Processing alternative word orders in Japanese

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INTRODUCTION

Word order is a crucial source of information to understand sentences. Changes in word order often lead to different propositional contents (i.e., who did what to whom; compare ‘Mary saw John.’ to ‘John saw Mary.’). In Japanese, however, the same proposition can be expressed with the exact same words in different orders as long as the verb is the last constituent of the clause. Below, two of the possible six orders of a ditransitive construction are presented.

(1) a. Canonical order
   John-ga Mary-ni ocha-o dasita.
   John-nom Mary-dat tea-acc served
   ‘John served tea to Mary.’

   b. Non-canonical order

Following generative linguistics (see Nemoto, 1999, for an overview), one word order is taken to be canonical and the remaining are assumed to contain scrambled constituents, that is, constituents that are dislocated to the left of their canonical position. As shown in (1b), a gap will be used to indicate the canonical position of the scrambled constituent, which will be surrounded with square brackets and coindexed with its gap. Canonicity captures the intuition that some orders sound more neutral, more natural, and are usually encountered more frequently in the language.

PROCESSING DIFFICULTY

Intuitively, it would seem that scrambled orders are harder to process. However, a self-paced reading study (see Just, Carpenter & Woolley, 1982, for a discussion on such techniques) comparing a ditransitive construction in canonical order to three of its scrambled versions did not detect any reading time differences (Yamashita, 1997). Scrambling has also been claimed not to affect antecedent resolution in control constructions (Sakamoto, 2002). Unfortunately, such null results, in which no statistically reliable difference is found in the critical comparisons,
are difficult to interpret because it is unclear whether there is really no difference or whether the experiment was not sensitive enough.

In other studies, reliable differences between scrambled orders and canonical orders have been found and in general they support the claim that scrambled orders are harder to understand.

For transitive constructions, Japanese readers take longer to judge whether a sentence makes sense when its order is scrambled (Chujo, 1983; Tamaoka et al., 2003). Furthermore, longer reading times for scrambled orders were reported using center-screen self-paced reading and eye-tracking methodologies with sentences like the following (Mazuka, Itoh & Kondo, 2002).

(2) a. Canonical order
   Mariko-ga ootoo-o yonda.
   Mariko-nom brother-acc called
   ‘Mariko called her brother.’

b. Non-canonical order
   [Ootoo-o] i Mariko-ga gap i yonda.

The experiment also included sentences in which the second NP in each sentence in (2) was modified by a relative clause. Longer reading times were consistently found at ‘Mariko-nom’ in the scrambled sentence compared to ‘brother-acc’ in the canonical sentence.

A non-cumulative moving-window self-paced reading experiment using ditransitive constructions (such as (1a,b)) supports Mazuka and colleagues’ conclusion that scrambled word orders are harder to process. Longer reading times were detected after the scrambled direct object (at ‘Mary-dat’ in (1b)) compared to its canonical counterpart (Miyamoto & Takahashi, 2002b, Experiment 1).

However, it is not entirely clear whether the slow reading times in these case are caused by scrambling or by some other unrelated factor such as the case markers of the NPs compared (Miyamoto & Takahashi, 2002b). Nominative subjects are particularly salient in mid-sentence in Japanese and display a number of special properties (see Miyamoto, 2002, for a summary).

Crucially, the position where the slowdowns are taking place is compatible with the claim that they are related to difficulty in processing scrambling. In (1b), the direct object is initially taken to be in its canonical position immediately after the nominative subject as in a transitive construction. The next NP ‘Mary-dat’ indicates that the upcoming predicate is more likely to be a ditransitive verb, in which case, the accusative NP must have been scrambled. Thus, the dative NP is the first point in which it is clear that the sentence involves scrambling and this is where the slow reading time was found (Miyamoto & Takahashi, 2002b). Similarly for (2b), ‘brother-acc’ is initially taken to be in its canonical position with the subject dropped (see Miyamoto & Nakamura, in press, for a frequency count supporting this assumption; also, neuroimaging results below), and it is only at ‘Mariko-nom’ that it becomes clear that the accusative NP was scrambled, and this is where the slowdown was detected by Mazuka and colleagues.

