Processing of relative clauses by Japanese native speakers and L2 learners

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要旨

日本語母語話者と日本語学習者による関係節の文処理

第一・第二言語習得研究において、関係節構文等に現われるギャップ(gap)は、そのおこる位置によって難易度が違うことが報告されている。主語の位置におこるギャップは目的語の位置におこるギャップより容易であると言われている。本研究はこの主語ギャップと目的語ギャップの間にある非対称性が日本語母語話者と日本語学習者による関係節の文処理にも現われるかどうかを比較調査したものである。被験者は日本語母語話者３４人と英語を母語とする日本語学習者１３人で、PsyScopeというソフトを使用し、コンピューターで文読解の時間を計測した。実験の結果、１）母語話者においてはギャップ間の非対称性は見られないが学習者においては見られること、２）母語話者は関係節の主要部の部分という大きな区切りで時間を配分するが、学習者は短い単純な名詞句等の部分で時間をとること、が明らかになった。

1. Introduction

Developmentalstudies on first and second language acquisition suggest that gaps in subject position are more easily dealt with than those in object position in relativeclauses and a varietyof other constructions (Yoshinaga 1996, Crain and Thornton 1998, Gass 1979, and O'Grady 1997, 1999).

(1) a. Relativeclause with a gap in the subject position
the car [that _ pushed the truck]
b. Relativeclause with a gap in the direct object position
the car [that the truck pushed _]

This raises the question of whether and how the asymmetry between subject and object gaps is manifested in the course of sentence processing by first and second language learners.

This paper reports on a comparativeexperimental study that investigates this issue. We begin by examining the parsing of Japanese relativeclauses by native speakers, and then turn our attention to the performance of English-speaking second language learners.

2. Some facts about relativeclause structure in Japanese

Relativeclauses are considered to be one of the most difficult patterns for L2 learners to acquire, presumably in part because of the gap (e.g., O'Grady 1999). In order to comprehend a relative clause structure, learners must not only recognize the gap but also identify its grammatical role within the clause and determine its reference. Thus, in the

English sentence *A girl met a man [who Mary knew _]*, interpretation of the relative clause requires the listener to take note of the gap, to identify its position as that of a direct object, and to recognize that it corresponds to *a man* rather than *a girl*.

The comprehension of Japanese relative clauses involves additional complications, especially for second language learners. For one thing, because Japanese is a pro-drop language, gaps occur rather freely and are not restricted to relative clauses and related structures.

In addition, because Japanese is a head-final language, relative clauses precede the head noun. Hence, a gap in a relative clause occurs before its reference can be determined. In English, in contrast, the noun that determines the referent of the gap always occurs first.

Finally, relative clauses in Japanese do not involve any unique morphological marking. They contain neither a relative pronoun (like English *who* or *which*) nor any special morphological marking on the verb to signal their status as embedded clausal modifiers.

(2) Japanese relative clause
Taroo-ga [_ hon-o katta] hito-o nagutta
Taroo-Nom book-Acc bought person-Acc hit.
'Taroo hit the person who bought the book.'

As example (2) helps illustrate, there is no way of knowing that the pattern being processed is a relative clause until 'after the fact'—at the point at which the head noun is encountered.

How then are Japanese relative clauses processed? We will begin the investigation with native speakers of Japanese

3. Experiment 1: Japanese native speakers

The first part of our study investigates how native speakers process four different types of Japanese relative clauses. Our investigation will focus on the question of whether there is an asymmetry in the processing of subject gap and object gap relatives.

3.1. Subjects

Thirty-four native speakers of Japanese participated in our experiment. Twenty-three were graduate and undergraduate students at the University of Hawaii; nine were high school students in Japan who were attending a two-week English training program; and two were

non-student, local residents of Honolulu. In all, there were ten males and twenty-four females ranging in age from 16 to 45.

