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Supporting the Maintenance of Global Coherence With Situational Instruction: Evidence From Eye Movements During EFL Reading

USHIRO, Yuji
University of Tsukuba
HOSODA, Masaya
MORI, Yoshinobu
Graduate School, University of Tsukuba
Japan Society for the Promotion of Science
TADA, Go
Graduate School, University of Tsukuba
KIMURA, Yukino
Dokkyo University
TANAKA, Natsumi
Yamaguchi Prefectural University
NAKAGAWA, Hiroaki
AMAGAI, Yuka
Graduate School, University of Tsukuba

Abstract

An eye-tracking experiment examined whether and how situational instruction that directs readers to mentally visualize texts supports EFL readers' maintenance of global coherence during reading. A total of 49 Japanese university students read narrative texts containing character traits (e.g., *junk food lover/vegetarian*) that were either consistent or inconsistent with character actions (e.g., *ordering a cheeseburger*) in target sentences presented later in the texts. They were instructed first to read for understanding and next to mentally visualize the texts in order to understand the situations in the texts while their eye movements were recorded. The results showed that readers paid more attention to character information when reading under the situational instruction, which consequently led to the construction of elaborated situational mental representations. Due to such increased attention and enriched situation models of character information, the situational instruction led readers to detect global inconsistencies in texts. In contrast, global inconsistencies did not affect look backs into distant prior information. Taken together, these findings confirm that the situational instruction is an effective way of promoting EFL readers' situation-model construction and maintenance of global coherence.

***Keywords*:** EFL reading, global coherence, situation models, situational instruction, eye tracking

Introduction

Successful text comprehension requires that readers construct coherent mental representations of the text, called *situation models* (e.g., Kintsch, 1998). By constructing coherent situation models, readers can maintain coherence of their comprehension at a global level (between the current sentence and distant prior sentences) in addition to at a local level (between adjacent sentences; Tapiero, 2007; Tapiero & Otero, 2002; van der Schoot, Reijntjes, & van Lieshout, 2012). On the other hand, when readers maintain only local and not global coherence, their comprehension may be confined to a narrow part of the text and, thus, remain fragmented.

However, as opposed to local coherence, it is quite difficult for readers who learn English as a foreign language (EFL) to maintain global coherence (Morishima, 2013; Ushiro et al., 2016, Experiment 2). Despite such difficulty, instructions aimed at supporting readers' maintenance of global coherence are quite limited in current EFL educational settings relative to those concentrating on local coherence (e.g., an instruction focusing on a referential or semantic relationship within one or between adjacent sentences). The general goal of the present study was to explore a reading instruction that can assist Japanese EFL learners to maintain global coherence during reading. To achieve this goal, we first review previous research on the maintenance of coherence. We also review an eye-tracking methodology used to objectively assess the maintenance of coherence across sentences during reading. Finally, we discuss a reading instruction that may help EFL readers in achieving global coherence by enriching their situation models.

Detecting Inconsistencies and Maintaining Coherence During Reading

In order to maintain coherence during reading, readers need to monitor consistencies between incoming information and their already established mental representations of texts, thereby continually updating evolving comprehension. One important and necessary first step to this updating process is the detection of inconsistencies when the current information is contradictory to what was previously understood in the text (Zwaan & Radvansky, 1998). The underlying rationale is that inconsistent information is difficult to integrate with the previous context and thus detrimental to the maintenance of coherence. Drawing on this view, researchers have examined readers' maintenance of coherence during reading by using texts that do or do not contain inconsistencies between sentences. This methodology is called the *contradiction paradigm* (e.g., Hakala & O'Brien, 1995; O'Brien, Rizzella, Albrecht, & Halleran, 1998; Poynor & Morris, 2003; Rinck, Gámez, Díaz, & de Vega, 2003; Ushiro et al., 2016; van der Schoot et al., 2012). Table 1 shows an example of an experimental passage. Here, readers read a *target sentence* stating a character's action (e.g., "Mary ordered a popular cheeseburger and French fries") following a consistent or inconsistent character trait (termed *elaborations*; e.g., "Mary always wanted to eat fantastic junk food" or "Mary has been a strict vegetarian for 10 years"). It is assumed that, when readers maintain coherence in their comprehension during reading, they experience comprehension difficulty associated with the coherence break in the inconsistent condition (e.g., Why did a vegetarian want a cheeseburger?). This yields longer reading times in the inconsistent than in the consistent condition (the

inconsistency effect).

Table 1
An Example Passage Used in the Present Study

Section	Text
Introduction:	Mary was meeting a friend for lunch at the restaurant. She arrived early, so she started looking at the menu.
Elaboration:	Mary always wanted to eat fantastic junk food. She would never be serious about her diet. She loved meat and anything cooked with oil. (Consistent) Mary had been a strict vegetarian for 10 years. She was always very serious about her diet. She would not eat anything cooked with oil. (Inconsistent)
Filler:	It had been a few years since Mary and her friend had seen each other. She looked forward to meeting her good friend. Mary waited for her friend for 10 minutes. When her friend arrived, Mary checked the menu again and called the waiter.
Target:	Mary ordered a popular cheeseburger and French fries.
Post-target:	She returned the menu to the young waiter.
Closing:	Her friend also ordered what she wanted. After they had ordered, they began to chat again.

Of primary significance to the present study, past studies (e.g., Hakala & O'Brien, 1995; Long & Chong, 2001; Morishima, 2013; Ushiro et al., 2016; van der Schoot et al., 2012) have investigated the levels of coherence (local vs. global) that readers can maintain during reading by manipulating distances between contradictory character information (i.e., elaborations, target sentences). Hakala and O'Brien (1995) inserted one to three (*local* condition) or six (*global* condition) filler sentences between elaborations and target sentences to examine first-language (L1) college readers' maintenance of local and global coherence, respectively. In the local condition, character traits in elaborations are assumed to be kept active in working memory and, therefore, are available for maintaining coherence when readers encounter target sentences. In the global condition, on the other hand, character traits are no longer available in working memory at the point where target sentences are read, because readers have to process a substantial amount of information contained in longer fillers before reading target sentences. In other words, detecting inconsistencies in the global condition (termed *global inconsistencies* hereafter) requires readers to represent prior character traits in situation models that are stored in long-term memory and reactivate them when reading target sentences. Hakala and O'Brien revealed that L1 college readers took longer times to read inconsistent than consistent target sentences both in the local and global conditions. This finding suggests that L1 adult readers maintain global as well as local coherence during reading.

