L2 Processing of Japanese Scrambling under the Parallel Architecture Framework

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1. Introduction

This paper presents evidence that learners can establish filler-gap dependencies in processing scrambling sentences in Japanese by using linguistic information beyond the lexical-semantic type derivable from the verb. The evidence is inconsistent with Clahsen and Felser's (2006a; 2006b) shallow structure hypothesis. The paper also proposes linguistic analyses under Culicover and Jackendoff's (2005) Simpler Syntax within the Parallel Architecture framework (Jackendoff, 2002a, 2007). The framework allows for a fine-grained, unified account of both native-like and first language (L1)-influenced processing of scrambling in Japanese.

The sentence-final probe recognition study reported below utilized two properties of Japanese, those of verb-finality and scrambling, and it included two learner groups, Korean and Chinese. Use of the two properties along with the research design enabled the study to avoid two problems of inconclusiveness in previous L2 studies that found no evidence of learners' syntactic gap-processing. The present study found that Korean learners of Japanese showed antecedent reactivation effects resulting from processing of syntactic gaps that occurred in scrambling sentences. Chinese learners showed no evidence of antecedent reactivation effects because of L1 effects.

2. Problems in Earlier L2 Studies

As Clahsen and Felser (2006b) note, early L2 gap-processing studies (Juffs, 2005; Juffs & Harrington, 1995, 1996; Williams, Mobius, & Kim, 2001) are indeterminate on whether structure-based or verb-driven processing was responsible for effects observed during learners' processing of filler-gap dependencies. Several approaches have been taken to avoid the indeterminacy: one examined L2 processing of the intermediate gap in a long-distance dependency; another investigated L2 processing of the indirect object gap in a double object construction. Because the studies have not adequately taken limited L2-processing capacity into account, it remains open whether L2 processing is structure-based or verb-driven. A third approach to the indeterminacy problem is to use a verb-final language as the target language. The present study has used Japanese as the target language, scrambling as the test construction, and a sentence-final probe recognition task to circumvent the problems of previous L2 gap-processing studies.

2.1. Excessive Computational Load

Marinis, Roberts, Felser, and Clahsen (2005) conducted a self-paced reading study of L2 processing of intermediate gaps in three-clause sentences with two layers of center-embedding: *The nurse who the doctor argues ___ that the rude patient had angered ___ is refusing to work late*. The authors found no evidence for learners' reading facilitation at the second gap position. If learners had

* The research project reported in this article was conducted at the Graduate School of Japanese Applied Linguistics at Waseda University. This project would not have been possible without its support. I am particularly indebted to Mina Kobayashi and Yoshikazu Kawaguchi for hosting me as a visiting scholar and for helping with the data collection. The project was supported by the *Language Learning* Small Grants Research Program 2007.

 Proceedings of the 10th Generative Approaches to Second Language Acquisition Conference (GASLA 2009), ed. Melissa Bowles et al., 125-135. Somerville, MA: Cascadilla Proceedings Project.

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 that effect led the authors to conclude that learners had failed to postulate an intermediate gap. Yet it is possible that the design of Marinis *et al.*'s study had the unintended consequence of imposing on learners an excessively high computational load that arose from reading structurally complex sentences (see Indefrey, 2006). Under that condition, an effect resulting from learners' processing of the intermediate gap may have disappeared by the time they reached the second gap position in the sentence.

In order to avoid excessive computational load, the present study utilized a type of scrambling in which the displacement of a constituent is contained clause-internally (see Nemoto, 1999, for an overview of scrambling in Japanese).

2.2. Slow L2 Processing Speed

A second method for avoiding the interpretive indeterminacy comes in Felser and Roberts' (2007) study which used the English double object construction. Because the indirect object follows the direct object in that construction, the gap for the indirect object is separated from the verb by the direct object. In Felser and Roberts' cross-modal picture priming experiment, learners listened to sentences with relativized indirect objects, such as *Fred chased the squirrel to which the nice monkey explained the game's difficult rules ___ in the class last Wednesday*. While listening to those sentences, learners made an 'alive' or 'not alive' decision about picture targets presented on a computer screen. It was hypothesized that if learners mentally reactivated antecedents at their gap position, they would respond more quickly to the pictures describing the actual antecedents (e.g. a picture of a squirrel) than to those describing unrelated entities (e.g. a picture of a toothbrush). The authors found no evidence for learners' facilitated identification of the pictures describing antecedents when those pictures were presented immediately after learners heard the direct object, which suggests learners had failed to reactivate the antecedents at the earliest position signaling the gap.

