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Abstract

Interword spacing facilitates English native readers but not native readers of Chinese, a writing system that does not mark word boundaries. L1-English readers of Chinese as a Second Language (CSL) could then be facilitated if spacing is added between words in Chinese materials. However, previous studies produced inconsistent results. This study tested the hypothesis that interword spacing facilitates L1-English CSL readers. We used an online multiple-choice gap-filling task to test 12 English CSL readers and 12 Chinese natives reading a series of eight texts of suitable difficulty, written with or without interword spacing. The CSL readers read faster with interword spacing than without, while Chinese native readers were not affected. The interword spacing effect was negatively correlated with measures of reading proficiency. It is argued that interword spacing facilitates CSL readers reading materials of sufficient difficulty by facilitating their lexical parsing. Pedagogical implications are discussed.

Keywords: second language reading, Chinese, spacing, word, interword spacing

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1. Effects of interword spacing on reading

Different writing systems represent languages differently (Coulmas, 2003), resulting in differences in reading processes among native (L1) users of different writing systems (Harris & Hatano, 1999). Such cross-orthographic differences in reading processes have consequences for second language (L2) readers. Before learning to read their second language, L2 learners have already developed reading processes suitable for a different writing system, and the effects of L1 low-level reading processes on L2 reading are widely documented (Koda, 2007). L2 readers' reading processes are then influenced both by characteristics of their L2 writing system and by their first language (L1) reading processes (Cook & Bassetti, 2005). Among other differences, writing systems vary in their use of spacing. Most writing systems in the world use spacing to separate words, however writing systems such as Chinese, Japanese and Thai do not mark word boundaries (Daniels & Bright, 1996). L1-English readers of L2-Chinese may then be affected by the different use of spacing to mark the boundaries of orthographic and linguistic units in written English and Chinese.

1.1 Effects of interword spacing on native readers of English and Chinese

Spacing is used to separate different orthographic and linguistic units in written Chinese and English. In written English, *interword spacing* marks the boundaries of *orthographic words*, which are strings of letters. In written Chinese, spacing separates *hanzi* ('characters'), which are orthographic units made of one or more strokes and inscribed within a square area, e.g. 狗. Each hanzi represents a monosyllabic morpheme, for instance 老, /lau3/, 'old'. Chinese words can consist of one or more hanzi, e.g., 老, /lau3/, 'old'; 老师, /lau3ʂɨ1/, 'teacher' (lit.: old-master). However, word boundaries are not marked, and written Chinese appears as a sequence of hanzi broken down by punctuation, e.g. 老师，你怎么那么高兴？ ('Teacher, why are you so happy?).

Interword spacing plays an important role for readers of English. If interword spacing is removed, English readers' reading speed decreases by 30-50% (Epelboim, Booth, & Steinman, 1994; Pollatsek & Rayner, 1982), and their eye movements are disrupted (Rayner, 1998). On the other hand, adding interword spacing in writing systems that are not word-spaced does not facilitate native readers. For instance, interword spacing does not facilitate normal reading in Thai readers, although it helps them read texts composed of scrambled words (Kohsom & Gobet, 1997).

There is consistent evidence that adding interword spacing does not facilitate the reading of normal texts or sentences in Chinese native readers (Bai, Yan, Zang, Liversedge, & Rayner, 2008; Hsu & Huang, 2000a; Inhoff, Liu, Wang & Fu, 1997; Liu, Yeh, Wang & Chang, 1974), not even in primary school children (Bassetti & Masterson, 2012), including poor reading children (Shen, Bai, Zang, Yan, Feng, & Fan, 2010). In general, research shows that adding interword spacing to Chinese reading materials only facilitates native readers if the reading is done under unusual circumstances, in terms of presentation (scrolling texts, high-speed RSVP), materials (ambiguous sentences), or both (high-complexity materials with unusual presentation).

Chinese natives are facilitated when reading ambiguous sentences without context (Hsu & Huang, 2000b), single-line scrolling texts (Shieh, Hsu & Liu, 2005), sentences presented with Rapid Serial Visual Presentation at high speed (Lin & Shieh, 2006), and highly complex texts with scrolling or other unusual video displays (Hsu & Huang, 2000a). Similarly, Japanese readers are facilitated by interword spacing when reading texts written exclusively in syllabic kana, but not with texts that are written in the normal mixture of kana and kanji ('Japanese characters', Sainio, Jukka, Bingushi & Bertram, 2007). However, no positive effects were found in Chinese natives reading romanised Chinese (Bassetti, 2009; Bassetti & Masterson, 2012; King, 1983). It appears that the marking of word boundaries only facilitates Chinese readers in abnormal reading conditions, in the same way as the marking of phrase or clause boundaries can facilitate English readers (Bever, Jandreau, Burwell, Kaplan & Zaenen, 1991; Hartley, 1993; Keenan, 1984). There is even limited evidence that interword spacing may disrupt Chinese adults and children (Bassetti and Masterson, 2012). Finally, Chinese readers' satisfaction is lower when text on mobile devices is presented with interword spacing (Lin & Shieh, 2006).

