Subject/Object Asymmetries in the Processing of Relative Clauses in Japanese

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1. Introduction

A large body of evidence indicates that, in English, relative clauses with gap in subject position (Sgap) are easier to understand than relative clauses with object gap (Ogap; King and Just 1991; Traxler et al. 2002; inter alia).

(1)  a. Relative clause with gap in object position (Ogap):
    the reporter, \[ [\textit{RC} \ that \ the \ senator \ attacked <\textit{gap}_1>] \]

      b. Relative clause with gap in subject position (Sgap):
    the reporter, \[ [\textit{RC} \ that \ <\textit{gap}_1> \ attacked \ the \ senator] \]

A similar preference for Sgaps has been found for Dutch, French, German (Mak et al. 2002; Holmes and O’Regan 1981; Lipka et al. 2000; and references therein; also Grodzinsky 2000, for comprehension by aphasics). In these languages, relative clauses are postnominal (i.e., they come after the noun they modify), and the requirement for a gap has to be stored in working memory until the gap position is determined. Ogaps may be harder to process because they are farther from the filler (i.e., the head-noun reporter; compare the number of italicized words in (1a,b)), and therefore they take longer to be identified (Gibson 1998; Hawkins 1994; King and Just 1991).

In Japanese, relative clauses are prenominal, and some studies have found a preference for Sgaps (Sheldon 1976; inter alia) while others found no statistically reliable difference (e.g., Kanno and Nakamura 2001). However, these studies did not control for independent factors such as plausibility and sometimes included garden paths (e.g., the object-modifying relative clauses in Sheldon 1976; also Mazuka and Itoh 1995; Miyamoto 2002).

This paper provides evidence that relative clauses with Sgaps are easier to process than relative clauses with Ogaps in Japanese. We then discuss present and previous results in light of different types of distance metrics.

2. Prenominal relative clauses

Japanese is an SOV language in which relative clauses precede the head noun.

(2)  a. Object gap (Ogap)
    \[ n_n \text{tosiyorino} \text{obaasan-}ga \text{<gap> basutei-made miokutta]} \text{onnanoko,} \vphantom{\cdot} \text{accompanied girl} \]
    ‘the girl that the elderly woman accompanied to the bus stop’

    b. Subject gap (Sgap)
    \[ n_n \text{<gap>} \text{tosiyorino obaasan-o basutei-made miokutta]} \text{onnanoko,} \vphantom{\cdot} \text{accompanied girl} \]
    ‘the girl that accompanied the elderly woman to the bus stop’

Relative clauses are particularly ambiguous in Japanese because they do not have any marking to indicate their beginning or end, and arguments can be freely dropped (see Inoue 1991, for a discussion). It is commonly assumed that readers do not posit unnecessary clausal structure if an overt indicator is not available; in Japanese, that is equivalent to assuming that relative clauses are initially processed as main clauses with dropped arguments. For example, the Ogap relative clause in (2a) is initially interpreted as (3).

(3) Tosi9orino obaasan-ga pro basutei-made miokutta.
    elderly woman-Nom bus stop-to accompanied
    ‘The elderly woman accompanied (somebody) to the bus stop.’

Because the relative clause is initially treated as a matrix clause, there is no need to make predictions related to the relative clause structure (e.g., there is no expectation for an upcoming head noun). Thus, in contrast to post-nominal relative clauses, the initial processing of relative clauses in Japanese does not incur extra memory cost. It is only at the head noun that it becomes clear that a relative clause is being processed, and only then are extra memory resources used in order to determine the gap position. Thus, possible differences due to gap position should be observed at the head noun or later.

If we assume that retrieval difficulty increases with distance, the retrieval of a Sgap should be harder than the retrieval of an Ogap because the former
type of gap is farther from the head noun in Japanese. However, we report two reading time experiments providing evidence that Sgaps are easier to process.

