26 - Improving L2 Reading Efficiency Through Chunk-Based Reading: An Eye-Tracking Investigation

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Abstract

This study explores the impact of chunk-based reading and gaze fixation training on L2 English reading speed and comprehension. Chunk reading, which involves processing text in meaningful multiword units, has been widely recognized for enhancing fluency and comprehension. This research hypothesizes that training learners to fixate their gaze on chunk centers can improve reading efficiency by enabling the processing of chunks as unified units. Using an eye-tracking tool, 42 Japanese university students of varying English proficiency (CEFR A2 and B1) participated in a controlled experiment. Participants completed reading tasks with and without chunk-focused training, and their eye movements and reading outcomes were analyzed. Results indicate that lower-proficiency learners (A2) benefited most, showing significant reductions in eye fixations, faster reading speeds, and improved comprehension post-training. In contrast, higher-proficiency learners (B1) displayed minimal improvement, suggesting chunk-based strategies are particularly effective for foundational language processing. Findings highlight the pedagogical potential of integrating eye movement strategies into L2 instruction, particularly for less proficient learners. These results offer practical insights for optimizing L2 reading strategies and underscore the need for tailored approaches based on learner proficiency.

Keywords: Chunk-based reading, Gaze fixation training, L2 reading comprehension, Eye-tracking technology, Proficiency-based strategies

1. Introduction

Chunk reading, also known as slash or phrase reading, involves reading a passage by dividing it into meaningful multiword units of information that are manageable at a single time (Miller, 1956). Chunking divides a sentence into smaller, meaningful units, comprising several words that form a cohesive word group (Nation, 2011) or meaningful phrase (Kadota, 2001). Due to its potential to improve reading and listening fluency, L2 learning settings have widely adopted this strategy.

In chunk reading, readers segment sentences into meaningful units by visually "slashing" or breaking them down. These chunks typically contain seven plus or minus two words, a concept famously described as the "magic number" (Miller, 1956), or represent lexical bundles that can be spoken within a two-second span (Baddeley, 1992, 2002). Numerous studies have revealed chunk reading as a key facilitator of fluency (Le & Nguyen, 2014; Yamashita & Ichikawa, 2010). As Nation (2011) argue, chunk reading enables learners to process texts in multi-word units, reducing the number of eye fixations and accelerating reading speed (Sutz, 2009).

Beyond improving speed, chunk reading has also been associated with enhanced reading comprehension (Pulido, 2021; Yubune, 2010). By reducing the cognitive load on working memory, chunk reading allows readers to allocate more cognitive resources to comprehension. This, in turn, strengthens inferencing and predictive reading strategies, leading to more effective overall reading

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(Anderson, 1999). Additionally, chunk reading may enhance listening skills (Yubune, 2010), which further reinforces its value for language learning. Moreover, successful reading experiences foster higher self-efficacy among learners (Samuels, 2008), promoting sustainable, motivated learning.

Despite these documented benefits, several key challenges remain unaddressed in the current literature. One persistent issue is how to effectively train learners in chunk reading. For instance, L2 learners whose first language (L1) differs structurally from English, such as Japanese learners, often struggle with chunk-based reading due to differences in word order (Hijikata, 2005). Another challenge involves teaching learners to identify and process chunks as cohesive units. While some learners may naturally develop a visual scanning pattern conducive to chunk reading, others require explicit instruction on how to visually group chunks (Rayner, 1998).

We need further research to understand the individual components of chunk reading and its varied efficacy among learners. As previous studies suggest (Wood, 2007), chunk reading may not be equally effective for all learners, and individual differences may influence the success of this strategy. Therefore, our present study aims to explore methods for training L2 learners in shifting their visual scanning patterns to facilitate chunk reading. Additionally, it seeks to investigate the individual factor that may impact the efficacy of chunk reading as a L2 learning strategy. Based on the above discussion, this study poses the following research questions.

1. Does training with a chunk reading tool designed to reduce eye fixations lead to a measurable decrease in the number of eye fixations during reading among L2 learners?
2. After undergoing chunk-reading training, do L2 learners demonstrate improved reading speed and enhanced reading comprehension compared to their performance prior to training?
3. Does L2 proficiency influence the effect of chunk reading training on reducing eye fixations during L2 reading?

