Evidence for L2 Syntactic Gap-Processing in Japanese Scrambling Sentences

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1. Introduction

The ability of second language (L2) learners to use structural information during sentence processing has been questioned by Clahsen and Felser (2006a; 2006b) in their shallow structure hypothesis. They maintain that L2 learners process target language by using semantic information derived from the argument structure of the verb, not by using structural information such as a syntactic gap. The present article offers evidence at odds with that hypothesis by circumventing two problems that have made earlier L2 processing studies inconclusive on whether learners can draw on structural information in processing displaced elements. The self-paced reading study reported below utilized two properties of Japanese, verb-finality and scrambling, and included two learner groups, Korean and Chinese. It found that advanced Korean learners of Japanese are capable of syntactic gap-processing when reading short-scrambling sentences that impose moderate demand on learners' computational resources. In processing long-scrambling sentences, however, Korean learners did not engage in syntactic gap-processing because of the excessive demand that condition placed on their computational resources.

2. Problems in Earlier L2 Studies

Two confounding factors in earlier L2 studies on learners' syntactic gap-processing capability are indeterminacy and computational overload. Both can be circumvented by using Japanese as the target language, owing to its properties of verb-finality and scrambling.

2.1. Indeterminacy

Clahsen and Felser (2006b) point to the interpretive ambiguity in the findings of L2 studies on processing of *wh*-dependencies in English (Juffs, 2005; Juffs & Harrington, 1995, 1996; Williams, Mobius, & Kim, 2001). The findings are indeterminate on the cause of learners' reading slowdown at a post-verbal position when they read sentences such as *Who did Anne say her friend likes __?* (Juffs & Harrington, 1995, p. 505). Clahsen and Felser note that the observed reading slowdown could have resulted from learners' application of syntactic gap-filling operations or from their semantic association of the displaced constituent with its verb on the basis of the verb's argument structure information. The indeterminacy arises because these two types of processing occur at the same post-verbal position in English.

That indeterminacy is precluded when Japanese is used as the target language. Owing to the property of verb-finality in Japanese, the gap that signals the need for syntactic gap-filling operations is located prior to the verb, before the verb's argument structure information becomes available. Therefore, if learners engage in syntactic gap-filling operations, a slowdown in their reading should occur at the pre-verbal gap-implicating position. If learners rely instead on the verb's argument

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structure information, as posited by the shallow structure hypothesis, then a reading slowdown should occur at the verb position.

2.2. Computational Overload

Another confounding factor in L2 studies on gap-processing is learners' processing only of sentences that may have overtaxed their computational resources. One example from the literature is Marinis *et al.*'s (2005) use of long-distance *wh*-movement sentences containing an intermediate gap, such as *The nurse who the doctor argues ___ that the rude patient had angered ___ is refusing to work late*. The authors found that in reading such sentences, learners failed to facilitate their reading at the second gap position. If learners had reactivated the filler at its intermediate gap position, there would have been an observable reading facilitation effect at the second gap position (cf. Gibson & Warren, 2004). The absence of such an effect led the authors to conclude that learners had failed to postulate an intermediate gap.

The design of Marinis *et al.*'s study (having learners read three-clause sentences with two layers of nesting in a phrase-by-phrase moving window format) may have had the unintended consequence of imposing an excessively high computational load on learners (see Indefrey, 2006). Under such conditions, an effect arising from their processing of the intermediate gap may have disappeared by the time they reached the second gap position in the sentence. Alternatively, the excessive computational load may have forced the learners to resort to a processing mode other than syntactic gap-filling as a way of compensating for the drain on their computational resources.

In order to control for computational overload, the present study utilized a type of scrambling in which the displacement of a constituent can be contained within a single clause (see Nemoto, 1999, for an overview of scrambling in Japanese). Furthermore, the study varied the degree of demand placed on processing by including two scrambling conditions: a moderately demanding short-scrambling and a more computationally taxing long-scrambling condition (described below). If L2 syntactic gap-processing is impeded when a high demand is placed on learners' limited computational resources, then they would not engage in it when processing long-scrambling condition sentences. On the other hand, when processing short-scrambling condition sentences which place moderate demand on computational resources, learners would engage in syntactic gap-filling operations.

