EFL Readers’ Understanding of Protagonist, Temporal, and Spatial Links in Narrative: Evidence From Eye Tracking

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Abstract

There are 5 types (dimensions) of information links between sentences in narrative texts: protagonist, intentionality, causality, temporality, and spatiality. Unlike the first 3 dimensions, little is known about how students of English as a foreign language (EFL) understand temporality and spatiality during reading. This eye-tracking study explored whether and how Japanese EFL readers understand these intersentential links by differentiating their initial and late processes during reading. In the experiment, 39 Japanese university students read short narrative texts. The texts contained a target sentence (e.g., Patricia ordered a cup of coffee) that was either consistent or inconsistent with a preceding context sentence (e.g., She was a coffee lover or She did not like bitter drinks) in terms of the protagonist, temporality, and spatiality. Students’ eye movements during reading were recorded and analyzed. The results showed that the students did not understand the intersentential links of any dimensions in their initial processes but did understand protagonist links in their later processes (lookbacks). These findings suggest that EFL students’ intersentential comprehension of multiple dimensions is limited compared to that of first-language readers both in terms of the number of dimensions understood and in terms of the processes during reading. This paper discusses the implications of these findings for education and research.
1. Introduction

To successfully comprehend texts, readers need to build a coherent mental representation of situations described in the texts, or situation models (Kintsch, 1998). To construct situation models, readers must understand not only the meanings of each sentence in the text but also how they are linked (Zwaan, Langston, & Graesser, 1995; Zwaan & Radvansky, 1998). It is suggested that situation models in narratives consist of at least five dimensions (types of information links): protagonist [traits and actions], intentionality [goals and actions], causality [cause and effect], spatiality [spatial layout or movement], and temporality [temporal order] (Zwaan, Radvansky, Hilliard, & Curiel, 1998). Thus, building situation models involves understanding links between sentences (intersentential links) in terms of such dimensions.

This motivated our research group to conduct a series of studies that explored how students learning English as a foreign language (EFL) understand intersentential links in terms of these multiple dimensions (e.g., Ushiro et al., 2018, 2019). So far, we have examined the protagonist, intentional, and causal dimensions, but it remains unclear how EFL readers understand the other two dimensions—temporality and spatiality. Although one of our studies examined these two dimensions, it used a self-paced reading method, whereby readers process only one sentence at a time (Ushiro et al., 2017). The method does not allow readers to perform natural and flexible reading processes (e.g., looking back). Due to this methodological limitation, we have not fully clarified EFL readers’ comprehension processes across all five of the noted situational dimensions. That is, we lack a complete understanding of EFL readers’ construction of situation models.

To address this gap and advance our previous research, this study investigated EFL readers’ understanding of intersentential links in terms of temporal and spatial dimensions by employing the eye-tracking method, which allows for the reading to take place under more natural circumstances than the self-paced reading method and enables the assessment of different types of processes associated with comprehension (e.g., initial analytic processes, late strategic processes). We examined the protagonist dimension as a baseline for comparison. The protagonist dimension is the most important in situation models and is routinely understood by EFL readers (Takaki, 2014; Ushiro et al., 2019). Therefore, it can be taken as a benchmark when examining the degree to which EFL readers understand temporal and spatial links. Although it is crucial to understand multiple dimensions of intersentential links for constructing situation models, some EFL students have difficulty understanding the links. Thus, uncovering EFL readers’ difficulties in processing dimensions will have implications for providing suitable instructions and materials to help the students achieve better text comprehension.

1.1 Different Types of Situational Links in Narratives

In their research on first-language (L1) reading, Zwaan and his colleagues proposed a theoretical model of narrative comprehension called the event-indexing model (Zwaan et al., 1995;
Zwaan & Radvansky, 1998). According to this model, situation models are multidimensional, and readers understand intersentential links along five dimensions (protagonist, intentionality, causality, temporality, and spatiality). As clarified above, this study focuses on the protagonist dimension, the most widely investigated dimension, as well as on temporality and spatiality, which are relatively unaddressed dimensions in second-language (L2) reading research.

The protagonist dimension represents links between characters’ traits and actions (e.g., Patricia likes coffee and She ordered a cup of coffee). In narratives, protagonists form the central core, and stories progress around them. Thus, the protagonist dimension plays an important role in narrative comprehension (Zwaan & Radvansky, 1998). Past studies empirically showed that L1 readers firmly understand protagonist links (Hakala & O’Brien, 1995; O’Brien, Rizzella, Albrecht, & Halleran, 1998), as do L2 readers, to some extent (Ushiro et al., 2016, 2019).

