Interpretation of Zero Pronouns in Japanese Discourse in a Computational Model of Centering

Kazuhiro MOGI†, Wataru NAKAMURA†, Shigeru SATO† and Hiroyuki NISHINA††
†Tohoku University ††Saitama University

1. Introduction

It is well-known that pronouns referring to speakers/hearers or discourse topics often fail to be realized overtly in Japanese discourse. This explains why there are numerous sentences with more than one zero pronoun. The aim of this paper is to show how to identify antecedents of zero pronouns in Japanese conversations within the framework of Centering Theory [CT] (Grosz, Joshi, and Weinstein 1983, 1995).

CT is a model of discourse comprehension with a particular focus on inter-sentential pronoun resolution. Gordon, Grosz, and Gilliom (1993), for example, argues on the basis of a series of experiments conducted on English speakers that a referent which serves as the focus of attention in each utterance (which is defined here as a clause with a predicate) is most likely to be realized as syntactic subject. This paper aims to extend Gordon et al.’s (1993) analysis of English written discourse to naturally-occurring dialogues in Japanese, a domain which has received much less attention than Japanese written discourse in the previous CT literature (Iida 1996, Kameyama 1998, Takei, Takada, and Aizawa 2000).

2. Phenomena to be Explored

Discourse often involves inherent ambiguity and allows multiple
interpretation especially when it contains more than one zero pronoun.

Discourse segment (1) comes from a dialogue in a Japanese radio show. In what follows, we will represent zero pronouns which would receive nominative case ('ga'), accusative case ('o'), and dative case ('ni') if they were realized overtly as \( \varphi\)-ga', \( \varphi\)-o', and \( \varphi\)-ni', respectively:

(1) 1. Speaker C: De, koo hirame-teiu-no-wa kono, and this fluke-what.is.called-TOP this esa-o taber-u-tokini-desu-ne bait-ACC eat-PRES-when-POL-SFP

2. Speaker B: Ee uh-huh

3. Speaker C: Hizyooni maa kono-u esa-o very well this bait-ACC kut-ta-dake eat-PAST-to.the.extent.that ookiku-nar-u-sakana-desi-te. big-become-PRES-fish-POL-CONJ

4. Speaker D: Ee uh-huh

5. Speaker C: Desukara kono-toki-ni sono hayai the.result.is this-time-DAT that quick sonoookii-mono-hodo hayaku that-big-one-ever quickly agattekur-u-n-desu-ne. surface-PRES-POL-SFP

6. Speaker B: Hoo really

7. Speaker C: Desukara ookisa-ni sa-ga the.result.is size-DAT difference-NOM detekur-u-n-desu-nee. appear-PRES-POL-SFP
There are, logically speaking, 882 ways of tracking all the referents mentioned in utterances 9 through 17. When one hears these utterances, one is expected to narrow down the range of possible transition relations in
accord with one’s real-world knowledge, local/global coherence, and a set of semantic constraints. Discourse comprehension is, thus, a process of narrowing down or, if possible, determining semantic interpretations of utterances including antecedents of (zero) pronouns.

For example, utterance 15 (Speaker C) in (1) allows the following three interpretations: (a) the fluke chose the bait; (b) speaker C chose the fluke; and (c) speaker C chose the bait. It turns out that (b) is the most natural interpretation for the conversation participants and is, in fact, the correct interpretation of utterance 15.

Given these data, we are now in a position to show how to identify the antecedents of zero pronouns in Japanese conversations in terms of attention shifting. Section 3 will outline CT and Section 4 will propose two probabilistic constraints and illustrate how they work.

3. Framework: Centering Theory

3.1. Preliminaries

CT is concerned with discourse coherence (cf. Givon 1983, Myhill 1992). It claims that coherence is mental in nature and that the degree to which a discourse segment makes sense depends on the amount and complexity of inferences required to process it. The essential idea is that the fewer inferences a hearer is required to make to interpret a discourse segment (i.e. the less processing effort is required on his/her part), the more coherent the segment is judged to be. CT further assumes that processing cost is decided primarily by the linguistic form of referring expressions and the relationship between focused entities in adjacent utterances. The previous CT literature (e.g. Joshi and Weinstein 1981, Hudson, Tanenhaus, and Dell 1986, Gordon, Grosz, and Gilliom 1993) establish that a hearer makes fewer inferences when s/he is required to focus on a single entity across adjacent utterances than otherwise.

