Expectation driven by case-markers: Its effect on Japanese relative clause processing

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1. Introduction

Native speakers understand sentences of their own language in remarkable speed and accuracy. Recent research on human sentence processing revealed that this remarkable performance is achieved by the cognitive mechanisms that yield strong forward expectation for up-coming elements. In this research we explore the nature of cognitive mechanisms for language and the role of expectation in sentence processing through a series of experiments on relative clause processing in Japanese.

It is well known that there is a processing asymmetry between subject and object relative clauses (SRC and ORC respectively), and SRCs are easier to process than ORCs (e.g., Dutch: Frazier 1987, Mak et al. 2006, English: King & Just 1991, Traxler et al. 2002, French: Holmes & O’ Regan 1981, German: Schriefers et al. 1995). Many studies have tried to account for the processing asymmetry and they have argued that the processing load of RCs depends on the position where the relative head nouns are extracted. Based mainly on data from English, competing hypotheses have been proposed taking factors such as structural complexity or working memory load into considerations. Among them are Structural Distance Hypothesis (SDH: Hawkins 1999, O’Grady 1997) and Linear Distance Hypothesis (LDH: Gibson 1998, 2000, Tarallo & Myhill 1983).
Many researchers have examined the validity of these hypotheses through head-final languages such as Japanese and Korean (e.g., Kwon et al. 2006, Ishizuka 2005, Miyamoto & Nakamura 2003, Ueno & Garnsey 2008). Many of them confirmed that SRCs are processed easier than ORCs in head-final languages as well and the results seem to be consistent with SDH. Although recent studies in English have provided evidence for the importance of other factors in relative clause processing, such as frequency (Reali & Christiansen 2007) and animacy (Traxler et al. 2002), cross-linguistic studies on relative clause processing have mostly concentrated on Structural and Linear Distance Hypothesis so far.

Yet, there is another factor that calls for a serious attention when Japanese relative clauses are to be investigated. Japanese is a language with case particles, and there are case-marking differences between SRC and ORC. In (1a), giin “senator” is marked with the accusative marker while in (1b), giin “senator” is marked with the nominative marker.

(1) a. SRC
   
   giin-o  hihansi-ta  repootaa
   senator-ACC  attack-PAST  reporter

   “the reporter that attacked the senator …”

b. ORC
   
   giin-ga  hihansi-ta  repootaa
   senator-NOM  attack-PAST  reporter

   “the reporter that the senator attacked …”

Miyamoto & Nakamura (2005) conducted an experiment using sentence
fragment completion task and showed Japanese native speakers tend to complete sentences omitting an overt subject when only an accusative NP is presented as a sentence fragment. Then, it can be inferred that the parser would immediately predict that the nominative NP is omitted before the verb appears. On the other hand, the sentence-initial nominative NP might not provide any expectation with respect to another NP. Moreover, many researchers have repeatedly shown that case markers help the parser to construct the structure and predict the subsequent part of the sentence (Aoshima et al. 2004, Kamide et al. 2003, Miyamoto 2002, Miyamoto & Nakamura 2005, Yamashita, 1997). These considerations lead us to assume that the earlier expectation of another NP derived from case markers is responsible for the ease of processing of SRC in Japanese. We call this Case-marker Driven Expectation Hypothesis (CDEH). In this research, we compared predictions derived from CDEH to those from SDH and LDH using a sentence fragment completion experiment and two self-paced reading experiments. The result revealed that expectation driven by case-markers plays a major role in relative clause processing in Japanese.

2. Hypotheses and materials

First, we would like to introduce two major hypotheses. SDH calculates the processing load of a dependency between a gap and a relative head by the number of intervening nodes between them. In Fig. 1, less number of nodes intervenes between the filler repootaa “reporter” and the gap in SRC compared to those in ORC. As a consequence, SDH predicts that SRCs are read faster than ORCs. On the other hand, LDH calculates the processing load of a dependency between a gap and a relative head by the number of intervening words. Since less number of words intervenes between the filler and the gap in ORC
Fig. 1. Structural Distance Hypothesis

Fig. 2. Linear Distance Hypothesis

compared to those in SRC as shown in Fig. 2, LDH predicts that ORCs are read faster than SRCs.

