Effects of Working Memory Capacity on On-Line Goal Inference Generation in EFL Reading

Daiki KATO
Graduate School, University of Tsukuba

Abstract

To coherently comprehend a narrative, readers need to infer implicit relationships between a goal (e.g., a character’s aim during the narrative) and other information (e.g., actions and outcomes). Previous studies have revealed that readers generate on-line goal inferences, which are related to connecting a goal with other information during reading. This process contributes to the coherent comprehension of a narrative. However, few studies have investigated EFL readers’ on-line goal inference generation and related cognitive factors in EFL reading. Thus, the present study examined whether or not EFL readers make the inference and how working memory capacity (WMC) affects these inferences. A group of 42 Japanese undergraduates read narratives and performed recognition task, in which they recognized goal information as a target probe. Results of correct response rates and response times showed that EFL readers generated goal inferences despite cognitive constraints, and EFL readers who had greater WMC automatically generated on-line goal inferences. These results suggested that EFL learners’ WMC should be considered when teachers select materials and instruct narrative reading.

1. Introduction

1.1 On-line Goal Generation During Narrative Reading

In many cases, one final purpose of second language (L2) reading is not to comprehend language from a text but to comprehend the content. In reading, successful comprehension is equal to constructing a situation model (i.e., a whole image of the text). To construct the situation model, people need to integrate information from each sentence within the text and understand implicit relationships between the sentences. This is referred to as an inference, which connects respective information. In narrative reading, in order to understand a full story, readers will observe goals, plans, and outcomes. From there, readers will integrate all of this information. Goal information (e.g., information regarding a character’s aims) within the narrative plays a central role in the story line of the narrative. Goal information will help a reader understand a character’s motives and the actions/states that result. For readers to understand narratives, they need to connect details based on goal information. This process is referred to as a goal inference. If
readers succeed with inferring relationships between information from each sentence, this leads to the coherent construction of a situational model within the text.

Within a narrative, a character’s goal provides connections for coherently organizing the narrative. Lynch and van den Broek (2007) argued that goal information connect events together to create a coherent story. Success or failure in achieving a primary goal marks the natural conclusion of a narrative. If a character fails to achieve his or her primary goal or foresees difficulty in fulfilling the goal, a subordinate goal is established. Attaining the desired outcome of the subordinate goal leads toward achievement of the primary goal. Primary and subordinate goals have a hierarchical relationship. On the other hand, if a character succeeds at achieving a primary goal, another goal is established at the same hierarchical level. According to Suh and Trabasso (1993), readers’ goal inference generation differs from these textual structures. For example, versions of two goal structures are shown in Table 1. This story is one of narratives used in the present study. These narratives were originally used in Lutz and Radvansky (1997), being revised to some extent for EFL reading.

Table 1
Text Versions of an Example Narrative

<table>
<thead>
<tr>
<th>Hierarchical Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once there was a boy named Jimmy. One day, Jimmy saw his friend Mark riding a new bike. Jimmy wanted to buy a new bike. Jimmy spoke to his mother. (Probe Point 1) Jimmy’s mother refused to get a new bike for him. Jimmy was very sad. Next day, Jimmy’s mother told him that he should have his own money. Jimmy wanted to earn some money. Jimmy asked about a job at a nearby store. Jimmy brought items for the store. Jimmy earned a lot of money. Jimmy went to the department store. Jimmy walked to the second floor. (Probe Point 2) Jimmy bought a new bike.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sequential Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once there was a boy named Jimmy. One day, Jimmy saw his friend Mark riding a new bike. Jimmy wanted to buy a new bike. Jimmy spoke to his mother. (Probe Point 1) Jimmy’s mother got a new bike for him. Jimmy was very happy. Next day, Jimmy’s mother told him that he should have his own money. Jimmy wanted to earn some money. Jimmy asked about a job at a nearby store. Jimmy brought items for the store. Jimmy earned a lot of money. Jimmy went to the department store. Jimmy walked to the second floor. (Probe Point 2) Jimmy bought a new basketball.</td>
</tr>
</tbody>
</table>