3.2. Test Stimuli

The test sentences consisted of four types of relative clauses classified in the standard way in terms of the two variables—head position (the grammatical role of the noun modified by the relative clause) and gap position (the grammatical role of the gap within the relative clause). Each sentence consisted of five words—three NPs and two transitive verbs, as illustrated below:

(3) Four sets of test sentences. (six tokens of each)

a. The SS type (subject gap relative modifying a subject)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
[Taroo-o	nagutta]	otoko-ga	tegami-o	kaita
Taroo-Acc	hit	man-Nom	letter-Acc	wrote

'The man who hit Taroo wrote a letter.'

b. The SO type (object gap relative modifying a subject)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
[Taroo-ga	oikaketa]	otokonoko-ga	kabin-o	kowashita.
Taroo-Nom	chased	boy-Nom	vase-Acc	broke.

'The boy whom Taroo chased broke the vase.'

c. The OS type (subject gap relative modifying an object)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Obaasan-ga	[Taroo-o	nagutta]	otokonoko-o	sagashita.
grandma-Nom	Taroo-Acc	hit	boy-Acc	looked-for

'The grandmother looked for the boy who hit Taroo.'

d. The OO type (object gap modifying an object)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Hanako-ga	[Taroo-ga	karakatta]	otokonoko-o	waratta.
Hanako-Nom	Taroo-Nom	made-fun-of	boy-Acc	laughed-at

'Hanako laughed at the boy whom Taroo made fun of.'

There were six tokens for each type of relative clause. In addition, six filler sentences were added, making for a total of thirty test items.

The verbs in the relative clauses were all reversible in the sense that the noun functioning as subject could just as naturally serve as direct object, and vice versa. (Thus, in (3b) it is just as natural for Taroo to chase a boy as it is for a boy to chase Taroo.) The noun modified by the relative clause was always *otokonoko* 'boy', *otoko* 'man' or *onna* 'woman'.

The nouns occurring inside the relative clause were one of two proper nouns (*Taroo* or *Hanako*) or one of two common nouns (*obaasan* 'grandmother' or *ojiisan* 'grandfather'). This was intended to minimize the memory load that might result from exposure to too many different nouns during the experiment.

Two native speakers of Japanese checked the naturalness and grammaticality of the test sentences. The vocabulary and the Chinese characters used in the test sentences were also judged to be sufficiently common by subjects in a pilot study.

3.3. Procedure

Our experiment utilized a self-paced, word-by-word reading technique. The test stimuli were presented on a computer screen controlled by PsyScope run on a Macintosh Performa 6300CD. The procedural instructions were given in Japanese, primarily in a written text shown on the screen.

Only one word appeared at a time on the screen. By pressing the space bar, that word was replaced by the next word. Following the last word of each sentence, a probe word appeared in red.[1] The subjects were asked to press a 'yes' or 'no' key on the keyboard to indicate whether they had seen the word in the sentence that they had just read.[2]

The subjects were instructed to read the test sentences as fast as possible while still keeping track of the content. They were told that reading times for each word would be measured and that they could not go back to words already read. They were also informed that there were no incomplete or ungrammatical sentences. Each test session was preceded by a practice session, which consisted of three sentences.

3.4. Data Analysis

The computer recorded both the reading times for the test stimuli and the answers for the probe word recognition. Only the results of subjects who scored at least 80% correct on the probe word recognition task were used for the subsequent analysis. After excluding the data of four subjects on the basis of this criterion, the analysis was conducted on a total of thirty subjects.

3.5. Results

3.5.1. Overall reading times

Table 1 and Figure 1 present the overall reading times for our native speaker subjects. As can be seen here, the mean reading time for the object gap relatives that modify the subject is 5717 milliseconds (hereafter msec.) compared to an almost identical 5604

