Preverbal Prediction in the Comprehension of Filler-gap Dependencies by Japanese Learners of English

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Itsuki MINEMI

Abstract

This study investigates whether Japanese learners of English form filler-gap dependencies in advance of a verb, predicting an upcoming verb's information in English, using a self-paced reading experiment. The results demonstrate that Japanese learners of English, at least those who have experienced sufficient exposure to English in English-speaking countries, postulate a gap at the complement position of a verb before the actual verb is encountered and predict a verb that takes a complement while reading English relative clauses. This finding provides evidence that Japanese learners' comprehension of filler-gap dependencies in English is predictive and is driven by the thematic motivation for early confirmation of the thematic role of the filler. This study also demonstrates that the predictive process in non-native language comprehension of filler-gap dependencies depends on the nature of exposure to a target language.

Key Words: Psycholinguistics, Sentence comprehension, non-native language, Filler-gap dependencies, Prediction

1. Introduction

A central goal of psycholinguistics is to reveal the underlying processing mechanisms of human sentence comprehension. Specifically, regarding the comprehension of linguistic dependencies (e.g., *wh*-questions or relative clauses [RCs]), many studies have focused on predictive processes in the comprehension of "filler-gap dependencies" to elucidate "when" readers start to construct such dependencies and "what" information they use during dependency construction (Aoshima, Phillips, and Weinberg 2004, Crain and Fodor 1985, Frazier and Clifton 1989, Frazier and Flores d'Arcais 1989, Lee 2004, Nakano, Felser, and Clahsen 2002, Omaki et al. 2015, Stowe 1986). The terminology filler-gap dependency refers to a dependency between a non-adjacent element like *the book*, which is called a "filler," and its original position "gap" (represented by an underline) in a sentence such as *This is the book that the man wrote* _____

yesterday.[1]

Previous research has revealed that native speakers (L1 speakers) of both head-initial and head-final languages construct long-distance dependencies before the verb is encountered and that preverbal dependency formation in each type of language would be driven by different motivations (Aoshima et al. 2004, Lee 2004, Nakano et al. 2002, Omaki et al. 2015). The predictive formation of filler-gap dependencies in L1 English is in particular motivated by the need to complete filler-gap dependencies as soon as possible; that is, the need to postulate a gap at the syntactically earliest available position (Frazier and Clifton 1989). By contrast, the preverbal dependency formation in L1 Japanese is driven by the requirement to confirm a thematic role of a filler as early as possible (Aoshima et al. 2004).

Few studies have explored the preverbal predictive formation of filler-gap dependencies in non-native language (L2) processing, and the results of those studies are inconsistent (Aldwayan, Fiorentino, and Gabriele 2010, Canales 2012, Johnson, Fiorentino, and Gabriele 2016). Moreover, some studies have proposed that L2 learners have difficulty generating predictions due to reduced cognitive resources for higher-level processing such as syntactic, semantic, or pragmatic processes, since L2 sentence comprehension requires more cognitive resources for lower-level processes such as lexical processing than comprehension in L1 (Grüter, Rohde, and Schafer 2014, Hopp 2009, 2010, McDonald 2006). However, the literature has suggested that a sufficient amount of exposure and immersion in the target L2 environment reduces the requirement of cognitive resources for lexical processing (Perani et al. 2003) and that naturalistic exposure and immersion change L2 comprehension behavior (Pliatsikas and Marinis 2013).

2. The Present Study

This study investigates at what point in time Japanese speakers initiate the filler-gap dependency formation in L2 English, and what triggers the preverbal prediction; the structural or the thematic requirement. More specifically, this study examines whether Japanese learners of English preverbally posit a gap and consequently predict an upcoming verb's information based on the gap position during the processing of English RCs and whether a preference for early gap-filling or early thematic-role assignment drives such predictive processes.

If Japanese learners of English make predictions about an upcoming verb while they process a segment like *the driver who the millionaire*, an appearance of an unexpected verb would cause processing difficulty reflecting expectation mismatch. Two expectations can be made with regards to processing difficulty at the verb due to expectation mismatch. First, if Japanese learners specifically posit a direct object gap and predict a transitive verb to complete the dependency as soon as possible, processing difficulty is expected to increase when an intransitive verb appears

such as *walk* or *depend*, regardless of whether the intransitive verb takes a prepositional phrase (PP) complement or not (the transitivity mismatch effect).