Interestingly, distance correctly predicts that prenominal relative clauses in Chinese are easier with Ogaps than Sgaps (Su 1994; Law and Leung 2000, for aphasic patients comprehension of Mandarin Chinese and Cantonese; also, Hsiao and Gibson 2003, for recent reading time data from intact readers). Although Chinese may seem less ambiguous than Japanese as the end of the relative clause can be marked with the nominalizer de, it has considerable lexical ambiguity, and the results should be examined carefully. For example, in a Sgap relative clause (schematically, \([\text{NP} \text{ gap} \text{ V obj de} N]\), the verb can often be mistaken for a noun. Furthermore, de is also ambiguous, and obj de can be interpreted as a possessor modifying N.

3. Experiment 1

This experiment provides evidence that Sgaps are easier to process than Ogaps in Japanese when the head noun is marked as a topic.

3.1. Materials

Thirty-two sets of items with two conditions each were constructed. Region 1 in Table 1 contains an example of the two types of relative clauses used, which only differ in the case marker of the first NP. The two types of relative clauses were completed with the same matrix clause (regions 2 to 4; regions indicate the segmentation in the self-paced reading presentation).

<table>
<thead>
<tr>
<th>Regions:</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ogap:</td>
<td>Tosiyorino obaasan-ga basutei-made miokutta elderly woman-Nom bus stop-to accompanied</td>
</tr>
<tr>
<td>Sgap:</td>
<td>Tosiyorino obaasan-o basutei-made miokutta elderly woman-Acc bus stop-to accompanied</td>
</tr>
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<table>
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<tr>
<th>Regions:</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrix clause:</td>
<td>onnanoko-wa nuigurumi-o daiteita. girl-Top stuffed-toy-Acc hugging</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ogap: ‘The girl that the elderly woman accompanied to the bus stop was holding a stuffed toy.’

Sgap: ‘The girl that accompanied the elderly woman to the bus stop was holding a stuffed toy.’
Test items were distributed into two lists according to a Latin Square design and were shown with 76 filler items in pseudo-random order so that at least one filler intervened between two consecutive test items.

### 3.2. Norming study

In order to guarantee that both types of relative clauses are equally plausible, 32 native speakers of Japanese rated sentences created by replacing the gap in each relative clause with the corresponding head noun. For example, for the relative clauses in Table 1, the sentences in (4) were created.

(4) a. Sentence created from the Ogap condition
   "Tosiyorino obaasan-ga onnanoko-o basutei-made
    elderly woman-Nom girl-Acc bus stop-to
   miokutta.
   accompanied
   ‘The elderly woman accompanied the girl to the bus stop.’

b. Sentence created from the Sgap condition
   "Onnanoko-ga tosiyorino obaasan-o basutei-made
    girl-Nom elderly woman-Acc bus stop-to
   miokutta.
   accompanied
   ‘The girl accompanied the elderly woman to the bus stop.’

Participants saw one sentence from each pair and rated it on a scale from ‘1’ (natural) to ‘5’ (strange). Ratings for the Sgap (1.89) and the Ogap sentences (1.77) did not differ ($F_1(1, 31) = 1.96$, $P < 0.18$; $F_2 < 1$). Thus, the relative clauses in the main experiment are assumed to be equally natural.

### 3.3. Participants

Twenty-four native speakers of Japanese participated in the experiment for financial compensation. They were members of the Nara Institute of Science and Technology (NAIST) community and had not taken part in the norming study.

### 3.4. Procedure

The experiment was conducted with PsyScope (Cohen et al. 1993) running on Macintosh computers with a button-box. The self-paced reading moving-window program presented sentences one region at a time on a single line in a non-cumulative fashion (Just et al. 1982) using the uniform-width
A yes-no question was presented after each item. Items were distributed in two blocks with equal number of items. Each block was preceded by one screen of instructions and eight practice trials. Because the test sentences were relatively simple, a secondary task, in which participants articulated a nonsense syllable (ru or ne), was included in one of the blocks in order to avoid a ceiling effect. The order of the tasks (with articulation or in silence) was counterbalanced across participants.