Felser and Roberts' (2007) finding does not rule out the possibility that reactivation effects might have occurred at a later time in learners' processing. It is conceivable that in their cross-modal study, reactivation effects were measured too soon, the timing of which was determined on the basis of L1 processing studies. Considering that L2 processing is generally slower than L1 processing, learners might have needed more time for antecedent reactivation effects to surface (see Roberts, Marinis, Felser, & Clahsen, 2007, for a consideration of that factor in the case of low working memory-span L1 speakers (adults and children)). The present study measured reactivation effects (resulting from learners' processing of scrambling) at the end of sentences, which should allow ample time for such effects to emerge.

3. The Study

The aim of the present study was to determine whether advanced L2 learners can engage in syntactic gap-processing. In order to avoid the above two problems, clause-internal scrambling in Japanese served as a non-complex test construction and the sentence-final probe recognition task design allowed ample time for gap-processing effects to surface before measurement. 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).

The study, modeled on Miyamoto and Takahashi (2002; 2004), used clause-internal scrambling in an end-of-sentence probe recognition paradigm. The study contained two test sentence conditions: a canonical-ordered (subject-object-verb (SOV)) condition (1) and a scrambling (object-subject-verb (OSV)) condition (2). (1) represents a canonical-ordered sentence with a matrix nominative-accusative order. (2) exemplifies a matrix accusative-nominative scrambling sentence, with the matrix accusative noun phrase (NP), *kyaku-o* 'customer-ACC', scrambled to the front of the matrix nominative NP, *tenin-ga* 'salesperson-NOM'. The gap resulting from scrambling is indicated by t_i, the canonical position of the matrix accusative NP:

(1) Canonical-ordered condition:

Konbini de	*pan-o*	*katta*	*kyaku-ga*	*hima-soo na*	*tenin-o*
Convenience store at	bread-ACC	bought	customer-NOM	leisurely-looking	salesperson-ACC
yonda.					
called to					

'The customer who bought bread at the convenience store called to the leisurely-looking salesperson.'

(2) Scrambling condition:

Konbini de	*pan-o*	*katta*	*kyaku*$_i$*-o*	*hima-soo na*	*tenin-ga*
Convenience store at	bread-ACC	bought	customer-ACC	leisurely-looking	salesperson-NOM
t_i *yonda.*					
called to					

'The leisurely-looking salesperson called to the customer who bought bread at the convenience store.'

Both conditions have identical content words and linear order. To achieve the identicality, reversible verbs (*yonda* 'called to') were used as the main-clause verb so that, pragmatically, either argument of the verb (*kyaku* 'customer' or *tenin* 'salesperson') could be taken as subject or object of the main clause. The target word was the second content word (*pan* 'bread'), which is a constituent of the subject-relativized relative clause contained in the initial matrix NP (subject in (1) and object in (2)). Note that the linear distance from the target word to the end of the sentence is identical in both conditions.

Participants read sentences like (1) and (2) as segmented above in a self-paced reading format (Just, Carpenter, & Woolley, 1982). Immediately after they read the last segment, a probe word (*pan* 'bread') appeared on the computer screen. They had to determine whether the probe word was in the sentence they had just read (cf. Nicol & Swinney, 2003).[1] Because the probe word was presented sentence-finally, learners should have had enough time to engage in gap-processing before the probe presentation, making this a paradigm suitable for taking learners' slow processing speed into account.

It was hypothesized that in the scrambling condition, the scrambled matrix object NP (*kyaku* 'customer') containing the target word (*pan* 'bread') would be mentally reactivated when the matrix subject NP (*tenin* 'salesperson') was encountered, as the result of gap-processing that involves associating the gap with its antecedent. Therefore, a higher accuracy rate and a faster response time in the probe recognition task would be expected in the scrambling condition as compared to the canonical condition. Because of the absence of a gap in the canonical condition, no reactivation of the matrix subject NP containing the target word was expected. On the other hand, if participants relied on verb-driven word integration, no difference between the two conditions would surface in probe recognition. That was expected because the linear distance from the sentence-final verb to the target word is identical in both conditions (see the Discussion for a complication arising in verb-driven processing of sentences with semantically reversible verbs).

