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Chinese Text Presentations and Reading Efficiency

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Abstract

Unlike alphabetic languages, Chinese text marks no word demarcation. Previous research inserted word-demarcating spaces into Chinese text but found inconsistent effects on reading efficiency. To address the potential trade-off effects of the additional length caused by inserted spaces, this study introduces color-and-font formatting as a word demarcation. A total of 41 first-language (L1) and English-speaking second-language (L2) Chinese speakers read Chinese text presented in conventional, interword spaced, nonword spaced, interword formatted, and nonword formatted conditions. Participants further answered comprehension questions and shared retrospective perceptions. The results suggest altered text presentations can facilitate reading for L2 Chinese learners in accordance with proficiency levels and learning objectives. Interword spaced text facilitated reading speed, especially for higher-level Chinese learners. Interword formatted text facilitated accuracy for all L2 Chinese learners. Nonword formatted text facilitated accuracy for lower-level Chinese learners. In addition, altered text presentations were generally acknowledged and welcomed by L2 Chinese learners.

Keywords: L2 Chinese reading, reading efficiency, reading speed, reading accuracy, word demarcation, space, formatting

Alphabetic languages, such as English, places demarcating spaces between words in writing. With interword space retracted, English reading speed slowed down by 30–50% (Malt & Seamon, 1978; Morris et al., 1990; Rayner et al., 1998; Spragins et al., 1976; Winskel et al., 2009). By contrast, Mandarin Chinese writes in the form of a string of discrete characters with no prominent word boundaries, which requires the readers to identify and segment words themselves. Previous research has studied how inserting prominent word demarcations such as spaces may facilitate readers' identification and segmentation of Chinese syntactic words. However, such inserted space demarcation resulted in inconsistent effects on reading efficiency.

This study starts by reviewing previous research on how text alteration affects reading efficiency. Of particular interest is how previous research handled their participants' language backgrounds, text presentation conditions, and reading efficiency assessment. Next, in an attempt to address the potential trade-off effects of adding interword spacing, this study introduces formatting changes to color and font as an alternative for interword demarcation and nonword demarcation, in both sentence and paragraph length. This study then investigates the effects of spaced and

formatted text alteration. Data were collected on the performance and perceptions of both L1 and L2 Chinese speakers reading Chinese text in varied presentations altered by space and formatting. After that, the effects of different text presentations on reading efficiency to L1 and L2 Chinese speakers across proficiency levels are analyzed. Finally, based on the results, this study suggests varied text designs in accordance with targeted reading purposes for L2 Chinese learning and teaching at different stages.

Literature Review

Previous studies on how different Chinese text presentations affect reading efficiency were initially performed on adult native Chinese speakers and later extended to children and Chinese second language (L2) learners. In such studies, to facilitate or disrupt word recognition, conventional Chinese text presentation was altered by inserting interword and nonword demarcations in the forms of spaces, highlighting, and commas (Bai et al., 2010; Liu et al., 1974; Ren & Yang, 2010). Reading efficiency was typically examined via reading time, comprehension accuracy, as well as eye fixation and movement. This section reviews existing research with a focus on their participants' language backgrounds, the text presentations that were used, and the methods of assessing reading efficiency.

Participant language backgrounds

To investigate whether and how altered text presentations may affect Chinese reading efficiency, earlier studies focused on Chinese native speakers and mostly showed no benefits from inserted interword spaces. With additional spaces marking word boundaries, Chinese native speakers' comprehension accuracy did not improve, and their reading speed was hindered (Bai et al., 2008; Inhoff et al., 1997; Liu et al., 1974). These results were consistent with findings in other languages typically written without word spaces, such as Japanese (Sainio et al., 2007) and Thai (Kohsom & Gobet, 1997; Winskel et al., 2009). However, some studies showed that interword spacing facilitated Chinese native speakers' word identification in specific circumstances. Comprehension was improved when text included ambiguous or difficult sentences (Hsu & Huang, 2000a, 2000b; Inhoff et al., 1997) and when text display took the forms of moving single-lines on computer (Shieh et al., 2005). In line with the mixed findings on reading accuracy, reading time was also found significantly reduced when Chinese native speakers read spaced text with ambiguous characters (Hsu & Huang, 2000a). To interpret this broad range of findings, some researchers (Bai et al., 2008; Zang et al., 2013) argued that there is a trade-off between the potential facilitatory effect of word demarcation and the unusual visual appearance of the spaced text for Chinese native speakers. For adult Chinese native speakers who are used to reading conventional text, they had to adjust their pre-existing reading habits to reading the altered text with interword spaces.

Because there may be trade-off costs of overcoming preexisting reading habits, recent studies diversified the language backgrounds of participants. To begin with, studies recruited children who had not yet fully established a reading habit on conventional text, but also found no clear beneficial effects of spaced text. Shen et al. (2010) performed an eye-tracking study on 72 Chinese elementary school students. They found interword spaced Chinese text did not

accelerate children's reading speeds; however, the nonword spaced text showed more disruptive effects to children with lower reading proficiency. They, therefore, concluded that children with lower reading proficiency relied more on the marked word boundary. Zang et al. (2013) suggested word identification and reading speed could be facilitated for both adults and children, because the interword spaced text benefited their word segmentation and reduced lateral masking. However, no net decrease in overall reading times was found due to the unfamiliar visual appearance of the spaced text. In addition to reading speed and accuracy, altered text presentation may also help children learn new words. Blythe et al. (2012) found both adult and child participants in the interword spaced group read the new words more quickly than participants in the unspaced group. Moreover, children were able to carry over the benefit of reading spaced text to their reading of unspaced text afterward, which Blythe et al. argued was a demonstration that spacing manipulation helped the children learn the new words.

In addition to child participants, researchers have also investigated L2 Chinese learners whose Chinese proficiency is not yet fully developed. For L2 Chinese learners, identifying word boundaries is considered very challenging. Li and Wang (1987) surveyed 55 L2 Chinese learners and found that 43% of participants reported word and phrase identification difficult. Researchers, therefore, presumed that L2 Chinese learners might be more receptive to text alteration. Studies that applied text alteration to L2 Chinese speakers have gone through three phases in how they approach the topic. The first phase has been to recruit L2 Chinese learners of mixed first language (L1) backgrounds. Gao (2008) recruited 15 Chinese native speakers and 30 Chinese L2 learners of varied L1 backgrounds (i.e., Korean, Japanese, Mongolian, Vietnamese, and English) to read 18 Chinese sentences each composed of 17.1 characters on average. The interword spaced (of half-character length) text neither significantly accelerated reading speed nor improved comprehension. The second phase has been to categorize L2 Chinese speaking participants based on the orthographic conventions of their L1s. This was based on the hypothesis that whether L2 Chinese learners' native language is written with interword spaces could affect their Chinese text reading. Shen et al. (2012) recruited L2 Chinese speakers whose L1 were written either with interword space (i.e., English, Korean) or without interword space (i.e., Japanese, Thai). They found that the unspaced texts required longer reading times compared with character-spaced texts, and word-spaced texts caused the least disruption while non-word-spaced texts yielded the most disruption. These effects were however not influenced by participants' L1 background. The third phase has been to focus specifically on English-speaking L2 Chinese speakers. Bai et al. (2010) recruited 38 American L2 Chinese learners into eye movement tracking experiments to read Chinese texts inserted with interword or intercharacter spaces. Their results indicated that American L2 Chinese learners read word-spaced text faster than reading conventional text or character-spaced text. Similar results were confirmed in Bassetti and Lu (2016) with 12 English-speaking L2 Chinese learners (who majored in Chinese for three years) as they read faster with word-spaced text than with the conventional text. In the same study, Chinese native speakers were also tested. Their reading speed was not affected, whereas comprehension accuracy was negatively affected by interword spacing. Bassetti and Lu concluded that interword spacing facilitates English-speaking L2 Chinese learners when they read materials of sufficient complexity by facilitating their lexical parsing. Along the same lines, when reading texts that intentionally included ambiguous words, interword space was also found to facilitate reading accuracy and speed of L2 Chinese speakers (Bai et al., 2010). It concurred

that there might be a facilitatory effect of word demarcation on ambiguous text for native speakers (Hsu & Huang 2000a, 2000b; Inhoff et al., 1997).