In order to evaluate the relationship between adjacent utterances with
reference to a hearer’s attention states, CT proposes two constructs associated with each utterance, Cf and Cb. Cf is an abbreviation for forward-looking center and refers to a list of entities mentioned in each utterance. Cb is an abbreviation for backward-looking center and refers to the privileged referent among the Cf entities which receives a hearer’s focus of attention. The Cb entity links the current utterance to the previous discourse. (2a)-(2c) explain how Cb is related to Cf under the assumption that there is a single and no other Cb entity per utterance (whose abbreviation is Ui). It is also important to note that the Cf entities are ranked according to discourse salience (i.e. how likely they are to receive focus of attention) as in (3):

(2) a. Each Ui has exactly one Cb (Ui).
   
   b. All the entities in Cf (Ui) are realized in Ui.
   
   c. Cb (Ui+1) is the highest ranking entities among the set of Cf (Ui) entities realized in Ui+1.

(3) Cf/Ranking (Default): Subject > Object > Others

The highest-ranking Cf entity is termed Cp (preferred center); this is a prediction about the Cb of the following utterance. (2) and (3) combine to constrain the choice of the Cb entity in the subsequent discourse.

CT posits the following four types of transition relations in Table 1 across adjacent utterances in terms of Cf, Cb, and Cp:

These four types reflect the degree of local coherence. When the Cb remains

<table>
<thead>
<tr>
<th>Table 1: Transitions of Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cb (Ui) = Cb(Ui+1) or Segment Initial</td>
</tr>
<tr>
<td>--------------------------------</td>
</tr>
<tr>
<td>Cb (Ui) = Cp (Ui)</td>
</tr>
<tr>
<td>Cb (Ui) ≠ Cp (Ui)</td>
</tr>
</tbody>
</table>
the same across adjacent utterances, the transition relation is termed CONTINUE/RETAIN: CONTINUE is a case in which the $Cb$ in the following utterance coincides with its $Cp$, while RETAIN is a case in which the $Cb$ in the following utterance is different from its $Cp$. In contrast, when the $Cb$ changes across adjacent utterances, the transition relation is termed SMOOTH-SHIFT/ROUGH-SHIFT: S-SHIFT is a case in which the $Cb$ in the following utterance serves as its $Cp$, while R-SHIFT is a case in which the $Cb$ in the following utterance does not coincide with its $Cp$.

Finally, CT proposes the following two rules in addition to (2) and (3):

(4) a. Pronominalization Rule:
    If some element of $Cf(U_i)$ is realized as a pronoun in $U_{i+1}$, then so is $Cb(U_{i+1})$.

b. Ranking of Transition Relations:
    CONTINUE > RETAIN > S-SHIFT > R-SHIFT

(4a) captures our intuition that pronominalization is one way to signal discourse salience and that $Cb$s are often pronominalized or omitted. It is important to note that (4a) is extended by Walker, Iida, and Cote (1994) to accommodate zero pronouns as found in Japanese.

3.2. Extension of CT: Walker, Iida, and Cote (1994)

Walker et al (1994) is an important extension of CT outlined in Section 3.1 (cf. Kameyama 1985, Takeda and Doi 1994). They revise the relational hierarchy in (3) in such a way as to accommodate topicalization and empathy (Kuno 1987), which refers to a speaker’s identification, to varying degrees, with a participant in the event or state the speaker describes:

(5) $Cf$ Ranking for Japanese:
    (Grammatical or Zero) Topic > Empathy (Viewpoint)
Given the ranking in (5), Walker et al. (1994) proposes the following rule of zero topic assignment [ZTA] in order to account for zero pronouns in the constructed (not naturally-occurring) Japanese discourse:

(6) Rule of Zero Topic Assignment:
When a zero in $U_{i+1}$ represents an entity that was the $Cb(U_i)$, and when no other CONTINUE transition is available, that zero may be interpreted as the zero topic of $U_{i+1}$.

What is peculiar about discourse comprehension in Japanese is illustrated by the following discourse segment:

(7) a. Taroo-wa Jiroo-o mina-no-mae-de tataki-masi-ta.
   Taro-TOP Jiroo-ACC everyone-GEN-front-in hit-POL-PAST
   ‘Taro hit Jiro in front of everyone’.

      all.day.long completely $\varphi$-NOM $\varphi$-ACC ignore-PAST
      ‘Somebody ignored somebody else all day long’.