3.1. Participants

There were three groups of participants in the study: Korean-speaking and Chinese-speaking learners of Japanese, and native speakers (NSs) of Japanese. Each group had 20 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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[1] For L1 processing studies using the probe recognition task, see Bever and McElree (1988), Cloitre and Bever (1988), MacDonald (1989), and McElree and Bever (1989).

[2] Chinese and Korean learners' group average scores on the JLPT were significantly different from each other ($F(1, 38) = 16.675$, $p < .0005$). 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				
	20	97.1 (89.3-100)	4.71 (2.0-8.0)	11.5 (3.5-29.0)
Chinese				
	20	91.2 (82.1-100)	4.29 (2.0-8.0)	16.7 (3.5-93.0)

Note: JLPT stands for the Japanese Language Proficiency Test.

3.2. Materials

The material for the study included a total of 36 sentences: 12 test sentence items and 24 fillers. A total of 12 pairs of canonical-ordered and scrambling test sentences such as (1) and (2) were created. Using those pairs, two experimental lists were generated in a Latin Square design, by assigning one test sentence of a pair to the first list, the other sentence of that pair to the second list, and so on through all 12 pairs. Both lists had six canonical-ordered and six scrambling test sentences. Neither list had both of the sentences of any pair. Each list had a total of 24 filler sentences that varied in structural complexity and length. The two lists were pseudo-randomized as follows: Each was divided into six blocks, with each block containing six sentences in total: two test sentences (one canonical-ordered and one scrambling), and four filler sentences. The ordering of sentences within each block was pseudo-randomized, as were the blocks within each list so that test sentences were not adjacent. Finally, the number of correct and incorrect probes and the number of true and false statements (both described below) were counterbalanced within each block. Each participant saw only one of the two lists in the experimental session.

3.3. Procedures

Prior to arrival at an experimental session, learner participants filled out a questionnaire on their Japanese language learning experience and 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* (Chinese) characters that appeared in the experimental material. The experimental session consisted of two experiments (the first 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.

In the experiment, a participant first read each sentence by the phrase-by-phrase self-paced reading method (Just *et al.*, 1982). Each sentence was presented segment-by-segment as indicated in (1) and (2).[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. After having read the first region, the participant pressed the leftmost button of a response button-box connected to the computer to call up the second region. That continued until the participant reached the end of the sentence. Next, immediately after the final segment of the sentence was read, a word probe appeared in blue at the

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[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. That 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 discomfort with the occasional presence of *hurigana* in the experimental material when interviewed after the experiment.

center of a new screen. The experimental task was to determine as quickly as possible whether the probe was in the sentence the participant had just read, then to press one of the two rightmost buttons of the button-box, one colored green (correct), the other red (incorrect). All 12 probes for the test sentences were correct; that is, the probe words appeared in the test sentences. Of the 24 probes for the filler sentences, 6 were correct, 18 were incorrect, so that there was an equal number of correct and incorrect probes in each experimental list. The correct filler-sentence probes were selected from various places in the filler sentences so that participants would not develop a strategy of paying attention only to the first few words of the sentence.

Third, after the participant responded to a probe, a brief statement was presented at the center of a new screen. The experimental task was to determine if the statement was true or false relative to the sentence the participant had just read, then to press one of the two rightmost buttons of the button-box: green (true) or red (false). The purpose of that task was to ensure that the participant read each sentence for comprehension instead of simply memorizing each word. After the participant responded to the statement, visual feedback was provided indicating if the response was correct or not. The true/false statements were counterbalanced with half of the test and filler sentences having true statements, the other half having false statements. The accuracy of the response to each probe and to each true/false statement was recorded. The reaction time on each probe was measured using E-Prime software (Schneider, Eschman, & Zuccolotto, 2002), as was the reading time for each segment of every sentence.

A hard copy of the instructions for the experiment (written in the participant's L1) was provided to the participant at the beginning of the experimental session. 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 statements in the practice session in order to proceed to the testing session. The experiment took learner participants approximately 20 minutes to complete.