Finally, studies started directing attention to the moderating variable of Chinese language proficiency when assessing how text alternation affects reading efficiency. Some studies categorized L2 Chinese learners by how many years they had been learning Chinese (Gao, 2008; Bassetti & Lu, 2016). Though the length of study correlates to learners' language proficiency, it is not necessarily an accurate indicator. Therefore, some studies employed language tests to more accurately assess L2 participants' Chinese proficiency. Bassetti (2009) conducted a cloze test, self-rating, and teacher-rating to assess Chinese reading proficiency. There were also attempts to use standardized Chinese tests like HSK, but this was not consistently applied to all participants (Shen et al., 2012). To better investigate the effects of Chinese language proficiency, this study argues that researchers should recruit L2 Chinese speakers across levels, and moreover, employ a reliable Chinese language proficiency test to assess their proficiency level.

Altered text presentations

In concert with diversifying participants' language backgrounds, studies have also explored different placement, lengths, and coverage of additional spaces. First, the placement of additional demarcation was mostly interword and nonword (Inhoff & Liu, 1998). Interword demarcation distinguishes syntactic words, which supposedly enhances reading, whereas nonword demarcation confuses the word boundary, which supposedly adds challenges to lexical parsing and impedes reading. Some studies also investigated intercharacter space and found positive effects (Bassetti, 2009; Bai et al., 2010). Second, the length of space has also been investigated. Half-character spacing was shown to have worked better than one-character spacing at facilitating higher reading efficiency, while the intercharacter spacing did not show much difference from interword spacing (Hsu & Huang, 2000b; Liang & Bai, 2010). Aiming to further visually demarcate the space, Ren and Yang (2010) added commas as a word demarcation which showed a facilitatory effect on reading efficiency. Finally, the inserted space may be used throughout the full text (Winskel et al., 2009) or may be used exclusively before, in-between, or after the target word of comprehension while the remaining text was not altered (Liu & Li, 2014). Li et al. (2009) proposed a word segmentation and recognition model that predicted the pre-word rather than the post-word space would facilitate word processing. Their prediction was supported by consistent results across several eye-tracking experiments (Li et al., 2014; Liu & Lu, 2018): As long as the word *n* is recognized, its ending point simultaneously defines the starting point of word *n* +1. However, it was also suggested that inserting a space before a word may hurt the efficiency of parafoveal vision processing and result in longer fixation times (Liu & Li, 2014). Such different functions of the pre- and post-word space may have additionally played a part in the potential trade-off effect of inserted interword space throughout the full text. Nonetheless, these findings confirmed that inserted word demarcation, such as space, showed effects on word segmentation and reading efficiency.

To address the potential trade-off effect caused by added length from spaces, studies employed alternative word boundary markers such as highlight and alternating colors. A potential facilitatory effect of interword highlight was argued since word-highlighted text was not found to be disruptive, whereas nonword-highlighted text was found to be disruptive to reading efficiency

for adult Chinese native speakers (Bai et al., 2008), Chinese children (Shen et al., 2010), and American students who were studying Chinese language (Bai et al., 2010). In an iteration on highlighting, alternating colors that were either consistent or inconsistent with word-boundary information was applied to text presentation. Such explicit demarcation also found no effects on Chinese native speakers because they were capable of using parafoveal word-boundary knowledge for saccade generation, even if such information is unfamiliar to them (Zhou et al., 2018).

Reading efficiency assessment

Reading efficiency has been typically measured in terms of reading speed and comprehension accuracy. Reading time was recorded for the target word (Blythe et al., 2012) or complete sentences (Bai et al., 2008). In order to minimize the reading time difference caused by uneven character numbers across text presentations, the reading rate in addition to net reading time was employed. Reading rate was calculated using the number of syllables per second in oral reading (Bassetti, 2009) or characters per minute (Bai et al., 2008).

In contrast with reading speed, comprehension accuracy employed a variety of assessments. Bassetti (2009) used sentence-picture verification tasks where participants pressed a button to indicate whether the given sentence matched the picture. Both reading time of the overall sentence and picture, as well as comprehension accuracy were thus recorded. To enhance the validity of comprehension assessment by reducing the possibility of guessing, many studies chose multiple-choice questions over true-or-false questions. Bassetti and Lu (2016) employed an online multiple-choice gap-filling task to test 12 English-speaking Chinese L2 learners and Chinese natives reading a series of eight texts of suitable difficulty, written with or without interword spaces. Only the sentence reading time for correct responses was kept for analysis.

In addition to measuring accuracy rate, advanced technology allows comprehension assessment to take a further step. For instance, eye-tracking experiments enabled an analytic look into the reading process by measuring readers' eye fixation and movement. Examples of such measures included readers' first fixation duration, gaze duration, total time of all fixations, the total number of fixations, initial landing positions, and skipping rate (Li et al., 2014; Liu & Li, 2014; Liu & Lu, 2018; Zang et al., 2013).

The Present Study

Based on the previous research, this study took the following steps in an attempt to address the potential trade-off effects as well as further refine the experiment design. First, this study introduced color-and-font formatting as an alternative to spaces to mark word boundaries. The reason is that color-and-font formatting can be implemented in a manner that does not increase text length like spaces or commas. Moreover, color-and-font formatting, online or in print, marks a sufficient visual distinction from conventional text presentation while remaining familiar to students, compared with highlight or alternating colors. Therefore, this study employed both color-and-font formatting and spaces to form interword as well as nonword demarcations. Second, this study included paragraphs consisting of 3–5 sentences in addition to single

sentences as the reading texts. The paragraphs were included as an attempt to mitigate the impact of the additional length caused by inserted space as well as to increase reading complexity. Third, this study began the reading test with a preparation session gauging participants' focus on space, color, and shape of visual presentations. The preparation session aimed to ease participants into varied text presentations and thus minimize the intervening variable of readers' unfamiliarity to text alternation. Fourth, this study recruited both L1 and L2 Chinese speakers and categorized their proficiency levels utilizing a reliable proficiency test in order to better control for language proficiency. Finally, this study added a brief interview upon participants' completion of the reading test, documenting participants' perceptions of how different text presentations affected their reading experience.

Research Questions

This study investigates how interword or nonword-marked Chinese text presentations may affect the difficulty of identifying word boundaries and thus affect reading efficiency for Chinese speakers across different proficiency levels. Two research questions are proposed.

1. How does Chinese text presentation with interword and nonword demarcation affect the reading speed and comprehension accuracy of low, high, and native proficiency speakers of Chinese?
2. How is Chinese text presentation with interword and nonword demarcation perceived by low, high, and native proficiency speakers of Chinese?

