The Contribution of Working Memory Capacity to Processing Sentences with Prepositional Phrases for Japanese EFL Learners

Hiroshi NAKANISHI
Tohoku Gakuin University

Abstract

This research addresses whether Working Memory (WM) capacity influences syntactic parsing strategies by using temporarily ambiguous prepositional phrases (such as “The boy read the book on the chair instead of the other books.”). We used four types of experimental sentences: minimal attachment and non-minimal attachment sentences, and two versions of modificant-prepositional phrase distance (i.e., short and long versions). The results showed that Japanese EFL learners, as well as L1 readers, find low non-minimal attached sentences more difficult to process than they do minimal attachment sentences. On the other hand, the length of the distance between the modificant and prepositional phrases does not affect processing performance. It was also found that the participants with a large WM capacity performed better than those with a small WM capacity, but they show the preference for minimal attachment regardless of WM capacity. This suggests that Japanese EFL learners, in the processing of temporarily ambiguous sentences with prepositional phrases, follow the Minimal Attachment Strategy regardless of WM capacity.

1. Introduction

Working Memory (WM) refers to a cognitive system that simultaneously processes and stores information; it plays an important role in complex cognition such as language comprehension (Baddeley, 1986; Just & Carpenter, 1992). In addition, the capacity of WM is strictly limited, and language processing is constrained by this capacity. The capacity is different according to the individual, and individual differences in WM capacity affect the process in sentence comprehension (Just & Carpenter, 1992). Furthermore, for Japanese EFL learners, whose language processing in English is less automatized than in L1 processing, L2 processing will consume more WM resources than L1 processing and will rapidly deplete those resources. Thus, the efficient functioning WM could be a stronger determining factor for language comprehension in L2 than in L1 processing (Geva & Ryan, 1993; Miyake & Friedman, 1998). Therefore, the issue of how WM capacity influences parsing strategies is central to current research on sentence processing, especially in L2 research.
The garden-path sentence, which contains temporarily ambiguous syntactic structure, such as sentences with reduced relative clause and prepositional phrase (i.e., “The horse raced past the barn fell” and “She loaded the boxes on the cart onto the van,” respectively) is often used to investigate the psycholinguistic mechanisms of human sentence processing. Previous L1 studies confirmed that participants took more time to read garden-path sentences than control sentences, and fixation durations were longer in the disambiguated region of the garden-path sentence (Ferreira & Clifton, 1986; Rayner et al., 1983; Frazier & Rayner, 1982). Such a phenomenon, known as the garden-path effect, occurs because the parser employs heuristics, such as building the simplest structure (minimal attachment) when more than one structure is licensed (Traxler, 2005). In these cases, the minimal attachment strategy guides the parser away from creating the extra clause constituent (or S-node) that is required by the reduced relative clause and prepositional phrase (Rayner et al., 1992). For example, the sentence “The horse raced past the barn fell” is a non-minimal attachment sentence. However, participants considered raced to be the main verb of the sentence, trying to build the simplest structure (Fig. 1a). The emergence of fell required them to reinterpret raced as a past principle form (Fig. 1b). In the same way, consider the sentence “She loaded the boxes on the cart onto the van,” which is a non-minimal attachment sentence. Following the minimal attachment strategy, the prepositional phrase on the cart is attached to the verb phrase loaded (Fig. 1c). However, the emergence of onto the van forced them to reanalyze the structure (Fig. 1d). This reanalysis is manifested by slower reading times and regressions in eye movement measurement studies (Ferreira & Clifton, 1986; Rayner et al., 1983; Frazier & Rayner, 1982).

