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PROCESSING OF SCRAMBLED SENTENCES BY LEARNERS OF JAPANESE AS A SECOND LANGUAGE

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This study used a sentence correctness decision task to examine whether second language (L2) learners of Japanese might experience slowdowns and greater difficulty in comprehending sentences with the scrambled word order (OSV) as compared to those with the canonical SOV order. Twenty-four L2 learners of Japanese read simple monotransitive canonical and scrambled sentences displayed on a computer monitor and made decisions as to whether the sentences were correct or incorrect. The data indicated that, overall, scrambled sentences were responded to more slowly and elicited more errors in correctness decisions than canonical sentences. However, when reversible sentences (those with an animate subject and an animate object) and non-reversible sentences (those with an animate subject and an inanimate object) were analyzed separately, it was found that the scrambling effect was more robust in non-reversible sentences. Comparison of the present data with those in previous studies of native speakers (Chujo, 1983; Muraoka, Tamaoka, & Miyaoka, 2004) suggests that the L2 participants in the present study integrated animacy information in a manner similar to native speakers in the comprehension of scrambled sentences but that L2 learners might not use the information provided by case markers as consistently as native speakers.

INTRODUCTION

The Japanese language, among many others, exhibits a free word-order phenomenon called scrambling. In Japanese, each noun phrase (NP) is often case-marked with postpositional case markers, allowing a freer word order in sentences. The exception to this is the verb which must be placed at the end of the clause. In (1) below, (1a) is the sentence in canonical word order while (1b) is its scrambled counterpart:

(1) a. John-ga Mary-o ketta.
-Nom -Acc kicked
'John kicked Mary.'

b. Mary-o John-ga ketta.
-Acc -Nom kicked

The NPs (*John* and *Mary*) are marked with the nominative case marker *–ga* and the accusative case marker *–o*, respectively, and therefore, the

grammatical subject is *John* and the object is *Mary* in both sentences, regardless of word order.

Studies that have examined the processing of scrambled sentences by native speakers (NSs) of Japanese have provided evidence that there is a psychological cost in processing scrambled sentences. That is, it takes NSs longer to read and comprehend scrambled sentences than canonical sentences. On the other hand, studies that have examined the processing of scrambled sentences by second language (L2) learners of Japanese are scarce, and it is not entirely clear whether such slowdowns are also experienced by L2 learners when they read and comprehend scrambled sentences. The present study attempts to provide a preliminary answer to the question by means of a sentence correctness decision task performed by L2 learners of Japanese.

This paper briefly reviews the general theoretical background of the phenomenon of scrambling in Japanese, followed by a review of previous psycholinguistic studies that have examined the processing of scrambling by NSs and L2 learners of Japanese. The method used and the results of the sentence correctness decision task will be reviewed. Finally, the limitations of the present study will be discussed and suggestions for future research will be presented.

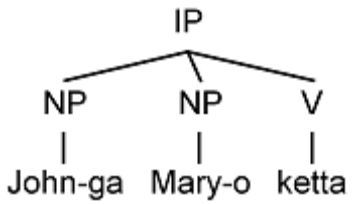
LITERATURE REVIEW

The structure of Japanese scrambling

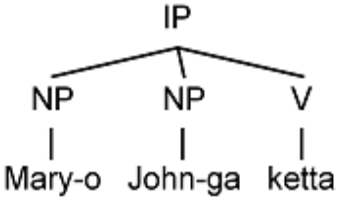
In some earlier analyses, scrambling was taken as evidence that Japanese has a non-configurational, 'flat' structure (e.g., Farmer, 1984; Hale, 1980). In a non-configurational language, a verb phrase (VP) in a clause is not assumed, and therefore, there is no hierarchical difference between the subject and the object. According to such analyses, the canonical sentence (1a) and its scrambled counterpart (1b) are represented by the reduced tree diagrams in the following manner.

(2)

a.



b.



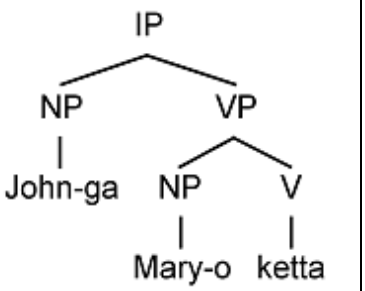
All the arguments are sisters of the verb in (2). The apparent advantage of this analysis is that it can easily account for the freer word order of Japanese. However, no word order is assumed to be canonical within this analysis, which goes against native Japanese speakers' intuition that

"NP-*ga* NP-*o* V", for example, is the canonical word order (Yamashita, 1997).

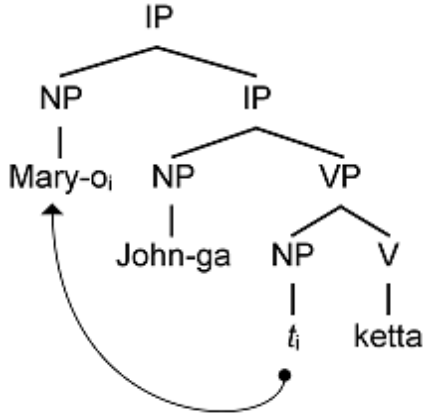
More recently, several researchers have suggested that Japanese does have a configurational, hierarchical structure, just as languages, such as English and French, have, and currently it is generally assumed that scrambled sentences are derived from canonical ones by movement. Following this analysis, the canonical sentence (1a) and its scrambled counterpart (1b) can be represented in the following way using reduced tree diagrams. Note that in (3b) an additional IP node is adjoined to the tree, and the accusative NP *Mary* is moved higher in the tree, leaving a gap (trace).