Utterance (7b) allows multiple interpretation, depending on who hit who else. It is important to observe here that the $Cb$ in (7b) (Taroo) is not realized by the syntactic subject. In fact, it is possible to interpret (7b) such that Jiroo or the speaker ignored Taroo all day long.

4. Data and Analysis

This section adopts Walker et al.’s version of CT and applies it to a corpus of Japanese conversations (including the discourse segment in (1)) which abound in zero pronouns. We focus on the utterances with more than one zero pronoun and the syntactic realization of speakers/hearers, which
are often realized by zero pronouns, in order to investigate the scope of ZTA in the naturally-occurring (not constructed) conversations and find out whether or not there is any other constraint which works in tandem with (6).

The data examined below comes from dialogues carried on by a reporter and two announcers in a radio show. They consist of six sets of dialogues which took place in the show from April 1st through April 6th of 2002. These conversations, which lasted 48 minutes and 25 seconds, are segmented into 698 utterances (i.e. a clause with one predicate) except for words of agreement and quotations. We assume the existence of zero pronouns when a predicate’s obligatory arguments are not expressed overtly within the clause. These 698 utterances contain 386 zero pronouns which would receive nominative case if they were realized overtly, 149 zero pronouns which would receive dative case, and 41 zero pronouns which would receive accusative case. Table 2 shows distribution of the \( C_b \) entities according to these potential case markers of zero pronouns.

Table 2: Classification of Zero Pronouns

<table>
<thead>
<tr>
<th>Zero Pronoun</th>
<th>( C_b )</th>
<th>Non- ( C_b )</th>
<th>Total</th>
<th>( C_b )/Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \varphi )-ga</td>
<td>229</td>
<td>157</td>
<td>386</td>
<td>59.32</td>
</tr>
<tr>
<td>( \varphi )-ni</td>
<td>45</td>
<td>104</td>
<td>149</td>
<td>30.20</td>
</tr>
<tr>
<td>( \varphi )-o</td>
<td>18</td>
<td>23</td>
<td>41</td>
<td>43.90</td>
</tr>
<tr>
<td>Total</td>
<td>292</td>
<td>284</td>
<td>576</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Applicability of the WIC Model

<table>
<thead>
<tr>
<th>( C_b )</th>
<th>SI</th>
<th>No ( C_b )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>465</td>
<td>120</td>
<td>113</td>
<td>698</td>
</tr>
</tbody>
</table>

Table 3 shows the result of applying Walker et al.’s (1994) [WIC] model to the data described above as classified according to whether they have \( C_b \)s, \( S_I \)s (\( S_I \) is an abbreviation for Segment Initial), or no \( C_b \)s. We can see that the WIC model covers 83.8% of the data, as shown by \((C_b+S_I)/((C_b+S_I)+No\_C_b)\) divided by
Total in Table 3. It is also worthy of mention at this juncture that 62.8% of the 465 \( Cb \) entities [292 (the total of \( Cb \)s in Table 2) divided by 465 (\( Cb \) in Table 3)] are zero pronouns.

Table 4 describes the distribution of transition patterns in the data when ZTA does not apply.

<table>
<thead>
<tr>
<th>Transition Patterns</th>
<th>Token</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTINUE</td>
<td>285</td>
<td>61.29</td>
</tr>
<tr>
<td>RETAIN</td>
<td>101</td>
<td>21.72</td>
</tr>
<tr>
<td>SMOOTH-SHIFT</td>
<td>61</td>
<td>13.11</td>
</tr>
<tr>
<td>ROUGH-SHIFT</td>
<td>18</td>
<td>3.87</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>465</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>

Applying ZTA to the data yields the result shown in Table 5. The proportion of CONTINUE increases by 9.89%, while the proportion of the remaining three patterns decrease. This means that application of ZTA increases the probability of retaining \( Cb \) in the discourse and therefore increases the degree of local coherence.

