Advances in Educational Technology and Psychology (2024)
Clausius Scientific Press, Canada
DOI: 10.23977/aetp.2024.080601
ISSN 2371-9400 Vol. 8 Num. 6

The Influence of Native Language and Text Presentation on Reading Comprehension on Smartphones

Zichun Zhao

School of Social Sciences, University of Warwick, Coventry, Warwick, CV48UW, UK

Keywords: Reading comprehension, Text presentation formats, English as a second language (ESL), Language proficiency, Educational psychology, Cognitive psychology

Abstract: Whilst there is increasing usage of small-screen devices such as mobile phones shape the way of acquiring information that was different from the traditional way of static text on paper. Literature indicates not only different text presentations influence people reading comprehension level but also language contributes to reading abilities. However, the extent to which recent text presentation formats influence comprehension remains unclear, as does the interaction between text presentation and language proficiency among native English speakers and Chinese readers with second language English. This study aimed to examine the effects of different text presentations and first or second language readers on English reading comprehension. Participants with volunteers (N = 51) were grouped independently of either Chinese or English readers and presented with four different text presentations. A bespoke reading comprehension task was used to measure participants' comprehension levels and data was analysed by factorial mixed measure ANOVA. The findings demonstrated that overall, first language readers had better comprehension compared to Chinese readers when engaging in English reading. However, there is no significant difference in comprehension between different text presentations. Theoretical factors contributed to the current study and use to explain the phenomenon of the current findings, while also acknowledging the potential methodological limitations related to culture and individual differences. Future research should consider these factors to get deeper insight. Despite these limitations, the study offered real-life applications with benefits to both technological science and educational psychology.

1. Introduction

The expanding amount of information available clashes with the amount of time that we need to process. Nowadays, smaller electronic devices are becoming more and more popular for people to access information, such as mobile phones, smartwatches. The changes in way of accessing information play an important role in shaping our reading habits. Modern society presents text in various ways, such as scrolling subtitles on YouTube or the Rapid Serial Visual Presentation (RSVP) used in Instagram ads. With the rise of social media, new formats, like TikTok's brief 3–5-word text displays, are reshaping information access. Studies suggest that comprehension varies across text formats [1], but the impact of different formats on small screens remains unclear. Given the growing prevalence of smartphone-based information access, it is crucial to investigate the research question.

RSVP, developed by Gilbert in the 1950s, presents challenges for reading comprehension due to oculomotor and cognitive limitations [2]. During typical reading, readers rely on regressions—backward eye movements—to reprocess information [2]. However, RSVP restricts this, preventing re-reading and diminishing access to unprocessed information [3]. Additionally, parafoveal processing, which helps gather information before fixation in static texts are reduced in RSVP, further impairing comprehension, this increases cognitive load and leads to lower comprehension compared to static text [4]. Similar results were found that static text outperforming RSVP in reading comprehension [5]. However, comprehension in RSVP is speed-dependent, with slower speeds (700 wpm) aiding verbatim understanding and faster speeds (1000 wpm) improving inferential comprehension. They ignored the average reading speed of native English readers which are 200 to 250 words a minute [6], in this way to establish the causal and effect of current study, RSVP speeds over 250 will not be considered.

Comprehension levels differ across other types of text presentation, for example, the horizontal scrolling text display which is often used on a digital screen. The display usually drifts from right to left and people follow the text rightward at the same time, this inconsistency in direction may create a conflict that reduces attention for coming text which potentially challenges reading comprehension [7]. Scrolling limits regression and parafoveal processing, reducing information acquisition. Static text had better comprehension and the worse performance in RSVP, although long sentences may introduce natural pauses that are absent in scrolling and RSVP conditions [8]. Using shorter sentences as stimuli can enhance internal validity by ensuring performance differences arise from text format rather than natural pausing. TikTok, launched in 2017, presents brief 4–5-word text segments within videos, offering a novel way of acquiring information. As comprehension of this format remains unexamined, it warrants investigation as a new text presentation. Based on previous research, we hypothesise that participants would score highest on comprehension task for static text condition and score lowest for RSVP condition, with varying scores between TikTok and scrolling text formats.