(3)

a)



b)



One piece of evidence for the scrambling-as-movement analysis comes from pronominal coreference (Saito, 1985: 39):

(4) a. *Kare$_i$-ga [Mary-ga John$_i$-ni okutta tegami]-o mada yonde inai (koto)
he-Nom -Nom -to sent letter-Acc yet read not
'He has not yet read the letter Mary sent to John.'

b. [Mary-ga John$_i$-ni okutta tegami]-o kare$_i$-ga mada yonde inai (koto)
-Nom -to sent letter-Acc he-Nom yet read not
'The letter Mary sent to John, he has not read yet.'

(4a) is ungrammatical because the pronoun *kare* ("he") c-commands the R-expression *John*. On the other hand, the scrambled version (4b) is well-

formed, which suggests that the pronoun *kare* does not c-command *John* in the sentence. Thus, it can be taken as evidence that the object has moved to a position higher than the subject as illustrated in (3b).

Additional evidence for the movement analysis comes from quantifier floating. Kuroda (1980) observes that the object and the numeral quantifier (NQ) can be separated by the intervening subject, but the subject and the NQ that modifies it cannot be separated by the intervening object. The sentences in (5) are from Kuroda (1980: 27):

(5) a. Utide-no kozuti-o igirisuzin-ga hutatu katta
striking-Gen mallet-Acc Englishman-Nom 2 objects bought
'An Englishman bought 2 *mallets of luck*.'

b. *Igirisuzin-ga utide-no kozuti-o sannin katta
Englishman-Nom striking-Gen mallet-Acc 3 people bought
'Englishman bought (the) *mallet of luck*, three people.'

(5a) is the case for the intervening subject and (5b) is for the intervening object. While (5a) is grammatical, (5b) is ill-formed. Based on this contrast, Kuroda maintains that the basic Japanese word order is SOV, and that the scrambled word order derives from the canonical word order via movement.

As observed, scrambled sentences are considered more complex than canonical ones from the theoretical perspective, and researchers have investigated whether such syntactical complexity might influence the processing of scrambled sentences. In the following sections, we will review some of the psycholinguistic investigations into the processing of Japanese scrambling by NSs, followed by a review of studies on the processing of scrambling by L2 learners.

Comprehension and processing of Japanese scrambling by native speakers

The first inquiries into the comprehension of Japanese scrambling were conducted with NS children in the context of first language (L1) acquisition. Such studies were inspired by sentence comprehension studies with L1 English children which found that they go through a developmental stage during which they consistently misunderstand passive sentences. Bever (1970) suggested that this misinterpretation is due to the overgeneralization of NVN (agent-action-theme) sequence, which is statistically predominant in English. L1 English children during this particular stage, around age 4, overuse the NVN template in the comprehension of passive sentences, choosing the first NP of the sentence as the agent, which results in the misinterpretation of passive sentences.

Hayashibe (1975) used two act-out procedures to examine comprehension of active SOV and OSV sentences by Japanese children

between three and five years of age. In the first experiment, the experimenter read aloud three words (two nouns and a verb), and children were instructed to act out the meaning of the sentences using toys. The data analysis revealed that four and five year-old children showed a strong tendency to interpret the first noun as the agent, while three-year-old children showed more "egocentric" interpretation (i.e., takes himself as the agent of the sentence). In the second experiment in which children were instructed to act out based on case-marked SOV and OSV sentences, it was found that there was a period during which children relied heavily on word order, before case-marking particles were used reliably as comprehension cues. Based on the findings, Hayashibe concludes that SOV word order is dominant to OSV, and that word-order cue is acquired before case-marking particles.

Sano (1977) examined the comprehension of canonical and scrambled sentences by Japanese children between three and six years old, using act-out and imitation tasks. The results of the act-out task suggested that children's ability to comprehend canonical sentences develops earlier than their ability to comprehend scrambled sentences. In the imitation task, the children tended to interchange the particles in imitating OSV sentences, so that the resultant sentences would have the canonical SOV word order. The results of the imitation task also showed that, when simple active sentences with omitted particles were presented, the children displayed a strong tendency to supply the *-o* particle after the second NP, the position right before the verb. Based on this observation, Sano suggests that a particle in the position immediately preceding the verb may play a significant role in a child's sentence comprehension.[1] These studies with Japanese children, therefore, seem to suggest that they also go through a developmental stage during which they overgeneralize the canonical template (NNV for Japanese) in their sentence comprehension, while they also seem to rely on the match between the NP position and the case marker.[2]

Recent investigations on the processing of scrambling have found evidence that slowdowns take place when NS adults read scrambled sentences and that scrambling might thus require additional processing cost for NS adults as well. Mazuka, Itoh, & Kondo (2002), for instance, used eye tracking and self-paced reading techniques to examine the processing of scrambled sentences. Their stimuli consisted of the following simple and complex canonical/scrambled sentences.[3]

(6) a. *Canonical simple sentence:* [NP-*ga* NP-*o* V]
b. *Scrambled simple sentence:* [NP-*o* NP-*ga* V]
c. *Canonical sentence with a center embedding:* [NP-*ga* [modifier phrase] NP-*o* V]
d. *Scrambled sentence with a center embedding:* [NP-*o* [modifier phrase] NP-*ga* V]

The results of their eye-movement experiment indicated, for overall reading time, that sentence type (6d) was read significantly more slowly than type (6c),

indicating a processing cost associated with scrambled sentences. On the other hand, differences in overall reading time between (6a) and (6b) did not reach a level of statistical significance, which suggests that the eye-tracking method might not have been sensitive enough in measuring overall reading time to detect slowdowns caused by very simple scrambled sentences such as (6b).

A more detailed analysis by Mazuka et al. (2002) of their eye-tracking data indicated that the readers tended to gaze longer and made more regressive eye movements at the second argument position in the scrambled sentences, while the accusative-marked NP that was fronted in the scrambled sentence did not take longer to read. Their self-paced reading experiment showed a similar trend, indicating that the reading times at the second NP in scrambled sentences were significantly longer for both simple and complex sentences than the reading times for canonical sentences.[4]

Based on their results, Mazuka et al. (2002) speculate that the parser processes scrambled sentences in the following way: when the parser encounters an accusative-marked NP in the first argument position, a significant slowdown does not take place because ellipses occur quite frequently in Japanese and it is possible that the sentence which the parser is currently processing is canonical with the subject omitted. However, when the parser encounters a nominative NP at the second argument position, the parser identifies that the sentence is scrambled and it needs to create an additional IP node as previously illustrated in (3b). It is the identification of scrambling and the reanalysis of the sentence structure that is realized as longer reading times.

