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Text Processing and Memory in EFL Reading: The Role of Relevance Instructions

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Abstract

This study examined the effects of relevance instructions on English as a foreign language (EFL) readers' text processing and memories. The participants were randomly assigned to one of two conditions: the experimental condition, where they read texts to identify a specific category of information, and the control condition, where they read texts just for general comprehension. They read two expository texts that differed in difficulty, and the sentence-by-sentence reading times were recorded. The results demonstrated that relevance instructions induced readers to pay additional attention to relevant information, leading to better text recall. However, it was suggested that the size of relevance effects in the easy text was larger than those in the difficult text. The study discussed why the impact of relevance instructions depends on text factors and demonstrated that certain effects of relevance instructions are specific to EFL readers.

Keywords*:* relevance instructions, reading goal, text processing, text memory, expository texts

Reading comprehension is a goal-directed activity wherein a text is read for various goals (Britt et al., 2018). Especially in expository text comprehension, individuals read a text to achieve particular post-reading tasks, such as reading a textbook to study for an exam, reading an online article to search for pieces of information, and reading a research paper to write a summary. Depending on their reading goals, readers need to change their text processing while reading to retain information. However, many second language (L2) and English as a foreign language (EFL) readers have difficulty controlling their reading processes to achieve reading goals (Grabe, 2009). Therefore, teachers provide students with relevance instructions, which are explicit cues that indicate the extent to which information is relevant to the task, and direct students to read a text in a particular way. The present study examined how relevance instructions affect text processing and memory in EFL reading.

Background

Effects of relevance instructions on text processing and memory in L1 reading

The goal-focusing model of relevance explains the effect of relevance instructions on readers' goals, text processing, and learning (McCrudden & Schraw, 2007). Readers set a reading goal based on both personal and given intentions. Personal intentions are internal standards that readers develop in order to comprehend a text, such as personal interests, beliefs, and values. On the other hand, relevance instructions are given intentions, which provide readers with "criteria for determining information's relevance to a particular reading task" (McCrudden et al., 2010, p. 230). Relevance instructions can assume many forms, including general relevance instructions (e.g., providing readers with reading purposes or reading perspectives) and specific relevance instructions (e.g., pre-reading questions or providing students with targeted segments to focus on a specific category of information). Relevance instructions help readers to identify information that is relevant to the reading tasks and to change their text processing based on the information's relevance. They direct their attentional resources to task-relevant information, which leads to better memory for such information. For example, consider the following expository text excerpt:

> (a) The flying fox is a large bat from Australia. (b) It is about 25 cm long and the span of their wings is about one meter. (c) Flying foxes are so named because their faces are covered with fur like a fox. (d) Most people who get close to a flying fox want to touch them. (e) Flying foxes are sometimes called fruit bats because they look like fruit as they hang down from trees during the day. (modified from Tilstra & McMaster, 2013, p. 73)

When the relevance instructions require students to read the text and pay special attention to how each bat got its name, sentences (c) and (e) become relevant information to readers, whereas the other sentences become less relevant. According to the goal-focusing model of relevance, readers pay more attention to these relevant sentences than to less relevant sentences and recall relevant information better.

Previous studies have examined the effects of relevance instructions on text processing and memory when participants read in their first language (L1) (e.g., Kaakinen & Hyönä, 2005; Kaakinen & Hyönä, 2008; Kaakinen et al., 2002; Kaakinen et al., 2003; León et al., 2019; McCrudden, 2011; McCrudden et al., 2010; McCrudden & Schraw, 2010; McCrudden et al., 2005). A number of studies have demonstrated that relevance instructions affect both text processing and memory. Kaakinen et al. (2002) conducted an eye-tracking study and demonstrated that, when readers were provided with reading perspectives (e.g., read the text to decide the good and the bad sides of Honduras as a new home country), they showed longer fixation times and better recall for the perspective-relevant information than for the irrelevant information. The results suggested that relevance instructions guide readers to allocate extra attention to process the relevant text information, which results in readers remembering the relevant information better. Other previous studies have demonstrated similar effects in regard to how relevance instructions impact on-line text processing and off-line text memory (e.g., Kaakinen & Hyönä, 2005; León et al., 2019; McCrudden et al., 2010).

On the other hand, other previous studies have demonstrated that relevance instructions facilitated text memory but did not affect reading time. McCrudden et al. (2005) examined the effects of pre-reading questions on reading time and text recall, and they demonstrated that the text information that was relevant to the questions was recalled better than the less relevant information even though the text relevance did not affect reading time. McCrudden (2011) also investigated the effects of two types of pre-reading questions (what- and why-questions) on reading time and post-reading questions. The results showed that readers performed better on the post-reading questions that were aligned with pre-reading questions. However, there were no significant differences in reading time for the task-relevant and less relevant information across question conditions. McCrudden and his colleagues claimed that the instructions in these studies did not affect reading times because readers were able to quickly identify the text's relevance without effort when the relevance instructions were specific (i.e., pre-reading questions). Such specific relevance instructions enabled readers to process the task-relevant information in a more systematic way; thereby, all of the relevant information was encoded and interconnected in their mental representations without increasing their reading times.

