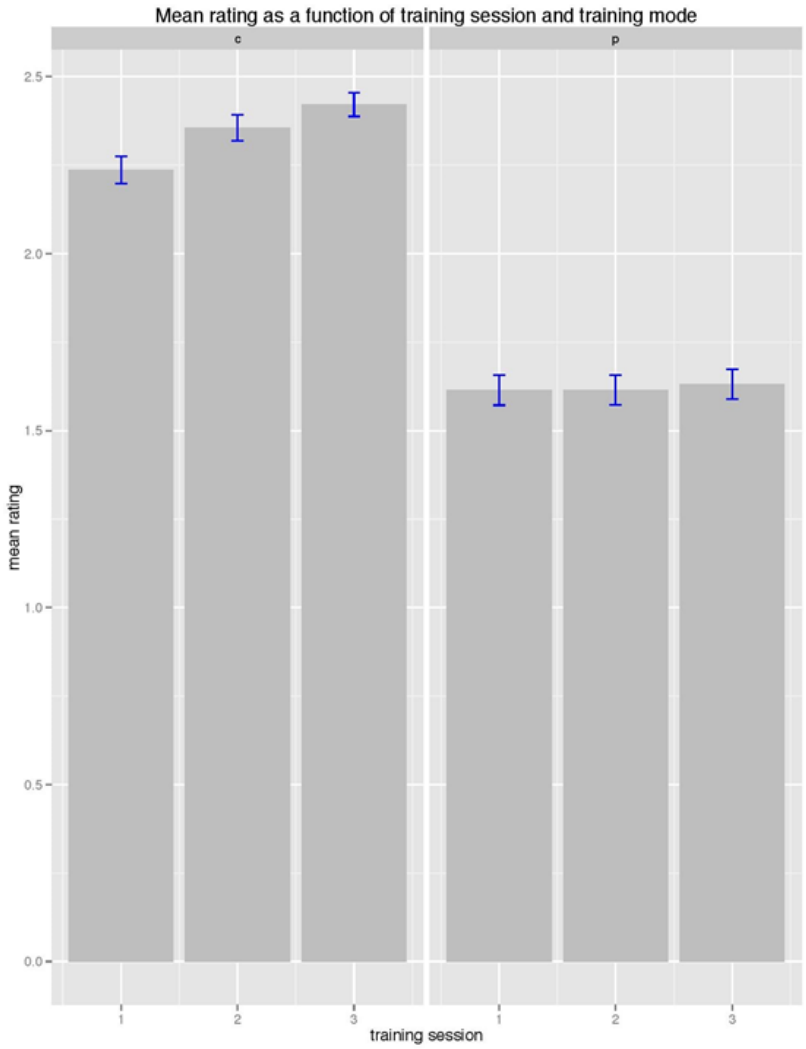

Figure 4: Ratings of characters vs ratings of pinyin.

Interestingly, the results also show that the ratings for handwritten characters tended to increase over three training sessions, whereas the ratings for pinyin were likely to be level. This effect was the basis for a statistically significant interaction between training session and

trial type ($z = -4.78$, $p < 0.001$). This finding may suggest that the reader's empathy effect on the handwriting can be found primarily from Chinese characters rather than pinyin. More analyses were conducted to investigate this, as presented next.

The teaching experience of each rater was examined against the ratings they gave (see Figure 5 below). Inter-rater reliability was measured using the Fleiss variant of kappa, resulting in a value of 0.4, indicating only moderate levels of agreement among the four raters.