1.2 Effects of interword spacing on L1-English CSL readers

With regards to second language readers, whether interword spacing has a facilitative effect or not appears to depend on both the orthographic conventions of the L2 writing system and the reading processes developed to read the L1 writing system. When the target writing system is word-spaced, removing interword spacing disrupts L2 readers, even if their L1 writing system is not word-spaced. For instance, eliminating interword spacing from English materials disrupts Thai readers of L2 English, although their L1 orthography is not word spaced (Kohsom & Gobet, 1997; Winskel, Radach, & Luksaneeyanawin, 2009). On the other hand, L2 readers can also be facilitated when spacing is added to separate orthographic units that are normally not separated in the target writing system, such as nouns and postpositions in Hebrew (Wade-Woolley & Geva, 1998). While Hebrew native readers are not facilitated, English readers of L2 Hebrew are, probably because nouns and prepositions are separated in their L1 orthography.

It is not clear whether adding interword spacing facilitates L2 readers of Chinese. Very limited research has investigated the effects of adding interword spacing on CSL readers, and results were inconsistent. Everson (1986) first investigated eye movements in beginner and advanced American CSL learners reading a short beginner-level Chinese text. He found no facilitative effects of interword spacing on reading rate or comprehension in either group, and on the contrary found disruption to eye movements and a non-significant decrease of 25% in reading rates. Bassetti (2009) tested L1-English university students of L2 Chinese reading short simple sentences, written either in hanzi or in romanised Chinese. Interword spacing increased L2 readers' reading rates with romanised sentences, but there were no effects with hanzi sentences. Bassetti (2009) argued that effects may only appear with texts of suitable difficulty and may not be evident with the simple sentences and texts used in her own study and in Everson (1986). There could be support for this idea in the literature on native reading. Reading processes vary when reading whole paragraphs rather than sentences (Bader, Pearce & Thompson, 1980). More specifically, in King's (1983) study of romanised Chinese reading, interword spacing had no effects on native readers' sentence reading, but it had negative effects with texts. Yao (2011) used two texts of suitable complexity (taken from a second-year textbook) to compare the effects of interword spacing in readers of L2 Chinese who had word-spaced or non-word-spaced L1 writing systems, and who had intermediate or advanced Chinese language proficiency, as measured with a test of vocabulary and grammar. Interword spacing speeded up L2 readers who had a word-spaced L1 orthography, but it slowed down advanced L2 readers who had a non-word-spaced L1 orthography.

It therefore appears that adding interword spacing can speed up L2 readers whose L1 is word-spaced, if the materials are of suitable complexity (Yao, 2011), but not with simple materials (Bassetti, 2009; Everson, 1986). Interword spacing may even have disruptive effects with simple texts (Everson, 1986) and in native readers of non-word-spaced orthographies (Yao, 2011). However, results are far from clear-cut, and other variables probably play a role, including task and word segmentation criteria. On the other hand, many experienced Chinese language teachers believe that interword spacing facilitates L1-English learners of L2-Chinese, and some Chinese language teaching materials are written with spacing between words (e.g., Zhang, Liu, Chen, Zuo, Shi, & Liu, 2002). The topic then deserves further investigation.

2. The present study

The present study investigated whether interword spacing facilitates L1-English CSL readers. The experiment used an online multiple-choice gap-filling task to compare English and Chinese readers' reading rate and comprehension of Chinese texts written with or without interword spacing. We predicted that L1-English readers of L2-Chinese would read faster with than without interword spacing. We predicted no positive effects of interword spacing on native readers, and no effects on comprehension in either group.

A few characteristics of this study are worth noting. First, we used materials of suitable complexity for our readers. Previous studies that found no effects of interword spacing on CSL reading used short simple sentences (Bassetti, 2009) or first-year textbook materials (Everson, 1986). We used reading materials from a second-year textbook to test students with three years of learning Chinese as a major. Such materials and participants are very similar to those used by Yao (2011), who demonstrated interword spacing effects.

Second, we adopted an online multiple-choice gap-filling task. This task ensures that participants are reading for comprehension without disrupting their reading. In Yao (2011), participants circled the last character read in a text during a period of 90 seconds, then the text was removed and participants answered comprehension questions. The comprehension questions required memorisation of the text (e.g., in what time of the year a certain event took place, or how long it lasted), and participants were not allowed sufficient time for answering (90 seconds for 15 questions summing up to about 800 characters). On average participants only answered correctly 21% of the comprehension questions. The multiple-choice gap-filling task requires no memorisation, is likely to interfere only minimally with reading, and provides an online measure of reading speed.