3.4. Results

The NS, Korean learner, and Chinese learner groups responded correctly to the true or false statements appearing after the test sentences at a rate of 88.75%, 91.25%, and 90.83%, respectively.[4] Excluded from subsequent analyses were probe recognition data from the trials in which participants incorrectly responded to true/false statements on test sentences.

Table 2 presents the three participant groups' probe recognition accuracy rates on the canonical-ordered and scrambling conditions. All three groups recognized probes with high accuracy on both conditions. Repeated-measures ANOVAs by both participants and items were conducted on the accuracy rates for each participant group. No participant group showed a significant difference in probe recognition accuracy between both conditions: $F_1(1, 19) = .069$, $p = .796$, $F_2(1, 11) < .0005$,

Table 2. Participants' probe recognition accuracy rates (%)

Participant groups	Canonical-ordered condition	Scrambling condition
Japanese		
	97.3 (1.5)	96.5 (2.6)
Korean		
	97.3 (1.5)	93.2 (2.5)
Chinese		
	96.3 (2.2)	94.4 (2.3)

Note: Figures in parentheses represent standard deviations.

[4] The three participant groups' accuracy rates for all true/false statements on both test and filler sentences were 92.78% for the NS, 94.58% for the Korean, and 92.08% for the Chinese group.

p = .985 (the Japanese NS group); $F_1(1, 19) = 2.134$, p = .160, $F_2(1, 11) = 1.887$, p = .197 (the Korean group); and $F_1(1, 19)$ = .292, p = .595, $F_2(1, 11) = 2.124$, p = .173 (the Chinese group). An accuracy rate of around 95% for all three groups indicates a ceiling effect. Their nearly perfect performance correctly recognizing probes, along with their good accuracy verifying true/false statements, suggests that both NS and learner participants had little difficulty processing the test sentences.

Prior to analysis of the probe recognition reaction time data, the following two data trimming measures were performed. First, data points from the trials in which participants failed to recognize probes in test sentences were discarded, resulting in elimination of 2.82% of data from the NS group, 4.57% from the Korean group, and 4.59% from the Chinese group. Second, for each participant, reaction times that lay beyond two standard deviations from the participant's mean reaction time were removed: those outliers comprised 3.38% of the reaction time data for the NS group, 4.31% for the Korean group, and 4.81% for the Chinese group. Each participant's mean reaction time was calculated by averaging the participant's reaction times to correctly recognized probes appearing in the test or filler sentences.

Table 3 presents the three participant groups' probe recognition reaction times in the canonical-ordered and scrambling conditions. All three groups exhibited the same reaction time pattern in numerical terms, with shorter reaction times on the scrambling condition than on the canonical-ordered condition. For each of the participant groups, repeated-measures ANOVAs by both participants and items were conducted on the reaction times for both conditions. There was no significant difference in reaction time between the two conditions in the Japanese NS group: $F_1(1, 19) = 1.270$, p = .274, $F_2(1, 11)$ = .411, p = .535. The Korean group, on the other hand, responded faster to probes for the scrambling condition than they did to probes for the canonical-ordered condition in the participants analysis ($F_1(1, 19) = 4.885$, p = .040), but not in the items analysis ($F_2(1, 11)$ = .314, p = .586). The Chinese group showed no difference in reaction time between both conditions: $F_1(1, 19) = 3.595$, p = .073, $F_2(1, 11)$ = .728, p = .412.

The absence of a reaction time difference in the NS group likely resulted from test sentences having imposed insufficient computational demand on NS participants (cf. Miyamoto & Takahashi, 2002). Importantly, the Korean group produced evidence for antecedent reactivation effects as evinced (in the participants analysis) by the confirmed asymmetry between reaction times to probes for the canonical-ordered condition and for the scrambling condition. Finally, the Chinese group showed no evidence for antecedent reactivation effects.