Nakanishi (2007, 2011a) explored whether processing the garden-path sentence (reduced relative clauses with <animate> noun phrase), such as “The woman paid after the end of the month had worried the man,” is also difficult for Japanese EFL learners, and affects whether the capacity of WM influences parsing strategies. The results showed that the reaction times of the garden-path sentences in disambiguated regions (i.e., had worried) are longer than other types of sentences (unreduced relative clauses with <animate>noun phrase), such as “The woman that was paid after the end of the month had worried the man,” irrespective of WM capacity. These results suggest that Japanese EFL learners parse sentence following the principles of minimal attachment strategy regardless of their WM capacity.
The first purpose of the present study is to explore the parsing process of other types of garden-path sentences (specifically sentences with prepositional phrases) for Japanese EFL learners and the contribution of WM capacity to the parsing process.

The other purpose of the present study is to explore whether the distance between modificand (verb phrase and second noun phrase) and prepositional phrase affects the parsing strategy. It is hypothesized that the longer the distance between the two factors is, the more difficult the participants have maintaining the multiple modifiee in WM, which results in difficulty
attaching the prepositional phrase with a modificand of a further distance—in this case, verb phrase—especially for the participants with small WM capacity.

2. Purpose

The purposes of the present experiment were as follows:
1. To examine whether the parsing strategies of Japanese EFL learners are based on minimal attachment strategy, such as in L1 studies
2. To explore whether or not the length of the modificand-prepositional phrase distance (short and long sentence conditions) influence parsing strategy
3. To investigate whether or not WM capacity influences parsing strategy

3. Method

3.1 Participants

The participants in the present study were 69 Japanese university students: 54 females and 15 males.

3.2 Procedure

The participants completed two tasks: (1) the Reading Span Test (RST) and (2) a sentence-processing task. All the tasks were completed on a Windows computer, using a psychological experiment software SuperLab Pro 4.5 (Cedrus Corporation, 2010). The entire experiment took approximately 40 minutes.

3.2.1 The RST

The RST, originally developed by Daneman and Carpenter (1980), is a commonly used assessment of a participant’s verbal WM capacity. In the original version of L1 RST, the participants were asked to read aloud a set of unrelated sentences presented on cards and then recall the final words of each sentence. The RST can provide insights into the efficient functioning of the WM and how participants allocate their finite WM resources to the processing and storage functions (Nakanishi & Yokokawa, 2011). In this experiment, we adopted a computer-based version of the RST for Japanese EFL learners (Nakanishi, 2007, 2011a).

The RST was administered as follows: after the fixation marker was presented for one second on a computer monitor, the marker was replaced with a sentence. The participants were required to press the space key immediately after they read the sentence aloud and to remember the final word of the sentence. Then the Japanese equivalent of the previous English sentence appeared on the monitor. The participants were required to press the B key if the sentence was correct and press N if it was incorrect. Then, the next sentence appeared on the monitor following
the fixation mark. The participants were asked to read the sentence while remembering the final word of the former sentence, and then they were asked to perform the Japanese translation verification task. This procedure was repeated until they saw an instruction indicating the end of the session. Then, the participants were required to write down on an answer sheet all the final words of the sentences that had been presented. For example, under the four-sentence condition, after the participants read four sentences and were asked to remember each final word, they encountered the instruction showing the end of the session. They were then required to write four final words on the answer sheet. Sentences were presented to the participants under the conditions of two, three, four, and five sentences. Each condition consisted of three sets. The participants were asked to read aloud increasingly longer sets of sentences until they finished reading three sets of five-sentence conditions. The test consisted of 42 sentences. Part of the modified versions of the experimental sentences used in tests by Osaka and Osaka (1992) and Harrington and Sawyer (1992) were used in this experiment (see Appendix A). The RST, incorporated with a Japanese translation task, is confirmed to correlate significantly with the standard version of the RST ($r = 0.39, p < .01$) and English proficiency test (i.e., Oxford placement test and reading section of the 2nd grade STEP; $r = 0.45, p < .01, r = 0.38, p < .05$, respectively) (Nakanishi & Yokokawa, 2011).