Second, if Japanese learners' filler-gap dependency formation is motivated by the requirement to confirm a thematic role of a filler as soon as possible, a different pattern of processing difficulty is expected. In English RCs, a filler can receive a thematic role earlier when a corresponding gap is located at the complement of the RC verb such as *the driver who the millionaire saw _____* than when it is located at an adjunct position such as *the driver who the millionaire saw the movie with _____* because verbs distribute thematic roles only to their arguments (Theta Criterion: Chomsky 1981). In this sense, transitive verbs and intransitive verbs that take a complement can assign a thematic role to the filler earlier than intransitive verbs that do not take a complement. If Japanese learners have the preverbal preference for the early fulfillment of the thematic requirement, they would postulate a gap at the complement of a verb and predict a verb that holds a complement. If this is the case, processing difficulty would increase when the actual verb is one that does not take a complement.

2.1 Method

Participants

Twenty-nine Japanese learners of English were recruited from the University of Tokyo (LOW EXPOSURE group) and the University of Hawai'i (HIGH EXPOSURE group); 17 participants for the Low Exposure group and 12 for the High Exposure group. Their English proficiency was assessed with the Quick Placement Test (University of Cambridge Local Examinations Syndicate 2001). The participants also completed a language background questionnaire (Table 1). There was no significant difference in the placement test score and the age of first exposure to English (*p*s < .10). However, the High Exposure group spent longer in English-speaking areas than the Low Exposure group (*p* < .001). All the participants were paid an honorarium for their participation and were naïve to the purpose of the experiment. The duration of the whole experiment was approximately one hour.

Table 1
Summary of the language background information. The maximum score of the placement test is 60. *SE* indicates standard error of the mean, and *SD* indicates standard deviation.

	Placement Test Score	Age-of-Acquisition (yrs.)	Immersion Duration (yrs.)
Low Exposure	43.063 (*SE* = 1.365)	9.765 (*SD* = 3.545)	0.210 (*SD* = 0.848)
High Exposure	46.417 (*SE* = 1.373)	10.417 (*SD* = 3.476)	2.868 (*SD* = 3.534)

Materials

Target experimental sentences were created by crossing two factors: SENTENCE TYPE (GAP/NON-GAP) and VERB TYPE (INTRANSITIVE WITHOUT COMPLEMENT/INTRANSITIVE WITH COMPLEMENT/TRANSITIVE). The verbs for the intransitive with complement conditions were intransitive verbs that Japanese learners preferred to use with a complement in an offline norming study (sentence completion task), for example, *talk* or *depend*.[2] An example set of the target sentences is presented in (1). Subscript numbers represent the region number.

(1) a. Intransitive Without Complement/Gap:

The$_1$ driver$_2$ who$_3$ the$_4$ millionaire$_5$ would$_6$ <u>walk</u>$_7$ with$_8$ left$_9$ a$_{10}$ job$_{11}$ suddenly$_{12}$ yesterday.$_{13}$

b. Intransitive Without Complement/Non-Gap:

The$_1$ driver$_2$ of$_3$ the$_4$ millionaire$_5$ should$_6$ <u>walk</u>$_7$ with$_8$ his$_9$ wife$_{10}$ all$_{11}$ day$_{12}$ long.$_{13}$

c. Intransitive with Complement/Gap:

The$_1$ driver$_2$ who$_3$ the$_4$ millionaire$_5$ would$_6$ <u>depend</u>$_7$ on$_8$ left$_9$ a$_{10}$ job$_{11}$ suddenly$_{12}$ yesterday.$_{13}$

d. Intransitive with Complement/Non-Gap:

The$_1$ driver$_2$ of$_3$ the$_4$ millionaire$_5$ should$_6$ <u>depend</u>$_7$ on$_8$ his$_9$ wife$_{10}$ for$_{11}$ everything$_{12}$.

e. Transitive/Gap:

The$_1$ driver$_2$ who$_3$ the$_4$ millionaire$_5$ would$_6$ <u>bring</u>$_7$ to$_8$ this$_9$ party$_{10}$ lost$_{11}$ his$_{12}$ way$_{13}$.

f. Transitive/Non-Gap:

The$_1$ driver$_2$ of$_3$ the$_4$ millionaire$_5$ should$_6$ <u>bring</u>$_7$ his$_8$ wife$_9$ to$_{10}$ the$_{11}$ party$_{12}$ tonight$_{13}$.