3. The Study

The aim of the study was to determine whether advanced L2 learners can engage in syntactic gap-filling operations. In order to avoid the above two problems, the study utilized verb phrase (VP)-internal scrambling in Japanese, constructed by moving a constituent a short or a long distance away from its canonical position. In order to investigate first language (L1) effects on processing of scrambling, two learner groups were included: one whose L1 exhibits scrambling (Korean) and one whose L1 lacks it (Chinese).

Following Miyamoto and Takahashi (2002; 2004), the study used the indirect object–direct object construction, plus an adverbial phrase (AdvP) (locative or temporal), to create short and long versions of scrambling (see footnote 1 for clarification of terminology). The study contained three test sentence conditions: a canonical-ordered condition (1), and two versions of a scrambling condition, a short (2) and a long (3). (1) represents a canonical-ordered sentence in which the AdvP *resutoran no atarasii kicchin de* 'in the restaurant new kitchen' precedes the indirect object–direct object sequence (i.e., *wueetoresu-ni* 'the waitress-DTA'–*kokku$_i$-o* 'the cook-ACC'). (2) exemplifies a short-scrambling sentence in which the direct object *kokku$_i$-o* 'the cook-ACC' has been scrambled to the position immediately preceding the indirect object *wueetoresu-ni* 'the waitress-DTA' (the direct object's canonical position is indicated by the "t_i"). (3) illustrates a long-scrambling sentence in which the direct objedt *kokku$_i$-o* 'the cook-ACC' has been more distantly scrambled to the position preceding the AdvP *resutoran no atarasii kicchin de* 'in the restaurant new kitchen'[1]:

[1] Note that the term *long*-scrambling is used for contrastive purposes, to differentiate it from *short*-scrambling. Long-scrambling differs from *long-distance* scrambling in which a constituent is scrambled across the clause

(1) Canonical-ordered condition:
Maneejyaa-wa resutoran no atarasii kicchin de wueetoresu-ni kokku-o
Manager-TOP restaurant new kitchen in waitress-DAT cook-ACC
syookai-sita soo da.
introduced seemed

(2) Short-scrambling condition:
Maneejyaa -wa resutoran no atarasii kicchin de $\underline{kokku_i\text{-}o}$ *wueetoresu-ni* t_i
Manager-TOP restaurant new kitchen in cook-ACC waitress-DAT
syookai-sita soo da.
introduced seemed

(3) Long-scrambling condition:
Maneejyaa -wa $\underline{kokku_i\text{-}o}$ *resutoran no atarasii kicchin de wueetoresu-ni* t_i
Manager-TOP cook-ACC restaurant new kitchen in waitress-DAT
syookai-sita soo da.
introduced seemed

In each condition, the region immediately preceding the verb is critical for it implicates the presence of a structural gap in (2) and (3), but not in (1). The greater the distance between the gap and its antecedent, the more difficult syntactic gap-processing becomes. This is expected because the greater that distance is, the more decayed the initial activation of the antecedent would be by the time syntactic gap-filling operations would take place (Gibson, 1998; 2000). Therefore, syntactic gap-processing in (3) should be more difficult than it is in (2). (1) excludes syntactic gap-processing.

It was expected that the long-scrambling condition (3) would tax Japanese native speakers' (NSs) computational resources enough to cause them to slow down their reading at the critical region. The short-scrambling condition (2) would not do so. As for L2 learners, suppose that a high demand placed on their computational resources would impede syntactic gap-processing, whereas a moderate demand would not. Then an asymmetry in learners' reading pattern would appear that is the inverse of the NSs' asymmetrical reading pattern. That is, learners would show no reading slowdown at the critical region in (3) because that long-scrambling condition would overtax their computational resources. They would exhibit a reading slowdown at the critical region in (2), however, because the moderate computational effort required for processing the short-scrambling condition would not impede their engaging in syntactic gap-filling operations. Finally, if learners' L1 lacks scrambling, they might not exhibit a reading slowdown at the critical region in either condition (2) or (3).