4. Discussion

Korean-speaking learners of Japanese evinced antecedent reactivation effects during processing of clause-internal scrambling sentences: they responded faster to probes when reading scrambling than when reading canonical-ordered sentences. The asymmetrical reaction time result came from reading scrambling and canonical-ordered sentences that differed only in the presence or absence of the syntactic gap which resulted from scrambling; the linear distance from the sentence-final verb to the target word was identical in both sentence types. This finding contradicts the shallow structure hypothesis which discounts L2 syntactic gap-processing capability and attributes L2 gap-processing

Table 3. Participants' probe recognition reaction times (milliseconds)

Participant groups	Canonical-ordered condition	Scrambling condition
Japanese	871.6 (50.3)	846.9 (39.5)
Korean	1042.9 (86.5)	1005.9 (78.1)
Chinese	1222.3 (48.1)	1180.3 (54.4)

Note: Figures in parentheses represent standard deviations.

effects (such as antecedent reactivation) to verb-driven processing (see Hara, submitted, for additional evidence of L2 syntactic gap-processing by Korean learners in reading verb phrase-internal scrambling sentences in Japanese).

Chinese-speaking learners of Japanese, on the other hand, showed no evidence of antecedent reactivation effects in reading clause-internal scrambling sentences. In performing the probe recognition task, neither response accuracy rates nor reaction times differed between reading scrambling and canonical-ordered sentences. Importantly, Chinese learners had little difficulty comprehending scrambling sentences as demonstrated by their high accuracy rate of 91.67% on the true or false statements for scrambling sentences, which is similar to their 90.0%, accuracy rate for canonical-ordered sentences.

The high accuracy on true or false statements would not have been expected if Chinese learners had relied on verb-driven processing in comprehending scrambling and canonical-ordered sentences. Learners using verb-driven processing would have had difficulty assigning the matrix verb's thematic roles to the matrix NPs in those sentences because the verbs were of a semantically reversible type. Information from the verb was uninformative for determining which thematic role should be assigned to which NP. For instance, in (2), both of the matrix NPs *kyaku* 'customer' and *tenin* 'salesperson' were equally plausible as either Agent or Theme of the verb *yobu* 'call to'. It is unclear how Chinese learners could have resolved that ambiguity and achieved high accuracy on true/false statements had they relied on verb-driven processing[5,6] (see Hara, submitted, for evidence that Chinese learners' processing of Japanese scrambling is not verb-driven).

4.1. Processing of Scrambling Sentences under the Parallel Architecture Framework

The following two sections discuss how Korean and Chinese learners of Japanese processed clause-internal scrambling sentences under Simpler Syntax (Culicover & Jackendoff, 2005) within the Parallel Architecture framework (Jackendoff, 2002a, 2002b, 2007). The advantage of this approach is that it allows a unified account of Korean and Chinese learners' processing in place of postulating two distinct types of processing, e.g. L1-like processing for Korean learners and verb-driven processing for Chinese learners. The current section illustrates how the antecedent reactivation effects shown by Korean learners in processing scrambling are characterizable under Simpler Syntax. In the next section, I propose that Chinese learners analyzed the initial part of the input string, viz. the sentence-initially scrambled accusative NP, as containing *pro* (*pro*-Object …). Upon encountering the nominative NP, Chinese learners made an adjustment at the syntax-semantics interface as a consequence of reanalysis.

As shown in Figure 1, the linguistic description of a sentence under Simpler Syntax consists of conceptual, syntactic, and phonological structures. The information structure and the propositional structure tiers correspond to the conceptual structure; the tree diagram represents the syntactic structure, and the bottom line in the figure is the phonological structure (simplified for expository reasons). Under a Simpler Syntax account of scrambling, the discontinuous complex of operator variable and bound variable in the conceptual structure maps into the chain consisting of the scrambled

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[5] It is untenable that advanced Chinese learners adopted word order-based processing strategies such as 'first NP-as-Agent and second NP-as-Theme', without regard for case-marking information. First, see Koda (1993) for evidence of elementary-level Chinese learners' sensitivity to case marking information during auditory sentence comprehension in Japanese. Moreover, word order-based processing strategies are logically incompatible with verb-driven processing in the case of verb-final Japanese because they entail making thematic role assignments prior to the arrival of the verb in the input string.

[6] It is unclear what could prompt Chinese learners to rely on verb-driven processing during processing of scrambling sentences. L1 effects are most likely, but problematic. First, note that L1 processing of Chinese is not verb-driven (Li, 1998): therefore, if Chinese learners used verb-driven processing, they cannot have adopted an L1 processing strategy. Alternatively, if Chinese learners had relied on verb-driven processing because of processing difficulty resulting from the lack of scrambling in Chinese, or because of the basic word order difference between Chinese and Japanese, that would mean they had fallen back on verb-driven processing as a last resort; the verb-driven processing strategy itself makes processing test sentences difficult, as discussed in the text. Therefore, it is unlikely that learners could have relied on a last resort type of verb-driven processing and achieved high accuracy rates on true or false statements on test sentences.