Second, we would like to explicitly state CDEH. Previously we suggested that the processing ease of SRCs observed in previous studies can be attributed to the expectation of another NP obtained from the patterns of case markers. CDEH can thus be stated as (2).
(2) Case-marker Driven Expectation Hypothesis

The parser processes RCs with more ease if early expectation of another NP is obtained from case-marker driven expectation before it encounters the verb.¹

As we said in Introduction, the results of previous studies in Japanese supported SDH. However, CDEH is also able to capture the same results. Since the sentence initial accusative NP in SRC indicates that a nominative NP is missing in its canonical sentence-initial position, it elicits a strong expectation of another NP. On the other hand, the sentence initial nominative NP in ORC does not elicit a specific expectation for another NP. CDEH thus predicts that SRCs are processed with more ease compared to ORCs. To test CDEH against SDH, simple SRCs and ORCs that have been used in previous studies are not sufficient. SDH calculates the processing load by the number of intervening nodes. Since the gap position in SRCs is structurally higher than that of ORCs, SDH also predicts that SRCs would be processed with more ease compared to ORCs. We thus need a paradigm in which CDEH and SDH can lead to different predictions. Japanese relative clauses with a causative verb provide us with an ideal test case. An example of causative constructions is shown in (3).

(3) butyoo-ga kakarityoo-ni syain-o sikar-ase-ta.
   head-NOM chief-DAT employee-ACC scold-CAUSE-PAST
   “The head made the chief scold the employee.”

In Japanese, when the causative morpheme -sase is attached to the verb that takes an accusative NP as an argument, the causee has to be marked with a
dative case-marker. Kuno (1973) argued that the dative NP is in a structurally higher position than the accusative NP as shown in (4).

(4)  
```
(4)  
  S
  |   VP
  NP    S'
       |   V
       NP   ase-ta
       kakarityoo-ni
       chief-DAT
         |   VP
       syain-o   V
       employee-ACC  sikar
                        scold
```

Now, let us consider the relative clauses containing causative constructions. We shall call such relative clauses with a gap of DAT NP as DAT RCs, and relative clauses with a gap of accusative NP as ACC RCs, Example of DAT RCs and ACC RCs are given in (5) and (6) respectively.

(5)  DAT RC  
```
butyoo-ga  gap  syain-o  sikar-ase-ta  kakarityoo-wa …
head-NOM   employee-ACC  scold-CAUSE-PAST chief-TOP …
```

“The chief that the head made scold the employee …”

(6)  ACC RC  
```
butyoo-ga  kakarityoo-ni  gap  sikar-ase-ta  syain-wa …
head-NOM  chief-DAT  scold-CAUSE-PAST employee-TOP …
```

“The employee that the head made the chief scold …”
As shown in (6), ACC RCs start with a nominative-dative sequence. Research on Japanese sentence processing has been argued that such a sequence elicits expectation of an accusative NP (Kamide et al. 2003, Miyamoto & Nakamura 2005, Muraoka 2006). On the other hand, DAT RCs start with a nominative-accusative sequence. Such a sequence does not elicit expectation of another NP. CDEH thus predicts that ACC RCs should be read faster than DAT RCs. On the other hand, the gap position is higher in DAT RCs than in ACC RCs. Henceforth, SDH that calculates the processing load by the number of intervening nodes predicts that DAT RCs should be read faster than ACC RCs. Relative clauses containing causative constructions are useful to tease apart the predictions by CDEH from SDH.

However, if we turn our eyes to LDH, CDEH and LDH are indistinguishable in the causative construction introduced above. Because LDH calculates the processing load of relative clauses by the number of intervening words, LDH predicts that ACC RCs should be read faster than DAT RCs. In order to tease apart the predictions by LDH from those by CDEH, we have to use another type of causative constructions in Japanese. If the causative morpheme -sase is attached to the verb that takes a dative NP as an argument, the causee is marked with the accusative marker. We call this type of causatives as “O- causative”. In O-causatives, the accusative NP is structurally higher than the dative NP, and the accusative NP precedes the dative NP as the basic word order (Kuno 1973, Shibatani 1972, Tamaoka et al. 2005).²

(7) butyoo-ga sinnyuusyain-o kakarityoo-ni dookoo-sase-ta
head-NOM new employee-ACC chief-DAT accompany-CAUSE-PAST
“the head made the new employee accompany the chief.”
If a gap is posited in the position of accusative NP, the number of intervening words will be two, while if a gap is posited in the position of dative NP, the number of intervening words will be one. Thus, LDH predicts that DAT RCs should be read faster than ACC RCs. CDEH still predicts that ACC RCs should be read faster than DAT RCs, because it just concerns with expectation of another NP driven by case-particles.

