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Japanese Discourse and the Process of Centering *

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Abstract

This paper has two aims: (1) to generalize a computational account of discourse processing called CENTERING and apply it to discourse processing in Japanese, and (2) to provide some insights on the effect of syntactic factors in Japanese on discourse interpretation. We argue that while discourse interpretation is an inferential process, that syntactic cues constrain this process, and demonstrate this argument with respect to the interpretation of ZEROS, unexpressed arguments of the verb, in Japanese. The syntactic cues in Japanese discourse that we investigate are the morphological markers for grammatical TOPIC, the post-position *wa*, as well as those for grammatical functions such as SUBJECT, *ga*, OBJECT, *o* and OBJECT2, *ni*. In addition, we investigate the role of speaker's EMPATHY, which is the perspective from which an event is described. This is morphologically indicated through the use of verbal compounding, i.e. the auxiliary use of verbs such as *kureta*, *kita*. Our results are based on a survey of native speakers of their interpretation of short discourses, consisting of minimal pairs, varied by one of the above factors. We demonstrate that these syntactic cues do indeed affect the interpretation of ZEROS, but that having previously been the TOPIC and being realized as a ZERO also contribute to an entity being interpreted as the TOPIC. We propose a new notion of TOPIC AMBIGUITY, and show that CENTERING provides constraints on when a ZERO can be interpreted as the TOPIC.

1 Introduction

1.1 Centering in Japanese Discourse

Recently there has been an increasing amount of work in computational linguistics involving the interpretation of anaphoric elements in Japanese (Yoshimoto, 1988; Kuno, 1989; Walker et al., 1990). This paper has two aims: (1) to generalize a computational account of discourse processing called CENTERING (Sidner, 1979; Grosz et al., 1983; Grosz et al., 1986; Joshi and Weinstein, 1981) and apply it to discourse processing in Japanese, and (2) to provide some insights on the effect of syntactic factors in Japanese on discourse interpretation.

In the computational literature there seems to be two strongly opposed positions on how contextual elements such as pronouns are interpreted. The first position is that this is a purely inferential

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process driven by the underlying semantics and relations in the domain (Hobbs, 1985a; Hobbs et al., 1987; Hobbs and Martin, 1987). The polar position is that interpretation relies solely on information derived from syntax such as what was previously the topic or subject (Yoshimoto, 1988). We will argue a third position with respect to the interpretation of ZEROS, unexpressed arguments of the verb, in Japanese¹. Our position is that the interpretation of zeros is an inferential process but that syntactic information provides constraints on this inferential process (Sidner, 1979; Grosz, 1977; Joshi and Weinstein, 1981). Indeed we believe that syntactic cues and semantic interpretation are mutually constraining (Prince, 1981b; Prince, 1985).

The syntactic cues in Japanese discourse that we investigate here are the morphological markers for grammatical TOPIC, the post-position *wa*, as well as those for grammatical functions such as SUBJECT, *ga*, OBJECT, *o* and OBJECT2, *ni*. In addition, we investigate the role of speaker's EMPATHY, which is the perspective from which an event is described. This is morphologically indicated through the use of verbal compounding, i.e. the auxiliary use of verbs such as *kureta*, *kita*.

In addition to the argument that a purely inference-based account does not consider the fact that agents are resource-bounded, another argument against a purely inference-based account is provided by the minimal pair below. Here, the only difference is whether *Ziroom* is the subject or the object in the second utterance. Note that zeros are indicated in parentheses:

- (1) a. *Taroo ga kooen o sanpositeimasita.*
 Taroo SUBJ park in walking-was
Taroo was taking a walk in the park.
- b. *Ziroom ga () hunsui no mae de mitukemasita.*
 Ziroom SUBJ OBJ fountain of front in found
Ziroom found (Taroo) in front of the fountain.
- c. *() () kinoo no siai no kekka o kikimasita.*
 SUBJ OBJ yesterday of game of scores OBJ asked
(Ziroom) asked (Taroo) the score of yesterday's game.
- (2) a. *Taroo ga kooen o sanpositeimasita.*
 Taroo SUBJ park in walking-was
Taroo was taking a walk in the park.
- b. *() Ziroom o hunsui no mae de mitukemassta.*
 SUBJ Ziroom OBJ fountain of front in found
(Taroo) found Ziroom in front of the fountain.
- c. *() () kinoo no siai no kekka o kikimasita.*
 SUBJ OBJ yesterday of game of scores obj asked
(Taroo) asked (Ziroom) the score of yesterday's game.

The syntactic position that *Ziroom* is realized in seems to have the effect that 1c means *Ziroom asked Taroo the score of yesterday's game*, while 2c means *Taroo asked Ziroom the score of yesterday's game*. On the other hand, the purely syntactic account requires that antecedents for zeros be realized as the TOPIC, and thus cannot explain the above example because *Taroo* is never explicitly marked as the topic.

¹In the literature these are known as zero pronouns ((Kuroda, 1965; Martin, 1976; Kameyama, 1985)).

In section 5 we propose an interpretive rule of TOPIC AMBIGUITY, by which we demonstrate conditions on when a zero can be thought of as the TOPIC. We use two notions of TOPIC, grammatical topic and discourse topic. The grammatical topic is often understood as the discourse topic but may not be, depending on other discourse factors. Topic ambiguity characterizes some ambiguities in Japanese discourse interpretation and predicts interpretations that previous accounts claim would be unavailable. We use the centering model to formalize constraints on when a zero may be interpreted as a TOPIC.

First, in section 1.2 we will describe the methodology that we applied in this investigation. In section 2, we will present the theory of centering and some illustrative examples. Then in section 3 we will discuss particular aspects of Japanese discourse context, namely the notions of TOPIC and speaker’s EMPATHY. We will show how these can easily be incorporated into a centering account of Japanese discourse processing, and give a number of examples to illustrate the predictions of the theory. We also discuss the way in which a discourse center is instantiated in section 4. We delay the review of related research to section 6 when we can contrast it with our account.

1.2 Methodology

Most of the examples in this paper are constructed as 4 utterance discourses that fit one of a number of structural paradigms. In all of the paradigms, a discourse entity is introduced in the first utterance, and established as the CENTER, what the discourse is about, by the second utterance. The manipulations of context occur with the third and the fourth utterances. In each case the zero in the third utterance cospecifies the entity already established as what the discourse is about in the second utterance. The variations in context are as shown below:

Third Utterance		Fourth Utterance	
SUBJECT	OBJECT(2)	SUBJECT	OBJECT(2)
(1) zero	NP(o or ni)	zero	zero
(2) zero	NP(o or ni)	zero	zero, empathy
(3) NP(ga)	zero	zero	zero
(4) NP(wa)	zero	zero	zero
(5) NP(ga)	zero	zero	zero, empathy

Thus we are manipulating factors such as whether a discourse entity is realized in subject or object position in the third utterance, whether a discourse entity realized in subject position is *ga*-marked or *wa*-marked in the third utterance, and whether a discourse entity realized in the fourth utterance in object position is marked as the locus of speaker’s EMPATHY.

We collected a group of about 35 native speakers by solicitation on the net to provide judgements for most of the examples given in this paper. This data collection was carried out on written examples using electronic mail in a situation in which the informants could take as long as they wanted to decide which interpretation they preferred. Whenever an example was tested in this way, we will provide the number of informants who chose each possible interpretation to the right of the example. This paradigm clearly cannot provide information on which interpretation a subject might

arrive at first and then perhaps change based on other pragmatic factors, and thus it contrasts with reaction time studies. However the judgements in some sense may then reflect the fact that our informants were able to use all the information in the discourse.

In addition, we constructed a test with certain properties, e.g. few cue words such as *but*, *because*, *then*, which could result in a bias towards, say, a cause-effect or temporal sequence of events interpretation. We also omitted honorific markers, which are normally a part of Japanese ambiguity resolution. We used same gender for discourse participants to prevent societal biases, as well as verbs in which it seemed that the the described event did not give status to one entity over the other, e.g. *invited* or *explained*². This was done to isolate the effects of the variables that we were exploring in this study, namely topic marking, grammatical function, empathy, and realization with a zero or with a full noun phrase.

2 The Centering Theory

2.1 What is centering?

Within a theory of discourse, CENTERING is a computational model of the process by which discourse participants make obvious to one another their assumptions about the salience of discourse entities (Grosz et al., 1986). Centering has its computational foundations in the work of Grosz and Sidner (Grosz, 1977; Sidner, 1979) and was further developed by Grosz, Joshi and Weinstein (Joshi and Kuhn, 1979; Grosz et al., 1983; Grosz et al., 1986; Joshi and Weinstein, 1981). Centering is intended to reflect aspects of ATTENTIONAL STATE in a tripartite view of discourse structure that also includes INTENTIONAL STRUCTURE and LINGUISTIC STRUCTURE (Grosz and Sidner, 1986). In Grosz and Sidner’s theory of discourse structure, discourses can be segmented based on intentional structure and a discourse segment exhibits both local and global coherence. Global coherence depends on how each segment relates to the overall purpose of the discourse; local coherence depends on aspects such as the syntactic structure of the utterances in that segment, the choice of referring expressions, and the use of ellipses. CENTERING models local coherence and is formalized as a system of constraints and rules. Our analysis uses an adaptation of a centering algorithm that was developed by Brennan, Friedman and Pollard, based on these constraints and rules (Brennan et al., 1987; Walker, 1989).

The purpose of centering as part of a computational model of discourse interpretation is to model ATTENTIONAL STATE in discourse in order to control inference (Joshi and Kuhn, 1979; Joshi and Weinstein, 1981; Grosz and Sidner, 1986)³. Our approach to modeling attentional state is to explore aspects of the correlation between syntax and discourse function. This assumes that there are language conventions about discourse salience and that conversants attempt to maintain a sense of shared context.

²While native speakers understandably found some of these examples “stilted” or “awkward”, they were still able to give their judgements based on the information that was provided in the discourses.