Reading time analyses only included the items for which the participant answered the comprehension question correctly. The reading time data were trimmed so that data points beyond four standard deviations from the relevant condition × region cell mean were discarded, which corresponded to less than 1% of the data.

3.5. Results: Comprehension performance

Comprehension performance as measured by the yes-no question (Articulation/Sgap, 88%; Articulation/Ogap, 80%; Silence/Sgap, 94%; Silence/Ogap, 89%) was affected both by gap position (better for Sgaps, \( F_1(1,23) = 18.17, P < 0.01; F_2(1,31) = 3.84, P = 0.059 \)) and task (better in silence than with simultaneous articulation, \( F_1(1,23) = 7.23, P < 0.05; F_2(1,31) = 11.31, P < 0.01 \)). There was no interaction (\( F_1 s < 0.5 \)).

3.6. Results: Reading times

See Figure 1 for the reading times for the matrix clause regions (the first region with the relative clause took between 3,440 ms and 3,914 ms and is not shown). There was no interaction between task and gap position in any of the regions (all \( F_1 s < 1 \)). In region 1 (the relative clause region), Sgaps were slower than Ogaps but the difference was not statistically reliable (\( F_1(1,23)=3.59, P = 0.07; F_2(1,31)=1.76, P = 0.19 \)). This result contrasts with the prediction that clauses with missing subjects are easier to process because subjects are more commonly dropped than objects. Another related prediction is that because dropped objects are infrequent, a missing object in a clause could be an early indicator that a relative clause (not a matrix clause) is being processed, and this should facilitate processing at the head noun. This prediction is not confirmed either, given the results in the next region.

In the critical region (region 2; the head noun), Ogaps were slower than Sgaps (\( F_1(1,23)=6.01, P < 0.05; F_2(1,31)=6.22, P < 0.05 \)).

In the last two regions (the main clause), there was no difference between the two types of gaps (\( F_1 s < 1 \)) whereas the articulated conditions were slower than the silent conditions (\( P_1 s < 0.01 \)).
3.7. Discussion

The slowdown at the head noun indicates that relative clauses with Sgaps are easier to process than relative clauses with Ogaps. However, it is unclear whether the difference is due to inherent properties of the two types of gaps or to interference by the topic marker on the head noun. Previous findings indicate a preference for a parallelism to hold between gap and filler. The parallelism has been expressed in terms of a preference for coindexed constituents to have the same grammatical function (Sheldon 1974) or to keep the perspective (roughly, the subject) constant across clauses (MacWhinney 1982). Because topic markers are preferentially interpreted as subjects, we may have inadvertently favored Sgaps. To address this concern, we conducted a second experiment in which we varied the particle on the head noun.

The lack of interaction between gap position and task (silent or articulated) indicates that even without extra memory load, the reading task is sensitive enough to detect differences between the two types of gaps. Therefore, the secondary task was eliminated in the next experiment.

4. Experiment 2

In this experiment, we provide evidence that the Sgap advantage is observable even when the head noun is not a matrix subject.
4.1. Participants

Twenty-eight native speakers from the NAIST community participated in the experiment for financial compensation. None of them had participated in the previous experiment or in the norming study. Four participants’ data were eliminated because their comprehension performance was below 70%.

4.2. Materials

Thirty sets of items were created. The two types of relative clauses used are exemplified on the top half of Table 2 (regions 1 to 4). There were three types of matrix clauses (regions 5 to 6) depending on whether the particle of the head noun was topic, nominative or accusative. The two relative clauses were crossed with the three matrix clauses in a two by three design.