2. Method

2.1 Participants

A total of forty-two Japanese university students participated in the study. Twenty-one students from a university of science and technology (α), whereas an additional 21 students from another science-focused university (β). Participation was entirely voluntary, and compensation was provided for the time dedicated to the study. The research was approved by the research ethics board of both universities, and all participants have signed the consent form. The participants demonstrated varying English proficiency levels: those from the university α were at the CEFR B1 level, as indicated by their TOEFL ITP® test scores. In contrast, the participants from the university β demonstrated an average proficiency level of A2, as evidenced by their TOEIC ® L&R scores. Furthermore, all participants completed the EF SET, a free English proficiency test, prior to the experiment. The mean score for the university α with A2 level was 68.9 and S.E. was 2.9, while that of the other university with B1 was 55.1 and S.E. was 2.8.

2.2 Treatment

The participants were instructed in chunk reading with the aid of a computer-based reading aid tool designed to minimize the number of eye fixations per chunk. The tool displayed passages in consecutive chunks, with the center of each text chunk on the screen (see to Figure 1 for clarification). The participants were instructed to focus their attention on the center of each chunk and to move their eye gaze steadily downward as additional chunks presented. By shifting the participants' reading strategy from word-by-word reading to chunk-based reading, this design aimed to enhance reading comprehension by reducing the eye fixation durations.

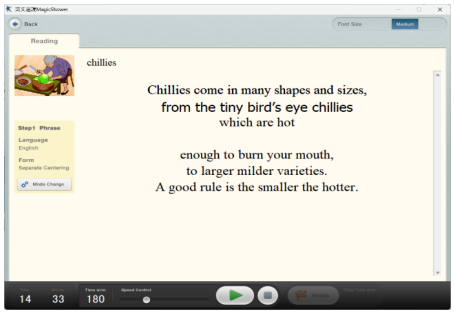

Figure 1 - Reading aid tool

For the treatment, three passages were selected from Nation's (2018) book. The three passages (thereafter, passage 1, 2 or 3) had the same word count and vocabulary level, designed for reading at a rapid pace. The passages addressed scholarly topics, but we selected two that were less directly related to scientific or technological subjects to prevent the participants from relying on their prior knowledge of the subject to answer comprehension questions. The participants had to read the entire passage to correctly answer the questions. One passage was read before and during treatment, while the other passage was read just after the treatment. The order of the passages was counterbalanced.

2.3 Procedure

Participants visited the author's office (university α) or the experimental room (university β) at their respective universities, where the research setup was the same: each room was equipped with a 32-inch computer screen displaying each reading passage, a Windows notebook with the chunk-reading aid tool, and Tobii Pro Glasses 3 for eye tracking, which was connected to a separate Windows PC to record eye movement data.

Participants sat on the front of the display with a resolution of 3840×2160. We conducted the calibration of the Tobii Glasses3 prior to the experiment. The experiment had four phases. First, the subjects read either passage 1 or 2 (We will refer to this as Reading 1). After reading, they completed a 10-question test related to the passage they read. Secondly, they utilized the tool to practice chunk-based reading using the reading passage they read in Reading 1. Third, the participants read either passage 1 or 2 they did not read in Reading 1 (Reading 2). Upon completion of this reading, they took a 10-question test related to the passage they had just completed. Finally, they read passage 3 (Reading 3). After finishing this reading, they took a 5-question test related to the reading they completed.

3. Hypotheses

Training with a chunk reading tool is hypothesized to have the following effects.

1. Training with a chunk reading tool will help the participants reduce in the number of their eye fixations during reading.
2. After training, the participants will exhibit improved reading speed and comprehension compared to their pre-training performance.
3. The L2 proficiency influences the effect of chunk reading training on reducing eye fixations during L2 reading at both universities.

4. Results

4.1 Reading time

To assess the reading time, we conducted a two-way repeated-measures ANOVA (Alpha level is 0.05). Figure 2 shows the results of the reading time. Regarding the reading times, significant main effects were revealed in the reading factor F2, 60=5.812, p<0.01, 2=.098. There is marginally interaction effect between readings × universities F2, 60=2.58, p<0.10, 2=.003. We conducted

multiple comparisons with the Holm methods that show no significant difference is found in the reading factor within univ. α F2, 60=.815, p=.448, 2=.026 and significant differences were found in the reading factor within univ. β F2, 60=7.440, p<0.01, 2=.199. On the other hand, significant differences were found in the reading factor within univ. β: reading 1 > reading 2 (p<0.05) and reading1 > reading2 (p<0.01). No significance was found between reading 1 and reading 2 (p=.635). Thus, Prediction 2 was partially supported.