Methods

Participants

Both L1 and L2 Chinese speakers (total $N = 41$) participated in this study. All L2 Chinese speaking participants were English native speakers who had completed at least two-year college level or equivalent Mandarin courses in the USA. Each L2 participant completed a Mandarin Elicited Imitation (EI) test (See more in the section *Mandarin EI Test* below) to assess their Chinese. Based on their EI scores, the L2 Chinese learners were placed into two groups: (a) *Low Proficiency Group*: EI Score ≤ 47 ($n = 14$, $M = 36.2$, $SD = 1.72$); and (b) *High Proficiency Group*: EI Score ≥ 49 ($n = 13$, $M = 61.4$, $SD = 2.96$). There was a substantial and meaningful difference between the proficiency levels of the low proficiency group and the high proficiency group. A *t*-test between the two groups' mean EI scores showed a statistically significant difference, with $t(27) = -7.50$, $p < .001$. Participants who were L1 Chinese speakers were placed into the third group (c) *Native Proficiency Group* ($n = 14$). All the data in this study were analyzed using IBM SPSS Statistics for Macintosh, Version 26.0.

Design

In a quiet room, each participant individually completed the experiment by performing three tasks in sequence: (a) a reading test; (b) a short interview; and (c) a Mandarin EI test.

Completion of all three tasks took approximately 40–60 minutes. Below are the detailed procedures.

Reading test

Each participant first completed a reading test which took around 25–40 minutes, depending on one's Chinese proficiency level. The reading test was delivered via PsychoPy (v1.84.2), an open-source software package written in the Python programming language. PsychoPy allowed the study to record the reading time of each screen as well as save the answers input by participants. To reduce potential order effects, this study applied a structured randomization of the text presentations following previous studies (e.g., Gao, 2008; Liang & Bai, 2010). Specifically, sentences and paragraphs were each first labeled by condition (i.e., a, b, c, d, e) with a token number (i.e., 1, 2, 3, 4, 5), and then randomized across conditions following the Latin square.

All participants started the reading test with a three-minute preparatory session that primed them with unconventional text presentations. It started with image spotting questions such as *how many faces are hidden in an image*, *where are the faces hidden among the coffee beans*, and *what image can you identify in a picture of black and white chunks and dots*. Such image spotting questions directed participants' attention to the general contrast and interaction between lines, chunks, colors, and space. Next, the preparatory session presented the same Chinese sentence in five conditions (i.e., conventional, interword spaced, nonword spaced, interword formatted, and nonword formatted) and asked the participants to observe the difference. This served as a trial to familiarize the participants with experiment procedures on computer and the differences between the presentation conditions. All the images and text (i.e., sentence, paragraph) were given with multiple-choice questions. Additionally, the preparation session also served to confirm participants did not have deficiencies in their color vision.

Once participants completed the preparation session, they proceeded to reading texts in varied presentations and answering questions. Each participant read four sentences and one paragraph in five different conditions, for a total of twenty sentences and five paragraphs. The five different conditions (listed in Table 1 below) were: (a) conventional text; (b) interword spaced text where half-character space was inserted between words to prominently mark word boundaries; (c) nonword spaced text where half-character space was inserted randomly between each 1–4 characters which do not mark word demarcation; (d) interword formatted (colored-and-fonted) text where prominent word boundaries were marked by contrasting color and font; and (e) nonword formatted (colored-and-fonted) text where nonword demarcations were marked by color and font. All the texts were composed with consistent complexity and difficulty by only using second-year level vocabulary and grammar from the textbook in use *Integrated Chinese* (4th ed.) (Liu et al., 2018). Each of the five presentation conditions has a consistent total number of characters (M = 203.0, SD = 6.89), with each punctuation mark counted as one character. In addition, all added interword demarcations were in accordance with the vocabulary list of *Integrated Chinese* (4th ed.) (Liu et al., 2018). This was to address the interpretive variability of Chinese word boundary, as a Chinese syntactic word does not have fixed syllables but may be a unigram, bigram, trigram, or a quadgram without prominent marking.

Table 1

Examples of the Five Text Presentations

Text Presentations	Example
(a) Conventional	李先生只买大小长短和颜色都合适的衣服。
(b) Interword spaced	李 先生 只 买 大小 长短 和 颜色 都 合适 的 衣服。
(c) Nonword spaced	李先 生 只买大 小长 短 和颜 色都合 适的衣 服。
(d) Interword formatted	李先生只买大小长短和颜色都合适的衣服。
(e) Nonword formatted	李先生只买大小长短和颜色都合适的衣服。

Note. For (d) and (e), the characters shown in the *Kaiti* font (e.g., 先生) are colored in red.

The reading test was designed such that the skipping and backward functions were disabled. Thus, participants were not able to skip questions or go back to the previous slide once they proceeded to the next one. Participants read the question(s) on one slide before proceeding to the next slide of Chinese text. This way, they were aware of what to look for before reading each sentence or paragraph. Upon finishing reading each sentence or paragraph, participants then tapped the spacebar to proceed to the next slide with the question(s) repeated and five options listed as A, B, C, D, and E (E was always listed as *I don't know*). Participants were asked to be honest with their choices because their performance would not affect anything. Each sentence was followed by one question, and each paragraph had two questions. All the questions and multiple-choice options were provided in English. Participants tapped one of five clearly-marked buttons on the keyboard to input answers. Their answers were then recorded in a way that each correct answer received one point, and an incorrect answer received zero points. Participants were neither informed that they were scored on their responses, nor informed that the time they spent on each slide of Chinese text was recorded with .001-second accuracy. The reading speed was calculated as time duration per character.

Retrospective interview

Upon completion of the reading test, the researcher interviewed participants individually for 5–10 minutes on their retrospective perception of reading different texts. The interview consisted of two open-ended questions: (a) How do you feel the different text presentations affected your reading speed and accuracy? and (b) What would you think if your reading material was printed in one of these designs?

Mandarin EI test

This study employed the Mandarin Elicited Imitation (EI) test (see the transcript in Zhou, 2012, p. 188) as a proficiency test to assess L2 participants' language proficiency after the interview. The 10-minute Mandarin EI test has been confirmed valid and reliable for Mandarin proficiency assessment (Wu & Ortega, 2013; Zhou, 2012; Zhou & Wu, 2009). When taking the EI test,

participants heard 30 Chinese sentences of various lengths and complexity. After hearing each sentence, the participants were required to repeat the sentence they heard as exactly as possible in a limited time, through which both their comprehension and production skills were evaluated. Two raters each rated all 27 of the test files containing 810 (= 27 participants × 30 responses per participant) responses based on a 5-point rating scale (developed by Ortega et al., 2002, with Mandarin examples provided in Zhou 2012: 190). The inter-rater reliability was found high with an agreement rate = 90.4%, and Cohen's weighted kappa = .908 (Altman, 1991). Disagreements were resolved via discussion between the raters.

Results

Reading test performance

Table 2 summarizes the descriptive statistics across proficiency levels, followed by visualizations of the results across proficiency levels in Figures 1 and 2. Participants within different proficiency groups demonstrated different performances when reading the text of varied presentations. Overall, reading speed and accuracy increased as a participant's Chinese proficiency increased. More importantly, reading efficiency across varied text presentations displayed notable interactions. When the design is balanced with equal sample sizes across the groups, assumptions of normality and homoscedasticity are relaxed (Larson, 2008). A separate 3×5 factorial ANOVA was then conducted to compare the main effects of language proficiency (i.e., low, high, and native), text presentations (i.e., conventional, interword spaced, nonword spaced, interword formatted, and nonword formatted), and the interaction thereof on reading speed and comprehension accuracy. The ANOVA results confirmed the pattern illustrated in descriptive statistics and provided further information. The subsequent sections provide an in-depth look at the effects of text presentations on reading speed, comprehension accuracy, and the interaction thereof.