Recent Event Related Potential results support the claim that the slowdowns at those points reflect both reanalysis of the initial interpretation as well as complexity of the filler-gap dependency (Ueno & Klunder, 2003). The word immediately following a scrambled accusative-marked demonstrative elicited a P600 response, which indicates that the word (the beginning of another NP) was not expected. Furthermore, scrambling generated a sustained anterior negativity, usually associated with increased memory load.
In sum, it seems safe to conclude that scrambled orders are harder to process than canonical orders. Moreover, given that the slow reading times occur before the predicate of the clause, the data support the claim that readers are interpreting NPs together before reaching the predicate (Miyamoto, 2002, and references therein), contrary to predictions by head-driven models of parsing (e.g., Pritchett, 1991) which require a predicate to be available in order for NPs to be associated.

**SOURCES OF DIFFICULTY**

We now turn to the factors that may be behind the difficulty in understanding scrambled sentences. One possibility is that because scrambled orders are encountered less frequently than their canonical versions (Kuno, 1973, pp. 353-354; Miyamoto & Takahashi, 2002b; Yamashita, 2002), readers may be less accustomed to processing them. Clearly, frequency is not a complete answer as we would still like to know why some word orders are more frequent. In fact, even the direction of causality is not self-evident. Is a given word order easy to process because it is frequent or is it frequent because it is easy to process? Or alternatively, are frequency and processing difficulty independently caused by a third factor, and therefore no direct relation holds between the two of them?

**Filler-Gap Dependencies**

Apart from frequency, another possible factor in processing scrambling is the complexity of the mental representation. Scrambled constituents can be argued to behave like fillers that have to be associated with their gap in so-called filler-gap dependencies in order to have their semantic role determined. The processing properties of filler-gap dependencies have been extensively studied in relative clauses and fronted wh-phrases as in (3) (adapted from Crain & Fodor, 1985).

(3) [Who]\(^{\text{1}}\), did the children force us to sing the songs for gap\(^{\text{2}}\)?

The filler who generates the prediction for a gap, which readers attempt to posit as soon as possible. The gap is initially inserted immediately after force as indicated by the wedge sign. However, the next word us indicates that the position of the gap is incorrect and readers slow down in a so-called filled-gap effect (Crain & Fodor, 1985), which suggests that a required gap is created as soon as possible without waiting for confirmation from the following words.

Assume that a similar process is taking place in scrambling (Miyamoto & Takahashi, 2002a, 2002b, 2004). As soon as a constituent is found to be scrambled, a corresponding gap is inserted at the earliest possible point. For example, for (1b), the position immediately after ‘Mary-dat’ is a possible position for the direct object and a gap is inserted when this word is read.

The following sections explore two types of evidence supporting the filler-gap model for scrambling.

**Reading Times and Filler-Gap Distance**

In order to avoid comparing NPs with different case markers, sentences like the following were investigated in a non-cumulative self-paced reading experiment (Miyamoto & Takahashi, 2004).
(4) a. Scrambled (adjacent)
  Ueitoresu-wa doogu-ga okareteiru sooko-de [kokku-o]i
  waitress-top tools-nom stored storage-loc cook-acc
  rejigakari-ni gap1 shookaisita sooda.
  cashier-dat introduced seems
  ‘The waitress seems to have introduced the cook to the cashier in the storage room
  where the tools are stored.’

b. Scrambled (far)
  Ueitoresu-wa [kokku-o]i doogu-ga okareteiru sooko-de
  rejigakari-ni gap2 shookaisita sooda.

In both sentences in (4), a gap should be inserted when ‘cashier-dat’ is read. But, because
the gap is farther from its filler ‘cook-acc’ in (4b) than in (4a), longer reading times should be
detected in the former sentence (see Gibson, 1998, and references therein, for the effects of
distance on processing). This was in fact the case. There was an interaction so that ‘cashier-dat’
was read more slowly in (4b) than in (4a), but no comparable difference was found in sentences
in which the direct object was in its canonical position. Furthermore, frequencies of those
constructions in newspaper corpora do not match the pattern in the behavioral data (Miyamoto
& Takahashi, 2002b), therefore a simple frequency-based explanation is unlikely to account for
the result.

**Antecedent Priming**

Filler-gap dependencies have been investigated using another type of methodology. The
representation of words is assumed to have a level of activation, which decays over time. It has
been shown that gaps, like pronouns, reactivate or prime their antecedents. For example, when
native speakers of English were asked to decide whether a probe (such as astute in (5a,b), from
Bever & McElree, 1988) had appeared in a sentence just read, they were faster to recognize the
probe after reading (5a) than after (5b). Presumably, the gap in (5a) reactivated its antecedent
(the complex NP headed by lawyer), therefore facilitating the recognition of the probe.

(5) a. Passive construction
  [The astute lawyer who faced the female judge]i was suspected gapi constantly.

b. Adjectival construction
  The astute lawyer who faced the female judge was suspicious constantly.