Tamaoka, Sakai, Kawahara, Miyaoka, Lim, & Koizumi (2005), among others, examined the scrambling effect using a sentence correctness decision task. Their study (Experiment 1) consisted of the following sentence types.

(8) a. *Correct canonical:*
Tomoko-ga Taro-o hometa.
-Nom -Acc admired
'Tomoko admired Taro.'

b. *Correct scrambled:*
Taro-o Tomoko-ga hometa.
-Acc -Nom admired

c. *Incorrect canonical:*
*Junko-ga Kenji-o nutta.
-Nom -Acc stitched
'*Junko stitched Kenji.'

d. *Incorrect scrambled:*
*Kenji-o Junko-ga nutta.
-Acc -Nom stitched

The entire sentence was presented on a computer monitor, and the participants were instructed to make a decision as to whether the sentence was correct or incorrect as quickly and as accurately as possible. The results indicated that the canonical sentences were read and comprehended significantly faster than the scrambled sentences for both 'correct' and 'incorrect' conditions, indicating the scrambling effect. Also, the 'correct scrambled' sentences elicited error rates that were significantly higher than the 'correct canonical' sentences, but no such significant differences in error rates were observed for the incorrect sentences.

Unlike eye-tracking and self-paced reading methods, the sentence correctness decision task, such as that used above, is not as informative because it does not tell us exactly where the slowdowns take place in scrambled sentences (Miyamoto, 2008). However, other studies (e.g., Chujo, 1983; Muraoka, Tamaoka, & Miyaoka, 2004) have also found evidence of the scrambling effect among NSs of Japanese using this method, and therefore, the correctness decision of simple transitive sentences appears to be a suitable method for a preliminary investigation of the processing of scrambled sentences by L2 learners.

Comprehension and processing of Japanese scrambling by L2 learners

While L2 studies that examine the slowdowns in the processing of scrambled sentences are scarce, those studies that have investigated the comprehension and production of Japanese scrambling have shown that L2 learners of Japanese experience more difficulty with scrambled sentences than canonical ones, at least in the initial stages of their L2 acquisition. As will be observed, such difficulty seems to derive from L2 learners' over-dependence on word order instead of case markers, just as observed in the sentence comprehension by NS children.

Kilborn & Ito (1989) report a study which investigated, from the perspective of the competition model, the interaction of word order and case-marking particles in sentence comprehension by novice and advanced learners of Japanese as an L2 (L1: English) and by an NS control group. The results showed that NSs relied on the nominative case marker *–ga*, when it was available, to identify the agent in a word sequence, while mostly ignoring the word order information. Advanced L2 learners showed a similar pattern, although less consistently than the NSs. Novice L2 learners, on the other hand, relied mostly on word order in the identification of the agent in a word sequence, ignoring the case markers. Based on their data, Kilborn & Ito suggested that novice L2 learners seem to take "a short cut to sentence interpretation" (p. 284), that is, the use of the "first noun as the agent" strategy or the NNV template.

Rounds and Kanagy (1998), also from the perspective of the competition model, investigated the influence of word order and case markers on the comprehension of Noun-Noun-Verb sequences in Japanese by L1 English children learning L2 Japanese in an immersion context. The children

listened to the tape-recorded NNV strings, and chose the picture that best described the string. The researchers found that, for non case-marked strings, children preferred to choose the first noun of the string as the agent (76% of the time, overall) but that such "first noun as agent" preferences seem to be reinforced after two years of Japanese study. It was also found that, even when scrambled sentences were clearly case-marked, the children still tended to choose the first noun, which was case-marked with *–o*, as the agent (89.8 % of the time). This tendency was also reinforced as the children's exposure to Japanese increased. While kindergarten and first-grade children chose the *–o* case-marked first noun as the agent 74.6% of the time, sixth and seventh grade children chose it as the agent 95.1% of the time.

Iwasaki (2003) examined the comprehension and production of SOV and OSV sentences by three levels of adult learners of Japanese (L1: English). In a picture description task, the participants of all levels were similarly less accurate for non-canonical word order sentences. Iwasaki points out that there were a number of instances in which the participants made errors such as "O-*ga* S-*o* V" and "O-*wa* S-*o* V", indicating that the L2 learners used the "NP1-*ga* NP2-*o*" template to produce sentences. Iwasaki also administered a fill-in-the-blank task, in which the participants were asked to fill in the case-marking particles. The results revealed that L2 Japanese learners used case markers less accurately for OSV sentences, regardless of their proficiency. They also tended to fill in *–ga* for the blanks after sentence initial NPs.

In the same study, Iwasaki (2003) examined the scrambling effect with a timed grammaticality judgment task (a task similar to the correctness decision task in the present study). The participants saw a Japanese sentence (written in both Japanese orthography and in Romanization) along with a matching picture, and they made a judgment as to whether the sentence was correct. The result indicated that the L2 Japanese learners made more errors and took longer to judge OSV sentences than SOV sentences, suggesting that L2 learners, like Japanese NSs, experience slowdowns in comprehending scrambled sentences. Since there was no main effect for proficiency, it appears that the L2 Japanese learners' knowledge of case particles for scrambled OSV sentences does not necessarily develop as their general proficiency in Japanese increases.