The temporal dimension is defined as the temporal order of events (e.g., Patricia arrives at the meeting point before John and She is waiting for him). Zwaan (1996) proposed the strong iconicity assumption as readers’ default assumption that subsequent sentences in narratives are contiguous in time and follow a chronological order. It is theoretically assumed that building situation models entails understanding the temporal dimension. Underlying this notion is an account called temporal priority that posits that temporality constitutes the basis of intentionality and causality, two critical dimensions of situation models (Trabasso, van den Broek, & Suh, 1989; van den Broek, 1990); characters must have a goal before they can take an action to achieve it (intentionality), and the cause must occur before the effect (causality). However, empirical evidence is mixed. For instance, adult L1 readers routinely understand temporal links during reading (e.g., Rinck, Gámez, Díaz, & de Vega, 2003), whereas younger readers do not (Wassenburg, Beker, van den Broek, & van der Schoot, 2015). Similarly, for L2 readers, Ushiro et al. (2017) reported that high-proficiency Japanese EFL students understand temporal links, whereas Takaki (2014) showed that both Japanese high school and university students fail to understand temporal dimensions. This inconsistency in the literature leaves room for verification with regards to the temporal dimension.

The spatial dimension is defined as the spatial layout or movement of objects or characters (e.g., Patricia was at the first row and She turned around to see friends behind her). Researchers agree that L1 readers do not routinely monitor the spatial dimension during reading (Wassenburg et al., 2015; Zwaan et al., 1998; Zwaan & van Oostendorp, 1993). Likewise, Ushiro et al. (2017) reported that EFL readers with low L2 reading proficiency have difficulty understanding spatial links. This difficulty in comprehending the spatial dimension is attributable to the fact that understanding it requires capturing the three-dimensional organization of objects (Wassenburg et al., 2015; Zwaan & Radvansky, 1998). This means that readers must spontaneously track the length, width, and height of objects during reading (Wassenburg et al., 2015), which is a demanding task using language input alone (e.g., Zwaan et al., 1998). Thus, the spatial dimension can only be understood in limited conditions such as when readers are instructed to pay attention
to spatial information (Zwaan & van Oostendorp, 1993) or given a map depicting the location of objects before reading (Zwaan et al., 1998).

In sum, past studies showed that the protagonist dimension is routinely understood during both L1 and L2 reading, whereas there are difficulties in understanding spatiality. Regarding temporality, studies have shown mixed evidence and there is room for investigation.

1.2 Inconsistency-Detection Paradigm

To examine readers’ understanding of intersentential links, past studies employed the inconsistency-detection paradigm (IDP; e.g., Hakala & O’Brien, 1995; Ushiro et al., 2016). In the IDP, participants read narrative texts that contained a target sentence that was either consistent or inconsistent with a preceding context sentence in terms of the situational dimension in question (the consistent or inconsistent condition, respectively). Table 1 shows an example protagonist text.

<table>
<thead>
<tr>
<th>Table 1 An Example Protagonist Text Used in This Study</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Introduction</strong></td>
</tr>
<tr>
<td>Patricia went to the cafeteria on campus to study for exams.</td>
</tr>
<tr>
<td><strong>Context</strong></td>
</tr>
<tr>
<td>Since childhood, her favorite drink had always been coffee. (Consistent)</td>
</tr>
<tr>
<td>Since childhood, she had not liked bitter drinks like cofee. (Inconsistent)</td>
</tr>
<tr>
<td><strong>Filler</strong></td>
</tr>
<tr>
<td>She went to the counter to place an order.</td>
</tr>
<tr>
<td><strong>Target</strong></td>
</tr>
<tr>
<td>As she usually did, Patricia ordered a cup of coffee.</td>
</tr>
<tr>
<td><strong>Closing</strong></td>
</tr>
<tr>
<td>She also ordered a light meal from the menu.</td>
</tr>
</tbody>
</table>

If readers link the context and target sentences, they should have difficulty in processing target sentences that are inconsistent with context sentences (Hakala & O’Brien, 1995). This difficulty increases reading times for target sentences and lookbacks from the target to the context sentence in the inconsistent condition compared with the consistent condition (the inconsistency effect; Rinck et al., 2003). Therefore, the inconsistency effect with regards to a certain dimension of a text is interpreted as evidence of readers’ intersentential comprehension of that dimension.

Previous L1 studies using the IDP reported the inconsistency effect for the protagonist (Hakala & O’Brien, 1995), temporal (Rinck et al., 2003), and spatial dimensions (O’Brien & Albrecht, 1992). In L2 reading, Morishima (2013) demonstrated that Japanese EFL readers understood protagonist links when the context and target sentences were adjacent to each other. Ushiro et al. (2018) extended Morishima’s findings to the causal and intentional dimensions, indicating a larger inconsistency effect for the intentional than for the causal dimension.