Thirty sets of the target sentences were distributed into six lists with the Latin Square design so that each participant read only one token of each set, and 64 filler sentences were added to each list. Each list contained 94 sentences. The filler items included various types of RC sentences to prevent the participants from adapting to the structure of the target sentences.

Procedure

A self-paced reading experiment was conducted using the Linger software developed by Doug Rohde. In the experiment, the participants read each sentence word-by-word by pressing the spacebar to reveal each word (Just, Carpenter, and Woolley 1982). At the beginning of each trial, a series of dashes was presented on the PC display monitor. When a participant pressed the spacebar first, the first dash was replaced with a fixation point "+." Subsequently, every time they pressed the spacebar, a sentence unfolded word by word, from left to right. Thus, they saw only

one word at a time. The duration from when the spacebar was pressed to when it was pressed again was recorded as reading time (RT) for each word. RTs were considered to reflect cognitive load for the processing of each word. A comprehension question followed each sentence, which could be answered by *yes* or *no*. The purpose of comprehension questions is to make the participants concentrate on reading the experimental sentences. The reading experiment took approximately 30 minutes.

Data Analysis

Data were analyzed separately for the high and low exposure groups since previous studies have demonstrated that nature of exposure to the target language has an influence on L2 online sentence comprehension (Dussias 2003, Dussias and Piñar 2009, Dussias and Sagarra 2007, Foucart and Frenck-Mestre 2011, Frenck-Mestre 2002, Pliatsikas and Marinis 2013).

The data from trials in which the participants answered incorrectly to the comprehension task were not excluded in the following statistical analysis for RTs because incorrect answers to comprehension questions do not necessarily indicate that the readers did not parse filler-gap dependencies. Notably, even when removing the data from trials in which the participants answered incorrectly, RT patterns were not far different from those calculated based on the data including them.

For each region in each group, RT data with extreme deviation from distributions were excluded because such data cannot be considered to represent natural RT. The remaining RT data were submitted to linear mixed-effects (LME) models, and the accuracy of the comprehension tasks was analyzed with logistic mixed-effects models (Baayen 2008, Baayen and Milin 2010, Baayen, Davidson, and Bates 2008).[3] The models contained Sentence Type (Gap/Non-Gap), Verb Type (Intransitive Without Complement/Intransitive with Complement/Transitive), and their interaction as fixed effects as well as random-effects structures with intercepts and slopes for the fixed effects by participants and by items. The models were implemented in R version 3.5.3 (R Core Team 2019) using the "lme4" package version 1.1.21 (Bates, Mächler, et al. 2015). *P*-values were approximated using the "lmerTest" package version 3.1.0 (Kuznetsova, Brockhoff, and Christensen 2017).

The first factor Sentence Type was coded with dummy coding, with 0 for the gap conditions and 1 for the non-gap conditions and centered (i.e., subtracting the mean from each value) before model construction. The second factor Verb Type was coded with Reverse Helmert contrasts (Vasishth and Broe 2011, Venables and Ripley 1999). The first contrast targets the transitivity mismatch effect by comparing the transitive verbs to the intransitive verbs with a complement, with −1 for the transitive conditions, 1 for the intransitive with complement conditions, and 0 for the intransitive without complement conditions (TRANSITIVITY). The second contrast compares

the intransitive without complement conditions to the means of the transitive and intransitive with complement conditions (ARGUMENT STRUCTURE), with −1 for the transitive and intransitive with complement conditions and 2 for the intransitive without complement conditions, targeting the expectation mismatch effect on argument structure, namely, whether a verb takes a complement or not.