Finally, we determined the word segmentation of the Chinese texts on the basis of the text's English translation. In Yao (2011), word segmentation was determined by Chinese native speakers. This word segmentation method may not be suitable for CSL readers. CSL learners' word segmentations are very different from Chinese native speakers' segmentations (Bassetti, 2005). CSL learners segment Chinese texts into words by relying on translation in their first language: They group together into words those Chinese characters that correspond to an orthographic word in their L1 orthography, so that English, German and Japanese CSL learners segment the same Chinese text differently (Bassetti, 2005; 2007). Indeed, some CSL textbooks aimed at L1-English learners use English translation for word segmentation (e.g., Kan, 1994). Segmenting Chinese texts to reflect the boundaries of orthographic words in the texts' English translation may be the most appropriate word segmentation criterion for our target L1-English CSL readers.

2.1 Design

A 2 x 2 mixed design was used to test the effects of language background and type of spacing on reading rate and comprehension of texts. Language background was a between-group factor, with two levels: Chinese native readers and L1-English CSL readers. Spacing was a within-group factor, with two levels: no interword spacing and interword spacing. There were two dependent variables: reading rate, expressed in number of hanzi per second, and comprehension, expressed as the percentage of correct responses.

2.2 Participants

There were 24 participants: 12 Chinese native readers and 12 L1-English CSL readers.

The Chinese participants were native speakers and readers of Standard Chinese (*putonghua*) from the People's Republic of China (mean age = 28, females = 11). They were familiar with interword spacing, as they had studied English on average for eleven years (range 9-15), and were enrolled at a British university.

The English participants were native speakers and readers of English who had studied Chinese as their major for three years, recruited at various British universities (mean age = 24, females = 7). All but two were studying Chinese out of interest in the Chinese language or culture; the other two reported an instrumental motivation (work or travel). Most of them had lived in China for one year (*Med* = 11 months). Their Chinese reading proficiency was measured using self-rating on a 7-point scale, which in previous research with similar participants correlated with teacher ratings and with performance on a cloze task (Bassetti, 2009). Participants rated their reading ability as 'fair' (33%) 'good' (25%) or 'proficient' (42%). Their self-rated reading ability correlated with self-rated writing ability (τ = .84, p = .001), but not with speaking or listening comprehension (τ = 0.43, p = .102 and τ = 0.45, p = .089 respectively). It was therefore a measure of reading skills, rather than overall language proficiency. Participants considered the spoken language skills more important (listening and speaking: both *Med*s = 4, on a 4-point scale) than written language skills (reading: 3; writing: 3.5). However, they were spending more time practising written than spoken language. They reported spending more classroom time reading (*Med* = 3.50 on a 4-point scale) than speaking, listening or writing (*Med* = 2, 2.5 and 2 respectively). Outside the classroom, they also spent more time reading (*Med* = 4) and writing (*Med* = 3), than listening and speaking (both *Med* = 2).

Participation was voluntary and paid. All participants reported normal or corrected-to-normal vision.

2.3 Task

An online multiple-choice gap-filling task was used to measure participants' reading rate and comprehension under two presentation conditions: with inter-hanzi spacing or with interword spacing.

In the multiple-choice gap-filling task, participants read texts where the last content word had been eliminated, and selected the appropriate missing words from a list. This task was adopted because it tests comprehension without requiring production or memorisation (Alderson, 2000). Tasks that require written or spoken production (e.g., oral reading, open-ended questions) and tasks that require memorisation (e.g., oral or written recall, multiple-choice questions after reading) might underestimate L2 readers' comprehension, as L2 readers might comprehend more than they can recall or report in speaking or writing. Indeed, in our own pilot studies we tried using self-paced reading followed by a short-answer question, or timed reading followed by open-ended questions. Although both pilots tested general text comprehension rather than memory for specific content, both paradigms resulted in low accuracy and low reader satisfaction, as students disliked memorising contents. The multiple-choice gap-filling task does not require memorisation, as the options appear simultaneously with the text, rather than afterwards. In order to minimise the disruption caused by the decision task to normal reading, in our

task we created incorrect responses that made no sense in the context. For instance, at the end of the clause '[…] 所有的孩子都成了独生' ('[…] all kids became only') the correct answer was 子女 ('children') and the two incorrect answers were 环境 ('environments') and 胜利 ('successes'). This was done because, if the options provided are real contenders for the correct response, as in many cloze tests and other gap-filling tasks, selecting the correct answer among various options can slow down reading, and reading speed would be strongly affected by the decision processes. Furthermore, in order to prevent guessing based on prosodic or grammatical information, the two alternative options matched the target words in length (number of hanzi) and lexical category (noun, verb or adjective).