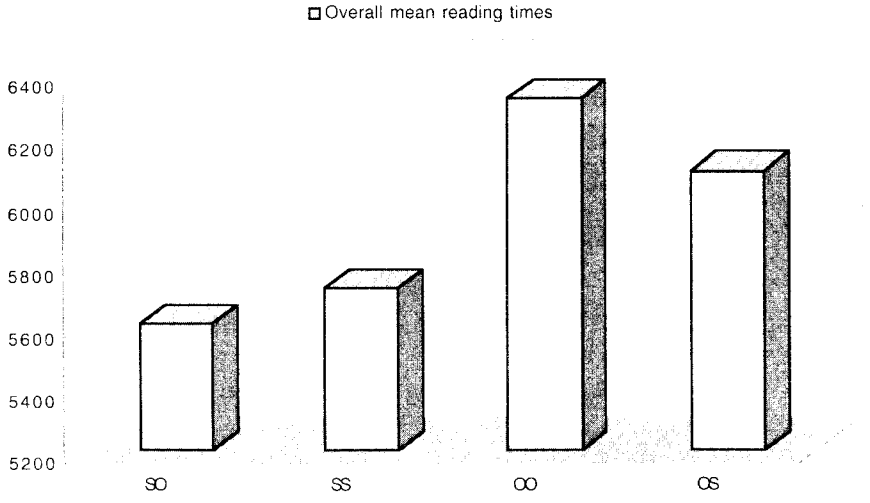
msec. for subject gap relatives. A similar pattern is observed for relative clauses that modify the direct object, with an overall reading time of 6091 msec. for object gap relatives and 6323 msec. for subject gap relatives.

Table 1 Japanese native speakers' overall reading times in msec.

Relative clause modifying the subject		Relative clause in object position	
Subject gap (SS)	Object gap (SO)	Subject gap (OS)	Object gap (OO)
5603.65	5717.38	6322.69	6091.04

Statistical analysis shows that there is no significant difference between the subject and object gap relative clauses ($p = .606$), but that the difference between relative clauses that modify a subject and those that modify a direct object is significant ($p = .047$).

Figure 1: Japanese native speakers' overall mean reading times (in msec.)



3.5.2. Local reading times

Table 2 and Figure 2 present mean position-by-position reading times for native Japanese speakers on the subject and object gap relative clauses that modify a subject. Sentences (3a) and (3b) are repeated here as (4) and (5), respectively for convenience.

(4) The SS type (subject gap relative modifying a subject) (=3a)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
[Taroo-o	nagutta]	otoko-ga	tegami-o	kaita
Taroo-Acc	hit	man-Nom	letter-Acc	wrote

'The man who hit Taroo wrote a letter.'

(5) The SO type (object gap relative modifying a subject) (=3b)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
[Taroo-ga	oikaketa]	otokonoko-ga	kabin-o	kowashita.
Taroo-Nom	chased	boy-Nom	vase-Acc	broke.

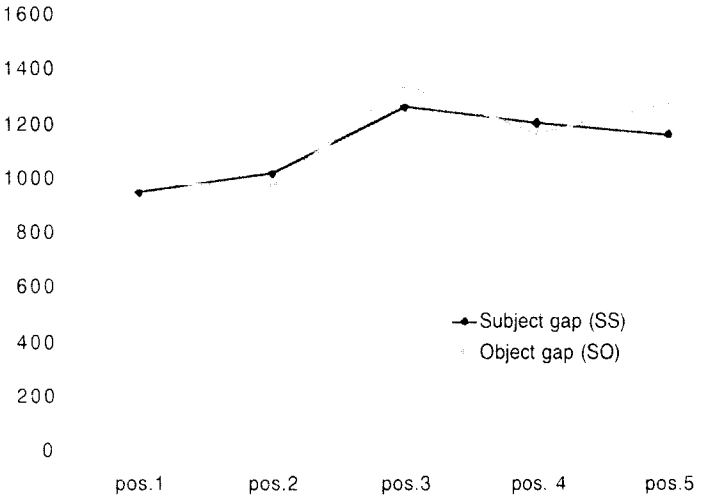
'The boy whom Taroo chased broke the vase.'

Table 2: Mean position-by-position reading times for subject- and object-gap relative clauses that modify the matrix subject (in msec.)

	Pos.1	Pos.2	Pos.3	Pos.4	Pos.5
Subject gap (SS)	[NP-Acc	Verb]	Head	NP-Acc	Verb
	947	1016	1260	1203	1160
Object gap (SO)	[NP-Nom	Verb]	Head	NP-Acc	Verb
	981	969	1336	1162	1269

*The shaded area refers to the head position. The brackets indicate the embedded clause boundaries.

Figure 2:
Native speakers' mean position-by-position reading times for subject position relatives (in msec.)



As can be seen here, these two structures exhibit a clear peak in response time at position 3, where the noun modified by the relative clause appears.