More recently, Mitsugi & MacWhinney (2010) examined the processing of scrambled ditransitive sentences by three groups of adult L2 learners of Japanese (L1: Chinese, English, Korean) and by NSs of Japanese as a control group. The reading time data was obtained using the self-paced moving window technique in which the participants read the sentences in a phrase-by-phrase manner on a computer monitor by pressing a designated key at their own pace. Contrary to Iwasaki's (2003) grammaticality judgment result, Mitsugi & MacWhinney's result indicated that there was no significant difference in reading time among the canonical sentences and the few different types of scrambled sentences in either of the participant groups. Based on the results, the researchers suggest that the way Japanese scrambled sentences are processed is not different between NSs and L2 learners. Because the previous

studies with NSs observed the scrambling effect in contrast to the Mitsugi & MacWhinney study which did not, this discrepancy may be attributable to the sentence types they examined (i.e., ditransitive) and/or the technique that they used to investigate (i.e., self-paced reading) which had failed to detect the scrambling effect in previous studies with NS participants (e.g., Yamashita, 1997).

THE PRESENT STUDY

Purpose

Due to a scarcity of the research on this topic, it appears inconclusive whether L2 learners of Japanese experience slowdowns in comprehending scrambled sentences. Therefore, the present study seeks to investigate and confirm the point using a sentence correctness decision task with which previous studies have found evidence of the scrambling effect among NSs and L2 learners.

The distinction between reversible and non-reversible sentences has been included in the present correctness decision experiment. In this study, reversible sentences refer to sentences with an animate subject and an animate object whereas non-reversible sentences refer to those with an animate subject and an inanimate object. The reversible/non-reversible distinction was included for the purpose of evaluating the role of animacy and case-marking information in the processing of scrambling. In reversible sentences, because both subject and object NPs are animate, the only information that signals that the sentence is scrambled is the case markers. In non-reversible sentences, on the other hand, the 'inanimate-animate' NP order would also signal that the sentence is scrambled because it is less likely, from our general knowledge, that an inanimate subject would do something to an animate object. If we assume that scrambling causes slowdowns and more difficulty in comprehension and that L2 readers integrate animacy information in their comprehension of scrambling, there will be different degrees of the scrambling effect between reversible and non-reversible sentences, both in terms of response times and error rates. On the other hand, no difference in the scrambling effect would suggest that L2 learners, in comprehending these sentences, might not be making use of the animacy information.

L2 learners' use of case markers in the processing of scrambled sentences may be evaluated by observing how they respond to reversible sentences. Because both the subject and object are animate in reversible sentences, the only thing that signals scrambling in such sentences is case markers. If we assume that scrambling causes slowdowns and more difficulty in comprehension, longer response times and higher error rates in reversible scrambled sentences relative to canonical sentences would indicate that L2 learners have integrated case markers into their comprehension of scrambled sentences, while no difference between reversible canonical/scrambled sentences might suggest that case markers are being overlooked (or are not integrated) in their comprehension of those sentences.

As for previous studies with NS participants, Chujo (1983) included the reversible/non-reversible distinction in a sentence correctness decision task. Muraoka et al. (2004) also used a sentence correctness decision task specifically to examine the processing of reversible sentences. It is hoped that addition of the reversible/non-reversible distinction to the present correctness decision experiment and the comparison of present results with those in the previous NS inquiries will further our understanding of how Japanese scrambling is processed by L2 learners.

Method

Participants. Twenty-four people (12 females and 12 males) in Tucson, AZ who learned Japanese as an adult (18 years of age or higher) participated in the experiment. They were all native speakers of English, except for two participants whose native language was Chinese (one female and one male). Participants of this experiment varied in terms of their ages and their experiences with the Japanese language. Ages ranged from 20 years to 54 years, but the majority of participants (19 out of 24) were in their 20s. The length of their Japanese studies ranged from 1.5 to 20 years, with the mean of 4.3 years and the median of 3 years. Thirteen participants had stayed in Japan for more than a month. When asked to evaluate their overall proficiency in Japanese on a 7-point scale, 1 being beginner and 7 being near-native, four participants answered 3, thirteen participants answered 4, six participants answered 5, and one participant answered 6.

Materials. There were eight types of sentence stimuli as shown below. (For a complete list of sentences, refer to the Appendix.)

(9) a. *Correct reversible canonical:*
Taro-ga Kazuko-o mita.
-Nom -Acc saw
'Taro saw Kazuko.'

b. *Correct reversible scrambled:*
Kazuko-o Taro-ga mita.
-Acc -Nom saw

c. *Correct non-reversible canonical:*
Taro-ga shatu-o kita.
-Nom shirt-Acc wore
'Taro wore a shirt.'

d. *Correct non-reversible scrambled:*
Shatu-o Taro-ga kita.
Shirt-Acc -Nom wore

e. *Incorrect reversible canonical:*
*Taro-ga Keiko-o kabutta.

-Nom -Acc wore
'*Taro wore Keiko.'

f. *Incorrect reversible scrambled:*
*Keiko-o Taro-ga kabutta.
-Acc -Nom wore

g. *Incorrect non-reversible canonical:*
*Taro-ga shatu-o kotaeta.
-Nom shirt-Acc answered
'*Taro answered a shirt.'

h. *Incorrect non-reversible scrambled:*
*Shatu-o Taro-ga kotaeta.
Shirt-Acc -Nom answered

To prepare the stimuli set, canonical sentences were created first. Sixteen sentences were constructed for each of the four sentence types (correct reversible, correct non-reversible, incorrect reversible, and incorrect non-reversible), totaling 64 sentences. In an effort to limit the number of verbs used in the experiment and also for the purpose of counterbalancing, the sentences were built from a list of 32 verbs, each verb being used twice in the complete set of 64 canonical sentences.

To ensure that the 64 sentences were plausible or implausible as intended, seven NSs of Japanese were asked to rate the sentences using a 7-point scale, 1 being completely unacceptable as a Japanese sentence and 7 being completely acceptable. A Wilcoxon signed-rank test was performed and indicated that the NS ratings differentiating 'correct' from 'incorrect' sentences were significantly different ($p < .0001$), suggesting that the plausibility/implausibility of the sentences was, in fact, as intended. However, one of the NS raters did point out that the verb "*haku*", which was used to construct "incorrect reversible" sentences, could be interpreted as either "to wear" or "to vomit" when written in the *hiragana* syllabary. Therefore, "*haku*" was replaced with "*untensuru*" ("to drive"), the meaning of which is unambiguous.