3. Experiment 1

Before testing CDEH, SDH, and LDH, we checked if the sequence of nominative-dative markers indeed elicits an expectation of another NP by a sentence fragment completion experiment.

Method

Participants. 24 native speakers of Japanese participated in Experiment 1. All of them were graduate and undergraduate students of Hiroshima University.

Materials. 20 experimental materials were created. Each item involved two conditions as in (8).

(8) Experimental stimuli (NOM-DAT; NOM-ACC)

a. NOM-DAT
   sihatsu-no  sinkansen-de  butyoo-ga  kakarityoo-ni ______
   first-GEN  bullet train-by  manager-NOM  chief-DAT
b. NOM-ACC
   sihatsu-no  sinkansen-de  butyoo-ga  kakarityoo-o ______
   first-GEN  bullet train-by  manager-NOM  chief-ACC
Each target item included two case-marked NPs. One is the nominative marker, and the other is either the dative marker or the accusative marker.

We expected that participants tend to add an accusative NP and complete the sentences as three-argument structure in NOM-DAT condition while in NOM-ACC condition, they tend to complete the sentences as two-argument structure as Miyamoto & Nakamura (2005) reported (also see Kamide et al. 2003, Muraoka 2006).

Two counter-balanced lists of items were constructed. Each list contains 60 filler sentence fragments and the total number of items in each list is 80. Items were pseudo-randomized in each list.

Procedure. 80 sentence fragments were listed on paper and the participants were asked to complete them.

Results

The total number of completed sentences was 480 (240 in NOM-DAT and 240 in NOM-ACC). Because one sentence in NOM-DAT condition was ungrammatical, we excluded it from the following analyses. We classified the rest of sentences into three classes according to the kind of argument added in the completed sentences. If an accusative NP or a dative NP was added, we classified it as NP class. If a clause was added, we classified it as Clause class. On the other hand, if participants did not add any NP, we classified it as No extra NP class. The distribution of completed sentences in each condition is listed in Table 1.
Table 1. The results of Experiment 1

<table>
<thead>
<tr>
<th></th>
<th>No extra NP</th>
<th>Extra argument added</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NP</td>
</tr>
<tr>
<td>NOM-DAT</td>
<td>71</td>
<td>147</td>
</tr>
<tr>
<td>NOM-ACC</td>
<td>220</td>
<td>19</td>
</tr>
</tbody>
</table>

A chi-square test of independence was performed to test the relation between the case patterns (NOM-ACC or NOM-DAT) and what kind of extra argument (No extra NP, NP, or Clause) was added. The relation between these variables were significant ($\chi^2(2) = 279.081, p < .01$). In NOM-DAT condition, Ryan’s procedure revealed a significant difference between No extra NP and NP class ($\chi^2(1) = 5.08, p < .01$). In the NOM-ACC condition, Ryan’s procedure revealed a significant difference between No extra NP and NP class ($\chi^2(1) = 12.94, p < .01$). The main findings of this experiment was that the sentence fragments in NOM-DAT condition tended to be completed by adding an accusative NP and the sentence fragments in NOM-ACC condition tended to be completed without adding an extra NP.

Discussion

We replicated the results of previous research (Kamide et al. 2003, Miyamoto & Nakamura 2005, Muraoka 2006) and showed that the sequence of nominative-dative markers elicits the expectation of another NP while the sequence of nominative-accusative markers elicits the expectation of a verb. We have now confirmed that the sequence of nominative-dative markers and the sequence of nominative-accusative markers have different expectation of the subsequent part of the sentence. From this result we can say that the material is appropriate to test the validity between the CDEH and SDH.
4. Experiment 2

We conducted an online experiment using self-paced reading task to test CDEH and SDH.