Similarly, probe recognition should be facilitated by the gap of a scrambled constituent.
However, native speakers of Japanese were slower to recognize probes after reading scrambled
sentences (Nakayama, 1995, Experiment 1).

One problem with Nakayama’s study is that the word used as a probe did not occur at
comparable positions in the sentences. The probed word occurred several words later in the
canonical sentence than in the scrambled sentence, therefore it had been subjected to less decay
when participants recalled it at the end of the canonical sentence. Another experiment con-
firmed that the linear position of the probed word affects recognition times (Nakayama, 1995,
Experiment 2). When the position of the probed word is held constant across the conditions,
recognition of mondai ‘question’ is faster after reading (6a) than after (6b).
The quiet student saw the lecturer who asked the question at school.

The lecturer who asked the question at school saw the quiet student.

The result is compatible with the filler-gap model, but it is conceivable that the different propositional contents expressed by the two sentences influenced recognition times. Furthermore, the result is not very informative as it only measures the activation level at sentence end.

In another technique called cross-modal priming (Nicol & Swinney, 1989), participants listen to sentences while performing a lexical decision task (i.e., deciding whether a string of letters constitutes a word). Activation levels can be monitored in detail by showing words at various points of the sentence being attended to. Unfortunately, the methodology is controversial and has been claimed to indicate apparent reactivation even when the sentence has no gaps (McKoon & Ratcliff, 1994; but see Nakano, Felser, & Clahsen, 2002, for a study investigating reactivation in long-distance scrambling in Japanese).

DISCUSSION

Studies supporting the claim that scrambled word orders are harder to process than canonical orders were surveyed. Two types of evidence arguing for the filler-gap model for processing scrambled word orders were also presented, namely longer reading times when the gap is far from the scrambled constituent and faster recognition of a probe at sentence end.

A natural question is why scrambled constituents need to have their canonical position identified. One possibility is that only canonical positions are interpretable. In the syntax literature, constituents have been argued to be interpreted in relation to the other constituents in the clause (e.g., Hale & Keyser, 1993); therefore, scrambled constituents are not in a configuration where they can be interpreted appropriately. Another possibility is that the human conceptual system requires an isomorphic relation to hold between the order in which entities are interpreted and how the event is perceived to unfold in the real world (e.g., Suzuki et al., 1999).

Although much of the discussion focused on difficulty during reading, there are situations in which scrambling can facilitate processing. For example, scrambled orders are easier to understand if they avoid temporary ambiguities (Inoue, 1990) or if they eliminate long dependencies (Yamashita & Chang, 2001). In these cases, the assumption is that the cost of the filler-gap dependency is compensated by the complexity that scrambling avoids.

Evidence should be expanded in a number of different directions. For example, only scrambled accusative NPs were discussed, but scrambled phrases with other particles should also be considered (for scrambled dative NPs, see Aoshima, Phillips, & Weinberg, 2002). Factors such as agentivity and animacy should also be investigated (see Tamaoka et al., 2003, for the contribution of semantic roles, case and grammatical functions to canonicity).

Ditransitive constructions need further investigations. Even though it was assumed that the dative-accusative order in (1a) is canonical (Hoji, 1985; Yatsushiro, 2003), the accusative-dative
order has been claimed to be canonical as well (Miyagawa, 1997). In acquisition some results suggest that children master the dative-accusative order faster than the accusative-dative order (Sugisaki & Isobe, 2001), whereas more detailed studies counterbalancing presentation suggest the opposite (Suzuki et al., 1999). The results of a probe recognition experiment (Miyamoto & Takahashi, 2002a) were inconclusive, although favoring the dative-accusative order. One possibility is that more fine-grained classifications for ditransitive verbs (e.g., Matsuoka, 2003; Sadakane & Koizumi, 1995) need to be considered. The reading time data for the sentences in (4) may have avoided such factors because the critical comparisons were made before the verb is read.

Finally, the discussion ignored context and factors such as focus. Work on Finnish tracking participants’ eye movements over pictures while they heard sentences, suggests that difficulty in processing scrambled constituents can be ameliorated by providing appropriate context (Kaiser & Trueswell, 2002). But some evidence suggests that emphasis and saliency alone cannot explain the data on probe recognition (Miyamoto & Takahashi, 2002a, Experiment 2). A complete model of how people process sentences requires an understanding of how intra- and inter-sentential factors interact, and scrambling seems to be ideal for this kind of investigation.

REFERENCES