Furthermore, several studies have also demonstrated that relevance effects depend on readers' factors (Kaakinen et al., 2002; Kaakinen et al., 2003; McCrudden & Schraw, 2010). One reader characteristic that affects relevance effects is readers' working memory capacity. According to Kaakinen et al. (2002), readers with high working memory spans showed both immediate (i.e., first-pass fixation) and delayed effects (i.e., look-back times) on their reading perspective, whereas readers with low working memory spans showed only delayed effects. The results suggest that readers with low working memory spans allocate many cognitive resources to lower-level processing such as lexical and syntactic processing, during first-pass reading of sentences, and therefore, they execute higher-level, goal-directed processes only during the later look backs. Kaakinen et al. (2003), who also examined the effects of readers' working memory capacity, demonstrated that while readers with high working memory capacity were able to efficiently encode relevant information to memory without extra processing, readers with low working memory capacity needed to reread relevant information. McCrudden and Schraw (2010) investigated the effect of relevance on text processing and memory, focusing on the relationship between relevance instructions and readers' verbal ability. The results showed that relevance instructions led to readers having longer reading times and improved memories for relevant information; however, the results also indicated that the relevance instructions did not compensate for differences in verbal ability.

Effects of reading goals on L2 and EFL reading comprehension

In L2 and EFL reading, reading comprehension is also a purposeful activity where readers need to strategically control their reading processes in accordance with a given purpose. Text processing generally includes lower-level processing, such as lexical and grammatical processing, which contributes to decoding processes, and higher-level processing, such as inference generation and comprehension monitoring, which contributes to the construction of durable mental representations (Graesser et al., 1994; Kintsch, 1998; Zwaan & Radvansky, 1998). In order to read a text to achieve a given goal, readers need to engage in higher-level processes where they judge whether the current information is relevant to the goal and encode relevant information into their memory representations. In this process, they are able to allocate

many cognitive resources to higher-level strategic processing when they effortlessly and automatically execute lower-level processing (Linderholm & van den Broek, 2002; Magliano et al., 1999). However, L2 and EFL readers' lower-level processing skills are less sufficiently developed than L1 readers (Koda, 2005), so L2 and EFL readers allocate many more cognitive resources to lower-level language processes such as lexical and grammatical processing than do L1 readers (Horiba, 1996; Morishima, 2013). As a result, it is expected that they would have difficulty in flexibly allocating the remaining limited cognitive resources in accordance with the provided relevance instructions.

A number of studies have investigated the effects of reading goals on L2 readers' cognitive processes during reading (e.g., word and sentence analysis, inference generation, self-monitoring) and text recall (Horiba, 2000; Horiba, 2013; Yoshida, 2012). In Horiba (2000)'s Experiment 2, L1 and L2 readers read an expository text under one of two reading goals: read for coherence or read freely. The results demonstrated that the L1 readers controlled their reading processes in accordance with the given goals (i.e., there were more comments on inference generation and text structure for the read-for-coherence condition). On the other hand, the L2 readers did not alter their reading processes under different reading goals, although their text recall was facilitated by the read-for-coherence instructions.

Horiba (2013) also investigated the effects of three reading goals (i.e., the expression, image, and critique conditions) on reading processes as reflected in think-aloud comments. The results indicated that L2 readers' processes were partly altered by the reading goals. Specifically, the learners in the expression condition engaged in lower-level linguistic processing more than those in the other conditions, whereas the learners in the critique condition made more comments in regard to the higher-level conceptual processing (e.g., reaction and evaluation) than did learners in the other conditions. On the other hand, there were no significant differences in text recall by reading condition. One of the reasons why reading goals did not affect text recall was that the reading goal was not specific enough to alter the products of comprehension.

Yoshida (2012) also compared the effects of three different task instructions (reading for outlining, for answering embedded questions, and for general comprehension) on text recall and indicated that the task instructions did not improve L2 readers' text recall. The outlining and embedded questions were assumed to encourage L2 readers' text comprehension, but the learners did not benefit from the intervention (i.e., task instructions) when there was a mismatch between the task demands and the participants' linguistic proficiency levels.

Thus, the aforementioned studies investigated the overall cognitive processes in which L2 readers engage in reading and post-reading text memory. The results suggest that L2 readers are less likely to strategically control their reading processes in accordance with their reading goals than L1 readers. Additionally, reading goals given by the task instructions do not always facilitate L2 and EFL readers' text recall, although they partly affect the reading processes. However, these previous studies did not consider the relevance of reading goals and text information, so they did not investigate how L2 and EFL readers pay attention to each piece of textual information during reading in accordance with given instructions (i.e., relevance effects).

Effects of questions on L2 and EFL text comprehension

To enhance reading comprehension, questions have been widely used as educational interventions in L2 and EFL reading classrooms. Questions have functions similar to relevance instructions because they aim to direct readers' attention to particular information in the text. In Brantmeier et al. (2012), Chinese EFL learners read English texts either with or without a "what" question. The results demonstrated that the question did not facilitate text recall. Furthermore, the readers showed worse performance in text recall, particularly when they were instructed to pause and write down the answer to the question. In Callender et al. (2013), L2 readers read texts to answer either what- or why-questions or for text comprehension (i.e., no questions). The results indicated that the questions had negative effects on text recall and did not enhance reading comprehension. One possible reason why questions did not facilitate text recall in these studies was that L2 and EFL learners devoted too many attentional resources to the text information addressed by the questions and, as a result, they failed to comprehend the text as a whole, which led to the construction of incoherent mental representations. However, as these studies did not directly measure online processes during reading, it was not clear how readers allocated their attentional resources to information that was relevant or less relevant to questions.

Text factors and relevance instructions

Reading comprehension is a result of the interaction among texts, readers, and tasks (van den Broek et al., 2001; van den Broek et al., 1995). Therefore, text factors as well as reader factors can alter relevance effects. Among various text factors, text difficulty has a significant impact on L2 reading comprehension. A number of previous studies have examined effects of text difficulty on L2 readers' text processing and memory (Crossley & McNamara, 2016; Crossley et al., 2014; Kim et al., 2018). Crossley et al. (2014) compared L2 readers' processing time of authentic texts and simplified texts (i.e., beginning and intermediate level texts) differing in linguistic features such as cohesion, lexical sophistication, and syntactic complexity. The results showed that authentic texts and intermediate-level texts were processed slower than beginning level texts. Similarly, Kim et al. (2018) showed that authentic texts were processed slower than beginning and intermediate-level texts. With regard to text memory, Crossley and McNamara (2016) compared L2 readers' text-retelling performance of beginning and intermediate-level simplified texts with authentic texts. The results demonstrated that fewer propositions were recalled from authentic texts than from simplified texts. Thus, the overall results indicated that as the text became increasingly difficult, readers showed slower processing and poorer recall.