It is, however, important to note that most of the above IDP studies employed the self-paced reading method, which has methodological limitations in terms of ecological validity (Rinck et al., 2003). Specifically, it forces participants to read a text sentence-by-sentence (i.e., only one sentence is presented at a time) without looking back to a previously read part of the text. This is problematic particularly for investigating intersentential comprehension processes because in performing those processes, readers often move across sentences rather than staying on a single sentence (Hyönä, Lorch, & Rinck, 2003; Rinck et al., 2003; Ushiro et al., 2016). In addition, the
self-paced reading method requires participants to press a button to move onto the next sentence. With a secondary task to carry out, participants’ reading times can increase not just because of difficulty in comprehension but also because of their strategic or metalinguistic responses as well as their fatigue (e.g., Hyönä et al., 2003; Roberts, 2013).

### 1.3 Use of Eye Tracking in Reading Research

To overcome the methodological problems associated with the self-paced reading method, this study employed eye tracking. Recently, an increasing number of studies have employed eye tracking to investigate moment-to-moment comprehension processes during reading (e.g., van der Schoot, Reijntjes, & van Lieshout, 2012). Compared to the self-paced reading method, eye tracking is advantageous as a text can be presented in its entirety, allowing participants to look back to a previous part of the text whenever they want. This flexibility, in turn, allows researchers to differentiate late reading processes, which are associated with lookbacks, from initial reading processes (see below). In addition, participants do not need to perform a secondary task (e.g., button presses) that may interfere with their natural reading processes. Therefore, using the IDP in combination with eye tracking enables us to observe in detail how readers process inconsistent information in a text.

Rare L2 studies that used eye tracking in the IDP design are those conducted by Ushiro et al. (2016) and Ushiro et al. (2019). They investigated how EFL readers understand protagonist (Ushiro et al., 2016), intentionality, and causality (Ushiro et al., 2019). The key eye-movement measures used were first-pass reading times for target sentences and lookbacks from target to context sentences. First-pass reading times refer to the total duration of all fixations on a target sentence from the first fixation on the sentence until readers first go out of the sentence. This measure reflects initial reading processes, such as readers’ first accessing and encoding the semantic or syntactic information of the sentence (van der Schoot et al., 2012). Lookbacks are the total count or frequency of regressions to the prior context sentence after the target sentence is fixated on at least once. This measure reflects late reading processes, such as readers’ conscious or strategic confirmation of what has been understood in the text (van der Schoot et al., 2012).

Ushiro et al. (2016) showed that protagonist inconsistency did not affect EFL readers’ first-pass target reading times, but it did affect the number of participants who looked back to the context sentences, suggesting that they understood protagonist links by means of late reading processes. Later, Ushiro et al. (2019) also showed that EFL readers understood protagonist and intentional links through late reading processes, which is reflected in the readers’ increased lookbacks to target sentences in the inconsistent condition. These findings indicate that although eye tracking reveals readers’ inconsistency detection better than self-paced reading by providing information on readers’ regressive eye movements, few L2 studies have applied eye tracking to examine subjects’ understandings of temporality and spatiality during reading.
1.4 The Present Study

Most previous studies have explored EFL readers’ comprehension of intersentential links focusing on protagonist, intentionality, and causality. Although a few studies have dealt with temporality and spatiality, those studies were methodologically limited by the use of self-paced reading, which did not allow participants to look back to prior sentences. Thus, it is difficult to draw a decisive conclusion from the existing evidence on how EFL readers understand temporal and spatial links during reading. To address this issue, we conducted an eye-tracking experiment with IDP-designed texts to reveal whether and how EFL readers understand protagonist, temporal, and spatial links between sentences. We employed the protagonist dimension as a baseline indication of EFL readers’ understandings of intersentential links, to which we then compared the extent of readers’ understandings of temporality and spatiality. We discriminated initial and late reading processes according to the different eye-movement patterns manifested (i.e., first-pass reading vs. lookbacks). The following research questions (RQs) were addressed.

RQ1: Do inconsistencies in protagonist, temporal, and spatial links affect EFL readers’ initial reading processes, as reflected by their first-pass target reading times?

RQ2: Do inconsistencies in protagonist, temporal, and spatial links affect EFL readers’ late reading processes, as reflected by their target-to-context lookbacks?