Table 2

Mean Reading Speed and Accuracy by Text Presentation across Proficiency Levels

Text Presentations	Low Proficiency		High Proficiency		Native Proficiency	
	Seconds /Character	Accuracy	Seconds /Character	Accuracy	Seconds /Character	Accuracy
(a) Conventional	.543	.810	.462	.910	.196	.905
(b) Interword spaced	.661	.619	.518	.769	.189	.964
(c) Nonword spaced	.756	.714	.735	.718	.208	.952
(d) Interword formatted	.630	.750	.562	.872	.231	.869
(e) Nonword formatted	.689	.702	.635	.718	.183	.964

Figure 1

Reading Speed for Each Text Presentation across Proficiency Levels

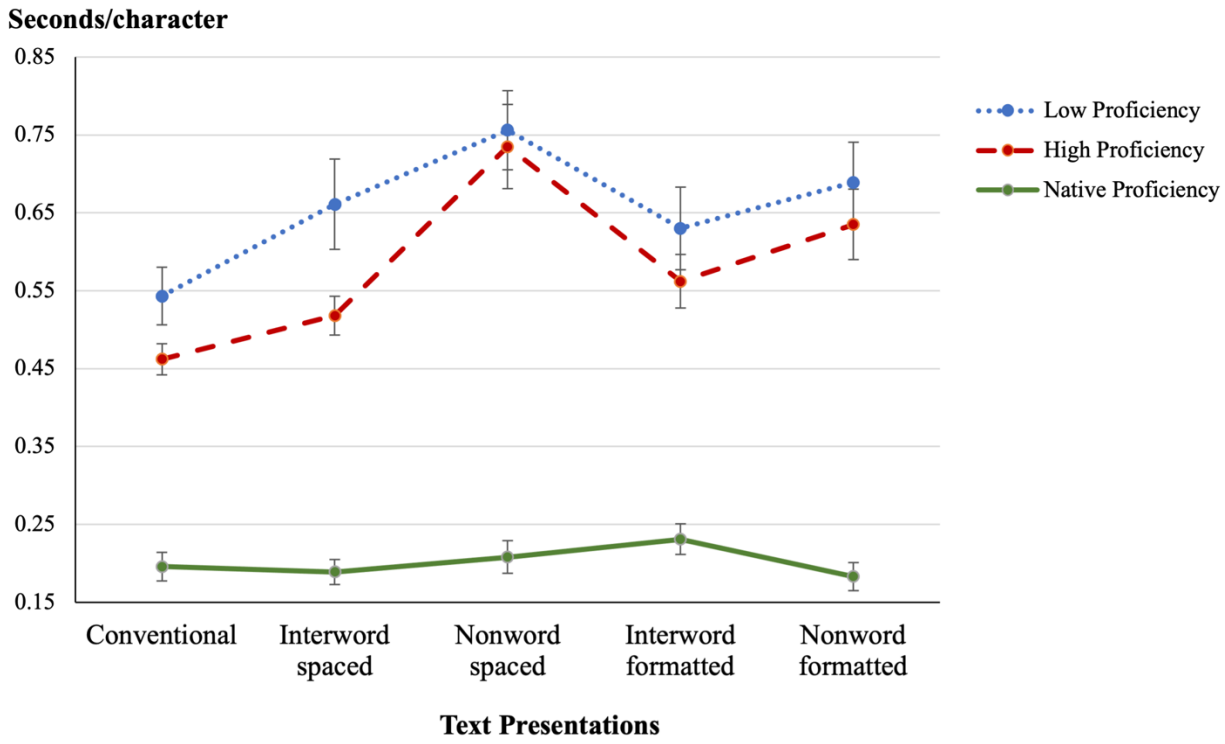
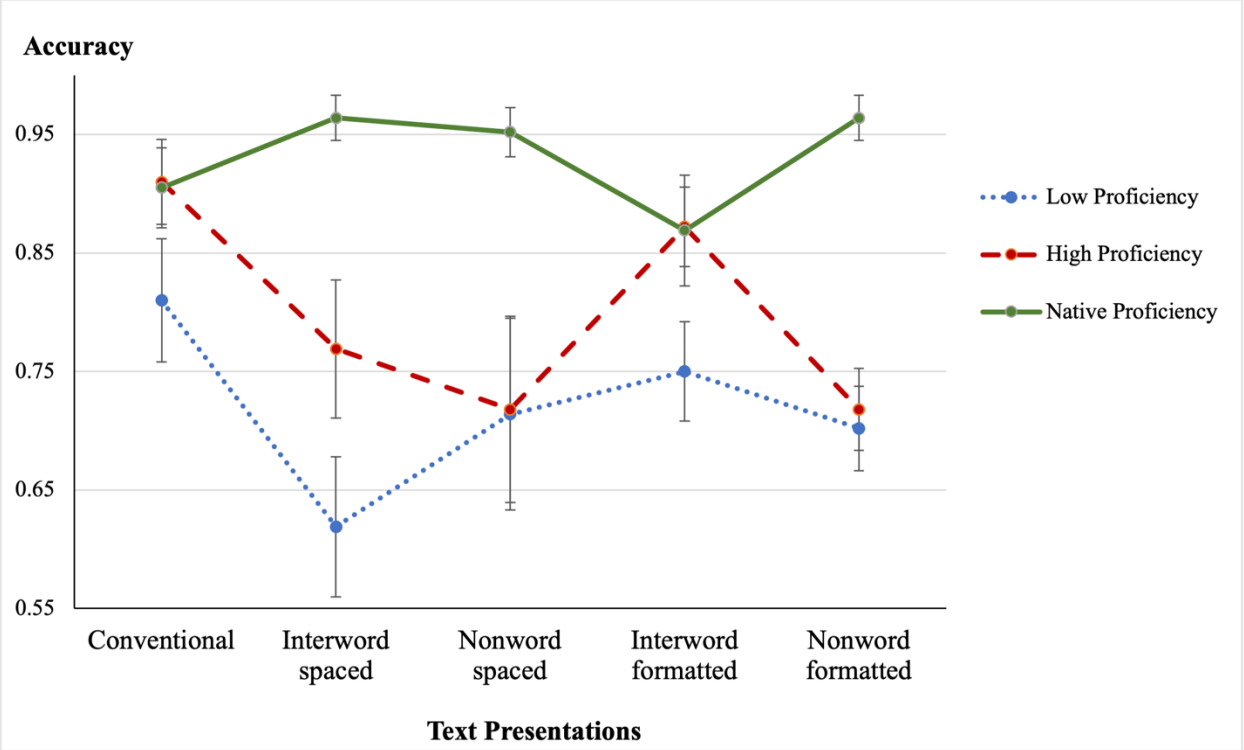


Figure 2

Reading Accuracy for Each Text Presentation across Proficiency Levels



Reading speed

There was a statistically significant difference in reading speed by proficiency groups ($F_{2, 190}$ = 209.438, $p < .001$, $\eta_p^2 = .688$). A post hoc Tukey test identified the significant differences between the Low Proficiency Group and the High Proficiency Group ($p = .008$), the Low Proficiency Group and the Native Proficiency Group ($p < .001$), as well as the High Proficiency Group and the Native Proficiency Group ($p < .001$). There was also a statistically significant difference in reading speed by text presentation ($F_{4, 190} = 7.701$, $p < .001$, $\eta_p^2 = .140$). A post hoc Tukey test identified the significant differences between conventional text and nonword spaced text ($p < .001$), conventional text and nonword formatted text ($p = .013$), as well as interword spaced text and nonword spaced text ($p = .006$). There was a statistically significant difference in reading speed based on the interaction between proficiency and text presentation ($F_{8, 190} = 2.283$, $p = .024$, $\eta_p^2 = .088$). Note the small partial eta square interaction, which indicated that the significance fell more on the proficiency level than the text presentation.