Since relevance instructions strategically induce readers to focus on specific information, they can compensate for text difficulty. However, there has been little examination of how and whether text factors interact with relevance effects. Although no research has directly examined the relationship between text difficulty and relevance effects, Lehman and Schraw (2002) manipulated text coherence and examined whether relevance instructions compensate for text complexity in L1 reading. Results showed that relevance instructions enabled readers to write essays that contained more inferences and better integration, thereby suggesting that relevance instructions facilitated readers' deeper processing of text and compensated for the difficulty imposed by text characteristics.

The Present Study

The purpose of this study was to examine the effects of relevance instructions on Japanese EFL learners' text processing and text memories. Of the various types of relevance instructions, the present study adopted specific relevance instructions that required learners to focus on particular categories of information (i.e., targeted segments). Given that the participants were all EFL learners, it was a better intervention to include specific relevance instructions rather than general relevance instructions because readers can more consistently interpret and can more easily identify the relevance of text information (e.g., McCrudden, 2011; McCrudden et al., 2005). A self-paced reading method was adopted to capture the learners' online text processing moment-by-moment, and the learners' text memories were measured by a written recall task. The research questions (RQs) were as follows:

1. Do specific relevance instructions affect EFL learners' text processing as measured by reading time?
2. Do specific relevance instructions affect EFL learners' text memory as measured by a written recall task?
3. Do effects of specific relevance instructions depend on text difficulty?

In regard to RQ1, there are three possible outcomes. First, the reading times for relevant information will be longer than the times for less relevant information. According to the goal-focusing model of relevance (McCrudden & Schraw, 2007) and other L1 research (e.g., Kaakinen et al., 2002), readers will strategically pay additional attention to the text information that is relevant to the given instructions, which results in longer reading times. Another possibility is that relevance instructions will facilitate goal-focused processing, but that reading times will not be affected by text relevance. Since the present study used specific rather than general relevance instructions, it was expected that the participants would be able to immediately identify the relevance of the text information without increasing their reading times as in McCrudden et al. (2005) and McCrudden (2011). The third possibility is that reading times cannot be influenced by the relevance instructions because EFL learners are not likely to flexibly control their reading processes in accordance with the given goals. Given that the effects of relevance on L1 reading depend on individual-level factors such as working memory capacity (e.g., Kaakinen et al., 2002), relevance instructions might not work as effectively as they do in L1 reading because EFL learners require the use of many cognitive resources to engage in lower-level language processes such as lexical and grammatical processing (Horiba, 1996; Morishima, 2013).

Regarding RQ2, there are also a number of possible outcomes. First, as numerous studies on the effects of relevance instructions on L1 reading have found (e.g., Kaakinen et al., 2002; McCrudden et al., 2005; McCrudden & Schraw, 2010), it is possible that relevance instructions will facilitate readers' recall of relevant information. On the other hand, another possibility is that the relevance instructions will not affect text recall because EFL readers are not strategic enough to alter their reading processes and subsequent post-reading products (Horiba, 2013; Yoshida, 2012). In addition, when readers allocate too much attention to relevant information, it will cause them to construct incoherent mental representations (Brantmeier et al., 2012;

Callender et al., 2013). As a result, the relevance instructions will have a negative influence on text recall.

In regard to RQ3, when the readers read a difficult text, it was expected that they would show longer reading time and poorer recall than when they read an easy text (e.g., Crossley et al., 2014). In contrast, when relevance instructions were given to readers, they would focus on text information that is relevant to the instructions and show longer reading time and better recall of relevant information (e.g., Kaakinen et al., 2002). Therefore, it was predicted that relevance instructions would compensate for text difficulty, or relevance instructions and text difficulty would affect text processing and memory, independently.

Method

Participants

The participants were 49 Japanese undergraduate and graduate students (16 males, 33 females; 18–25 years old) with different majors (e.g., economics, engineering, biology, medical science, literature, etc.). They had studied English for more than six years as part of their formal Japanese education, and their English reading proficiency levels ranged from upper-beginner to lower-intermediate levels (based on their self-reported test scores). The participants were assigned to either the experimental or control condition (see *Relevance Instructions* section for more details) based on both their self-reported English proficiency levels (e.g., TOEIC® reading test, the STEP Eiken test, or TOEFL iBT® scores) and the university's English class placements (which were based on the students' TOEIC® listening and reading test scores). Therefore, the participants in both the experimental and control conditions had nearly equal English proficiency levels. The data of two participants were excluded from the analysis because their reading times were not accurately measured due to technical failures; thus, data from 47 participants (23 participants in the control condition and 24 participants in the experimental condition) were available for the following analysis.

Materials

Since the participants were all Japanese EFL learners, it was important that the experimental materials were not too long. Furthermore, to avoid the readers' background knowledge affecting the results, it was necessary that the texts' topics were unfamiliar to the participants. Considering these conditions, two expository texts differing in difficulty—"The World of Bats (hereafter the easy text)" and "The Rodeo (hereafter the difficult text)"—were adapted from Tilstra and McMaster (2013). In the easy text, the first few sentences introduce basic information about bats, and the following sentences describe the characteristics of three different types of bats and how each bat got its name. In the difficult text, the first few sentences introduce the history of rodeo, and the following sentences describe the characteristics of three different events in the rodeo and the way cowboys are scored in each event.

