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The Role of Accessibility and Identifiability in Accounting for Japanese Zero Pronouns

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Abstract

This paper describes a model to account for the appropriate usage of Japanese zero pronouns in context. The context of an utterance is modeled as a set of situations. The usage of a zero pronoun is explained in terms of the conditions under which the antecedent can be identified among entities in the situations that the zero pronoun has access to. In particular, I propose the identifiability condition on a situation about social relationships between participants, and the accessibility condition described in terms of subordinate relationships between situations. These conditions have not been captured in existent models.

1 Introduction

Linguistic expressions can convey a variety of informational content according to the context in which the expressions are used. Referring expressions such as pronouns and definite expressions, can be regarded as such context-dependent expressions. In Japanese dialogues, context dependent expressions called elliptical sentences are frequently used. In a Japanese elliptical sentence, references to entities previously introduced into a dialogue are not realized as overt referring expressions. In this case, we can assume that Japanese elliptical sentences contain zero pronouns, which can be taken as anaphoric referring expressions[1].

The usage of referring expressions such as Japanese zero pronouns can be explained in terms of the notions of accessibility and identifiability. The notion of accessibility concerns the linguistic conventions by virtue of which a referring expression has access to discourse entities already introduced into a dialogue. The entities which a referring expression has access to can be regarded as candidates for the antecedent of the referring expression. The notion of identifiability concerns the criteria by which the antecedent of a referring expression can be distinguished from other candidates. A referring expression can be used when the antecedent can be identified among the entities that it has access to.

A diverse set of models has been proposed to provide an account of the usage of referring expressions. These include a model of discourse structure to account for the usage of referring expressions [9], models of the continuity of local focus of attention, what is called center, to

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[1]In this paper, I use the term, *zero pronoun*, only for convenience. I do not claim that a Japanese elliptical sentences have zero pronouns as their constituents. The point is that a Japanese elliptical sentence does not have constituents corresponding to a portion of the informational content that it conveys, and the process to determine the omitted content can be taken as similar to the process to determine the entity described by referring expressions such as overt pronouns according to the context.

identify the referents of Japanese zero pronouns [8, 13, 20] and models based on plan inference to interpret elliptical sentences [3, 16]. In the model of discourse structure, the notion of the participants' focus of attention is defined. As I will describe in section 2, referring expressions has easy access to entities in focus of attention. Constraints on the continuity of center can be used as a criterion relating to the identifiability.

However, the existent models are not sufficient for accounting for Japanese zero pronouns: *(i.e.)* there are cases where a zero pronoun does not have access to entities in focus of attention, and there is other criterion than constraints on the continuity of center, by which to identify the antecedent of a zero pronoun.

In this paper, I will provide an account of the usage of Japanese zero pronouns [2] which the existent models have not captured. In the following, in section 2, I describe problems with existent models in terms of the notions of accessibility and identifiability, and clarify the role these notions play in accounting for zero pronouns. From the considerations, in section 3, I present a model of the usage of zero pronouns to settle the problems. The model aims at serving as an underlying framework to interpret and generate Japanese elliptical sentences with zero pronouns. Based on the model, in section 4, I show how the model can treat cases that the existent models can not capture. Finally, in section 5, I summarize the claims of this paper, and clarify in what respects this model has an advantage over, and is discerned from, previous approaches.

2 Problems with Existent Approaches

2.1 Existent Approaches

The notions of accessibility and identifiability play a role in existent models of referring expressions. Grosz *et al.* have provided an account of referring expressions based on a model of discourse structure [9]. Referring expressions have easier access to entities in the participants' focus of attention than the other entities. [3].

Moreover, the use of pronouns such as Japanese zero pronouns can be explained by exploiting the notion of center [8, 13, 20]: *(i.e)* when adjacent sentences in the same discourse segment continue centering the same entity, subsequent references to the center are pronominalized. As shown in section 2.2, constraints on the continuity of the center are related to a criterion, by which the antecedent of a zero pronoun is identified among the entities to which the zero pronoun has access. In fact, the mechanisms that Dale developed to generate referring expressions [4] can be explained in terms of these two notions [4].

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[2] In this paper, I ignore the cases where zero pronouns refer to the entities that are not explicitly introduced in the course of discourse.