Different language written systems in people's first and second language may also vary reading comprehension levels. Chinese and English have very different writing systems, for example, it is known as English is a phonetic language and the words use the alphabet whereas Chinese is a pictographic language that uses characters so that cannot be sounded out, all the characters are made of elements, called radicals that hold meanings. For instance, ‘Mu' (The Chinese Romanisation system: pinyin) means eye and ' name of ‘water’ radical in Chinese characters (Kangxi radical 85)' represent water, therefore 'Lei (two partials add up)' indicates tears. Therefore, for Chinese readers, processing English requires accessing a phonetic system, which may lead to different cognitive strategies. Moreover, Language fluency is an important element that influences reading comprehension levels [9]. Readers with English as their second language might be more aware of how they solve the reading difficulties they encounter as their abilities have not yet researched the level of fluent readers. They might associate text with their experiences which are not the same as automatic reading processes of first language readers [10]. This raises the second interest of the study of examining how this difference influence comprehension performance.

China has one of the largest populations of English learners, making Chinese speakers a representative sample for studying second language (L2) reading comprehension. Japanese L2 English readers improved comprehension by accessing their first language, their performance still lagged native reading. It remains unclear if Chinese learners experience similar effects, particularly when using modern digital devices with small screens [11]. Given that over a million international student from Chinese students using mobile phones for learning and reading English resources, investigating comprehension on these devices has practical relevance. According to the existing literature, we hypothesise that first language English readers would score higher on comprehension tasks than second language readers. Based on current literature, the lacking investigation on

interaction effects of other types of text presentations such as scrolling and Tiktok presentation, our interaction hypothesis is that both English and Chinese readers would perform better with static text and would score differently in other text conditions.

2. Method

2.1 Participants

Participants were recruited from the UK and China through WeChat and Instagram, with a total of 93 participants. Of these, 24 were native English speakers and 69 were native Chinese speakers. 36 Chinese participants were excluded due to time-out, 4 participants with diagnosed dyslexia or reading disabilities, and 1 participant whose first language was Italian, the final sample consisted of 51 participants with 27 Chinese and 24 English. All participants self-reported no dyslexia or reading disabilities and spoke either English or Chinese as their first language. This study was granted ethical approval by the Ethics Committee of Royal Holloway, University of London.

2.2 Materials

The current study was carried out by using an online cloud-based experiment platform Gorilla Experiment Builder (www.gorilla.sc) on participants' smartphones.

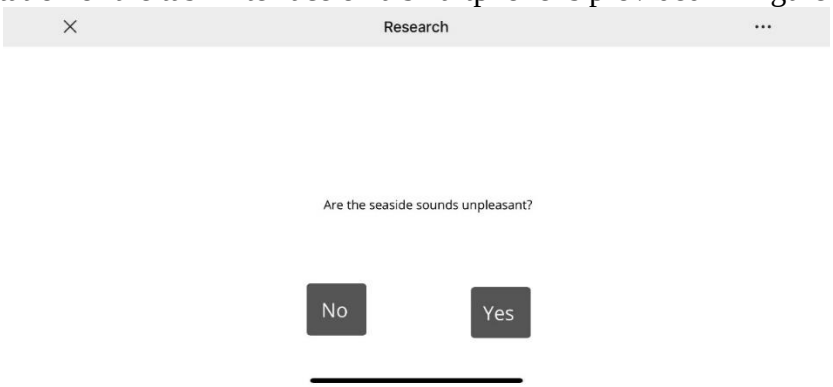
Firstly, the participant's information slide was shown to participants outlining the study aim, the right to withdraw and contact details of researchers. The full version of the participant information slide was provided in Appendix A. The important General Data Protection Regulation (GDPR) information was then presented on a subsequent slide (Appendix B). Followed by task instructions (Appendix C). The informed consent was then obtained on the fourth slide, and participants were then asked to complete a demographic questionnaire, including questions of gender, dyslexia diagnosed history, and first language (Appendix D).