Table 1 displays the overview of these texts. They were modified to ensure that the EFL learners did not have much trouble with lexical-level processes while reading. In addition to calculating

the Flesch Reading Ease and Flesch-Kincaid Grade Level scores, L2 readability was calculated with a web-based software—Coh-Metrix (McNamara et al., 2014). L2 readability is based on word overlap, word frequency, and syntactic similarity. These values predict reading difficulty more accurately than traditional readability measures (Crossley et al., 2008).

Table 1

The Overview of the Experimental Texts

Text	Words	Sentences	FRE	FKGL	L2 readability
Easy	238	18	85.3	4.6	22.62
Difficult	294	20	76.0	6.3	13.02

Note. The Flesch Reading Ease (FRE) and Flesch-Kincaid Grade Level (FKGL) scores were calculated with Microsoft Word 2016. L2 readability was calculated with *Coh-Metrix* (McNamara et al., 2014).

Relevance instructions

The relevance instructions used in this study were based on Tilstra and McMaster (2013), and they were translated into Japanese in order to make sure that all the participants could understand the instructions. In the experimental condition, the participants received specific instructions where they were asked to read the expository texts to identify particular categories of information. Table 2 shows the relevance instructions for the experimental condition and excerpts from the experimental texts. In the easy text, information about the origin of the name of each bat was categorized as relevant information. In the difficult text, information about how cowboys are scored in each event was categorized as relevant information. All the other sentences were categorized as irrelevant information, which refers to information related to the topic but not directly relevant to the instructions. Table 3 shows the number of words and sentences in the irrelevant information and relevant information. Eight Japanese graduate students majoring in English education also confirmed that this relevant information was actually relevant to the instructions.

Table 2

Relevance Instructions and Excerpt of Experimental Texts

Text	Relevance instructions	Experimental text
Easy	"Read this passage and pay special attention to how each bat got its name."	… The flying fox is a large bat from Australia. It is about 25 cm long and the span of their wings is about one meter. Flying foxes are so named because their faces are covered with fur like a fox. Most people who get close to a flying fox want to touch them. Flying foxes are sometimes called fruit bats because they look like fruit as they hang down from trees during the day....
Difficult	"Read this passage and pay special attention to the way cowboys are scored in each event."	… In the Saddle Bronc event, a cowboy rides a moving horse. The rider holds a thick rope with one hand and tries to stay on the horse. The rider receives points for the position of his toes and how much control he has over the horse. On the field, working cowboys catch wild horses and control them for their work. The Saddle Bronc rider must stay on the horse at least 8 seconds. The rider will lose in the game if he touches any part of the horse or his own body with his free hand. Many people consider Saddle Bronc Riding the most difficult events of rodeo….

Note. Experimental texts were modified from Tilstra and McMaster (2013). Underlined sentences were categorized as relevant information, and the other sentences were considered irrelevant information.

Table 3

The Number of Sentences and Words in the Relevant and Irrelevant Information

	Relevant information		Irrelevant information	
	Sentences	Words	Sentences	Words
Easy	6	102	12	136
Difficult	6	98	14	196

In the control condition, on the other hand, the participants were instructed to read the passage to understand the important information rather than being asked to focus on a specific category of information. The instruction was as follows: "Read the passage carefully and try to understand the important information." This instruction can be compared to the relevance instruction in the experimental condition; Tilstra and McMaster (2013) regarded this instruction as a kind of "general comprehension control condition" (p. 69) because it did not specify which information in the text participants should pay attention to.

Procedures

The experiment was conducted individually. The author explained the experiment's purpose and procedure and obtained informed consent from the participants before the experimental sessions began. First, the participants read a practice passage that was similar in length to the experimental texts in order to adjust to reading a text sentence-by-sentence on the computer. Each sentence appeared when the participant pressed a button on the Response Pad RB-730 (Cedrus Corporation, USA) at their own pace. Their reading times for individual sentences, calculated in milliseconds (ms), were collected using SuperLab 5.0 software (Cedrus Corporation, USA). In the practice session, they did not receive any relevance instructions. After that, they started reading the two experimental texts. The order in which the two texts were presented was randomized. Half of the participants (11 participants in the control condition and 12 participants in the experimental condition) read the easy text first, and the other half (12 participants in the control condition and 12 participants in the experimental condition) read the difficult text first. They received instructions according to the reading condition immediately before reading each text. To minimize any instruction effects other than the relevance instructions, the participants were not told that they would complete a written recall task after they finished reading; instead, they were told that they would answer comprehension questions after reading the passages to measure how well they comprehended the two texts. After reading the two passages, they evaluated the level of difficulty and the familiarity of each text's topic with a five-point Likert scale (from 1: *easy* to 5: *difficult* for difficulty; from 1: *unfamiliar* to 5: *familiar* for familiarity). Finally, they engaged in a written recall task in which they wrote down, in their first language (Japanese), all of what they remembered about the two texts. The entire procedure was completed in approximately 75 minutes.

Scoring

Reading time. Since the easy text and the difficult text differ in the number of sentences in the relevant information and irrelevant information (see Table 3), the reading times were divided by the number of words, and the average reading times per word (millisecond) were calculated, as in previous studies (e.g., McCrudden, 2011; McCrudden et al., 2005; McCrudden et al., 2010). Reading times shorter than 100 ms were excluded, and those greater than ±3*SD* were replaced with cut-off values (Jegerski & VanPatten, 2014) because extreme outliers can skew results. These deletions affected 1.82% of the reading time data. The reading times for relevant information and irrelevant information were calculated and compared.