[3] Grosz *et al.* have proposed a model of discourse structure and provided an account of referring expressions based on the model [9]. In the model, discourse structure is composed of three interrelated components: the linguistic structure, the intentional structure and the attentional state. The linguistic structure consists of discourse segments, into which utterances in a discourse naturally combine. There are embedding relationships between discourse segments, which are determined by the intentional structure. This means that entities introduced into a discourse segment constitute a space and the spaces are hierarchically related to each other according to the intentional structure. The attentional state shows the spaces in the participants' focus of attention. When an expression is used in a discourse segment, participants draw attention to the space associated with the segment and the higher segment in the hierarchical structure of spaces. Referring expressions can be used when the antecedent of the expressions is included in a space in the focus of attention. In other words, referring expressions have access to entities in the space in the focus of attention.

[4] Dale developed mechanisms to generate referring expressions based on the model of discourse structures [4]. In the mechanisms, subsequent references to the center are pronominalized. Moreover, reference to other entities in cache memory may also be pronominalized, provided the center is pronominalized. Cache memory in Dale's model contains the entities referred to in the previous utterance[4, p.69]. Namely, cache memory in Dale's

Finally, plan-based approaches have been proposed to interpret elliptical sentences[3, 16] [5]. They can be considered to have elaborated on discourse structure by exploiting the descriptive framework of plan schema. In the following, I show cases where the existent models can not account for the appropriate usage of zero pronouns in Japanese dialogues.

2.2 Problems relating to the Identifiability

Consider the following dialogue (d1) between a secretary(S) at a conference office and a questioner(Q). An English sentence follows the Japanese ones only for easy comprehensibility.

Dialogue (d1)

(s1) Q:Donoyouni kaigi ni sanka-sure-ba yoi-desu ka?

(How can I apply to the conference?)

(s2) S:Touroku-yousi   ni   kinyusuru-hituyougaari-masu.
   registration form Obj2 fill-need-Polite

(You need to fill in the registration form.)

(s3) S:Mou   o-mochi-deshou ka?
   already have-Respect   Question

(have you got one?)

(s4) Q:Iie.
   no

(No.)

(s5) S:Dewa, o-okuri-si-masu.
   then   send-Condescend

(Then, I will send you one.)

In sentence (s3) of the above dialogue, both the subject and object role of the verb 'o-mochi (have)' are zero-pronominalized. The zero pronoun corresponding to the subject role describes questioner Q, and that corresponding to the object role describes an entity of being a registration form. The antecedents of these zero pronouns are questioner Q and a type, being a registration form, respectively. The two entities have already been introduced by the precedent sentence (s2). In using sentence (s3), they are in the focus of attention according to the model of discourse structures [9]. Thus, the zero pronouns have access to these entities. For the zero pronouns to be appropriately used, the antecedent of each zero pronoun must be identified among these two entities according to some criteria.

First, selectional restriction associated with the verb 'o-mochi (have)' is regarded as such a criterion. Secondly, constraints on the continuity of center [13, 20] are related to such a criterion. The usage of zero pronouns that continues centering the same entities in a discourse is preferred over the other usages. The center of sentence (s2) is questioner Q, according to the models of centering. If the zero pronoun corresponding to the subject in sentence (s3) is

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model can be taken as composed of entities that referring expressions have access to. Some constraints on the continuity of center are used to identify the antecedent of a referring expression among entities in cache memory.

[5]Plan-based approaches can be considered to have provided a certain account of the usage of elliptical sentences in the context, although they mainly concern the interpretation. Plan-based models interpret elliptical sentences by virtue of strong predictions of the contents of subsequent sentences from the plan structures that the participants draw attention to, and merge elliptical sentences with the predicted contents by force.

used to refer to Q, the usage continues centering the same object, Q. The other usage of zero pronouns in (s3) does not continue centering Q. Therefore, the antecedent of the zero pronoun corresponding to the subject can be identified with Q, and that of the zero pronoun for the object role can be identified with a type, being a registration form.