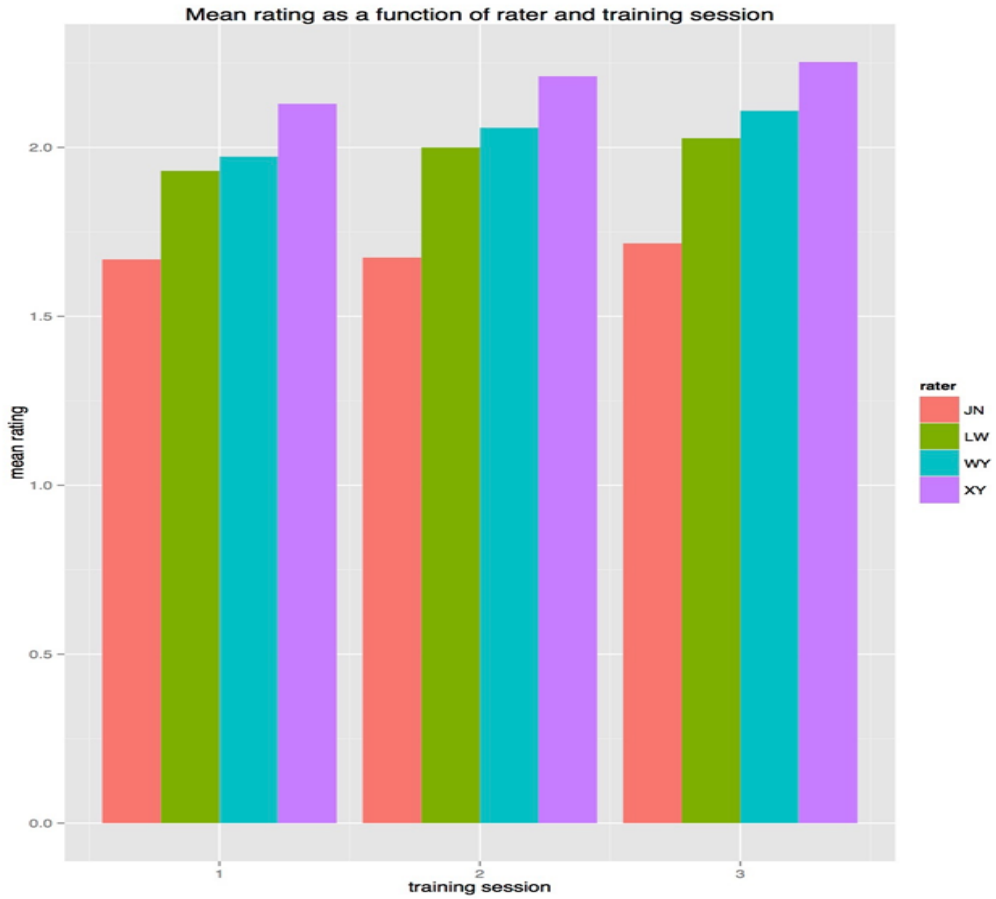

Figure 5: Each rater's evaluation of writing quality in three training sessions.

Interestingly, evaluator X, who was the youngest and had the least CFL teaching experience, tended to give significantly higher ratings. In contrast, the two more experienced raters (J & L), with more exposure to the handwriting of CFL learners, tended to give lower

ratings. This result indicates that the teaching experience might be a factor that interplays with the reader's empathy effect, affecting the evaluation of writing quality.

When each evaluator's rating was examined, L, the most experienced, mostly used just two categories: incorrect and good (see Figure 6). The second most experienced rater, J, also mainly rated the writing in two categories: incorrect and okay. That is to say, the more experienced an evaluator was in CFL teaching, the more confident he/she was in the evaluation decision.