Table 3 and Figure 3 present mean position-by-position reading times for the native Japanese speakers on the subject- and object-gap relative clauses that modify the matrix direct object. Sentences (3c) and (3d) are repeated here as (5) and (6), respectively for convenience.

(5) The OS type (subject gap relative modifying an object) (=3c)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Obaasan-ga	[Taroo-o	nagutta]	otokonoko-o	sagashita.
grandma-Nom	Taroo-Acc	hit	boy-Acc	looked-for

'The grandmother looked for the boy who hit Taroo.'

(6) The OO type (object gap modifying an object) (=3d)

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos. 5
Hanako-ga	[Taroo-ga	karakatta]	otokonoko-o	waratta.
Hanako-Nom	Taroo-Nom	made-fun-of	boy-Acc	laughed-at

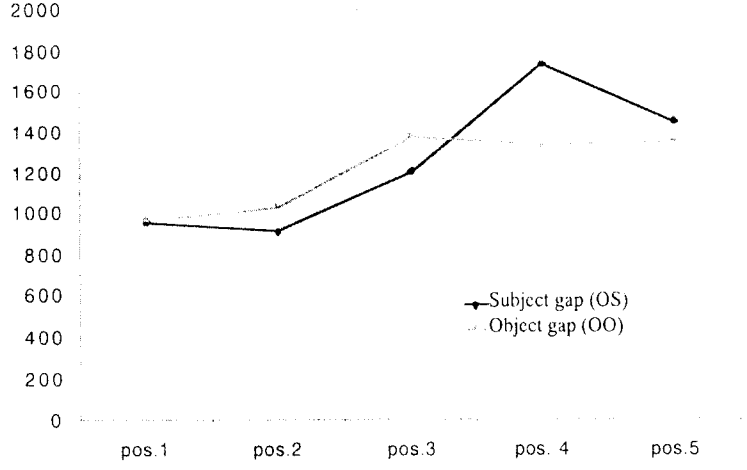
'Hanako laughed at the boy whom Taroo made fun of.'

Table 3: Mean position-by-position reading times for subject and object gap relative clauses that modify the matrix direct object (in msec.)

	Pos.1	Pos.2	Pos.3	Pos.4	Pos.5
Subject gap (OS)	NP-Nom	[NP-Acc	Verb]	Head	Verb
	968	919	1207	1739	1457
Object gap (OO)	NP-Nom	[NP-Nom	Verb]	Head	Verb
	977	1039	1383	1336	1356

*The shaded area refers to the head position. The brackets indicate the embedded clause boundaries.

Figure 3:
Native speakers' mean position-by-position reading times for object position relatives (in msec.)



There is a peak at the first verb (position 3) in the subject relative and a very high peak at position 4, where the head modified by the relative clause appears. This reflects a mild 'garden path effect' that results from the fact that it is tempting to treat the first two NPs as the subject and direct object, respectively, of the transitive verb that appears in the third position. Only when the parser reaches the noun that follows the verb does it become clear that the second and third words make up a relative clause and that first noun in the sentence functions as subject of a higher clause.

The object gap relative clause manifests a somewhat different pattern, with a slightly higher peak over the verb than over the noun modified by the relative clause. This may reflect the fact that the sequence of two consecutive nominative-marked nouns creates an

incorrect expectation that the verb will be a so-called stative transitive predicate (such as *wakaru* 'understand'), which takes two nominative arguments. When a different type of verb is encountered, this expectation must be suppressed.

3.6. Summary

In summary, the first part of our study has yielded two key findings. One is that there is no difference in overall processing times of subject- and object-gap relative clauses for native speakers of Japanese, although relative clauses that modify a direct object require more processing time than those that modify a subject.

The other key finding is that a high peak in response times occurs at the position corresponding to the head noun in all four types of relative clause. This longer pause demonstrates that significant processing activity takes place at this point. This is consistent with the finding reported by Yamashita, Stowe, and Nakayama (1993)[3] as well as Nakamura (2000).[4]

4. Experiment II: JSL learners

This brings us to the second part of our study and to the question of how English-speaking second language learners go about processing Japanese relative clauses.