While the text presentations did not cause much difference for the Native Proficiency Group, as shown in Figure 1, the Low Proficiency and High Proficiency Groups demonstrated largely paralleled reading speed distributions across the five text presentations. First, the conventional text took the shortest reading time for all the L2 Chinese speakers. Second, interword demarcated (i.e., interword spaced, interword formatted) text showed a less disruptive effect to reading speed compared with the nonword demarcated (i.e., nonword spaced, nonword formatted) text. The

results showed that L2 Chinese speakers, regardless of their proficiency levels, spent less time reading interword demarcated text than nonword demarcated text. In addition, comparing the reading time difference between nonword and interword demarcated text, the High Proficiency Group exhibited a larger gap than the Low Proficiency Group. This may suggest that the High Proficiency Group was more responsive to the text alteration. Finally, for L2 Chinese speakers, their reading time gap between interword and nonword spaced text was more pronounced than their reading time gap between interword and nonword formatted text. This was especially true for the High Proficiency Group, which spent the shortest time reading interword spaced text and the longest time reading nonword spaced text, excluding conventional text. Therefore, space, compared with formatting, seemed to have more effects on reading speed.

Comprehension accuracy

There was a statistically significant difference in comprehension accuracy by proficiency groups ($F_{2, 190} = 26.549$, $p < .001$, $\eta_p^2 = .218$). A post hoc Tukey test identified the statistically significant difference between the low proficiency group and the high proficiency group ($p = .026$), the low proficiency group and the native proficiency group ($p < .001$), as well as the high proficiency group and the native proficiency group ($p < .001$). There was also a statistically significant difference in comprehension accuracy based on the interaction between text presentation and proficiency ($F_{8, 190} = 2.352$, $p = .020$, $\eta_p^2 = .090$). Note the small partial eta square interaction, which indicated that the significance fell more on the proficiency than text presentation. However, there was no statistically significant difference in reading accuracy by text presentation ($F_{2, 190} = 1.887$, $p = .114$, $\eta_p^2 = .038$). No significant difference was found between conventional text ($M = .874$, $SD = .157$), interword spaced text ($M = .785$, $SD = .227$), nonword spaced text ($M = .797$, $SD = .262$), interword formatted text ($M = .829$, $SD = .160$), and nonword formatted text ($M = .797$, $SD = .165$).

Figure 2 above illustrates how participants' proficiency levels affected their performance across text presentations, which confirms the statistically significant interaction effect between the text presentation and participants' Chinese proficiency. First, L1 and L2 Chinese speakers demonstrated inverse accuracy curves across the five text presentations. L1 Chinese speakers showed relatively lower comprehension accuracy when reading conventional and interword formatted texts, and achieved relatively higher comprehension accuracy when reading interword spaced, nonword spaced, and nonword formatted texts. However, these differences for L1 speakers were very small. Conversely, L2 Chinese speakers achieved relatively higher comprehension accuracy when reading conventional and interword formatted texts, and showed relatively lower comprehension on the interword spaced, nonword spaced, and nonword formatted texts. Despite the opposite score distributions, it is worth noting that the accuracy of L1 Chinese speakers, comparatively, did not vary much across text presentation methods. Second, the Low and High Proficiency Groups showed divergent performance reading interword demarcated text but convergent performance reading nonword demarcated text. On the one hand, interword text showed similar impacts on both groups, as their accuracy score distributions mostly paralleled. On the other hand, nonword demarcated text led to the low proficiency group and high proficiency group performing equally on accuracy. Such convergent performance may also have contributed to the statistically nonsignificant effect of text presentation. Last, formatting worked better than space for the reading accuracy of L2 speakers, as the interword

formatted text resulted in both groups' highest comprehension accuracy level, excluding conventional text. In addition, despite the fact that interword spaced text did not result in as high accuracy as interword formatted text, it still resulted in higher accuracy than nonword demarcated text for the High Proficiency Group. By contrast, interword spaced text saw the lowest accuracy for the Low Proficiency Group. Such a contrast may further support the different effects of nonword demarcated text for the Low and High Proficiency Groups.

Interview responses

Upon completing the reading test, all participants were interviewed on two retrospective questions: (a) their perception how the different text presentations affected their reading speed and accuracy; and (b) their opinion on adopting text alteration in print Chinese reading materials. Follow-up clarification questions were asked whenever necessary. The researcher took notes of participants' responses, then coded and collapsed the responses within each proficiency group in an Excel file. Different viewpoints were put into four categories of "space," "formatting," "space and formatting," and "application," as shown in the Appendix. The frequency distribution of comments across proficiency levels was also counted to show participants' diverse opinions.

L1 Chinese speakers generally shared an indifferent or negative perception towards text alteration. Many of them (11 out of 14) found that the text alteration had "no effect" and "did not notice" the formatting or space was for word demarcation but "focused on the content." Even when some (5 out of 14) found text alteration "annoying and disturbing," they were able to "ignore them." However, the spaced and formatted text both made some L1 Chinese speakers (5 out of 14) "assume" the altered text "is important information" and thus adjusted their reading strategy to "read slower" and "re-read."

By contrast, L2 Chinese speakers generally shared a positive attitude towards text alteration, with varying perception on the interword and nonword demarcated text. First, L2 Chinese speakers of different proficiency levels expressed varying satisfaction with the effects of altered text presentations. The Low Proficiency Group generally showed higher satisfaction with text alteration. Most of the Low Proficiency Group (11 out of 14) focused more on the facilitatory effect of text alteration, acknowledging that interword space "helped recognizing the word and answering questions better." Within the Low Proficiency Group, space seemed to be slightly favored over color, as space received more positive comments compared with formatting. There were positive comments (9 out of 14) on formatting (both interword and nonword) describing that it "helped with the reading comprehension by identifying grammar, vocab, part of speech, and key word." However, there were also some negative comments about nonword formatting (9 out of 14) describing nonword formatting as "reading really hard and confusing" and "taking longer time to put the right composition together." Most of the High Proficiency Group also showed satisfaction with text alteration, with some reservations about nonword formatting. Most of the High Proficiency Group recognized the facilitatory effect of interword demarcated text by acknowledging spaces "help recognize the word" (7 out of 13) and formatting helped them "focus more to comprehend" (7 out of 13). However, the High Proficiency Group also commented on the disruptive effect of nonword demarcated text, such as "random spacing was annoying and confused me" (8 out of 13) and "spaces threw me off" (5 out of 13).

Second, the L2 Chinese speakers of different proficiency levels also took varying approaches to the formatted text. While the Low Proficiency Group used formatted text to help reading compression by "identifying grammar, vocab, part of speech, and key word" (9 out of 14), the High Proficiency Group utilized formatting to adjust their reading strategy. Most of the High Proficiency Group (7 out of 13) commented that "formatting made them spend a bit more time to think, to re-read, and to focus more to comprehend because it was in line with their habits of bolding some text to show the importance."

Last, when asked about the application of diversified text presentation, some L1 Chinese speakers (5 out of 14) explicitly expressed objection with a concern that "altered text would be uncomfortable to read." However, some participants in both the Low and High Proficiency Groups expressed cautious optimism for the pedagogical implications of text alteration, despite individual preferences towards space and formatting. Some L2 Chinese learners (9 out of 27) believed that "different text might be helpful at the entrance level," and "formatting new word will help, like some textbooks do but bold would be more economical." One participant reflected that it was useful to read different fonts as she recalled her experience "reading cursive on street signs in Shanghai." On the other hand, some of the L2 Chinese speakers (9 out of 27) expressed the desire and determination to "learn the Chinese ways" and their hesitancy about "how realistic it is to have font and space."