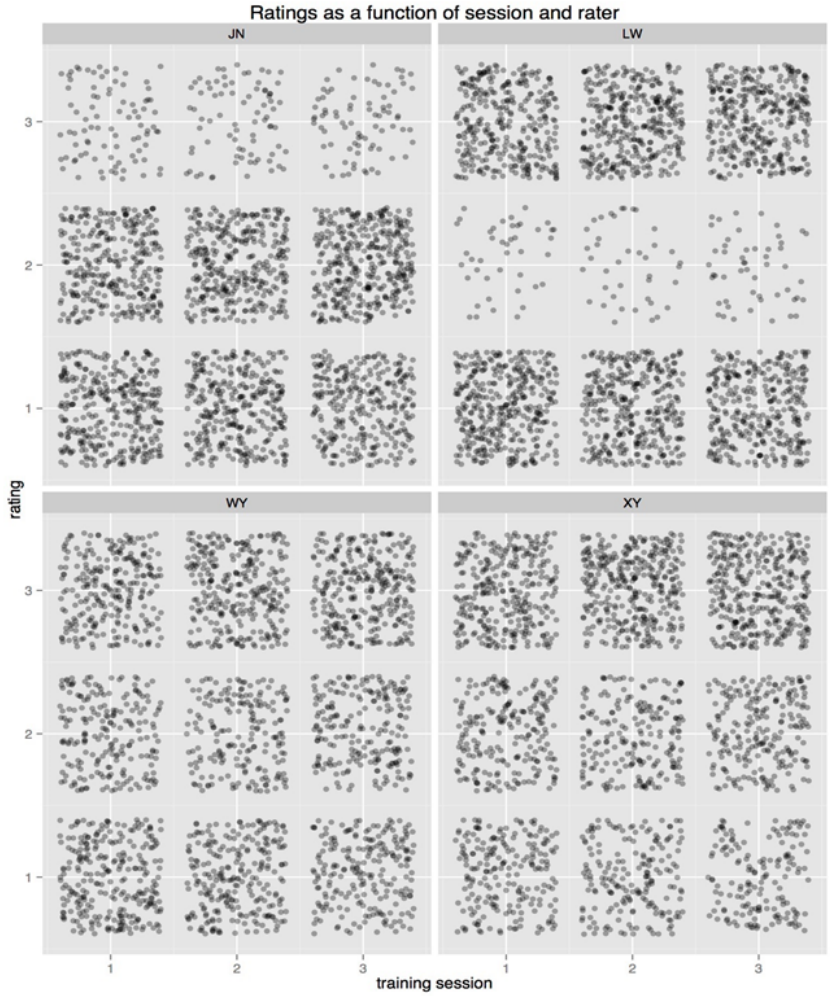

Figure 6: Each rater's evaluation of writing quality using a 3-point scale.

On the other hand, the ratings given by the two evaluators with less CFL teaching experience are relatively spread out in three categories (see Figure 8). Although this may be

interpreted as their being less confident in deciding the correctness of handwritten Chinese, it may also imply that they tended to be more sensitive to subtle differences in writing quality.

4. General discussion

Regarding the first experiment, while the overall effect of congruency is close to significance, with congruent training and responding providing a recognition advantage, congruency alone cannot account for the significant advantage that training in character writing has for character recognition. The congruency-by-training interaction in Experiment 1 suggests that even when one controls for different response modes, learning to write a character rather than its pinyin has a stronger overall positive effect on visual recognition. Moreover, aural recognition appears to be less sensitive to congruency than visual recognition is. If anything, we see a trend towards an inverted congruency effect in the case of pinyin training and aural recognition.

The basis for this interaction is not entirely clear. However, within a neuronal embodiment account (e.g., Pulvermueller, 2013), we could argue that it is due to differences in the neural encoding of the two modes of training. In the case of the character training mode, the participant goes straight from the visual representation to a motor encoding of the character. There is, therefore, potential for reciprocal connections to be reinforced between motor and visual representations, allowing visual representations to evoke motor ones, and vice versa (e.g., Garagnani et al., 2008). However, in the case of the pinyin encoding, there is an intermediate step involved – the sound has to be converted to the abstract pinyin code, which in turn is mapped to a motor programme involved in writing the pinyin. This affords the establishment of reciprocal connections between pinyin and its motor encoding, but not between the perceived sound and these motor encodings. This lack of direct support from the

motor level in the case of the aural test may disadvantage recognition of the spoken character. A schematic representation of this account is given in Figure 7.

Returning to the initial motivation for carrying out this experiment, which was to understand what impact character drawing has on recognition in Chinese, the results of Experiment 1 described here support the hypothesis that character drawing is helpful in the visual recognition of Chinese characters. It is argued here that the reason for this is that the motor programs entrained during the learning phase of the experiment act to enhance recognition memory. This form of memory support, however, is not available for the pinyin learning phase (see Figure 7).