3.2.2 The sentence-processing task

Eight sets of sentences such as those in Table 1 were constructed. There were four versions of each sentence. In two of the sentences, the minimal attachment analysis of the sentence was designed to be the most plausible syntactically, as in (1) and (3); in the other two sentences, the non-minimal attachment analysis was the most plausible, as in (2) and (4). The length between second noun phrase and the prepositional phrase was varied by inserting adverb phrases (i.e., on Sunday morning) within both the minimal attachment and non-minimal attachment sentences, yielding a short and long version of each. The sentences were constructed to be in a pragmatically neutral context. In an interactive view, the initial parsing decision is affected by various factors, such as the semantic structure of a verb (Ford et al, 1982), the biasing context (Britt et al, 1992), and the verb argument structure (Abney, 1989; Britt, 1994). In this experiment, we focus on Japanese EFL learners’ parsing strategies in neutral contexts.

A total of 52 sentences were used, including 8 sentences for each sentence type and 20 sentences for fillers (see Appendix B). The number of syllables in the sentences and the familiarity of the sentences (Yokokawa et al., 2006) were set to be statistically equal among the tests ($F = 0.402, ns, F = 0.413, ns$, respectively).

Sentences were presented phrase-by-phrase in a computer-generated random order. When participants pressed the space button to advance the display to the next phrase in a sentence, the previous phrase would revert to dashes and the next phrase appeared. The procedure continued until the final phrase of the sentence appeared. Each sentence was followed by a comprehension
question (i.e., Who had the car? (b) woman (n) man). The participants were asked to press the appropriate key as quickly as possible.

Table 1
Sample sentences from the sentence-processing task

(1) Minimal Attachment — Short
The woman visited the man with a car instead of walking.

(2) Non-minimal Attachment — Short
The woman visited the man with a car instead of the man with a bike.

(3) Minimal Attachment — Long
The woman visited the man early this morning with a car instead of walking.

(4) Non-minimal Attachment — Long
The woman visited the man early this morning with a car instead of the man with a bike.

4. Results

4.1 Reading span data
4.1.1 Reading span data for all the participants
First, Table 2 shows the reading span scores. The recall score is the total number of sentence-ending words remembered, the e-f score represents the number of recalled words when the participants correctly processed the presented sentences, and the accuracy shows the number of sentences processed correctly.

Table 2
Descriptive statistics of RST data for all participants

<table>
<thead>
<tr>
<th></th>
<th>Recall score</th>
<th>E-f score</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave.</td>
<td>27.41</td>
<td>22.06</td>
<td>32.71</td>
</tr>
<tr>
<td>Min.</td>
<td>5.33</td>
<td>5.55</td>
<td>4.30</td>
</tr>
<tr>
<td>Max.</td>
<td>10.00</td>
<td>18.00</td>
<td>21.00</td>
</tr>
<tr>
<td>S.D.</td>
<td>35.00</td>
<td>39.00</td>
<td>40.00</td>
</tr>
</tbody>
</table>

Note: N = 69, Mark range: 0–42 (Recall, E-f score, Accuracy).

4.1.2 RST span data by WM size
The participants were divided into two groups according to their e-f scores: those with a larger WM capacity were in one group, while those with a smaller WM capacity were in another. Each group consisted of 35 and 34 students, respectively. Tables 3 and 4 show RST data for individuals with larger and smaller WM capacity. A significant difference exists between the
larger and smaller WM groups in recall, e-f scores, and accuracy (recall: $t(67) = 6.6305, p < .01$; e-f score, $t(67) = 9.8206, p < .01$; accuracy: $t(67) = 5.1168, p < .01$). The reason the higher WM group obtained higher recall and e-f score was that they could conserve as much of their WM resources as possible for the storage function, while using as little of their resources as possible for the processing function.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>Recall score</th>
<th>E-f score</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave.</td>
<td>30.69</td>
<td>26.23</td>
<td>34.94</td>
</tr>
<tr>
<td>Min.</td>
<td>24.00</td>
<td>22.00</td>
<td>28.00</td>
</tr>
<tr>
<td>Max.</td>
<td>39.00</td>
<td>35.00</td>
<td>40.00</td>
</tr>
<tr>
<td>S.D.</td>
<td>4.63</td>
<td>4.28</td>
<td>3.59</td>
</tr>
</tbody>
</table>

Note. N = 35, Mark range: 0–42 (Recall, E-f score, Accuracy).