Optimal models were selected with "parsimonious" model selection (Arai and Roland 2016, Bates, Kliegl, et al. 2015), using the "rePsychLing" package version 0.0.4 (Baayen, Bates, Kliegl, and Vasishth 2015). For RT data analysis, additional outlier removal was conducted based on the model estimates of RT in each region (Baayen and Milin 2010, Baayen et al. 2008). RT data points were excluded if they exceeded 2 *SD*s above the residuals from the estimated RT by the optimal model. Through the data exclusions, in total, 5.748% of the high exposure group data and 5.807% of the low exposure group data were removed.

2.2 Predictions

First, if Japanese learners of English specifically posit a direct object gap before accessing verb information and predict a transitive verb, RT for the intransitive verb in the gap condition would increase due to the expectation mismatch, resulting in a significant interaction between Sentence Type and Transitivity (the transitivity mismatch effect).

Second, if Japanese learners predictively postulate a gap at a complement position of the verb and consequently anticipate a verb that takes a complement, RT for the intransitive verb that does not take a complement would be longer in the gap condition than in the non-gap condition, and no such effect due to the expectation mismatch would be observed neither in the transitive nor intransitive with complement conditions. Statistically, an interaction between Sentence Type and Argument Structure would be significant (the argument structure mismatch effect).

Third, if Japanese speakers do not predict the upcoming verb's information and initiate the filler-gap dependency formation only after confirming that the verb is transitive and can hold the direct object, the RT difference would be observed for the transitive conditions. RTs for the transitive verb would be longer in the gap condition than in the non-gap condition, resulting in a significant interaction between Sentence Type and Transitivity with a different RT pattern than the first prediction expects.

2.3 Results

High Exposure Group

Comprehension Accuracy

By-subject mean accuracy of the comprehension questions for the target sentences was

75.000% (*SE* = 4.294). The logistic mixed-effects model revealed a significant effect of Sentence Type, indicating that the mean accuracy was lower in the gap conditions than in the non-gap conditions (β = 1.011, z = 3.739, p < .001). However, no interaction was significant.

Table 2
By-subject mean accuracy of the comprehension tasks of the high exposure group. Numbers in parentheses indicate *SE*.

	Gap	Non-Gap
Intransitive Without Complement	70.000% (7.588)	81.667% (6.256)
Intransitive with Complement	70.000% (8.348)	83.333% (5.946)
Transitive	60.000% (7.785)	85.000% (4.352)

Reading Time

By-subject mean RT for each condition per region is illustrated in Figure 1. Prior to the critical region (Region 7 *Verb*), there was a main effect of Sentence Type in Region 3 *who/of* (β = −83.403, t = −4.670, p < .001) and Region 4 *the* (β = −92.503, t = −5.301, p < .001), which reflected longer RTs in the gap conditions than in the non-gap conditions.
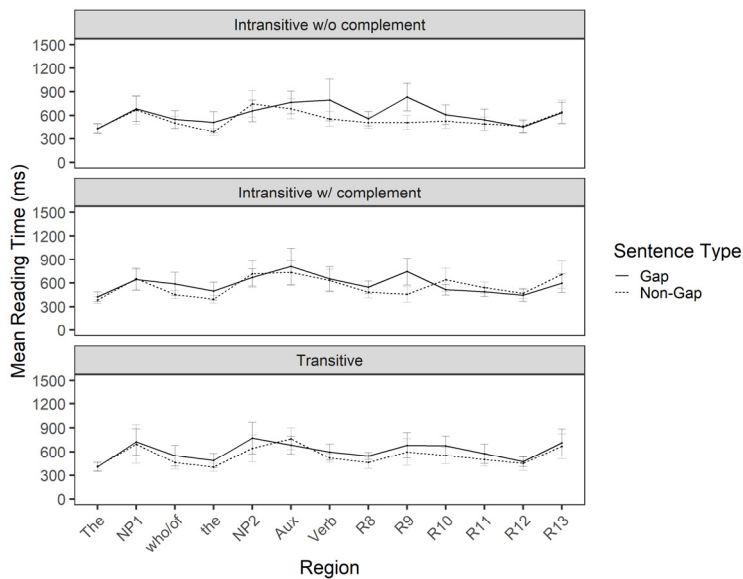

Figure 1. By-subject mean RT per region in each condition of the high exposure group. Error bars indicate 95% confidence interval (CI) of the mean.