³Recent work in situation theory formulates a similar notion of background information in terms of constants of the situation that thus are not explicitly realized in an utterance (Nakashima, 1990). The situation-theoretic work does not as yet distinguish shared knowledge that determines discourse salience and derives from the discourse context and the way utterances are expressed (Clark and Haviland, 1977; Clark and Marshall, 1981; Prince, 1978b; Prince, 1981b) from shared knowledge that is part of general background knowledge such as cultural assumptions (Prince, 1978b) or shared knowledge that might derive from the task context (Grosz, 1977).

2.2 Rules and Constraints

The centering model is very simple. Each utterance in a discourse segment has two structures associated with it. First, each utterance in a discourse has associated with it a set of discourse entities called FORWARD-LOOKING CENTERS, Cf. Centers are semantic entities that are part of the discourse model. Second, there is a special member of this set called the BACKWARD-LOOKING CENTER, Cb. The Cb is the discourse entity that the utterance most centrally concerns, what has been elsewhere called the ‘theme’ (Reinhart, 1981; Horn, 1986). The Cb entity links the current utterance to the previous discourse.

The set of FORWARD-LOOKING CENTERS, Cf, are ranked according to discourse salience; for convenience the highest ranked member of the set is referred to as the PREFERRED CENTER, Cp⁴. The PREFERRED CENTER corresponds to a prediction about what the following segment of discourse will be about. This prediction is based on aspects of the current utterance such as which discourse entities are realized as discourse prominent based on syntactic position or intonation. Sometimes the Cp will be what the previous segment of discourse was about, the Cb, but this is not necessarily the case.

In addition to the structures for centers, Cb and Cf, the theory of centering specifies a set of rules and constraints. Constraints are meant to hold strictly whereas rules may sometimes be violated.

• CONSTRAINTS

For each utterance U_i in a discourse segment U_1, \dots, U_m :

1. There is precisely one backward looking center Cb.
2. Every element of the forward centers list, $Cf(U_i)$, must be realized in U_i .
3. The center, $Cb(U_i)$, is the highest-ranked element of $Cf(U_{i-1})$ that is realized in U_i .

Constraint (1) says that there is one central discourse entity that the utterance is about, and that is the Cb. The second constraint depends on the definition of *realizes*. An utterance U *realizes* a center c if c is an element of the situation described by U , or c is the semantic interpretation of some subpart of U . A specialization of the relation REALIZE is the relation DIRECTLY REALIZE. A center is directly realized if it corresponds to a phrase in an utterance. We are restricting this paper to entities realized by noun phrases, however it is clear that propositions can be centers, so we assume that the account given here can be extended to propositional entities as well (Prince, 1978a; Sidner, 1983; Ward, 1985; Prince, 1986; Horn, 1986).

Thus the relation REALIZE describes both zeros as well as those implicitly realized centers that are entities inferable from the discourse situation (Prince, 1978b; Prince, 1981b). As we discuss further in section 3, zeros refer to entities that are already part of the discourse model, ie. EVOKED entities. The fact that the current utterance contains one or more zeros follows from information specified in the subcategorization frame of the verb. These arguments must be interpreted and thus acquire a degree of discourse salience that nonsubcategorized-for discourse entities lack.

Constraint (3) stipulates that the ranking of the forward centers list, Cf, determines from among the elements that are realized in the next utterance, which of them will be the Cb for that utterance. The PREFERRED CENTER of $Cf(U_i)$ is predicted to be the $Cb(U_{i+1})$. We will use the following forward center list ranking for Japanese⁵:

⁴The notion of PREFERRED CENTER corresponds to Sidner’s EXPECTED FOCUS (Sidner, 1981).

⁵We do not include discourse entities for verb phrases or other propositional entities in this ranking since we have

(DISCOURSE) TOPIC > EMPATHY > SUBJ > OBJ2 > OBJ > OTHERS

Backward-looking centers, Cb's, are often deleted or pronominalized and discourse segments that continue centering the same entity are more coherent than those that shift from one center to another. So in addition to the constraints, the model also proposes several rules:

• **RULES**

For each U_i in a discourse segment U_1, \dots, U_m :

1. If some element of $Cf(U_{i-1})$ is realized as a pronoun in U_i , then so is $Cb(U_i)$.
2. Transition states are ordered. CONTINUE is preferred to RETAIN is preferred to SMOOTH-SHIFT is preferred to SHIFT⁶.

Rule (1) captures the intuition that pronominalization is one way to indicate discourse salience. It follows from Rule (1) that if there are multiple pronouns in an utterance, one of these must be the Cb. In addition, if there is only one pronoun, then that pronoun must be the Cb. For Japanese, we extend this rule directly to zeros.

Rule (2) states that the modeling of attentional state depends on analyzing adjacent utterances in a discourse according to a set of transitions⁷. These transitions are a measure of the coherence of the segment of discourse in which the utterance occurs and so some transitions are preferred over others⁸. The typology of transitions from one utterance, U_i , to the next is based on two factors: whether the backward-looking center, Cb, is the same from U_{i-1} to U_i , and whether this discourse entity is the same as the preferred center, Cp, of U_i .

1. $Cb(U_i) = Cb(U_{i-1})$
2. $Cb(U_i) = Cp(U_i)$

If both (1) and (2) hold then we are in a CONTINUE transition. The CONTINUE transition corresponds to cases where the speaker has been talking about a particular entity and indicates an intention to continue talking about that entity by placing that entity in a discourse prominent position. If (1) holds but (2) doesn't hold then we are in a RETAIN transition. RETAIN is supposed to correspond to a situation where the speaker is intending to SHIFT onto a new entity in the next utterance and is signalling this by demoting the current center to a less prominent position (examples follow below).

If (1) doesn't hold then we are in one of the SHIFT states depending on whether or not (2) holds. This definition of transition states is summarized in Figure 1, (BACKWARD-LOOKING CENTER = Cb, PREFERRED CENTER = Cp).

not studied their contribution, but see (Sidner, 1979; Sidner, 1981; Webber, 1986; Webber, 1988; Prince, 1986; Ward, 1985). This ranking resembles Kameyama's Antecedent Hierarchy and is used for Kameyama's mechanism of Cb Establishment (Kameyama, 1985; Kameyama, 1988). This will also be discussed in section 6.

⁶Smooth-shift was called shifting-1 by (Brennan et al., 1987).

⁷The claim that it is only necessary to model relationships between adjacent utterances rather than some larger domain depends partially on the definition of the relation REALIZE which states what centers are realized by an utterance.

⁸A prediction made by the preference for CONTINUE is that intersentential antecedents for pronouns will be preferred over intrasentential candidates at least so much as to find a Cb for the current utterance. This preference is one that distinguishes the centering account of pronoun interpretation from that described by Hobbs in (Hobbs, 1976b; Hobbs, 1976a). However this preference needs to be constrained further by the fact that sortal filters may rule out the Cp of the previous utterance as the current Cb. In this case the data suggests that perhaps intrasentential candidates should be preferred (Walker, 1989). This thesis was explored by Carter in his extension of Sidner's theory of local focusing (Carter, 1987; Walker, 1989).

	$Cb(U_i) = Cb(U_{i-1})$	$Cb(U_i) \neq Cb(U_{i-1})$
$Cb(U_i) = Cp(U_i)$	CONTINUE	SMOOTH-SHIFT
$Cb(U_i) \neq Cp(U_i)$	RETAIN	SHIFT

Figure 1: Transition States

The ordering of the Cf list is the main determinant of which transition state holds between adjacent utterances. Therefore, the predictions of the theory for the resolution of pronouns is largely determined by the ranking of the items on the Cf. However in calculating an ordering we can consider only correlations between syntactic form and discourse function. Furthermore, factors that we will not examine here such as intonation, cue words, and tense may contribute to the salience of discourse entities. In this paper we explore the influence of various syntactic factors, which we will discuss in detail in section 3. We will also examine the relative contribution of pronominalization and post-position marking in section 5. We postulate that the Cf ordering will vary from language to language depending on the means the language provides for expressing discourse functions. But the modularity of the theory means that much of this variation can be captured in the ranking of the Cf.

The CENTERING ALGORITHM that was proposed by Brennan, Friedman and Pollard incorporates the centering rules and constraints in addition to linguistic constraints on coreference (Brennan et al., 1987). We assume a theory that specifies the contra-indexing constraints in the subcategorization frame of the verb. Other constraints that are lexically specified such as [+animacy] can also be easily applied. Application of the algorithm requires three basic steps.

1. GENERATE possible Cb-Cf combinations
2. FILTER by constraints, e.g contra-indexing, sortal predicates, centering rules and constraints
3. RANK by transition orderings

These steps are not necessarily done serially: it is possible to pursue a 'best first' strategy in which step (1) is interleaved with steps (2) and (3) so that a CONTINUE will be found without extra processing if one exists. This strategy uses information from the Cf ordering and the ordering on transition states.

2.3 The Distinction between Continue and Retain

Let us look at a simple example. Observe the discourse segment in 3: the unexpressed argument in the second sentence is understood as referring to *Taroo*, and not to *Hanako*.

- (3) a. Taroo wa Hanako o eiga ni sasoimasita.
 Taroo TOP/SUBJ Hanako OBJ movie to invited
Taroo invited Hanako to the movie.

Cb:	TAROO
Cf:	[TAROO, HANAKO]

- b. 0 itiniti-zyuu nani mo te ni tukimasendesita.
 SUBJ all-day anything even hand to attached-not
(Taroo) could not do anything all day.

Cb:	TAROO
Cf:	[TAROO]

In example 3, the Cf list from 3a contains Taroo as the first element and Hanako as the second element. When the unexpressed argument is interpreted in 3b, the information from this Cf list is used. That is, the highest ranked element of Cf(3a) is realized as the Cb of 3b following constraint 3⁹. This means that Taroo is taken as the Cb. Then by interpreting the zero as being Taroo, it is possible to get a preferred CONTINUE interpretation *Taroo could not do anything all day*. In this interpretation Taroo is both the Cb(3b) and the Cp(3b).