Recall task. To score the recall task, the experimental texts were parsed into idea units based on Carrell (1985). Two raters carried out this division, and the agreement between them was 97.06% for the easy text and 98.30% for the difficult text. The total number of idea units was 47 (20 units for relevant information and 27 units for irrelevant information) for the easy text and 58 (18 units for relevant information and 40 units for irrelevant information) for the difficult text. Based on the idea unit separation, 30% of the recall data were randomly selected and separately scored by two raters. In scoring the recall protocols, one point was given when an idea unit in the passages was correctly included in the recall protocols. The agreement between the two raters was 93.62% for the easy text and 85.82% for the difficult text. Any disagreements were resolved with discussions, and one rater scored the remaining data. Since the easy text and the difficult

text are different in the number of idea units in the relevant information and irrelevant information, the number of recalled idea units was converted into a proportion of the total number of idea units as in previous studies (e.g., Kaakinen et al., 2002; McCrudden et al., 2010), and the arcsine transformation was used for analysis.

Results

Difficulty and familiarity rating

The results showed that the difficulty ratings (M = 2.77, 95% CI [2.52, 3.01], SD = 0.84 for the easy text; M = 3.77, 95% CI [3.51, 4.02], SD = 0.87 for the difficult text) were significantly different between the two texts, $t(46) = 6.86$, $p < .001$, $r = .711$. On the other hand, familiarity rating scores (M = 1.53, 95% CI [1.29, 1.78], SD = 0.83 for the easy text; M = 1.36, 95% CI [1.15, 1.58], SD = 0.74 for the difficult text) did not differ between the two texts, $t(46) = -1.09$, $p = .281$, $r = .159$. It was confirmed that the two texts were similar in regard to topic familiarity, but that the participants found the difficult text to be more difficult than the easy text.

Reading time

Table 4 displays the means and standard deviations for the reading times for the relevant and irrelevant information.

Table 4

Reading Times for Each Condition

	Easy text				Difficult text			
	Irrelevant		Relevant		Irrelevant		Relevant	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Control (n = 23)	628.71	152.85	652.02	155.68	712.01	189.78	700.58	208.28
Experimental (n = 24)	651.47	179.30	770.29	206.24	720.43	222.66	747.80	202.90

A 2 (condition: control, experimental) × 2 (relevance: irrelevant, relevant) × 2 (text: easy, difficult) mixed analysis of variance (ANOVA) was conducted on reading time (see Note 1). The results showed that the main effect of text, $F(1, 45) = 10.71$, $p = .002$, $\eta_G^2 = .014$, and the main effect of relevance, $F(1, 45) = 7.70$, $p = .008$, $\eta_G^2 = .011$, were significant, but the main effect of condition was not significant, $F(1, 45) = 0.95$, $p = .336$, $\eta_G^2 = .017$. More importantly, while the interaction among condition, relevance, and text was not significant, $F(1, 45) = 1.14$, $p = .291$, $\eta_G^2 = .001$, the interaction between condition and relevance was significant, $F(1, 45) = 5.56$, $p = .023$, $\eta_G^2 = .008$ (see Note 2). To follow up on this significant interaction effect, a post-hoc analysis was conducted to examine whether the reading time data were consistent with the goal-focusing model of relevance (McCrudden & Schraw, 2007). The model predicts that the participants in the experimental condition would show longer reading times for the relevant

information than for the irrelevant information, whereas those in the control condition would show no differences in reading times between the two sentence types. The results showed that while the simple main effect of relevance was significant in the experimental condition, $F(1, 23) = 10.13$, $p = .004$, $\eta_G^2 = .033$, the simple main effect of relevance was not significant in the control condition, $F(1, 22) = 0.13$, $p = .722$, $\eta_G^2 < .001$. The results indicated that while the reading times for relevant and irrelevant information did not differ in the control group, the reading times were longer for relevant information than for irrelevant information in the experimental group.

Furthermore, to examine the size of relevance effects in each text respectively, paired t-tests were conducted. With regard to the easy text, participants in the experimental condition showed a longer reading time with the relevant information than with the irrelevant information, and the effect size was large, $t(23) = -4.80$, $p < .001$, $r = .708$. Participants in the control condition did not show a significant difference between irrelevant and relevant information, $t(22) = -0.89$, $p = .385$, $r = .186$. In contrast, with the difficult text, participants did not show a significant difference between irrelevant and relevant information in the experiment condition, $t(23) = -0.75$, $p = .463$, $r = .154$, or in the control condition, $t(22) = 0.62$, $p = .542$, $r = .131$.

Written recall task

Table 5 displays the means and standard deviations for the recall production rates. Arcsine transformation was performed on each recall rate because the number of idea units were different for the irrelevant and relevant information.

Table 5

Recall Rates With Arcsine Transformation

	Easy text				Difficult text			
	Irrelevant		Relevant		Irrelevant		Relevant	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Control ($n = 23$)	24.03	10.27	28.51	11.72	22.55	6.94	23.62	12.68
Experimental ($n = 24$)	25.99	9.96	42.47	8.45	21.82	6.85	26.41	10.87