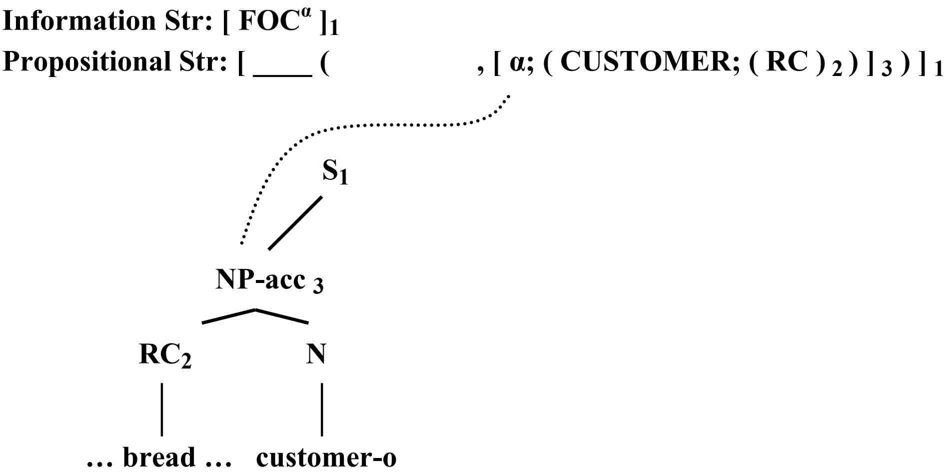

Figure 1. Simpler Syntax representations prior to antecedent reactivation (Korean learners)
Notes:
1) The "__" in the propositional structure (Str) tier represents a verb anticipated to appear later on;
2) The "RC" in the propositional structure and in the syntactic diagram represents a relative clause contained in the matrix accusative NP.

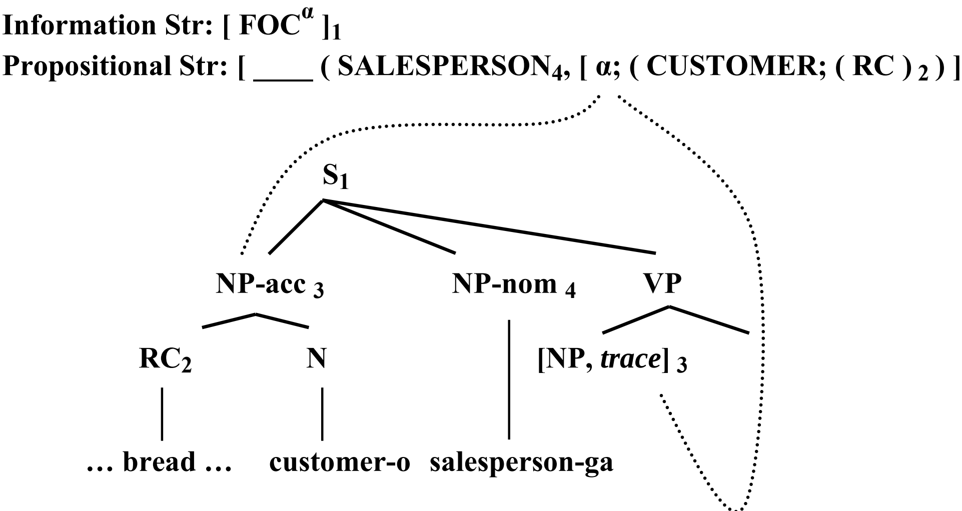

Figure 2. Simpler Syntax representations at antecedent reactivation (Korean learners)

constituent and its trace in the syntactic structure. The proposition in the information structure, over which the focus operator (FOC) takes scope, corresponds to the clause in the syntax in which scrambling has taken place. At the left edge of the clause is the scrambled constituent (the matrix accusative NP); the position of the trace is determined by the position of the bound variable α via semantics-syntax linking rules.