Let us take a more complex example. This theory predicts preferences in the interpretation of utterances whose meaning depends on parameters from the discourse context. Thus if there are still multiple possibilities for interpretation after the application of all constraints and rules, the ordering on transitions applies, and CONTINUE interpretations are preferred. Indeed, many cases of the preference for one interpretation over another follow directly from the distinction between the transition states of CONTINUE and RETAIN. In example 4, we will illustrate in more detail how the steps of the algorithm work and the difference between CONTINUE and RETAIN. Each utterance shows what the Cb and Cf would be for that utterance. We will mostly be concerned with the process of resolving the two zeros in the third utterance of this segment, utterance 4c. The numbers shown to the right of an interpretation correspond to how many native speakers preferred that interpretation.

- (4) a. Taroo wa saisin no konpyuutaa o kaimasita.
 TOP/SUBJ newest of computer OBJ bought
Taroo bought a new model of computer.

Cb:	TAROO
Cf:	[TAROO, COMPUTER]

- b. 0 John ni sassoku sore o misemasita.
 SUBJ John OBJ2 at once that OBJ showed
He showed it to John.

Cb:	TAROO
Cf:	[TAROO, JOHN, COMPUTER] CONTINUE

- c. 0 0 atarasiku sonawatta kinoo o setumeisimasita.
 SUBJ OBJ2 newly equipped function OBJ explained
He explained the newly equipped functions to him.

⁹The hypothesis that *wa* in 3a instantiates Taroo as the Cb will be discussed in section 4.

Cb:	TAROO		
Cf1:	[TAROO, JOHN]	CONTINUE	27
	SUBJ OBJ		
Cf2:	[JOHN, TAROO]	RETAIN	1
	SUBJ OBJ		
Cf3:	[JOHN, JOHN]	CONTRA-INDEX FILTER	
	SUBJ OBJ		
Cf4:	[TAROO, TAROO]	CONTRA-INDEX FILTER	
	SUBJ OBJ		

When the centering constraints apply at (c), Constraint (3) restricts the Cb to being TAROO since TAROO must be realized in the utterance and is the highest ranked element from the Cf(4b). The interpretive process must also generate the possible candidates for the Cf list. If no constraints applied, then all 4 candidates shown above as Cf1, Cf2, Cf3, and Cf4 would be possible. However the filter that applies linguistic constraints based on contraindexing will rule out Cf3 and Cf4. The filter based on Rule (1) also disfavors Cf3.

The only CONTINUE interpretation available, *Taroo explained some newly equipped functions to John*, corresponds to the forward centers list Cf1. It is a CONTINUE interpretation because Cb(4c) = Cb(4b) and also Cb(4c) = Cp(4c). The RETAIN interpretation is less preferred and is defined by the fact that Cb(4c) = Cb(4b), but Cb(4c) ≠ Cp(4c).

2.4 The Distinction between Smooth-Shift and Shift

In example 5, we illustrate the difference between the transition states of SHIFT and SMOOTH-SHIFT. Remember that SHIFT is claimed to be less coherent than SMOOTH-SHIFT (Brennan et al., 1987). In both cases the speaker has shifted attention to a different discourse entity. However in the SMOOTH-SHIFT transition state, the speaker has indicated an intention to continue talking about the recently shifted-to entity by placing that entity in a discourse prominent position such as subject, whereas no such indication is available with the SHIFT transition.

- (5) a. Taroo ga kooen de hon o yondeimasita.
 Taroo SUBJ park at book OBJ reading-was
Taroo was reading a book in the park.

Cb:	[?]
Cf1:	[TAROO, BOOK]
	subj obj

- b. 0 cola o kai ni baiten ni hairimasita.
 SUBJ cola OBJ buy to shop into entered
He entered a shop to buy a cola.

Cb:	TAROO
Cf1:	[TAROO, COLA] CONTINUE
	subj obj

- c. Ziroom wa 0 sokode guuzen dekuwasimasita.
 Ziroom TOP/SUBJ there by chance met
Ziroom met him there by chance.

Cb:	TAROO		
Cf1:	[ZIROO, TAROO]	RETAIN	
	top	obj	

- d. 0 0 eiga ni sasoimasita.
 SUBJ OBJ movie to invited.
He invited him to a movie.

Cb:	ZIROO		
Cf1:	[ZIROO, TAROO]	SMOOTH-SHIFT	32
	subj	obj	
Cf2:	[ZIROO, TAROO]	SHIFT	2
	subj	obj	

In this example the use of TOPIC marking in the phrase *Ziroo wa* of utterance (c) means that (c) is interpreted as a RETAIN. ZIROO becomes the most highly ranked discourse entity for c, although TAROO is the Cb since TAROO was most highly ranked for utterance (b) (by Constraint 3). Then when we apply the centering algorithm at (d), there are two candidates for the Cb(d) from the Cf(c), both ZIROO and TAROO. However this time when constraint 3 applies, stipulating that the Cb must be the highest ranked element of Cf(5c) realized in 5d, ZIROO must be the highest ranked entity realized, and therefore must be the Cb. At this point it is clear that some kind of SHIFT is forced by the application of constraint 3. Then the candidates for the Cf list are considered. Before any constraints apply, there are four Cf candidates, but two of them are ruled out by conraindexing and by Rule(1). The two that are left are a SMOOTH-SHIFT and a SHIFT interpretation. The SMOOTH-SHIFT interpretation corresponds to the reading *Ziroo invited Taroo* whereas the SHIFT interpretation corresponds to the *Taroo invited Ziroo* reading. The SMOOTH-SHIFT interpretation is more highly ranked, thus considered more coherent and so is the desired interpretation.

In the next section we will examine further the application of the centering framework to the interpretation of anaphoric expressions in Japanese. We will examine the ranking of the forward centers list that we have adopted for Japanese and explain how this is partially determined by the way the Japanese language allows a speaker to express discourse function. We will also give some examples of the application of the rules and constraints given above to the interpretation of zeros where discourse functions such as TOPIC and EMPATHY that are explicitly marked in Japanese are involved.

3 Centering in Japanese

The theory of centering is a formal specification that is intended to model attentional state and is defined by the rules and constraints given in section 2.2. Attentional state in turn constrains the discourse participant's interpretation process; one aspect of attentional state is the notion of discourse salience. In the centering model, the ordering of the forward centers is an approximation of discourse salience. This in turn is the main determinant of discourse interpretation processes such as the resolution of zeros in Japanese. A crucial question then is what discourse factors must be considered to determine the ordering of the forward centers, Cf, in Japanese discourse.

Both subjectness and pronominalization have been shown to be important factors for English and this is reflected in a Cf ordering by grammatical function (Prince, 1981b; Brennan et al., 1987; Hudson-D'Zmura, 1988). Aspects of surface order may also affect the interpretation (Dieugenio, 1988; Hajicova and Vrbova, 1982). Furthermore, it is significant that zeros in Japanese are not

realized syntactically and thus there is a potential problem with distinguishing zeros from other entities possibly inferred as part of a discourse situation. Consider:

- (6) Taroo ga aimasita.
Taroo SUBJ met
Taroo met 0.

This sentence is not felicitous unless the addressee has already been given some information about the person that Taroo met, either in the current discourse or in previous discourses. In contrast, nonsubcategorized-for arguments like adjuncts are not necessarily given a specific interpretation, but rather a non-specific one.

- (7) Taroo ga Hanako ni aimasita.
Taroo SUBJ Hanako OBJ2 met
Taroo met Hanako.

The sentence means that Taroo met Hanako at some time in some place: the temporal-location of the *meeting* situation need not be specified. The speaker can utter this sentence even if the addressee does not know where and when Taroo met Hanako. Thus, in this work we only represent obligatorily subcategorized arguments of the verb on the Cf, assuming that the salience of discourse entities is partially determined by virtue of filling a verb's argument role, and the information from the subcategorization frame is used to determine that a zero is present in an utterance.¹⁰

This zero is then interpreted with reference to the current context. Prince has proposed that the current context should be categorized by ASSUMED FAMILIARITY, what has elsewhere been called SHARED KNOWLEDGE. As Prince describes, a goal of pragmatics is to determine the correlation between the use of certain linguistic forms and the types of assumed familiarity. The first division of assumed familiarity is into the subtypes of NEW, INFERABLE and EVOKED. NEW can be divided into BRAND-NEW, discourse entities that are both new to the discourse and new to the hearer, and UNUSED, discourse entities old to the hearer but new to the discourse. The information status of EVOKED can be further divided into TEXTUALLY EVOKED, old in the discourse and therefore old to the hearer as well, and SITUATIONALLY EVOKED, entities in the current situation. INFERABLES are technically both hearer-new and discourse-new but depend on information that is old to the hearer and the discourse, and are often treated as though they were both hearer-old and discourse-old. There is a hierarchy of assumed familiarity in terms of discourse salience:

Assumed Familiarity Hierarchy(Prince 1981):

TEXTUALLY EVOKED > SITUATIONALLY EVOKED > INFERABLE > UNUSED > BRAND-NEW

Zeros must refer to discourse entities that are HEARER-OLD, and a zero typically refers to EVOKED entities, but there is a scale of relative salience among the EVOKED entities. That is the role of the Cf ranking. We repeat the proposed ranking of the Cf here and justify it in the following sections:

Cf Ranking for Japanese

(DISCOURSE) TOPIC > EMPATHY > SUBJ > OBJ2 > OBJ > OTHERS

¹⁰Note that the subcategorization frame in Japanese is not the same as in English. See Iida (1991) for the syntactic tests for subcategorization in Japanese.

