Working memory fails to explain subject-extraction advantages
(and object-extraction advantages) in relative clauses in Japanese

Edson T. MIYAMOTO (University of Tsukuba)

Abstract
For some 40 years, working-memory factors have been used to explain difficulty in the processing of relative clauses. This paper discusses results that working-memory models fail to explain. In particular, Japanese and other similar languages have consistently challenged the predictions of working-memory models. One possibility is that working-memory effects are only observed while verbatim content remains stored. After closure takes place, processing difficulty is dictated by the complexity of associating the embedded clause with the modified noun.

1 Introduction
Relative clauses (RCs) are interesting because they add complexity to sentences, thus imposing strains on cognitive resources during comprehension. For example, they often interrupt the main statement of the sentence (thus incomplete bits of the matrix clause must be retrieved after the RC is processed). For some 40 years, working-memory factors have been used to explain the comprehension of relative clauses (RCs) as in (1) (Wanner & Maratsos, 1978; King & Just, 1991; Gibson, 1998).

(1) a. Subject-extracted RC (SRC): the man that △ saw Mary

b. Object-extracted RC (ORC): the man that Mary saw △

(The marker △ indicates the position from which the modified noun man was extracted.)

As soon as people read (or hear) the modified noun and the relativizer in English (e.g., the man that), it is clear that the fragment will continue as an RC, thus leading to the expectation that an extraction position will follow and will have to be associated with the modified noun. Keeping track of this pending dependency has been argued to increase memory load. Moreover, this dependency is longer in ORCs (as indicated with arrows in the examples), therefore reading times are correctly predicted to be slower for ORCs than for SRCs (Wanner & Maratsos, 1978; King & Just, 1991; Gibson, 1998; inter alia).

However, in languages such as Japanese (Miyamoto & Nakamura, 2003; Ueno & Garnsey, 2008; inter alia; also, Korean, Kwon et al., 2010), this prediction has been consistently challenged as SRCs are easier to comprehend even though their dependencies are longer than those for ORCs, as shown in (2).

(2) a. SRC: △ Sato-kun-o aisiteita onnanoko (“the girl who loved Sato”)

b. ORC: Sato-kun-ga △ aisiteita onnanoko (“the girl who Sato loved”)

A second type of explanation is provided by expectation-based models according to which ORCs are harder to understand because they have more competing alternatives (Gennari & MacDonald, 2008, 2009; Levy, 2008). Some versions of expectation-based models also assume that SRCs are facilitated by its word order. The order of the content words in SRCs is subject-verb-object, which is also the base word order in simple clauses (e.g., the man saw Mary). The high frequency of SVO in English is predicted to facilitate the processing of SRCs (MacDonald & Christiansen, 2002). This requires ignoring the relativizer (e.g., that, who), but most crucially it assumes that the processing of RCs can be reduced
to the processing of simple clauses and in particular to the processing of propositional content (i.e., who did what to whom). But expectation fails to explain the SRC advantage in Japanese for L1 as well as L2 readers (in this volume, see: Miyamoto & Tsujino, 2016; Tsujino & Miyamoto, 2016).

A third way of explaining the relative difficulty in processing ORCs is to assume that there is some inherent complexity in their meaning (e.g., Keenan & Comrie, 1977; also Kuno, 1976, for related discussion for Japanese). One way of making this more precise is by looking at transitive verbs. Although transitive verbs are binary functions, the two arguments are asymmetrical in that the verb holds a closer relation with the object (Tomlin, 1986). This is reflected in proposals in which the transitive verb takes the object as its single argument to yield a one-place predicate, which in turn takes the subject as its argument (Marantz, 1984). Therefore, the verb alone assigns a thematic role to the object, but the verb and the object together assign a role to the subject. This kind of staggered role assignment explains a range of phenomena, including why the role of the subject is dependent on the type of object chosen, but the role of the object is largely independent of the subject chosen. This leads to an object-before-subject (ObS) preference in processing as SRCs have more straightforward role assignments than ORCs (see Figure 1; for further discussions, see Miyamoto & Nakamura, 2012; Nakamura & Miyamoto, 2013).

![Figure 1: Order of semantic-role assignment in SRCs (left) and ORCs (right) in Japanese](image)

2 When ORCs are easier than SRCs

Animacy contrasts have been shown to eliminate the SRC advantage (in Dutch: Mak, Vonk & Schriefers, 2002; in English: Traxler, Moris & Seely, 2002). But when only animate nouns are involved, SRCs have been found to be consistently easier than ORCs (see Table 1).