Crucially, in the critical region, the optimal LME model revealed a significant interaction between Sentence Type and Argument Structure (β = −49.691, t = −1.974, p = .049), as reported

in Table 3. The interaction reflected RT slowdown in the intransitive without complement/gap condition. The RT was particularly longer in the gap condition than in the non-gap condition in the intransitive without complement condition, and no such difference was observed in the other conditions. In addition, an interaction between Sentence Type and Transitivity was not significant ($p > .100$). This finding shows that the RT patterns in the intransitive with complement and transitive conditions were not significantly different. In other words, verb transitivity did not induce a great difference in RTs.

Table 3
Summary of fixed effects estimates on RT data from the LME model in Region 7 *Verb* for the high exposure group. Significance markers: * = $p < .050$, ** = $p < .010$, *** = $p < .001$.

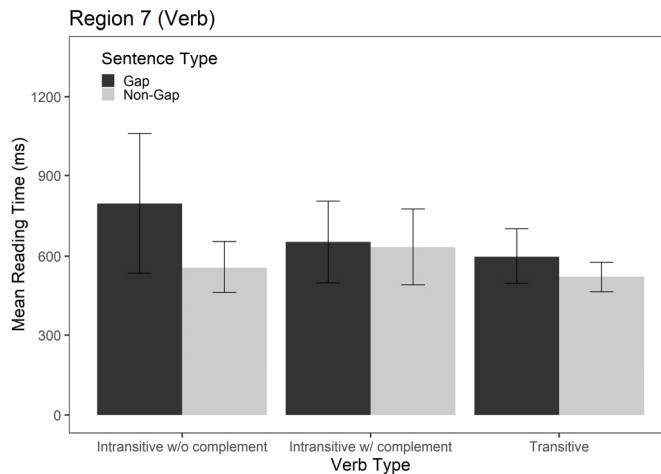|	β	t	p	
(Intercept)	619.209	12.762	< .001	***
Sentence Type	−107.111	−2.994	.003	**
Transitivity	34.854	1.578	.116	
Argument Structure	19.296	1.535	.126	
Sentence Type × Transitivity	26.963	.612	.541	
Sentence Type × Argument Structure	−49.691	−1.974	.049	*

Figure 2. By-subject mean RT in Region 7 *Verb* of the high exposure group. Error bars indicate 95% CI of the mean.

Low Exposure Group

Comprehension Accuracy

By-subject mean of the comprehension questions for the target sentences was 80.784% (*SE*

= 2.735). The mean score of each condition is presented in Table 4. Similar to the high exposure group, the mean accuracy in the gap conditions was lower than in the non-gap conditions (β = 0.518, z = 2.169, p = .030). The other effects were not significant (all ps > .100)

Table 4
By-subject mean accuracy of the comprehension tasks of the low exposure group. Numbers in parentheses indicate *SE*.

	Gap	Non-Gap
Intransitive without Complement	77.647% (6.390)	82.353% (4.815)
Intransitive with Complement	74.118% (5.359)	82.353% (4.499)
Transitive	80.000% (3.835)	88.235% (4.869)

Reading Time

By-subject mean RT in each condition per region is presented in Figure 3. Before the critical RC verb region, the LME models exhibited a significant effect of Sentence Type in Region 3 *who/of* (β = −76.306, t = −3.730, p < .001) and Region 4 *the* (β = −77.587, t = −5.511, p < .001), with longer RTs in the gap conditions than in the non-gap conditions. Region 5 *NP2* showed a significant effect of Sentence Type in the opposite direction (β = 202.014, t = 3.794, p < .001); longer RTs were observed in the non-gap conditions than in the gap conditions.
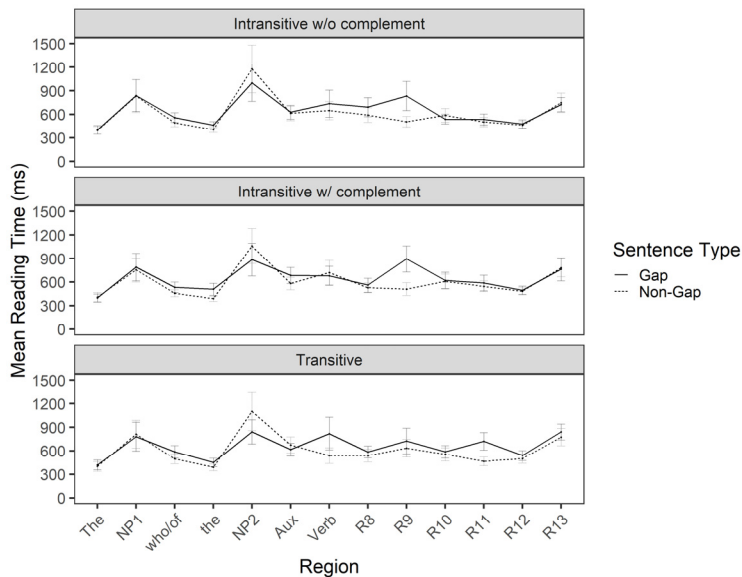