The 64 sentences were then split into two equivalent sub-lists. At this point, two sets of scrambled sentences were created by switching the order of the *–ga* and *–o* marked NPs (e.g., [9a] → [9b]) in each of the two sub-lists. To make sure that participants in the experiment would not see two sentences with the same combination of NPs and verb, the scrambled sentences which were created from the canonical sentences on one list were added to the alternative list, and vice versa. Thus, each of the two lists (List A and List B) consisted of eight sentences in each of the eight sentence types listed in (9) above, with a total of 64 sentence items.

All the verbs and inanimate nouns that were used to construct the sentence items were taken from *Nakama 1 & 2 2nd Edition* (Hatasa, Hatasa, &

Makino, 2009), the textbooks used in beginning and intermediate Japanese courses at the University of Arizona. The animate nouns (common Japanese names; four female names and four male names) were adopted from Tamaoka et al. (2005). The sentence items were written with *kanji* (Chinese characters) if the *kanji* were listed in *Nakama 1 & 2*. In some instances, however, a *kanji* that was not covered in *Nakama* was used when the *kanji* was judged common enough. *Furigana* (phonetic syllabary) was added above all *kanji* so that unfamiliar *kanji* might not hinder the participants' comprehension of the sentences.

Procedure. The participants first answered questions on a "language background questionnaire" which collected information on their experience with languages, including their native languages, L2s other than Japanese, their length of Japanese study, the length of any stays in Japan, their self-evaluation of proficiency in Japanese, and so on. They were then given a list of words, which included all the nouns and verbs that would appear in the sentence items. They were instructed to study the list to be sure that they knew the meanings of the words. The definitions of the words (in English) were written next to them. The purpose of the word list was to familiarize the participants with the words that they would be seeing in the sentence correctness decision task in an effort to minimize instances in which unfamiliarity with a word might slow down their reading and comprehension speed.

For the sentence correctness decision task, the participants were randomly assigned to one of the two item lists, which included eight practice items followed by the 64 test items. The sentence items were presented with the DMDX software (Forster & Forster, 2003) on a laptop computer. The participants were instructed to press "yes" (right shift key on the computer keyboard) if they thought the sentence displayed on the computer monitor was a good Japanese sentence and to press "no" (left shift key) if they thought the sentence was not good. They were asked to make the decisions as quickly and as accurately as possible. Each task began with the appearance of a string of asterisk marks '**********' in the middle of the monitor for 1000 milliseconds (ms), followed by the sentence item which appeared in the middle of the monitor for 10 seconds, or until the correctness decision was made. Feedback ("Right" or "Wrong") was given after each response. If there was no response within 10 seconds, a "No Response" message was displayed, and the next sentence, preceded by asterisk marks, was displayed automatically. The presentation of stimuli was randomized, so that no participant would see the stimuli in the same order. For each participant, the sentence correctness decision task took approximately 10-15 minutes.

After the correctness decision task, the participants were given a list of Japanese sentences and were asked to write an English translation for each. The list consisted of two each of the reversible canonical, reversible scrambled, non-reversible canonical, and non-reversible scrambled sentences, along with 10 sentences of various structures not directly related to the present study. The purpose of this 'translation task' was to make sure that participants had the

grammatical knowledge sufficient to assign correct thematic roles to the NPs using case markers.

Analysis and results

In order to observe whether scrambled sentences elicited longer reading times and/or more errors in general, data from the reversible and non-reversible sentence items were combined and analyzed first. The descriptive statistics for reaction times (RT) and error rates are presented in Table 1. Trials in which an error was made were omitted from the analysis of RT. Also, RTs beyond 2.5 standard deviations were replaced by the values at the boundaries for each participant and for each sentence type.

		Reaction time (ms)		Error rate (%)	
Sentence type	Canonical/Scrambled	Mean	SD	Mean	SD
Correct	Canonical	3987	1011	6.79	8.44
	Scrambled	4256	814	13.05	9.57
Incorrect	Canonical	4225	996	12.00	12.21
	Scrambled	4427	1015	15.39	12.08

Table 1: Reaction times and error rates for each sentence type (reversible and non-reversible combined)

Repeated-measures *t*-tests were conducted on reaction times (milliseconds) and error rates (percentages) for canonical vs. scrambled pairs of 'correct' sentences and 'incorrect' sentences. The *t*-test results indicated that, for the correct sentences, the scrambled sentences were responded to significantly more slowly than were the canonical sentences, and that the scrambled sentences elicited significantly more errors than the canonical sentences [for RT, $t(23) = 2.791$, $p = .01$ by subject analysis, $t(31) = 3.637$, $p = .001$ by item analysis; for error rates, $t(23) = 3.542$, $p = .002$ by subject analysis, $t(31) = 3.649$, $p = .001$ by item analysis]. On the other hand, for incorrect sentences, while scrambled sentences were responded to more slowly and elicited more errors on average, none of the *t*-test results reached the $p < .05$ significance level (although the *t*-test on RT by subject analysis obtained a result very close to that) [for RT, $t(23) = 2.056$, $p = .051$ by subject analysis, $t(31) = 1.550$, $p = .131$ by item analysis; for error rates, $t(23) = 1.798$, $p = .085$ by subject analysis, $t(31) = 1.688$, $p = .101$ by item analysis]. These results seem to correspond to the results obtained in previous studies that also used the sentence correctness decision task and had observed the scrambling effect in terms of RT and error rates.

Next, data from reversible sentences and non-reversible sentences were analyzed separately. The descriptive statistics for reaction times (RT) and error rates are presented in Table 2.