3.1. Participants

There were three groups of participants in the study: Korean-speaking and Chinese-speaking learners of Japanese, and NSs of Japanese. Each group had 24 participants. Table 1 presents background information on the learner participants' Japanese language-learning experiences.[2] All learners were at an advanced level of language study at the Center for Japanese Language, Waseda University, Tokyo. At the time of experimentation, they had lived in Japan for at least three and a half months and many were taking undergraduate or graduate courses at Waseda University as degree-seeking students. All Japanese NS participants were university students in Tokyo. All participants were compensated for their participation in the study.

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boundary. In this study, both long- and short-scrambling are contained VP-internally in order to preclude the possibility that an observed reading slowdown has been caused by a computational load that would accrue in computing the clause-boundary (see Miyamoto, 2002, for such evidence).

[2] Chinese and Korean learners' group average scores on the JLPT were significantly different from each other ($t(46) = 4.630$, $p < .0005$). Note that the Chinese group attained a very high score, nevertheless.

Table 1. NNS participants' proficiency test scores and Japanese learning experiences

L1s	No.	JLPT scores average % (ranges)	Length of study average yrs (ranges)	Visiting experience average mo (ranges)
Korean	24	97.0 (89.3-100)	4.42 (2.0-8.0)	10.2 (3.5-29.0)
Chinese	24	90.9 (82.1-100)	4.67 (2.0-14.0)	18.1 (3.5-93.0)

3.2. Materials

First, 29 sets of test sentences were contrived. Each set contained four sentence conditions: the three shown in (1) to (3) and a fourth unrelated to the study reported here. The 29 test sentence sets were then subjected to a norming survey. Four questionnaires were created for that survey in a Latin Square design by assigning one of the four condition sentences of a test sentence set to one questionnaire, the next condition sentence of that set to another questionnaire, and so on, throughout the entire 29 test sentence sets. Each of the four questionnaires contained 29 test sentences, along with 22 (grammatical) fillers, for a total of 51 sentences. Sixty NS of Japanese participated in the norming survey, with 15 respondents per questionnaire version. They rated all test and filler sentences using a seven-point scale from 1 'natural' to 7 'unnatural'. Twenty-four sets of test sentences were then selected out of the original 29 sets on the basis of which sets had received the highest naturalness ratings in the questionnaire survey. The average rating scores for the selected test sentences were 1.90 for the canonical-ordered, 2.03 for the short-scrambling, and 2.64 for the long-scrambling condition. All verbs used in the norming study were those perceived by Japanese NSs to require the presence of both arguments (indirect object and direct object) in the ditransitive construction. This was ensured by consulting Kamide and Mitchell's (1999) L1 questionnaire data on the perceived requirement for a dative argument in verbs that participate in the indirect object–direct object construction.

Next, using the 24 selected sets, four experimental lists were generated in a Latin Square design, with each list containing six test sentences of each of the four conditions (24 test sentences per list). Each experimental list also contained 48 fillers, half of which were included for a separate experiment and the other half varying in structure and length. Thus there were a total of 72 sentences in each experimental list. The four lists underwent separate pseudo-randomizations: each list was divided into six blocks, with each block having one sentence of each of the four test conditions and eight filler sentences. The ordering of the 12 (test and filler) sentences within each block was pseudo-randomized so that at least one filler sentence intervened between two test sentences. The presentation of the six blocks within each list was also randomized. Finally, the number of true or false verification statements (described below) was counterbalanced within each block.

3.3. Procedures

Prior to arrival at an experimental session, learner participants filled out a questionnaire on their Japanese language learning experience and their personal background. They also individually took the grammar section of the Japanese Language Proficiency Test and were instructed to study a list of vocabulary items and *kanji* characters that appeared in the experimental material. The experimental session consisted of two experiments (the second of which is reported in this article) separated by a break during which the learner participants took a vocabulary and *kanji* character test to measure their familiarity with those used in the experiments. Completion of the entire session took learners 70 to 80 minutes. Native speaker participants took the same two experiments, also separated by a break during which they filled out a questionnaire on their foreign language learning experience and personal background. They completed their session in about 40 minutes. The experimental sessions took place in the author's office.