However, in Japanese dialogues, pragmatic constraints on the usage of honorific expressions [5] [6] are also related to such a criterion. For example, in sentence (s3), the verb 'o-mochi' is a honorific one. In the usage, the subject of the verb must describe a person that the speaker treats as being higher in social relationships than himself. In this dialogue domain, the participants are expected to respect each other. Thus, the referent of the zero pronoun can be identified with the speaker, questioner Q. In addition, there are cases where this criterion has an advantage over that pertaining to the continuity of center. For example, in sentence (s5), the subject of the verb 'o-okuri-si(send)' is zero-pronominalized. The referent must be secretary S. This usage does not continue centering Q. However, the verb is a condescending form of sending, and the subject must describe a person that the speaker, S, treats as being lower than himself. In this domain, it can be identified with secretary S. Therefore, the use of the zero pronoun in sentence (s5) can be explained by the criterion relating to social relationships between participants, although that relating to the continuity of the center is not available [7].

2.3 Problems relating to the Accessibility

Consider the following dialogue (d2).

Dialogue (d2)

(s6) Q:Donoyouni kaigi ni sanka-sure-ba yoi-desu ka?

(How can I apply for the conference?)

(s7) S:Touroku-yousi ni kinyusuru-hituyougaari-masu.
registration form Obj2 fill-need-Polite

(You need to fill in the registration form.)

(s8) S:Sorekara kaigi-jimukyoku ni okut-tekudasai.
Demonstrative adverb conference-office Obj2 send-please
(then)

(s9) Kaigi-jimukyoku ni okut-tekudasai. (*)
conference-office Obj2 send-please

(s10) Sochira wo kaigi-jimukyoku ni okut-tekudasai.
Demonstrative Obj conference-office Obj2 send-please

(Then send it to the conference office, please)

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[6]Pragmatic constraints on the use of honorific expressions are regarded as one of the criteria by which the antecedent of zero pronouns are identified among the candidates. In addition, there are other kinds of pragmatic constraints on the use of surface linguistic expressions in Japanese dialogues [5]. These include constraints on the use of a donatory verb relating to the speaker's empathy [15], and those imposed on the use of sentences with particular sentence-final expressions relating to the territory of information[14].

[7]The indirect object of the verb 'o-okuri-si(send)' in (s5) of dialogue (d1) is also zero-pronominalized. The zero pronoun can be identified with questioner Q according to another criterion pertaining to the disjoint reference principle [19]. The disjoint reference principle says that zero pronouns occurring in the same predicate are disjoint. In sentence (s5) of dialogue (d1), the zero pronouns corresponding to the subject and indirect object of the verb 'o-okuri-si(send)' must be disjoint. The referent of the zero pronoun for the subject role is identified with secretary S. Therefore, another zero pronoun must refer to questioner Q.

Using sentence (s7) introduces the entity of being a registration form. Secretary S intends to request questioner Q to send the entity to the conference office by using either sentence (s8), (s9) or (s10). In using these sentences, the entity introduced by sentence (s7) is in the focus of attention.

First, in sentence (s8), the object of the verb 'okut(send)' is zero-pronominalized. The zero pronoun can refer to the entity. Note that sentence (s8) is used with a demonstrative adverb 'sorekara'. Secondly, sentence (s9) is used without a demonstrative adverb. The object of sending is also zero-pronominalized. However, the use of sentence (s9) is not relevant to the context. The zero pronoun in (s9) can not refer to the entity of being a registration form. Finally, in sentence (s10), a demonstrative, 'sochira', can be used to refer to the entity. Sentence (s10) can be appropriate, although the sentence is used without the demonstrative adverb 'sorekara'.

In sentence (s9), the zero pronoun does not have access to the entity [8], although the entity is in the focus of attention. In addition, both the demonstrative adverb in sentence (s8) and the demonstrative pronoun in (s10) are related to the linguistic conventions by virtue of which a referring expression has access to the antecedent.

Now, let me compare sentence (s9) and sentence (s3) of dialogue (d1). In dialogue (d1), sentence (s3) has zero pronouns corresponding to both the subject and object role of having. The antecedents are questioner Q and a type, being a registration form. The zero pronouns in (s3) have access to the antecedents, because they are in the focus of attention. On the other hand, in using sentence (s9), the zero pronoun does not have access to the entity.