Like the analysis of reading time, a 2 (condition: control, experimental) × 2 (relevance: irrelevant, relevant) × 2 (text: easy, difficult) mixed ANOVA was conducted on recall production rates (see Note 3). The results showed the significant main effects of condition, $F(1, 45) = 4.77$, $p = .034$, $\eta_G^2 = .051$; text, $F(1, 45) = 32.69$, $p < .001$, $\eta_G^2 = .105$; and relevance, $F(1, 45) = 30.09$, $p < .001$, $\eta_G^2 = .105$. More importantly, while the interaction among condition, relevance, and text was not significant, $F(1, 45) = 3.48$, $p = .069$, $\eta_G^2 = .038$, the interaction between condition and relevance was significant, $F(1, 45) = 10.24$, $p = .003$, $\eta_G^2 = .039$. To follow up on this significant interaction effect, a post-hoc analysis was conducted to examine whether the recall production rate data were consistent with the goal-focusing model of relevance (McCrudden & Schraw, 2007). According to the model, the participants in the experimental condition should show better recall for the relevant information than for the irrelevant information, whereas those in the control condition should not be influenced by the relevance of information. The results

showed that while the simple main effect of relevance was significant in the experimental condition, $F(1, 23) = 50.76$, $p < .001$, $\eta_G^2 = .256$, the simple main effect of relevance was not significant in the control condition, $F(1, 22) = 2.04$, $p = .167$, $\eta_G^2 = .018$ (see Note 4). The results indicated that the recall rates for relevant and irrelevant information did not differ in the control group, whereas the relevant information was better recalled than irrelevant information in the experimental group.

Furthermore, to examine the size of relevance effects in each text respectively, paired t-tests were conducted. With regard to the easy text, participants in the experimental condition showed better recall of the relevant information than with the irrelevant information, and the effect size was large, $t(23) = -7.88$, $p < .001$, $r = .854$. Participants in the control condition did not show a significant difference between irrelevant and relevant information, $t(22) = -1.43$, $p = .166$, $r = .292$. In contrast, with the difficult text, participants in the experimental condition showed better recall of the relevant information than the irrelevant information, but the effect size was medium, $t(23) = -2.13$, $p = .044$, $r = .405$. Participants in the control condition did not show a significant difference between irrelevant and relevant information, $t(22) = .571$, $p = .574$, $r = .121$.

Discussion

Effects of relevance instructions on text processing (RQ1)

The results demonstrated that the participants in the experimental condition showed longer reading times for the relevant information than for the irrelevant information, whereas those in the control condition showed no differences in reading times between these two sentence types. These results indicate that the relevance instructions affected EFL learners' text processing while reading. Specifically, the pre-reading relevance instructions induced readers to devote more time and attention to processing the relevant information. These results are consistent with the previous studies that have examined the effects of relevance instructions on L1 reading (e.g., Kaakinen et al., 2002; McCrudden & Schraw, 2010), which suggests that readers are able to set reading goals based on the provided instructions and can strategically allocate more attention to the goal-relevant information. Although it is difficult for L2 and EFL learners to alter their cognitive processes based on the provided instructions compared to L1 readers (Horiba, 2000), the present study revealed that the participants were able to focus their attention in ways that aligned with the provided relevance instructions. In the present study, the participants were able to identify the relevant information while reading and thus could efficiently pay additional attention to the relevant information because specific relevance instructions provided clear criteria in regard to how attentional resources should be allocated while reading.

On the other hand, the present study's reading time results were not consistent with the previous research that has examined the effects of specific relevance instructions (McCrudden et al., 2005; McCrudden, 2011), as L1 readers can process information that is relevant to the specific relevance instructions without increasing their reading times. There are two different explanations for this. One possible explanation is that EFL readers judge the relevance of text information more carefully than L1 readers do. While L1 readers are able to quickly and

effortlessly identify the text information's relevance (McCrudden et al., 2005; McCrudden, 2011), EFL readers must devote extra effort to evaluate whether each piece of text information that they are currently processing is relevant to given instructions. If this is true, participants in the experimental condition should show longer reading times for both irrelevant information and relevant information than should those in the control condition. However, the present study demonstrated that the reading time of irrelevant information, $F(1, 45) = 0.09$, $p = .767$, $\eta_G^2 = .002$, and the reading time of relevant information, $F(1, 45) = 2.45$, $p = .125$, $\eta_G^2 = .045$, were not significantly different between two conditions. Therefore, the results suggest that even EFL readers selectively pay attention during reading instead of reading the overall text carefully.

Another and more plausible explanation is that EFL readers need to devote extra processing resources to encode relevant information into their long term-memory. L1 readers do not need to pay additional attention to relevant information because each piece of relevant information is encoded and interconnected during text processing without additional effort; thereby, a mental representation based on these interconnected elements is constructed (McCrudden et al., 2005). In contrast, since EFL readers devote many cognitive resources to lower-level processing, such as lexical and syntactic processing (Horiba, 1996; Morishima, 2013), they cannot have enough capacity to effectively allocate their remaining cognitive resources. Kaakinen et al. (2003) showed that L1 readers with high working memory capacity can process and encode relevant information without extra effort because they are better at retrieving and accessing information in the long-term memory than low-span readers; however, those with low working memory capacity need to strategically pay more attention to relevant information (e.g., rereading the relevant information) to be able to recall it later. Although the present study did not directly measure working memory capacity or readers' detailed moment-by-moment reading process including rereading and look-back processes, EFL readers, who need to allocate more cognitive resources to lower-level processing during reading than do L1 readers, might compensate for their lack of remaining capacity of working memory with strategic processing. For example, they might reread within a relevant sentence or carefully pay attention to important keywords in relevant sentences to encode relevant information to memory. This possibility can be further examined in future study by using eye-tracking measurements for readers' moment-by-moment reading processes.

Effects of relevance instructions on text memory (RQ2)

The results demonstrated that the participants in the experimental condition showed better recall for the relevant information than for the irrelevant information, whereas those in the control condition was not influenced by the relevance of information. The results demonstrated that the relevant information was recalled better than the irrelevant information when the participants received relevance instructions. Furthermore, the participants in the experiment condition recalled as much irrelevant information as did those in the control condition, $F(1, 45) = 0.09$, $p = .722$, $\eta_G^2 = .131$. The results indicate that the relevance instructions, which intended to induce readers to pay attention to relevant information, facilitated recall of relevant information without inhibiting recall of irrelevant information. The facilitative effects of relevance instructions on text memory are consistent with findings in L1 reading research (e.g., Kaakinen et al., 2002; McCrudden, 2011). As the reading time results indicated, the instructions induced the readers to

pay additional attention to relevant information; consequently, they facilitated text recall for the relevant information but not for the irrelevant information.