We continue Kuno's use of the term EMPATHY to represent the notion of EMPATHY LOCUS in a given discourse¹¹. The relevance of the notions of TOPIC and speaker's EMPATHY to centering is that a discourse entity realized as the TOPIC or the EMPATHY LOCUS is more salient and should be ranked higher on the Cf. Whenever a discourse entity simultaneously fulfills multiple roles, the entity is usually ranked according to the highest ranked role. In the following sections we will discuss the motivation for this ranking.

3.1 Topic

Discourse entities that are EVOKED, INFERABLE or UNUSED can be marked as the TOPIC. The speaker cannot introduce a new TOPIC when s/he knows that the hearer does not know or is not aware of the object that s/he is going to talk about (Prince, 1981a; Kuno, 1976). As Kuno observed the TOPIC marker *wa* normally indicates the information status of a discourse entity to be discourse-old. For example:

- (8) Hutari wa partii ni kimasita.
 two-person TOP/SUBJ party to came
Speaking of two persons, they came to the party.

Example 8 is grammatical only when *hutari* ('two persons') is understood as meaning *the two people (under discussion)*. The sentence never means that the people who came to the party numbered two.

The fact that the *wa*-marked entity must be discourse-old is also shown by the fact that a *wh*-question cannot be answered with a *wa*-marked NP.

- (9) a. Dono hito ga Ziroo o bengosimasita ka.
 which person SUBJ Ziroo OBJ defended Q
Which person defended Ziroo?
- b-1. Taroo ga Ziroo o bengosimasita.
 Taroo SUBJ Ziroo OBJ defended
Taroo defended Ziroo.
- b-2. *Taroo wa Ziroo o bengosimasita.
 Taroo TOP/SUBJ Ziroo OBJ defended
Taroo defended Ziroo.

What the question context shows is that even in a simple declarative sentence, the use of the topic marker *wa* contrasts with the subject marker *ga* in what is understood as already in the discourse context. For instance in a discourse initial utterance 10a assumes no shared information or that *someone defended Ziroo* and asserts that the someone is *Taroo*. In 10b, the discourse-old proposition is that *Taroo did something* and what is asserted is that what he did was to defend Ziroo.

- (10) a. Taroo ga Ziroo o bengosimasita.
 Taroo SUBJ Ziroo OBJ defended
Taroo defended Ziroo.

¹¹In Kameyama's analysis of zeros in Japanese, she introduces a property IDENT, which is intended to correspond to Kuno's notion of EMPATHY LOCUS (Kameyama, 1988).

- b. Taroo wa Ziroo o bengosimasita.
 Taroo TOP/SUBJ Ziroo OBJ defended
Taroo defended Ziroo.

The assumption that the TOPIC is more salient than the SUBJECT when the two are different is supported by the fact that an indefinite NP in subject position such as *who*, *which*, or *somebody* cannot be regarded as the TOPIC: an indefinite NP is never marked by the topic marker *wa*, but by the subject marker *ga*. For example:

- (11) Dono hito ga Ziroo o bengosimasita ka.
 which person SUBJ Ziroo OBJ defended Q
Which person defended Ziroo?

- (12) *Dono hito wa Ziroo o bengosimasita ka.
 who person TOP/SUBJ Ziroo OBJ defended Q
Which person defended Ziroo?

It is clear from these examples that the grammatical topic, *wa*-marked entity in Japanese, represents assumable shared information in an on-going conversation. It has been taken to be the ‘theme’ or ‘what the sentence is about’ (Kuno, 1973; Shibatani, 1990). In our framework this is the role of the Cb. We will provide evidence supporting this position in section 4. However we claim that this is just a default and that other factors can contribute to an entity being thought of as the discourse topic or center. Kuno also claims that a zero subject is equivalent to a *wa*-marked entity. We provide support for Kuno’s claim in section 5, showing that the property of having been previously established as the Cb can contribute to an entity being thought of as the discourse topic.

3.2 Empathy

Kuno (1976) proposed a notion of EMPATHY in order to present the speaker’s position or identification in describing a situation. Giving an example of a *kissing* situation involving a man named *John* and his wife *Mary*, he says that this situation can be described in various ways, some of which are shown in 13.

- (13) a. John kissed Mary.
 b. John kissed his wife.
 c. Mary’s husband kissed her.

According to Kuno, these sentences differ from each other with respect to *camera angle*, the position that the speaker takes to observe and describe this situation. In 13a, the speaker is assumed to be describing the event objectively: the camera is placed at the same distance from both *John* and *Mary*. When the speaker describes the event objectively, the speaker’s position is neutral and so is identification. On the other hand, the camera may be placed closer to *John* in 13b and closer to *Mary* in 13c, which is clear by the use of relational terms such as *wife* and *husband*, respectively. Kuno uses the term *empathy* in reference to this *camera angle*, which indicates the speaker’s position among the participants in the event described.¹²

¹²The speaker’s position is not determined by his physical proximity but also measured by the emotional or social relationship. In this sense, the term *speaker’s identification*, which Kuno uses in his definition of the notion of Empathy, may be more suitable than the term *speaker’s position*.

In Japanese the realization of the speaker's position is especially important when describing an event involving some *giving* and *receiving* relation. There is no way to describe a *giving* and *receiving* situation objectively (Kuno and Kaburaki, 1977). In 14, the use of the verb *kureru* indicates the speaker's taking the perspective of the discourse entity realized in object position, i.e. Taroo, while in 15, the speaker's identification with the subject entity's perspective, i.e. Hanako, is indicated by the use of the past tense form *yatta* of the verb *yaruu*.

(14) Taroo ga Ziroo ni hon o kureta.
 Taroo SUBJ Ziroo OBJ2 book OBJ gave
Taroo gave Ziroo a book. EMPATHY=OBJ2=ZIROO

(15) Taroo ga Ziroo ni hon o yatta.
 Taroo SUBJ Ziroo OBJ2 book OBJ gave
Taroo gave Ziroo a book. EMPATHY=SUB=TAROO

Kuno calls a verb that is sensitive to the speaker's identification an EMPATHY-LOADED verb. He defines EMPATHY LOCUS as the argument position whose referent the speaker automatically identifies with. In other words, the verb *kureru* has the EMPATHY LOCUS on the object, while verbs like *yaruu* place the EMPATHY LOCUS on the subject.

The use of deictic verbs such as *kuru* ('come'), *iku* ('go'), *okuru* ('send to'), and *yokosu* ('send in') also imply the speaker's perspective. For example, the speaker indicates that she is taking *Taroo's* perspective by using the past tense form *kita* of the verb *kuru* in the following example.

(16) Hanako wa Taroo no tokoro ni kita.
 Hanako SUBJ Taroo of place to came
Hanako came to Taroo.

Any Japanese verb can be made into an empathy-loaded verb due to a productive verb-compounding operation by which these empathy-loaded verbs can be used as the auxiliary verb, attaching to the main verb. For example, *kureru* can be used as a suffix, to mark OBJ or OBJ2 as the EMPATHY LOCUS. The attachment of *yaruu* mark SUBJECT as the EMPATHY LOCUS. The complex predicate made by this operation inherits the EMPATHY LOCUS of the suffixed verb. For example:

(17) Hanako ga Taroo ni hon o yonde-kureta.
 Hanako SUBJ Taroo OBJ2 book OBJ read-gave
Hanako gave Taroo a favor in reading a book. EMPATHY = OBJ2 = TAROO

In this case *Taroo* is interpreted as the EMPATHY LOCUS due to the auxiliary *kureta* attached to the main verb. Similarly in 18, the speaker is naturally interpreted as being closer to *Hanako* than to *Taroo*.

(18) Hanako ga Taroo o tazunete-yatta.
 Hanako SUBJ Taroo OBJ visit-gave
Hanako received a favor in visiting Taroo. EMPATHY = SUBJ = HANAKO

The speaker indicates that she is taking Hanako's perspective by using the past tense form *yatta* of the verb *yaruu* as an auxiliary verb to the main verb *tazuneru*.

As demonstrated in the following examples, a discourse entity that is realized as the EMPATHY LOCUS must already be in the discourse context.

- (19) Taroo ga Ziroo ni okane o kasite-kureta.
 Taroo SUBJ Ziroo OBJ2 money OBJ lend-gave
Taroo gave Ziroo a favor in lending him some money.
- (20) *Taroo ga dareka ni okane o kasite-kureta.
 Taroo SUBJ somebody OBJ2 money OBJ lend-gave
Taroo gave somebody a favor in lending him some money.
- (21) *Taroo ga misiranu hito ni okane o kasite-kureta.
 Taroo SUBJ unknown person OBJ2 money OBJ lend-gave
Taroo gave a stranger a favor in lending him some money.

The contrast between 19, 20, and 21 demonstrates that the use of a BRAND-NEW entity in the EMPATHY LOCUS position of the verb *give* is not acceptable; the position should be filled by a discourse-old entity (Kuno, 1976). Therefore an entity in the EMPATHY-locus position is discourse prominent and is ranked in a higher position on the Cf than the subject.

In this theory, the addition of the discourse entity that is marked as the EMPATHY LOCUS as a position in the Cf ranking is all that is necessary to model this language-specific discourse factor. With EMPATHY in the ranking of the Cf, preferences for CONTINUE over RETAIN when EMPATHY is involved can be demonstrated, as in example 22 below: ¹³

- (22) a. Hanako wa kuruma ga kowarete komatteimasita.
 Hanako TOP/SUBJ car SUBJ broken at a loss-was
Her car broken, Hanako was at a loss.

Cb:	HANAKO
Cf:	[HANAKO, KURUMA]

- b. Taroo ga 0 sinsetu-ni te o kasite-kuremasita.
 Taroo SUBJ OBJ2 kindly hand OBJ lend-gave.
Taroo kindly gave her a favor in helping her.

Cb:	[HANAKO]
Cf:	[HANAKO, TAROO] EMPATHY SUBJ

- c. Tugo no hi 0 0 eiga ni sasoimasita.
 next of day SUBJ OBJ movie to invited
Next day she invited him to a movie.