The experiment employed a phrase-by-phrase self-paced reading paradigm (Just, Carpenter, & Woolley, 1982). Each sentence was presented region-by-region as segmented in (1) to (3).[3] Each region appeared in the center of a 17-inch display screen on a Toshiba laptop computer, in black letters on a white background in Mincho 24-point font. At each trial, a '+' mark first appeared in the center of the display. The mark was replaced with the first region of a sentence when the participant pressed the leftmost button of a response button-box connected to the computer. After having read the first region, the participant pressed the button to replace it with the second region. This continued until reaching the end of the sentence. After the participant read the final region of the sentence, a brief statement was presented in the center of a new display. The participant had to determine if the statement was true or false relative to the (test/filler) sentence just read, then press one of the two rightmost buttons of the button-box, labeled green (true) or red (false). The purpose of this task was to ensure that each sentence was read for comprehension. After the participant responded to the verification statement, visual feedback was provided indicating if the response was correct or not. The true/false verification statements were counterbalanced: half of the test and filler sentences had true statements, the other half had false statements. The reading time for each region of every sentence was measured on the computer. The accuracy of the response to each true or false verification statement was also recorded, using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002).

At the beginning of the experimental session, a hard copy of the instructions for the experiment (written in the participant's L1) was provided to the participant. After the experimenter (i.e., the author) confirmed that the participant understood the experimental procedures, the participant proceeded to a practice session containing eight practice sentences not used in the testing session. The participant had to respond correctly to at least two-thirds of the true or false verification statements in the practice session in order to proceed to the testing session. Upon completing the first half of the testing session, the participant took a brief relaxation break. Then, after working on two additional practice sentences, the participant continued until finishing the experiment.

3.4. Results

The NS, Korean learner, and Chinese learner groups responded correctly to the true/false verification statements appearing after the test sentences at a rate of 89.53%, 89.99%, and 87.79%, respectively. Excluded from subsequent analyses were reading time data from test sentences whose verification statements were incorrectly answered. A regression equation for predicting reading time from region length was computed for each participant, using all sentences (test and filler) whose verification statements the participant correctly answered. The region length was defined in terms of the number of morae in the region. For each participant and at each region, the predicted reading time was subtracted from the observed reading time to generate the residual reading time. This statistical procedure removed extraneous variance by subtracting out the participant's button-press baseline time and by controlling for length effects due to region-length differences. All analyses were performed using residual reading time data (see Ferreira & Clifton, 1986; Trueswell, Tanenhaus, & Garnsey, 1994, for discussion of residual reading time analysis).

It was hypothesized that the computational effort required for processing the critical pre-verbal region would be high in long-scrambling, moderate in short-scrambling, and negligible in the canonical-ordered condition. If so, Japanese NSs would read the critical gap-implicating region in long-scrambling sentences more slowly than they would read that region in short-scrambling sentences. They would show no reading slowdown at the pre-verbal gap-implicating region in short-scrambling sentences in comparison to their reading time at the pre-verbal region implicating no gap in canonical-ordered sentences. As for Korean learners, they would show no reading slowdown at the gap-

[3] Because learners might be unfamiliar with some *kanji* (logographic characters adopted from Chinese) appearing in the experimental material, Japanese phonetic symbols called *hurigana* were added above those *kanji* suspected of being unfamiliar to the learners to indicate pronunciation. This writing convention is used in Japanese newspapers, magazines and books containing uncommonly used *kanji*. Thus it did not introduce any peculiarity into the experiment. No participant (native or non-native) expressed his/her discomfort with the occasional presence of *hurigana* in the experimental material when interviewed after the experiment.

implicating region in long-scrambling sentences compared to their reading time at the gap-implicating region in the short-scrambling sentences. On the other hand, Korean learners would read the pre-verbal gap-implicating region in short-scrambling sentences more slowly than they would read the pre-verbal region implicating no gap in canonical-ordered sentences. Finally, Chinese learners would show no difference in their reading of the critical region among all three conditions.