2. Method

2.1 Participants

The participants were 39 Japanese university students with normal or corrected-to-normal vision. Data from 11 participants were excluded owing to inaccurate eye-movement recording, and the data from the remaining 28 participants (11 females and 17 males; average age = 20 years) were used. All the participants were native Japanese speakers who had learned English for at least six years in Japan. Their majors were varied (e.g., human sciences, humanities and culture, & science and engineering). Their general English proficiency was estimated to be at the basic to independent level (A1 to B2) in Common European Framework of Reference for Language according to their self-reported standardized test scores (e.g., TOEIC® Listening and Reading Test). Note that 24 of 28 participants reported at least one of the scores, and four reported none.

2.2 Materials

Experimental texts. Twelve short narratives derived from Ushiro et al. (2017) were used as experimental texts. These were from prior L1 studies (e.g., Wassenburg et al., 2015) and were revised so that EFL readers could understand them without linguistic difficulty (see below). They consisted of five sentences: (a) an introduction describing the setting of the story, (b) a context giving the first piece of information with regards to one of the three dimensions (protagonist, temporality, and spatiality) that was either consistent or inconsistent with the corresponding target
sentence, (c) a filler separating the context and target sentences, (d) a target giving the second piece of information regarding the dimension in question, and (e) a closing sentence concluding the story. Tables 1 to 3 show some examples of the experimental texts in the three dimensions.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>An Example Temporality Text Used in This Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Yoko found old pictures while cleaning her room.</td>
</tr>
<tr>
<td>Context</td>
<td>One was of sports day; another recent one was of her friend. (Consistent)</td>
</tr>
<tr>
<td></td>
<td>One was of her friend; another recent one was of sports day. (Inconsistent)</td>
</tr>
<tr>
<td>Filler</td>
<td>As Yoko looked at the pictures, old memories come back.</td>
</tr>
<tr>
<td>Target</td>
<td>The oldest picture was the one of sports day.</td>
</tr>
<tr>
<td>Closing</td>
<td>She started looking at the rest of the pictures.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 3</th>
<th>An Example Spatiality Text Used in This Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introduction</td>
<td>Jane was not well prepared for her exam</td>
</tr>
<tr>
<td>Context</td>
<td>She was sitting at a desk in the first row. (Consistent)</td>
</tr>
<tr>
<td></td>
<td>She was sitting at a desk in the last row. (Inconsistent)</td>
</tr>
<tr>
<td>Filler</td>
<td>During the exam, the teacher looked away to check the time.</td>
</tr>
<tr>
<td>Target</td>
<td>Jane quickly turned around to see her friend’s answers behind her.</td>
</tr>
<tr>
<td>Closing</td>
<td>Quickly, she wrote down the correct answers in her paper.</td>
</tr>
</tbody>
</table>

The texts were simplified to avoid any unintended language difficulties and to make EFL readers engage in discourse-level processes. Specifically, low-frequency words at Level 5 or above on the *Japan Association of College English Teachers (JACET) 8000 list* (Ishikawa et al., 2003) replaced high-frequency words at Level 4 or below. The text length was controlled across the dimension and consistency conditions as follows: protagonist ($M = 48.00$ words, $SD = 2.16$ for consistent, $M = 49.25$ words, $SD = 1.71$ for inconsistent), temporality ($M = 47.75$ words, $SD = 1.89$ for consistent, $M = 47.75$ words, $SD = 1.89$ for inconsistent), and spatiality ($M = 47.50$ words, $SD = 2.38$ for consistent, $M = 47.75$ words, $SD = 2.22$ for inconsistent).

These texts were presented in either a consistent or inconsistent condition in terms of the consistency between the context and target sentences. The consistency manipulation’s homogeneity was confirmed in a pilot study by Ushiro et al. (2017, 2018), who used a likelihood rating to show that links between the context and target sentences were less likely in an inconsistent condition than in a consistent condition. We made two material sets of 12 texts (four texts each for the protagonist, temporal, and spatial dimensions). The consistency conditions were counterbalanced across the sets: The experimental texts were presented in the consistent condition in one set and in the inconsistent condition in the other set, and vice versa.

**Comprehension questions.** Each text was accompanied by a yes-no comprehension question (e.g., “Did Patricia study in the library?” in Table 1). Each question asked about the content of each experimental text except for the consistency-condition-related context and target sentences, because these questions were intended to motivate the participants to read texts for understanding rather than to measure their understanding of dimensional coherence.

**Inconsistency questions.** To confirm whether the participants consciously detected the inconsistency included in the texts or not, inconsistency questions were set (cf. Rinck et al., 2003).
These questions were provided with the first sentence of each of the 12 texts after reading all the texts (e.g., “Patricia went to the cafeteria on campus to study for exams.” for the passage in Table 1), and participants were asked to report whether those texts included any inconsistency or not.