Cb:	HANAKO		
Cf1:	[HANAKO, TAROO]	CONTINUE	16
	SUBJ OBJ		
Cf2:	[TAROO, HANAKO]	RETAIN	2
	SUBJ OBJ		

In example 22, Hanako is the most highly ranked entity from 22b that is realized in 22c, and therefore must be the Cb. The preferred interpretation will therefore be the *she invited him...*

¹³The verb form *kuremasita* in (23)b is the polite form of *kureta*, the past tense form of the verb *kureru*.

one corresponding to Cf1, that results from the more highly ranked CONTINUE transition, in which Hanako is the preferred center (Cp). But notice that nothing special needs to be said about the fact that EMPATHY is the discourse factor that made Hanako most salient at 22b and thus predicted that Hanako would be the Cb at 22c. The preference in the interpretation follows from the distinction between CONTINUE and RETAIN and the ranking of Cf. Thus, the centering framework is easily adapted to handle this language specific feature.

3.3 Topic and empathy

In general the assignment of the EMPATHY relationship is pragmatic. It is determined by the speaker's relation with the discourse participants in the discourse. In 22, for example, the EMPATHY relationship between the speaker and *Hanako* and between the speaker and *Taroo* is clear: the use of the empathy verb in the second sentence indicates that the speaker is closer to *Hanako* than to *Taroo*.

However, besides cases where the speaker clearly expresses who s/he empathizes with, it is also possible for the context to provide some information about the speaker's proximity relationship with discourse participants in the given discourse, so that the hearer can determine the EMPATHY relation that the speaker has in mind. In this paper, we only consider cases where EMPATHY is morphologically marked. However Kuno's notion of EMPATHY is more general. For instance, Kuno's EMPATHY HIERARCHY consists of different scales for EMPATHY that include notions such as TOPIC and SPEAKER (Kuno, 1987). Kuno's Topic empathy hierarchy suggests that the discourse entity realized as the TOPIC will often coincide with the EMPATHY LOCUS:

(23) *Topic Empathy Hierarchy:*

Given an event or state that involves A and B such that A is coreferential with the topic of the present discourse and B is not, it is easier for the speaker to empathize with A than with B:

Discourse-Topic > Discourse-Nontopic

In support of this, we have found that when no empathy relation is clearly indicated and no topic has been clearly established that it is difficult for a hearer to determine the empathy relation that the speaker intends. In general discourse entities that are both discourse-old and currently SALIENT are taken to be high on the empathy scale. However the discourse entity realized as TOPIC does not necessarily coincide with the discourse entity realized as the EMPATHY LOCUS. A simple sentence to show this point is given below:

- (24) Taroo wa Ziroomi hon o yonde-kuremasita.
 Taroo TOP/SUBJ Ziroomi OBJ2 book OBJ read-gave
Taroo read a book to Ziroomi. EMPATHY = OBJ2 = ZIROOMI

Similarly, the zero does not have to be realized as the EMPATHY LOCUS. In 25b the zero in subject position realizes the Cb and refers to Taroo.

- (25) a. Taroo wa syukudai o zenbu yari-oemasita.
 Taroo TOP/SUBJ homework OBJ all do-finished
Taroo finished (his) homework.

- b. 0 Ziroo ni hon o yonde-kuremasita.
 SUBJ Ziroo OBJ2 book OBJ read-gave
(Taroo) read a book to Ziroo. EMPATHY = OBJ2 = ZIROO

The Cf ranking that we are using ranks TOPIC higher than EMPATHY. The higher degree of salience of the TOPIC over the EMPATHY LOCUS is observed in the different interpretation of (b) sentences in examples 26 and 27. The only difference in these examples is that Taroo is *wa* marked in 26a but is *ga* marked in 27a:

- (26) a. Taroo wa boku no tomodati o gityoo ni osite-kuremasita.
 Taroo TOP/SUBJ I of friend OBJ chairman OBJ2 recommend-gave
Taroo gave my friend a favor in recommending him as chairman.

- b. 0 asu no kaihyoo-kekka o tanosimi-ni siteimasu.
 SUBJ tomorrow of results OBJ look-forward doing-is
(Taroo) is looking forward to tomorrow's results.

- (27) a. Taroo ga boku no tomodati o gityoo ni osite-kuremasita.
 Taroo SUBJ I of friend OBJ chairman OBJ2 recommend-gave
Taroo gave my friend a favor in recommending him as chairman.

- b. 0 asu no kaihyoo-kekka o tanosimi-ni siteimasu.
 SUBJ tomorrow of results OBJ look-forward doing-is
(Taroo) is looking forward to tomorrow's results.
(My friend) is looking forward to tomorrow's results.

The TOPIC *Taroo* is preferred to be interpreted as the unexpressed subject of the (b) sentence in 26. On the other hand, the subject *Taroo* does not have such strong preference as shown in 27: the unexpressed argument in the second sentence in 27 is understood as referring to either *Taroo* or *my friend*. That is, the possible interpretation in these examples shows that the NP *my friend*, which is realized as the EMPATHY LOCUS, is not as salient as the TOPIC¹⁴.

So why is it easier to empathize with a discourse entity that has been the topic as Kuno demonstrates? It seems important to keep the notions of TOPIC and EMPATHY separate, but in section 5.2 we will demonstrate the effect of empathy associating with topic. We claim that the ranking of the Cf and the potential for a CONTINUE interpretation affects whether empathy and topic will tend to be associated. In other words, the tendency to associate follows from more general discourse processing factors, such as a hearer attempting to find CONTINUE interpretations within a given local stretch of discourse.

3.4 Summary

To summarize, we have outlined the roles of discourse markers such as those for TOPIC and EMPATHY by which Japanese grammaticizes some aspects of discourse function and we have argued that both TOPIC and EMPATHY markers indicate entities that are typically both discourse-old and hearer-old. hearer.

¹⁴Although it seems as though empathy isn't higher than subject, the conflating factor is that topic marking establishes a Cb whereas in this case no Cb has been established. See section 4.

One factor that hasn't been discussed is the role of pronominalization, but many researchers have argued that discourse entities realized by pronouns are more salient than other discourse entities (Clark and Haviland, 1977; Grosz et al., 1986; Kuno, 1976; Kuno, 1987). We take zeros in Japanese to be analogous to pronouns in English in this respect. Since pronominalization can apply at any position in the ranking of the Cf, the role of its contribution is particularly interesting when it is in conflict with some other factor such as grammatical function or topic marking. This will be discussed further in section 5.

4 Initial Center Instantiation

INITIAL CENTER INSTANTIATION is a process by which a discourse entity introduced in a segment-initial utterance becomes the Cb. In our framework, this happens as a side effect of the general centering mechanism. Typically, when an interpretation is found for the second utterance in a discourse segment, the Cb that was previously an unbound variable becomes instantiated¹⁵. This occurs because the Cb of an initial utterance U_n is treated as a variable which is then unified with whatever Cb is assigned to the subsequent utterance U_{n+1} . Our claim is that there is a center for every utterance, but in some cases there is only partial information in the discourse at the point of interpretation, and so the center is not bound. This has the effect that in discourse initial utterances the Cf ranking is not a strong constraint as it is once a Cb is established.

The possible interpretation in 28 demonstrates that the instantiation of the Cb defines the course of discourse. In 28a, the fact that the Cb is a variable is indicated by [?]. Then Hanako is instantiated as the Cb when 28b is interpreted. There are two possible CONTINUE interpretations for the third utterance. This follows from the fact that HANAKO has been instantiated as the Cb when the zeros are resolved in 28c.

- (28) a. Hanako ga HP de hataraitemasu.
 Hanako TOP/SUBJ HP at work
Hanako works at HP.

Cb: [?]
Cf: [HANAKO]

- b. 0 Yosiko ni Mitiko o syookaisimasita.
 SUBJ Yosiko OBJ2 Mitiko OBJ introduced
She introduced Mitiko to Yosiko.

Cb: [HANAKO]
Cf: [HANAKO, YOSIKO, MITIKO]
SUBJ OBJ2 OBJ

- c. Tugi no hi 0 0 Ginza no restoran ni sasoimasita.
 next of day SUBJ OBJ Ginza of restaurant to invited
Next day she invited her to a restaurant in Ginza.

¹⁵In (Walker et al., 1990) we called this Center Establishment. Henceforth we will refer to this process as center instantiation in order to avoid confusion with Kameyama's term center establishment, which is a different mechanism in her theory.

Cb:	HANAKO	
Cf1:	[HANAKO, YOSIKO]	CONTINUE
	SUBJ OBJ	
Cf2:	[HANAKO, MITIKO]	CONTINUE
	SUBJ OBJ	

Because Hanako has been instantiated as the Cb, one of the zero's in 28c will be interpreted as Hanako, since in 28b the subject topic Hanako is ranked more highly than both Yosiko and Mitiko. Furthermore we cannot distinguish in advance which discourse entity is the one that is realized by the zero in object position in 28c, so both are proposed as the object of *sasotta* ('invited') and both interpretations are CONTINUE transitions.

A contrast observed with the GA-WA alternation in 29 indicates that a discourse entity that is topic-marked by *wa* is instantiated as the Cb when it is first introduced. As indicated by the translation of each example, there appears to be some ambiguity when *Taroo* is marked with GA in the first sentence.

- (29) a. *Taroo ga Ziroom ni eki de battari aimasita.*
 Taroo SUBJ Ziroom OBJ2 station at by accident met
Taroo met Ziroom at the station by accident.

Cb:	[?]
Cf:	[TAROO, ZIROO]

- b. 0 0 *syokuzi ni sasimasita.*
 SUBJ OBJ2 dinner to invited
He invited him to dinner.