<table>
<thead>
<tr>
<th>Relative clauses:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tosiyorino obaasan-(-ga, -o) basutei-made miokutta elderly woman-(-Nom, -Acc) bus stop-to accompanied</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ogap: ‘the girl that the elderly woman accompanied’
Sgap: ‘the girl that accompanied the elderly woman’

<table>
<thead>
<tr>
<th>Regions:</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matrix clause (Top):</td>
<td>onnanoko-wa</td>
<td>nuigurumi-o</td>
<td>daiteita.</td>
</tr>
<tr>
<td>Matrix clause (Nom):</td>
<td>onnanoko-ga</td>
<td>nuigurumi-o</td>
<td>daiteita.</td>
</tr>
<tr>
<td>Matrix clause (Acc):</td>
<td>onnanoko-o</td>
<td>omawarisan-ga</td>
<td>yobitometa.</td>
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</tbody>
</table>

‘Topic/nominative: ‘The girl [relative clause] was holding a stuffed toy.’
Accusative: ‘The policeman stopped the girl [relative clause].’

Thirty relative clauses from Experiment 1 were used. One set of items was eliminated from further analysis because participants answered its comprehension question correctly 46% of the time (for the other sets, $M = 89\%$, $SD = 18\%$). For the remaining 29 sets, plausibility of the two types of relative clauses did not differ (Sgaps 1.91, Ogaps 1.79; $F_1(1,31) = 1.35$, $P > 0.25$; $F_2(1,28) < 1$).
4.3. Procedure

The procedure was the same as in Experiment 1, except that all sentences were read in silence in a single block. Each participant saw one Latin Square list with 60 fillers in pseudo-random order. The data were trimmed as in the previous experiment, and less than 1% of the data points were eliminated.

4.4. Results: Comprehension performance

In the comprehension task, the accusative conditions were answered less accurately (83%) than the topic conditions (93%; $P < 0.01$) and the nominative conditions (91%, $P < 0.05$). Sgaps and Ogaps did not differ ($F < 1.1$). There was no interaction between gap type and the particle of the head noun ($F < 0.5$).

4.5. Results: Reading times

Reading times per region are shown in Figure 2.

![Figure 2](image-url)

Figure 2  Experiment 2: reading times and standard errors per region

In region 1 (the modifier *elderly*), apart from the topic condition with Ogap, the other conditions did not differ ($F < 1.1$). Slow reading times in the Top/Ogap condition must have been due to noise given that the same word was read in all conditions. The slowdown does not seem to have affected the
critical regions and will be ignored in the remaining discussion. This type of 
spurious slowdown sometimes occurs in the first region because participants 
rest instead of reading the new sentence.

There were no reliable differences in regions 2 to 4 inside the relative 
clause. In particular, Sgap and Ogap conditions did not differ ($P_s > 0.16$).

In region 5 (the noun girl), the Ogap conditions were slower than the 
Sgap conditions ($F_1(1,23) = 16.97, P < 0.01$; $F_2(1,28) = 10.5, P < 0.01$). 
As for the particles, nominative conditions were slower than the topic condi-
tions ($P_s < 0.01$). There was an interaction between gap type and particle 
($F_1(2.46) = 6.81, P < 0.01$; $F_2(2,56) = 6.58, P < 0.01$). That was primarily 
because of the slowdown in the Nom/Ogap condition. With the nominative 
conditions excluded, the interaction particle (Acc × Top) and gap is not re-
liable ($F_1(1,23) = 2.8, P = 0.11$; $F_2(1,28) < 1.1$). The advantage of Sgaps 
over Ogaps was reliable in the nominative and in the topic conditions (all 
$P_s < 0.05$) but not in the accusative conditions ($F_s < 0.5$).

In region 6, Ogaps were slower than Sgaps in the participant analysis 
($F_1(1,23) = 10.50, P < 0.01$; $F_2(1,28) = 3.75, P = 0.063$). The accusative 
conditions were slower than the nominative and the topic conditions (all $P_s < 
0.01$). There was no interaction ($F_s < 1.5$). In region 7 (the matrix predicate), 
Ogaps were slower than Sgaps ($F_1(1,23) = 10.02, P < 0.01$; $F_2(1,28) = 6.14, P < 0.05$). The topic conditions were faster than the accusative and the 
nominative conditions ($P_s < 0.01$). There was no interaction ($F_s < 1$).