4.1. Subjects

Thirteen native English speakers enrolled in third- and fourth-year Japanese courses at the University of Hawaii participated in this experiment.

4.2. Test Stimuli

Subject- and object-gap relative clauses modifying a subject or direct object in the matrix clause were tested (as in experiment 1). Hence, there were four sets of test sentences, as illustrated in (7).

(7) Four sets of test sentences (five tokens of each)

a. Subject gap relative clause modifying a subject

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos 5	Pos. 6	Pos. 7
[Uchi-ni	shukudai-o	wasureta]	gakusei-wa	isoide	sensei-ni	denwasita
home-at	homework-Acc	forgot	student-Top	hurriedly	teacher-to	phone

'The student who left his assignment at hoome phoned the teacher.'

b. Object gap relative clause modifying a subject

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos 5	Pos. 6	Pos. 7
[Kahara-de	otooto-ga	mita]	eiga-wa	nihonno-de	totemo	nagakatta
Kahala-at	brother-Nom	saw	movie-Top	Japanese-be	very	long

'The movie that my brother saw at Kahala was Japanese and very long.'

c. Subject gap relative clause modifying a direct object

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos 5	Pos. 6	Pos. 7
Otoko-no	sensei-ga	[eigo-o	tsukatta]	gakusei-o	kenkyuushitsu-ni	yonda
male-Gen	teacher-Nom	English-Acc	made	teacher-Acc	office-to	called

'The male teacher called the student who used English to his office.'

d. Object gap relative clause modifying a direct object

Pos. 1	Pos. 2	Pos. 3	Pos. 4	Pos 5	Pos. 6	Pos. 7
Otoko-no	gakusei-ga	[sensei-ga	wasureta]	tokee-o	gakkoo-ni	todoketa
male-Gen	student-Nom	teacher-Nom	forgot	watch-Acc	school-to	delivered

'The male student brought the watch the teacher forgot to school.'

There were five tokens of each sentence type.

Because of limitations in the vocabulary of the second language learners, we were not able to use the same test items in this experiment as in our first study. Instead, we used tests sentences containing words frequently found in teaching materials used up to the third semester of instruction. Furthermore, because of the difficulty that even third-year students had encountered with reversible relative clauses on a previous experiment conducted by the first author, only non-reversible relative clauses containing one animate argument and one inanimate argument were employed. Each test sentence was followed by a *yes/no* question to help ensure that subjects paid attention to its content as well as its form.

In addition to the test sentences, 15 non-test items were also included.

4.3. Procedure

A procedure similar to the one employed in Experiment I was used except that at the end of each session, a follow-up interview was conducted in order to make sure that there were no words or kanji unknown to the subjects. None reported any problems.

4.4. Results

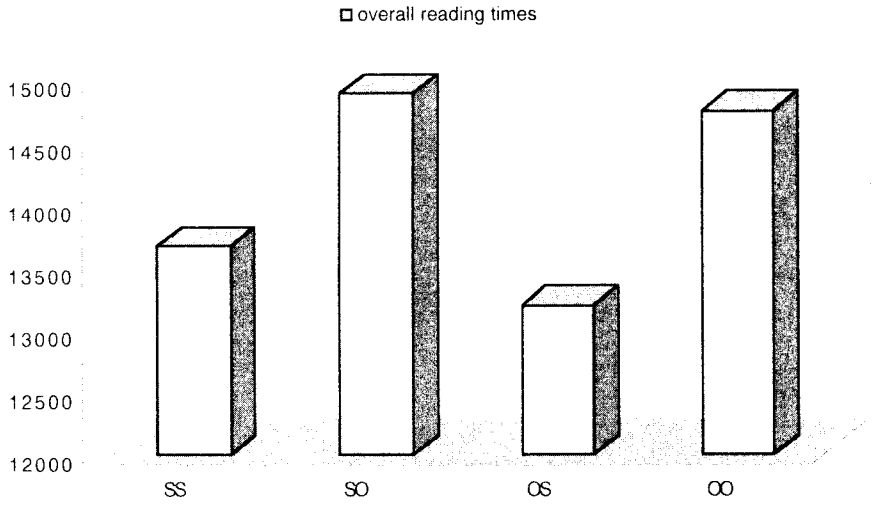
The English JSL learners had an accuracy rate of 83% on the *yes/no* question, which indicates that they were paying attention to the content of the test sentences. Table 4 and Figure 4 present the overall mean reading times for the four different types of relative clauses.