Figure 1 diagrams the conceptual, syntactic, and phonological structures that Korean learners constructed prior to antecedent reactivation in processing (2). As the "signature" of scrambling, the initial matrix NP bearing the accusative case ($NP\text{-}acc_3$) signaled that it was located at the left edge of the clause in which scrambling took place. Encountering the signature led to constructing the representations in the conceptual structure as shown in Figure 1. The scrambled (accusative) NP was linked to the variable α (in the propositional structure) which was bound by the focus operator (in the information structure). The position of the α was determined by means of semantics-syntax linking rules so that the accusative NP was mapped into the anticipated verb's internal semantic argument.

Next, the NP bearing the nominative case (NP-nom$_4$) arrived in the input string. As shown in Figure 2, processing of that NP led to establishing the trace in the syntactic structure because assignment of the nominative NP in the syntactic representation enabled locating the canonical position of the accusative NP (e.g., [$_S$ … NP-nom NP-acc …]).[7] The trace was then linked to the α in the propositional structure via semantics-syntax linking rules. Because the α had *also* been linked to the matrix accusative NP, the information contained in that NP was reactivated as the result of linking between the trace and the α. Under the Simpler Syntax account, antecedent reactivation is thus formulated in terms of syntax-semantics interface phenomena.

4.2. L1 Transfer in L2 Processing under the Parallel Architecture Framework

In the case of Chinese learners' processing of scrambling sentences, I propose that Chinese learners initially analyzed them as subject-less *pro* sentences due to L1 effects. They undertook reanalysis upon encountering the matrix nominative NP. Figure 3 shows the conceptual, syntactic, and phonological structures that Chinese learners constructed after processing the matrix accusative NP. Because there was no nominative NP in the input string, Chinese learners analyzed the string as containing *pro* (cf. Li, 1998). Under Simpler Syntax, *pro* plays a role in the conceptual structure and in the Grammatical Function (GF) tier, but has no function in the syntactic and phonological structures. Those aspects of *pro* are incorporated into Figure 3 with *pro* functioning as the anticipated verb's external argument in the conceptual structure and as the grammatical subject (GF$_4$, the highest ranked GF) in the GF-tier. On the other hand, the syntactic subject is absent in the syntactic structure as is *pro*'s phonological content in the phonological structure.[8]

Next, as shown in Figure 4, the actual (matrix) nominative NP arrived in the input string, necessitating reanalysis because the presence of the nominative NP contradicted the analysis of the input string as subject-less.[9] Because the NP bearing the nominative case is associated with the highest ranked GF (GF$_4$ in the figure), the nominative NP was linked to that GF. That linking was possible

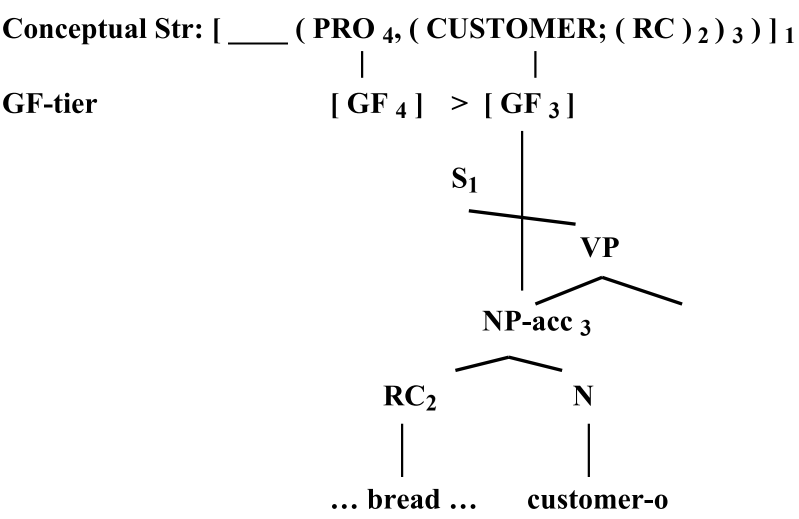

Figure 3. Simpler Syntax representations incorporating the accusative NP (Chinese learners)

7 The Grammatical Function tier is involved in mapping between the conceptual and syntactic structures. For clarity, Figures 1 and 2 omit the Grammatical Function tier, which is discussed in Figures 3 and 4.