2.4 Materials

The reading materials consisted of eight texts, with a mean length of 310 hanzi each (roughly equivalent to 207 words, see Sun, Morita & Stark, 1985). Two shorter texts were also prepared for the practice session. Materials were taken from Chinese language textbooks, because a pilot study had revealed low accuracy rates in an online multiple-choice gap-filling task that used authentic materials. Texts were taken from two second-year textbooks (Chou & Chao, 1997; Chou, Link & Wang, 1997), and slightly amended to match length requirements. Left-alignment was used to avoid breaking words at line breaks. An experienced Chinese language teacher judged the resulting texts as being of suitable difficulty for the target participants. Indeed, Yao (2011) demonstrated effects of interword spacing on the reading of second-year textbook materials in L2 learners with about 32 months of Chinese language learning (similar to our third-year students).

Each text was divided into eight chunks of similar length (M = 38.5 hanzi, SD = 11), each consisting of one to three sentences. In each chunk, the last content word was deleted to create a blank, and three options were provided: the correct answer and two alternative options. The multiple-choice questions were numbered from one to three, and appeared in a column indented under the chunk. Options were selected from the top 2,000 entries in a word frequency list (Beijing yuyan xueyuan, 1986) as follows. The first selection was random, then the option was matched to the target answer in length and lexical category, and finally a native and a non-native speaker of Chinese checked that the option did not make sense in the context.

For each text, two versions were prepared (word-spaced and non-word-spaced), by varying the type of spacing. In the word-spaced condition, hanzi were grouped in orthographic words preceded and followed by a hanzi-wide space, which was a visible mark of word boundaries. However, once spacing is inserted, the word-spaced version of a text becomes longer than non-word-spaced version, which may result in longer reading times. To ensure that the two versions of the same chunk occupied the same length of space on screen (number of lines and line width), we inserted a half-hanzi space between hanzi in the non-word-spaced condition (see also Bassetti, 2009; Bassetti & Masterson, 2012). Such small spaces are unlikely to affect reading rates (Hsu & Huang, 2000a; Liu et al., 1974). Word segmentation was based upon the English translation of the sentence, so that spacing preceded and followed a string of one or more hanzi that corresponded to one orthographic word in the English translation. This is the most appropriate segmentation for these participants, as CSL learners segment Chinese texts in words on the basis of L1 translations (Bassetti 2005, 2007).

The example below shows the word-spaced and the non-word-spaced versions of the same chunk of text, and its English translation. The Appendix shows both versions of one of the eight texts.

在 中国 我们 不 常 看到 肥胖的 成年人， 却 常 看到 过重的
1. 外边
2. 时期
3. 孩子 。

在中国我们不常看到肥胖的成年人，却常看到过重的
1. 外边
2. 时期
3. 孩子 。

In China, one rarely sees fat elderly people, but one often sees overweight
1. outsides
2. periods
3. children.

2.5 Procedure and instruments

Experimental trials consisted of the presentation of a series of eight short texts. All participants saw the texts in the same sequence. The software randomly allocated each text to the word-spaced or non-word-spaced g condition, so that each participant saw four texts under each condition. Each of the eight texts was divided in eight chunks that appeared one at a time, for a total of 64 trials. Participants were tested individually in a quiet room. The participant sat in front of a laptop screen, read the instructions and performed a practice session. Participants were asked to read silently and choose the correct answer as quickly and accurately as possible by pressing a button on the response box. Instructions were in the participant's native language. For each text, the title was provided in the participant's native language, to help them read about different topics in rapid sequence. At the press of a button, the first of the eight chunks of text and its three multiple-choice options appeared in emboldened black 24-point Beijing font, on a white background within a black frame of 8 x 12 cm centred in the middle of the screen. Each hanzi occupied a 70 x 70 mm area. The chunk remained on screen until the participant selected one of the three multiple-choice options provided, by pressing a key labelled '1', '2' or '3' on the response box. When participants pressed a key, the text disappeared. There was then an interval of 1000 msecs before the presentation of the next trial. The sequence was repeated for eight chunks for each text. There was no time-out condition, and participants were allowed unlimited pauses between texts.

The task was programmed using the PsyScope 1.2.5 software (Cohen, MacWhinney, Flatt & Provost, 1993) and administered on a MacIntosh laptop computer. Stimulus presentation, randomisation and recording of responses were managed by PsyScope. Timing was measured by means of a response box that interfaced with the computer.

3. Results

Reading times for incorrect responses, and those beyond three standard deviations, were eliminated prior to analysis of reading rates. We also eliminated the reading time for a whole text if the participant had answered more than two questions incorrectly, which resulted in the elimination of 2% of texts in the L2 readers group. A reading rate was

calculated for each participant for each of the eight texts, by dividing the number of hanzi in the text (including the multiple-choice options) by the total reading time for the text, measured as the sum of the number of seconds between stimulus onset and response button press for the eight chunks. Finally, to ensure that participants were not trading off speed for comprehension, we entered each participant's reading rate and comprehension in a correlation. Reading rate and comprehension were positively correlated in the English group, $r = .61$, $p = .036$; there was no correlation in the Chinese group, , $r = -.51$, $p = .087$. This shows that there was no trade-off in either group.