The mean reading time for the subject gap relatives that modify a subject is 13647 msec.—faster than the 14864 msec. required for object gap relatives. A similar contrast was observed for relative clauses that modify a direct object, where we observe an overall reading time 14720 msec. for object gap relatives compared to only 13177 msec. for subject gap relatives.

Table 4 L2 learners' overall reading times in milliseconds

Relative clause modifying a subject		Relative clause modifying an object	
Subject gap (SS)	Object gap (SO)	Subject gap (OS)	Object gap (OO)
13647.231	14864.308	13177.00	14719.769

Figure 4:
L2 learners' overall mean reading times



As Figure 4 shows, subject gap relatives were processed significantly faster than the object gap relative clauses (p=0.0345), regardless of whether they modify a subject or a direct object. (Recall that there was no difference between subject- and object-gap relatives in the case of native speakers.)

Let us now examine more closely the differences among the four different types of relative clauses that we investigated, beginning with relative clauses that modify a direct

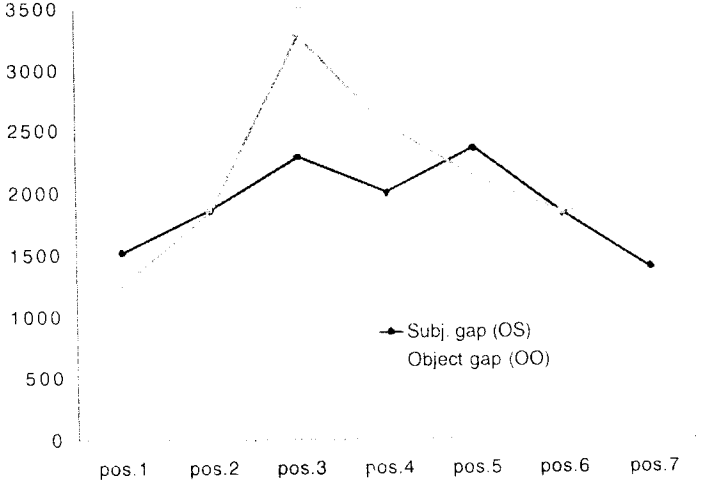
object. Table 5 and Figure 5 present the mean position-by-position reading times for these two patterns.

Table 5: Mean position-by-position reading times for subject- and object-gap relative clauses that modify the direct object (in msec.)

	Pos.1	Pos.2	Pos. 3	Pos. 4	Pos.5	Pos.6	Pos.7
Subject gap (OS)	1526	N-Nom 1867	[NP-Acc 2289	Verb] 1997	Head 2352	1836	Verb 1385
Object gap (OO)	1243	N-Nom 1858	[NP-Nom 3262	Verb] 2542	Head 2124	1834	Verb 1950

*The shaded area refers to the head position. The brackets indicate the embedded clause boundaries.

Figure 5:
L2 learners' mean position-by-position reading times for relative clauses that modify a direct object (in msec.)



These two types of relative clauses exhibit different processing profiles. The highest peak for the object-gap relatives is at position 3, where the second nominative marked phrase

appears, while the second highest peak is at the position of the embedded verb. There is also a slight peak at the head noun position (position 5).

In contrast, the major peak in the subject gap relative clause is at the position of the head noun. However, if we reexamine Figure 5, we see that this peak is not as noticeable as in the case of the native speakers. (Recall that this type of relative clause involves a garden path that was responsible for the very high peak at the head noun position among the native speakers.) Moreover, the second language learners appear to expend processing effort not just at clause boundaries, but also at phrasal boundaries, where noticeable peaks occur.