In the context of EFL reading, studies using the contradiction paradigm to examine the maintenance of coherence are quite limited compared to L1 reading. Nevertheless, a few demonstrated that detecting global inconsistencies is more difficult for EFL readers than detecting local inconsistencies. Morishima (2013) conducted a series of experiments in which Japanese university students read narrative texts sentence by sentence at their own pace. The results showed that, when elaborations and target sentences were adjacent to each other, reading times for target sentences were longer in the inconsistent than in the consistent

condition. However, no such inconsistency effect manifested when elaborations and target sentences were separated by a single filler sentence. Morishima reasoned that EFL readers' basic reading skills (e.g., word decoding, syntactic analyses) are less automatized than in L1 readers, and consequently, processing associated with those skills competes and draws limited cognitive resources from higher-level processing, such as maintaining global coherence.

Although these findings are informative, researchers point out that the sentence-by-sentence reading methodology adopted in Morhishima (2013) may make detecting inconsistencies unreasonably difficult with increased memory demands on readers; because only one sentence is presented at a time, readers are unable to look back to previous sentences (Rinck et al., 2003; Ushiro et al., 2016). To overcome this methodological limitation, recent research applies eye-tracking measures to more objectively assess the inconsistency effect on moment-by-moment reading processes (Poynor & Morris, 2003; Rinck et al., 2003; Ushiro et al., 2016; van der Schoot et al., 2012). Specific advantages of the use of eye tracking to expose the detection of inconsistencies during reading are that (a) readers do not need to engage in a secondary task (e.g., button presses in sentence-by-sentence reading) that may compromise natural reading; (b) readers are free to look back to and from wherever and whenever they want, because texts are presented in their entirety; and (c) initial and later reading processes are distinguishable (Hyönä, Lorch, & Rinck, 2003; Rayner, Chace, Slattery, & Ashby, 2006).

Ushiro et al. (2016, Experiment 2) studied Japanese EFL readers' detection of inconsistencies during reading using such eye-tracking measures as *first-* and *second-pass reading times* for target sentences and *look backs* into elaborations. First-pass reading times for target sentences are defined as the sum of all fixation durations during the first reading of target sentences before moving on or moving back to another sentence. This measure is indicative of initial reading processes, including readers' immediate detection of inconsistencies in texts. Second-pass reading times are defined as the sum of the fixation durations for a target sentence that occur after at least one other sentence was fixed on following the first-pass reading. This indicates later reading processes, which are strategic in nature, such as integration of character actions with prior character traits from long-term memory. In addition, they also analyzed look backs into elaborations, which are registered when at least two fixations occur in elaborations after target sentences are read. This reflects later reading processes, such as reanalysis or repair of comprehension.

In the experiment, 32 Japanese university students (21 were analyzed) read narratives in which local and global coherence were operationalized by inserting one (local condition) or four (global condition) sentences between elaborations and target sentences. The results showed that local inconsistencies increased the number of participants who looked back to elaborations compared to when texts contained no inconsistency, suggesting that look backs are a good indicator of the detection of local inconsistencies. In the global condition, on the other hand, none of the above eye-movement measures were influenced by global inconsistencies. This result confirmed that EFL readers have difficulty maintaining global coherence during reading.

Effects of Situational Instruction on the Construction of Situation Models

As reviewed thus far, it is more difficult for EFL readers to maintain global coherence during reading relative to local coherence. It has been proposed that one reason for this is that those readers have difficulty constructing rich situation models of texts and, as a result, fail to sufficiently reactivate relevant prior information during reading (Tapiero, 2007; Tapiero & Otero, 2002; van der Schoot et al., 2012). Van der Schoot et al. (2012) empirically proved this view by showing that less-skilled L1 students, who could not detect global inconsistencies during reading, performed significantly more poorly on a post-reading task pertaining to the situational content of texts compared to skilled students. They concluded that less-skilled readers were not able to represent character traits, actions, and events described in texts in situation models, which made them insensitive to global inconsistencies.

To alleviate less-skilled readers' difficulty, researchers have sought to elucidate the effectiveness of a reading instruction that explicitly directs readers how to address texts (Horiba, 2013; van der Schoot, Horsley, & van Lieshout, 2010). To avoid confusion, we should note here that we use the word *instruction* in the sense of a direction to do something rather than teaching knowledge or a task. One reading instruction that has widely been examined in terms of supporting situation-model construction is having readers imagine or mentally visualize situations described in texts (e.g., Horiba, 2013; van der Schoot et al., 2010). This is referred to as *situational instruction* (see de Koning & van der Schoot, 2013, for a review). In theoretical terms, the effectiveness of situational instruction can be explained by the character that assists readers in placing themselves within the story. Considerable research has evidenced that a richly elaborated situation model is constructed by readers' mentally situating themselves within the narrated situation rather than outside of it (de Koning & van der Schoot, 2013; Zwaan, 1999). Such a "mental leap into the imagined world" (Zwaan, 1999, p. 15) aids understanding of relations among ideas, events, and characters in texts, facilitating the construction of robust mental representations. For example, in van der Schoot et al.'s (2010) experiment, 38 L1 elementary school students were instructed to "imagine the events and developments described in the story" (p. 819) so that they could situate themselves in the middle of the story. The results from sentence reading times revealed that, when given the situational instruction, poor comprehenders allocated more cognitive resources to constructing situation models than when they were given a standard instruction to read for understanding.