2.3 Apparatus and Procedure

The experiment was individually conducted from December 2018 to January 2019, with each experiment lasting approximately 60 minutes. Before starting, we notified the participants of the purpose and procedures of the experiment, and informed consent was obtained (approved by the research ethics committee of the university to which the first author belongs). Participants’ eye movements were recorded with EyeLink® 1000 Plus eye tracker (SR Research Ltd., Canada). The participants were asked to sit 51 cm from the camera and 70 cm from a 21.5-inch computer screen (screen resolution: 1920 × 1080). To keep the head still, they were asked to put their chin and forehead on a chinrest. The eye tracker was calibrated and validated twice by using a nine-point grid in the reading session: before reading a practice text and then the first experimental text. The experimental texts were presented on the screen in 20-pt Times New Roman font using EyeLink® Experiment Builder.

In the reading session, the participants read a practice text in the consistent condition and answered a comprehension question to establish familiarity with the procedure. They were then asked if they had any questions, which the experimenter addressed. The participants next read the experimental texts, which were in either a consistent or inconsistent condition. Each text was displayed on the screen, and the participants read it silently at their own pace. After each text, the participants answered the comprehension question by pressing the keys. We gave them feedback by showing them either “Correct” or “Incorrect” on the screen. This sequence was repeated for each of the 12 texts. Finally, after reading all the texts, participants answered the inconsistency questions. They were asked to report whether each text included inconsistency.

2.4 Scoring and Analysis

Data from an accurately recorded eye were used for the analyses. Prior to the analysis, data in which a participant mistakenly skipped a sentence or looked at the margin were removed by checking the recorded footage. The areas of interest for eye-movement measures were the target and context sentences relevant to the consistency manipulation (Ushiro et al., 2016).

To avoid the effects of outliers, the participants’ target reading time over $M + 3 \text{SD}$s in each condition were replaced by their $M + 3 \text{SD}$s (0.36% of the dataset). The target reading times were then converted to milliseconds (ms) per syllable to account for differences in sentence length. We computed first-pass target reading times as an indicator of initial reading processes (e.g., readers’ first accessing and encoding semantic or syntactic information of the sentence). If readers immediately detected an inconsistency between the context and target sentences, reading times were expected to increase (e.g., van der Schoot et al., 2012).
Lookbacks from the target sentences directly to the context sentences were counted. First, we noted which sentence participants moved their eyes to after reading target sentences. Then, we counted the numbers of participants' target-to-context lookbacks (including target-to-introduction lookbacks). Lookbacks, as an indicator of late reading processes (e.g., readers' conscious or strategic processes), were expected to increase in cases where readers were trying to confirm the source of the detected inconsistency after encountering target sentences (e.g., target-to-introduction lookbacks). Lookbacks are expected to occur in the inconsistent condition more than in the consistent condition in their attempt to strategically resolve the inconsistency between the sentences (cf. eye-movement matrix, Hyönä, et al., 2003).

We analyzed the first-pass reading times using linear mixed effects modeling (LME), which enabled us to model both fixed and random effects to take into account individual variation among participants and item. Random variables include fixed effects of Consistency × Dimension (protagonist, temporality, spatiality), participants as random intercepts, and items as well as participants as random slopes. To analyze lookback frequency, we compared the number of target-to-context lookbacks for each dimension by using Chi-squared tests.

### 3. Results

#### 3.1 Comprehension Questions

Proportions of correct answers for the comprehension questions were high (M = 0.96, SD = 0.15). These results indicate that the participants understood the texts equally well across all six conditions (Protagonist × Consistent: M = 0.93, SD = 0.18; Protagonist × Inconsistent: M = 0.96, SD = 0.23; Temporality × Consistent: M = 1.00, SD = 0.00; Temporality × Inconsistent: M = 0.99, SD = 0.01; Spatiality × Consistent: M = 0.96, SD = 0.12; Spatiality × Inconsistent: M = 0.96, SD = 0.15). This result indicated that there was no difference in the difficulty of text comprehension across conditions. Thus, we judged that a difference among dimensions observed in the following analyses would reflect a dimensional difference in the difficulty of intersentential comprehension.

#### 3.2 First-Pass Reading for Target Sentences

Tables 4 and 5 show the descriptive statistics of first-pass target reading times and the results of the LME, respectively. It was found that neither the consistency, dimension, nor their interaction significantly affected first-pass target reading times.

