L2 Learners' English Prepositional-Phrase Processing with Consideration of L2 Proficiency and Word Familiarity: A mixed-effect Analysis

Hiroki FUJITA[1]

Abstract

A considerable number of studies have hitherto examined how native speakers and second language (hereafter L1 and L2, respectively) learners of English process English prepositional phrases. It is usually thought that both L1 and L2 speakers have a preference for verb phrase modification (e.g., The boy broke the old window with a ball of snow.) over noun phrase modification (e.g., The boy broke the old window with a view of snow.). However, little research has attempted to reveal how non-structural factors interact with L2 learners' prepositional phrase processing. In this study, I examined whether L2 learners' syntactic processing preference for prepositional-phrase attachment was affected by their L2 proficiency and word familiarity with reading time data obtained from the word-by-word self-paced reading task. In addition, the possibility that L2 syntactic priming is influenced by such non-syntactic factors was also investigated. The research results showed that L2 learners' prepositional-phrase processing and syntactic priming were not subject to those factors, indicating that in prepositional phrases, there was no interaction between L2 learners' syntactic processing and those non-syntactic elements.

Keywords: prepositional phrase; syntactic processing; second language acquisition; L2 proficiency; word familiarity; mixed-effect model

1. Introduction

In the field of psycholinguistics, many L1 and L2 researchers have attempted to clarify the mechanisms of human behaviour in sentence processing. For this purpose, the garden-path phenomenon has often been used. Garden paths refer to the situation where the parser adopts one interpretation during sentence processing and, at the subsequent point of the sentence, it realises that the interpretation is likely to be wrong; as a result, it is forced to reanalyse that interpretation (Bever, 1970). For example, the parser is considered to be garden-pathed when reading the following sentence.

(1) After Bill drank the water proved to be poisoned

(Juffs and Harrington, 1996).

In the case that the sentence (1) is read from left to right, the garden-path effect is observed at the matrix verb, *proved*, because the parser tends to favour the analysis where *the water* is attached to the verb, *drank*, rather than interpret the noun as the subject of the main clause. What this tendency indicates is that the parser interprets the input incrementally. Numerous studies prove that both L1 speakers and L2 learners are subject to the garden-path phenomenon (Hopp, 2006, 2013; Juffs, 2004; Pickering and Traxler, 1998; Roberts and Felser, 2011; Sturt, Pickering and Crocker, 1999). English prepositional phrases can also trigger the garden-path effect. Consider the following example from Rayner, Carlson, and Frazier (1983).

[1]Graduate School of Education, English Education, Osaka Kyoiku University, 4-698-1 Asahigaoka. Kashiwara-shi, Osaka, 582-8582 Japan. E-mail: 62111991f6h8@gmail.com

(2) The spy saw the cap with a revolver.

The sentence (2) is locally ambiguous because the preposition, *with*, can be interpreted either as a modifier of the main clause's verb or of the post verbal noun (hereafter VP and NP, respectively). This ambiguity is disambiguated when the post prepositional noun, *revolver*, appears for the semantic reason: a revolver cannot be used for seeing something, and therefore, it must be attached to the post verbal noun. Several studies have demonstrated that both native and non-native speakers of English are garden-pathed when they read such sentences (Clifton, Speer and Abney, 1991; Frazier, 1979; Fujita, 2016; Rayner, Carlson and Frazier, 1983). This indicates that, in general, the parser has a preference for VP over its counterpart.

Some L1 psycholinguistic studies have also shown that during sentence processing, first language speakers are affected by non-syntactic factors such as plausibility and lexical information (Pickering and Traxler, 1998; Frazier and Clifton, 1989). Recently, in L2, the interplay between syntax and the other linguistic elements has been investigated as well. One of the best-known theories concerning this issue is the Shallow Structure Hypothesis developed by Clahsen and Felser (2006). According to the Shallow Structure Hypothesis, sentence processing involves two elements: one is structural processing, where the processor computes all syntactic information during comprehension; and the other is shallow processing, where the processor partially makes use of syntactic information but mainly hinges on pragmatic and lexical information. The main point of Clahsen's and Felser's argument is that while L1 speakers are capable of handling both types of sentence processing, L2 learners cannot conduct full syntactic processing. Since their research was published, several L2 processing studies have shown that L2 learners are likely to underuse syntactic information, and, as a consequence, they rely more on lexical and pragmatic information compared to native speakers (Roberts, Gullberg and Indefrey, 2008; Robert and Felser, 2011). With regard to the effect of word familiarity and degree of L2 proficiency on L2 sentence processing, Hashimoto (2011) conducted an experiment targeting Japanese language learners of English, who were divided into two groups: high proficiency and low proficiency groups,according to their scores on English tests such as IELTS and TOEIC. In the experiment, he used subject- and object-relative clause sentences, which were either lexically demanding or not. Examples of each sentence are illustrated below.

(3a) High frequency, subject-extracted relative clause
The boy who helped the girl passed the examination last week.
(3b) High frequency, object-extracted relative clause
The boy who the girl helped passed the examination last week.
(4a) Low frequency, subject-extracted relative clause
The defendant who insulted the journalist confessed the sin at last.
(4b) Low frequency, object-extracted relative clause
The defendant who the journalist insulted confessed the sin at last.

As is stated above, each pair contains subject- and object-relative clauses that may or may not contain lexically demanding processing. It is generally considered that an object-extracted relative clause is more difficult to process than its counterpart. The results showed that while advanced-level learners found it more challenging to read object-relative clause sentences only in the condition where lexical processing was less demanding, the low-level learners did not show any sign of difficulty in reading both sentence types of relative clauses regardless of the lexical demands. These findings clearly indicate that L2 learners' syntactic processing is affected by word familiarity and how proficient they are in their second language. In fact, some L2 studies have shown that there is a difference in syntactic processing between high proficiency learners and low proficiency learners (Hopp, 2006, 2015; Roberts and Felser, 2011). However, there are still few studies that examine the effect of L2 proficiency on L2 sentence processing (Hashimoto, 2009). In addition, no research has attempted to investigate how these non-syntactic elements influence the way L2 learners process English prepositional phrases. If what Hashimoto (2011) and the other researchers found applies to L2 prepositional-phrase processing, there might be a different research result from the past sentence processing studies (as mentioned above), which assume that VP modification is usually favoured over NP modification. In order to address this issue, I conducted a mixed-effect analysis for the online performance data collected and reported in Fujita (2016).

2. The current study

As is illustrated in Fujita's article, he carried out two experiments for investigating how L2 learners processed English prepositional phrases (Experiment 1) and whether the priming effect could be observed during prepositional phrase processing (Experiment 2).

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). Even though he found that L2 prepositional phrases were processed as the previous L1 studies have shown (Clifton, Speer and Abney, 1991; Frazier, 1979; Rayner, Carlson and Frazier, 1983) and that processing tendency disappeared when the priming effect facilitated NP modification processing, he did not take into consideration the difference in the participants' L2 proficiency. With regard to word familiarity, he mentioned in the article that it was controlled well by drawing words from a word list with a score of more than 3 on a scale from 1 (very unfamiliar) to 7 (very familiar; Yokokawa, 2006). This is very tricky because using only words whose familiarity is more than 3 does not necessarily mean that word familiarity is equal in both conditions. Given that non-native speakers are not automatised in language performance—and as a result, they greatly rely on lexical information—it should be strictly controlled. In order to probe the possibility that word familiarity affected L2 learners' syntactic preference on prepositional phrases in Fujita's experiments, I first conducted an off-line norming study on the same scale as the word list mentioned above.

Twenty-one undergraduate students at Setsunan University participated in the norming study. Their English proficiency was between B1 and A2 on the Common European Framework of Reference for Languages (CEFR), according to their TOEIC scores (Mean = 537, SD = 49). In the study, each participant was required to write down how familiar each word of the critical region reported in Fujita's experiment was.

Table1. Mean reading times of the critical region reported in Fujita (2016)

	VP attachment	NP attachment	
Experiment1	475 (119)	524 (144)	*
Experiment2	460 (117)	470 (99)	

Note: Standard deviations in parentheses. VP = verb phrase; NP = noun phrase.
*$p < .05$. (Wilcoxon signed-rank test).

A critical region is where research results are determined according to participants' reading times in it. The result showed that word familiarity in the VP condition was higher than that in the NP condition (VP mean = 5.8, SD = 0.5 vs. NP mean = 5.3, SD = 0.8). I then ran the *t*-test, which showed that there was a significant difference between each condition: $t(20) = 2.3149$, $p < .04$, $r = .51$. The statistical results clearly indicated that experimental items used in the VP condition were less difficult than those in the NP condition, which might account for the reason why the participants in Fujita's experiment read VP attachments faster than NP attachments. In order to investigate whether the participants in Fujita's experiment really had a syntactic preference for the VP condition, I ran the mixed-effect model for Fujita's experiments.

2.1 Mixed-effect analyses and results

A mixed-effect model is a statistical method, which is becoming more and more popular in SLA and psycholinguistics. What makes the method attractive to researchers in those study fields is that both participant and item data can be handled simultaneously as cross random effects in contrast with the ever-popular statistical methods such as *t*-test and ANOVA, which often end up with $F_1 \times F_2$ criterion (Cunnings, 2012, see also Baayen, Davidson and Bates, 2008 for discussion on the problem of $F_1 \times F_2$ criterion). Another benefit that the mixed-effect model brings about is that, theoretically, any number of factors can be incorporated into the statistic model as fixed effects to consider if those factors affect the dependent variable. Thus, by using the mixed effect model, where word familiarity and L2 proficiency differences are included as fixed effects, it becomes clear whether or not these factors influence prepositional phrase processing. In the present study, I included "condition", "proficiency", and "word familiarity" as fixed effects; "subject" and "item" as random effects with random slopes for word familiarity and intercepts for subjects and items; and "reading times" as an dependent variable for the obtained online performance data reported in Fujita's article. Proficiency data were input as categorical valuables and word familiarity data and reading time data were transformed into centred data and z-scores, respectively. The effect size will be reported with Cohen's f^2 (Selya, et al., 2012). Table 2 shows the results of the mixed effect analysis for both Experiment1 and Experiment2.

Table 2: Mixed-effect models by measures

Measure	Critical region (postpre positional noun)			
	Estimate	SE	t	
Experiment1				
(Intercept)	0.064	0.158	0.410	
Condition	−0.264	0.127	−2.074	*
Familiarity	0.026	0.090	0.295	
Proficiency	0.195	0.267	0.731	
Experiment2				
(Intercept)	−0.017	0.196	0.930	
Condition	0.012	0.162	0.074	
Familiarity	−0.136	0.078	−1.737	
Proficiency	−0.473	0.336	−1.409	

Note: *p < .05.

As is observed in Fujita's research results, the participants showed significantly longer reading times for the NP condition than the VP condition: estimate = −0.264, *SE* = 0.127, t = −2.074, p = .039, t^2 = .02. In addition, the mixed-effect analyses found that familiarity and proficiency did not affect z-score-transformed reading times: estimate = 0.006, *SE* = 0.083, t = 0.075, p = .731, t^2< .01; and estimate = 0.125, *SE* = 0.290, t = 0.431, p = .466, t^2< .01, respectively. These results proved that VP modification was easier for L2 learners than NP modification irrespective of the differences in their proficiency and word familiarity, indicating that L2 learners are probably sensitive to syntactic information. This is also supported by Experiment 2, which showed that there was no significant difference in reading times between the VP and NP conditions: estimate = 0.012, *SE* = 0.162, t = 0.074, p = .941, t^2 = .00. Note again, Experiment 2 investigated whether L2 learners were able to overcome the difficulty processing NP attachments with appropriate primes, and no difference in reading times between the two conditions meant that the difficulty disappeared. There was also no effect of proficiency and word familiarity on participants' reading times in Experiment 2. This proved that the priming effect was not subject to these non-syntactic factors, meaning that the participants obtained the syntactic priming effect.

3. Discussion

The mixed-effect analyses produced not only the same results as Fujita's experiments but also the evidence that VP modification is favoured regardless of the differences in the level of L2 proficiency and word familiarity. These findings also correspond to the past L1 studies (Clifton, Speer and Abney, 1991; Frazier, 1979; Rayner, Carlson and Frazier, 1983). However, the fact that word familiarity did not affect participants' sentence processing is counter to the Shallow Structure Hypothesis, which assumes that non-native speakers cannot fully make use of syntactic information and consequently rely on lexical information. Given the pre t-test showed that familiarity of the experimental stimuli in the NP condition was significantly lower than that of the experimental stimuli in the VP condition, NP attachments should have been read more quickly than VP attachments if the Shallow Structure Hypothesis could have applied. This is probably due to the element of English prepositional phrases, which might be less sensitive to lexically-based constraints, compared with other syntactic structures such as the main verb/reduced relative ambiguity (e.g., The man helped by the woman was reliable). In this sentence, the verb *helped* is locally ambiguous because, at this point, it can be either the main verb (the man helped someone) or the past perfect, which introduces a reduced relative clause (The man who was helped by the woman was reliable). These two analyses totally differ in message content and the thematic relations between the verb and its arguments (the man is either the agent or the patient), and this difference is triggered by the lexical factor. On the other hand, these things in prepositional phrases do not differ significantly, and therefore, prepositional phrases are less sensitive to lexical information. This could have been the reason why the participants were able to use syntactic information.

4. Conclusion

This article is intended to clarify how word familiarity and L2 proficiency affect L2 sentence processing with a prepositional phrase. The mixed-effect analyses conducted in this article showed that L2 learners could perform syntactic processing, and their syntactic processing was primed without being affected by those elements.

Future research might want to explore how the other non-syntactic factors, such as plausibility information and working memory capacity, interact with prepositional phrase processing in L2.

References

Baayen H, Davidson D, and Bates D (2008) Mixed-effects modeling with crossed   random effects for subjects and items. *Journal of Memory and Language*, 59,   390–412.

Bever, T. G. (1970). The cognitive basis for linguistic structures. In: J. R. Hayes (Ed.), *Cognition and the development of language* (pp. 279–352). New York, NY: Wiley.

Clahsen, H. & C. Felser (2006). Grammatical processing in language learners. *Applied Psycholinguistics* 27, pp. 3-42.

Clifton, C., Speer, S. &Abney, S. (1991). Parsing arguments: Phrase structure and argument structure as determinants of initial parsing decisions. *Journal of Memory and Language* 30,pp. 251-271.

Frazier, L.(1979). On Comprehending Sentences: Syntactic Parsing Strategies. Indiana University Linguistics Club, Bloomington, IN.

Frazier L., & Clifton C., Jr. (1989). Successive cyclicity in the grammar and the parser. *Language and Cognitive Processes*, 4(2), pp. 93-126.

Fujita, H. (2016). Priming Effect on Automatisation of L2 Prepositional-Phrase Processing Ability. Studies in English Language Teaching, Vol. 4, No. 1.Retrieved   from http://www.scholink.org/ojs/index.php/selt/article/view/432/425

Hashimoto, K. (2009). First language influence on second language syntactic processing of   English relative clauses PhD Thesis, School of English, Media Studies and Art   History, The University of Queensland.

Hashimoto, K. (2011). Syntactic Processing of L2 English Relative Clause Sentences: The   Effect   of   Proficiency. ARELE: annual review of English language education in   Japan 22, pp. 95-110.

Hopp, H. (2006). Syntactic features and reanalysis in near-native processing. Second Language Research, 22, pp. 369–397.

Hopp, H. (2015). Individual differences in the second language processing of object–subject ambiguities. Applied Psycholinguistics, 36, pp. 129-173.

Jegerski, J &VanPatten. B. (2013). 2 SELF-PACED READING. In Research Methods in   SecondLanguage Psycholinguistics (pp. 20-49). Abingdon, Oxon: Routledge.

Juffs, A. (2004). Representation, processing, and working memory in a second language. *Transactions of the Philological Society, 102,* 199–225.

Juffs, A., & Harrington, M. (1996). Garden path sentences and error data in second language   processing   research. *Language Learning, 46,* 286–324.

Pickering, M., & Traxler, M. (1998). Plausibility and recovery from garden paths: An eye-tracking study. *Journal of Experimental Psychology: Learning, Memory   and   Cognition, 24,* 940–961.

Roberts, L., & Felser, C. (2011). Plausibility and recovery from garden paths in second language sentence processing. Applied Psycholinguistics, 32, 299-331.

Roberts, L., Gullberg, M., & Indefrey, P. (2008). Online pronoun resolution in L2   discourse: L1   influence   and general learner effects. *Studies in Second Language Acquisition,* 30, 333-357.

Selya, A. S., Rose, J. S., Dierker, L. C., Hedeker, D., & Mermelstein, R. J. (2012). A   Practical   Guide   to Calculating Cohen's f2, a Measure of Local Effect Size,   from PROC MIXED. Frontiers in Psychology, 3, 111. http://doi.org/10.3389/fpsyg.2012.00111

Sturt, P., Pickering, M., & Crocker, M. (1999). Structural change and reanalysis difficulty in language comprehension. *Journal of Memory and Language, 40,*   136–150.

Tulving, E., Schacter, D. L., & Stark, H. A. (1982). Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition, 8,* 336-342.

Yokokawa, H. (Eds). (2006). 『*Daini Gengo Kyoiku・Kenkyu no Tameno Database: Nihonjin Eigo Gakushusha no Eitango Shinmitsudo <Moji Hen>*』. [Database   for second language education and research: English word familiarity of   Japanese learners of English. Tokyo: Kuroshio.