Table 1 shows mean reading rate (in hanzi per second) and comprehension (percentage of correct responses) by language background (Chinese; English) and type of spacing (inter-hanzi, interword). Chinese native readers read about four times faster (M = 532 hanzi per minute, SD = 213) than English CSL readers (M = 115 hanzi per minute, SD = 40). Native readers also gave more correct responses (M = 97.96%, SD = 2.31%) than L2 readers (M = 88.54%, SD = 6.00%). Interword spacing increased reading rate in the English group but not in the Chinese group. The mean increase in reading speed in the English group was 8%, or 9.26 hanzi per minute (Med = 9%). The Chinese group read at almost the same speed with and without interword spacing (on average, 6.89 hanzi per minute slower with interword spacing than without). However, the difference between reading speeds with and without interword spacing varied widely in both groups. In the English group, the standard deviation was 11, and the range was -9 to +36 hanzi per minute, or an increase ranging -6% to +25%. In the Chinese group, the standard deviation was 57, and the range -94 to +124 hanzi per minute. For both groups, comprehension levels were almost identical under the two conditions.

Language background	**Reading rate (hanzi/s)**		**Correct responses (%)**	
	No interword spacing	**Interword spacing**	**No interword spacing**	**Interword spacing**
English CSL readers	1.83 (0.67)	1.99 (0.69)	88.63% (6.18%)	88.45% (6.70%)
Chinese readers	8.93 (3.46)	8.81 (3.69)	97.31% (3.25%)	98.61% (2.19%)

Table 1. Mean reading rate (hanzi per second) and percentage of correct responses by language background and type of spacing (standard deviations are in brackets)

Reading rates were subjected to a logarithmic transformation to correct for heterogeneity of variance. Separate 2 x 2 repeated-measures ANOVAs were performed on the reading rate and comprehension data.

The ANOVA for reading rate revealed a main effect of language background and a large effect size, $F(1, 22) = 112.82$, $p < .001$, partial $\eta^2 = .84$, showing that Chinese native readers read faster than L2 readers. There was no significant main effect of spacing, $F(1, 22) = 2.34$, $p = .140$. However, a significant interaction with a large effect size was obtained, $F(1, 22) = 8.91$, $p = .007$, partial $\eta^2 = .29$. Planned comparisons using Bonferroni's t-tests showed that interword spacing sped up text reading in the English group, and the effect size was large, $t(11) = -3.52$, $p = .005$, Cohen's $d = 2.12$. Chinese native readers' reading rate was descriptively slightly slower with interword spacing, however the difference was not significant, $t(11) = .95$, $p = .363$.

The ANOVA for comprehension revealed a main effect of language background with a large effect size, $F(1,22) = 25.74$, $p < .001$, partial $\eta^2 = .54$, showing that the Chinese group answered more questions correctly than L1-English L2-Chinese readers. There was no main effect of spacing or interaction, both Fs < 1.

In order to confirm whether interword spacing facilitates less proficient L2 readers (see Yao, 2011), an interword spacing effect was calculated for each participant by subtracting their reading rate without interword spacing from their reading rate with interword spacing. The interword spacing effect was then entered into a correlation analysis with self-rated Chinese reading proficiency, which had been previously shown to correlate with teacher's rating and with performance on a cloze task (Bassetti, 2009), and which correlated with reading comprehension in the present study ($\tau = 0.52$, $p = .037$). Figure 1 shows the size of the interword spacing effect by level of proficiency. Among the self-rated 'fair' readers ($n = 4$), the mean increase was 18.45 hanzi per minute, ranging from 8.15 to 36.39, the latter corresponding to an increase of 25% compared to the participant's overall reading rate across conditions. Among the self-rated 'good' and 'proficient' readers, the increase was much smaller, and one reader even showed a decrease (good readers: $n = 3$, $M = 5.03$, range: -.03 to 13.32; proficient readers: $n = 5$, $M = 4.44$, range: -9.17 to 11.56). Among native readers, the mean interword spacing effect was -6.89, with a wide range of between -94.17 and 123.72, reflecting the fact that one fourth of participants read faster with interword spacing than without.

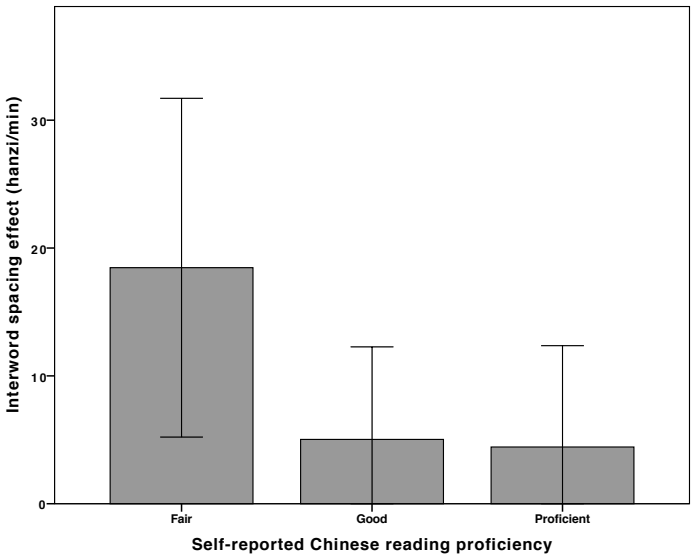

Figure 1. CSL readers' mean interword spacing effect (difference between reading rate with and without interword spacing) in hanzi per minute (error bars represent standard deviations) by level of self-rated Chinese reading proficiency