We analyzed the first-pass reading times using linear mixed effects modeling (LME), which enabled us to model both fixed and random effects to take into account individual variation among participants and items. Random variables include fixed effects of Consistency × Dimension (protagonist, temporality, spatiality), participants as random intercepts, and items as well as participants as random slopes. To analyze lookback frequency, we compared the number of target-to-context lookbacks for each dimension by using Chi-squared tests.
### Table 4

<table>
<thead>
<tr>
<th>Condition</th>
<th>Protagonist</th>
<th>Temporality</th>
<th>Spatiality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
</tr>
<tr>
<td>Consistent</td>
<td>404.5 (186.94)</td>
<td>354.74 (146.84)</td>
<td>307.55 (162.70)</td>
</tr>
<tr>
<td></td>
<td>[217.56, 473.74]</td>
<td>[300.35, 409.13]</td>
<td>[247.29, 367.81]</td>
</tr>
<tr>
<td>Inconsistent</td>
<td>376.35 (158.03)</td>
<td>418.03 (229.07)</td>
<td>419.99 (206.28)</td>
</tr>
<tr>
<td></td>
<td>[317.82, 434.88]</td>
<td>[333.18, 502.88]</td>
<td>[343.58, 496.40]</td>
</tr>
</tbody>
</table>

Note: CI = Confidence Interval.

### Table 5

**Linear Mixed Effects Model Predicting First-Pass Reading Times**

<table>
<thead>
<tr>
<th>Fixed effect</th>
<th>Estimate</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>403.98</td>
<td>43.27</td>
<td>9.34</td>
<td>&lt; .001 ***</td>
</tr>
<tr>
<td>Consistency</td>
<td>-35.31</td>
<td>57.26</td>
<td>-0.62</td>
<td>0.549</td>
</tr>
<tr>
<td>Dimension [Spatial] (protagonist baseline)</td>
<td>-96.43</td>
<td>57.42</td>
<td>-1.68</td>
<td>0.118</td>
</tr>
<tr>
<td>Dimension [Temporal] (protagonist baseline)</td>
<td>-49.23</td>
<td>53.18</td>
<td>-0.93</td>
<td>0.374</td>
</tr>
<tr>
<td>Dimension [Spatial] (temporal baseline)</td>
<td>-47.18</td>
<td>54.03</td>
<td>-0.87</td>
<td>0.402</td>
</tr>
<tr>
<td>Consistency: Dimension [Spatial] (protagonist baseline)</td>
<td>148.19</td>
<td>85.48</td>
<td>1.73</td>
<td>0.105</td>
</tr>
<tr>
<td>Consistency: Dimension [Temporal] (protagonist baseline)</td>
<td>98.60</td>
<td>80.80</td>
<td>1.22</td>
<td>0.244</td>
</tr>
<tr>
<td>Consistency: Dimension [Spatial] (temporal baseline)</td>
<td>49.50</td>
<td>49.50</td>
<td>0.66</td>
<td>0.525</td>
</tr>
</tbody>
</table>

Note. *** p < .001.

### 3.3 The Proportions of Lookbacks

Table 6 summarizes the proportions of target-to-context and target-to-other eye movements in each condition. Chi-squared tests showed that the number of target-to-context lookbacks was significantly higher in the inconsistent condition than it was in the consistent condition for the protagonist texts, $\chi^2(1) = 5.54, p = .019, \phi = .15$. By contrast, this effect was not significant for the spatiality, $\chi^2(1) = 0.06, p = .811, \phi = .02$, and temporality texts, $\chi^2(1) = 2.83, p = .092, \phi = .11$.

### Table 6

**Proportions of Target-to-Context and Target-to-Others Lookbacks in Each Condition (N = 28)**

<table>
<thead>
<tr>
<th>Path</th>
<th>Protagonist</th>
<th>Temporality</th>
<th>Spatiality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consistent</td>
<td>Inconsistent</td>
<td>Consistent</td>
</tr>
<tr>
<td>Target-to-context</td>
<td>4.2</td>
<td>13.4</td>
<td>10.5</td>
</tr>
<tr>
<td>Target-to-others</td>
<td>95.8</td>
<td>86.6</td>
<td>89.5</td>
</tr>
</tbody>
</table>

Note. Numbers were percentages; Data from two texts were excluded from the analysis because of inaccurate recordings.

### 3.4 Inconsistency Questions

For the protagonist dimension, the participants reported that they noticed the inconsistencies in 62.5 % of the texts in the inconsistent condition (35/56 texts). For the temporality and spatiality, conversely, they reported the inconsistencies in 33.9 % of the texts in the inconsistent condition (19/56 texts). A Chi-squared test showed a significant difference in these proportions between the three dimensions, $\chi^2(2) = 18.81, p < .001, \phi = .32$. Multiple comparisons with the Bonferroni adjustment showed that the participants reported the inconsistencies significantly more frequently for the protagonist dimension than for the other two dimensions, $\chi^2(1) = 13.96, p < .001, \phi = .27$. 

