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Original Paper

Priming Effect on Automatisation of L2 Prepositional-Phrase Processing Ability

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Abstract

Most L2 learners cannot process a second language as native speakers do because of their less automatic syntactic processing ability. In this article, the author reports two experiments that used a word-by-word self-paced reading task to examine how Japanese language learners of English process English prepositional phrases. The study also examined whether these learners could improve their syntactic processing ability, using the priming method. The research findings showed that while L2 learners had more difficulty processing a prepositional phrase when it modified the noun of the matrix verb than modified the verb, they were able to overcome that difficulty with appropriate primes. The research findings indicated that L2 learners were able to improve their syntactic processing ability if they encountered the same syntactic structure repeatedly.

Keywords

syntactic priming, ambiguity resolution, automatisation, second language acquisition

1. Introduction

The technical term “automatisation” has attracted the interest of many second language acquisition scholars as it is one of the key components for becoming a fluent language user (McLaughlin, 1987) and because developing fluency in the second language is the ultimate goal for L2 learners (Lim & Godfroid, 2014). However, compared with native speakers, most L2 learners lack an automatic representation of syntactic structures, which is one of the subcomponents considered to play a key role in sentence comprehension (Terauchi, 2010; Geba & Ryan, 1993). This is considered to be one of the reasons why most L2 learners of English often find it difficult to read English fluently (Yokokawa, Sadato, & Yoshida, 2014). Studies have proved that L2 learners’ syntactic processing ability is qualitatively different from that of L1 speakers (Felser & Roberts, 2007). In addition, many L2 learners tend to have trouble using or processing prepositional phrases, especially “with”, due to their different meanings in different contexts. Studies have shown that the syntactic processing ability of L2 learners improves if they are exposed to syntactic structures repeatedly (Nagai & Yokokawa, 2010). Thus, the present study explores how Japanese language learners of English process prepositional phrases when the prepositional phrase

"with" is attached either to the matrix verb or the direct object of the verb. The study also examines whether L2 learners can process prepositional phrases automatically.

2. Literature Review

Sentence processing is considered to be important in second language acquisition. Several studies have hitherto clarified that sentence processing of L2 learners is subject to non-structural factors such as plausibility and pragmatic information (Roberts, Gullberg, & Indefrey, 2008; Robert & Felser, 2011; Williams, Mo'bius, & Kim, 2001). However, there are many aspects of L2 sentence processing that remain unexplored. One of them is how L2 learners process English prepositional phrases. In L1 prepositional-phrase studies, it is basically considered that native speakers of English are likely to interpret a prepositional phrase in a sentence such as "*Tom shot the man with a pistol*" as a verb phrase modifier rather than a noun phrase modifier (Clifton, Speer, & Abney, 1991; Rayner, Carlson, & Frazier, 1983). However, only a few studies have clarified the mechanisms of L2 learners' sentence processing of prepositional phrases. A recent study by Pan and Felser (2011) investigated how Chinese language learners of English deal with attachment ambiguities containing prepositional phrases. They reported that the L2 participants had a preference for verb phrase modification over noun phrase modification from the research finding that the L2 learners were garden pathed when they read a noun phrase modification. The garden-path phenomenon refers to the situation when the readers realise that their first interpretation of a sentence is wrong (Pritchett, 1992). The observation of the garden-path phenomenon depends on reading times because reinterpretation takes more time than reading without reinterpretation. Therefore, Pan and Felser (2011) indicated that the L2 learners had more difficulty processing a noun phrase modification. However, to the best of my knowledge, no research has attempted to explore whether Japanese language learners of English face more difficulty processing a prepositional phrase attached to the direct noun of the matrix verb than to the verb and whether they can overcome this difficulty. It is important to apply previous research results to language learners whose first language is different from those whom the previous research was directed for given that L1 is considered to influence L2 sentence processing (Frenck-Mestre & Pynte, 1997; Harrington, 1987). With regard to the occurrence of automatisation, the priming method is thought to be one of the effective ways. Priming refers to "facilitative effects of an encounter with a stimulus on subsequent processing of the same stimulus (direct priming) or a related stimulus (indirect priming)" (Tulving, Schacter, & Stark, 1982, p. 336). For example, individuals are likely to produce a double object construction like *Meghan gave Michael a hug* immediately after hearing or producing a sentence containing the same structure like that one instead of a prepositional object construction such as "*The teacher sent the students a message*" (Kaschak et al., 2011). This facilitation effect indicates a sign of automatisation because facilitation includes fast and less effortful processing, which are a part of automatisation (Segalowitz, 2003). Thus, if the priming effect is observed when L2 learners read prepositional phrases containing a noun phrase modification consecutively, it will suggest that they can process a noun phrase attachment more easily and thus