With Japanese EFL readers, Horiba (2013) reported beneficial effects of situational instruction (termed the *image* condition in her study) on during-reading processes based on think-aloud protocol data. When given an instruction to "visualize in their minds events, actions and situations that are described in the text" (p. 102), Japanese university students exhibited think-aloud comments indicative of integrative or inferential processing relevant to situation-model construction. This indicates that situational instruction can orient EFL readers toward situational understanding of texts rather than letting them settle for surface-level understanding (e.g., literal interpretation of individual words or sentences). Collectively, past research has proven that instructing readers to mentally visualize texts is an effective way of promoting their situation-model construction. When considering the view that representing relevant information in situation models is a prerequisite for detecting global inconsistencies

during reading (Tapiero & Otero, 2002; van der Schoot et al., 2012), it can be assumed that situational instruction may support EFL readers in their detecting of global inconsistencies in texts, thereby assisting their maintenance of global coherence during reading. We designed the present study to address this possibility.

The Present Study

The goal of the present study was to explore whether and how situational instruction that directs readers to mentally visualize situations in texts assists EFL readers' maintenance of global coherence during reading. To this end, we drew on the contradiction paradigm and examined whether and how such situational instruction supports EFL readers in their detection of global inconsistencies. We compared EFL readers' processes under situational instruction against processes under more standard instruction (i.e., read for understanding). As for the methodology, we adopted eye-tracking measures to objectively assess the impact of situational instruction on during-reading processes. In particular, we focused on processes associated with character information (i.e., elaborations, target sentences) that was relevant to the textual consistencies. The following three research questions (RQs) were addressed:

RQ1: Does situational instruction increase EFL readers' overall attention devoted toward character information as reflected in their total reading times for elaborations and target sentences?

RQ2: Does situational instruction promote EFL readers' detection of global inconsistencies in texts as reflected in their first- and second-pass reading times for target sentences?

RQ3: Does situational instruction promote EFL readers' detection of global inconsistencies in texts as reflected in their look backs into elaborations?

RQ1 was intended to examine whether situational instruction makes EFL readers more attentive toward character information compared to standard instruction to obtain an overall picture of the impact of situational instruction on during-reading processes. RQ2 and RQ3 were intended to specifically explore whether situational instruction is advantageous over standard instruction in facilitating EFL readers' detection of global inconsistencies by focusing on processes with respective parts of character information (i.e., traits, actions).

Method

Participants

A total of 49 Japanese university students aged 18 to 24 (average = 19.98) participated in the experiment (19 males and 30 females). All of them had normal or corrected-to-normal visual acuity. We analyzed data from 28 participants whose eye recordings were sufficiently accurate. Participants were native speakers of Japanese and had learned English for more than six years in Japanese formal education. Their majors were diverse, including education, engineering, environmental sciences, humanities, international studies, and medicine. Participants' English proficiency was estimated to be at an intermediate to upper-intermediate level according to their self-report on the EIKEN grade (third to pre-first grade), TOEIC test scores (550 to 850), and TOEFL ITP test scores (490 to 607).

Materials

Texts. A total of 14 narrative passages were derived from previous studies using the contradiction paradigm (e.g., Hakala & O'Brien, 1995; Ushiro et al., 2016). A sample passage is shown in Table 1. Eight of them were used as experimental texts, four as fillers, and the remaining two as practice texts (see the procedure section). We modified these texts such that they exclusively consisted of high-frequency words (level 4 or less on the *JACET 8000* list; Japan Association of College English Teachers [JACET], 2003) in order to focus on participants' discourse-level processes without having them experience much trouble with lexical-level processes. Table 2 shows the number of words and readability in each condition.

Table 2
Features of Experimental Texts as a Function of Consistency Conditions

	Consistent		Inconsistent	
	M	*SD*	*M*	*SD*
Words	127.75	6.63	128.38	5.58
FKGL	4.81	1.02	4.91	1.03

Note. Standard deviations are in parentheses. FKGL = Flesch-Kincaid grade level, calculated with Microsoft Word 2013.

As in the example, the texts had six sections: an *introduction* (two sentences) introducing a main character of the story, an *elaboration* (three sentences) describing the character traits that were either consistent or inconsistent with target sentences, a *filler* (four sentences) intervening between elaborations and target sentences, a *target sentence* stating a character's action relevant to the prior traits, a *post-target sentence* describing another action of the character unrelated to the consistency with elaborations, and a *closing* (two sentences) concluding the story. It should be noted that target sentences were always placed distant from elaborations with four filler intervening sentences (about 40 words) to ensure that character traits in elaborations were not active in working memory when encountering target sentences. Detecting inconsistencies in these texts therefore required participants to reactivate preceding character traits from their situation models stored in their long-term memory (van der Schoot et al., 2012).

There were consistent and inconsistent conditions in the experimental texts as a function of the consistencies between elaborations and target sentences. (Filler and practice texts were presented only in the consistent condition.) In the consistent condition, character traits in elaborations (e.g., "Mary always wanted to eat fantastic junk food") were compatible with actions in target sentences (e.g., "Mary ordered a popular cheeseburger and French fries"). In the inconsistent condition, on the other hand, character traits in elaborations were contradictory (e.g., "Mary had been a strict vegetarian for 10 years") to target sentences.[1] The number of words and readability (Flesch-Kincaid grade level) were adjusted to be as close as possible between the consistency conditions. The sections other than elaborations and target sentences were not related to the consistencies.

Finally, each text was accompanied by a yes–no comprehension question querying

information in the introduction or closing section (e.g., "Was Mary meeting her husband for lunch?") to keep participants from reading carelessly.[2] Half of the questions had a correct answer of "yes" and the other half "no." We constructed four material sets, each containing two texts in each of the four conditions crossing 2 × 2 (Instruction [standard, situational] × Consistency [consistent, inconsistent]) factors based on a Latin-square procedure. Across these sets, each passage occurred once in each of the four conditions.