3.4.1. Processing a Syntactic Gap in Long-Scrambling Sentences

Figure 1 presents the three participant groups' residual reading times at the critical gap-implicating region in the long- and short-scrambling conditions. Positive residual reading times indicate reading times longer than were predicted by the regression equations; negative residual reading times are reading times shorter than were predicted by the regression equations. Repeated-measures ANOVAs by both participants and items were conducted on the residual reading times at the critical regions for each of the participant groups. The Japanese NS group read the critical region in the long-scrambling condition more slowly than they did in the short-scrambling condition, with a significant difference in the participants analysis ($F_1(1, 23) = 5.199$, $p = .032$) and with a difference approaching a significant level in the items analysis ($F_2(1, 23) = 3.478$, $p = .075$). Neither the Korean nor the Chinese learner group exhibited that reading pattern with statistical significance (Korean learners: $F_1(1, 23) = 1.083$, $p = .309$; $F_2(1, 23) = .248$, $p > .50$; Chinese learners: $F_1(1, 23) = .017$, $p > .50$; $F_2(1, 23) = .242$, $p > .50$). These findings on the NSs and on the learners suggest that, first, the NSs engaged in syntactic gap-processing at the pre-verbal region in the long-scrambling condition; the learners did not. Second, the NSs' slower reading of the critical region in the long-scrambling condition as compared to that in the short-scrambling condition confirms the greater computational effort they had to expend processing the long scrambling. Third, it was that greater-effort requirement of long-scrambling that overtaxed learners' computational resources, thereby impeding their syntactic gap-processing. If that is the case, it should be possible to find evidence of L2 gap-processing in a condition where less computational effort is required, namely, in the short-scrambling condition.

3.4.2. Processing a Syntactic Gap in Short-Scrambling Sentences

A reading slowdown occurring at the critical region in short-scrambling sentences was expected to be slight (if at all) for NSs of Japanese and moderate for learners, because in short-scrambling, the

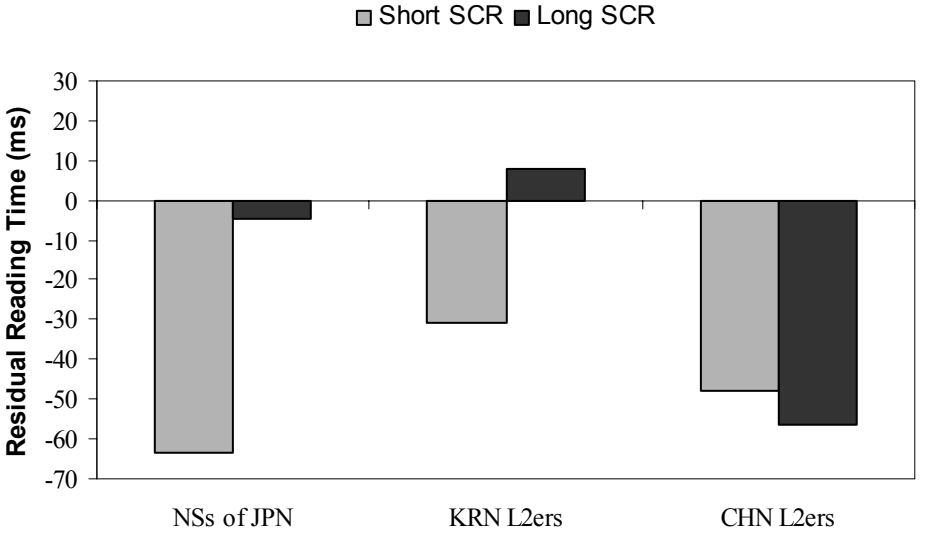

Figure 1. Residual reading times at the gap-implicating region in short- and long-scrambling (SCR)

direct object has been scrambled over only one phrase (the indirect object). Therefore, the analysis examined how participants read two adjacent regions, from the region preceding the critical region to the critical region itself (one region corresponding to the direct object, the other to the indirect object). The aim of the analysis was to determine if there was an interaction effect, whether a slowdown that occurred when reading through these two adjacent regions was dependent on test sentence condition types. In the canonical-ordered condition, NSs and learners alike should show no slowdown as they read from the indirect object to the direct object region. This particular sequence of noun phrases (NPs) was what they anticipated encountering during processing of these two regions.[4] In reading a short-scrambling sentence, however, their encountering the indirect object after the direct object should alert participants that these two NPs had been scrambled. Subsequent gap-processing might lead to a moderate yet measurable reading slowdown for Korean learners. In the case of NSs, a slowdown might be too miniscule to measure. Chinese learners, whose L1 lacks scrambling, might not engage in syntactic gap-processing even when reading short-scrambling sentences with their limited demand on computational resources.