automatically in the long run. From the previous studies, I developed the following research questions:

RQ1. Do Japanese language learners of English have a certain preference for prepositional phrase attachment?

RQ2. Do L2 learners enjoy benefit from the priming effect, and are their syntactic processing ability automatised?

3. Method

3.1 Experiment 1

Experiment 1 was conducted to investigate whether Japanese language learners of English have an attachment preference for prepositional phrases.

3.1.1 Participants

A total of 15 university students majoring in English education at Osaka Kyoiku University participated in Experiment I. Each participant was paid in compensation for his or her time. All of them had normal hearing and normal or corrected to normal vision. Their English proficiency was measured by the Versant English Test, which showed that their English level was between A2 and B1 on the Common European Framework of Reference for Languages (CEFR). All of them had little knowledge of psycholinguistic methods and considered English as L2.

3.1.2 Self-Paced Reading Task

The experiment involved the self-paced reading task, which is a widely used psychological technique to measure reading times. In this task, each participant is presented with a set of sentences segmented either word-by-word or phrase-by-phrase and asked to read one word or one phrase at a time and press the button when he or she is ready for the new word or phrase. The sentences used in this experiment were presented word-by-word. A cue appeared at each sentence before the first word of each sentence was shown in order to inform the participants of the position of the first word, and the previous word disappeared as a new word appeared to prevent them from backtracking and seeing the entire sentence on the screen at the same time.

3.1.3 Materials

In this experiment, 16 sets of two sentences were constructed. One set will be exemplified below.

(a) The engineer repaired the front door with a tool at night.

(b) The engineer repaired the front door with a hole at night.

As stated above, each sentence was manipulated to appear word-by-word and began with a subject noun phrase, a verb and a direct object followed by two prepositional phrases. Two sentences of each set were composed of the same words except for ones appearing in the critical region, which were the last word of the first prepositional phrase and at the subsequent regions. Depending on reading times taken by the participants to read these segments, it was revealed whether L2 learners have a preference for either the verb phrase or noun phrase attachment. In addition, the experiment also included segments to observe the garden-path effect and spillover effect. The spillover effect is considered to be important, especially

in L2, because it shows how the L2 learners can recover from garden paths. It also shows that the garden-path effect could be delayed in L2 sentence processing due to the low language proficiency of the L2 learners. These regions were matched in length. If a significant difference in reading times between the verb phrase modification and the noun phrase modification is found, the number of letters in those regions of each condition cannot account for it. In addition, each set contained exactly one condition of each experimental set in order to prevent the participants from being presented both conditions of each set. The second prepositional phrase in each sentence played a role to prevent the participants from sentence or clause wrap-up. The sentence or clause wrap-up refers to the phenomenon where the readers are likely to spend longer time on sentence- or clause-final words than on sentence- or clause-internal words since it has been traditionally considered that the integration of information is implemented in this region (Aaronson & Scarborough, 1976; Just & Carpenter, 1980; Warren, White, & Reichle, 2009). All the words used in the experimental sentences were drawn from words appearing in the list of Yokokawa (2006) with word familiarity of at least 4.0 on a scale from 7 (referring to the highest familiarity) to 1 (the lowest familiarity). This procedure was considered to easily process those words so that a difference in reading times cannot be attributed to the lexical factor.