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4. Discussion

The results of the first-pass reading time and lookback analyses showed that the participants exhibited more target-to-context lookbacks in the inconsistent than in the consistent condition (i.e., inconsistency effect) when they read the protagonist texts. This indicates that the participants understood protagonist links via late strategic reading processes. In line with this, the participants reported that they were aware of inconsistencies more often for the protagonist texts than for the temporal and spatial ones. Together, these findings indicate that the protagonist dimension is likely to be understood by EFL readers. This conclusion is consistent with the event-indexing model, which assumes that the protagonist dimension plays an important role in narrative comprehension (Zwaan & Radvansky, 1998), as well as with the previous findings of L1 and L2 reading research (e.g., Hakala & O’Brien, 1995; O’Brien et al., 1998; Ushiro et al., 2016, 2019).

It is also noteworthy that the participants understood protagonist links through late conscious or strategic processes, shown by the increased lookbacks in the inconsistent condition. In contrast, previous studies suggested that L1 readers understood protagonist links through initial reading processes indexed by first-pass target reading times (e.g., van der Schoot et al., 2012). This may be owing to L2 readers’ limited cognitive resources. It is well known that L2 readers have to focus many of their cognitive resources on basic-level reading processes (lexical access, syntactic parsing) during initial reading, and as a consequence of this, their discourse-level processes, including the integration of information from multiple sentences, are often delayed compared with L1 readers (Horiba, 2000). On this account, participants in this study initially concentrated on basic-level processes for each sentence and then understood intersentential links through late processes. Thus, they did not notice intersentential inconsistencies immediately but did so later in a conscious manner. This observation is also supported by the previous eye-tracking studies reporting that readers notice inconsistencies by not staying on the spot but by consciously rereading prior sentence(s) to find relevant information (Rinck et al., 2003; Ushiro et al., 2016).

In contrast to the protagonist dimension, the participants failed to detect temporal and spatial inconsistencies either by initial or late processes, as is reflected in the absence of the inconsistency effect in these dimensions. This result means that the participants had difficulty understanding temporal or spatial links during reading compared with protagonist links. In what follows, we discuss the findings relevant to these two dimensions.

For temporality, the present finding supports the previous work pinpointing difficulty in comprehending the temporal dimension (e.g., Wassenburg et al., 2015). Difficulty comprehending temporality may be explained by the strong iconicity assumption of readers. According to Zwaan (1996), readers assume that subsequent sentences in narratives follow a chronological order; if there is a time shift (e.g., past–now), readers decrease their engagement with the past event and focus on the current situation. Taking a look at an experimental text in Table 2, understanding temporality requires readers to understand situations that occurred at different times: past
situations (e.g., a sports day) and the current situation (e.g., cleaning the room and finding pictures). Based on their assumption, readers’ attention might fixate on the current situation and they might have difficulty linking situations occurring at different times. Thus, intersentential comprehension across time shift may be difficult for EFL readers. However, given that Rinck et al.’s (2003) eye-tracking study found the inconsistency effect in the temporal dimension with L1 readers, the absence of the inconsistency effect in this study possibly indicates that the difficulty with temporality is specific to L2 reading.

It should also be noted that Ushiro et al. (2017) reported results opposite to ours; they found the inconsistency effect with regards to the temporal dimension among high-proficiency EFL readers. This incongruency may be accounted for by the experimental environments. In contrast to the present study, Ushiro et al. (2017) used the self-paced reading method in which increased reading times could result from other factors (e.g., readers’ fatigue) than the comprehension process in question, because of its sentence-by-sentence presentation coupled with the interference of the secondary tasks (Roberts, 2013). On the other hand, this study used eye tracking, which functions to overcome the methodological limitations mentioned above. Moreover, the present study used LME for reading time analysis in contrast to the statistical analyses (analyses of variance) used in Ushiro et al.’s (2017). As is pointed out by Barr et al. (2013), they could not have fully considered individual variations and could have overestimated the significance of certain aspects of the data (Type I error). Given these issues, it is reasonable to assume that the present findings are more reliable than Ushiro et al.’s (2017).

For spatiality, the observed difficulty in comprehending the spatial dimension aligns with both previous L1 (e.g., Wassenburg et al., 2015) and L2 studies (Ushiro et al., 2017). Hence, the findings together indicate that the spatial dimension poses a constant difficulty in comprehension. As pointed out in previous studies (e.g., Zwaan & Radvansky, 1998), understanding spatial links means capturing the three-dimensional organization of objects—length, width, and height (e.g., Kelly was seated far from the stage and When the guitarist threw his cap, she couldn’t catch it). This process is difficult for L2 readers, especially when no specific instruction is given to explicitly direct the reader’s attention to spatial information or any extra materials to aid in visualizing the locations of objects (e.g., Zwaan et al., 1998; Zwaan & van Oostendorp, 1993). Future research should explore what types of instruction or materials are effective at improving L2 readers’ spatial comprehension.