The difference between sentence (s3) and (s9) is as follows. In dialogue (d1), sentence (s2) introduces an event, "Q fills in a registration form." In sentence (s3), the antecedents of the zero pronouns are questioner Q and a type, being a registration form. They are not existentially quantified within the event. On the other hand, in dialogue (d2), the intended antecedent of the zero pronoun in sentence (s9) is the entity that is existentially quantified within the kind of event sentence (s7) introduces.

This phenomenon is not peculiar to this dialogue example. A similar phenomenon can be found in the following dialogue example, (d3).

Dialogue (d3)

(s11) Q:Yokoushu wo morae-masu ka?

  (Can I get the proceedings?)

(s12) S:Ronbun ga happyousa-reru tabini,   ronbun no   kopii ga kubara-re-masu.
    paper   Sbj present-Passive every   paper   Gen copy Sbj hand-out-Passive
  (Every time a paper is presented,   a copy of the paper is handed out.)

(s13) S:Sono-tsudo   goran-kudasai.
    Demonstrative adverb see-please
    (on each occasion)

  (On each occasion, see it, please.[9])

(s14) Sochira   wo goran-kudasai.
    Demonstrative   Obj see-please

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[8]From the considerations in section 2.2, in both sentence (s8) and (s9), the antecedent of the zero pronoun corresponding to the object of sending can be identified with the entity of being a registration form introduced by (s7). Therefore, the anomaly of the use of the zero pronoun in sentence (s9) can not accounted for in terms of the notion of identifiability.

[9]I do not care whether the use of the pronoun 'them' in this English sentence is relevant or not. I concentrate on the relevance of Japanese sentences displayed in this example.

(s15) Goran-kudasai.(*)
         see-please

In the above dialogue (d3), sentence (s13) has a zero pronoun corresponding to the object role of seeing. The sentence is used with a demonstrative adverb, 'sono-tsudo'. The demonstrative adverb can refer to an iterative event. The zero pronoun can be appropriately used to refer to the entity of being a copy of the paper, which is existentially quantified in the iterative E-situation already introduced by sentence (s12). Without the demonstrative adverb, a zero pronoun can not be used in sentence (s14). Sentence (s15) is relevant, which is used together with a demonstrative pronoun, 'sochira'.

Consequently, the accessibility of entities described in terms of the participants' focus of attention in the existent model of discourse structure is not sufficient to account for Japanese zero pronouns. The existent model can apply to the case where the antecedents of zero pronouns are either types or entities such as participants, which are not existentially quantified within events previously introduced into a dialogue. However, it can not apply to the cases where the antecedents are existentially quantified in such events. Likewise, the existent plan-based models can not discern sentence (s9) from relevant sentences, (s8) and (s10), unless the models are extended to account for distinctions in the accessibility of discourse entities among these sentences according to plans shared between the participants.

3 A Model

In this section, I will present a model of the usage of zero pronouns based on Situation Theory [2] [10]. Situation Theory is suitable for the basis of this model in that it allows for a variety of situations constituting the context of linguistic expressions, and the relationships between situations [11].

3.1 A Descriptive Framework for Discourse Entities

First, I present a descriptive framework for discourse entities. In a dialogue, participants use linguistic expressions to describe various objects such as illocutionary acts [18], events in the dialogue domain and individuals. Using linguistic expressions introduces the objects described by the expressions. Likewise, types referred to in linguistic expressions are also introduced. Moreover, individuals such as the questioner and the secretary are assumed to exist. These objects are discourse entities, which the participants can talk about in subsequent utterances. In this model, both individuals and types are regarded as the antecedents of zero pronouns[12].

Both illocutionary acts and events introduced into a dialogue are treated as situations in Situation Theory. There are other situations than these two kinds of situations. Situations used in this model are as follows.

1. Dialogue situation DS: a situation about the individuals which are assumed to exist in a dialogue.

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[10]In this paper, I use the descriptive device that Situation Theory provides. I try to mention the meaning of the representations each time they appear. However, I can not explain this in detail because of space limitations in this paper. For further details, see either Appendix which contains a glossary for representations used in this paper, or the bibliography [2, 7].

[11]Situation Theory is not the only candidate that this model can be based on. Other theories such as the Theory of Mental Spaces [6] or Discourse Representation Theory [11] are also available, in which hierarchically related spaces/situations are allowed for.