3.1.4 Procedures

The experiment was conducted in Super Lab 5, which is a sentence processing experimental presentation program and run on an operating system, OS X in a MacBook Air. Each participant was instructed to sit in front of the computer monitor to receive aural and written on-screen instructions in their first language and to press the spacebar with the index finger of his or her dominant hand to reveal each subsequent word and make all other words revert to dashes. After experiencing eight practice trials to get accustomed to self-paced reading, each participant was provided 16 experimental sentences and 48 filler sentences of various types, which were to reduce the likelihood that the participants would recognise the targeted linguistic structure. Half of both the experimental and filler sentences were followed by a yes/no question, which the participants had to answer by pressing a Y (yes) or N (no) key as appropriate.

Table 1. Accuracy Score Percentages for Comprehension Questions Following the Experimental and Filler Sentences

	VP attachment	NP attachment	Filler
Japanese L2 learners	88	77	87

Note: VP, verb phrase; NP, noun phrase.

The sentences on each list were pseudo-randomised by manipulating at least three filler sentences appearing between two experimental items in an attempt to avoid the possibility that the participants would notice the experiment's objectives. Between the two trials including the experimental and filler sentences, a screen was shown to encourage the participants to take a short break if necessary. Each

participant took approximately 15 min on an average for each task.

4. Results for Experiment 1

All the participants in this experiment responded to at least 85% of the sentences followed by a comprehension question. In addition, the incorrectly answered target trials were removed from the analysis, and the remaining data of reading times were trimmed to within two standard deviations in each condition for each participant. The latter procedure was executed for the removal of possible outlier values. This procedure affected less than approximately 7% of the data. The Wilcoxon signed-rank test was performed on the mean reading times for the three segments from the critical region to the end of the sentence and on the total reading times of the comprehension questions. Here, only the results of these segments are presented, as each condition was identical up to the critical region.

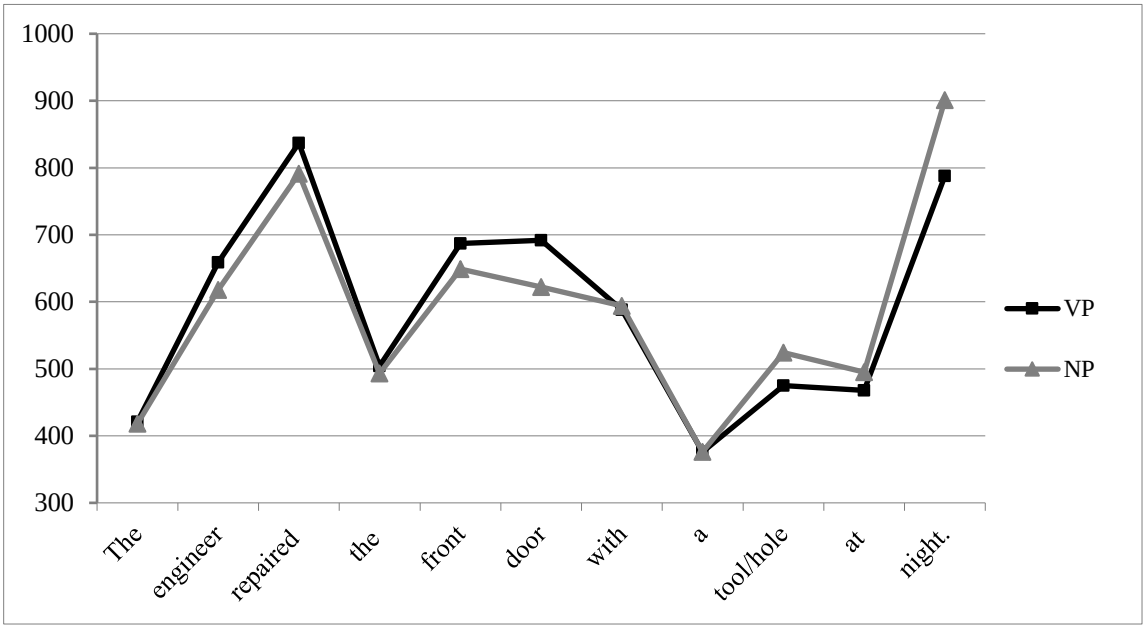

Figure 1. Word-by-Word Reading Times for Prepositional Phrase Attachment Sentences

In Segment 9, where the participants' preference is revealed, there was a significant difference in reading times between verb phrase and noun phrase attachments ($z = 2.29$, $p = 0.02$, $r = 0.42$). This statistical difference indicates that the participants had a tendency to read verb phrase modifications more quickly than the noun phrase modifications. In the following segment, which was to capture the spillover effect from the preceding word, there was no significant difference between the verb phrase and noun phrase conditions ($z = 0.99$, $p = 0.32$, $r = 0.18$) though the difference of reading times seemed to indicate that the participants had difficulty processing this segment when it was the noun phrase attachment (VP: 468 vs. NP: 495 ms). Segment 11 supports the possibility that they might have had difficulty recovering from garden paths as on this segment there was a significant difference in reading times, indicating that the difficulty of recovery from garden paths lasted to the end of the sentence ($z = 2.36$, $p = 0.02$, $r = 0.43$).

However, no evidence of processing difficulty was observed on the summed up reading times of comprehension questions ($z = 0.12$, $p = 0.90$, $r = 0.02$) (VP: 3677, NP: 3909 ms). Nevertheless, the rates of accuracy scores for comprehension questions following either verb phrase or noun phrase sentences showed that there was a significant difference between those percentages ($U = 65$, $p = 0.03$, $r = 0.39$) (VP: 88%, NP: 77%). These results suggest that the participants seemingly succeeded in recovery from being garden pathed during on-line processing, and therefore, the difficulty of comprehension questions both for verb phrase modifications and noun phrase modifications seemed equal to them, but they failed to recover from garden paths. Note that the result of the off-line reading times could not be attributed to the length of the comprehension questions because the mean number of letters of the comprehension questions for the verb phrase attachments and noun phrase attachments is approximately 18.9 and 17.1, respectively, and there was no significant difference between them ($U = 22.5$, $p = 0.30$, $r = 0.30$).

The results of Experiment 1 indicated that like L1 speakers of English, Japanese language learners of English found it more challenging to process a prepositional phrase attached to the postverbal noun than that modifying the matrix verb. Although they had difficulty processing the subsequent segments of the noun phrase sentences, the processing difficulty appeared to disappear at the end of the sentence, which was evidenced by the off-line reading times. However, it was likely that the participants could not recover from garden paths after all, given the average scores of the comprehension questions. Based on these results, Experiment 2 was conducted to examine whether L2 learners could overcome the difficulty caused by a noun phrase attachment.

5. Method

5.1 Experiment 2

Experiment 1 showed that Japanese language learners of English read the verb phrase modification more easily than the noun phrase modification. Experiment 2 was performed with the self-paced reading task to test the possible priming effect on automatisation of L2 learners' prepositional-phrase processing ability.

5.1.1 Participants

A total of 15 students studying at the Osaka Kyoiku University participated in this experiment. These students were paid for their participation. All of them took the Versant English Test, which proved that their English proficiency was between A1 and B2 on the CEFR. None of these students had participated in Experiment 1.

5.1.2 Materials

In order to clarify the possible effect of syntactic priming on processing a prepositional phrase, 16 priming sentences were constructed to trigger the priming effect. The following sentence is one of the priming sentences:

(1) The child cleaned the shelf with the cloth, not using the cloth.

In order to make it easy for the priming effect to occur, the prime sentence is manipulated to cause

reanalysis during the course of sentence processing. This means that the sentence seems to contain a noun phrase attachment up to the point of a postprepositional noun but when the next gerund is encountered, the reader is required to change the noun-phrase attachment analysis to verb-phrase attachment for the semantic reason. For this, I conducted off-line questionnaires to 10 university students whose English proficiency was B2 on the CEFR according to the Versant English Test. The questionnaire required them to translate 20 sentences containing a prepositional phrase and ending with a post prepositional noun (e.g., the child cleaned the shelf with the cloth) into Japanese. In addition, 16 out of those 20 sentences that most of the participants (90%) interpreted as the prepositional phrase modifying the postverbal noun were employed in Experiment 2 (The one student seemed not to know the usage of "with" as indicating the instrument used to perform an action). Moreover, 48 pseudo-priming sentences for the filler sentences were also constructed to serve as distractors. Between each target item, at least three distractor sentences, whose grammatical constructions totally differed from prepositional phrases, were provided so that the participants could hardly recognise the objective of the questionnaires. In Experiment 2, each priming sentence was manipulated to appear before each experimental sentence.

Table 2. Accuracy Score Percentages for Comprehension Questions Following the Experimental and Filler Sentences

	VP attachment	NP attachment	Filler
Japanese L2 learners	89	83	83

6. Results for Experiment 2

In this experiment, about 84% of the comprehension questions following the target and filler sentences were answered correctly, and all the incorrect answers to the questions for the target sentence were removed from the analysis. In order to remove the possible outlier values, the same statistical method was followed as in Experiment 1. This process affected less than 7% of the data, which were then analysed with the Wilcoxon signed-rank test.

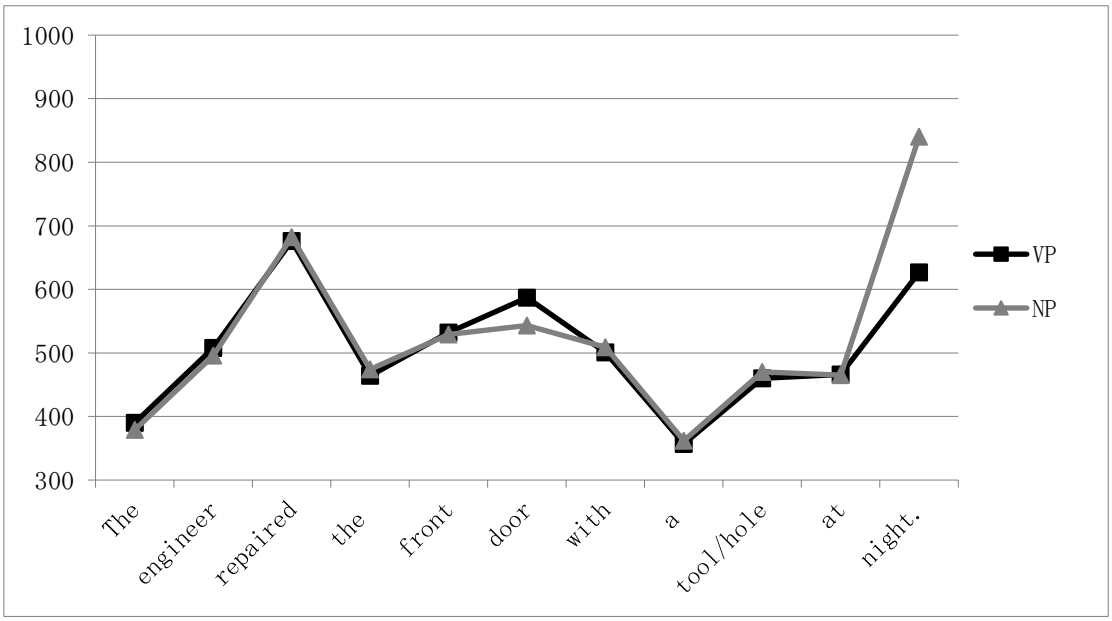

Figure 2. Word-by-Word Reading Times for Prepositional Phrase Attachment Sentences

The test unveiled that the difference in reading times between the verb phrase and noun phrase modifications was not statistically significant in Segment 9, which was a critical region ($z = 0.37$, $p = 0.28$, $r = 0.07$). This obviously shows that the participants found it easier to process sentences containing a noun phrase attachment when they were exposed to the same structure than when they were not. The decreased difficulty is also reflected in accuracy score percentages for comprehension questions and reading times on the following segment where the spillover effect could be observed. On comparing the figures for the noun phrase attachments in Tables 1 and 2, it is clear that the rate of accuracy scores increased with the priming effect (NP without priming: 77%, NP with priming: 83%). In addition, there was not a significant difference in accuracy score percentages for comprehension questions for verb phrase and noun phrase attachments in Experiment 2 ($U = 94.5$, $p = 0.40$, $r = 0.15$), indicating that the participants in Experiment 2 succeeded in recovering from garden paths as opposed to those in Experiment 1. Segment 10 showed that there was no significant difference between reading times of each condition ($z = 0.34$, $p = 0.73$, $r = 0.06$). These results support the fact that the difficulty of noun-phrase sentence processing was reduced when the priming effect took place. However, in Segment 11, a significant difference in reading times between verb phrase and noun phrase conditions was observed ($z = 2.89$, $p = 0.003$, $r = 0.53$). The summed reading times of comprehension questions did not show any significant difference between them ($z = 0.39$, $p = 0.69$, $r = 0.04$). This indicates that the comprehension questions following the noun-phrase sentences were as easy as those following the verb-phrase sentences.

7. Discussion

In Experiment 1, the participants read the critical regions of verb-phrase-attachment sentences more quickly than those of noun-phrase-attachment sentences. This result obviously shows that Japanese

language learners of English had difficulty processing a prepositional phrase attached to the adjacent noun. The difficulty seemed to last until the end of the sentence and the participants were less likely to recover from garden paths. Moreover, the result that L2 learners had a preference for the noun phrase attachments over the verb phrase attachments is correspondent to the findings of several sentence-processing studies targeting English native speakers. However, Experiment 2 showed that the participants were able to overcome the difficulty caused by noun phrase attachments when they were exposed to the syntactic structure in silent reading. This indicates that L2 learners can improve their prepositional-phrase processing ability. However, it is still an enigma that reading times in the final segment of the noun phrase condition were significantly higher than that of the other condition. To the best of my knowledge, no theory accounts for this phenomenon, and it cannot be considered that the participants had difficulty reading this segment in the noun phrase condition given that they processed the preceding segments as quickly as those in the verb phrase condition. As stated above, the integration of information takes place in this segment, thus, the participants could be forced to integrate extra information gained from the priming sentence into the other information.

8. Conclusion

The goal of this thesis is to investigate how Japanese language learners of English process sentences containing a prepositional phrase and whether their syntactic processing ability improves. Many L1 sentence-processing studies have proven that native speakers of English have a preference for verb phrase modification when they read sentences such as *Mary shot the man with the pistol*. Therefore, they find it more difficult to process noun-phrase-attachment sentences. The research findings reported in this thesis show that this can be applied to L2 learners as well, but in the latter case, the difficulty disappears if they process such sentences sequentially, indicating that they can be automatised in processing prepositional phrases. The goal of this thesis is to investigate how Japanese language learners of English process sentences containing a prepositional phrase and whether their syntactic processing ability improves. Many L1 sentence-processing studies have proven that native speakers of English have a preference for verb phrase modification when they read sentences such as *Mary shot the man with the pistol*. Therefore, they find it more difficult to process noun-phrase-attachment sentences. The research findings reported in this thesis show that this can be applied to L2 learners as well, but in the latter case, the difficulty disappears if they process such sentences sequentially, indicating that they can be automatised in processing prepositional phrases.

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