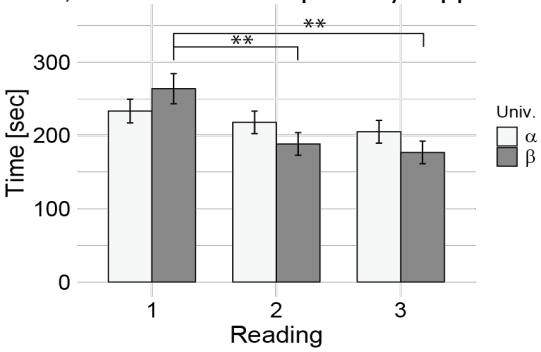

Figure 2 - Result of reading time

4.2 Question score

To align the scores with the other readings, we doubled the results from Reading 3. We conducted a two-way repeated-measures ANOVA (Alpha level is 0.05) to assess the question score. Figure 3 shows the results of the question score. Regarding the reading times, significant main effects were revealed in the university factor F2, 60=23.461, p<0.01, 2=.136. There is no interaction effect. Thus, Prediction 2 was not supported.

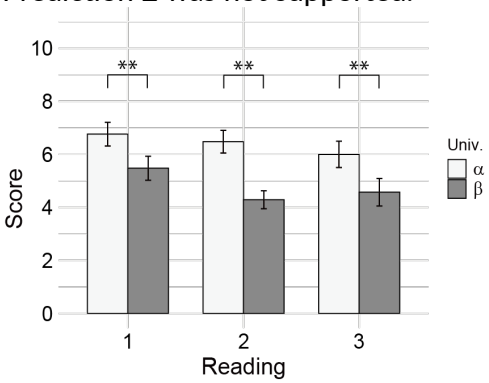

Figure 3 - Result of question score

4.3 Eye tracker data

Tobii Pro Lab software enabled the projection of gaze data onto snapshots of English text from the gaze and video data recorded with Tobii Glasses 3 (Figure 4). We projected the fixation points onto a 1920x1080 image and analysed the gaze data based on accurate projection calculations.

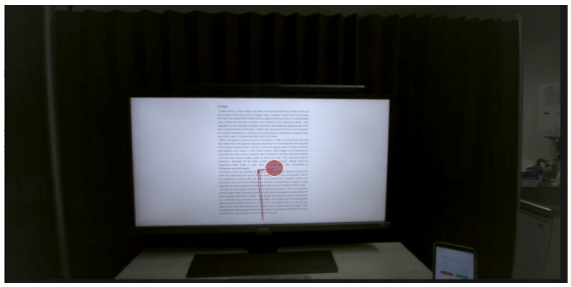

Figure 4 - Fixation data projection

We use the participants' gaze fixation duration from these projected eye tracker data. Figure 5 shows an example of fixation space. The text (680 × 1080 pixels) is divided into five predefined spaces (136 pixels tall, 1080 pixels wide). We obtained the fixation duration of each Space by using Tobii Pro Lab and performed chi-squared test of independence between each university and space condition. The tests revealed significant differences between universities and readings. Table 2 and Table 3 shows the results of fixation duration at in each space and readings in each university.