Questionnaire. We developed four questionnaire items using a 5-point Likert scale (1 = *disagree*, 2 = *generally disagree*, 3 = *neither agree nor disagree*, 4 = *generally agree*, 5 = *agree*). The items specifically fell into two types: those examining the understandability and the workability of the situational instruction (Item 1 "Was the instruction to mentally visualize situations in texts while reading easy to understand?" and Item 2 "Could you actually visualize situations in texts while reading?") and those examining the effectiveness of the situational instruction (Item 3 "Could you concentrate more when you were instructed to visualize texts compared to when instructed to read for understanding?" and Item 4 "Was the instruction to mentally visualize situations in texts helpful for deepening comprehension of texts?"). Items 3 and 4 also had a free description space to allow participants to write down specific explanations of their answers.

Apparatus and Procedure

The experiment was conducted from July to September in 2015. Participants were tested individually for approximately 1 hour. Before the experiment, we first explained the purposes and the overall procedures of the study and obtained informed consent (approved by the research ethics committee of University of Tsukuba). Participants' eye movements were recorded with EMR 9 by nac Image Technology Inc. (Tokyo, Japan). Participants sat approximately 55 cm from a 21.5-inch computer screen and put their chins and foreheads on a chinrest to prevent head movements. From this distance, about two letters corresponded to 1° of the visual angle. The eye tracker was calibrated using a standard nine-point grid before text reading. The texts were shown on the screen in 14-pt Times New Roman font using SuperLab 4.5 (Cedrus, U.S.). The entire passage was presented at once, in which each sentence was aligned on a new line with line spaces in between.

Participants read 12 passages in a random order. Six of these passages were provided in the standard instruction condition and the other six in the situational-instruction condition. In the standard condition, participants were instructed to read texts for understanding. After finishing reading under the standard condition, the situational instruction was provided; participants were instructed to mentally visualize the texts while reading in order to comprehend the situation described there. The specific instruction was, "The purpose of reading this time is to understand the situation described in texts. To this end, please mentally visualize characters' traits, actions, and events in texts as vividly as possible while reading." Participants familiarized themselves with each instruction by reading one practice passage each. It is also important to note that the situational condition always came after the standard condition; if it had preceded the standard instruction, the instruction to visualize texts could have potentially affected the subsequent reading under the standard condition that was

supposed to be natural one.

Each text was displayed by pressing a key on the response pad (RB-730 model, Cedrus, U.S.) after the signal "Ready?" Participants read the text silently at their own pace and pressed the "yes" key when finished. Each text was followed by a comprehension question, to which participants were asked to answer by pressing a "yes" or "no" key. In response to the answer, feedback was given to inform participants of whether the answer was correct or not. After reading all texts, participants took the questionnaire.

Scoring and Data Analysis

Eye-tracking data. From the data of both eyes, the more accurate one (usually the data from the right eye) was used for the analysis. Fixation durations longer than $M + 3\ SD$ in each experimental condition were substituted by the value of $M + 3\ SD$ (1.89% of the data set). We then aggregated fixation durations in each sentence to yield total fixation durations for the corresponding sentence, which in turn were converted to milliseconds (ms) per syllable to account for differences in sentence length (Hyönä et al., 2003; Rinck et al., 2003).

We examined eye-movement data focusing on the following areas of interest: (a) the combination of elaborations and target sentences (elaboration + target) regarding character information relevant to the textual consistencies, (b) target sentences, and (c) elaborations. First, for elaboration + target, total reading times were computed to explore how participants were attentive to character information (van der Schoot et al., 2010). Total reading times are defined as the sum of all fixation durations spent in a region, indicating total amount of attention paid by readers toward that region during reading (Hyönä et al., 2003). Second, for target sentences, first- and second-pass reading times, indicative of initial and later reading processes, respectively, were analyzed to examine readers' detection of global inconsistencies during reading (Poynor & Morris, 2003; Ushiro et al., 2016). It is assumed that, when readers immediately detect inconsistencies upon encountering target sentences, first-pass reading times should take longer with textual inconsistencies. On the other hand, when textual inconsistencies cause readers to experience difficulty with the integration of target sentences with prior elaborations, second-pass target reading times should increase. Finally, we examined participants' look backs into elaborations that occurred after participants fixated on target sentences at least once. Look backs into elaborations are assumed to increase when readers feel doubts about their comprehension with inconsistencies and try to confirm it by referencing prior information.

Results

Questionnaire

First, we analyzed questionnaire results to examine whether the situational instruction worked as intended for the present participants (see Table 3). We conducted chi-squared tests, comparing the number of participants who marked 4 (*generally agree*) or 5 (*agree*) and those who marked 3 (*neither agree nor disagree*) or below for each item. To Items 1 and 2, significantly more participants rated 4 or 5 than 3 or less, indicating that participants generally admitted that they managed to mentally visualize texts during reading. The same result held for Items 3 and 4 (see the lower two rows in Table 3), suggesting that participants recognized

that the situational instruction was effective and helpful for deep text comprehension. The perceived effectiveness of the situational instruction was accompanied by the following typical answers provided in the free description space: "Text contents were more easily understandable with the situational instruction as story situations were made clearer" (17 participants [61%]), "Understanding of an character in each situation improved" (16 participants [57%]), and "Texts were better remembered because situations were understood as images rather than linguistic information" (10 participants [36%]). Combined, the questionnaire results provided subjective evidence that participants generally recognized that (a) the situational instruction was helpful to better understand the situation in the text, and (b) they actually visualized text situations during reading.

Table 3
Results of Questionnaire Regarding the Understandability (Item 1), Workability (Item 2), and Effectiveness (Items 3 and 4) of the Situational Instruction (N = *28)*

	Scale 4 or above	Scale 3 or below	$\chi^2(1)$	p	Cramer's V
Item 1	24 (86%)	4 (14%)	14.29	< .001	.71
Item 2	26 (93%)	2 (7%)	20.57	< .001	.86
Item 3	21 (75%)	7 (25%)	7.00	.008	.50
Item 4	24 (86%)	4 (14%)	14.29	< .001	.71

Note. The percentages of participants are in parentheses.