Lutz and Radvansky (1997) compared the two goal structures within each narrative. Although each textual structure consists of three episodes, the roles of the goal are different between the hierarchical and sequential text versions. In the hierarchical goal structure, the primary goal, which is underlined, is introduced, and the character attempts to attain this goal;
however, he is unable to do so. In this story, from the introduction to the failure of attaining the primary goal (i.e., Jimmy’s mother refused to get him a new bike) is the first episode. In the second episode, a subordinate goal of the primary goal arises and is achieved (i.e., Jimmy wanted to and did earn money to buy a bike). In the third episode, as the subordinate goal has been achieved, additional actions lead to successful achievement of the primary goal, which is illustrated by the dotted line. In this goal structure, the primary goal plays a meaningful role throughout the text. Therefore, when readers understand the story, they have to connect the primary goal to the actions in the first episode, the subordinate goals in the second episode, and the actions in the final episode. They need to activate the primary goal information during whole reading. On the other hand, the sequential goal structure is as follows. In the first episode, the primary goal is introduced, and the character achieves the goal, which is illustrated by the dotted line. Therefore, in the second episode, a second goal, which is not relevant to the primary goal, is introduced and achieved, although the textual information is literally the same with the hierarchical version. In the third episode, some actions leads to an outcome, which does not have connection to the primary goal (i.e., Jimmy bought a new basketball). When good readers read narratives, they are able to understand goal structures and appropriately generate goal inferences from the text.

Due to the central role of goals in narrative comprehension, readers must be able to infer connections between goals and other elements for coherent narrative comprehension (Lynch & van den Broek, 2007). Several studies have revealed that first language (L1) readers could make goal inferences on-line (e.g., Suh & Trabasso, 1993; van den Broek & Lorch, 1993). Even young children are often able to infer connections between goals and actions when asked questions about reasons for characters’ actions (Wenner, 2004). By making on-line goal inferences, connections between goals and other information are integrated into readers’ situation models of a text. Lynch and van den Broek (2007) verified that the number of on-line goal inferences predicted recall rates of textual information. Studies assessing preschoolers have shown that goal-related information is better encoded in memory, easier to remember, and recalled better than other information unrelated to protagonists’ intentions (e.g., Flecher & Bloom, 1988). Moreover, based on evidence that young children remember hierarchical goal narratives better than narratives without coherent structures, Wenner (2004) suggests that it is possible that a goal structure provides support for constructing coherent situation models. In this way, on-line goal inferences facilitate recall and learning in L1, which supports the construction of a coherent situation model of the text.

To make a goal inference, both goal information and other information must be simultaneously active in working memory (WM: e.g., van den Broek & Lorch, 1993). In other words, readers make on-line goal inferences, only if the goals are currently in the WM (Lutz & Radvansky, 1997). To generate a goal inference it is necessary for readers to activate goal information when goals and incoming information are related. This issue related to goal inference generation and WM is discussed further below.
1.2 Related Factors: Working Memory Capacity

An important component of reading is WM. It is widely acknowledged that WM plays an essential role when engaging in a variety of cognitive activities, especially language processing. The main functions of WM are the simultaneous storage and processing of information (Just & Carpenter, 1989). Within reading processes, readers engage in parallel operations of temporarily storing and processing information. However, available cognitive resources for these operations are limited, and individuals differ in their ability to coordinate storage and processing in WM. Readers with a large working memory capacity (WMC) are much more capable of carrying information over from one sentence to the next, maintaining coherence within and between sentences, and conducting various processes at the same time (Daneman & Carpenter, 1983). Therefore, individual differences in WMC are one of the predictors of language competence in L1 reading.

In EFL reading, it has been reported that WMC is a good predictor of language processing (e.g., Osaka & Osaka, 1992). If a reader excels at storage and processing, in other words, if he or she has a large WMC, he or she will better comprehend information than those who have less WMC. Particularly in EFL reading, readers have to allocate their limited cognitive resources toward lower-order processes, such as lexical access and syntactic processing, as these processes are less automatized in English as L2 than as L1. The more automatically EFL readers can conduct lower-order processes, the more cognitive resources they can spare for higher-order semantic or inferential processes (e.g. goal inference generation; Yoshida, 2003). Efficient processing is a key factor in language comprehension (Nakanishi & Yokokawa, 2011).