		Reaction time (ms)		Error rate (%)	
Sentence type	Canonical/Scrambled	Mean	SD	Mean	SD
Correct reversible	Canonical	4274	1252	10.94	14.89
	Scrambled	4425	851	14.06	15.34
Correct non-reversible	Canonical	3721	925	2.60	6.36
	Scrambled	4056	906	11.98	10.73
Incorrect reversible	Canonical	4505	1158	16.15	18.24
	Scrambled	4633	1130	18.23	17.28
Incorrect non-reversible	Canonical	3997	931	7.81	9.62
	Scrambled	4256	990	12.50	11.06

Table 2. Reaction times and error rates for each sentence type (reversible and non-reversible separate)

A series of repeated-measures *t*-tests was again carried out on reaction times (milliseconds) and error rates (percentages) for the canonical/scrambled pairs in each sentence type (correct reversible, correct non-reversible, incorrect reversible, incorrect non-reversible).

For correct reversible sentences, although scrambled sentences were responded to more slowly and elicited more errors on average, the *t*-test results did not reach the $p < .05$ significance level in either RT or error rates [for RT, $t(23) = .996$, $p = .330$ by subject analysis, $t(15) = 1.872$, $p = .081$ by item analysis; for error rates, $t(23) = 1.064$, $p = .299$ by subject analysis, $t(15) = 1.381$, $p = .188$ by item analysis]. On the other hand, for correct non-reversible sentences, *t*-test results indicated that the scrambled sentences were responded to significantly more slowly and elicited significantly more errors [for RT, $t(23) = 2.716$, $p = .012$ by subject analysis, $t(15) = 3.299$, $p = .005$ by item analysis; for error rates, $t(23) = 4.097$, $p < .001$ by subject analysis, $t(15) = 3.926$, $p = .001$ by item analysis]. Thus, a very clear scrambling effect was observed only for non-reversible sentences for those sentence items that elicited correct "yes" responses.

A similar tendency was observed for incorrect sentences. None of the *t*-test results for the canonical/scrambled pairs of incorrect reversible sentences reached levels of significance, although again the scrambled sentences were read more slowly and elicited more errors on average [for RT, $t(23) = 1.031$, $p = .313$ by subject analysis, $t(15) = .882$, $p = .392$ by item analysis; for error rates, $t(23) = .778$, $p = .445$ by subject analysis, $t(15) = .752$, $p = .464$ by item

analysis]. For incorrect non-reversible sentences, *t*-tests on both RT and error rates reached significance by subject analysis, but not by item analysis [for RT, $t(23) = 2.505$, $p = .020$ by subject analysis, $t(15) = 1.253$, $p = .229$ by item analysis; for error rates, $t(23) = 2.584$, $p = .017$ by subject analysis, $t(15) = 1.592$, $p = .132$ by item analysis].

The analysis of the translation task data revealed that, while none of the participants made mistakes in translating non-reversible sentences, four of them did not translate reversible scrambled sentences correctly, translating the first accusative-marked NP as the subject and the second nominative-marked NP as the object. This pattern corresponds with the "first noun as the agent" strategy or the NNV template reported in previous studies with NS children and L2 learners. Because it is possible, based on the translation data, that those four participants did not have the grammatical knowledge to use case markers to assign correct thematic roles to NPs, the correctness decision data was analyzed excluding the data obtained from the four participants. The descriptive statistics are presented in Table 3.

		Reaction time (ms)		Error rate (%)	
Sentence type	Canonical/Scrambled	Mean	SD	Mean	SD
Correct reversible	Canonical	4226	1298	10.63	15.85
	Scrambled	4399	870	14.38	15.32
Correct non-reversible	Canonical	3718	971	1.88	4.58
	Scrambled	4023	921	11.88	11.09
Incorrect reversible	Canonical	4340	1077	12.50	14.62
	Scrambled	4468	1099	15.00	16.02
Incorrect non-reversible	Canonical	3931	950	6.88	9.49
	Scrambled	4210	983	12.50	11.47

Table 3. Reaction times and error rates for each sentence type (excluding the data from the 4 participants who did not translate the reversible scrambled sentences correctly)

For the correct reversible sentences, the *t*-test results on RT by item analysis reached significance [$t(15) = 2.556$, $p = .022$], while subject analysis did not indicate a significant difference [$t(19) = .961$, $p = .349$]. The error rates remained non-significant [$t(19) = 1.101$, $p = .285$ by subject analysis, $t(15) = 1.307$, $p = .211$ by item analysis]. The correct non-reversible sentences again indicated a significant scrambling effect both in RT and error rates [for RT, $t(19) = 2.253$, $p = .036$ by subject analysis, $t(15) = 3.451$, $p = .004$ by item

analysis; for error rates, $t(19) = 4.292$, $p < .001$ by subject analysis, $t(15) = 3.303$, $p = .005$ by item analysis].

For the incorrect reversible sentences, no *t*-test results showed significant differences [for RT, $t(19) = .892$, $p = .384$ by subject analysis, $t(15) = .828$, $p = .421$ by item analysis; for error rates, $t(19) = .890$, $p = .385$ by subject analysis, $t(15) = 1.074$, $p = .300$ by item analysis]. For the incorrect non-reversible sentences, subject analyses on RT and error rates again reached significance [$t(19) = 2.502$, $p = .022$ for RT; $t(19) = 2.651$, $p = .016$ for error rates]. In addition, item analysis of error rates indicated a significant difference [$t(15) = 2.334$, $p = .034$], but the item analysis of RT remained non-significant [$t(15) = 1.464$, $p = .164$]. Thus, a significant scrambling effect was not observed for reversible sentences even when the data from the four participants who provided incorrect translations for reversible scrambled sentences were excluded (except for RT of the correct reversible sentences which was significant by item analysis).