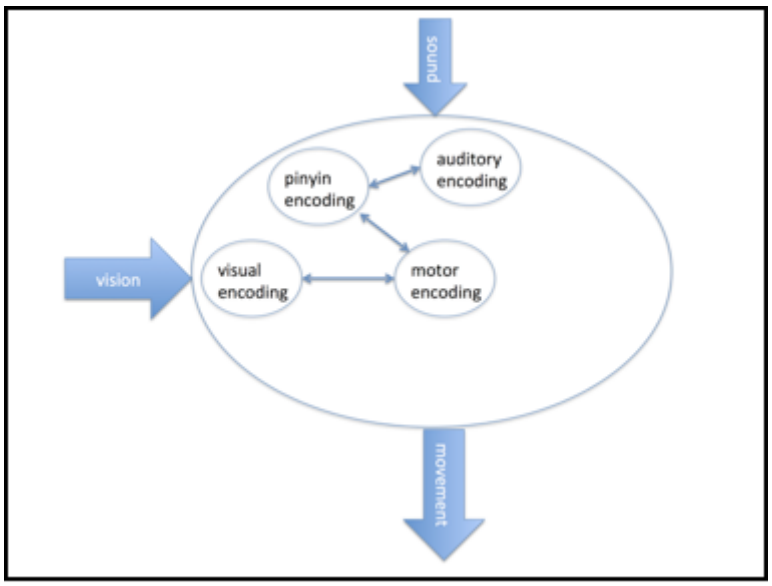

Figure 7. Schematic representation of the putative neural encoding processes underlying the two training modes in both experiments.

The key proposed difference between pinyin training and character drawing is that visual encoding has a more direct access to motor encoding processes than does auditory encoding, which must be mediated by the pinyin translation process. Generalising this finding beyond the experimental paradigm to the broader topic of reading, we can argue that readers who draw characters, as opposed to writing pinyin, build a memory reserve for characters that

can be used to augment their subsequent retrieval and recognition. On the other hand, readers who rely more extensively on pinyin input do not have this memory support to draw upon.

Regarding handwriting quality, despite moderate inter-rater reliability, there was still a significant increase in quality of handwriting over training sessions. Therefore, from the perspective of a reader/evaluator, practising Chinese characters by hand can significantly contribute to handwriting quality. Even though the evaluation of pinyin handwriting was not as positive as that of character handwriting and was quite even across the three training sections, pinyin handwriting had quite a positive impact on the visual recognition of characters. The significant improvement in character writing compared to pinyin writing might be due to the fact that all raters were native Chinese speakers accustomed to reading and evaluating Chinese characters rather than pinyin. In other words, it is possible that the reader's empathy is applicable to handwritten characters but not to pinyin, at least from a native speaker perspective. It would be worthwhile to investigate, in comparison with the raters of the current study, whether and to what extent a non-native Chinese speaker would evaluate the pinyin writing similarly.

Even in a relatively constrained evaluation task such as this, there are some striking variations in rater style. The present study suggests that teaching experience seems to play a vital role in the evaluation of Chinese handwriting. The more experienced a rater is, the more confident he/she is in deciding whether the writing is correct or not. However, he/she also tends to pay less attention to the details of writing quality among characters and pinyin that were correctly written. These results suggest that different emphases should be given when providing training to CFL teachers. For the less experienced, while they might be well trained to gain a good knowledge of writing accuracy, it is necessary that they be exposed to illegible characters written by CFL learners and be made aware of rules for evaluating handwritten

Chinese. For experienced teachers, it is worthwhile to draw their attention to differentiations in writing quality among learners.

5. Conclusion

The results of the write-to-read experiment could contribute to the debate regarding optimum curriculum design for the CFL classroom. For example, they suggest that the 'delay' or 'lag' curricula, which strongly focus on listening and speaking in the early stages of learning, may not be optimal for helping CFL learners develop their knowledge of the relationship between characters and sound. In fact, some sort of combination of sound and character training, as exemplified in the training paradigm used in the first experiment, may turn out to be best. However, future research is needed, to include a 'lag' condition incorporated into the training regimen.

While the pinyin writing was on average evaluated similarly throughout the three training sessions, the quality of character writing improved gradually in the eyes of the evaluators. However, the factor of CFL teaching experience played a significant role in the evaluative variations. This result leads to different focuses in CFL teacher training for novice and expert teachers. Although there were four evaluators in the current study, they examined more than 2,000 handwritten characters and pinyin equivalents. It is recommended that future research include more evaluators, if the sample size for evaluation is manageable for a bigger population.

Acknowledgement

Part of the data was published in the Proceeding of the 29th Pacific Asia Conference on Language, Information and Computation (Zhang & Reilly, 2015).

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