Cb:	TAROO	
Cf:	[TAROO, ZIROO]	16

Cb:	ZIROO	
Cf:	[ZIROO, TAROO]	7

The example above is ambiguous (for 5 informants out of 18), 11 prefer Taroo as the Cb and 2 informants prefer the interpretation where Ziroom is the Cb. We believe this shows that Taroo has not been instantiated as the Cb when it is time to interpret the two zeros in 29b. Thus taking either Taroo or Ziroom to be the Cb can result in a CONTINUE interpretation. By the assumption that the Cb is a variable which unifies with the following Cb and the centering definitions, both of these are CONTINUES. However constraint 3 is violated in the second interpretation of 29b: if you assume that the Cf ordering at 29a is correct then the Cb in 29b must be the most highly ranked entity in Cf of 29a. Our conclusion is that in discourse initial utterances, when no clear indication of topic is given, the Cf ordering based on grammatical function alone is not a strong constraint. Compare 29 with 30.¹⁶

- (30) a. *Taroo wa Ziroom ni eki de battari aimasita.*
 Taroo SUBJ Ziroom OBJ station at by accident met
Taroo met Ziroom at the station by accident.

¹⁶We allowed informants to indicate if they thought two interpretations were equally preferred in testing this discourse sequence. We got less ambiguous results when we forced informants to choose only one interpretation: 29 favored the subject as the Cb and 5 favored the object. We believe that this is attributed to a different degree of prominence associated with arguments.

Cb:	[TAROO]
Cf:	[TAROO, ZIROO]

- b. 0 0 syokuzi ni sasoimasita.
 SUBJ OBJ2 dinner to invited
He invited him to dinner.

Cb:	TAROO
Cf:	[TAROO, ZIROO] 18

Cb:	ZIROO
Cf:	[ZIROO, TAROO] 1

In contrast 30b is not ambiguous. It only has the interpretation of *Taroo invited Ziroo to dinner*. This can be explained by assuming that the TOPIC has acquired the status of Cb when it is first introduced in the discourse initial utterance 30a. This assumption is also supported by the interpretation of the following example.

- (31) a. Taroo ga zikan-doori eki ni tukimasita.
 Taroo SUBJ on-time station at arrived
Taroo arrived at the station on time.

Cb:	?
Cf:	[TAROO]

- b. 0 Ziroo ni battari aimasita.
 SUBJ Ziroo OBJ by accident met
Taroo met Ziroo by accident.

Cb:	[TAROO]
Cf:	[TAROO, ZIROO]

- c. 0 0 syokuzi ni sasoimasita.
 SUBJ OBJ2 dinner to invited
He invited him to dinner.

Cb:	TAROO
Cf:	[TAROO, ZIROO]

The preferred interpretation of the third sentence in 31 is the same as in 30. Here *Taroo* is introduced as the subject, but not the topic, but it has acquired the status of the Cb in the second sentence.

5 Topic ambiguity

A hearer's discourse interpretation process is based on partial information combined with assumptions about cooperative speakers and conventions with respect to the correlation between context, discourse function and syntax. Since a hearer cannot read a speaker's mind, it is necessarily true that at times the hearer may entertain multiple hypotheses as to a speaker's intent. These multiple hypotheses may be related to where the speaker's attention is as much as to any other aspect of discourse understanding. It is this that gives rise to what we will call a ZERO TOPIC. In this section

we will introduce the notion of ZERO TOPIC and a rule or assumption that can be employed as part of the interpretive process called ZERO TOPIC ASSIGNMENT. This rule allows a zero that has previously been established as salient in the discourse to continue to be thought of as the discourse topic.

5.1 Zero Topic Assignment

We propose that ambiguity in discourse can sometimes occur due to the optional assignment of TOPIC to a zero. This is represented by a ZERO TOPIC ASSIGNMENT rule:

Zero Topic Assignment

When no CONTINUE transition is available, and a zero in U_{i+1} represents an entity that was the $Cb(U_i)$, that zero may be interpreted as the TOPIC of U_{i+1} .

What this means is that, in certain discourse environments, the entity that was previously the Cb can continue to be thought of as the Cb , even though it is not placed in a discourse prominent position¹⁷.

This option, as an assumption available to the interpretive process, has been overlooked in previous treatments of zeros in Japanese. ZERO TOPIC ASSIGNMENT (henceforth ZTA) explains why the discourse entity Hanako, which is realized in object position in 32c continues to be salient enough in the dialogue to be the preferred interpretation for the SUBJECT in 32d.

- (32) a. Hanako wa siken o oete, kyoositu ni modimasita.
 Hanako TOP/SUBJ exam OBJ finish classroom to returned
Hanako returned to the classroom, finishing her exams.

Cb: HANAKO
Cf: [HANAKO, exam]

- b. 0 hon o locker ni simaimasita.
 SUBJ book OBJ locker in took-away
She put her books in the locker.

Cb: HANAKO
Cf: [HANAKO, book] CONTINUE

- c. Itumo no yooni Mitiko ga 0 mondai no toki-kata o setumeisi-dasimasita.
 always like SUBJ Mitiko OBJ2 problem solve-way OBJ explain-started
Mitiko, as usual, started explaining how to solve the problems.

Cb: HANAKO	
Cf1: [HANAKO, MITIKO, SOLUTION] [TOP, SUBJ, OBJ]	ZTA CONTINUE
Cf2: [MITIKO, HANAKO, SOLUTION] SUBJ, OBJ2, OBJ]	RETAIN

¹⁷We only look at object topics here but there may be limits as to how unimportant an entity can be and still be thought of as the zero topic, e.g. by-passive agentive.

- d. 0 0 ohiru ni sasimasita.
 SUBJ OBJ lunch to invited
(Hanako) invited (Mitiko) to lunch.

Cb1:	HANAKO		
Cf1:	[HANAKO, LUNCH, MITIKO]	CONTINUE from Cf1(c)	28
	[SUBJ, OBJ2, OBJ]		
Cb2:	MITIKO		
Cf2:	[MITIKO, LUNCH, HANAKO]	SMOOTH-SHIFT from Cf2(c)	6
	SUBJ, OBJ2, OBJ]		

The difference in the attentional state of the speaker is reflected in the fact that in 32, there are two possible Cf lists for 32c; Cf2, is the only list possible without ZTA, and represents a RETAIN rather than a CONTINUE. The fact that there is no CONTINUE transition available triggers ZTA, as per the formulation above.

This leads to a potential ambiguity in 32d, because it is possible for a hearer to simultaneously entertain both of the Cf(32c). The availability of ZTA means that HANAKO can be thought of as the topic and thus be the Cp even when MITIKO is realized as the subject. In this case the ZTA interpretation is preferred. The less preferred SMOOTH-SHIFT interpretation would result from the algorithm's application to Cf2 of 32c¹⁸.

ZTA explains the contrast between the discourse segments in example 32 above and 33 below. The only difference between 32 and 33 is that in 32c, MITIKO is a *ga* marked subject, whereas in 33c, MITIKO is a *wa* marked subject/topic. The utterance 32c, has the same meaning in either case. This minimal pair provides a test to see whether topic ambiguity is actually the discourse phenomenon at work here. The minimal pair consists of replacing 32c with 33. We see that overt topic marking in 33c dampens ZTA and thus affects the interpretation of 33d.

- (33) a. Hanako wa siken o oete, kyoositu ni modimasita.
 Hanako TOP/SUBJ exam OBJ finish classroom to returned
Hanako returned to the classroom, finishing her exams.

Cb:	HANAKO
Cf:	[HANAKO, exam]

- b. 0 hon o locker ni simaimasita.
 SUBJ book OBJ locker in took-away
She put her books in the locker.

Cb:	HANAKO
Cf:	[HANAKO, book] CONTINUE

- c. Itumo no yooni Mitiko wa 0 mondai no toki-kata o setumeisi-dasimasita.
 always like TOP/SUBJ Mitiko OBJ2 problem solve-way OBJ explain-started
Mitiko, as usual, started explaining how to solve the problems.

¹⁸See section 2 for an example of how a smooth-shift interpretation is calculated.

Cb:	HANAKO	
Cf1:	[HANAKO, MITIKO, SOLUTION]	ZTA CONTINUE
	[TOP, SUBJ, OBJ]	
Cf2:	[MITIKO, HANAKO, SOLUTION]	RETAIN
	[TOP, OBJ2, OBJ]	

- d. 0 0 ohiru ni sasimasita.
SUBJ OBJ lunch to invited
She invited her to lunch.

Cb2:	HANAKO		
Cf2:	[HANAKO, LUNCH, MITIKO]	CONTINUE from Cf2(c)	18
	[SUBJ, OBJ2, OBJ]		
Cb1:	MITIKO		
Cf1:	[MITIKO, LUNCH, HANAKO]	SMOOTH-SHIFT from Cf1(c)	16
	[SUBJ, OBJ2, OBJ]		

The *wa* marking has the predicted effect. Because the discourse entity realized as the grammatical topic and indicated by the *wa*-marked NP is often interpreted as the discourse topic, 10 subjects who previously did, can no longer get an interpretation that depends on ZTA. In 33, it is more difficult for hearers to continue to think of Hanako as the discourse topic at 33c, so the RETAIN is more favored than in the parallel utterance in 32c. The RETAIN indicates that these hearers expect the conversation to shift to being about Mitiko; the fact that Mitiko is the Cp(33c), along with constraint 3 will force a shift. Given a SHIFT, i.e. a change in Cb, the *Mitiko invited Hanako to lunch* interpretation is preferred because it is the more highly ranked SMOOTH-SHIFT transition.

If MITIKO could represent a topic object in 33d, there would be another equally ranked SMOOTH-SHIFT interpretation for 33d. However, according to the formulation of ZERO TOPIC ASSIGNMENT, MITIKO can not be a zero topic because it was not the Cb of the previous utterance, 33c.

The astute reader will have noticed that in the cases where Hanako is continued as the discourse topic, the *wa*-marked Mitiko discourse entity is ranked according to its grammatical role position on the Cf list. We conjecture that in the cases where the grammatical topic is not interpreted as the discourse topic that an inference of contrast may be supported. These examples clearly show that the *wa*-marked NP does not always correspond to the discourse topic and also supports Shibatani's claim that the interpretation of *wa* depends on the discourse context (Shibatani, 1990).