Method

Participants. 23 native speakers of Japanese participated the experiment. All participants were graduate and undergraduate students of Hiroshima University. The experiment usually lasted about 20 min.

Materials. 30 experimental materials including two conditions were created, and an example is shown in Table 2. Materials used in Experiment 2 were identical to those used in Experiment 1 up to the second NP in the sentence.

<table>
<thead>
<tr>
<th>Table 2. Example of target materials in Experiment 2</th>
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<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>DAT RC</td>
</tr>
<tr>
<td>manager-NOM</td>
</tr>
<tr>
<td>&quot;The employee that the manager made the secretary train lost the document.&quot;</td>
</tr>
<tr>
<td>ACC RC</td>
</tr>
<tr>
<td>manager-NOM</td>
</tr>
<tr>
<td>&quot;The employee that the manager made the secretary train lost the document.&quot;</td>
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</table>

In the DAT RC condition, sentences involve a sequence of nominative-accusative markers, and in the ACC RC condition, sentences involve a sequence of nominative-dative markers.

SDH predicts that the relative head noun, syain “employee” in the DAT RCs will be read faster than the same part in the ACC RCs, while LDH predicts
that ACC RCs will be read faster. CDEH predicts that ACC RCs will be read faster at the relative head noun, because they have a sequence of nominative-dative NPs that elicit an expectation of another NP while DAT RCs have a sequence of nominative-accusative NPs that elicit an expectation of a verb.

Norming. We conducted a norming survey in order to exclude semantic bias in the stimuli. Since the DAT RC condition contains an accusative NP with patient thematic role and the ACC RC condition contains a dative NP with agent (or causee) thematic role, we made sure that the NP does not have a bias towards either patient or agent of the action denoted by the embedded verb. We extracted Causee NP and Patient NP in each condition from experimental stimuli and created two counter-balanced lists of declarative sentences. 20 native speakers of Japanese participated were told to evaluate the semantic naturalness of each sentence with a scale ranging from 1 to 5 (1: not natural, 5: very natural). Semantic bias was found in 9 target stimuli ($p < .05$) and they were removed from the material.

Procedure. The sentences were presented on a computer monitor using non-cumulative, word-by-word, self-paced reading (Just et al. 1982). The experiment was run on a laptop computer using Linger 2.94 (developed by Dough Rohde). Each trial started with an image of the sentence in which dashes replaced all the printed characters. Participants pressed the spacebar to reveal each new word, causing the preceding word to revert to dashes. At the end of the sentence, participants answered a comprehension question by pushing “f” for Yes and “j” for No. Participants were encouraged to read as naturally as possible and to answer the questions according to their first impulse.
Results

The data from five participants who missed more than 30% of the comprehension questions (of the target stimuli) were removed from the analysis. The data from one target item were also removed from the analysis because its comprehension accuracy was 50%. The mean accuracy of the remaining participants was 83% (DAT-RC: 69%; ACC-RC: 93%), and there was reliable difference between two conditions ($F_1(1,17) = 19.73, p < .01; F_2(1,19) = 9.20, p < .01$). Before analyzing the reading times, we discarded the data whose reading times exceeded 3500ms in each region. Fig 3 illustrates the mean reading times of each region. Our region of interest is Region 4, which is the relative head noun.

There were no significant main effects in Regions 1 to 3. At Region 4, there was a significant main effect of RC type ($F_1(1,17) = 8.95, p < .01; F_2 (1,19) = 4.38, p < .05$). At Regions 5 and 6, was no significant main effect. The main finding of this experiment was that the reading times of ACC RCs were
significantly faster than those of DAT RCs at Region 4.

Discussion
The results were consistent with CDEH’s prediction, because the head-noun of ACC RCs was read faster than that of DAT RCs. On the other hand SDH cannot explain the increased reading times in DAT RCs at Region 4, because it predicts that the head-noun of DAT RCs should be read faster than that of ACC RCs. This indicates that the expectation of another NP might be responsible for the increased reading times. However, there is still another possible interpretation for the results. LDH can capture the results. Since LDH calculates the processing load of relative clauses using the number of intervening words and the number of intervening words between the head-noun and its gap is smaller in ACC RCs than that of DAT RCs, it predicts that the head-noun of ACC RCs should be read faster than that of DAT RCs as CDEH does. In the following experiment, we aimed to distinguish CDEH and LDH using O-causatives.