Discussion

The results of the sentence correctness decision task indicate that correct sentences with scrambled word orders result in longer reaction times and higher error rates. This agrees with Iwasaki's (2003) grammaticality judgment experiment with L2 learners of Japanese as well as other studies with NS participants. Thus, the present study suggests that L2 learners of Japanese experience psychological cost in reading and comprehending scrambled sentences as do NSs.

Furthermore, the present study found evidence that the scrambling effect on reaction times and error rates is more robust in the non-reversible sentences than the reversible ones. While the 'inanimate-animate' order of the NPs as well as the case markers signal that the sentence is scrambled in non-reversible sentences, it is only the case markers that indicate scrambling in reversible sentences. It is thus possible that such saliency might have contributed to a more robust scrambling effect with non-reversible sentences.

Chujo (1983) reports results of a correctness decision task by NSs which included the reversible/non-reversible distinction. The study's results indicated that, while the RTs for scrambled sentences were longer for both reversible and non-reversible types, the scrambling effect in RT was larger for the non-reversible type. As the present study also observed that the scrambling effect was larger for non-reversible sentences, it is possible that the L2 participants in the present study integrated the animacy information of nouns in a manner similar to the NSs in Chujo's study when they read the scrambled sentences.[5]

On the other hand, the use of case-marking information by the L2 participants in the present study may be different from that of NSs in previous studies. Muraoka et al. (2004) observed a significant difference in RT between the canonical/scrambled pairs of reversible sentences while the present study observed a significant difference only with item analysis (when the four participants were excluded from analysis).[6] Even in an untimed

translation task, there were four participants who translated reversible scrambled sentences using the "first noun as subject" strategy or the "NNV" template. It is thus quite probable that some participants, in performing the timed correctness decision task, overlooked the case markers and did not notice scrambling in some of the reversible sentences. In these instances, reanalysis of the sentence structure (from canonical to scrambling) could not have taken place, resulting in a weaker scrambling effect in reversible sentences. On the other hand, the observed significant difference in Muraoka et al., suggests that NS participants integrated case-marking information more consistently, thereby correctly identifying scrambling in reversible sentences. The results of the present study thus seem to coincide with the findings of previous studies: that L2 learners of Japanese experience some difficulty in integrating case-marking information when comprehending scrambled sentences.

Limitations of the present study and further research

One limitation of the present study lies in the way the sentence items were presented. In the correctness decision experiment, the participants were given up to 10 seconds to respond to the stimuli. Ideally, the experimenter wanted to observe the participants' reactions to the sentences as reflected by the amount of time they spent in reading and comprehending the sentences. Therefore, participants were instructed to respond as quickly and as accurately as possible. However, the allowance of 10 seconds may have caused some participants to ponder far too long before responding. For instance, one participant, who had studied Japanese for seven years and whose proficiency in Japanese was felt to be quite high in casual conversation after the experiment, took 7476 ms on average to respond to the correct reversible canonical sentences. Given that the sentence items consisted of only three words, it appears that this participant was being very careful in making correctness decisions on this particular set of stimuli, which may have resulted in some 'noise' in the data. While it would be impossible to completely eliminate such 'pondering' from the data, the participants should have been given shorter time periods to respond (possibly around seven seconds), as shorter time limits would encourage participants to respond faster and discourage them from overthinking their decisions.

A more significant limitation of the present study may come from the fact that it did not include NS participants as a control group. Although Chujo (1983) and Muraoka et al. (2004), among other studies, provide important references on NS behavior in sentence correctness decision tasks, the present study employed a different set of stimuli that was designed with intermediate L2 learners in mind. It is therefore not possible to directly compare the current L2 data with NS data in previous studies. A follow-up study with NS participants, using the same stimuli, is necessary to make a more precise comparison between L2 learners and NSs.

The present correctness decision study, together with Iwasaki (2003) found evidence that L2 learners slow down in comprehending scrambled

sentences. Unfortunately, however, sentence correctness decision tasks are not informative when trying to understand precisely where the slowdowns occur (Miyamoto, 2008). In order to identify exactly where in scrambled sentences the slowdowns take place, it is necessary to investigate the processing of scrambling using online measures such as a self-paced reading and an eye-tracking technique. L2 data obtained through such measures would provide important information on the issue of whether L2 sentence processing is fundamentally different from that of its L1 counterpart (the Shallow Structure Hypothesis; Clahsen & Felser, 2006).

Comparison of L2 learners with different levels of proficiency would be valuable in deepening our understanding of L2 processing of scrambling. As observed, some studies (e.g.. Kilborn & Ito, 1989) have found evidence that L2 Japanese learners' knowledge and use of case markers for scrambled sentences develops as their general proficiency in Japanese increases, while others (e.g., Iwasaki, 2003) did not observe evidence for such development. Thus, examining the processing of scrambling by learners of different proficiencies using online measures will provide important pedagogical and theoretical information on the acquisition of case markers by L2 learners.

Also valuable would be the comparison of learners with different L1 backgrounds. Koda (1993) found that L1 Korean learners, whose L1 exhibits scrambling in ways similar to Japanese, were able to comprehend SOV and OSV Japanese sentences equally well while L1 Chinese and English learners, whose L1s do not have the scrambling property, had more difficulty with scrambling. More recently, Hara (2009), employing a self-paced reading method, found evidence that L1 Korean learners processed the gap in scrambled sentences while L1 Chinese learners did not. This line of research, especially when online measures are employed, would make an important contribution to our knowledge of the transfer of L1 cognitive strategies to the processing of an L2.

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APPENDIX

The canonical sentences used in the present correctness decision task. (The scrambled sentences were created by switching the order of the nominative and accusative NPs.)