5.2 Empathy and Zero Topic Assignment

In the following examples we investigate the interaction of the interpretation of the EMPATHY LOCUS and ZERO TOPIC ASSIGNMENT(ZTA) . The discourse segment in 34 is a minimal pair with that in 35. In 34d the main verb is *setumeisita* ('explain') without any EMPATHY marking, whereas in 35d, the same sentence occurs with an auxiliary empathy verb as *setumeisita-kureta*. Remember that *kureta* marks the OBJ or OBJ2 as the EMPATHY LOCUS.

- (34) a. Taroo wa deeta o konpyuutaa ni utikondeimasita.
Taroo TOP/SUBJ data OBJ computer in was-storing
Taroo was storing the data in a computer.

Cb:	TAROO
Cf:	[TAROO, DATA]

- b. 0 yatto hanbun yari-owarimasita.
 SUBJ finally half do-finished
Finally he was half finished.

Cb:	TAROO
Cf:	[TAROO] CONTINUE

- c. Ziroom ga 0 hurui deeta o misemasita.
 Ziroom SUBJ OBJ2 old data OBJ showed
Ziroom showed him some old data.

Cb:	TAROO	
Cf1:	[TAROO, ZIROO, DATA]	ZTA CONTINUE
	[TOP, SUBJ, OBJ]	
Cf2:	[ZIROO, TAROO]	RETAIN
	SUBJ, OBJ2, OBJ	

- d. 0 0 ikutuka no kuitigai o setumeisimasita.
 SUBJ OBJ2 several of differences OBJ explained
He explained several differences to him.

Cb1:	TAROO		
Cf1:	[TAROO, ZIROO, DIFFERENCES]	CONTINUE from Cf1(c)	12
	[SUBJ, OBJ2, OBJ]		
Cb2:	ZIROO		
Cf2:	[ZIROO, TAROO, DIFFERENCES]	SMOOTH-SHIFT from Cf2(c)	22
	SUBJ, OBJ2, OBJ]		

In 34c we again see that it is possible for some subjects to interpret Taroo as the zero topic. The previous discourse was about Taroo; Taroo was the Cb for 34a and 34b. So two discourse structures are available for 34c, reflecting differences in attentional state, although they have the same meaning. One interpretation involves the assumption that ZTA is in effect and the other interpretation involves the RETAIN transition. Neither interpretation is optimal in discourse coherency and in this case while it appears that subjects have a slight preference for RETAIN which predicts the SMOOTH-SHIFT interpretation of 34d, this preference just misses being significant. It seems that there is not enough syntactic information for subjects to base their inferences on.

However in 35, the speaker provides more syntactic information as to where her attention is by using the empathy verb *kureta* to indicate that the discourse entity realized as the OBJECT is the EMPATHY locus in 35d.

- (35) a. Taroo wa deeta o konpyuutaa ni utikondeimasita.
 Taroo TOP/SUBJ data OBJ computer in was-storing
Taroo was storing the data in a computer.

Cb:	TAROO
Cf:	[TAROO, DATA]

- b. 0 yatto hanbun yari-owarimasita.
 SUBJ finally half do-finished
Finally he was half finished.

Cb:	TAROO
Cf:	[TAROO] CONTINUE

- c. Ziroom ga 0 hurui deeta o misemasita.
 Ziroom SUBJ OBJ2 old data OBJ showed
Ziroom showed (Taroo) some old data.

Cb:	TAROO
Cf1:	[TAROO, ZIROO, DATA] ZTA CONTINUE TOP, SUBJ, OBJ
Cf2:	[ZIROO, TAROO, DATA] RETAIN SUBJ, OBJ2, OBJ

- d. 0 0 ikutuka no kuitigai o setumeisita-KURE-masita.
 SUBJ OBJ2 several of differences OBJ explained-gave
(Ziroom) gave (Taroo) a favor of explaining several differences.

Cb1:	TAROO
Cf1:	[TAROO, ZIROO, DIFFERENCES] CONTINUE from Cf1(c) 33 [EMP-OBJ2, SUBJ, OBJ]
Cb2:	ZIROO
Cf2:	[ZIROO, TAROO, DIFFERENCES] SMOOTH-SHIFT from Cf2(c) 1 EMP-OBJ2, SUBJ, OBJ]

Note that in this case the utterance is no longer ambiguous and EMPATHY associates with the previous Cb to get a CONTINUE interpretation, but the empathy verb in 35d is the only difference between 34, and 35. Thus the preference in interpretation does not follow from inferences based on information about who is likely to explain what to whom, depending on who showed who the data, or whether the data is new or old. In this case it is possible to interpret both 35c and 35d as CONTINUES with the one extra assumption of ZTA at 35c.

Example 36 contrasts minimally with example 35 but on another dimension. In this case the third utterance (c) is a CONTINUE with *Taroo* in subject position, rather than a CONTINUE based on ZTA as in 35. In this case, one interpretation is again clearly preferred.

- (36) a. Taroo wa deeta o konpyuutaa ni utikondeimasita.
 Taroo TOP/SUBJ data OBJ computer in was-storing
Taroo was storing the data in a computer.

Cb:	TAROO
Cf:	[TAROO, data]

- b. 0 yatto hanbun yari-owarimasita.
 SUBJ finally half do-finished
Finally he finished half.

Cb:	TAROO
Cf:	[TAROO] CONTINUE

- c. 0 Ziroo ni hurui deeta o misemasita.
 SUBJ Ziroo OBJ2 old data OBJ showed
(Taroo) showed Ziroo some old data.

Cb:	TAROO		
Cf1:	[TAROO, ZIROO, DATA]	CONTINUE	
	SUBJ, OBJ2, OBJ]		

- d. 0 0 ikutuka no kuitigai o setumeisite-kure-masita.
 SUBJ OBJ2 several of differences OBJ explained-gave
(Ziroo) gave (Taroo) a favor of explaining several differences.

Cb1:	TAROO		
Cf1:	[TAROO, ZIROO, DIFFERENCES]	CONTINUE	26
	[EMP-OBJ2, SUBJ, OBJ]		
Cf2:	[ZIROO, TAROO, DIFFERENCES]	RETAIN	8
	EMP-OBJ2, SUBJ, OBJ]		

Again in this case, we see that EMPATHY associates with the TOPIC entity, the previous Cb, ie. *Taroo*. We claim that this tendency (Kuno, 1976), follows from the ordering of the Cf and the attempt to find a CONTINUE interpretation.

Note that the interpretation of the last utterance remains the same as that in 35d, although in this case it is *Taroo* that shows *Ziroo* some old data in 36c; nevertheless *Ziroo* is the one who does the explaining. It seems that inference from world knowledge and domain information alone is unlikely to predict which interpretations hearers will prefer. These inferential processes must take syntactic information into account to provide constraints and reduce processing time.

5.3 Summary

We proposed a rule of ZERO TOPIC ASSIGNMENT that systematically introduces ambiguity as to the speaker's attentional state in certain discourse situations. Furthermore we have shown that tendencies for different interpretations depends on which discourse entity has previously been the Cb, as well as which entities are currently marked as the grammatical TOPIC and the EMPATHY locus. However we also noted that the preference in interpretation exemplified by the minimal pairs in this section may be affected by other discourse factors. Among these factors, intonation may indicate whether the current utterance should be taken as initiating a new topic and predicting a SHIFT, or continuing the previous one (Pierrehumbert and Hirschberg, 1990). Another factor may be the inferred relationship that holds between adjacent utterances such as whether it is possible to interpret (d) as *Ziroo's* reason for having done (c). However this is clearly not the only factor, or even necessarily the dominant one, as we have demonstrated.

It is important to note that ZTA applies in cases where the only centering transition available otherwise would be a RETAIN. This leads to the speculation that when the Cb is realized by a pronoun in a less prominent position, giving rise to a transition state that would be defined as a RETAIN based on the grammatical function hierarchy or even the Cf ranking including topic and empathy that we use here, that this type of transition is inherently ambiguous. Since different factors contribute to the salience of discourse entities, such as 'subjectness' and 'pronominalization', ambiguity can occur when these are in conflict with one another. This may be especially true in Japanese since another indicator of salience or prominence, namely word order, is not present whenever zeros are involved.

We will not speculate as to whether ZTA applies in English as well. However we would like to comment on the notion of a RETAIN: A RETAIN is proposed as a way for a speaker to mark a coordinated transition to a new topic (Grosz et al., 1986; Brennan et al., 1987). However as first noted by Brennan et al. the formulation of the centering rules and constraints makes a slightly non-intuitive prediction as to what state is preferred following a RETAIN. If the utterance has one pronoun in subject position then it is possible to get a CONTINUE interpretation by taking the previous Cb as the antecedent of the pronoun, despite the fact that it was not the $C_p(U_{n-1})$, ie. not predicted as the next Cb. In two pronoun cases this is not possible. This follows from the fact that constraint 3 is defined in terms of what is REALIZED in the utterance, but what is realized depends on what the pronoun refers to.

6 Related Research

Other researchers working on discourse interpretation have focused on the role of inference (Hobbs, 1985b; Hobbs, 1979). While it is important to elucidate the information needed for inference and the type of inferential process involved in discourse interpretation, it is clear from our examples that syntactic realization has a strong effect on the interpretive process and may provide processing constraints on these inferential processes.