5. Experiment 3

In order to test CDEH against LDH, we conducted a self-paced reading experiment using O-causative construction.

Method
Participants. 33 native speakers of Japanese participated in the experiment. All participants were graduate and undergraduate students of Hiroshima University. The experiment usually lasted about 20 min.

Materials. 30 experimental materials were created. An example of experimental stimuli is presented in Table 3. From Region 1 to 3, the presented words were
completely identical across conditions.

<table>
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<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>kiremono-no</td>
<td>kakarityoo-o</td>
<td>dookoo-sase-ta</td>
</tr>
<tr>
<td>5</td>
<td>densya-de</td>
<td>head-ACC</td>
<td>sinnyusyain-wa</td>
</tr>
<tr>
<td>6</td>
<td>butyoo-ga</td>
<td>accompany-CAUS-PAST</td>
<td>syorui-o</td>
</tr>
<tr>
<td>7</td>
<td>head-NOM</td>
<td>new employee-TOP</td>
<td>wasureta.</td>
</tr>
<tr>
<td>8</td>
<td>&quot;The new employee that the head made the clever head accompany by the first train forgot the document.&quot;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>ACC RC</td>
<td>new employee-TOP</td>
<td>document-ACC</td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>ACC RC</td>
<td>new employee-TOP</td>
<td>document-ACC</td>
</tr>
</tbody>
</table>

Each item included two conditions as in Table 3. In the DAT RC condition, relative clauses contained the sequence of nominative-accusative NP so that the sequence elicited the expectation of a verb. In the ACC RC condition, relative clauses contained the sequence of nominative-dative NP so that the sequence elicited the expectation of an accusative NP. CDEH predicts that ACC RCs should be read faster than DAT RCs. On the other hand, LDH calculates the processing load of relative clauses by the number of intervening words. In the DAT RC condition, the number of intervening words between a gap and its filler is 1, while in the ACC RC condition, the number of intervening words is 2. LDH predicts that DAT RCs should be read faster.

Norming. Before the experiment, we conducted two norming surveys. Since Japanese $O$-causative construction is not so frequent and there is a concern that readers might be confused with $NI$-causative construction, we first conducted a preliminary norming survey in order to make sure that readers regard the material as $O$-causative construction. We constructed two counter-balanced lists.
that contain 30 sentences in $O$-causative construction and 42 fillers. Participants were presented the list and multiple-choice questions asking the agent of the action (i.e., causee) denoted by the verb in the causative predicates. The agent has to be an accusative NP if the materials are judged as $O$-causative as intended. As a result, six items were removed and 24 remaining items were used in the second norming survey. In the second survey, we aimed to exclude items with semantic bias as we did in the norming survey in Experiment 2. Eighteen items were selected as target stimuli for Experiment 3.

**Procedure.** The procedure of Experiment 3 was completely same as that of Experiment 2.

**Results**

The data from five participants who missed more than 50% of the comprehension questions of target stimuli and the data from one item whose comprehension accuracy was 33% were removed from the analysis. The mean accuracy of the remaining participants was 64.1% (DAT-RC: 63.6%; ACC-RC: 64.5%), and there was no reliable difference between two conditions ($F$s < 1). Before analyzing the reading times, we discarded the data exceeding 3600ms.

Fig. 4 indicates the mean reading times for each region. Our region of interest is Region 7, which was the relative head noun. At Region 1, a main effect was observed only in the item analysis ($F_1 (1, 27) = 0.39, p > .50$; $F_2 (1, 16) = 6.73, p < .05$). There were no significant main effects in Region 2 to 6. At Region 7, a main effect of RC type was observed ($F_1 (1,27) = 4.99, p < .05$; $F_2 (1,16) = 7.10, p < .05$). At Region 8, there was no reliable difference between conditions. At Region 9, the main effect of RC type was marginally significant only in the subject analysis ($F_1 (1,27) = 3.122, p < .10$; $F_2 (1,16) = 1.92, p > .18$).
The main finding of this experiment was that the reading times of ACC RCs were significantly faster than those of DAT RCs at Region 7.