[12]This model does not treat zero pronouns referring to events already introduced into a dialogue.

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2. Utterance situation US: a situation about the fact that a speaker utters a sentence to a hearer.

3. Social situation SS: a situation about social relationships between participants.

4. Illocutionary act situations (**IA-situations** for short) IA_i: situations about illocutionary acts.

5. Linguistic resource situation (**LR-situations** for short) LR_i: a situation about types referred to in a sentence.

6. Event situations (**E-situations**, for short) E_i: situations about an extralinguistic event in the dialogue domain.

Judging from the discussion in section 2, social situations are required, and the distinction between LR-situations and E-situations is significant.

For example, either sentence (s7) in dialogue (d2) or sentence (s2) in dialogue (d1) describes an IA-situation, IA_1. The content of the IA-situation is the illocutionary act of asserting the necessity of an E-situation, E_1, in which the questioner, Q, fills in an individual, I_1, of being a registration form. A noun, 'touroku-yousi (registration form)' describes the individual, I_1. These discourse entities are introduced into dialogue. Likewise, an LR-situation, LR_1, is introduced, which contains a type, T_1, being a registration form.

Note that individual I_1 of being a registration form exists relative to E-situation E_1. This means that the individual is existentially quantified within the E-situation. In this case, the E-situation is said to *support* the individual. On the other hand, the questioner Q is not existentially quantified within E-situation E_1, although the questioner is an element of the E-situation. In this case, the E-situation is said to *contain* the questioner, but it does not support the questioner.

The discourse entities introduced by either sentence (s7) or (s2) are represented as follows.

(r1) $(IA_1 : T_2)$.
      $(E_1 : T_3)$.
      $(I_1 : T_1)$.
      $(E_1 \models I_1)$.
      $(E_1 \ni Q)$.
      $(LR_1 \ni T_1)$.
      $T_2 \stackrel{\text{def}}{=} [^*s \mid {}^*s \models \ll \text{Asserting, S, Q,} \ll \text{Need}, T_3 ;1 \gg ;1 \gg]$.
      $T_3 \stackrel{\text{def}}{=} [^*s \mid \exists {}^*x \, ({}^*s \models \ll \text{Fill-in, Q,} \, {}^*x_{\ll T_1, \, {}^*x ;1 \gg} ;1 \gg)] = [^*s \mid {}^*s \models \ll \text{Fill-in, Q, } I_1 ;1 \gg]$.
      $T_1 \stackrel{\text{def}}{=} [^*w \mid \ll \text{R-Form}, {}^*w ;1 \gg]$.

In the above, descriptions from Situation Theory are used. I will explain those descriptions shortly (See Appendix for detail). The following form is called an infon.

(r2) $\ll R, \, o_1, \ldots, o_n ; p \gg$.

The infon shows the fact that objects $o_1, \ldots, o_n$ stand in relation R when the polarity, p, is 1, and the objects do not stand in relation when the polarity, p, is 0.

The following form is called a type.

(r3) $[^*x \mid P(^*x)]$

This represents a type, which classifies an object *x such that proposition P(*x) holds true. A type represents the content of the object that the type classifies. In the description, a symbol starting with '*' is called a parameter, and behaves like a label. A representation,

(r4) $*x_{P(*x)}$

is called a restricted parameter, which describes a parameter, *x, such that proposition P(*x) holds true.

In addition, the following propositions are used.

(r5) (x : T(x)): object x is classified by type T(x).

(r6) (s $\models \sigma$): situation s supports infon σ. This means that the infon is a fact relative to situation s

(r7) ($\models \sigma$): there is a situation supporting infon σ. In other words, σ is a fact independent of situations.

(r8) (s $\models$ i): situation s supports individual i.

(r9) (s $\ni$ i): situation s contains individual i.

In this model, dialogue situation DS and social situation SS are assumed to exist. The following propositions hold true.

(r10) (DS $\models$ Q).
      (DS $\models$ S).
      (DS $\models$ Conf).

(r11) (SS $\models$ «Honor_rel, Q, S, Q »∧
          «Honor_rel, S, Q, S »).