Figures 2 to 4 present residual reading times for the three participant groups' reading of the region preceding the critical region and the critical region itself. Repeated-measures ANOVAs by both participants and items were conducted on the residual reading times at these regions for each of the participant groups. Japanese NSs showed no interaction effect ($F_1(1, 23) = .302$, $p > .50$; $F_2(1, 23) = .938$, $p = .343$). Korean learners showed the expected interaction effect in the participants analysis ($F_1(1, 23) = 5.175$, $p = .033$). The effect was not significant in the items analysis ($F_2(1, 23) = 1.574$, $p = .222$), suggesting that the effect did not generalize over all items. Although Korean learners read the two adjacent regions in canonical-ordered sentences equally fast, their reading slowed down when they read from the direct object to the indirect object region in short-scrambling sentences.[5] Chinese learners showed no indication of an interaction effect: ($F_1(1, 23) = .020$, $p > .50$; $F_2(1, 23) = .315$, $p > .50$).

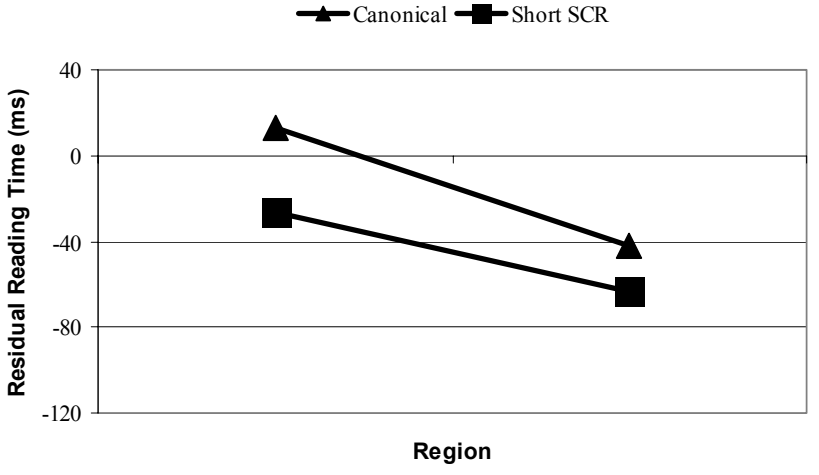

Figure 2. Japanese native speakers' residual reading times at the two pre-verbal regions

[4] The psycholinguistic literature offers ample argument and evidence for predictive sentence-processing in the human language processor: in the case of languages wherein a verb appears clause-finally, Kamide, Altmann, & Haywood (2003) and Miyamoto (2002) for Japanese; Bader & Lasser (1994) and Weyerts, Penke, Mèunte, Heinze, & Clahsen (2002) for German;, in the case of English, a head-initial language, Kamide, et al. (2003); Gibson & Hickok (1993); Tanenhaus, Spivey-Knowlton, Eberhard, & Sedivy (1995).

[5] See Hara (Submitted) for evidence that advanced Korean learners' reading of the verb region did not differ among the three conditions, which runs counter to the view that L2 processing is verb-driven.