Table 4

<table>
<thead>
<tr>
<th></th>
<th>Recall score</th>
<th>E-f score</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave.</td>
<td>24.03</td>
<td>17.76</td>
<td>30.41</td>
</tr>
<tr>
<td>Min.</td>
<td>18.00</td>
<td>10.00</td>
<td>21.00</td>
</tr>
<tr>
<td>Max.</td>
<td>31.00</td>
<td>21.00</td>
<td>38.00</td>
</tr>
<tr>
<td>S.D.</td>
<td>3.64</td>
<td>2.67</td>
<td>3.77</td>
</tr>
</tbody>
</table>

Note. N = 34, Mark range: 0–42 (Recall, E-f score, Accuracy).

4.2 Sentence-processing task data

Tables 5 through 7 provide the average scores, reaction times (RTs; ms) per syllable for correct responses, and solution times (STs; ms) for the correct responses in the short- and long-distance conditions. The scores revealed a reliable interaction of sentence type and region, $F = 14.303, p < .01$. A 2 (minimal versus non-minimal attachment) × 2 (long versus short distance) ANOVA was performed on the scores, RTs, and STs. As for scores, the analysis of variance revealed that there was a significant main effect of attachment type, $F(1, 276) = 261.475, p < .01$ and the interaction was also significant, $F(3, 276) = 4.014, p < .05$. The analysis of the simple main effect of attachment type and distance disclosed that the scores of minimal attachment were higher than those of non-minimal attachment ($p < .01$), and the scores of longer distance was higher than those of shorter distance in minimal attachment ($p < .05$). As with RTs, the results of the two-way ANOVA revealed that there was no significant main effect in attachment and distance ($F(1, 264) = 2.097, ns; F(1, 264) = .004, ns$, respectively). The analysis also indicated that there
was no interaction between attachment and distance $F(1, 264) = .002, ns$. Finally, STs produced a reliable interaction of attachment type and distance $F(1, 264) = 6.301, p < .05$, while there were not any significant main effects on the attachment and distance ($F(1, 264) = .493, ns; F(1, 264) = 1.643, ns$, respectively). The analysis of the simple main effect of attachment type and distance disclosed that the STs for the NMA were significantly longer than those for the MA in the long-distance condition ($p < .01$) and STs for the long distance were significantly longer than those for the short distance in NMA condition ($p < .05$).

Table 5

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th></th>
<th>Long</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MA</td>
<td>NMA</td>
<td>MA</td>
<td>NMA</td>
</tr>
<tr>
<td>Average</td>
<td>5.99</td>
<td>3.12</td>
<td>6.62</td>
<td>2.94</td>
</tr>
<tr>
<td>S.D.</td>
<td>1.43</td>
<td>2.00</td>
<td>1.32</td>
<td>1.88</td>
</tr>
</tbody>
</table>

Note. N = 69, Mark range: 0-8

Table 6

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th></th>
<th>Long</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MA</td>
<td>NMA</td>
<td>MA</td>
<td>NMA</td>
</tr>
<tr>
<td>Average</td>
<td>478.97</td>
<td>480.92</td>
<td>453.88</td>
<td>454.06</td>
</tr>
<tr>
<td>S.D.</td>
<td>139.64</td>
<td>165.28</td>
<td>133.35</td>
<td>143.74</td>
</tr>
</tbody>
</table>