Discussion

The mean accuracy was low in this experiment (64.1%). As we mentioned before, O-causatives were very rare in Japanese and this might make the interpretation very difficult for participants. The results of reading times are consistent with the prediction of CDEH, because the head-noun of ACC RCs was read faster than that of DAT RCs as in Experiment 2. On the other hand, LDH cannot explain the results, because it predicts that DAT RCs should be read faster than ACC RCs. This indicates that the linear distance between the head-noun of RC and its gap-site is not the main source for the processing asymmetry.
6. General Discussion

We tested CDEH through three experiments against two major hypotheses, SDH and LDH. The results of Experiment 1 showed that the sequence of nominative-dative markers elicits the expectation of another NP while the sequence of nominative-accusative markers does not. This result is consistent with previous studies (Kamide et al. 2003, Miyamoto & Nakamura 2005, Muraoka 2006). In Experiment 2, we found that SDH could not capture the results while CDEH could. And in Experiment 3, we found that LDH could not capture the results while CDEH could. Overall results indicate that CDEH can capture the entire results in this study while SDH and LDH cannot.

In the previous studies SDH or LDH has been considered as main factor for the processing difficulty of relative clauses in Japanese. We can say that our study clearly showed that, an expectation of an additional NP that is driven by case markers is the most influential factor for relative clause processing in Japanese rather than structural or linear distance between the filler and the gap.

 Needless to say, this study is not the first one that says expectation is an important factor for the processing difficulty of relative clauses in Japanese. For example, Ishizuka (2005) has already argued that sentence initial accusative noun elicits an expectation of a relative clause construction rather than a main clause, whereas sentence initial nominative NP does not elicit such expectation. Thus, processing asymmetry between SRCs and ORCs may be due to this expectation difference. In this sense, we can say that our study supports the view that takes the expectation as an important factor for the processing difficulty of relative clauses. Ishizuka (2005), however, does not explain why the sentence initial accusative NP elicits an expectation for a relative clause. The results of Experiment 1 showed that, just given a sequence of either NOM-ACC or
NOM-DAT, NPs, no particular expectation of a relative clause is elicited. Nevertheless, ACC RCs were processed faster than DAT RCs. These results support the another NP expectation view rather than the relative clause construction expectation view (Ishizuka 2005).

One may think that the relationship between an expectation of another NP and the processing ease in relative clauses is not so straightforward. We suggest that the existence of an expectation of another NP might initiate the gap finding process. In DAT RCs, the sequence of nominative-accusative markers does not elicit an expectation of a dative NP and the verb argument structure information is the only source for finding and positing a gap. On the other hand, in ACC RCs, the sequence of nominative-dative markers elicits an expectation of an accusative NP and this might help the parser to construct the temporary structure with a gap before arriving at the verb position. This might accelerate the process of constructing a filler-gap dependency, and reduce the processing load of relative clauses.

Overall results showed that CDEH could capture the processing load of relative clauses in Japanese. It is without saying that structural factors do not have any effects on sentence processing in Japanese. Nevertheless, in the present research, the effects of those factors might have been surpassed by the expectation of another NP driven by case markers in Japanese which has stronger impact on relative clause processing.

7. Conclusion

The series of experiments in this paper shows that SDH and LDH are not sufficient to explain the results, and the expectation that comes from case markers has a major impact on relative clause processing in Japanese. Different
languages have different characteristics and those characteristics cause different temporary ambiguous structures. The parser has to resolve them in various ways and various points in online sentence processing. Language specific characteristics such as case-markers should be taken into consideration as much as universal characteristics such as working memory load or structural complexity, in order to deepen our understanding of the nature of the human sentence parser.

Notes
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1 Although the expectation of an additional NP is derived from case-markers in CDEH, such expectation can be elicited by different cues in typologically different languages. In Japanese, case-markers happen to work as one of the cues that elicit an expectation. We can independently state what elicits such expectations.

2 Tamaoka et al. (2005) showed that the basic word order in O-causatives is nominative-accusative-dative using whole sentence reading experiments.
References


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