Figure 3. By-subject mean RT per region in each condition of the low exposure group. Error bars indicate 95% CI of the mean.

Fixed effect estimates for the critical region, Region 7 *Verb*, are presented in Table 5. The model revealed a significant interaction between Sentence Type and Transitivity, which is due to the larger RT difference in the transitive conditions than in the other conditions as shown in Figure 4 ($\beta = 153.738$, $t = 3.996$, $p < .001$). That is, in the transitive conditions, the gap condition elicited longer RT than the non-gap condition. By contrast, no significant interaction was observed between Sentence Type and Argument Structure ($p > .100$).

Table 5

Summary of fixed effects estimates on RT data from the LME model in Region 7 *Verb* for the low exposure group. Significance markers: *** = $p < .001$.

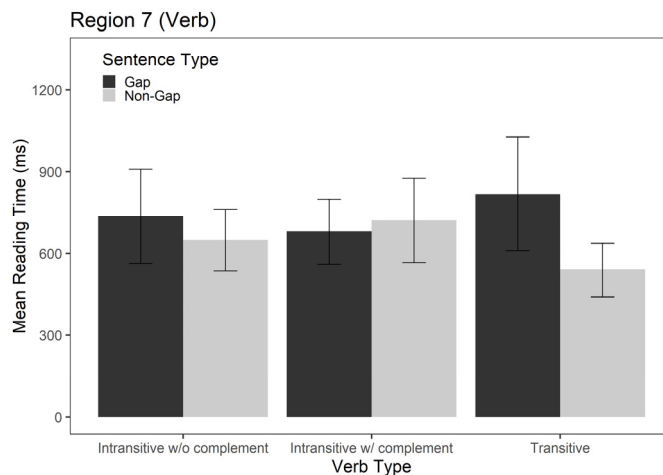|	β	t	p	
(Intercept)	688.803	10.850	< .001	***
Sentence Type	−107.808	−3.429	< .001	***
Transitivity	14.802	.770	.442	
Argument Structure	2.881	.260	.795	
Sentence Type × Transitivity	153.738	3.996	< .001	***
Sentence Type × Argument Structure	3.570	.161	.872	

Figure 4. By-subject mean RT in Region 7 *Verb* of the low exposure group. Error bars indicate 95% CI of the mean.

3. Discussion

High Exposure Group

The results support the second prediction, that is, Japanese learners of English initiate the filler-gap dependency formation even before an actual verb is encountered and predict a verb that

takes a complement. Crucially, the Japanese learners in the high exposure group showed a significant interaction between Sentence Type and Argument Structure in Region 7 *Verb*: The RT for the intransitive verbs that do not take a complement was particularly longer in the RC sentences than in the non-RC sentences. This RT disruption in the intransitive without complement/gap condition would reflect the argument structure mismatch effect, suggesting that RT slowed down because the verbs in the condition were the ones that do not take a complement such as *walk* although the participants predicted the presence of a verb that takes a complement such as *bring* or *depend*. This result is compatible only with the prediction that Japanese learners of English posit a gap in a complement position of a verb and thereby anticipate a verb that takes a complement in advance of the actual verb.