As mentioned above, individuals' WMC is limited, and EFL readers use their cognitive resources to deal with lower-order processes. This makes it difficult for these individuals to engage in higher-order processing, such as creating goal inferences. This indicates a difficulty in coherently understanding text in EFL reading. Goal inference, which plays an important role in coherent narrative comprehension, is one higher-order process that requires activation of both goal information and other information in order to integrate the two. However, for EFL learners, L2 processing is less automatized than L1 processing, and L2 processing is more resource consuming than L1 processing (Friedman & Miyake, 2005; Nakanishi & Yokokawa, 2011). Thus, since EFL readers allocate their limited cognitive resources to lower-order processes, it is thought to be challenging for them to generate goal inferences. On the other hand, Horiba, van den Broek and Fletcher (1993) indicated that L2 readers could conduct higher-order processing, such as using knowledge about the text structure to fully comprehend the narrative. Ikeno (2002) investigated the relationship between WMC and high-order processing in L2 reading by revealing a WM effect on text structure prediction. Inference generation has been regarded as one of the processes that depend on WMC both in L1 and L2 (e.g., Yoshida, 2003). Thus, WMC is assumed to be relevant for on-line goal inferences, although, this relationship has not been verified.
1.3 Purposes of the Present Study

The purpose of present study was to examine on-line generation of goal inferences while EFL readers were reading narratives. Additionally, the present study assessed the role of WMC on generating goal inferences. To get a clearer picture of inferences in EFL reading, it is necessary to verify whether EFL readers are able to activate goal inferences on-line. In addition, based on previous studies, it is predicted that goal inferences are relevant to WM processes, and WMC affects goal inference generation. However, few studies have verified the effect of WMC on goal inference generation. Therefore, the present study addressed these questions. This study examined different processes of goal information against two different structures (i.e., hierarchical and sequential) among EFL readers with variable WMC. By measuring responses to a recognition task, on-line goal inferences were examined. The present study addressed the following two research questions (RQs):

RQ1: Do EFL readers appropriately generate on-line goal inferences based on goal structures within a narrative?
RQ2: Does WMC affect on-line goal inference generation in EFL reading?

2. Method

2.1 Participants

A total of 42 Japanese undergraduates participated in this study. Participants majored in various fields, such as international studies, pedagogy, social science, and engineering science. The study sampled students across all undergraduate levels (i.e., freshmen to seniors) that had been studying English for at least six years. All 42 participants completed the tasks and were subject to all analyses.

2.2 Materials

a. Reading Span Test:

A reading span test (RST) for English as Second Language (ESL) learners was used to measure individual WMC. Daneman and Carpenter’s (1980) RST has been used in several previous studies. In the RST, individuals must read increasingly longer sets of sentences while trying to maintain and recall the final word of each sentence in the set. From the number of words they could maintain while reading sentences, the RST estimates individuals’ WMC as related to reading (e.g., Friedman & Miyake, 2005; Just & Carpenter, 1989). Several studies verified that RST scores correlate with reading proficiency, reading skill, and reading comprehension and this test has been used to assess the relationship between WMC and basic reading skills (e.g., Friedman & Miyake, 2005; Just & Carpenter, 1989). However, the original RST targets native speakers of English and contains several words and phrases that are difficult for non-native speakers of English to understand. This test includes the types of processing that exhausts L2
learners’ WMC and makes it difficult to remember the final words of each sentence (Nakanishi & Yokokawa, 2011). It is possible that Daneman and Carpenter’s RST is too difficult for EFL learners. Therefore, in this study, an RST for ESL learners developed by Osaka (1998) was used to assess the WMC of Japanese EFL learners. This version has shorter and simpler sentence structures for EFL learners to read, comprehend, and store. In this way, the possibility of floor effects due to task difficulty was curtailed. Furthermore, the revised RST test has shown a strong correlation with Daneman and Carpenter’s (1980) RST. The RST is composed of 70 sentences, which are simple, active, and 8-12 words in length. The final word in each sentence was a target. Sentences were presented in sets of increasing size, starting with two sentences per set and expanding to five sentences per set.

b. Experimental Narratives:

Four out of 12 narratives used by Lutz and Radvansky (1997) were employed, which had both hierarchical and sequential versions. One of the examples is shown in 1.1 and the others had similar structures. We selected appropriate texts whereby EFL readers could generate goal inferences relatively easily. Because the original 12 narratives were written for L1 readers, it was possible that they were not suitable for EFL reading. Therefore, materials were revised and most suitable texts were selected in Pilot Study. First, some words and structures within sentences were revised for EFL reading. The word levels were calculated by the criteria based on The Japan Association of College English Teachers (JACET) 8000, which was specially created for Japanese EFL learners (JACET, 2003). Some words above Level 5 were translated into synonyms at Levels 1 to 3, or some footnotes were attached to these words. With regard to sentence structure, easier expressions replaced the more difficult expressions for EFL learners. Finally, a native speaker of English revised materials to provide natural expressions. After the revision, 16 EFL Japanese undergraduates completed a recognition task, which is described in detail in the following section, and also took a recall task. They read all the narratives within the hierarchical or sequential versions and recognized whether goal information as target probes appropriately represented the text. As a result, eight candidate texts had correct responses at 70% or greater. Finally, two raters marked the recall protocols written by the participants and selected four texts as the experimental narratives which had almost equal recall rates, considering that the texts had equal levels of difficulty. The texts were named after the main characters in each narrative: Charlie, Jimmy, Kevin, and Bill.

2.3 Procedure

The most part of the procedure was based on Lutz and Radvansky (1997). All experimental tasks were administered individually in a quiet room. To begin, the participants were given a general explanation about task procedures. First, the participants read the four narrative texts and performed a recognition task during reading. As for narrative reading, They read two narratives
with a hierarchical structure and two with a sequential structure on a personal computer (PC). Presentation order was counterbalanced across the participants. The participants read narratives sentence by sentence on the screen. We used SuperLab 4.5 software for Windows to create the tasks. The PC and response a pad controlled presentation of the stimuli and recording of RTs. On each trial, the word “Ready?” appeared on the screen. The participants were told to try to comprehend each sentence as it appeared at the center of the screen. The reading task was self-paced, and participants pressed a blue button to advance to the next sentence.

During reading, the participants took a phrase recognition task. This task measured participants’ responses (i.e., correct responses or errors) and response times (RTs) for target probes to investigate goal inference generation. According to Suh and Trabasso (1993), the target probes represented goal information in each narrative in the form of a verb phrase. For example, the target probe in the example narrative (i.e., Jimmy’s story) was a verb phrase “buy a bike” because the Jimmy’s primary goal was to buy a new bike. The readers were told that they would be interrupted by probe questions while reading, and that they should answer whether each target probes presented in the previous sentences, as quickly and as accurately as possible. As Suh and Trabasso (1993) noted, readers can judge the presence of the target probes quickly and correctly if they are activating goal information to generate goal inferences during reading. The participants pressed one of two buttons to make the response. The left button was blue and denoted “yes, this is true,” whereas the right button was red and denoted “no, this is false.” Probes appeared after a fixation point (*** ) for 500 milliseconds (ms) at the center of the screen. There were two probe points: point 1 and point 2, as shown in the example narratives Table1. Point 2 placed after a action to achievement of the primary goal in hierarchical version or to that of another goal in sequential version, in the third episode. The response here would provide the answer to the interest of the present study. Point 1, which was in the first episode, was set for two reason. One reason is that if there is no difference between hierarchical and sequential versions at point 1, it would be assured that there was not any effect other than the goal structure. Second aim was to examine the effect of WMC on goal inference generation after both the near sentence from the explicit presentation of the primary goal information and distant sentence from it.

Before the main session, participants read two practice stories in order to become familiarized with the recognition task. One of the two practice stories included a hierarchical and sequential structure, respectively.

After the reading and the recognition tasks, the participants completed the RST for ESL learners on the PC. In order to measure individual differences in WMC, participants read several sentences and stored target words. First, participants read aloud five sets of sentences in each set, which consisted of 2-5 sentences. The reason participants read the sentences aloud was to confirm that they read every word in each sentence and were able to conduct syntactic and semantic processes. While reading, participants were asked to memorize the final word in each sentence. However, they were not allowed to write anything down while reading aloud. As soon as they
finished reading the sentence, the experimenter switched the screen to the next sentence. After the participants had read aloud all sentences in the sets, they recalled the final words within the sets, in English, without referencing the texts. The participants were told to write down as many of the test words as possible. For example, at the two-sentence level, participants read aloud the following sentences: “Practicing typing is not very difficult. Music always provides us with pleasure and comfort.” In that instance, participants had to recall the words “difficult” and “comfort.” Although there were no tasks to measure sentence comprehension, participants were instructed to comprehend the sentences while reading aloud. The purpose of this instruction was to prevent participants from trying to remember the final words without thinking about sentence meaning. After explaining the basic procedure of this task, the experimenter emphasized the importance of beginning to read each sentence aloud as soon as it appeared to prevent rehearsal of the target words. When recalling the final words of the sentences, the participants were told to recall the words in any order, but were prohibited from writing the last words first. In addition, the participants were told that spelling mistakes were allowed. Each set had five trials. Before the RST began, the participants practiced two trials at the two-sentence level.