On the other hand, the results of the text recall were not consistent with those from previous studies that demonstrated that L2 and EFL learners' text memory was not facilitated by reading goals (e.g., Horiba, 2013; Yoshida, 2012) or questions (Brantmeier et al., 2012; Callender et al., 2013). First of all, the present study adopted specific relevance instructions rather than general relevance instructions, so the relevance instructions provided clear criteria for which information readers should keep in their memory. In addition, achieving reading goals given by the specific relevance instructions was not too demanding for the proficiency level of the participants in the present study. When there is a mismatch between the task demands and the participants' linguistic proficiency level, the text recall is not facilitated by given reading goals (Yoshida, 2012). In the present study, however, the relevant information was easily identified during reading because of the explicitness of the relevant information. Finally, in contrast to the adjunct questions (e.g., Brantmeier et al., 2012), the relevance instructions allowed readers to flexibly control their text processing without paying too much attention to relevant information while reading or constructing incoherent mental representations. As a result, the relevance instructions functioned beneficially for EFL readers when they read texts with the relevance instructions.

Relevance effects and text difficulty (RQ3)

Previous studies have demonstrated that difficult texts are processed slower and recalled more poorly than easy texts (e.g., Crossley et al., 2014; Crossley & McNamara, 2016). The results of this study are consistent with the previous studies. Readers showed longer reading time (see Table 4) and worse recall (see Table 5) with the difficult text than with the easy text. Furthermore, this study is partly consistent with Lehman and Schraw (2002) in the way that relevance instructions compensated for the difficulties imposed by text characteristics by demonstrating that relevance instructions helped readers pay attention to and memorize relevant information in the difficult text as well as in the easy text. However, the post-hoc analyses suggested that the size of relevance effects in the easy text was larger than those of the difficult text.

This study explores why relevance effects were larger in the easy text than those in the difficult text. First, when EFL readers read the difficult text, they were not able to sufficiently engage in strategic processing in accordance with given relevance instructions. In order to comprehend the text, the participants were required to allocate many cognitive resources to lower-level processing, such as lexical and syntactic processing. Since they were not able to allocate enough cognitive resources to strategic processing, relevance effects were smaller in the difficult text. Furthermore, as reflected in the reading time data, EFL readers paid nearly an equal amount of attention to both relevant and irrelevant information while reading the difficult text even when they were given relevance instructions. Consequently, the text recall was less influenced by the text relevance. Another possible reason why the relevance effects in the difficult text were smaller than those in the easy text is that it was easier for EFL learners to identify the relevance of information in the easy text than in the difficult text. In the easy text, where the relevance instructions in the experimental condition asked readers to pay attention to how each bat got its name, the relevant information was explicitly signposted with words such as *because* (e.g.,

Flying foxes are so named *because* their faces are covered with fur like a fox.). In the difficult text, on the other hand, the relevant information was not explicit (see Table 2). Although the explicitness of relevance in the text does not influence text processing during L1 reading (Kaakinen & Hyönä, 2008), whether EFL readers were able to pay additional attention to the relevance of text information depends on the explicitness of relevant information. Specifically, EFL readers tend to judge the relevance of text information from surface linguistic signals, so the effects of relevance instructions were larger in the easy text than those in the difficult text.

Conclusion

Summary of main findings

The purpose of this study was to investigate the effects of relevance instructions on EFL learners' text processing and memories. The effects of relevance instructions had only previously been examined in L1 reading research, and the present study expanded the insight on this topic to include EFL reading settings.

The main findings of the present study can be summarized with the following two points. First, specific relevance instructions affected EFL readers' text processing and text memory. The specific relevance instructions induced participants to pay additional attention to the relevant information; accordingly, their text memory for the relevant information was improved. Second, the size of relevance effects in text processing and memory depends on text difficulty. When participants read the difficult text, they were not able to sufficiently engage in strategic processing and the reading times and text recall were less influenced by the relevance of text information.

The results are partly compatible with the goal-focusing model of relevance (McCrudden & Schraw, 2007), but the present study further demonstrated a number of relevance effects that are specific to EFL learners. First, the study demonstrated that the impact of relevance instructions on EFL readers' text processing and memories could depend on factors specific to the text. In L1 reading, relevance effects are robust and less likely to be influenced by text factors (León et al., 2019). In EFL reading, on the other hand, when the linguistic factors in a text are too complex for the readers' proficiency levels, the effects of linguistic factors exceed relevance effects, and readers do not sufficiently benefit from relevance instructions. Second, even when the relevance effects were found in the text processing and memory, the ways in which specific relevance instructions influence text processing and memory in EFL reading differ from those in L1 reading. Specifically, while L1 readers are able to retain information that is relevant to the specific relevance instructions without increasing their reading times (e.g., McCrudden et al., 2005), EFL readers need to pay additional attention to the relevant sentences to store them in their memories.

Limitations and suggestions for future research

The present study offered a first step towards investigating the effects of relevance instructions in EFL reading comprehension, but there are several topics that should be investigated in future

research. First, it should be noted that it is not possible to generalize the results of how text difficulty alters relevance effects since the study used only two materials. The study suggested that relevance effects might depend on text factors, such as linguistic characteristics in the text and the explicitness of relevant information. Furthermore, relevance effects can depend on the length of the text. The study used relatively short texts because the participants were Japanese EFL learners. However, if the experimental texts were longer, readers would need to engage in more strategic and selective processing in order to distinguish relevant information from irrelevant information. Therefore, replication studies that use varied texts will enable researchers to further investigate the interaction between relevance instructions and text factors. In particular, to precisely investigate the effects of linguistic characteristics in the text, it is possible to compare texts that have the same topics but differ in linguistic characteristics, rather than to compare texts with different topics.