List A	List B
Correct Reversible	***Correct Reversible***
太郎(たろう)が和子(かずこ)を見(み)た。	弘子(ひろこ)が雄二(ゆうじ)を見(み)た。
Taro saw Kazuko.	Hiroko saw Yuji.
恵子(けいこ)が健二(けんじ)を待(ま)った。	次郎(じろう)が弘子(ひろこ)を待(ま)った。
Keiko waited for Kenji.	Jiro waited for Hiroko.
健二(けんじ)が恵子(けいこ)を呼(よ)んだ。	順子(じゅんこ)が次郎(じろう)を呼(よ)んだ。
Kenji called Keiko.	Junko called Jiro.
和子(かずこ)が太郎(たろう)をいじめた。	雄二(ゆうじ)が順子(じゅんこ)をいじめた。
Kazuko bullied Taro.	Yuji bullied Junko.
太郎(たろう)が弘子(ひろこ)をさがした。	恵子(けいこ)が次郎(じろう)をさがした。
Taro looked for Hiroko.	Keiko looked for Jiro.
弘子(ひろこ)が健二(けんじ)を助(たす)けた。	次郎(じろう)が恵子(けいこ)を助(たす)けた。
Hiroko helped Kenji.	Jiro helped Keiko.
健二(けんじ)が順子(じゅんこ)を手伝(てつだ)った。	和子(かずこ)が雄二(ゆうじ)を手伝(てつだ)った。
Kenji assisted Junko.	Kazuko assisted Yuji.
順子(じゅんこ)が太郎(たろう)をたたいた。	雄二(ゆうじ)が恵子(けいこ)をたたいた。
Junko hit Taro.	Yuji hit Keiko.
Correct Non-Reversible	***Correct Non-Reversible***
太郎(たろう)がシャツを着(き)た。	恵子(けいこ)が着物(きもの)を着(き)た。
Taro wore a shirt.	Keiko wore a kimono.
弘子(ひろこ)がメールを書(か)いた。	次郎(じろう)が手紙(てがみ)を書(か)いた。
Hiroko wrote a mail.	Jiro wrote a letter.
健二(けんじ)がごはんを食(た)べた。	恵子(けいこ)がケーキを食(た)べた。
Kenji ate rice.	Keiko ate a cake.
順子(じゅんこ)がビールを飲(の)んだ。	雄二(ゆうじ)がお酒(さけ)を飲(の)んだ。
Junko drank beer.	Yuji drank sake.
太郎(たろう)が CD を聞(き)いた。	和子(かずこ)が音楽(おんがく)を聞(き)いた。
Taro listened to a CD.	Kazuko listened to music.
弘子(ひろこ)がドアを開(あ)けた。	次郎(じろう)がまどを開(あ)けた。

Hiroko opened the door. 健二がズボンを洗った。 Kenji washed pants. 順子がペンを使った。 Junko used a pen. ***Incorrect Reversible*** 太郎が恵子をかぶった。 Taro wore Keiko. 恵子が太郎を運転した。 Keiko drove Taro. 次郎が順子をあびた。 Jiro bathed Junko. 恵子が雄二を歩いた。 Keiko walked Yuji. 次郎が和子を来た。 Jiro came Kazuko. 順子が健二を入った。 Junko entered Kenji. 雄二が弘子を泳いだ。 Yuji swam Hiroko. 順子が雄二を晴れた。 Junko cleared Yuji. ***Incorrect Non-Reversible*** 太郎がシャツを答えた。 Taro answered a shirt. 弘子がメールを寝た。 Hiroko slept a mail. 健二がごはんを通った。 Kenji went through rice. 順子がビールをころした。 Junko killed beer. 太郎が CD を会った。 Taro met a CD. 弘子がドアを走った。 Hiroko ran the door.	Jiro opened the window. 恵子がくつしたを洗った。 Keiko washed socks. 雄二がパソコンを使った。 Yuji used a computer. ***Incorrect Reversible*** 弘子が次郎をかぶった。 Hiroko wore Jiro. 健二が和子を運転した。 Kenji drove Kazuko. 和子が健二をあびた。 Kazuko bathed Kenji. 太郎が順子を歩いた。 Taro walked Junko. 弘子が太郎を来た。 Hiroko came Taro. 雄二が和子を入った。 Yuji entered Kazuko. 和子が次郎を泳いだ。 Kazuko swam Jiro. 健二が弘子を晴れた。 Kenji cleared Hiroko. ***Incorrect Non-Reversible*** 恵子が着物を答えた。 Keiko answered a kimono. 次郎が手紙を寝た。 Jiro slept a letter. 恵子がケーキを通った。 Keiko went through a cake. 雄二がお酒をころした。 Yuji killed sake. 和子が音楽を会った。 Kazuko met music. 次郎がまどを走った。 Jiro ran the window.

健二(けんじ)がズボンをしかった。 Kenji scolded pants.	恵子(けいこ)がくつしたをしかった。 Keiko scolded socks.
順子(じゅんこ)がペンを出(で)かけた。 Junko went out a pen.	雄二(ゆうじ)がパソコンを出(で)かけた。 Yuji went out a computer.

NOTES

[1] See Hakuta (1982) for the observation that Japanese children may rely on the *–ga* case marking on the first NP in addition to the canonical NNV word order.
[2] See Murasugi & Kawamura (2005) for evidence that acquisition of scrambling by L1 Japanese children may take place earlier than suggested in previous studies such as Hayashibe (1975) and Sano (1977).
[3] Mazuka et al.'s (2002) experiments included another sentence type in which the modifier clause was placed at the beginning of the sentence.
[4] See also Miyamoto & Takahashi (2002) which used a self-paced reading technique and observed slowdowns in ditransitive VP-internal scrambling.
[5] While the tendency in scrambling effects between reversible and non-reversible sentences was similar in the two studies, Chujo's (1983) NS participants made correctness decisions much more quickly than the L2 participants in the present study. Chujo's (1983) sentence stimuli consisted of only three words as do the ones in the present study, but the RT for 'correct reversible canonical' and 'correct reversible scrambled' sentences were about 1350 ms and 1500ms, respectively.
[6] Chujo's (1983) data also suggest that there was a significant difference in RT between the canonical/scrambled pairs of reversible sentences. Due to the presentation of the data in the study, however, it is not known whether the difference was actually significant.