In addition, the results are inconsistent with the first prediction that Japanese learners anticipate a transitive verb in advance of the appearance of an actual verb. Namely, according to the first prediction, the interaction between Sentence Type and Transitivity was expected to be significant in the RC verb region, reflecting RT slowdown in the intransitive/gap conditions, regardless of the verb's argument structure. However, the interaction was not significant in the expected direction; The RT slowdown was observed only in the intransitive without complement/gap condition. This finding implies that the difference in verb transitivity does not influence Japanese learners' processing behaviors in online comprehension. Moreover, the results are not consistent with the third prediction that Japanese learners do not make a prediction about upcoming verb information because it did not expect the expectation mismatch effect.

Thus, the results demonstrate that Japanese learners' preverbal gap postulation mechanism is driven by the thematic requirement, not by the structural requirement. Previous studies have demonstrated that although native speakers of both head-initial and head-final languages predictively construct filler-gap dependencies before the verb is encountered, the preverbal gap postulation in each type of language would be motivated differently (Aoshima et al. 2004, Omaki et al. 2015). Native speakers of English posit a gap at the syntactically earliest available position during the processing of RCs (Omaki et al. 2015) while native speakers of Japanese postulate a gap at the earliest position where a filler can receive a thematic role during the processing of scrambled *wh*-sentences (Aoshima et al. 2004). This study assesses which mechanism triggers Japanese learners' filler-gap construction in L2 English by manipulating verb transitivity (whether a verb takes a direct object or not) and argument structure (whether a verb takes a complement or not). Critically, the argument structure mismatch effect was observed, but the transitivity mismatch effect was not, suggesting that Japanese speakers' preverbal gap creation mechanism in L2 English is driven by the preference for the early confirmation of the thematic role of the filler, not by the structural requirement to complete filler-gap dependencies as soon as possible.

The RT difference in Region 3 *who/of* and Region 4 *the* might provide supporting evidence for this interpretation. The RTs for Regions 3 and 4 were longer in the RC sentences than in the non-RC sentences, indicating that the learners experienced more processing difficulty with *who* than *of*. This finding might reflect an additional processing load for the predictive dependency formation in the RC sentences. That is, the RTs around the relative pronoun in those sentences became longer than in the non-RC sentences reflecting the additional processing load for predictive gap postulation because the participants initiated it as soon as they recognized the filler in the RC sentences. However, it should be noted that there remains a possibility that the differences in Regions 3 and 4 merely reflect the lexical difference between *who* and *of*.

In summary, the results of the high exposure group suggest that Japanese learners of English who have a sufficient degree of exposure and immersion in English-speaking countries start to build filler-gap dependencies prior to an actual verb and that it would be driven by the requirement for early confirmation of thematic role.

Low Exposure Group

By contrast, the results of the low exposure group support the third prediction, that is, they do not predict forthcoming verb information while reading English filler-gap dependencies and start the filler-gap dependency formation only after receiving verb information. As expected by the third prediction, the RC verb region exhibited a significant interaction between Sentence Type and Transitivity with the RT slowdown for the transitive/gap condition. This finding indicates that the Japanese learners in the low exposure group spent more time processing the transitive verb in the RC sentences than in the non-RC sentences. This effect should be considered the filler-gap integration cost. Therefore, the result suggests that the Japanese learners of the low exposure group initiate the filler-gap dependency formation only after accessing the verb.

Furthermore, the interaction between Sentence Type and Transitivity demonstrates that Japanese learners who do not experience a sufficient amount of exposure or immersion in English-speaking areas would not predict upcoming verb information. The interaction implies no or a smaller RT difference in the intransitive with complement conditions, as shown in Figure 4. This finding indicates that the participants did not experience much cognitive difficulty when processing the intransitive verb that takes a complement in the RC sentences. If the learners predicted a transitive verb as a consequence of the preverbal direct object gap postulation, they should undergo processing difficulty for the intransitive verbs, resulting in RT slowdown in the intransitive with complement/gap sentences due to the mismatch between the prediction and the actual input. However, no such effect was observed.