Note. MA: N = 69, NMA: N = 63

Table 7

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th></th>
<th>Long</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MA</td>
<td>NMA</td>
<td>MA</td>
<td>NMA</td>
</tr>
<tr>
<td>Average</td>
<td>3414.35</td>
<td>3230.11</td>
<td>3143.20</td>
<td>3711.83</td>
</tr>
<tr>
<td>S.D.</td>
<td>1173.06</td>
<td>1223.19</td>
<td>1098.40</td>
<td>1371.92</td>
</tr>
</tbody>
</table>

Note. MA: N = 69, NMA: N = 63

4.3 Overall performances of sentence-processing task by WM capacity

What follows is an analysis of the data in terms of WM capacity. Figures 2 through 7 provide the scores, RTs per syllable, and STs for correct responses for individuals with high and low reading spans. A 2 (attachment) $\times$ 2 (distance) $\times$ 2 (WM) ANOVA revealed that there were no significant interactions among WM, attachment type, and distance ($F(1, 276) = .957, ns$ in scores;
$F(1, 264) = .042, ns$ in RTs; $F(1, 264) = .528, ns$ in STs, respectively. Scores did not reveal any main effects or interaction. As for RTs, the main effect of WM was marginally significant, $F(1, 264) = 3.020, p = .083$. However, no other effects were reliable. As for STs, there was a significant main effect on WM, $F = 5.515, p < .05$. In addition, STs produced a significant interaction between attachment type and distance, $F(1, 264) = 6.346, p < .05$. However, no other effects were reliable. The analysis of the simple main effect of attachment type and distance disclosed that the STs of the long-distance condition were longer than those of short-distance condition in an NMA sentence ($p < .05$).
4.4 RTs per syllable in different regions of sentences by WM capacity

We also analyzed the RTs for certain regions. The regions are divided into the six or seven areas of the disambiguating phrase as follows: (1) Noun phrase, (2) verb phrase, (3) second noun phrase, (4) adverbial phrase (in a long-distance condition), (5) ambiguous segment (prepositional phrase), (6) neutral phrase, and (7) disambiguating segment (see Table 8).

Mean reading times in each region for all the participants are shown in Figure 8. A 4 (sentence type) × 7 (region) ANOVA revealed that there was a significant main effect of region, $F(6, 1716) = 71.104, p < .01$. However, the main effect on sentence type was not significant, nor was the interaction between sentence types and region, $F(3, 1716) = 1.317, ns$, and $F(16, 1716) = .985, ns$, respectively.

Table 8

<table>
<thead>
<tr>
<th>Scoring regions of sentences with prepositional phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Minimal Attachment — Short</td>
</tr>
<tr>
<td>The woman / visited / the man /</td>
</tr>
<tr>
<td>/ with a car / instead of / walking.</td>
</tr>
<tr>
<td>1 2 3 5 6 7</td>
</tr>
<tr>
<td>2) Non-minimal Attachment — Short</td>
</tr>
<tr>
<td>The woman / visited / the man /</td>
</tr>
<tr>
<td>/ with a car / instead of / the man with a bike.</td>
</tr>
<tr>
<td>1 2 3 5 6 7</td>
</tr>
<tr>
<td>3) Minimal Attachment — Long</td>
</tr>
<tr>
<td>The woman / visited / the man / early this morning /</td>
</tr>
<tr>
<td>/ with a car / instead of / walking.</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
</tr>
<tr>
<td>4) Non-minimal Attachment — Long</td>
</tr>
<tr>
<td>The woman / visited / the man / early this morning /</td>
</tr>
<tr>
<td>/ with a car / instead of / the man with a bike.</td>
</tr>
<tr>
<td>1 2 3 4 5 6 7</td>
</tr>
</tbody>
</table>

![Figure 8 RTs per syllable in each region for all the participants](image-url)
Furthermore, an ANOVA on the per syllable reading times in region 7, the disambiguating region, was carried out. No effect of sentence type approached significance, $F(3, 264) = 1.398$, ns.