Second, the effects of learners' English reading proficiency levels should be also investigated in future research. Due to the small number of participants, the present study did not consider individual-level factors in the analysis. However, given that the effects of relevance were related to certain individual-level factors such as working memory capacities (Kaakinen et al., 2002), future research needs to include EFL readers who have more varied English proficiency levels.

Finally, future research should combine and compare an eye-tracking study with the reading time method. Although numerous studies have adopted the self-paced reading method (e.g., McCrudden et al., 2005; McCrudden & Schraw, 2010), this method requires participants to press the button after they finish reading each sentence, which might interfere with their natural reading processes. Moreover, self-paced reading methods do not allow us to capture certain reading processes including look-back and rereading. A previous eye-tracking study has explored such processes to show that relevance effects can depend on readers' individual differences (Kaakinen et al., 2002); therefore, an eye-tracking study could offer more informative data about the interactions between readers, texts, and relevance instructions.

Pedagogical implications

The present study's findings have the following pedagogical implications. When EFL students need to complete post-reading tasks, teachers can induce them to engage in goal-focusing processing by using relevance instructions. Without relevance instructions, students are more likely to devote the same amount of attention to all of the text, which leads to inefficient text processing. Especially when reading for academic purposes, students tend to read long texts such as an academic textbook chapter or a research article. Providing students with pre-reading relevance instructions enables them to set a narrow focus and to more systematically read the text.

Furthermore, when teachers use relevance instructions to support students' reading comprehension, they need to consider certain factors specific to the text. If the text seems to be difficult for students, teachers need to reduce the cognitive load for lower-level processing, such as word and syntactic processing, before they offer the relevance instructions. For example, paraphrasing or annotating can reduce the amount of cognitive resources that students devote to

lower-level processing, which consequently leads to more strategic reading wherein they can flexibly control their text processing in accordance with the reading goals.

Notes

[1] In order to confirm that the text order did not affect reading time, 2 (condition: control, experimental) × 2 (relevance: irrelevant, relevant) × 2 (text order: the first reading, the second reading) mixed ANOVAs were conducted. The results indicated that the main effects of text order and the interactions between text order and any other factors were not significant (*p*s > .050). Specifically, regarding the reading time in the easy text, none of the main effect of text order, $F(1, 43) = 0.02$, $p = .904$, $\eta_G^2 < .001$, interaction between text order and relevance, $F(1, 43) = 2.94$, $p = .094$, $\eta_G^2 = .008$, interaction between text order and condition, $F(1, 43) = 0.17$, $p = .684$, $\eta_G^2 = .004$, and interaction between the three factors, $F(1, 43) = 2.76$, $p = .104$, $\eta_G^2 = .007$, were significant. In addition, in the difficult text, none of the main effect of text order, $F(1, 43) = 0.06$, $p = .813$, $\eta_G^2 = .001$, interaction between text order and relevance, $F(1, 43) = 2.35$, $p = .133$, $\eta_G^2 = .006$, interaction between text order and condition, $F(1, 43) = 0.19$, $p = .666$, $\eta_G^2 = .004$, and interaction between the three factors, $F(1, 43) = 0.05$, $p = .826$, $\eta_G^2 < .001$, were significant. Therefore, in the present study, the text order was not included in the analyses.

[2] In addition to the interaction between condition and relevance, the interaction between text and relevance was also significant, $F(1, 45) = 5.66$, $p = .022$, $\eta_G^2 = .007$. However, the result will not be discussed further as this study focused on the relevance effects (i.e., the interaction between relevance and condition).

[3] In order to confirm that the text order did not affect text recall, 2 (condition: control, experimental) × 2 (relevance: irrelevant, relevant) × 2 (text order: the first reding, the second reading) mixed ANOVAs were conducted. The results indicated that the main effects of text order and the interactions between text order and any other factors were not significant (*p*s > .050). Specifically, regarding the text recall in the easy text, none of the main effect of text order, $F(1, 43) = 0.54$, $p = .465$, $\eta_G^2 = .008$, interaction between text order and relevance, $F(1, 43) = 0.26$, $p = .616$, $\eta_G^2 = .002$, interaction between text order and condition, $F(1, 43) = 0.23$, $p = .635$, $\eta_G^2 = .003$, and interaction between the three factors, $F(1, 43) = 0.06$, $p = .814$, $\eta_G^2 = .001$, were significant. Additionally, in the difficult text, none of the main effect of text order, $F(1, 43) = 1.08$, $p = .304$, $\eta_G^2 = .018$, interaction between text order and relevance, $F(1, 43) = 0.002$, $p = .962$, $\eta_G^2 < .001$, interaction between text order and condition, $F(1, 43) = 0.16$, $p = .695$, $\eta_G^2 = .003$, and interaction between the three factors, $F(1, 43) = 0.06$, $p = .812$, $\eta_G^2 < .001$, were significant. Therefore, in the present study, the text order was not included in the analyses.

[4] In addition to the interaction between condition and relevance, the interaction between condition and text, $F(1, 45) = 8.89$, $p = .005$, $\eta_G^2 = .031$, and the interaction between text and relevance, $F(1, 45) = 11.31$, $p = .002$, $\eta_G^2 = .038$, were significant. However, these results will not be discussed further as this study focused on the relevance effects (i.e., the interaction between relevance and condition).

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