Discussion

Readers' Chinese proficiency level played a pivotal role in whether and how text alteration affected their Chinese reading efficiency. It is in accordance with readers' Chinese proficiency level whether and how interword demarcation can enhance reading efficiency or nonword demarcation can reduce reading efficiency. The results showed that space and formatting worked differently, as formatting showed more effects on comprehension accuracy, whereas space was more impactful to reading speed. Nevertheless, L2 Chinese speakers generally acknowledged and welcomed text alteration despite their varied performance across the five text presentations. Their different performance trajectories and approaches to text alteration provided great insights for the pedagogical application of text presentation.

Different effects of presentation on reading efficiency

Looking at the effects across text presentations on both reading speed and comprehension accuracy unveils the pivotal role of proficiency. As Chinese speakers' proficiency level varies, their reading efficiency responds to text alteration differently.

L1 Chinese speakers' reading efficiency overall was not affected much by text alteration, interword or nonword demarcated, spaced, or formatted. In contrast to L1 Chinese speakers, L2 Chinese speakers displayed very different reading efficiency distribution across the five text presentations. The High Proficiency Group showed higher reading speed and accuracy on interword demarcated text compared with nonword demarcated text. By contrast, the Low Proficiency Group responded to text alteration with different patterns on reading speed and accuracy. On reading speed, the Low Proficiency Group performed better on interword

demarcated text compared with nonword demarcated text, which was consistent with the High Proficiency Group. On reading accuracy, however, the Low Proficiency group achieved the same score as the High Proficiency Group on nonword demarcated text, while their lowest accuracy fell on interword spaced text. Such varying effects of text alteration on L2 Chinese speakers of different proficiency levels shed light on a likely source of previously mixed findings.

The different effects may be attributed to the varying skills of word and phrase identification and segmentation. With native proficiency level, L1 Chinese speakers were able to form the mental presentation of accurately segmented words, regardless of whether word segmentation was enhanced or mismatched by visual presentation. It confirmed previous findings that inserted interword space mostly showed no benefits to native Chinese readers (Bai et al., 2008; Inhoff et al., 1997; Liu et al., 1974). For L2 Chinese readers, the High Proficiency Group was more capable of identifying and segmenting words and phrases compared to the Low Proficiency group. They were nonetheless still distracted by nonword demarcated text compared with interword demarcated text. Therefore, their reading speed and accuracy responded consistently with higher scores on interword demarcated text compared with nonword demarcated text. With the lowest skills of word and phrase identification, the Low Proficiency Group may have had the most difficulty with nonword demarcation and thus had to slow down and focus additional attention and effort, which may have enhanced their reading accuracy at the expense of speed.

Overall, it is reasonable to suggest that text alteration can facilitate or disrupt reading efficiency as L2 Chinese learners gain more exposure and can adapt to altered text presentation. First, reading efficiency on interword and nonword demarcated text displayed an overall distinction. This by and large concurred with previous studies that argued a potential facilitatory effect of interword demarcation, as they found interword demarcated text not disruptive whereas nonword-demarcated text disruptive to reading efficiency (Bai et al., 2008; Bai et al., 2010; Shen et al., 2010). Second, the fact that L2 Chinese speakers achieved their best reading efficiency on conventional text rather than altered ones may be associated with some practical restrictions. Reading altered text presentation was likely a novel experience that would have required longer-term practice to reach full adjustment. The other restriction was that the reading text in this study, due to accommodating for lower-level speakers' proficiency, may have in the meantime led to a possible ceiling effect for higher proficiency speakers. Finally, the opposite accuracy score distributions of L1 and L2 Chinese speakers across five text presentations provided additional support for the argument that text alteration made a difference in reading efficiency.

Space and formatting worked differently

Space and formatting demarcations demonstrated different effects on reading speed and accuracy for L2 Chinese speakers. Formatting seemed more impactful on accuracy, especially for the Low Proficiency Group. Interword formatted text may have facilitated both the Low and High Proficiency Groups, as they reached their highest accuracy on this condition, excluding conventional text. Moreover, nonword formatted text may have further facilitated the Low Proficiency Group, as their accuracy scores converged with the high proficiency group. This concurs with Diemand-Yaumana, Oppenheimera, and Vaughanb's (2011) finding that, in both laboratory and classroom settings, presenting learning materials in a font that was slightly more difficult to read significantly facilitated readers' memory of certain facts. The extra cognitive

effort caused by the reading disfluency led to deep processing in the brain. For the Low Proficiency Group, the nonword formatting presented an appropriate amount of difficulty that signaled the brain that triggered extra effort, and led to higher accuracy. By contrast, space demarcation seemed more impactful on reading speed, especially for the High Proficiency Group. For both groups of L2 Chinese speakers, their reading speed gap between interword and nonword spaced text is bigger compared with their reading speed gap between interword and nonword formatted text. Especially for the High Proficiency Group, their reading speed reading nonword spaced text was almost as low as the Low Proficiency Group, whereas their reading speed was much higher than the Low Proficiency Group reading interword spaced text.

Interactions between performance and perceptions

Similar to how participants performed differently reading altered text, the study revealed that Chinese speakers of different proficiency levels also responded to text alteration differently with diverse stances and reading strategies. There were dynamic interactions between participants' performance and self-perceptions.

First, the perceptions of L2 Chinese speakers were generally in line with their performance trajectory. Overall, the performance of both the Low and High Proficiency Groups was less disrupted by interword demarcated text compared with nonword demarcated text. Correspondingly, both groups favored interword demarcated text over nonword demarcated text. Furthermore, the perceptions of participants across proficiency groups were mostly in line with their performance. Aligned with the Low Proficiency Group's mostly positive attitude toward text alteration, their reading seemed to have benefited from text alteration as shown in their enhanced accuracy, even on nonword demarcated text. Comparatively, the High Proficiency Group showed a more balanced view of both facilitatory and disruptive effects toward text alteration. Correspondingly, their reading speed was more responsive to the difference between interword and nonword demarcation, as displayed in the more pronounced time gap reading interword and nonword spaced text.

Second, space and formatting demonstrated different effects, and a corresponding difference was observed in L2 Chinese speakers in accordance with their proficiency levels. The Low Proficiency Group may have been the group that benefited most from text alteration, even nonword demarcation. Despite their lowest accuracy on interword spaced text and higher accuracy on interword formatted text, the Low Proficiency Group expressed positive opinions towards both space and formatting for learning facilitation. By contrast, the High Proficiency Group was more responsive to formatted than spaced demarcation on accuracy but the other way around on reading speed. They expressed both positive and negative opinions on space and formatting and perceived both facilitatory and disruptive effects. In addition, as L2 speakers' proficiency and reading strategy developed, they were increasingly able to recognize and proactively utilize formatting to mark new and underscored information, as well as complement authentic and diversified presentations.

Finally, the perception of L1 Chinese speakers has inversely related to their performance. At the native proficiency level, text alteration did not show much effect on reading efficiency. However, L1 Chinese speakers generally shared a negative perception towards altered text

presentation. It was partially due to their established reading habit on conventional text. Moreover, L1 Chinese speakers likely attributed the conventional text presentation to the tradition and identity of the Chinese language and writing. They were thus protective of the conventional text presentation and resistant to any text alteration.

Pedagogical implications

L2 Chinese learners' different performance trajectory and approach to text alteration provide great insights for the pedagogical application of text presentation. Given that Chinese proficiency played a pivotal role in the different effects of text alteration, varied text alterations may be applied accordingly to different levels of Chinese learning for specific pedagogical purposes. At lower-level Chinese language courses, nonword demarcated text may serve to raise learners' awareness of the word boundary and direct their attention to word recognition. Nonword demarcated text, especially nonword formatted text, could be applied to the target word of comprehension or designed with intentional ambiguity so as to direct readers to lexical parsing and important content analysis. In the meantime, interword demarcated text may be occasionally supplemented as extensive reading material to increase learners' reading speed and potentially carry on the higher speed in reading conventional text. At higher-level Chinese language courses, reading practice may also use interword spaced text as extensive reading material to enhance reading speed, and supplement interword formatted text as close reading material to enhance accuracy.