There was a negative correlation between the interword spacing effect and L2 readers' self-rated reading proficiency, one-tailed $\tau = -0.41$, $p = .045$. The interword spacing effect was then also entered into correlations with two other measures of reading proficiency obtained from the study, namely reading comprehension and reading speed. The interword spacing effect was negatively correlated with reading comprehension, $r = -0.42$, $p = .041$, but not with reading speed, $r = -0.30$, $p = .149$.

4. Discussion

4.1 Effects of interword spacing on L1-English CSL readers

Results confirmed the experimental hypothesis that adding interword spacing facilitates reading in L1-English readers of Chinese as a Second Language. Interword spacing on average increased L2 readers' reading rate by 8%, compared with non-word-spaced texts, with increases as high as 25%. Results are in line with previous findings by Yao (2-1011), who also used texts from a second year textbook with third-year CSL learners. Results differ from those of previous studies that found no facilitative effect of interword spacing on third-year CSL learners reading simple reading materials, such as texts from a first-year textbook (Everson, 1986) or short simple sentences (Bassetti, 2009). The absence of a main effect of type of spacing confirmed the hypothesis that the artificial addition of interword spacing does not facilitate Chinese native readers. This is in line with previous studies of Chinese natives that only found positive effects with the reading of unusual materials or under unusual circumstances, but not with normal reading (Bai, Yan, Zang, Liversedge, & Rayner, 2008; Hsu & Huang, 2000a; Inhoff, Liu, Wang & Fu, 1997; Liu, Yeh, Wang & Chang, 1974). The lack of effects on comprehension confirmed predictions that interword spacing increases L2 readers' reading rate but it does not affect comprehension, in line with previous findings (Bassetti, 2009, Yao, 2011). Finally, we found a main effect of language background on both reading rate and comprehension, with Chinese natives showing faster reading rates and higher levels of comprehension than L1-English L2-Chinese readers. This is in line with the literature. Slower reading rates are consistently found when readers of L2 Chinese are compared with native readers (Bassetti, 2009; Everson, 1986). Indeed, after 800 hours of Chinese language study, CSL readers still read at 54%-68% of the speed of Chinese final-year primary school students, and with lower levels of comprehension (Kupfer, 2007). English CSL readers read Chinese faster than native readers only when sentences are written in romanised Chinese, which uses the same script as CSL readers' L1 writing system (Bassetti, 2009), possibly because the absence of morphemic information is highly disruptive for Chinese native readers (Bassetti & Masterson, 2012).

It appears that interword spacing can facilitate English readers of Chinese as a Second Language, but these effects are modulated by their reading proficiency in relation to the level of difficulty of the materials being read. Interword spacing may facilitate CSL reading if materials are of an appropriate level of complexity for the readers, but not if materials are too easy for them. This conclusion is also supported by the negative correlation between the effect of interword spacing and self-rated reading proficiency. Although self-rating is not the ideal measure of reading proficiency, this result could confirm that interword spacing facilitates readers when the reading materials are of appropriate difficulty for them. Texts from second-year textbooks were probably suitably challenging for the less proficient of these third-year students, whereas the more proficient ones did not need the extra help provided by interword spacing. This then

shows that, as L2 readers become more proficient, their reading processes become more similar to those of native readers. It is interesting to note that one of the self-rated proficient readers even showed a negative effect of interword spacing, as in native readers. The negative correlation with reading comprehension also seems to support this interpretation, however the lack of correlation with reading speed, which is also a measure of reading proficiency, is puzzling. Future research should then look at the relationship between the interword spacing effect and objective measures of reading ability, rather than the self-reports used in this study or the vocabulary and grammar tests used in Yao (2011). Furthermore, there were very high levels of individual variation, with about half of the L2 readers showing a reading rate increase of 10-25%, and the other half showing a small increase or even a decrease. This was partly explained by reading proficiency, but future research should look into individual variables that may modulate the effects of interword spacing. Finally, the facilitative effects of interword spacing should not be generalised to all learners of written Chinese, but only to those whose L1 writing system is word spaced. Interword spacing does not universally facilitate less proficient readers: it does not facilitate either Chinese children (Bassetti & Masterson, 2012; Shen et al., 2010), or CSL readers with a non-word-spaced L1 writing system (Yao, 2011). The facilitative effect of interword spacing seems to derive from an interaction between a word-spaced L1 writing system and the CSL reader's reading ability in relation to the difficulty of the reading materials. This interword spacing effect is then very different from the interword spacing effect found in English natives' reading of English, where the absence of interword spacing disrupts all readers with all reading materials.