Eye-Tracking Data

Fixation durations of eye-tracking data were analyzed with 2 × 2 (Instruction [standard, situational] × Consistency [consistent, inconsistent]) two-way repeated analyses of variance (ANOVAs). We interpreted the results by combining statistical tests with corresponding effect sizes and confidence intervals (CIs), as recommended by Plonsky (2015).

Total reading times for elaborations and target sentences (RQ1). Descriptive statistics of total reading times for elaboration + target are presented in Table 4. To examine whether the amount of readers' attention invested toward character information varied between the conditions, total reading times were analyzed with the two-way ANOVA. It was revealed that total reading times were longer in the situational than in the standard condition, as indicated by a main effect of the instruction, $F(1, 27) = 15.24$, $p = .001$, $\eta^2 = .07$. It was thus shown that participants processed character information more carefully when reading under the situational than under the standard instruction. In addition, total reading times were longer in the inconsistent than in the consistent condition with a significant consistency main effect, $F(1, 27) = 17.59$, $p < .001$, $\eta^2 = .03$. The Instruction × Consistency interaction was not significant,[3] $F(1, 27) = 1.14$, $p = .295$, $\eta^2 = .01$.

Table 4
*Total Reading Times (ms) for Elaboration + Target (*N *= 28)*

	Standard			Situational		
Consistency	*M*	95% CI	*SD*	*M*	95% CI	*SD*
Consistent	319	[267, 371]	140	389	[326, 451]	168
Inconsistent	355	[291, 420]	174	467	[400, 535]	183

First- and second-pass reading times for target sentences (RQ2). Table 5 shows descriptive statistics of first- and second-pass reading times for target sentences. To examine whether readers immediately detected global inconsistencies upon encountering target sentences, we submitted first-pass target reading times to the two-way ANOVA. The results revealed that participants took longer in the inconsistent than in the consistent condition, $F(1, 27) = 5.10$, $p = .032$, $\eta^2 = .02$, and also longer in the situational than in the standard condition, $F(1, 27) = 6.81$, $p = .015$, $\eta^2 = .05$, during the first-pass reading of target sentences. In contrast, the Instruction × Consistency interaction failed to reach significance, $F(1, 27) = 1.32$, $p = .261$, $\eta^2 = .01$. However, a closer look at mean reading times and 95% CIs suggests that the observed main effect of the consistency was mostly guided by increased reading times in the Situational × Inconsistent condition. In the situational condition, mean reading times in the inconsistent condition (304 ms) did not fall within the CI in the consistent condition [205, 284] and vice versa (see also Figure 1). This indicates that there was reliable difference in reading times as a function of the textual consistencies in the situational condition (Plonsky, 2015). In the standard condition, on the other hand, the mean reading time in the inconsistent condition (232 ms) fell within the CI in the consistent condition [181, 254] and vice versa, indicating that there was no reliable difference in reading times between the consistency conditions. This interpretation on the basis of CIs suggests that participants detected global inconsistencies more in the situational condition than in the standard condition.

Table 5
*First- and Second-Pass Reading Times (ms) for Target Sentences (*N *= 28)*

	Standard			Situational		
Consistency	*M*	95% CI	*SD*	*M*	95% CI	*SD*
			First-pass reading times			
Consistent	217	[181, 254]	99	245	[205, 284]	106
Inconsistent	232	[191, 273]	110	304	[252, 356]	141
			Second-pass reading times			
Consistent	20	[4, 36]	44	18	[-13, 49]	83
Inconsistent	37	[14, 60]	62	138	[82, 194]	151

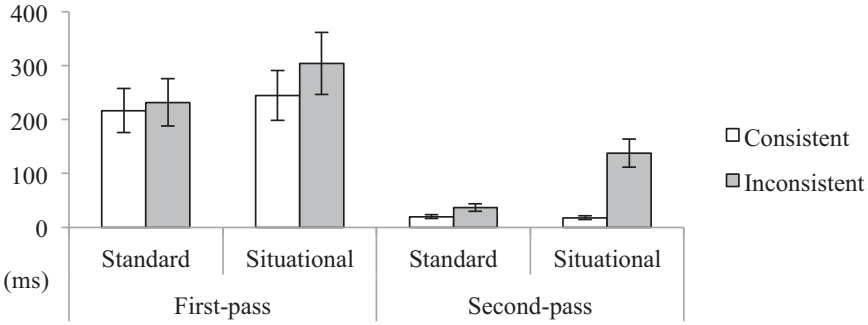

Figure 1. Means of first- and second-pass reading times for target sentences (±SEM bars).

Next, to examine whether the inconsistency effect manifested in later reading processes, we analyzed second-pass reading times for target sentences. First, following past research (e.g., van der Schoot et al., 2012), we calculated the number of participants who did or did not show second-pass reading in each condition. It was found that, when given the situational instruction, the number of participants who did second-pass target reading significantly increased when texts contained inconsistencies as opposed to when texts did not (21 vs. 3 participants [75% vs. 11%]), $\chi^2(1) = 23.63$, $p < .001$, $\varphi = 0.65$. However, such an inconsistency effect was not found in the standard condition (10 vs. 7 participants [36% vs. 25%]), $\chi^2(1) = 0.76$, $p = .383$, $\varphi = 0.12$. It was therefore revealed that the situational instruction led more participants to reread target sentences to reprocess character actions relevant to textual inconsistencies, but the standard instruction did not. Additionally, the two-way ANOVA on second-pass reading times showed a significant Instruction × Consistency interaction with a medium effect size, $F(1, 27) = 8.97$, $p = .006$, $\eta^2 = .06$, as well as main effects of the instruction, $F(1, 27) = 11.17$, $p = .002$, $\eta^2 = .06$, and the consistency, $F(1, 27) = 12.61$, $p = .001$, $\eta^2 = .11$. A follow-up test on this interaction revealed that participants exhibited significantly longer second-pass target reading times in the inconsistent than in the consistent condition when given the situational instruction with a large effect size, $F(1, 27) = 12.01$, $p = .002$, $\eta^2 = .20$ (see Figure 1). On the other hand, the inconsistency effect did not appear in the standard condition, $F(1, 27) = 2.09$, $p = .160$, $\eta^2 = .03$. This interactive effect coupled with the increased number of participants doing second-pass target reading with textual inconsistencies supports the idea that the situational instruction promoted participants' detection of global inconsistencies with an effect on later reading processes.