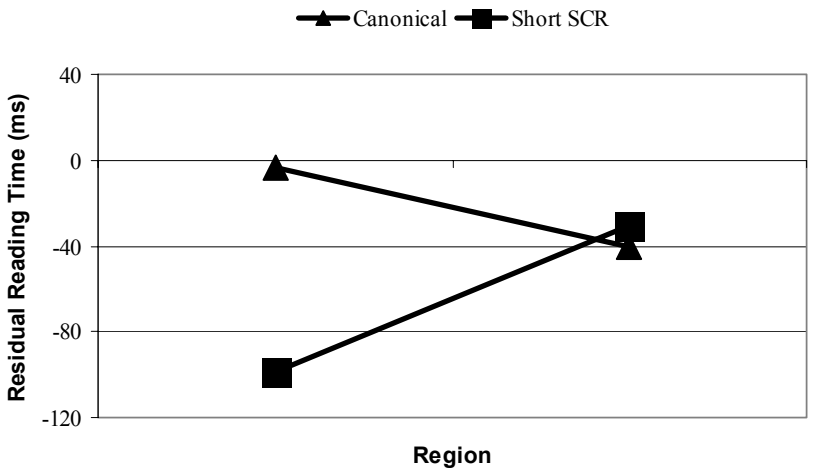

Figure 3. Korean learners' residual reading times at the two pre-verbal regions

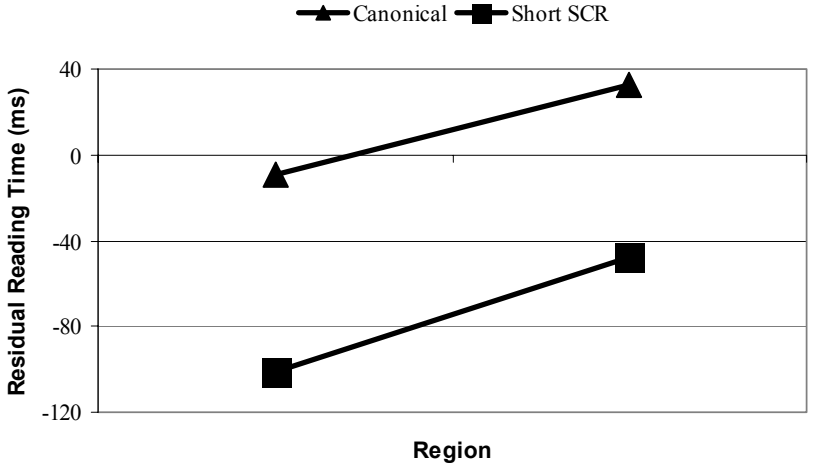

Figure 4. Chinese learners' residual reading times at the two pre-verbal regions

4. Discussion

The findings of the study show that advanced Korean learners of Japanese could engage in syntactic gap-processing, but not when a high demand was placed on their computational resources. Korean learners read the pre-verbal gap-implicating region in short-scrambling sentences more slowly than they read the pre-verbal region implicating no gap in canonical-ordered sentences. In reading long-scrambling sentences, they showed no reading slowdown at the critical gap-implicating region. NSs of Japanese exhibited the inverse of the Korean learners' asymmetrical reading pattern: NSs read the critical region in long-scrambling sentences more slowly than they read that region in short-scrambling sentences. NSs showed no reading slowdown during processing of short-scrambling sentences. In all, the study indicates that advanced Korean learners are capable of engaging in syntactic gap-processing, but not under a computationally taxing condition because their computational resources are more limited than those of NSs.

If the analysis had ended at the findings that, unlike NSs of Japanese, Korean learners showed no evidence of engaging in syntactic gap-processing when reading the computationally taxing long-scrambling sentences, those results would have mirrored Marinis *et al.*'s (2005) findings. But because

the present study included two scrambling sentence types (one imposing a high demand, the other a moderate demand on computational resources), it produced evidence of an interaction between computational load and L2 learners' engagement in syntactic gap-processing.

The study also found evidence for L1 effects on L2 syntactic gap-processing. Unlike Korean learners whose L1 has scrambling, Chinese learners showed no reading slowdown at the critical gap-implicating region in either short- or long-scrambling sentences. This was likely due to the Chinese language lacking scrambling properties, although it remains open whether Chinese learners' lower proficiency level as compared to Korean learners' was a factor (see footnote 2).

5. Conclusion

In the present study, L2 syntactic gap-processing was not observed during learners' reading of the computationally taxing long-scrambling sentences in Japanese, due to learners' resource limitations. Evidence in support of L2 syntactic gap-processing comes in advanced Korean learners' reading of the moderately demanding short-scrambling sentences: they engaged in syntactic gap-processing at the pre-verbal region, prior to having received information on the verb's argument structure. This contrasts both with the finding of Marinis *et al.*'s (2005) study and with the shallow structure hypothesis which disallows for the use of structural (syntactic gap) information during L2 processing.

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