2.4 Scoring

a. Reading Span Test

The total words method from Friedman and Miyake (2005) was adopted. In Just and Carpenter (1989), scores were provided only if the participant could answer over three trials correctly out of the five trials. However, this criterion is too strict to examine actual WMC of EFL learners. Friedman and Miyake (2005) revealed another method that provided higher reliability and higher correlations with reading comprehension than previous methods. To score this test, the total number of words recalled across all trials was calculated. For example, if a participant recalled three out of five words on the trial, he or she received three points for that trial. Because this score included words recalled from a set even if the other words in that set were not recalled, the method detects differences between individuals who could recall some words from each set and those who forgot most of the words in the set. The maximum score was 70. Spelling errors did not penalize the participants.

b. Recognition Task

The correct response rates and RTs were measured. With regard to RTs, the RTs of incorrect responses were excluded. Second, since the number of syllables of the probe verb phrases was different within 3–5 level sentences, RTs per syllable were calculated for each probe. Third, the responses longer than three standard deviations from the mean were also excluded based on Trabasso and Suh (1993). Although five responses were omitted by this criterion, all the participants’ data were analyzed from the remaining responses.
2.5 Data Analyses

To analyze RQ1 and RQ2, a two-way mixed design analysis of variance (ANOVA) was conducted on the correct response rates and RTs to examine goal inferences generation. The within-subject independent variable was the narrative text version (Hierarchical and Sequential). The between-subject variable was WMC group (Higher and Lower). The ANOVA was conducted against each probe point.

The following results were predicted: There would be no differences in the correct response rates and RTs between the hierarchical and sequential versions at probe point 1, but there would be differences at probe point 2. The main effects of the text version examined goal inferences at each goal structure. The two text versions had the same structure until point 1, but they had the different structure at point 2. In case the readers generated goal inference, they would respond more correctly in shorter RTs in the hierarchical version, which needs reader to make goal inferences. As for WMC, because probe point 1 is near the explicit presentation of goal information, holding goal information should not be too difficult, and there should be little or no effect of WMC. On the other hand, at probe point 2, since readers have to maintain goal information for a long time in WM and generate global goal inferences, there should be an effect of WMC. Since the ANOVA for RTs targeted RTs of correct responses, the number of targets available for analysis was 28 for probe point 1 and 25 for probe point 2.

3. Results

3.1 Reading Span Test

Table 2 shows descriptive statistics of RST scores. Based on the RST results, participants were divided into WMC higher and lower groups via a median split. The participants with an RST score greater than 47 comprised the higher group. Before the main analysis, a t-test was conducted to confirm that there was a significant difference between two groups on RST performance. The RST score of the WMC higher group was significantly higher than that of the lower group, t (39) = -8.40, p = .001, r = .80, 95%CI [-13.29, 18.13]. This means that the WMC of the higher group, according to the RST, was significantly better than the lower WMC group.

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>19</td>
<td>51.89</td>
<td>4.28</td>
<td>47</td>
<td>66</td>
<td>[49.83, 52.96]</td>
</tr>
<tr>
<td>Lower</td>
<td>22</td>
<td>41.18</td>
<td>3.89</td>
<td>32</td>
<td>46</td>
<td>[39.46, 42.91]</td>
</tr>
</tbody>
</table>
3.2 Correct Response Rates

To examine the existence of goal inference generation within each text version, the correct response rates were analyzed. Table 3 shows descriptive statistics for the correct response rates at points 1 and 2.