Look backs into elaborations (RQ3). To explore whether the inconsistency effect appeared in reading processes with elaborations, we analyzed look backs into elaborations. First, we found that global inconsistencies did not increase the number of participants who looked back to elaborations either in the standard (13 vs. 8 participants [46% vs. 29%]), $\chi^2(1) = 1.91$, $p = .168$, $\varphi = 0.18$, or in the situational condition (12 vs. 10 participants [43% vs. 36%]), $\chi^2(1) = 0.30$, $p = .584$, $\varphi = 0.07$. The ANOVA on look-back durations yielded only a consistency main effect with longer durations in the inconsistent than in the consistent condition (see

Table 6), $F(1, 27) = 8.10$, $p = .008$, $\eta^2 = .04$. Neither the main effect of the instruction, $F(1, 27) = 2.78$, $p = .107$, $\eta^2 = .02$, nor the Instruction × Consistency interaction, $F(1, 27) = 1.33$, $p = .259$, $\eta^2 = .01$, was significant. Thus, as opposed to second-pass target reading times, look backs into elaborations failed to support the advantage of the situational instruction in facilitating participants' detection of global inconsistencies.

Table 6
*Look-Back Durations (ms) Into Elaborations (*N = *28)*

	Standard			Situational		
Consistency	*M*	95% CI	*SD*	*M*	95% CI	*SD*
Consistent	15	[2, 28]	34	17	[4, 31]	35
Inconsistent	24	[10, 37]	35	53	[15, 91]	98

Discussion

Instruction Effect on Overall Attention to Character Information (RQ1)

Readers in the situational condition exhibited significantly longer total reading times for character information (i.e., elaboration + target) relative to the standard condition. Because total reading times are assumed to increase as a function of the amount of readers' attention devoted during reading (e.g., Hyönä et al., 2003), readers were supposed to pay an increased amount of attention toward character information when given the situational instruction. This finding from eye-tracking measures also meshes with the fact that the majority of readers reported in the questionnaire that they concentrated more on texts when reading under the situational instruction than when reading under the standard instruction. These results can be explained in terms of the following two perspectives.

First, it may be that the situational condition led readers to more carefully or strategically monitor what they were reading. This is mainly because the situational instruction gave readers a more specific reading goal of understanding situations in texts as opposed to the standard instruction, which only generally asked readers to read for understanding. Due to this, readers under the situational instruction supposedly needed to more carefully monitor the consistencies of character traits and actions in order to appropriately visualize situations in texts. It may be, then, that the situational instruction caused readers to have a more careful mindset toward textual descriptions as well as their own comprehension, resulting in increased attention toward character information pertinent to the situational instruction.

Second, the situational instruction might deepen the level of comprehension that readers strived to achieve. Specifically, the situational instruction required readers not only to understand individual meaning of words or phrases per se but also to integrate those text elements into a coherent mental image (de Koning & van der Schoot, 2013; van der Schoot et al., 2012). As demonstrated in Horiba (2013), such higher need for deeper understanding might keep readers from being satisfied with literal interpretation of explicit information while simultaneously orienting them toward the situational understanding of texts. In order to construct situation models, readers need to engage in additional higher-level processes, such as inference generation and associations with prior knowledge (e.g., van der Schoot et al.,

2010; Zwaan, 1999). The increased total reading in the situational condition might reflect these deeper processes.

Most important, the finding that readers were more attentive toward character information under the situational instruction might relate to the observed inconsistency effects, as discussed in the following section.

Instruction Effect on Coherence-Maintaining Processes for Target Sentences (RQ2)

The increased first- and second-pass target reading times in the inconsistent condition, as compared to the consistent condition, showed that readers detected global inconsistencies during reading under the situational instruction. Additionally, it was only in the situational condition that a significantly greater number of readers showed second-pass target reading in the inconsistent than in the consistent condition. Taken together, these results suggest that the situational instruction promoted readers' detection of global inconsistencies with an effect on both initial and later reading processes. As to initial reading processes (reflected in first-pass reading times), probably because readers were more attentive toward character information in the situational condition (as discussed in RQ1), their mental representations of that information were enriched. This presumably provided access to reactivate prior character traits (Tapiero & Otero, 2002; van der Schoot et al., 2012). On the other hand, regarding later reading processes (reflected in second-pass reading times), readers under the situational instruction more carefully or strategically monitored the consistencies of character information. They consequently experienced difficulty integrating target sentences with inconsistent elaborations.

Specifically, through these initial and later reading processes, the situational instruction facilitated readers' detection of global inconsistencies by aiding their construction of situation models of character information relevant to the consistencies. This might at least partially result from the increased attention devoted toward character information discussed in RQ1. This view is supported by the questionnaire result showing that the majority of readers admitted the effectiveness of the situational instruction on deepening comprehension. Some of them provided specific explanations for this facilitative effect (e.g., "Understanding of a character in each situation improved" and "Texts were better understood because situations were understood as images rather than linguistic information"), suggesting that they themselves recognized that the situational instruction contributed to elaborating on their situational understanding of texts. The constructed situation models can serve as a cue to retrieve prior relevant information (character traits in elaborations in the present case) in readers' long-term memory (Tapiero & Otero, 2002). As a result, readers became more sensitive to global inconsistencies under the situational than under the standard instruction. Accordingly, the findings converge to propose that the situational instruction promoted EFL readers' detection of global inconsistencies by positively impacting their attention toward information relevant to inconsistencies and their resulting situation models.