Table 6 shows both the distribution of zero pronouns when ZTA applies to the corpus and how their distribution changes as a result of applying ZTA to the same data. We observed statistically significant differences among the proportion of \( Cb \) of nominative-marked (‘ga’), dative-marked (‘ni’), and accusative-marked (‘o’) NPs when the ZTA rule...
applies ($\chi^2=29.45$, df=2, p<0.0001). Under the Tukey’s multiple comparison test, we confirmed statistically significant differences between nominative-marked and dative-marked NPs or between dative-marked and accusative-marked NPs, and not between nominative-marked and accusative-marked NPs.

Comparing Table 2 with Table 6 reveals that there is a statistically significant difference between the distribution of zero pronouns serving as $Cb$ (i.e. how likely they would be to be nominative-marked, dative-marked, and accusative-marked if realized overtly) when ZTA does not apply and the distribution of zero pronouns serving as $Cb$ when ZTA applies. This means that although syntactic subjects play a prominent role in linking the current utterance to the previous discourse, their function as a linker ($=Cb$) is partly taken over by zero topics.

Another point to observe regarding Table 6 is that nominative/accusative-marked arguments are more likely to serve as $Cb$ than dative-marked ones. (8) captures this observation:

(8) Preferred Ranking of $Cb$ Entities

Nominative-marked/Accusative-marked Arguments

> Dative-marked arguments
in Table 7, most of the expressions referring to speaker/hearer are nominative-marked or dative-marked arguments (172 tokens out of 173). Another point to note with reference to Table 7 is that 87.86% of the expressions referring to speaker/hearer are zero pronouns (152 tokens out of 173).

The above discussion leads us to the following two rankings:

(9) a. \( Cb: \) Nominative/accusative-marked arguments > Dative-marked arguments

b. Speaker/Hearer: Nominative/dative-marked arguments > Accusative-marked arguments

We propose that these two rankings function as probabilistic constraints. Utterances 14 and 15 in the discourse segment (1) (repeated here as (10)) illustrates a transition which maximally satisfies these two constraints:

(10) Utterance 14 (Speaker B):

\[
\phi_1-ga \quad \phi_2-o \quad takusan \quad taber-are-nai.
\]

\( \phi_1 \) (fluke)-NOM \( \phi_2 \) (bait)-ACC a.lot.of eat-can-NEG

‘The flukes cannot eat a lot of bait’.

\( Cf(U_{14}) = \{ \text{‘hirame’(fluke)}_1, \text{which functions as subject,} \)

‘esa’(bait)_2, \text{which functions as direct object} \}
Cp (U₁₄) = ‘hirame’ (fluke)  
Cb (U₁₄) = ‘hirame’ (fluke)  [CONTINUE]

Utterance 15 (Speaker C):
Desukara φ₃-ga φ₄-o senbetu-o
So φ₃ (speaker)-NOM φ₄ (fluke)-ACC selection-ACC
simasi-te-ne.
make-PAST-SFP
‘So I singled out the flukes’.
Cf (U₁₅) = {‘hirame’(fluke)₄, which functions as direct object,
‘I’(speaker)₃, which functions as subject }
Cp (U₁₅) = ‘hirame’ (fluke)
Cb (U₁₅) = ‘hirame’ (fluke)  [ZTA-CONTINUE]

The following describes how the interpretation of utterance 15 proceeds. First, ‘hirame’ (fluke) is more likely to serve as a nominative/accusative-marked argument than as a dative-marked argument. This is why ‘hirame’(fluke) is construed as direct object in utterance 15. Second, it is important to note that zero pronouns referring to speakers would be much more likely to be realized by nominative/dative-marked arguments than accusative-marked arguments if they were realized overtly. This explains why utterance 15 receives the above interpretation.

5. Conclusion

We set out to investigate the scope of CT with a particular focus on how well the ranking in (5) and the rule of ZTA in (6) (an attempt made by Walker et al. (1994) to extend the scope of CT) works when it is applied to the naturally-occurring dialogues in Japanese. We found that zero topics take over part of the function of syntactic subjects as Cb and that the rule of ZTA needs to be supplemented by the two probabilistic constraints, (9a) and (9b). We leave it for further research to investigate whether it is possible to derive (9a,b) from more basic constraints and to construct a computationally
feasible algorithm which accommodates the set of constraints mentioned in Section 3.2, i.e. (5) and (6), and (9a,b) (cf. Seki, Fujii, and Ishikawa 2002).

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References