The reading comprehension task was newly developed, drawing on modifications from the MNRead sentence corpus [12]. Each sentence contained 60 characters, with an average of 12.27 words, and the task comprised 40 sentences divided evenly across four text presentation formats (10 sentences per format). Each sentence was followed by a Yes/No comprehension question, such as "Did the bird eat the seeds after flying off?" based on the sentence "Our tiny bird ate the seed before flying off its perch." Participants selected either 'Yes' or 'No,' with one correct answer per question. Correct answers were awarded 1 point, for a total of 40 possible points indicating higher comprehension with increased scores. The full version of original MNRead sentences was shown in Appendix E. Due to technical limitations identified during pilot testing—specifically text overflow in scrolling formats—30 sentences from the original MNRead corpus were used, and 10 additional scrolling sentences were modified by replacing longer words with synonyms. Some comprehension questions were also revised to avoid response biases. The full new version sees Appendix F.

2.3 Procedure

Data collection spanned two weeks, with participants recruited via social media platforms (WeChat and Instagram) through a link directing them to the online experiment hosted on Gorilla. It was self-paced by asking participants to complete the study on their smartphone only in landscape mode. Upon accessing the link, they were greeted by a 'Welcome' page, participants need to click the button to start the experiment. Followed by participant information and GDPR compliance details, after it informed consent was obtained. A brief 10-second pause was included to ensure participants were ready to begin the comprehension task.

The conditions for the comprehension task were randomized per participant, though the sentence sequence within each condition remained consistent. In the RSVP condition, each word presented for 250ms, and the speed of presentation was 240wpm, the speed of scrolling presentation was 175 wpm, the speed for Static condition was 249wpm and speed in short format was 328wmp. Participants responded to comprehension questions by selecting 'Yes' or 'No,' based on the sentences presented. A visual representation of the task interface on a smartphone is provided in Figure 1.



Note. The question display screens are the same for all conditions.

Figure 1: Display Screen with Question and Response Boxes.

2.4 Design

A 4*2 with the first language and text presentation mixed factorial ANOVA was used to analysis two independent variables on reading comprehension level. An independent group design compared participants' first language either Chinese or English while a repeated method design assessed comprehension levels varying on four text presentations.

2.5 Results

Table 1: Descriptive Statistics of Text Presentations with Spliting File of Chinese and English Readers

First Language		N	Minimum	Maximum	Mean	Std. Deviation
Chinese	RSVP	27	3	10	6.81	2.020
	Static	27	3	10	6.78	1.783
	Scroll	27	4	10	6.52	1.528
	Shot	27	3	10	6.04	1.931
	Sum of Correct	27	20	36	26.15	4.546
	Valid N (listwise)	27				
English	RSVP	24	3	10	7.33	2.120
	Static	24	1	10	7.33	2.140
	Scroll	24	3	10	8.13	2.028
	Shot	24	3	10	7.63	1.907
	Sum of Correct	24	14	40	30.42	6.711
	Valid N (listwise)	24				

The descriptive statistics of text presentations with Chinese and English readers were shown in Table 1. The means clearly showed the task was able to discriminate performance as the range of mean scores was from 6.04 to 8.13 which was not very low or score close to 10. Overall, the Chinese participants had lower scores in all four conditions (Mean of Sum of correct = 26.15) than that for native English speakers (Mean of Sum of correct = 30.42).

The assumption of sphericity has been met (W = .960, $x^2(2) = 1.93$, $p = .859$). The assumption of homogeneity of variance been met for RSVP condition (F (1, 49) = .082, p = .776), for Static condition (F (1, 49) = .337, p =.564), for the Scroll condition (F (1, 49) = .628, p = .432) and for the Shot condition (Tiktok display) (F (1, 49) = .000, p = .989). There was a significant main effect of reading comprehension between first and second readers (F (1, 49) = 7.21, $p < .001$). For breaking down comparison, the overall (regardless of which text presentation conditions were displayed) English (first language) readers scored higher on reading comprehension task (Mean = 6.54, p = .010) than Chinese (second language) readers (Mean = 7.60, p = .010). There was no significant main effect of reading comprehension for text presentations (F (3, 147) = .884, p = .451) and there is no significant interaction effect between text presentations and first or second language readers (F (3,147) = 2.059, p = .108).

3. Discussion

This study explored the impact of various text presentation formats—RSVP, scrolling text, TikTok-style display, and static text—on English reading comprehension when presented on smartphone screens, while also examining differences between native English speakers and Chinese speakers using English as a second language. An online experiment took place on participants' smartphones, they were independently divided into either English readers or Chinese readers. All participants were presented in four different text conditions and comprehension levels were examined based on modification of MNRead sentences [12]. The findings indicated that native English readers had significantly higher task scores than Chinese readers. This finding was consistent with a previous study [11] and the hypothesis of the current study. However, no significant differences in comprehension were observed across the four text presentation formats, nor were any interaction effects found between language group and text format, in contrast to prior studies [5]. These divergent findings underscore the need for further investigation into the underlying factors shaping the relationship between text presentation and reading comprehension across linguistic backgrounds.