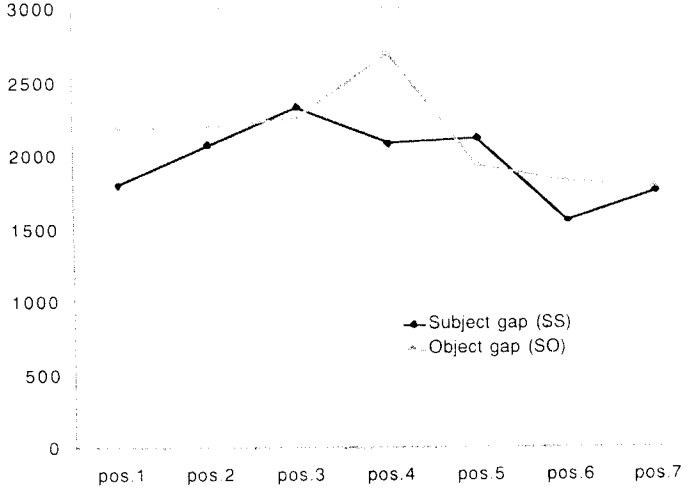
Now let us examine the results for relative clauses modifying the subject. Table 6 and figure 6 present the mean position-by-position reading times for these patterns.

Table 6: Mean position-by-position reading times for subject- and object-relative clauses that modify the matrix subject (in msec.)

	Pos.1	Pos.2	Pos. 3	Pos. 4	Pos.5	Pos.6	Pos.7
Subject gap (SS)	[	NP-Acc	Verb]	Head			Verb
	1800	2080	2331	2085	2114	1552	1753
Object gap (SO)	[	NP-Nom	Verb]	Head			Verb
	2188	2205	2247	2693	1929	1823	1778

*The shaded area refers to the head position. The brackets indicate the embedded clause boundaries.

Figure 6:
L2 learners' mean position-by-position reading times for relative clauses that modify a subject (in msec.)



There is a clear and relatively high peak at the head noun position in direct object relatives. In contrast, there is no clear high peak at all in the subject relatives.

Overall, the most remarkable feature of the JSL results is the variation in response patterns across the four types of relative clauses. Most noticeably, there is no uniform tendency for a major peak over the head noun, in contrast to what was observed among Japanese native speakers. This in turn suggests that Japanese native speakers differ from English JSL learners in terms of where they expend the greatest processing effort. Whereas the native speakers allocated extra time at the head of a relative clause, the second language learners often allocated extra time at simple phrasal boundaries. This suggests that L2 learners are not as good as native speakers at allocating the time on-line necessary to integrate larger structural/conceptual units. A separate study by the first author on the comprehension of subject- and object-gap relative clauses (Kanno 2000) suggests that a source for this difficulty lies in the poor utilization of case marking information. We hope that additional work in this area will reveal further insights into how L2 learners process Japanese sentence structure and how this affects their ability to produce and understand Japanese sentences.

5. Conclusion

Our study has investigated whether the asymmetry between subject and object gaps reported in developmental studies on first and second language acquisition is also manifested in the parsing of four types of Japanese relative clauses. Our results suggest no processing difference between subject gap and object gap relative clauses among native speakers, but indicate the presence of a significant contrast among second language learners. In addition, we have uncovered sharp differences between native speakers and second language learners with respect to the allocation of processing resources during the comprehension of relative clauses. Further study of these differences hold the promise of shedding light on the nature of the problems encountered by English speakering learners of Japanese

Notes

[1] Items in the probe word questions (presented after each test sentence) were chosen on the basis of their semantic similarity to the target words in a sentence, such as *arubamu* 'album' for *shashin* 'picture' or *hakkenshita* 'discovered' for *mitsuketa* 'found'.

[2] Once they had responded to the probe word, the subjects saw a simple transitive sentence appeared in on the screen and were asked to judge whether it was consistent with the content of the sentence they had just read. The sole purpose of asking content questions was to make the subjects pay more attention to the content of the sentences. Scores from this task were not used for screening the results for the data analysis.

[5] However, they tested only one type of regular relative clause (i.e., the SO type, with an object relative clause modifying a subject).

[6] In this study, the complexity of the test sentences was increased by adding a time adverb and a locative expression. Fifty-three monolingual native speakers of Japanese participated in the experiment, which followed the same procedure as the present study. As in our study, it was found that monolingual adult Japanese speakers paused longest on the head noun of a relative clause, except in OO type relative clauses where the longest pause occurred at the second nominative marked NP.

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