Firstly, at point 1, and as expected, there are no differences between hierarchical and sequential text versions and between WMC higher and lower groups. At point 1, results showed no main effects of text version $F(1, 39) = 0.12, p = .733, \eta^2 = .003$, WMC, $F(1, 39) = 2.00, p = .165, \eta^2 = .048$, and no interaction between the two, $F(1, 39) = 0.12, p = .733, \eta^2 = .003$. Therefore, there were no differences in goal inferences based on WMC and goal structure conditions at probe point 1. This is because goal structure is the same between the hierarchical and sequential versions until probe point 1, and because probe point 1 is so near the explicit presentation of goal information that the participants could respond accurately regardless of their WMC.

On the other hand, with regard to point 2, results revealed significant main effects of text version and WMC: text version, $F(1, 39) = 6.97, p = .012, \eta^2 = .147$; WMC, $F(1, 39) = 6.85, p = .013, \eta^2 = .149$. However, the interaction between the two factors was not significant, $F(1, 39) = 1.37, p = .249, \eta^2 = .028$. The results showed that the participants recognized the target probes more correctly in the hierarchical version than the sequential version, and the participants with higher WMC recognized them correctly than those who with lower WMC did. These results indicated that at point 2, the participants could generate goal inferences more correctly within the hierarchical version, which requires goal inferences throughout the narrative. Furthermore, at point 2, the participants with greater WMC generated more inferences that are correct.

### Table 3
**Descriptive Statistics of the Correct Response Rates**

<table>
<thead>
<tr>
<th>WMC Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher</td>
<td>22</td>
<td>.89</td>
<td>.31</td>
<td>.89</td>
<td>.31</td>
<td>1.00</td>
<td>.00</td>
</tr>
<tr>
<td>Lower</td>
<td>19</td>
<td>.77</td>
<td>.42</td>
<td>.73</td>
<td>.45</td>
<td>.86</td>
<td>.35</td>
</tr>
</tbody>
</table>

3.3 Response Times of Correct Responses

The correct response rates succeeded in providing evidence that EFL learners could appropriately generate goal inferences in line with the narrative structures. Next, RT data provided further evidence of on-line goal inference generation.
Table 4 shows descriptive statistics for RTs of correct responses at probe points 1 and 2. The goal inference conditions at two probe points are mentioned in some previous sections. With regard to point 1, results showed neither significant main effects nor an interaction: WMC, \( F(1, 28) = 0.34, p = .854, \eta^2 = .001 \); text version, \( F(1, 28) = 0.07, p = .796, \eta^2 = .002 \); and interaction, \( F(1, 28) = 1.11, p = .302, \eta^2 = .038 \). These results suggest that at probe point 1, there were no difference between the two versions and no statistical difference between the two RST groups. The RT results are similar to what we observed regarding the correct response rates at probe point 1. In addition, there was no effect of WMC on goal inferences at point 1 even after the explicit presentation of goal information.

While the ANOVA for point 2 indicated that there was no significant main effect of text version, \( F(1, 25) = 1.47, p = .236, \eta^2 = .046 \), and RST, \( F(1, 25) = 0.44, p = .513, \eta^2 = .017 \), the interaction between these factors was marginally significant, \( F(1, 25) = 3.92, p = .059, \eta^2 = .129 \). Although the results showed the interaction did not reach enough significant difference, the RTs of the individuals with different WMC in different texts versions were the theoretical interest of the present study. Therefore, a sub-effect was conducted on the marginally statistically significant interaction.

In order to deconstruct the marginally significant interaction, a test of simple main effects was conducted. This test revealed that text version was a significant factor for the WMC higher group, \( F(1, 25) = 6.26, p = .019 \). In addition, there was a marginally significant simple main effect of WMC within the hierarchical text version, \( F(1, 25) = 3.53, p = .072, \eta^2 = .128 \). Although this results should be interpreted with care, the results showed that the WMC higher group had shouter RTs to the hierarchical version than to the sequential version. Within the hierarchical version, the WMC higher group responded faster than the lower group. These results would mean that at point 2, participants who had higher WMC could respond quickly to goal information because they were able to adequately maintain goal information on-line and automatically make goal inferences.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Descriptive Statistics of Reading Times of Correct Responses</th>
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<tbody>
<tr>
<td></td>
<td>Point 1</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>WMC</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>( n )</td>
</tr>
<tr>
<td>Higher</td>
<td>22</td>
</tr>
<tr>
<td>Lower</td>
<td>19</td>
</tr>
</tbody>
</table>

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4. Discussion

The present study examined on-line goal inference generation and the effects of WMC on EFL reading. Answers to the two main research questions are discussed below.