8 The GF-tier mediates various patterns of mapping between semantic and syntactic arguments so that assignments between semantic arguments and grammatical functions remain constant and syntactic realizations of grammatical functions can vary (see Culicover & Jackendoff, 2005, chapter 6).

9 Reanalysis literature (Fodor & Inoue, 2000; Frazier & Clifton, 1998; Van Dyke & Lewis, 2003) suggests that initiating the reanalysis necessary for incorporating the nominative NP into the representations of the input string (as outlined in the text) should not be difficult due to the saliency of the error signal.

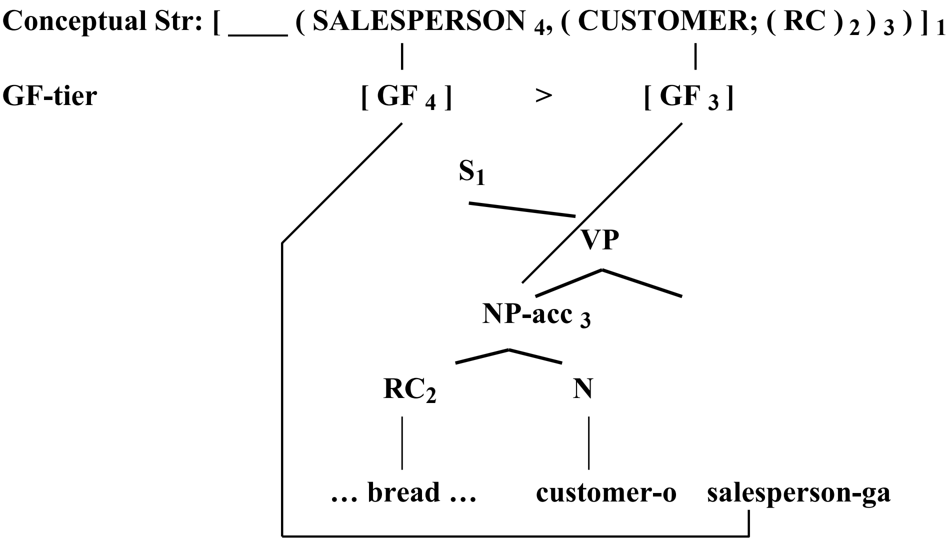

Figure 4. Simpler Syntax representations incorporating the nominative NP (Chinese learners)

because the GF_4 had been unlinked to the syntactic and phonological structures (see Figure 3). As the result of linking between the nominative NP and the GF_4, the NP's semantic content replaced *pro*'s in the conceptual structure. Because the reanalysis process had no effect on mapping involving the (matrix) accusative NP, no reactivation effect on that NP resulted.

Under Simpler Syntax, the lexicon contains not only words such as nouns, verbs, etc. but also abstract grammatical elements and rules such as *pro*. This view of the lexicon allows for characterizing the occurrence of L1 transfer in L2 processing as that of learners' retrieving items from the lexicon that are appropriate for L1 processing but inappropriate for L2 processing. In spite of that retrieval, learners do manage to process through the input string as evinced by Chinese learners making adjustments at the syntax-semantics interface and in the conceptual structure during processing of object-scrambled sentences in Japanese.

5. Conclusion

The present study found that in performing the sentence-final probe recognition task, Korean learners of Japanese showed antecedent reactivation effects that arose from processing of syntactic gaps located in clause-internal scrambling sentences. The finding runs counter to the shallow structure hypothesis. Chinese learners showed no such effects. The article proposed that Chinese learners initially analyzed scrambling sentences as *pro*-containing (subject-less) sentences due to L1 effects. Upon encountering the actual subject NP, they reanalyzed the sentences without postulating the syntactic gap. The Parallel Architecture framework and Simpler Syntax apparatus enabled proposing a unified, fine-grained account of Korean learners' native-like processing and Chinese learners' L1-influenced processing of scrambling sentences.

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Proceedings of the 10th Generative Approaches to Second Language Acquisition Conference (GASLA 2009)

edited by Melissa Bowles, Tania Ionin, Silvina Montrul, and Annie Tremblay

Cascadilla Proceedings Project Somerville, MA 2009

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ISBN 978-1-57473-434-8 library binding

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