4.6. Discussion

Results at the head noun and the following regions confirm that Sgaps 
are generally faster than Ogaps. Although we see interference of particle 
type (especially in the Nom/Ogap condition, but also to lesser extent in the 
Acc/Sgap compared to the other Sgap conditions), its effect seems to be re-
stricted to the head noun position. In the last two regions, Ogaps were slower 
overall and did not interact with the particles.

The results argue against the claim that the Sgap preference is a paral-
lelism preference (Sheldon 1974). If it were so, Ogaps should have been 
 Faster than Sgaps when the head noun was marked accusative. Similarly, 
the subjects of the two clauses are not the same in either of the two accusative 
conditions; thus, a preference to hold the subject constant (MacWhinney 
1982) is unlikely to explain the advantage for the Acc/Sgap condition.

5. General discussion

Linear distance between filler and gap correctly predicts ease of processing 
for Sgaps in postnominal relative clauses (e.g., in English) as well as 
for Ogaps in prenominal relative clauses in Chinese. However, it incorrectly
predicts Sgaps in prenominal relative clauses in Japanese to be harder. The following discusses alternative metrics.

5.1. Other distance metrics

Distance metrics vary according to two factors. One involves the entities counted. For example, instead of number of words, one can count the number of intervening discourse entities (Warren and Gibson 2002). Structural metrics use tree structures and count for example number of nodes (e.g., Hawkins 1999; O’Grady 1997). One can also incorporate linear and structural measures (Hawkins 1994 adopts a ratio of the two).

Second, one can reconsider the endpoints (i.e., the points whose distance is to be measured) and, instead of gap to filler, adopt the distance between gap and null operator (or its equivalent in Kayne 1994) in Spec/CP. This does not change the predictions of structural metrics, but it does affect the predictions of linear metrics for prenominal relative clauses as in (5a), given that Sgaps are linearly closer to the null operator and Ogaps to the head noun.

(5) a. Prenominal relative clause (Spec/CP to the left): \[ Op \quad [\_ \, \_] \quad N \]

b. Prenominal relative clause (Spec/CP to the right): \[ \_ \, \_ \quad Op \quad N \]

c. Postnominal relative clause: \[ N \quad Op \quad [\_ \, \_] \]

In Japanese, the null operator is sometimes assumed to be to the right of the complementizer (e.g., Watanabe 1992) as in (5b); then, both the null operator and the head noun are closer to Ogaps. For postnominal relative clauses as in (5c), Sgaps are linearly closer to both the head noun and the null operator.

All those different metrics correctly predict that postnominal relative clauses with Sgaps are easier to process. Therefore, results from other languages are critical in order to differentiate their predictions (see Table 3).

Table 3 does not include the structural metric proposed by Hawkins (1999), which counts the number of nodes in the path between the filler and the subcategorizer of the gap. Ogap paths always include the subject because objects are claimed to be syntactically and semantically dependent on the subject. Hence, Ogap paths are longer than Sgap paths regardless of the
Table 3 Empirical results (first row, in italics) and predictions by different metrics (incorrect predictions are shown in parentheses)

<table>
<thead>
<tr>
<th></th>
<th>Postnominal RCs</th>
<th>Prenominal RCs</th>
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<tbody>
<tr>
<td></td>
<td>English</td>
<td>Chinese</td>
</tr>
<tr>
<td>Empirical</td>
<td>Sgap</td>
<td>Ogap</td>
</tr>
<tr>
<td>Structural</td>
<td>Sgap</td>
<td>(Sgap)</td>
</tr>
<tr>
<td>Linear, gap to filler</td>
<td>Sgap</td>
<td>Ogap</td>
</tr>
<tr>
<td>Linear, gap to Spec</td>
<td>Sgap</td>
<td>(Sgap)</td>
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<td></td>
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</table>

language. This does not only make the wrong prediction for Chinese, but its justification is also doubtful given that subjects depend on objects in order to receive their thematic role (Marantz 1984). For Japanese, Hawkins (1999) also requires the object to be part of Sgap paths as it disambiguates the gap position. This, however, blurs the predictions for Japanese gaps as the length of their paths becomes virtually the same.