In the above, S, Q and Conf denote the secretary, the questioner and the conference office, respectively. The above propositions, (r10), say that DS supports questioner Q, secretary S, conference office CO. The proposition, (r11), says that questioner Q treats secretary S higher than himself Q, and secretary S treats questioner Q higher than himself S.

Note that, in representations, (r1), E-situation E_1 contains questioner Q, although it does not support Q. Dialogue situation DS supports Q. This is not contradictory, because, in this model, dialogue situation DS is regarded as *larger* [13] than any E-situation.

3.2 Contexts of Utterances

The participants use linguistic expressions to describe an object by exploiting their context. In this model, the context of an utterance is regarded as a set of situations. These situations include the dialogue situation, the social situation, the utterance situation, and both E-situations and LR-situations that have been already introduced into the dialogue.

For example, in using sentence (s8), (s9) or (s10) in dialogue (d2), situations displayed in (r1) serve as the context. Likewise, in using sentence (s3) of (d1), these situations serve as the context.

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[13]That a situation, s_1, is larger than another situation, s_2, means that situation s_2 can contain individuals supported by situation s_2. Namely, the scope of the existential quantifier quantifying individuals supported by situation s_1 contains situation s_1.

3.3 Parametric Contents Conveyed by Sentences

A linguistic expression conveys the informational content of the described objects. A sentence with zero pronouns initially conveys parametric content, in which the referents of the zero pronouns are parameterized. By exploiting the context, the parametric content can be equal to the intended content that the speaker wants finally to convey. The intended content is that of the IA-situation which the speaker intends to describe by the sentence.

For example, the parametric content of sentence (s9) in (d2) is written as follows.

(r12) $(IA_2 : T_4)$.
$(E_2 : T_5)$.
$T_4 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Requesting, S, Q, } T_5 ;1\gg]$.
$T_5 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Send, Q, Conf, } *f_1 ;1\gg]$ [14].

In the above, both IA-situation IA_2 and E-situation E_2 are objects that are to be described when sentence (s9) is used. In type T_5, parameter $*f_1$ represents the described object of the zero pronoun corresponding to the object role of the verb 'okut(send)' in sentence (s9). The parameter is to finally denote the individual, I_1 in representations (r1), of being a registration form, which has already been introduced in the precedent sentence (s7). The intended content is written as follows.

(r13) $(IA_2 : T_6)$.
$(E_2 : T_7)$.
$(E_2 \ni Q)$.
$(E_2 \ni \text{Conf})$.
$(E_2 \models I_1)$.
$T_6 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Requesting, S, Q, } T_7 ;1\gg]$.
$T_7 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Send, Q, Conf, } I_1 ;1\gg]$.

The above content is also the intended content that either sentence (s8) or (s10) is to convey. The parametric contents of both sentences are shown in section 4.

Likewise, the intended content of sentence (s3) in dialogue (d1)is written in the following representations, (r14). The parametric content is shown in section 4.

(r14) $(IA_3 : T_8)$.
$(E_3 : T_9)$.
$(I_2 : T_{10})$.
$E_3 \models I_2$.
$T_8 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Questioning, S, Q, } T_9 ;1\gg]$.
$T_9 \stackrel{\text{def}}{=} [*s \mid *s \models \ll\text{Have, Q, } *x_{\ll T_{10}, *x ;1\gg} ;1\gg] = [*s \mid *s \models \ll\text{Have, Q, } I_2 ;1\gg]$.
$T_{10} \stackrel{\text{def}}{=} [*w \mid \ll\text{R-Form, } *w ;1\gg]$.

In the above, individual I_2 exists relative to E-situation E_3. The individual does not co-refer to the individual, I_1 [15], of being a registration form which has already been introduced by the precedent sentence (s2) [16].

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[15]The individual, I_1 is displayed in representations (r1). The representations are used for both described objects of sentence (s7) in dialogue (d2) and sentence (s2) in dialogue (d1).

[16]Following Karttunen's terminology [12], the individual, I_2, can be considered as specific only in E-situation E_9.

3.4　Constraints for an Account of Zero Pronouns

As stated in section 3.3, the content of the described object of a sentence with zero pronouns can be represented as either the parametric content or the intended content. Accounting for the use of zero pronouns means elucidating the condition under which the parametric content and intended content are equal.