For RQ1, the present study examined whether EFL learners appropriately generate on-line goal inferences in narrative reading. Results of the correct response rates at probe point 2 showed that EFL readers were more successful in recognizing target probes (i.e., goal information) in the hierarchical version than the sequential version as shown in Figure 1. This indicates that EFL readers generate goal inferences to better understand the relationship between incoming information and goal information, when goal information has been related. Therefore, EFL readers appropriately generated goal inferences in line with the goal structure.

Results for RTs at probe point 2 showed no main effect of text version. This means that EFL readers would not automatically activate goal information while reading. Combining these two results, one could suggest that EFL readers were able to generate appropriate goal inferences on-line with the goal structure, but they would not automatically activate goal information to generate these inferences. That is, it is possible that they succeeded in making goal inferences strategically, rather than automatically. However, is goal inference generation the same between individuals based on variability in WMC?

With regard to RQ2, which investigated effects of WMC, EFL learner’s WMC affected their on-line goal inference generation. EFL readers with greater WMC were more successful at recognizing the goal information than those with less WMC. This suggests that the higher WMC participants were able to generate goal inferences. However, there was a tendency that readers with greater WMC had better recognition scores in the sequential condition, as well. This suggests the possibility that more information that greater WMC EFL readers have, the more information they are able to maintain and activate merely. This possibility was addressed with the RT analyses.

For the RT analyses, the marginally significant interaction between WMC and text version was observed. The simple main effects indicated that those EFL readers who had greater WMC recognized goal information more quickly than those with smaller WMC in the hierarchical condition. This means that EFL readers with greater WMC would be able to automatically generate clear, on-line goal inferences. However, because this interpretation depends on the
marginaly significant interaction, the extent of automaticity and clarity of inferences by readers with higher WMC should be discussed carefully.

In summary, EFL readers generate goal inferences on-line with the goal structure regardless of WMC. However, not all EFL readers were able to generate automatically on-line goal inferences; it is likely that some participants generated inferences strategically. The present study showed that if EFL readers have a large WMC, they would be able to automatically generate clear, on-line goal inferences. Suh & Trabasso (1993), who investigated L1 readers’ reading, observed that on-line goal inference generation was confirmed from RT analyses. However, in EFL reading where EFL readers are experiencing a task with high cognitive load, those with greater WMC can generate on-line goal inferences. These individuals try to construct a coherent mental representations of a narrative by generating on-line goal inferences in a natural reading.

5. Conclusion

The current study was conducted to verify EFL learners’ on-line goal information processing and the influence of WMC during narrative reading. As a result, it was found that EFL learners generate goal inferences despite cognitive load while reading. Moreover, WMC affects on-line inference generation, and there was the possibility that EFL readers with greater WMC could automatically generate on-line goal inferences.

In terms of pedagogical implications, the current study suggests that teachers consider WMC and cognitive resources when providing reading instruction with inferences. EFL learners who have less WMC were not able to automatically generate on-line goal inferences. This is likely because these individuals have to deploy their cognitive resources toward lower-ordered processes. Thus, when EFL readers with small WMC read a text, or when they read a text that requires extensive cognitive resources, teachers need to provide more support. First, teachers could help these students use fewer resources by providing an appropriate text level that does not require difficult lexical access, syntactic processes, and so on. This should lead to EFL reading where readers could infer the connection between a goal and other information while constructing coherent mental representation of the text. Here, students should be able to formulate these processes gradually.

The present study verified how on-line goal inferences are influenced by WMC in EFL reading. However, limitations of this study should be noted. For one, this study did not show strong results about the extent of automaticity and clarity of on-line inferences in EFL reading. This points should be reconfirmed in further studies. Next, the present study did not examine EFL readers who have broader range of WMC along with presenting a broader range of cognitive load to participants. Since the study assumed EFL readers would have to allocate significant cognitive resources toward lower processes while reading, relatively easy narratives were used. However, it is possible that for EFL learners who have some reading proficiency, reading these narratives was
not too difficult. Future research should examine EFL readers' goal inferences by using more difficult texts (e.g., long texts, complex syntactic processing, goal structures).

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References