Figures 9 and 10 present RTs per syllable by region for each WM span group. A $2 \times 4 \times 7$ ANOVA crossing WM (larger or smaller), sentence condition (SMA, SNMA, LMA, LNMA), and region (1-7) yielded a significant main effect of WM and region, $F(1, 1716) = 8.999, p < .01, F(6, 1716) = 70.876, p < .01$, respectively. Neither the main effect of sentence condition, $F(3, 1716) = 1.382$, ns, the interaction of WM $\times$ region, $F(3, 1716) = .376$, ns, the interaction of WM $\times$ region, $F(6, 1716) = .609$, ns, the interaction of sentence type sentence type $\times$ region, $F(16, 1716) = .994$, ns, nor the interaction of WM $\times$ sentence type $\times$ region, $F(16, 1716) = .215$, ns.

Furthermore, an ANOVA on per syllable reading times in region 7, the disambiguating region, was carried out. The main effect of WM was significant, $F(1, 264) = .900, p < .05$. However, the main effect of sentence type and the interaction of WM $\times$ sentence type were not significant, $F(3, 264) = 1.399$, ns, $F(3, 264) = .130$, ns, respectively.
In conclusion, the findings of section 4 can be summarized as follows:
(1) In the RST, a larger WM group could perform significantly better than a smaller WM group in terms of scores, e-f scores, and accuracy.
(2) The scores on NMA sentences were significantly worse than that those of MA sentences for all the participants.
(3) NMA s in long-distance conditions resulted in longer solution times than MAs in short-distance condition for all the participants.
(4) Larger WM groups could read and comprehend sentences with prepositional phrases significantly faster than smaller WM groups.
(5) Regional analysis of RTs showed that participants with larger WM exhibited very similar processing patterns as those with smaller WM.

5. Discussion

One of the main findings of this study was that Japanese EFL learners followed the minimal attachment (MA) strategy regardless of distance and WM capacity. This result mainly stems from data showing that the accuracy rate in NMA sentences was significantly lower than in MA sentences, regardless of distance condition (see Table 5) and that STs in NMA sentences were significantly longer than those in MA sentences in longer distance conditions (see Table 7). In this study, the distance between the modificand and prepositional phrase was varied by inserting prepositional phrases. The results suggest that the longer distance does not necessarily cause higher memory cost for the participants in order to change their syntactic strategy.

The other main finding of this study was that participants with larger WM capacity could read and comprehend sentences faster than those with lower WM capacity could. It can be concluded from the data that RTs and STs for the participants with longer WM were faster than those for participants with smaller WM capacity were (see Figures 4–7). In addition, the analysis of the RTs by region revealed that there was a significant main effect of WM (see Figures 9 and 10). The results were consistent with previous L2 studies using other types of temporally ambiguous sentences, such as garden path sentences and lexically ambiguous sentences (Nakanishi, 2007, 2011b). Processing such syntactically complex sentences requires a number of WM resources, and therefore, the participants with smaller WM could not utilize WM resources to interrupt such a syntactically complex structure, because they used up their resources to process the language itself (i.e., lexically, syntactically, semantically, pragmatically, and schema processing).

However, as Figures 9 and 10 show, RTs in critical disambiguating regions did not produce any significant difference between MA sentences and NMA sentences, which is not consistent with L1 previous studies. The previous L1 studies showed that NMA sentences were read more slowly than MA sentences because the syntactic analysis based on MA strategy turned out to be
incorrect, and the parser is led down the garden path (Ferreira & Clifton, 1986) and has to reanalyze the structure that was already built. On the other hand, this study showed that the STs in LNMA took significantly longer than those in LMA (see Table 7). This result suggests that the reanalysis process did not take place in disambiguating region but during the comprehension of the sentence as a whole for Japanese EFL learners. Japanese EFL learners may not have enough WM resources to take extra work for giving up the initial syntactic analysis when the critical disambiguating phrases are emerging, even in MA sentences. When and how Japanese EFL learners' syntactic reanalysis takes place is an issue to be studied in a future study.