Additionally, no significant interaction between Sentence Type and Argument Structure strengthens this interpretation. If the readers predictively posit a gap at a complement position of a

verb and consequently predict a verb that takes a complement, they should demonstrate a similar RT pattern as observed for the high exposure group. However, no such effect was observed. Thus, these results prefer the hypothesis that Japanese learners who have an insufficient degree of exposure and immersion in English-speaking countries do not build filler-gap dependencies in advance of a verb and do not make a prediction on upcoming verb information.

Moreover, there is a possibility that Japanese learners with little exposure and immersion start the filler-gap dependency formation immediately after they recognize the filler *who* but are unable to predict verb information because of some other factor. The RT slowdown occurred in the gap conditions in Regions 3 *who* and 4 *the*, and this may be attributed to the additional processing load for the filler-driven gap postulation. If this is the case, the result suggests that they form filler-gap dependencies before reading the verb. Nonetheless, the RT slowdowns due to the expectation mismatch were not observed in the verb region for the low exposure group.

Thus, one possible speculation is that Japanese learners with little exposure and immersion do not postulate a gap specifically at either a direct object or a complement position, and hence, they do not predict upcoming verb information. That is, they first posit a gap at the RC subject position because it is the earliest available argument position but are not able to move it into another position, for example, as a direct object or a complement, when the subject position was occupied by the actual subject NP *the millionaire*. Therefore, they anticipate neither verb transitivity nor argument structure. This speculation is compatible with previous literature that has argued that L2 learners have difficulty revising structural representations (Jacob and Felser 2016, Jessen and Felser 2019, Roberts and Felser 2011).

A question that arises is as follows: why can only learners with a sufficient amount of exposure and immersion successfully reanalyze the gap positions and predict upcoming verb information? The answer can be attributed to the difference in cognitive resources available for structural processes. Previous research has suggested that lexical access in L2 processing requires more cognitive resources than in L1 processing, which results in different processing behaviors in L2 than in L1 (Hopp 2009, 2010, 2013, McDonald 2006). Furthermore, it has been demonstrated that the greater amount of exposure to the target language L2 learners have, the fewer cognitive resources they need for lexical access (Perani et al. 2003). Given these findings, a plausible assumption is that the participants in the low exposure group were not able to revise the gap positions because they had an insufficient amount of cognitive resources to do that because they have less exposure and immersion in English-speaking countries.

To summarize, the results of the low exposure group show that Japanese learners of English with less exposure and immersion in English-speaking countries do not predict upcoming verb information during the processing of filler-gap dependencies and they are not likely to initiate the

filler-gap dependency formation until a verb appears.

4. Conclusion

This study shows that Japanese learners of English postulate a gap at a complement position of an upcoming verb and predict a verb that takes a complement during the processing of English filler-gap dependencies. However, this study did not find evidence that Japanese learners of English predictively posit a direct object gap and anticipate a transitive verb. This finding suggests that their preverbal gap postulation would be driven by the thematic requirement for early confirmation of thematic-role assignment, not by the structural requirement that a gap should be posited at the syntactically earliest available position. Furthermore, this study proposes that the nature of exposure to a target L2 is likely to affect the predictive gap creation in L2 because the predictive filler-gap dependency formation was observed only with the Japanese learners with a sufficient amount of naturalistic exposure and immersion in English-speaking countries.

Notes

[1] In this paper, the terminology gap is used. However, it does not mean that the processing mechanisms discussed in this paper need syntactic representations with empty categories. Instead, we use this terminology in a theoretically neutral manner to simplify the description of long-distance dependencies.

[2] Fifteen Japanese learners were recruited for the norming study who did not participate in the reading experiment. The participants were presented segments (subject NP and verb) and asked to complete them like below.

John talked _____. => John talked with Mary.

Experimental materials include 48 intransitive and 20 transitive verbs. The sentence completion data were submitted to the *do-so* substitution test in order to test whether prepositional phrases are the verbs' complement (Jackendoff 1977, Lakoff and Ross 1976). Verbs used more often with a complement than without a complement in the norming study (binomial test: $p < .050$) were categorized as the intransitive

verbs with a complement in the reading experiment.

3   The RT data for Regions 8 to 13 were not statistically analyzed because the words for these regions were not controlled across the conditions. For instance, the word for Region 8 was *to* in the transitive/gap condition, but it was *his* in the transitive/non-gap condition.

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