Our analysis builds on top of an earlier analysis using the centering framework that was put forth by Kameyama (Kameyama, 1985; Kameyama, 1986; Kameyama, 1988). Our treatment generalizes some of her results. When Kameyama proposed her property sharing account of centering, the CONTINUE/RETAIN transition states were not a component of centering theory. Thus Kameyama proposed that the binding of Japanese zeros depends on a default preference hierarchy of the properties to be shared between the antecedent and the zero. She uses the property IDENT to describe something similar to Kuno's notion of EMPATHY. Kameyama's account of zero interpretation consists of a PROPERTY-SHARING CONSTRAINT, henceforth PS, and an ANTECEDENT HIERARCHY, henceforth AH, which are as follows:

PROPERTY-SHARING CONSTRAINT: Two zero-pronouns in adjacent utterances, which co-specify the same discourse entity, must share one of the following properties (in descending order of preference): 1) both IDENT and SUBJECT, 2) IDENT alone, 3) SUBJECT-alone, 4) both NONIDENT and NONSUBJECT, 5) NONSUBJECT alone, or 6) NONIDENT alone.

ANTECEDENT HIERARCHY: In a sentence that contains one and only one zero, if it is to have an full NP as its antecedent, the default preference order among its potential antecedent NPs is: Topic > Ident > Subject > Object(s) > Others.

This formulation covers many of the examples in this paper with the added assumption of a SUBJECT IDENT default, ie. subjects are consider to be EMPATHY loci by default. But there are some differences between Kameyama's account and the one given here. For example, we would treat 37 and 38 with the same mechanism but in Kameyama's theory, the PS constraint applies to 37, while the AH applies in 38. In other words, Kameyama's account would predict that there are different processes going on in the resolution of zeros depending on the environments where the zero appears. Note that we use Kameyama's property IDENT here, which corresponds to our term EMPATHY.

- (37) a. Hanako wa repooto o kakimasita.
 Hanako TOP/SUBJ report OBJ wrote
Hanako wrote a report.
- b. 0 Taroo ni aini-ikimasita.
 SUBJ-IDENT Taroo OBJ2 see-went
She went to see Taroo.
- c. Taroo wa 0 kibisiku hihansimasita.
 Taroo TOP/SUBJ OBJ severely criticized
Taroo severely criticized her.

- (38) a. Hanako wa Taroo ni aini-kimasita.
 Hanako TOP/SUBJ Taroo OBJ2 see-came
Hanako came to see Taroo
- b. Taroo wa 0 hon o yonde-kure-masita.
 Taroo TOP/SUBJ OBJ2 book OBJ read-gave
Taroo gave her a favor of reading a book

PS applies in 37c because the previous utterance has a zero, but doesn't apply in 38b. PS predicts that in 37c the zero pronoun will not be interpreted as *Hanako*, since the zero carries the properties [+SUBJ, +IDENT] in 37b and [-SUBJ, -IDENT] in 37c. But in fact 37c is perfectly acceptable under the intended reading of *Taroo severely criticized Hanako* and 38b is likewise acceptable under the reading *Taroo gave Hanako a favor of reading a book*.

Also, as pointed out by Kuno (Kuno, 1989), Kameyama's analysis makes no predictions about zero interpretation in examples like 39 and 40.

- (39) a. Keiko ga Mitiko ni Hanako o syookaisimasita.
 Keiko SUBJ Masayo OBJ2 Hanako OBJ introduced
Keiko introduced Hanako to Mitiko.
- b. 0 0 totemo kiniitteiru yoodesu.
 very-much like seem
She seems to like her.
- (40) a. Hanako wa HP de hataraitemasu.
 Hanako TOP/SUBJ HP at work
Hanako works at HP.
- b. 0 Yosiko ni Mitiko o syookaisimasita.
 SUBJ Yosiko OBJ2 Mitiko OBJ introduced
She introduced Mitiko to Yosiko.
- c. Tugi no hi 0 0 syokuzi ni sasoimasita.
 next of day SUBJ OBJ dinner to invited
Next day she invited her to dinner.

The PS Constraint applies only to two zeros in adjacent sentences, and the AH applies only to sentences that have one zero. Neither of Kameyama's assumptions is applicable in these examples: in 39 there are two zeros, which would block the AH from applying, while in 40 it is not clear what predictions are made as to how the the second zero in (c) gets an interpretation since the AH does not apply.

Many of the examples that are explained in Kameyama's theory by the PS constraint are handled on our account by the distinction between CONTINUE and RETAIN. However, there are a number of cases where PS makes different predictions than our account. In particular note that for examples 32 and 35, Kameyama's SUBJECT IDENT default makes exactly the opposite prediction. 35 is repeated below and annotated with the SUBJECT IDENT default feature.

- (41) a. Taroo wa deeta o konpyuutaa ni utikondeimasita.
 Taroo TOP/SUBJ data OBJ computer in was-storing
Taroo was storing the data in a computer.
- b. 0 yatto hanbun yari-owarimasita.
 SUBJ/IDENT finally half do-finished
Finally he was half finished.
- c. Ziroo ga 0 hurui deeta o misemasita.
 Ziroo SUBJ/IDENT OBJ2 old data OBJ showed
Ziroo showed him some old data.
- d. 0 0 ikutuka no kuitigai o setumeisite-KURE-masita.
 SUBJ OBJ2/IDENT several of differences OBJ explained-gave
He gave him a favor of explaining several differences.

According to PS, the interpretation in which the property IDENT is shared is preferred to the one with SUBJECT shared, and hence, the interpretation *Taroo gave Ziroo a favor in explaining several differences* is preferred. However our survey shows that native speakers prefer the *Ziroo gave Taroo a favor reading*; this is explained by our notion of ZTA.

Our work is also related to that of Kuno (Kuno, 1989), who describes two different types of zeros. PSEUDO-ZERO-PRONOUNS are the result of deletion and occur as the result of one of two deletion strategies, (1) "FOCUS + VERB" DISCOURSE DELETION STRATEGY, and (2) "FOCUS + COPULA" DELETION STRATEGY. Both strategies may delete everything except the focus material and either the verb, strategy(1), or a substituted copula, strategy(2). Both strategies are subject to constraints on the order of deletion (the PECKING ORDER OF DELETION and the FLOW OF INFORMATION PRINCIPLE) which insure that the focus will not be deleted. Since Kuno argues that the position just to the left of the verb is the default focus position in Japanese, this means that a zero in that position is likely to be a REAL-ZERO-PRONOUN (unless the verb itself is the focus).

Kuno also states that pseudo-zero-pronouns must follow the same order and the same syntactic function as their source NPs (Kuno, 1989). Kuno's account can explain examples like the following:

- (42) a. Taroo wa Hanako ga sukida.
 Taroo TOP/SUBJ Hanako fond-of-is
Taroo likes Hanako.
- b. Ziroo wa Natuko ga sukida.
 Ziroo TOP/SUBJ Natuko fond-of-is
Ziroo likes Natuko.

- c. 0 Saburoo mo sukida.
 Saburoo also fond-of-is
Ziroo also likes Saburoo.
 **Saburoo also likes Natuko.*

In this case we would predict the preferred interpretation based on our distinction between CONTINUE and RETAIN. However consider the following example:

- (43) a. Taroo wa Hanako ga sukida.
 Taroo TOP/SUBJ Hanako fond-of-is
Taroo likes Hanako.
- b. Ziroo wa kirai da.
 Ziroo TOP/SUBJ 0 fond-of-is
Ziroo dislikes Hanako.
Taroo dislikes Ziroo.

In this case the interpretation that we would predict as possible would be the *Ziroo dislikes Taroo* (RETAIN) which native speakers rarely get. The *Taroo dislikes Ziroo* interpretation would be an example of ZTA. However we would predict that the *Ziroo dislikes Hanako* interpretation would be dispreferred, but this does not seem to be the case.

Thus our account cannot explain the contrast between these pairs. Moreover this is not due solely to the complexity of the stative verbs used here since we believe, based on preliminary investigation, that the same facts will hold for verbs like *sasotta* which we use elsewhere in our examples. It seems that what is at issue here is the fact that a discourse entity plus an open proposition such as *X likes Y* is what is discourse-old in these examples and not just a discourse entity. Our conclusion is that these enumerated lists and question-answer discourse segments may need an account of discourse center that is broader than that needed for discourse entities realized as NPs. Kuno's constraints on deletion must also be integrated to fully explain when entities or propositions in the discourse may be unexpressed. We leave this as an open issue.

7 Conclusion

In this paper we have attempted to elucidate the role of various types of syntactic marking as an indicator of discourse prominence. We then used this notion of discourse prominence to explain some facts about the interpretation of anaphoric elements in Japanese using the discourse processing framework of CENTERING. We have explored the relationship of different ways to mark salience in Japanese discourse, especially the interaction of such discourse notions as TOPIC and EMPATHY. We have suggested that while there is a correlation between syntax and discourse function, that there is also a useful notion of TOPIC AMBIGUITY, by which a zero is interpreted as continuing a previous discourse TOPIC. We showed how the centering algorithm allows us to formalize constraints on when a zero may be interpreted as a TOPIC.

The preferred interpretation of zeros and the discourse factors which are responsible for each interpretation are summarized below. Remember that in each case the zero in the third utterance was established as the Cb by the previous two utterances:

Third Utterance		Fourth Utterance		Discourse Factor
SUBJECT	OBJECT(2)	SUBJECT	OBJECT(2)	
zero(i)	NP(j)	zero(i)	zero(j)	Continue/Retain
NP(ga)(i)	zero(j)	zero(j)	zero(i)	ZTA
NP(wa)(i)	zero(j)	zero(i) zero(j)	zero(j) zero(i)	WA-effect ZTA
zero(i)	NP(j)	zero(j)	zero(i),empathy	empathy, Continue/Retain
NP(ga)(i)	zero(j)	zero(i)	zero(j),empathy	ZTA and empathy

This analysis suggests that centering may be a universal of context-dependent processing of language, although so far this theory has only been applied to English, Japanese and Italian (Brennan et al., 1987; Walker, 1989; Walker et al., 1990; Dieugenio, 1988). We proposed that the centering component of a theory of discourse interpretation can be constructed in a language independent fashion, up to the declaration of a language-specific value for one parameter of the theory, i.e., Cf list ranking (as in section 2). This parameter is language-dependent because different languages offer different means of expressing discourse function.

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