In addition to implementing word-demarcating text alteration for reading accuracy and speed training, L2 Chinese reading may use formatting to introduce novel words for learning facilitation, as informed by learners' retrospective perceptions. This is consistent with previous findings that suggested altered text presentation may help children learn new words (Blythe et al., 2012). Furthermore, the formatted text could go beyond word level and extend to important expressions and grammatical patterns. This has already been partially practiced with the keywords and patterns colored in textbooks (Liu et al. 2018). Finally, text alteration can go beyond the space and formatting explored in this study. Either in print or on-screen, both textbooks and workbooks should consider including diversified character font, art, and color that corresponds with the ubiquitous character scripting variations in the real world. For example, Chinese text may be presented in both horizontal and vertical layout. Progressive adoption of authentic and diversified text presentations can help bridge L2 learners' classroom learning with their real-world experience.

Conclusion and Limitations

This study outlined how altered text presentations affected reading efficiency, as well as how such effects were perceived by Chinese readers across proficiency levels. Chinese proficiency level played a pivotal role by moderating varying effects of inserted word demarcations on reading speed and comprehension accuracy. For L1 Chinese speakers, altered text presentation did not have a large effect on their reading efficiency. For L2 Chinese speakers, interword demarcated text seemed to have facilitatory effects, and nonword demarcated text had disruptive effects. Furthermore, the contrast between space and formatting added more dynamics by

working differently with reading speed and accuracy for readers of different proficiency levels. Interword spaced text showed more facilitation to reading speed, especially for higher-level L2 Chinese speakers. By contrast, interword formatted text generally showed facilitation to accuracy, whereas both nonword spaced and formatted text specifically facilitated lower-level L2 Chinese speakers. The study, therefore, suggests L2 Chinese reading practice to adopt spaced and formatted text presentation depending on specific learning objectives.

The results of this study, however, should be interpreted within the context of its small sample size and limited text reading. In addition, this study chose a structured randomized presentation of the text in order to reduce order effects, yet there is a likely switching cost for participants to adjust to different presentation conditions each time. With participant proficiency controlled and different word demarcation applied, this study was able to provide an innovative look at how text presentation may affect Chinese reading efficiency. To further pursue the research, recruiting more participants across proficiency levels, classifying proficiency into additional groups, or asking participants to read more and longer text may be able to provide more in-depth insights. Further, inserting word demarcation into specific text designed with certain ambiguity that requires correct lexical parsing might be able to reveal more insight regarding how word demarcation affects comprehension accuracy. Next, the different effects mediated by text presentation in sentence and paragraph was not the focus of this study, but it is worth further investigation. Last, prolonged preparation and training might help to remove any adaptation effects or minimize the potential trade-off effect. A longitudinal study that tracks L2 Chinese readers' performance on and perceptions of reading altered text would be able to provide a more comprehensive picture of L2 Chinese speakers' reading comprehension and word processing development.

References

Altman D. G. (1991). *Practical statistics for medical research.* London: Chapman and Hall.

Bai, X., Yan, G., Liversedge, S. P., Zang, C., & Rayner, K. (2008). Reading spaced and unspaced Chinese text: Evidence from eye movement. *Journal of Experimental Psychology: Human Perception and Performance*, *34*(5), 1277–1287. https://doi.org/10.1037/0096-1523.34.5.1277

Bai, X., Zhang, T., Tian, L., Liang, F., & Wang, T. (2010). Ci qiefen dui Meiguo liuxuesheng hanyu yuedu yingxiang de yandong yanjiu [Effect of Word Segmentation on American Students Reading Chinese: Evidence from Eye Movements]. *Xinli Yanjiu [Psychological Research]*, *3*(5), 25–30.

Bassetti, B. (2009). Effects of adding interword spacing on Chinese reading: A comparison of Chinese native readers and English readers of Chinese as a second language, *Applied Psycholinguistics*, *30*(4), 757–775. https://doi.org/10.1017/S0142716409990105

Bassetti, B. & Lu, M. (2016). Effects of interword spacing on native English readers of Chinese as a second language, *IRAL*, *54*(1), 1–22. https://doi.org/10.1515/iral-2016-0014

Blythe, H. I., Liang, F., Zang, C., Wang, J., Yan, G., Bai, X., & Liversedge, S. P. (2012). Inserting spaces into Chinese text helps readers to learn new words: An eye movement study. *Journal of Memory and Language*, *67*(2), 241–254. https://doi.org/10.1016/j.jml.2012.05.004

Diemand-Yauman, C., Oppenheimer, D. M., & Vaughan, E. B. (2011). Fortune favors the bold (and the Italicized): Effects of disfluency on educational outcomes. *Cognition, 118*(1), 111–115.

Gao, S. (2008). Butong shijue kongjian tiaojianxia de hanyu yuedu [Chinese reading of texts in different visual presentation conditions]. *Xiandai Yuwen [Modern Chinese], 9*, 108–109.

Hsu, S. H., & Huang, K. C. (2000a). Interword spacing in Chinese text layout. *Perceptual and Motor Skills*, *91*(2), 355–365. https://doi.org/10.2466/PMS.91.6.355-365

Hsu, S. H, & Huang, K. C. (2000b). Effects of words spacing on reading Chinese text from a video display terminal. *Perceptual and Motor Skills, 90*(1), 81–92. https://doi.org/10.2466/PMS.90.1.81-92

Inhoff, A. W., & Liu, W. (1998). The perceptual span and oculomotor activity during the reading of Chinese sentences. *Journal of Experimental Psychology: Human Perception & Performance, 24*(1), 20–34. https://doi.org/10.1037/0096-1523.24.1.20

Inhoff, A. W., Liu, W., Wang, J. & Fu, D. (1997). Hanyu juzi yuedu zhong de yandong yu kongjian xinxi de yunyong [Eye movements and the use of spacing information in reading Chinese sentences]. In D. Peng (Ed.), *Hanyu renzhi yanjiu [Cognitive research on the Chinese language]*, 296–312. Jinan, China: Shandong jiaoyu chubanshe [Shandong Education Press].

Kohsom, C., & Gobet, F. (1997). Adding spaces to Thai and English: Effects on reading. *Proceedings of the Cognitive Science Society*, *19*(1), 388–393.

Larson, M. G. (2008). Analysis of variance. *Circulation*, *117*(1), 115–121. https://doi.org/10.1161/CIRCULATIONAHA.107.654335

Li, X., Bicknell, K., Liu, P., Wei, W. & Rayner, K. (2014). Reading is fundamentally similar across disparate writing systems: A systematic characterization of how words and characters influence eye movements in Chinese reading. *Journal of Experiment Psychology: General*, *143*(2), 895–913. https://doi.org/10.1037/a0033580

Li, X., Rayner, K., & Cave, K. R. (2009). On the segmentation of Chinese words during reading. *Cognitive Psychology*, *58*(4), 525–552. https://doi.org/10.1016/j.cogpsych.2009.02.003

Li, Z., & Wang, J. (1987). Guanyu xuesheng yuedu lijie shiwu de diaocha baogao [A report on reading comprehension error]. *Yuyan Jiaoxue yu Yanjiu [Language Teaching and Research]*, *2*, 111–118.

Liang, F., & Bai, X. (2010). Qiefen kongjian he qiefen fangshi dui zhongwen yuedu jixiao yingxiang de yandong yanjiiu [The effects of segmentation space and type on Chinese reading: Evidence from eye movements]. *Xinli Yanjiu* [*Psychological Research], 1*, 21–28.