4.2 Possible explanations for the facilitative effects of interword spacing

The facilitative effect of interword spacing on English readers of L2 Chinese in this study is probably better explained in terms of higher-level reading processes than in terms of low-level ones. Some researchers argued that interword spacing could facilitate Chinese readers by guiding their eyes movements (Hsu and Huang, 2000a). However, if the facilitative effects of interword spacing on L1-English CSL readers were due to eye movements, such effects should be independent of reading proficiency and appear with all reading materials. The interword spacing effect found in L2 readers in this study is then probably best explained in terms of lexical parsing, i.e. the grouping of hanzi into lexical items. Since hanzi can represent lexical items or parts of lexical items, and there are no visual clues to lexical item boundaries, readers of L2 Chinese must parse the sentence in order to identify its constituents, and since this involves linguistic processes, word reading in Chinese is part of higher-level processes. Lexical parsing is a difficult task for L2 learners of Chinese (Everson & Ke, 1997), because many polymorphemic lexical items are not listed in their mental lexicons due to limited vocabulary knowledge, and because they have limited probabilistic knowledge of collocations in Chinese. The addition of interword spacing provides CSL readers with lexically pre-parsed materials. Of course other processes may be at play too. Perhaps word spacing also facilitates mental translation. Second language readers sometimes use mental translation while reading (Hosenfeld, 1977, 1984), particularly when reading difficult texts (Kern, 1994), or when performing decision tasks (Davies & Kaplan, 1998). Participants may then have used mental translation in this task, and we segmented Chinese texts into units that translate into English words, which are likely to be the units of mental translation. In conclusion, it is impossible to know why interword spacing facilitated our CSL readers,

but it is likely that it facilitated higher-level processes, such as lexical parsing and possibly mental translation, rather than lower-level processes. This would explain the lack of effects with simpler materials found in previous studies, and the negative correlation between reading ability and the interword spacing effect in this study.

4.3 Other findings, limitations and pedagogical implications

Besides confirming the hypotheses, the study produced other relevant findings. First, in line with previous research (Bassetti, 2009), there were high levels of variation in the effects of interword spacing in both groups. This study shows that a likely reason for the positive effects of interword spacing is the level of complexity of the text vis-à-vis the L2 reader's reading proficiency. However, other factors may also play a role. Future research could then investigate individual differences and other variables that may modulate the interword spacing effect, in order to explain why interword spacing has positive effects on some readers and negative effects on others, and why the effect size varies so much, both in native and non-native readers.

Second, the study confirmed that the online multiple-choice gap-filling task can be used to test L2 readers' reading, as it can provide a measure of reading speed while also ensuring that participants are reading for comprehension. Participants did not trade off speed for comprehension, as the two were positively correlated. The CSL readers in this study were slower than in Yao's (2011) study, which tested readers with similar length of L2 study reading texts of a similar level of difficulty. However, participants in our study showed high levels of comprehension compared with Yao's (89% versus 21%), and the slower reading rates could also be at least partly due to the effects of reading from screen (see Lin & Shieh, 2006).

The study suffers from some limitations. First of all, the number of participants was sufficient to reveal the effect of interword spacing, but it was very small. Second, while reading from computer screen is an everyday reality for both native and non-native readers, the extent to which on-screen reading processes can be assumed to reflect paper reading is unclear. Therefore, results cannot be generalised to paper reading.

With regards to pedagogical implications, the paper shows that interword spacing can help L1-English CSL readers when reading sufficiently complex texts. It is not clear whether interword spacing is useful for the intensive and repeated reading of hanzi texts in textbooks. However, on the basis of the limited evidence available, it is possible to argue that interword spacing could be used to encourage independent extensive reading of materials that are suitably complex for the target readers. This is how interword spacing is indeed used in some Chinese reading courses (e.g., Li, 1988; Lu, 1996, 1997). However, nothing is known about Chinese learners' attitudes towards word-spaced texts. Two previous studies found negative attitudes towards interword spacing in native readers of non-word-spaced writing systems. Thai readers considered word-spaced materials uncomfortable to read (Kohsom & Gobet, 1997), and Chinese readers displayed lower levels of reader satisfaction with word-spaced than with non-word-spaced materials on mobile devices (Lin & Shieh, 2006). Neither study found negative effects of interword spacing on reading, suggesting that attitudes may not be related to actual reading processes in native readers. However, second language learners' attitudes towards reading materials might affect their desire to engage with such materials. Therefore, future research could investigate CSL learners' attitudes towards word-spaced texts, and results

should be considered alongside evidence from experimental studies when deciding whether to use interword spacing or not.

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Appendix. Example of text: Word-spaced version, non-word-spaced version, and English translation.