5.2. Delay in pro-insertion

As suggested to us by Colin Phillips, one way of explaining why linear distance makes the incorrect prediction for Japanese is to propose that the insertion of empty argument positions is delayed in this language. This is certainly true for object positions. In the Ogap construction in (2a), it is only accompanied that readers know for sure that an object is missing (until then, an intransitive construction could be assumed). Hence, representation for the missing object (e.g., a pro) is only created at the verb. In contrast, we have tacitly assumed that the insertion of empty subject positions is not delayed because as soon as readers process the accusative NP, it should be clear that the subject is missing and a pro may be inserted before the verb is seen as in (6).

(6) pro tosiyorino obaasan-o
elderly woman-Acc

However, readers could assume that the subject was not dropped, but rather that the accusative NP was scrambled and, thus, the subject is upcoming as in (7a). It is only at the verb that readers will know for sure that the subject was dropped, rather than scrambled, and only then may they insert pro as in (7b).
The exact point when the empty argument position is inserted is critical. If we assume that mental representations decay with time, then linear distance is important because it indicates by how much a representation has decayed since its creation. However, if empty argument positions in Japanese are all created at the verb, then they will have decayed the same amount by the time the filler is reached. As a consequence, linear distance will not reflect the amount of decay involved in this case. (Assuming that word order in Chinese is SVO, Sgaps should be created earlier than Ogaps in this language, and distance correctly predicts Ogaps to be easier.)

The question then is whether sentence-initial accusative objects are commonly followed by a subject as suggested in (7a). A frequency count using sentences from the Mainichi Shinbun, a daily Japanese newspaper (Kyoto University Corpus 3.0 2002), suggests that such sequences are rare. A total of 38,383 sentences were automatically checked. There were 4,621 occurrences of a sentence initial accusative marked constituent; of those, only 84 (less than 2%) were scrambled, and the remaining 98% involved a missing subject. Thus, if corpus frequencies reflect preferences during reading, there should be a strong bias to favor the subject drop interpretation. Along with the assumption that parsing decisions are implemented without delay, readers should insert a pro in subject position as soon as they see the accusative NP as in (6). Consequently, delay should not apply for empty subject positions, and linear distance should still predict Sgaps to be harder than Ogaps in Japanese.

It may be objected that newspapers provide contextual support for subject omission, whereas the sentences in the reading experiment were shown in isolation. However, the scrambling interpretation would also be more natural if it was preceded by context. Furthermore, given the magnitude of the bias in favor of omission, it is unlikely that relative frequencies would be reversed in the absence of context. However, this is an issue that needs to be explored further.

5.3. Gaps in Japanese relative clauses

It has been suggested that gaps in relative clauses in Japanese are not represented by a trace left by movement but rather by the null pronoun pro (Murasugi 2000; and references therein). Hence, when building the relative clause structure at the head noun, linear distance may not be important be-
cause it is a cataphoric relation that is being created between the filler and the gap. Therefore, the phenomena in Japanese may fall outside the scope of linear gap-filler distance and is explained by independent factors such as prominence and accessibility (e.g., Keenan and Comrie 1977).

6. Conclusion

Two self-paced reading experiments were reported providing evidence that relative clauses with subject gaps are easier to understand than their equally-plausible counterparts with object gaps in Japanese. The result holds even if the particle on the head noun favors the object gap interpretation. The result is problematic for models that use linear distance between filler and gap to explain similar asymmetries in other languages, and we have suggested that this may be resolved by adopting proposals in which gaps in relative clauses in Japanese are represented with *pro*.

References