<table>
<thead>
<tr>
<th></th>
<th>SVO</th>
<th>SOV</th>
</tr>
</thead>
<tbody>
<tr>
<td>postnominal RC</td>
<td>SRC (English, French)</td>
<td>SRC (Dutch, German)</td>
</tr>
<tr>
<td>prenominal RC</td>
<td>ORC (Chinese)</td>
<td>SRC (Japanese, Korean)</td>
</tr>
</tbody>
</table>

The exception is Chinese where SRCs have been found to be harder locally (around the modified noun; Hsiao & Gibson, 2003; Gibson & Wu, 2013; Lin & Garnsey, 2011; inter alia; also Law, 2000, for aphasia patients; see Lin & Bever, 2011, on ambiguity issues that may have invalidated earlier results that found SRCs to be faster; also Lin, 2010, on potential problems with the contexts used by Gibson & Wu, 2013). However, SRCs have been found to be more frequent in corpora (e.g., Wu, Kaiser, & Andersen, 2011). One possibility is that working memory has a local effect but other factors (e.g., the ObS) favor SRCs in later stages as semantic processing takes place. A few studies have reported such reversals with an initial advantage for ORCs and a later facilitation for SRCs (Packard, Ye, & Zhou, 2011; Mansbridge, Kiong & Tamaoka, 2014). Crucially, there have been no reports of an initial advantage for SRCs followed by an advantage for ORCs.

2.1 Relative clauses with dropped argument

Another construction in which SRCs have been found to be harder is RCs with a dropped argument in Japanese (Nakamura & Miyamoto, 2013).
The modified noun is read faster when it is the object as in (3a) rather than the subject as in (3b). According to the ObS, this is because it is easier to interpret the RC if the object is specified first, before the subject. In (3a), the subject remains unspecified until later in the sentence; whereas in (3b) the subject is specified but the object remains unknown.

Working memory factors predict no difference in this case given that the amount of overt material intervening is the same in the two types of RCs.

2.2 Why working memory fails

Looking at Table 1, it is clear why Chinese and related languages have drawn so much interest in recent years as they are the only languages to display an ORC preference. However, from the point of view of working memory, the results for languages such as Japanese are the more interesting ones because these are the only languages that violate working-memory predictions. One possibility is that in such consistently head-final languages, closure (Frazier & Fodor, 1978, and references therein) is always performed at clause end. Thus, verbatim content is flushed out of working memory freeing up space and making working-memory load effects less evident. After closure takes place and the content of the RC is shipped to semantic interpretation, associating the overall meaning of the RC to the modified noun would be the main factor involved in comprehension difficulty.

In languages with mixed word orders such as Chinese (e.g., VPs are head initial but RCs are head final) closure may be performed less consistently especially at functional words (e.g. the relativizer de in RCs), which are read rapidly, as opposed to a content word such as the verb that ends the embedded clause in RCs in Japanese. This difference may explain why closure is consistently performed at the end of the embedded clause in Japanese but less consistently in Chinese.

3 Maybe relative clauses in Japanese are not relative clauses?

RCs in Japanese and other languages have been argued not to be constrained by accessibility because these languages do not have a distinct RC construction but, rather, a general noun-modifying clause construction, such that this construction is interpreted by trying to find a semantically and pragmatically plausible relation between the modifying clause and head noun (Comrie, 2007, p. 305). However, a similar observation that RCs in Japanese only require an aboutness relation with the modified noun have reached the opposite conclusion, namely, that RCs were affected by accessibility as the aboutness relation is constrained by the accessibility hierarchy (Kuno, 1976).

Comrie may be right and the plausibility of the relation between RC and modified noun may not be directly dependent on the relativized position. But in order to determine whether a semantic relation is plausible, we must first compute the semantic relation to be able to evaluate it. The ObS suggests that the computational steps to determine the semantic relation are simpler with SRCs.

4 Conclusion

Although the status of RCs in Chinese have drawn much attention, the advantage of SRCs over ORCs in Japanese is perhaps even more intriguing as it violates working-memory based predictions, thus requiring an explanation as to why longer dependencies can be easier to process. One possibility is
that working-memory effects are only observed before closure takes place. Later effects could be driven by factors such as the ObS, involving the computation of the relation between RC and modified noun.

References