Word-spaced version

在 中国 我们 不 常 看到 肥胖的 成年人 ， 却 常 看到 过重的
1. 外边
2. 时期
3. 孩子 。

“ 小胖子 ” 的 快速 增加 ， 显示了 一个 严重的 家庭 问题 ， 也 是
一个 严重的 社会
1. 人口
2. 时间
3. 问题 。

近 年 来 ，由于 中国 政府 严格地 推行 一 家 一个 孩子 的 人口
政策 ，所有的 孩子 都 成了 独生
1. 环境
2. 子女
3. 胜利 。

他们 都 是 父母 和 祖父母 唯一的 宝贝 。 他们 在 家 里 吃 最好 的 ，穿 最
贵 的 ， 用 最新 的 。他们 从 小 受到 所有 家人 的 关怀 和
1. 军事
2. 注意
3. 少爷 。

在 这样 环境 中 长大 的 孩子 常常 不 懂得 怎么 和 别人 相处 ，
怎么 和 别人 合作 。他们 只 会 求 别人 为 他们 做事 而 不 会 为 别人
1. 主张
2. 服务
3. 变成 。

父母 一 方面 把 独生 子女 养成了 家 里 的 一个 小 皇帝 ，另 一
方面 又 把 所有的 希望 都 放 在 这个 小孩子 的
1. 身
2. 坑
3. 棒
上。

在 情况 比较 好 的 家庭 里 ，这个 孩子 除了 上 学 念书 以外 ，还
得 学 钢琴 、小提琴 、芭蕾舞 …… 有的 还 要 学 游泳 、打
1. 网球
2. 特务
3. 政权 。

父母 恨不得 把 这个 孩子 训练 成 无所不能的
1. “ 超人 ”
2. “ 医生 ”
3. “ 环境 ”

Non-word-spaced version

在 中 国 我 们 不 常 看 到 肥 胖 的 成 年 人 ，却 常 看 到 过 重 的
1. 外边
2. 时期
3. 孩子 。

“ 小 胖 子 ” 的 快 速 增 加 ，显 示 了 一 个 严 重 的 家 庭 问 题 ，也 是 一 个 严 重 的 社 会
1. 人口
2. 时间
3. 问题 。

近 年 来 ，由 于 中 国 政 府 严 格 地 推 行 一 家 一 个 孩 子 的 人 口 政 策 ，所 有 的 孩 子 都 成 了 独 生
1. 环境
2. 子女
3. 胜利 。

他 们 都 是 父 母 和 祖 父 母 唯 一 的 宝 贝 。他 们 在 家 里 吃 最 好 的 ，穿 最 贵 的 ， 用 最 新 的 。他 们 从 小 受 到 所 有 家 人 的 关 怀 和
1. 军事
2. 注意
3. 少爷 。

在 这 样 环 境 中 长 大 的 孩 子 常 常 不 懂 得 怎 么 和 别 人 相 处 ，怎 么 和 别 人 合 作 。他 们 只 会 求 别 人 为 他 们 做 事 而 不 会 为 别 人
1. 主张
2. 服务
3. 变成 。

父 母 一 方 面 把 独 生 子 女 养 成 了 家 里 的 一 个 小 皇 帝 ，另 一 方 面 又 把 所 有 的 希 望 都 放 在 这 个 小 孩 子 的
1. 身
2. 坑
3. 棒

上。

在 情 况 比 较 好 的 家 庭 里 ，这 个 孩 子 除 了 上 学 念 书 以 外 ，还 得 学 钢 琴 、小 提 琴 、芭 蕾 舞 …… 有 的 还 要 学 游 泳 、打
1. 网球
2. 特务
3. 政权 。

父 母 恨 不 得 把 这 个 孩 子 训 练 成 无 所 不 能 的
1. “ 超人 ”
2. “ 医生 ”
3. “ 环境 ”

English translation

In China, one rarely sees fat elderly people, but one often sees overweight

1. exteriors
2. periods
3. children.

The fast increase in 'fatties' represents an important family problem, and [it] is also an important social

1. population
2. time
3. problem.

In recent years, because the Chinese government seriously implemented [a] one family one child population policy, all sons became only

1. environments
2. children
3. successes.

They all are parents' and grandparents' only treasure. At home, they eat the best [food], wear the most expensive [clothes], use the newest [things]. Since little, they enjoy the whole family's affection and

1. military
2. attention
3. master.

Children raised in such environments often do not understand how to relate to others, how to collaborate with others. They can only ask others to work for them and cannot ____ others

1. hold
2. help
3. become.

Parents on the one hand raise an only child as a little home emperor, on the other hand they also place all their hopes in the child's

1. body
2. pit
3. notice.

In well-off families, the child, apart from going to school, also has to study piano, violin, ballet, etc. Some also have to learn to swim and to play

1. tennis
2. special duty
3. power.

Parents wish to raise this child to become an almighty

1. superman
2. physician
3. environment.