Instruction Effect on Coherence-Maintaining Processes for Elaborations (RQ3)

As for processes with elaborations, the situational instruction failed to promote inconsistency detection concerning that part of texts. This is reflected in the absence of the

instruction effect as well as the Instruction × Consistency interaction on the number of participants who looked back to elaborations and the corresponding fixation durations. This finding is somewhat incompatible with the target-sentence results showing that readers were more aware of global inconsistencies under the situational than under the standard instruction. A possible explanation concerns the long distance that the present participants had to travel to look back to elaborations (at least five sentences from target sentences to the latest elaborative sentence). Rayner et al. (2006) pointed out that look backs usually occur within relatively short distances, and it is only when readers "are fairly accurate in finding that portion of the text where their understanding went astray" (p. 250) that they look back to distant prior information. Indeed, Ushiro et al. (2016, Experiment 2) found the inconsistency effect on look backs only in the local condition where target sentences and elaborations were separated by a single sentence. From this perspective, look backs into distant prior elaborations might be less likely compared to the second-pass target reading that occurred within a relatively short area.

In addition, it seems reasonable to consider that, because readers' situation models were enriched by the situational instruction, there was less need for them to overtly look back to elaborations. More specifically, provided that readers sufficiently represented character traits in situation models during the initial reading of elaborations, it should be possible for them to detect global inconsistencies by reactivating that information from long-term memory without physically looking back to elaborations (Tapiero, 2007; van der Schoot et al., 2012). Actually, van der Schoot et al. (2012) reported that readers who constructed rich situation models of relevant information rarely looked back to elaborations despite the fact that they successfully detected global inconsistencies. Thus, combining the results of target sentences and elaborations from this point of view, it can be assumed that situation models of character information, constructed during reading under the situational instruction, provided retrieval access to prior relevant information and allowed readers to effectively reactivate it without necessarily looking back to the corresponding part of texts (Tapiero & Otero, 2002; van der Schoot et al., 2012).

Conclusion

The goal of the present study was to investigate whether and how instructing EFL readers to mentally visualize situations in texts supports their maintenance of global coherence during reading. The results from the present eye-tracking experiment can be summarized into three points. First, the situational instruction made EFL readers more attentive toward relevant character information, as indicated by longer total reading times for elaboration + target in the situational than in the standard condition (RQ1). Second, at least partly due to such increased attention toward and enriched situation models of character information, the situational instruction led EFL readers to detect global inconsistencies in texts; they showed longer first- and second-pass reading times for target sentences in the inconsistent than in the consistent condition (RQ2). Finally, EFL readers were found less likely to look back to distant prior information (i.e., elaborations) than to immediate prior information (i.e., target sentences) when they were provided with the strategic reading instruction and contradictory information was distanced to each other (RQ3).

These findings might have some pedagogical implications. It has been shown to be difficult for EFL readers to maintain global coherence by themselves during reading (e.g., Morishima, 2013; Ushiro et al., 2016). Given the view that representing relevant information in situation models is a necessary condition for detecting global inconsistencies during reading (e.g., van der Schoot et al., 2012), the situational instruction used in this study can be considered to help the present participants enrich situation models of relevant information, thereby allowing more successful detection of global inconsistencies during reading. Therefore, the present study, along with others (Horiba, 2013; van der Schoot et al., 2010), confirms that instructing students to mentally visualize text situations is a powerful way of assisting their situation-model construction. The enriched situation models can in turn support their maintenance of global coherence during reading. This is an important implication given the scarcity of reading instructions in EFL settings that can effectively assist students' situational understanding of texts and their global coherence in comprehension as opposed to instructions focusing on local coherence.

Further, the situational instruction in this study was found to be relatively easy to understand and implement for participants; actually, the instruction proved to be effective without any intensive or long-term training to teach readers how to employ given strategies (see McNamara, 2004, for example). Considering the classroom settings, such understandability and workability of the instruction are particularly instrumental; otherwise, students' comprehension may suffer as difficult-to-understand instructions can increase cognitive demands on the part of students.

At the same time, it should also be noted that these implications are based on the present experimental environment where university students, who are supposedly relatively fluent in lower-level processing, read simplified narrative texts. If readers have much trouble with interpreting individual words or phrases, for example, constructing coherent situational understanding of texts would be quite difficult even when required by the instruction because they should be cognitively highly demanded in lower-level processing. Additionally, visualizing contents of abstract or unfamiliar texts would be much more difficult than the present ones, which dealt with characters' every-day experiences. In these cases, it is primarily important to train students' basic reading skills (e.g., lexical and syntactic knowledge) and/or provide background information about texts to scaffold them for higher-level processing, including construction of situation models and maintenance of global coherence. In this line, it merits future studies to examine relative contributions of higher-, and lower-level processing to maintaining global coherence and the effectiveness of situational instruction under resource-demanding conditions.

As for the methodological issues, this study suggests that researchers have to carefully select and interpret eye-tracking measures that well reflect processes of interest. In Ushiro et al. (2016, Experiment 2), where no strategic reading instruction was given, look backs into elaborations were better indicative of EFL readers' detection of local inconsistencies than other measures. However, this was not the case for the present experiment where contradictory information was distanced and strategic reading instruction was provided. Eye-tracking studies should accordingly consider various factors associated with readers, texts, instructions, and interactions between them.

In addition, as a limitation of eye-tracking measures, it is important to note that, although eye-movement data offer a dynamic account of cognitive processes as readers proceed through texts, they provide only indirect insights into the actual process that occurs at a specific point in time. To deal with this, it is necessary to compare results of eye movements and think-aloud protocols that may assess contents of the processes employed by readers (see Kaakinen & Hyönä, 2005 for the combined use of eye tracking and a think aloud method).

Finally, post-reading tasks that directly measure readers' situation models can supplement the present findings. Measures of situation models include inference questions requiring readers to integrate text ideas and their background knowledge and having them explain the situations in texts in their own words (see Goldman, 1997, for a review). Combining processing during reading and products after reading would provide us with a more comprehensive picture of EFL readers' discourse-level understanding.