Combined with the results of our past eye-tracking studies (Ushiro et al., 2016, 2019), the present results complete a picture of multidimensional situation models in EFL readers. We propose that situation models constructed by EFL readers are more limited than those of L1 readers in terms of (a) the number of dimensions understood and (b) the ways they process inconsistent information. First, EFL readers understand fewer dimensions than L1 readers. The dimensions understood during EFL reading are limited to the protagonist-related ones: (the protagonist and intentionality [protagonist’s goal and actions]; Ushiro et al., 2016, 2019). This
study found that temporality and spatiality are not routinely understood during EFL reading compared to the protagonist dimension. Note that L1 research constantly reports readers’ difficulty in comprehending the spatial dimension (e.g., Wassenburg et al., 2015; Zwaan et al., 1998), but previous eye-tracking evidence showed that L1 readers understood temporal links (Rinck et al., 2003). Thus, EFL readers’ situation models are specifically limited in terms of the temporal dimension.

Additionally, even for the understandable dimensions (protagonist, intentionality), EFL readers are limited in their comprehensive processes. L1 readers were reported to understand the protagonist and intentional links immediately (van der Schoot et al., 2012). Conversely, we found that EFL readers understand such links only by means of strategic or conscious processes (Ushiro et al., 2016, 2019). Given that such late reading processes characterize EFL reading, it is critical to distinguish between different types of reading processes by eye tracking when investigating discourse-level processing during EFL text comprehension.

5. Conclusion

5.1 Summary of Findings
This study aimed to reveal whether and how EFL readers understand intersentential links concerning protagonist, temporality, and spatiality. The results suggested that EFL readers understand intersentential protagonist links via late conscious or strategic processes. On the other hand, they have difficulty understanding temporal and spatial links. So far, research has examined protagonist, intentional, and causal links, exploring EFL readers’ intersentential comprehension processes (Ushiro et al., 2016, 2019). However, it remains unclear how EFL readers understand the other two dimensions—temporality and spatiality—, and there was room for reliable investigation of those dimensions. This eye-tracking study observed cognitive processes related to intersentential comprehension of these two dimensions and provided a more comprehensive picture of the multidimensional situation models constructed in EFL reading. Combined with the findings of our prior research (e.g., Ushiro et al., 2016, 2017, 2019), this study suggests that EFL readers’ intersentential comprehension is limited compared to that of L1 readers in terms of both the number of comprehended dimensions and the ways readers process inconsistent information to achieve comprehension.

5.2 Implications for Educators and Researchers
The current findings propose that teachers should be aware of EFL readers’ difficulty in achieving a coherent comprehension of the temporal and spatial relations relayed in narratives. It might be necessary to provide some educational interventions to help them comprehend the intersentential links of temporal and spatial information. For instance, visual aids such as a graph or map would be useful especially to help students grasp time shift and flow (temporality) or
three-dimensional positional relations (spatiality). On the other hand, the current study indicates that EFL readers understand protagonist links through conscious or strategic processes. This suggests that protagonist information is relatively firmly understood among EFL readers. Thus, especially for novice learners, an effective first step might be focusing on multiple sentences related to the protagonist and understanding the links between them to construct coherent situation models of narratives.

With regards to methodological factors, the present eye-tracking measures showed that late strategic processes play a critical role in EFL readers’ intersentential comprehension. Note that this evidence could not have been collected using the self-paced reading method, which cannot distinguish between late reading processes and initial ones. Although eye tracking is expensive, and it takes time to analyze the data, we propose that using eye tracking is beneficial for examining different stages of comprehension processes during L2 discourse processing. More eye-tracking research is needed to provide a better understanding of cognitive processes involved in EFL text comprehension.

5.3 Limitations of This Study

We note several limitations that might provide direction for further research. First, we tested a relatively small sample size without taking readers’ individual differences into account. The literature showed that some individual differences may affect inconsistency-detection processes, including readers’ L2 proficiency, working-memory capacity, and their various reading styles (Hyönä & Nurminen, 2006). Further research should test a larger sample size and directly examine the effects of these individual differences. Evidence from such studies would help provide a more comprehensive model of L2 comprehension processes, in addition to the pedagogical implications tailored to various types of learners.

In addition, this study used short narrative texts, each comprising only five sentences and a single dimension. Students may actually read much longer narratives consisting of hundreds of words or more and multiple situational dimensions. Future researchers should use more authentic materials and explore how EFL readers simultaneously understand different situational dimensions as a story unfolds.

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