6. Conclusion

Language comprehension includes various stages of processing (i.e., phonological, lexical, syntactic, semantic, pragmatic, and schema processing), all of which take place in the WM by retrieving appropriate information from our knowledge in long-term memory. Especially for Japanese EFL learners, syntactic processing is not fully automatized and thus consumes a large amount of WM resources, leaving scarce resources for supporting the storage of processed information (Nakanishi & Yokokawa, 2011) and further processing. The present study, however, suggests that Japanese EFL learners follow MA strategies in neutral contexts just as well as native speakers. This tendency was found under conditions when the distance between the modificand and prepositional phrase was longer and their WM capacity was smaller. Thus, it can be concluded that MA strategies may be efficient with low WM memory cost.

In further studies, we will explore how non-syntactic information such as pragmatic plausibility, prior context, and verb argument determine the initial syntactic strategy, and whether the ability to make use of non-syntactic information during parsing depends on individual differences in WM capacity. Previous L2 studies have shown that Japanese EFL learners, whose syntactic processing is not fully automatized, tend to deploy semantic cues while parsing sentences (Satoi et al., 2002; Kadota, 2006) and such semantic information (i.e., the animacy of the subject NP) reduces the processing difficulty of the garden path sentences (unreduced relative sentences) for both larger and smaller WM span readers (Nakanishi, 2007). In the next experiment, we will explore how such non-syntactic information is used to build syntactic structures during sentence comprehension and whether the strategy is different according to WM capacity using the temporally and syntactically ambiguous sentences with prepositional phrases, which will help further investigate the nature of L2 syntactic processing.

Acknowledgement

This study was partially supported by a JSPS Grant-in-Aid for Research Activity Start-up "The relation of Working Memory capacity of Japanese EFL learners with the processing of

293
syntactically ambiguous sentences" (PI: Hiroshi Nakanishi, No. 22820052).

References


Appendix A: Sample sentences of the RST

**Two-sentence condition**

They rented their house to him, not knowing he was poor.

The man gave the old woman a ride to the station.

**Three-sentence condition**

He decided to walk as far as he could in the snow.

She saw the boy who was talking to her sister.

The boy played football all day and hurt his foot.
Four-sentence condition
The telephone rang when he was about to have breakfast.
The knife was so sharp he almost cut his hand.
Their love only lasted one and a half months.
Spring is a season that people often associate with love.

Five-sentence condition
One day he had to go away for a short time.
The girl said nothing, which made her mother angry.
The first teacher arriving in the morning always picks up the mail.
The letter said you should bring your computer in for repair.
This is a story about a priest and his church.

Appendix B: Sample sentences of the sentence-processing task

Minimal Attachment—Short
The doctor examined the child with a pen instead of another tool.
The boy read the book on the chair instead of lying in bed.
The woman talked to the man with a cell phone and then she made another call.
The girl met the boy with a dog and then she walked the dog home.

Non-minimal Attachment—Short
The doctor examined the child with a pen instead of the child without a pen.
The boy read the book on the chair instead of the other books.
The woman talked to the man with a cell phone instead of the man with a computer.
The girl met the boy with a dog instead of the boy with a cat.

Minimal Attachment—Long
The doctor examined the child last Monday morning with a pen instead of another tool.
The boy read the book last Sunday morning on the chair instead of lying in bed.
The woman talked to the man night before last with a cell phone and then she made another call.
The girl met the boy early last summer with a dog and then she walked the dog home.

Non-minimal Attachment—Long
The doctor examined the child last Monday morning with a pen instead of the child without a pen.
The boy read the book last Sunday morning on the chair instead of the other books.
The woman talked to the man night before last with a cell phone instead of the man with a computer.
The girl met the boy early last summer with a dog instead of the boy with a cat.