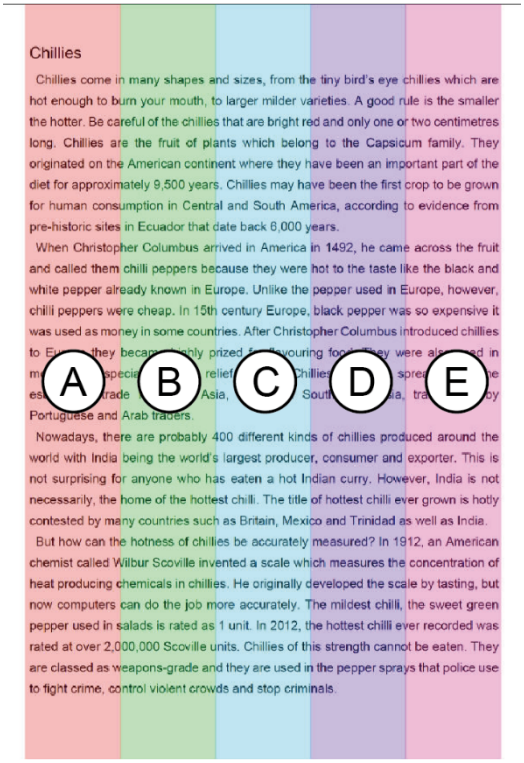

Figure 5 - Five spaces of display

Table 1 and 2 present the observed frequency and adjusted residual for the tests, respectively. If the adjusted residual score for a specific subgroup is greater than 1.96, the subgroup differs significantly ($p<0.05$) from the overall group percentage. The tests revealed no significant difference between the readings and spaces in univ. α students ($28=10.646$,$df=8$, $p=.223$, Cramer's $V=.025$). Conversely, the tests revealed significant differences between behaviors and spaces in univ. β students ($28=122.350$,$df=8$, $p<0.01$, Cramer's $V=.007$). Furthermore, the tests revealed significant differences between universities and spaces in reading 1 ($28=15.628$,$df=8$, $p<0.01$, Cramer's $V=.004$), in reading 2 ($28=79.820$,$df=8$, $p<0.01$, Cramer's $V=.117$) and in reading 3 ($28=75.533$,$df=8$, $p<0.01$, Cramer's $V=.119$).Given these findings, prediction 1 was partially supported, while prediction 3 was supported.

Table 1 - Eye tracker result (participants × spaces in each university)

	A	B	C	D	E
(a) Univ. α					
Reading1	663.150	939.421	943.800	942.696	514.089
	1.983*	-1.181	0.009	-0.386	-0.169
Reading2	364.130	601.828	601.879	622.497	306.876
	-1.876	0.070	0.741	1.659	-1.095
Reading3	322.976	522.887	477.465	472.216	286.859
	-0.320	1.301	-0.795	-1.309	1.357
(b) Univ. β					
Reading1	715.837	1197.705	1188.451	982.477	583.647
	4.541**	5.102**	-9.899**	0.467	2.047*
Reading2	430.009	665.523	1170.796	708.895	394.347

	-1.681	-5.735**	6.294**	0.348	-0.132
Reading3	384.146	753.246	1081.310	653.806	346.247
	-3.247**	0.250	4.414**	-0.862	-2.099*

Fixation duration and adjusted residual [sec] (*: p<0.05, **: p<0.01)

Table 2 - Eye tracker result (participants × spaces in each reading)

	A	B	C	D	E
(a) Reading1					
Univ. α	663.150	939.421	943.800	942.696	514.089
	1.563	-2.359*	-2.029*	2.795**	0.474
Univ. β	715.837	1197.705	1188.451	982.477	583.647
	-1.563	2.359*	2.029*	-2.795**	-0.474
(b) Reading2					
Univ. α	364.130	601.828*	601.879	622.497	306.876
	2.015*	4.002**	-8.779**	3.517**	0.684
Univ. β	430.009	665.523	1170.796	708.895	394.347
	-2.015*	-4.002**	8.779**	-3.517**	-0.684
(c) Reading3					
Univ. α	322.976	522.887	477.465	472.216	286.859
	3.739**	1.421	-8.324**	2.055*	3.309**
Univ. β	384.146	753.246	1081.310	653.806	346.247
	-3.739**	-1.421	8.324**	-2.055*	-3.309**

Fixation duration and adjusted residual [sec] (*: p<0.05, **: p<0.01)

5. Discussion

This study validated the effect of chunk-based reading training using eye-tracking technology to monitor changes in eye movements and reading performance. Additionally, it examined L2 proficiency differences by comparing students from two universities with varying L2 proficiency levels (B1 and A2).

The results of the reading time analysis indicated that chunk-based reading training benefited lower-proficiency learners, whereas no change was observed in higher-proficiency learners. This may suggest that higher-proficiency learners have already developed a well-established approach to reading, while lower-proficiency learners are less accustomed to reading English texts. Consequently, chunk-based reading training may be particularly beneficial for lower-proficiency learners. However, no significant differences were identified between the universities or reading levels in terms of question score results. This suggests no inherent correlation between reading speed improvement and content comprehension.

Eye-tracking data indicated that more proficient learners do not exhibit a fixation bias toward specific points in the passages, likely because they are segmenting sentences appropriately as they read. While overall fixation time decreased from Reading 2 onward, the difference was not statistically significant. An increase in reading speed is likely attributable to participants' constant exposure to English passages during the experiment. In contrast, before chunk-based reading training, less proficient learners tended to fixate at the beginning of sentences, reflecting a common tendency among beginners to start reading from the left edge of the page. After the training, however, their fixation points shifted more toward the center of the text, suggesting that the chunk-based reading training helped participants consciously control their gaze.

One limitation of this study is that the chunk-based reading training was administered only once and for a relatively brief period. Extending the training over a longer duration might yield positive effects for higher-proficiency L2 learners as well. Furthermore, prolonged training could potentially influence content comprehension.

6. Conclusion

This study aimed to verify the effectiveness of chunk-based L2 reading training and eye movement control using eye-tracking technology, as well as to examine its influence on L2 proficiency. Based on the findings, responses to each research question (RQ) are as follows: