The Influence of Verb Subcategorization Information and the Complementizer that on Sentence Processing by Japanese Learners of English as a Foreign Language

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Abstract
This study investigates the influence of English verb subcategorization information and the complementizer that on sentence processing with Japanese Learners of English as a Foreign Language (JFL learners). In the experiment, verb subcategorization preferences by participants were assessed through a sentence completion task, and the influence of the preferences on sentence processing was investigated in a self-paced reading task. The results indicated that, comparing the sentence structure with the complementizer that, a garden-path (GP) effect was found in processing syntactically ambiguous sentences both with verbs which tend to be followed by noun phrases (NP) as the direct object (DO-biased verbs) and with verbs which tend to be followed by NP as the subject of a sentential complement (SC-biased verbs). The participants of the higher-proficiency group, however, have shown a tendency to resolve temporary ambiguities when the SC-biased verbs were used, which indicates the verb information can guide learners’ on-line sentence processing. The lower-proficiency group, in contrast, seemed to read sentences paying less attention to verb subcategorization information or the complementizer that, and seemed to process sentences at a uniform pace regardless of syntactic structures.

Key words: sentence processing, garden-path sentence, complementizer, verb subcategorization information, self-paced reading

Background
Research since the 1980s on native speakers of English (NSE) has attempted to specify the comprehension process of syntactically ambiguous sentences. In such research, readers’ strategies are very often investigated by sentences, such as (1a) and (1b) below.

(1a) The reporter checked the picture of the beautiful mountain.
(1b) The reporter checked the picture did not have holes.

NSE tend to interpret the post-verbal NP (the picture) as the direct object of the sentential verb (checked) at the initial phase of interpretation due probably to their tacit expectation of...
the canonical SVO structure. If this expectation is violated, their processing preference can lead to a temporary misunderstanding of the sentence structure, generally known as the “GP effect” or “GP phenomenon”. In the above examples, (1b) would cause the GP effect because it does not match the readers’ expectation and requires reanalysis of the sentence structure in order to recognize the post-verbal NP (the picture) as the subject of an embedded clause (the picture did not have holes).

In order to explain how the GP effect occurs, two models of comprehension process have been proposed. The modular two-stage model advocates that the syntactic parser initially attempts to process the sentence fragment following the simplest possible structure (SVO in the case of English) (e.g., Frazier, 1987; Frazier & Rayner, 1982; Rayner & Frazier, 1987). Thus, nouns following verbs are firstly interpreted as direct objects. If the sentence violates this expectation, readers need to revise their parsing referring to lexical information at a later reanalysis stage, which causes readers to fall into temporary misunderstanding.

The other model is the constraint-based model (e.g., Garnsey, Pearlmutter, Myers, & Lotocky, 1997; Hare, McRae, & Elman, 2003; Holmes, Stowe, & Cupples, 1989; Merlo, 1994; Trueswell, Tanenhaus, & Kello, 1993; etc.), which posits that multiple factors, including syntactic information, lexical information, and pragmatic information, affect sentence interpretation from the outset. This offers an explanation for an occasional lack of the GP effect even when the simple SVO structure is broken. Many researchers working in this theoretical framework have investigated the role of verb information in sentence processing such as verb subcategorization information, and readers’ preference in the relationship between verbs and syntactic structures. Knowledge about verbs is thought to provide important clues to readers because “verbs tend to place strong constraints on how the other words in a sentence can combine” (Wilson & Garnsey, 2009, p. 369).

In L1 studies, a number of previous studies have been trying to explain the GP effect, several of which have investigated the relationship between the sentence structure and the verb bias. Although some studies (e.g., Kenninson, 2001; Pickering & Traxler, 2003) did not show the influence of verb bias, other studies indicated that readers can use the verb subcategorization information immediately after they saw the verb. For example, Garnsey et al. (1997) and Trueswell et al. (1993) examined the bias that the direct object tends to follow the verb (DO-bias) and the bias that the sentential complement tends to follow the verb (SC-bias). They found that the influence of the SC biased verb was strong enough to remove the GP effect during processing sentences like (1b). Furthermore, Trueswell and Kim (1998) used a priming technique in which a verb is displayed as a prime before the sentential verb in their word-by-word self-paced reading experiment. They found that the information of the prime verb displayed only for 39ms affected and worked on the sentence processing from the initial stage. In their study, the participants did not show the GP effect in sentences like (1b) when the SC-biased verbs were used as a prime, and sentence processing became more difficult in cases where the DO-biased verb was used as the prime.

Research into L2 learners’ use of verb subcategorization information in L2 sentence processing lags far behind the L1 studies, and the present study attempts to fill this gap. It utilizes the GP effect as a window through which we examine L2 sentence processing. The GP effect in this study is expected to occur due to a gap between learners’ preference of verb
subcategorization (e.g., DO-bias vs. SC-bias) and the given sentence structure in the task. The GP effect (or lack thereof) suggests how L2 learners make use of verb subcategorization information.

Studies of this sort usually include two phases. The first phase typically employs sentence completion to examine participants' preference of verb subcategorization. The result allows researchers to categorize verbs into DO-bias or SC-bias. Then researchers construct experimental conditions according to their hypotheses — for example, DO-biased verbs followed by an object noun (no GP effect is expected) and DO-biased verbs followed by a sentence complement (GP effect is expected). The second phase is the experimental task such as self-paced reading, where researchers obtain data indicative of L2 learners' on-line sentence processing.

This type of verb subcategorization is not the only type of verb information examined in past studies (e.g., Frencq-Mestre & Pynte, 1997; Juffs, 1998), but we focus on this feature (DO-bias / SC-bias) in the following reviews because it is the focus of our study.

In L1 Research, Holmes, Stowe, and Cupples (1989) examined a sentence completion task in which the participants were asked to fill in four blanks with words following each pair of pronouns (sentential subjects) and verbs. In their experiment, both DO-biased and SC-biased verbs were followed by zero-that clauses. They found a significant increase in reading time when the DO-biased verbs were used. No such increase was evident for the SC-biased verbs.

Despite their important findings regarding the influence of the verb information, there were methodological problems in their study. First, the reason why participants were asked to put exactly four words after the verbs is not clear. This restriction might distort the participants' preference judgments because it might be too long especially for less proficient learners to fill in, or it might be too short for them to adjust their ideas to the four blanks. Second, the criterion for classifying the verbs is not clear, either. For instance, verbs such as forget, whose answers from the sentence completion task consisted of 21% DO-continuation and 36% SC-continuation, were classified as SC-bias (cf. realize: DO-continuation 0%, SC-continuation 97%). As this vague criterion might lead to the false operational definition of the verb biases, we need to clarify the method of categorization of each verb.

Garnsey et al. (1997), which was reviewed above, seem to have resolved the problem of Holmes et al. in the sentence completion task. The task set no restriction on the number of words and the participants were asked to complete sentence fragments (e.g., Debbie remembered ________). Their criterion of classification appears more specific as "verbs were classified as SC-bias if they were used at least twice as often with an embedded sentential complement as with a direct object, while the reverse was true for verbs classified as DO-bias" (p. 65). However, at closer examination, their procedure also suffers from limitations. For example, the proportion of the completion type of decide (classified as SC-bias) was DO-continuation 1%, SC-continuation 14%, and Other 85%.

In the L2 field, Dussias and Cramer Scaltz (2008), who followed the method of Garnsey et al. (1997), is one of the pioneering studies. Their study showed L1-Spanish English learners had different verb subcategorization preferences from NSE. Five verbs classified as SC-bias by the NSE were classified as DO-bias by the learners. Since the Spanish substitutes of these verbs were also classified as DO-bias by the native speakers of Spanish, the results indicated

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that the preference of verb subcategorization information could be influenced by transfer from the L1. They also found that these five verbs had the same influence as the DO-biased verbs in the learners’ processing, and caused the GP effect, indicating that L1-induced verb bias affected L2 sentence processing.

Yoshida (1991) investigated how advanced JEFL learners process syntactically ambiguous English sentences. Using the self-paced reading technique, he found that the DO-bias and the SC-bias of verbs were concerned with the occurrence and absence of the GP effect.

Despite the contribution of Yoshida (1991), who has identified the effect of verb subcategorization on JEFL’s sentence processing, there seem some methodological limitations. First, Yoshida presented sentences two to six words at a time. This is different from a word-by-word presentation employed in many other studies (e.g., Dussias & Cramer Scaltz), and obscures exactly where the GP effect arises. Second, the length of the sentence following the critical words is different.

(2) *The ticket agent admitted (that) the mistake might not have been caught.*

(Dussias & Cramer Scaltz, 2008, pp. 505–506)

(3) *The boy accepted (that) the answer was correct.* (Yoshida, 1991, p. 180)

Sentences (2) and (3) illustrate the points, where *might* and *was* are disambiguating words (i.e., words where the reader realizes the syntactic role of the preceding NP). As the disambiguating phrase *was correct* in sentence (3) was presented at once, it is unclear whether the time increase, if it were observed, was due to the GP effect or the phenomenon called the wrap-up effect (see the details in Jiang, 2012).

Finally, Yoshida (1991) used verb classification by Holmes et al. (1989) and Mitchell (1987), instead of investigating the preference of the Japanese participants. Since Dussias and Cramer Scaltz (2008) showed that L2 learners may have different L2 verb bias from NSE, we should use L2 learners’ bias rather than applying NSE’s bias as a norm.

Based on these studies, the current study aims to identify whether the verb biases influence the learners’ sentence processing from the initial stage or at the later reanalysis stage. Although the constraint-based model, which assumes multiple interacting constraints from the onset, is currently popular in L1 studies, there must be the possibility that L2 processing is fundamentally different from NSE processing and L2 learners maintain shallower and less detailed syntactic representations as Clahsen and Felser (2006) claim. Therefore, it must be important to examine how sensitive the JEFL learners are to their own preferences about subcategorization frames during on-line processing. We also included L2 proficiency as a variable and examined the effects of proficiency on utilizing the verb bias and the complementizer *that*.

**Research Questions**

The research questions (RQs) are as follows:

(RQ1) Do JEFL learners reading English sentences exhibit a GP effect?

(RQ2) Is the GP effect influenced by verb bias?

(RQ3) Is the GP effect neutralized by the presence of the complementizer *that*?
(RQ4) Is proficiency level related to the GP effect?

Method

Participants
Thirty-five JEFL learners (17 undergraduates, 17 graduates, and 1 business person) participated in this study. The participants were divided into two groups according to their TOEIC scores: a Higher-proficiency group (N = 17; \( M = 893.24, SD = 52.85 \)) and a Lower-proficiency group (\( N = 18; M = 546.78, SD = 148.18 \)). An independent t-test showed that the difference between the group means was statistically significant, \( t(33) = 9.10, p < .001, r = .85 \).

Phase 1: Self-paced Reading Task
In line with many previous studies, the present study used a sentence completion task and a self-paced reading task. In the previous studies, the two tasks were completed separately by different participants. The sentence completion task was first followed by the reading task. However, in our study, we asked the same participants to perform both tasks in the opposite order, i.e., the first task was the reading task and the second was the sentence completion task. This was because we did not want them to see the experimental verbs before the reading task.

Materials
Verbs
The 51 verbs were selected from five previous studies (Argaman & Perlmutter, 2002; Garnsey et al., 1997; Hare et al., 2003; Merlo, 1994; Trueswell & Kim, 1998). Efforts were made so that all verbs were within the familiarity rank 2,000 in Yokokawa (2006) and the frequency ranks up to 3,000 of JACET 8,000 in order to ensure that the participants were familiar with the verbs.

Sentences
Fifty-one experiment sentences for each of following three sentence structures (153 sentences in total) were prepared using the afore mentioned 51 verbs by revising those in Garnsey et al. (1997) and Trueswell and Kim (1998), or by composing new sentences. The three sentence structures were Direct-Object structure (DO structure), Sentential-Complement-Ambiguous structure (SCA structure), and Sentential-Complement-Unambiguous structure (SCU structure), which are illustrated as sentences (4)-(6) (see more in appendix). SCA structure was the GP sentence, and it differed from SCU structure in the ambiguity of the post-verbal NP due to the absence of the complementizer that.

(4) The player felt the pain in his back yesterday. \([\text{DO structure}]\)
(5) The player felt the pain would not be eased. \([\text{SCA structure}]\)
(6) The player felt that the pain would not be eased. \([\text{SCU structure}]\)

1 As one of the reviewers pointed out, there might have been some order effect in the sentence completion task.

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If temporary ambiguity occurred, the participant needed to slow down in order to reanalyze the structure in the disambiguation region resulting in the GP effect. Time differences in this region between each structure were taken as evidence of a GP effect.

In addition, investigation of the two verb biases’ conditions enabled us to find the influence of the verb biases in the sentence processing. When the DO-biased verbs were used, the GP effect should have been found. In contrast, when the SC-biased verbs were used, the GP effect should have been weaker or might not have been found (i.e., no time difference between the SCA structure and the SCU structure) because readers should have expected the clause would follow the verb. This decrease or disappearance of the GP effect was regarded as the real time influence of the verb subcategorization information in the sentence processing, which guided readers’ initial analysis immediately after the verb was entered.

In SCU structure, however, the complementizer that might work as a guide which indicated that the embedded clause followed, which might lead to shorter processing time. Processing the disambiguation region in SCU structure should be faster than the comparable region in SCA structure, which indicated the GP effect is absent due to the complementizer that.

In composing the sentences, the following principles were taken into account:

[1] The length of each sentence: nine or ten words (including the complementizer that)
[2] The familiarity ranks of the words: up to 2,000 (referring to Yokokawa, 2006)
[3] The frequency ranks of the words: up to 3,000 (JACET 8000)
[5] The sentential noun: two-word animate NP starting with the, considering the relationship between animacy and the GP effect (cf. Trueswell, Tanenhaus, & Garnsey, 1994)
[6] Verbs used as sentential verbs were not repeated except for their comprehension questions.
[7] The length of the NP following the sentential verb: two words, considering the relationship between animacy and the GP effect (cf. Holmes et al., 1989)
[8] The plausibility of the post-verbal NP as DO are considered by asking two NSE to judge the sentence fragments such as the sentences below on a seven-point scale (Garnsey et al., 1997, p. 65)

\[\text{The senator regretted the decision.} \quad \text{[plausible]}\]
\[\text{The senator regretted the reporter.} \quad \text{[implausible]}\]

Filler sentences similar in length were also prepared so that participants would not notice the purpose of this experiment. Three lists were prepared, taking counterbalance into consideration. Each list had 102 experiment sentences and 108 filler sentences so that each verb appeared twice in different structures. Each list was also divided into four roughly equal sections and the participants took breaks between each section. The sentences were randomly presented by the computer program.
Task

In the self-paced reading task, the moving-window technique was employed. This procedure enabled the computer to record the time between each key-pressing. The sentences were presented on the screen word by word when pressing the right arrow key.

The participants were instructed to read each sentence as fast as they could. In order to ensure the participants' understanding of the sentences, a simple True or False comprehension question for each sentence was prepared. When the participants pressed the right arrow key at the end of the sentence, it was replaced by the question. An example is shown in sentence (7). The participants returned their answer with mouse clicks.

(7) The programmer found the error could not be avoided.
   True or False Question: The error could not be avoided.

Phase 2: Sentence Completion Task

Materials
Verbs

Verbs are the same 51 verbs used in the self-paced reading task.

Sentence Fragments

The 51 sentence fragments were two-word strings consisting of a proper noun followed by a verb (e.g., Kevin taught ________) for the 51 verbs selected. The order of proper nouns and verbs were randomized for each participant.

Task

Each participant was given a questionnaire that instructed them to provide the sentence continuation for 51 sentence fragments by hand.

Procedure

The experiments were conducted on an individual basis in a quiet room. As mentioned above, the first session was the self-paced reading task and the second session was the sentence completion task. Following the two tasks, a post experiment questionnaire was administered. This was a paper-based questionnaire in which the participants reported verbs and sentences they could not understand during the experiments. The entire experiment lasted approximately 90 minutes on average for each participant.

Analysis

The Sentence Completion Task

In the analysis, the sentence completion task was analyzed first in order to use the result as a norm for analyzing the data of the reading task. The completions by the participants were categorized as DO-completion, SC-completion, or Other according to the categorization scheme used by Hare et al. (2003, p. 285). When the participants did not fill in any words, this was categorized as Blank.

For the reliability of this categorization, three raters (two graduate students who majored
in English Linguistics and the first author) independently classified the answers of four participants (12.1% of the data). Cohen's kappa was used to measure the agreement of these three raters, which was \( k = .957 \). Therefore, the first author carried out the remaining categorizations alone.

In classifying the 51 target verbs, the criteria used by Garnsey et al. (1997) and Dussias and Cramer Scaltz (2008) was as follows: "Verbs were classified as SC-bias if they were used at least twice as often with an embedded sentential complement as with a direct object, while the reverse was true for verbs classified as DO-bias" (Garnsey et al., 1997, p. 65). Their criteria, as mentioned above, did not take into consideration other types of continuation. Therefore, if more than half of the participants' answers comprised of Other or Blank, such verbs were precluded from the analysis. This new criterion appeared to serve to maintain the validity of this categorization, as it avoided assigning biases to verbs whose answers were mostly irrelevant to the purpose of the study; to-infinitives (e.g., decide) or prepositional phrases (e.g., worry).

The Self-paced Reading Task

Prior to analyzing the data, reading times beyond 2.5 SD above or below each participant's mean time were replaced with the 2.5 SD value (3.1% of the data). Also, trials in which participants' response to the comprehension question was incorrect (8.2% of the data), trials in which participants admitted that they were not able to understand the meanings in the post questionnaire (8.5% of the data), and four verbs whose comprehension scores were under 3 on a 5-point scale (indicated, protested, sensed, signaled; 7.8% of the data) were precluded from the analyses.

The remaining data (75.4% of the original data) were analyzed in three ways in order to investigate the four RQs. Firstly, overall mean reading times in trials of all the 47 verbs were analyzed. Then, analyses on mean reading times in trials of DO-biased verbs and SC-biased verbs were carried out.

For these analyses, following the method by Dussias and Cramer Scaltz (2008), two regions in each sentence were assigned as illustrated in the sentences in Table 1. The reading time in each region was the sum of the two words (e.g., the and pain). The mean reading times were compared between SCA structures (i.e., the GP sentences), DO structures, and SCU structures.

Table 1

<table>
<thead>
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<th>The Regions of the Experiment Sentences for Analysis</th>
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The Japan Association of College English Teachers (JACET)

The Sentence Completion Task

Table 2 shows the results of this task. The completions showed that the verb biases differ between the two participants’ groups. As a result, 20 verbs were categorized as DO-biased verbs for the higher-proficiency group and 27 verbs for the lower-proficiency group. Except for two verbs (explained and ruled), 18 DO-biased verbs for the higher-proficiency group were also categorized as DO-bias for the lower-proficiency group. The number of SC-biased verbs was smaller than that of DO-biased verbs in each group; 10 SC-biased verbs for the higher-proficiency group and 6 SC-biased verbs for the lower-proficiency group. These results suggested that the number of DO-biased verbs decreased and the number of SC-biased verbs increased as the proficiency level developed.

Table 2
The Result of the Completion Task

| 20 DO-biased verbs for the higher-proficiency group | accepted, added, answered, checked, discovered, explained, found, learned, observed, ordered, printed, projected, recalled, remembered, repeated, reported, ruled, taught, understood, wrote |
| 27 DO-biased verbs for the lower-proficiency group | accepted, added, advised, announced, answered, argued, checked, discovered, forgot, found, heard, judged, learned, observed, ordered, printed, projected, proposed, proved, recalled, recognized, remembered, repeated, reported, taught, understood, wrote |
| 18 DO-biased verbs for both groups | accepted, added, answered, checked, discovered, found, learned, observed, ordered, printed, projected, recalled, remembered, repeated, reported, taught, understood, wrote |
| 10 SC-biased verbs for the higher-proficiency group | announced, claimed, expected, noticed, proposed, proved, realized, regretted suggested, suspected |
| 6 SC-biased verbs for the lower-proficiency group | expected, guessed, noticed, promised, realized, suspected |
| 4 SC-biased verbs for both groups | expected, noticed, realized, suspected |

The Reading Task

Descriptive statistics of the reading task are presented in Table 3. In order to analyze the data, a 2 (proficiency; higher vs. lower) × 3 (sentence structure; DO vs. SCA vs. SCU) ANOVA was run for each region initially. Proficiency was treated as a between-subject variable and sentence structure as a within-subject variable. For both regions, the difference in the mean reading times between the two groups was statistically significant (all $p$s < .01), and the higher-proficiency group always processed faster. Therefore, in the following sections, only the differences caused by the sentential structures are reported. Separate one-way ANOVAs for each subject group with the sentence structure as the independent variable were conducted; one for participants ($F_1$) and the other for items ($F_2$).
Table 3
Descriptive Statistics of Reading Times (ms.) in Each Reading Condition as a Function of Verb Bias (all, DO-biased, and SC-biased)

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Ambiguous noun region</th>
<th>Disambiguation region</th>
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<tbody>
<tr>
<td></td>
<td>DO s.</td>
<td>SCA s.</td>
</tr>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Reading times in trials of all the 47 verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HG</td>
<td>963</td>
<td>209</td>
</tr>
<tr>
<td>LG</td>
<td>1158</td>
<td>165</td>
</tr>
<tr>
<td>Reading times in trials of DO-biased verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HG</td>
<td>941</td>
<td>214</td>
</tr>
<tr>
<td>LG</td>
<td>1143</td>
<td>150</td>
</tr>
<tr>
<td>Reading times in trials of SC-biased verbs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HG</td>
<td>1030</td>
<td>262</td>
</tr>
<tr>
<td>LG</td>
<td>1243</td>
<td>265</td>
</tr>
</tbody>
</table>

Note. DO s. = DO structure; SCA s. = SCA structure; SCU s. = SCU structure; HG = Higher-proficiency Group; LG = Lower-proficiency Group.

Overall mean reading times in trials of all verbs

The mean reading times in the disambiguation region were significantly different (F(1, 266) = 14.47, p < .001, η²p = .30; F(2, 2184) = 12.51, p < .001, η²p = .12). Multiple comparison showed that the mean reading time in SCA structure (1009ms) was significantly slower than that of the other structures (DO structure, 925ms; SCU structure, 921ms), and there was no interaction effect (F(1, 266) = 0.73, n.s., η²p = .02; F(2, 2184) = 0.78, n.s., η²p = .01). In the ambiguous noun region, there was a significant difference in the mean reading times (F(1, 266) = 8.25, p < .001, η²p = .20; F(2, 2184) = 9.35, p < .001, η²p = .09), with the SCU structure (1000ms) faster than the other structures (DO structure, 1060ms; SCA structure, 1044ms), probably due to the effect of the complementizer that. There was no interaction effect (F(1, 266) = 0.50, n.s., η²p = .01; F(2, 2184) = 0.31, n.s., η²p = .00).

DO-biased verbs

In the second analysis, in order to check whether the DO-biased verbs caused the GP effect, data of the following three kinds were investigated, as in Table 2. First, the 20 DO-biased verbs for the higher-proficiency group were used. Second, the 27 DO-biased verbs for the lower-proficiency group were used. Finally, the 18 DO-biased verbs for both groups were used.

Analysis of the higher-proficiency group

The result indicated the GP effect among the three sentence structures. The mean reading times in the disambiguation region were significantly different (F(1, 232) = 7.34, p < .01, η²p = .31; F(2, 238) = 6.86, p < .01, η²p = .27). Multiple comparison showed that the mean reading time in SCA-structure (907ms) was slower than those in the other structures (DO structure,
Analysis 1 of the lower-proficiency group

ANOVA in the disambiguation region showed marginally significant effect in the participants analysis ($F_1(2,34) = 2.50, p < .10, \eta^2_p = .13$) and no significant effect in the item analysis ($F_2(2,52) = 0.98, n.s., \eta^2_p = .04$). Multiple comparisons showed no significant difference between the mean reading times of each sentence structure (DO structure (998ms) vs. SCA structure (1068ms) vs. SCU structure (1019ms)). This result indicated the GP effect was not strong. In the ambiguous noun region, there was no significant difference between the structures, either ($F_1(2,34) = 0.71, n.s., \eta^2_p = .04; F_2(2,52) = 1.42, n.s., \eta^2_p = .05$). Considering the results in the two regions, it can be said that the lower-proficiency group was not as sensitive to verb subcategorization information by DO-bias or to the complementizer that as the higher-proficiency group.

Analysis 2 of the lower-proficiency group

In the above analysis for the lower-proficiency group, the result did not clearly indicate the GP effect. This might be caused by insufficient performance by the less proficient participants in the sentence completion task, which might not reflect their verb subcategorization preferences, because past studies showed that productive vocabulary develops more slowly than receptive vocabulary (e.g., Laufer & Paribakht, 1998). It was reasonable to assume that their limited productive vocabulary might have led to an inappropriate norm for analyzing the data of the reading task. In order to check the possibility of this, the mean reading times by the lower-proficiency group under the condition of the 18 DO-biased verbs in common for the both groups were analyzed.

The mean reading times in the disambiguation region were not significantly different ($F_1(2,34) = 1.40, n.s., \eta^2_p = .08; F_2(2,34) = 1.13, n.s., \eta^2_p = .06$). Also, in the ambiguous noun region, there was no significant difference of the mean reading times ($F_1(2,34) = 1.09, n.s., \eta^2_p = .06; F_2(2,34) = 1.63, n.s., \eta^2_p = .09$), which was the same pattern as the result in the analysis of 27 DO-biased verbs for the lower-proficiency group. These results supported the idea that the DO-biased verbs and the complementizer that did not affect the sentence processing by the lower-proficiency group participants.

SC-biased verbs

The focal point of the analysis of SC-biased verbs was whether the GP effect would disappear due to the nature of the verbs' lexical information. The mean reading times between the three structures were expected to be not significantly different when the GP effect was absent. In this analysis, two ANOVAs (the 10 SC-biased verbs for the higher-proficiency group and the 6 SC-biased verbs for the lower-proficiency group) were conducted.

Analysis of the higher-proficiency group

835ms; SCU structure, 808ms). In the ambiguous noun region, there was no significant difference again ($F_1(2,32) = 1.50, n.s., \eta^2_p = .09; F_2(2,38) = 0.56, n.s., \eta^2_p = .03$), although the mean reading time in SCU structure (897ms) was faster than that of the other structures (DO structure, 941ms; SCA structure, 953ms).
Data from the 10 verbs perceived by the higher-proficiency group as the SC-biased verbs were used. The mean reading times in the disambiguation region were significantly different ($F_1(2,32) = 6.04, p < .01, \eta^2_p = .27; F_2(2,18) = 3.73, p < .05, \eta^2_p = .29$). Multiple comparisons showed that the mean reading time in SCA structure (936ms) was only significantly slower than that in SCU structure (818ms), and there was no significant difference between SCA structure and DO structure (862ms). In the ambiguous noun region, there was a significant difference in the mean reading times ($F_1(2,32) = 3.63, p < .05, \eta^2_p = .18; F_2(2,18) = 6.18, p < .01, \eta^2_p = .41$). Multiple comparisons showed that the mean reading time in SCU structure (884ms) was only faster than that in DO structure (1030ms).

The result of the disambiguation region indicated the influence of the SC-biased verbs because the time difference between DO structure and SCA structure disappeared, even though there was a time difference between these structures in the analysis of the DO-biased verbs. However, this did not mean the GP effect disappeared entirely, but simply became weaker because the time difference between SCA structure and SCU structure was still present. This difference also indicated that the influence of the complementizer that was stronger than that of the verb bias, which was similar to the results of Dussias and Cramer Scaltz (2008).

**Analysis of the lower-proficiency group**

In the analysis of the sentences with the 6 SC-biased verbs for the lower-proficiency group, the difference in the processing times in the disambiguation region was not significant ($F_1(2,34) = 0.15, \text{n.s.}, \eta^2_p = .01; F_2(2,10) = 0.36, \text{n.s.}, \eta^2_p = .07$). In the ambiguous noun region, there was no significant difference between the mean reading times, either ($F_1(2,34) = 0.64, \text{n.s.}, \eta^2_p = .04; F_2(2,10) = 1.08, \text{n.s.}, \eta^2_p = .18$), which was the same as the case of the DO-biased verbs. The complementizer that did not seem to affect the sentence processing by the lower-proficiency participants.

**Summary**

The results of the above analyses can be summarized as follows:
1. The GP effect was found in the disambiguation region in all 47 verbs for both of the participant groups, and the DO-biased verbs for the higher-proficiency group alone.
2. For the SC-biased verbs, the GP effect was weaker in the disambiguation region. This indicates that the JELF learners' preference about the syntactic information of each verb, supplied by the completion task, affect their prediction about the sentence structure.
3. The complementizer that was related to the absence of the GP effect especially in the processing by the higher-proficiency group. However, the results indicate that the lower-proficiency counterparts were not sensitive to it.
4. The proficiency level was related to the GP effect in this study. In the case of the higher-proficiency group, the GP effect was weaker or absent when the complementizer that was used, and stronger when the DO-biased verbs were used. The lower-proficiency counterparts seemed to be indifferent to them, although their overall mean reading times revealed the same pattern of the GP effect as those of the higher-proficiency group.
Discussion and Implications

This study has identified the GP effect by the higher-proficiency group and found that lexical information of sentential verbs (DO-bias / SC-bias) influences JEFL learners' English sentence processing. This point is consistent with several previous studies of NSE and L1-Spanish English learners. This study added evidence that the GP effect arises even if learners' L1 (Japanese) has a different canonical order from L2 (English).

This study has also shown a difference between the higher and lower proficiency groups. Although the overall inclination indicated that both groups fell into the GP effect, their reading processes were different in terms of how they utilize lexical information about syntactic structure from verbs and the complementizer *that*.

In the case of the DO-biased verbs, the reading speed of the higher-proficiency participants slowed in the disambiguation region of SCA structure, probably because they were led to a temporary misunderstanding of the sentence structure. The lower-proficiency participants, however, did not slow down. The possibility that the discrepancy might have been their insufficient performance in the completion task was ruled out by analysis 2. The result was the same, and enforced that the lower-proficiency learners were not sensitive to the verb bias.

The two groups showed opposing results regarding the use of the complementizer *that*, which was suggested most typically by the different mean reading times between SCU structure and SCA structure. Whereas the lower-proficiency group showed no difference between the two, the higher-proficiency group read faster in the presence of *that*. This indicates the higher-proficiency group's capability of utilizing the complementizer *that* in their sentence processing.

The above-mentioned between-group differences may imply the difference in attention given to the sentence structures. The lower-proficiency group may not be able to pay enough attention to lexical information such as verb subcategorization and the complementizer *that* in their on-line sentence processing. This is consistent with the shallow structure hypothesis by Clahsen and Felser (2006), who insist that effects of syntactic structure that were seen in native speakers appear to be absent in L2 processing.

In contrast, no difference was found between the mean reading times of DO structure and SCA structure, the SC-bias worked to a certain extent on the sentence processing by the higher-proficiency readers. The higher-proficiency group could use the lexical information to lessen the GP effect. This feature supports Dussias and Cramer Scaltz (2008) because both of the studies show that L2 subcategorization biases influence L2 sentence interpretation at an early stage of processing.

In the discussion of their results, Dussias and Cramer Scaltz (2008) criticized the shallow structure hypothesis in terms of the limited number of studies investigating L2 sentence processing. While they claimed that the hypothesis should be demonstrated to hold across different structures, the present study indicates the importance of covering different proficiency levels. Our results are a good example to provide another possible key to explain the discrepancies between the past studies, because the higher-proficiency group participants were able to parse L2 sentences as the constraint-based model claims and the lower-

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proficiency group participants did so in a much shallower way.

Pedagogically, the results of this study imply the importance of taking account of the difference in sentence processing by skilled and unskilled learners. Although it seems that verb subcategorization information has not been taken into consideration so much in the current reading instruction, it might hold clues to the reason why a L2 reader cannot find correct sentence structures. Also, as the successful use of the complementizer that in on-line processing told the difference between the two learner groups, instructors should be more careful about students' attention to the complementizer especially when teaching unskilled readers.

In terms of further research and measurement, the relationship between sentence structure, parsing, and learners' proficiency should be investigated. In particular, learners' proficiency promises to be an important key in the field of second language acquisition, because much progress would be made by suggesting when and how the learner begins to utilize verbs' lexical information for parsing L2 sentences. Furthermore, as the examples by Hare et al. (2003, p. 283) suggest that the verb grasp is DO-biased when it has the sense grip and SC-biased when it has the sense come to understand, verb sense also should be taken into consideration as one of the factors in predicting how verb bias guides processing.

Finally, some limitations of this study should be addressed in future studies. First, the number of verbs used in some analyses was small. This was because the present study identified verb-bias from the same participants as those involved in the reading task, and also because we have used a more rigid method for categorizing the verbs. Efforts to increase the number of verbs in each condition should be made. Second, one more participant should have been included in order to make the perfectly counterbalanced presentation of the items. Another is the wide range of the TOEIC score of the lower-proficiency group (M = 546.78, SD = 148.18). As a result, it remained obscure in which proficiency level JEFL learners start to use verb subcategorization information and the complementizer that, while this study showed the effects of them for the higher-proficiency group.

**Conclusion**

The present study focused on the influence of lexical information of verbs and the complementizer that during sentence processing. The findings suggest that the same types of cues used in past L1 and L2 studies can be utilized by the proficient learners, and that the constraint-based model, which claim the influence of knowledge tied to verbs at an initial phase of sentence processing, better explains the results reported here. In contrast, the less proficient learners show a different and shallower pattern of processing which does not reflect the influence of the verb information and the complementizer.

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References


**Appendix. Sentences Used in the Self-paced Reading Task (excerpt)**

The photographer accepted (that) the money could not be spent.
The photographer accepted the money from the magazine editor.
The lawyer added (that) the story had been a lie.
The lawyer added the story to his speech immediately.
The lawyer advised (that) the clients would need more money.
The lawyer advised the clients about the plan carefully.
The mother announced (that) the wedding would be something special.
The mother announced the wedding of her only son.
The officer answered (that) the call must have been wrong.
The officer answered the call from the company president.
The parent argued (that) the plan should be changed immediately.
The parent argued the plan with the English teacher.
The reporter checked (that) the picture did not have holes.
The reporter checked the picture of the beautiful mountain.
The traveler claimed (that) the bag had been stolen there.
The traveler claimed the bag at the airport yesterday.
The person discovered (that) the lake had caused a problem.
The person discovered the lake in the eastern region.
The worker expected (that) the raise would make them happy.
The worker expected the raise before the next month.
The leader explained (that) the holiday would be something special.
The leader explained the holiday to the young people.
The girl forgot (that) the name could not be used.
The girl forgot the name of the popular singer.
The programmer found (that) the error could not be avoided.
The programmer found the error in the game program.
The officer guessed (that) the name had been written quickly.
The officer guessed the name on the last page.
The neighbor heard (that) the story had never been true.
The neighbor heard the story of the company president.
The teacher judged (that) the speeches would not be satisfactory.
The teacher judged the speeches by the high-school students.
The student learned (that) the lesson was not so helpful.
The student learned the lesson through his own experience.
The lawyer noticed (that) the point might come up soon.
The lawyer noticed the point during the last meeting.
The expert observed (that) the child could have been saved.
The expert observed the child in the play room.
The manager ordered (that) the product should go on sale.
The manager ordered the product from the city yesterday.
The editor printed (that) the article had been really shocking.
The editor printed the article about the game yesterday.
The officer projected (that) the increase would be seven percent.
The officer projected the increase in the water rate.
The man promised (that) the present would be very exciting.
The man promised the present to his girlfriend yesterday.
The manager proposed (that) the idea might be worth trying.
The manager proposed the idea during the last meeting.
The scientist proved (that) the theory had not been tested.
The scientist proved the theory by several methods recently.