Liu, P., & Li, X. (2014). Inserting spaces before and after words affects word processing differently in Chinese: Evidence from eye movements. *British Journal of Psychology*, *105*(1), 57–68. https://doi.org/10.1111/bjop.12013

Liu, P., & Lu, Q. (2018). The effects of spaces on word segmentation in Chinese reading: Evidence from eye movements. *Journal of Research in Reading*, *41*(2), 329–349. https://doi.org/10.1111/1467-9817.12106

Liu, Y., Yao, T., Bi, N., Shi, Y., and Ge, L. (2018). Integrated Chinese volume 4 textbook (4th ed). Cheng & Tsui Company, Inc.

Liu, Y., Ye, C., Wang, L., & Zhang, Y. (1974). Yuci danwei dui yuedu xiaolv de yingxiang [The effect of word spacing on the reading efficiency], *Zhonghua Xinli Xuekan [Chinese Journal of Psychology], 16*, 25–32.

Malt, B., & Seamon, J. G. (1978). Peripheral and cognitive components of eye guidance in filled space reading. *Perception & Psychophysics*, *23*(5), 399–402. https://doi.org/10.3758/BF03204142

Morris, R. K., Rayner, K., & Pollatsek, A. (1990). Eye movement guidance in reading: The role of parafoveal letter and space information. *Journal of Experimental Psychology: Human Perception & Performance, 16*(2), 268–282. https://doi.org/10.1037/0096-1523.16.2.268

Ortega, L., Iwashita, N., Norris, J., & Rabie, S. (2002). *An investigation of elicited imitation in crosslinguistic SLA research.* Conference handout from paper presented at the 20th SLRF (Second Language Research Forum) Conference, University of Toronto/OISE, Toronto, October 3–6, 2002.

Rayner, K., Fischer, M. H., & Pollatsek, A. (1998). Unspaced text interferes with both word identification and eye movement control. *Vision Research, 38*(8), 1129–1144. https://doi.org/10.1016/S0042-6989(97)00274-5

Ren, G. Q., & Yang, Y. (2010). Syntactic boundaries and comma placement during silent reading of Chinese text: Evidence from eye movements. *Journal of Research in Reading, 33*(2), 168–177. https://doi.org/10.1111/j.1467-9817.2009.01406.x

Sainio, M., Hyönä, J., Bingushi, K., & Bertram, R. (2007). The role of interword spacing in reading Japanese: An eye movement study. *Vision Research, 47*(20), 2575–2584. https://doi.org/10.1016/j.visres.2007.05.017

Shen, D., Bai, X., Zang, C., Yan, G., Feng, B., & Fang, X. (2010). Ci qiefen dui chuxuezhe juzi yuedu yingxiang de yandong yanjiu [Effect of word segmentation on beginners' reading: Evidence from eye movements]. *Xinli Xuebao [Acta Psychologica Sinia], 42*(2), 159–172. https://doi.org/10.3724/SP.J.1041.2010.00159

Shen, D., Liversedge, S. P., Tian, J., Zang, C., Cui, L., Bai, X., Yan, G., & Rayner, K. (2012). Eye movements of second language learners when reading spaced and unspaced Chinese text. *Journal of Experimental Psychology: Applied, 18*(2), 192–202. https://doi.org/10.1037/a0027485

Shieh, K. K., Hsu, S. H., & Liu, Y. C. (2005). Dynamic Chinese text on a single-line display: Effects of presentation mode. *Perceptual and Motor Skills, 100*(3_suppl), 1021–1035. https://doi.org/10.2466/pms.100.3c.1021-1035

Spragins, A. B., Lefton, L. A., & Fisher, D. F. (1976). Eye movements while reading and searching spatially transformed text: A development examination. *Memory & Cognition, 4*(1), 36–42. https://doi.org/10.3758/BF03213252

Winskel, H., Radach, R., & Luksanneeyanawin, S. (2009). Eye movements when reading spaced and unspaced Thai and English: A comparison of Thai-English bilinguals and English monolinguals. *Journal of Memory and Languages, 61*(3), 339–351. https://doi.org/10.1016/J.JML.2009.07.002

Wu, S.-L. & L. Ortega. (2013). Measuring global oral proficiency in SLA research: A new elicited imitation test of L2 Chinese, *Foreign Language Annals, 46*(4): 680–704. https://doi.org/10.1111/flan.12063

Zang, C., Liang, F., Bai, X., Liversedge, S. P., & Yan, G. (2013). Interword spacing and landing position effects during Chinese reading in children and adults, *Journal of Experimental Psychology: Human Perception and Performance, 39*(3), 720–734. https://doi.org/10.1037/a0030097

Zhou, W., Wang, A., Shu, H., Klieg, R., & Yan, M. (2018). Word segmentation by alternating colors facilitates eye guidance in Chinese reading, *Memory & Cognition*, *46*(5), 729–740.

https://doi.org/10.3758/s13421-018-0797-5.
Zhou, Y. (2012). Willingness to communicate in learning Mandarin as a foreign and heritage language. [Doctoral dissertation, University of Hawai‘i at Mānoa]. Ann Arbor: ProQuest. (Identifier: ISBN9781267500793)
Zhou, Y., & S. L. Wu. (2009). *Can elicited imitation be used for the measurement of oral proficiency in L2 Chinese? A pilot study.* [Unpublished manuscript]. University of Hawai‘i at Mānoa.

Appendix

Participants' Retrospective Perceptions of Text Alteration

	Comments	Proficiency		
		Low	High	Native
Space	Interword space seems boundary; help recognize the word; help answer questions better	11	7	0
	Space made me spend more time to think about; think slower; re-read (assume it is important; later realized it was meant to distract)	6	3	5
	Space threw me off (made reading more choppy); space disrupt my fluency	3	5	0
	Random spacing confused me; was annoying	4	8	1
	Assumed space is distraction	0	0	1
	Space did not change or affect that much; did not notice the space (till late because was so focused on figuring out the meaning)	4	2	0
Formatting	(Both interword and nonword) formatting helped with the reading comprehension by identifying grammar, vocab, part of speech, and key word	9	6	0
	Interword formatting speeded up my reading	1	0	0
	Formatting (word-marking or random) made me spend a bit more time to think; re-read; like it because it is in line with my habits of bolding some text to show the importance; focus more to comprehend; seems highlighting the important information	3	7	5
	Formatting (word-marking or random) made it harder; red made me assume these are words I don't know; random formatting made reading really hard and confusing; random formatting took me longer time to put the right composition together	9	4	0
	formatting did not affect me; did not notice that much	2	2	0
Space and Formatting	Space is more helpful than formatting	1	2	0
	Space is more helpful for longer paragraph; not differ much for shorter sentences	1	0	0
	Space and formatting slowed me down; a bit annoying and disturbing; decided to ignore them after encountering random ones	0	0	5

	Spacing affected more than formatting	1	0	3
	Formatting affected more than space	1	0	1
	Space and formatting affected paragraph more than short sentence	0	0	1
	No effect; did not notice the formatting or space is for word-marking; focused on the content; would not even think about the spacing and color without the trial session	1	1	11
Application	Different text might be helpful at the entrance level; formatting new word will help, like some textbooks do but bold would be more economical; advanced level text should be real; formatting new word will help, like some textbooks do (both bold would be more economical)	7	2	0
	Conventional format is easier; I am used to it; want to learn the Chinese ways; not sure how realistic is to have font and space	4	5	1
	Spacing is not the same in the real life; would not be useful (detrimental for long term)	1	2	0
	Useful to read different font (experience reading cursive in Shanghai)	1	0	0
	Altered text would be uncomfortable to read	0	0	5

About the Author

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