Differences between previous research and the current study may lead to inconsistent findings. For example, a previous study [5]. was aimed to investigate RSVP and static display on reading comprehension with computer screen display which was different from the current study on a smartphone with small digital screens. Larger screen sizes have better readily, participants presented with computer screens may have more access to the information than that for small screens [13]. This may explain the difference in comprehension between current and previous studies. Another significant distinction between pervious study [5] and the current study is the level of experimental control. In their research, all participants viewed stimuli on a standardized monitor positioned 65.5 cm away, ensuring consistency across conditions. In contrast, this study lacked control over participants' screen properties, as different smartphone displays were used. Despite uniform instructions, the variability in screen sizes likely influenced task performance. Larger screens improve reading comprehension by reducing errors and increasing task completion rates [14]. Furthermore, environmental factors such as dim lighting [15] and screen brightness [16] have been shown to negatively impact comprehension, particularly when combined with blue light exposure, leading to cognitive strain. These uncontrolled variables—screen size and environmental lighting—may have confounded the relationship between text presentation and reading comprehension in this study.

Future research should implement standardized conditions, including consistent display devices and controlled environments, to minimize external influences and ensure more reliable results.

Perceptual span is a critical factor in reading comprehension to explaining the findings of this experiment. Reading comprehension is largely dependent on the perceptual span and the quantity of linguistic information that may be gained from the text determines the perceptual span, rather than the physical distance or eye movements [17]. The shape and size of perceptual span vary across languages; for instance, in Chinese, more information is processed to the left of fixation due to reading habits. Moreover, Shorter word length in Chinese results in a smaller perceptual span compared to English, which may account for the lower performance of Chinese participants when reading in English, as they must adjust to a longer perceptual span required by the language[17]. Also, perception span contributes more to processing complex words such as uncommon words or words with more complex spelling which were absent in this study, given the average word length of six letters [8]. As a result, perceptual span may not have significantly impacted comprehension across the different text conditions. Future research should integrate word complexity into the examination of perceptual span's influence on reading comprehension.

The absence of consideration for diverse cultural reading habits significantly limits the generalizability of this study's findings. Although both English and Chinese mainland read from left to right, the results cannot be extended to Chinese readers from regions such as Taiwan China, where right-to-left reading habits prevail [17]. The reversed perceptual span in these regions may impede regression and parafoveal processing in English, affecting comprehension. Similarly, languages like Hebrew and Arabic, which also follow a right-to-left orientation, may demonstrate distinct impacts on reading comprehension due to their unique perceptual spans. The exclusion of these groups underscores the need for future research to include more culturally and linguistically representative samples to provide broader, more comprehensive insights. Furthermore, individual differences, particularly in second-language proficiency potentially affecting the outcomes. This variability in English competence among the Chinese participants likely confounded the results, potentially attributing differences in reading comprehension to language proficiency rather than text presentation. To enhance validity, future studies should control for language proficiency and individual differences to more accurately examine the relationship between text presentation and reading comprehension.

In conclusion, as smartphones become more common, alongside this, English second language learners are usually told to read more in English so that they improve their language skills which further highlight the importance of real-life application of current study that reading manner on smartphones. The findings of this study suggest that different text presentations, such as RSVP or scrolling formats, do not significantly impact reading comprehension. This challenges the growing trend of using scrolling text in digital media and educational support materials [11], suggesting caution in adopting these methods for smartphone-based learning. The possible methodology limitations that are compared with other established research may underestimate the impact on text presentation, the potential benefits of a particular text format override the limitations of this study. Notably, TikTok-style text, while novel, showed no influence on comprehension, possibly due to evolving reading habits that have adapted to non-traditional formats. Future research should explore more deeply how evolving reading habits intersect with diverse text formats, offering a nuanced understanding of how digital media shapes cognitive processes and redefines reading comprehension in an increasingly technologically integrated world.

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