Notes

[1] The consistency conditions were piloted in Ushiro et al. (2016) where 18 Japanese university students reported on a 7-point scale that target sentences were less plausible in the inconsistent (M = 1.64, SD = 0.40) than in the consistent condition (M = 5.65, SD = 0.28).

[2] Overall performance (proportion correct) on comprehension questions was high (M = .95, SD = .22), confirming that participants understood texts across the conditions (Standard × Consistent: M = .93, SD = .18; Standard × Inconsistent: M = .95, SD = .16; Situational × Consistent: M = .95, SD = .16; Situational × Inconsistent: M = .98, SD = .09).

[3] The CIs indicate that total reading time differences between the consistency conditions were greater in the situational than in the standard condition. However, we decided not to elaborate on this effect because effects of the consistency and the interaction were less relevant to RQ1 than the instruction effect.

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References

de Koning, B. B., & van der Schoot, M. (2013). Becoming part of the story! Refueling the interest in visualization strategies for reading comprehension. *Educational Psychology Review*, *25*, 261–287. doi:10.1007/s10648-013-9222-6

Goldman, S. R. (1997). Learning from text: Reflections on the past and suggestions for the future. *Discourse Processes*, *23*, 357–398. doi:10.1080/01638539709544997

Hakala, C. M., & O'Brien, E. J. (1995). Strategies for resolving coherence breaks in reading. *Discourse Processes*, *20*, 167–185. doi:10.1080/01638539509544936

Horiba, Y. (2013). Task-induced strategic processing in L2 text comprehension. *Reading in a Foreign Language*, *25*, 98–125. Retrieved from http://nflrc.hawaii.edu/rfl

Hyönä, J., Lorch, R. F., Jr., & Rinck, M. (2003). Eye movement measures to study global text processing. In J. Hyönä, R. Radach, & H. Deubel (Eds.), *The mind's eye: Cognitive and applied aspects of eye movement research* (pp. 313–334). Amsterdam, Netherlands: Elsevier Science.

JACET. (2003). *JACET list of 8000 basic words*. Tokyo, Japan: Author.

Kaakinen, J. K., & Hyönä, J. (2005). Perspective effects on expository text comprehension: Evidence from think-aloud protocols, eyetracking, and recall. *Discourse Processes*, *40*, 239–257. doi:10.1207/s15326950dp4003_4

Kintsch, W. (1998). *Comprehension: A paradigm for cognition*. Cambridge University Press.

Long, D. L., & Chong, J. L. (2001). Comprehension skill and global coherence: A paradoxical picture of poor comprehenders' abilities. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *27*, 1424–1429. doi:10.1037/0278-7393.27.6.1424

McNamara, D. S. (2004). SERT: Self-explanation reading training. *Discourse Processes*, *38*, 1–30. doi:10.1207/s15326950dp3801_1

Morishima, Y. (2013). Allocation of limited cognitive resources during text comprehension in a second language. *Discourse Processes*, *50*, 577–597. doi:10.1080/0163853X.2013.846964

O'Brien, E. J., Rizzella, M. L., Albrecht, J. E., & Halleran, J. G. (1998). Updating a situation model: A memory-based text processing view. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *24*, 1200–1210. doi:10.1037/0278-7393.24.5.1200

Plonsky, L. (2015). Statistical power, *p* values, descriptive statistics, and effect sizes: A "back-to-basics" approach to advancing quantitative methods in L2 research. In L. Plonsky (Ed.), *Advancing quantitative methods in second language research* (pp. 23–45). New York, NY: Routledge.

Poynor, D. V., & Morris, R. K. (2003). Inferred goals in narratives: Evidence from self-paced reading, recall, and eye movements. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *29*, 3–9. doi:10.1037/0278-7393.29.1.3

Rayner, K., Chace, K. H., Slattery, T. J., & Ashby, J. (2006). Eye movements as reflections of comprehension processes in reading. *Scientific Studies of Reading*, *10*, 241–255. doi:10.1207/s1532799xssr1003_3

Rinck, M., Gámez, E., Díaz, J. M., & de Vega, M. (2003). Processing of temporal information: Evidence from eye movements. *Memory & Cognition*, *31*, 77–86. doi:10.3758/BF03196084

Tapiero, I. (2007). Current theories of text coherence: What about coherence. In I. Tapiero (Ed.), *Situation models and levels of coherence* (pp. 85–113). Mahwah, NJ: Lawrence Erlbaum Associates.

Tapiero, I., & Otero, J. (2002). Situation models as retrieval structures: Effects on the global coherence of science texts. In J. Otero, J. A., León, & A. C., Graesser (Eds.), *The psychology of science text comprehension* (pp. 179–198). Mahwah, NJ: Lawrence Erlbaum Associates.

Ushiro, Y., Nahatame, S., Hasegawa, Y., Kimura, Y., Hamada, A., Tanaka, N., …Mori, Y. (2016). Maintaining the coherence of situation models in EFL reading: Evidence from eye movements. *JACET Journal*, *60*, 37–55.

van der Schoot, M., Horsley, T. M., & van Lieshout, E. C. D. M. (2010). The effects of instruction on situation model construction: An eye fixation study on text comprehension in primary school children. *Educational Psychology*, *30*, 817–835. doi:10.1080/01443410.20

10.510600
van der Schoot, M., Reijntjes, A., & van Lieshout, E. C. D. M. (2012). How do children deal with inconsistencies in text? An eye fixation and self-paced reading study in good and poor reading comprehenders. *Reading and Writing*, *25*, 1655–1690. doi:10.1007/s11145-011-9337-4
Zwaan, R. A. (1999). Situation models: The mental leap into imagined worlds. *Current Directions in Psychological Science*, *8*, 15–18. doi:10.1111/1467-8721.00004
Zwaan, R. A., & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*, 162–185. doi:10.1037/0033-2909.123.2.162