For example, the parametric content of sentence (s9) is represented as (r12). The intended content is represented as (r13). If sentence (s9) is used appropriately, these two representations must describe the same content. In particular, parameter $*f_1$ in (r12) and individual I_1 in (r13) must describe the same object, that is, I_1 itself. In fact, as described in section 2.3, they must not describe the same content. The reason is explored in section 4.

Constraints serve this purpose. A constraint is written as below.

$$(r15)\quad *s \ni R_1 \Leftrightarrow *s \ni R_2 \text{ under } C.$$

In the above, a representation, R_1, is for a parametric content, and a representation, R_2, is for an intended content. The described object is contained by situation $*s$. C is the condition under which these representations can represent the same content. The condition is imposed on the current context, which is described in terms of the notions of accessibility and identifiability. When the condition holds true, both representation can be used to describe the same object.

The process of generating and interpreting sentences including zero pronouns can be explained by constraints. Given a representation, which represents the intended content of a sentence to be generated, the generation process is regarded as the process of rewriting the representation to another representation for parametric content through constraints, while guaranteeing that the conditions associated with the constraints are satisfied. The interpretation process is the converse one.

4　An Account of Zero Pronouns Based on the Model

The problem of accounting for zero pronouns are divided to two problems: *(i.e.)* that of how the parametric contents of relevant sentences such as sentence (s3) in dialogue (d1) and sentence (s8) in (d2) are represented, and that of how constraints are written to relate these parametric contents and the intended content.

4.1　Identifiability

From the consideration in section 2.2, the parametric content of sentence (s3) must be represented as follows.

$$(r16)\quad (IA_3 : T_{11}).$$
$$(E_3 : T_{12}).$$
$$T_{11} \stackrel{\text{def}}{=} [\,*s \mid *s \models \ll\text{Questioning, S, Q, } T_{12}\,;1\gg].$$
$$T_{12} \stackrel{\text{def}}{=} [\,*s \mid *s \models \ll\text{Have, } *x_{\sigma(*x)}, *f_2\,;1\gg].$$
$$\sigma(*w) \stackrel{\text{def}}{=} \ll\text{Honor-Rel, } *sp_{\ll\text{Speaker, } *sp\,;1\gg}, *w, *sp\,;1\gg.$$

In the above, parameter $*x$ is for the zero pronoun corresponding to the subject of the sentence, parameter $*f_2$ is for the zero pronoun corresponding to the object role. The restriction $\sigma(*x)$ on parameter $*x$ comes from the use of the honorific verb 'o-mochi'. Parameter $*sp$ is for the speaker, S. This restriction serves as a criterion by which to identify the described object of parameter $*x$, because parameter $*x$ satisfying the restriction can be identified with the questioner, Q, by exploiting the social situation, SS, whose content is displayed in representation (r11).

4.2 Accessibility

4.2.1 Weak accessibility

From the consideration in section 2.3, LR-situations are accessible if they are in the focus of attention. In using sentence (s3) of dialogue (d1), the context is represented as a set of situations in representations (r1). LR-situation LR_1 contains a type of being a registration form. The type can be exploited in using the zero pronoun represented as parameter $*f_2$ in the parametric content, (r16) of the sentence, because the LR-situation is in the focus of attention.

I propose the notion of weak accessibility to explain the usage of the zero pronouns which refer to the types already introduced.

(c1) An E-situation, e_1, has weak access to an LR-situation, lr_1, if LR-situation lr_1 is in the participants' focus of attention [9].

Consequently, a zero pronoun can exploit a type already introduced, when the E-situation which contains the parameter denoted by the zero pronoun has weak access to the LR-situation which contains the type. The following constraint (r17) is used to account for this usage of zero pronouns.

(r17) $(*s \ni *x) \Leftrightarrow (*s \ni *x_{\ll *T, *x ;1 \gg})$
     under $(*rs \ni *T) \wedge (\models \ll W\_Access, *s, *rs ;1 \gg) \wedge (\models \ll Ident, *T ;1 \gg)$.
     where $*rs$ is an LR-situation and $*T$ is a type.

In the above, the following representations are used.

(r18) $\ll Ident, x ;1 \gg$: entity x is identifiable.

(r19) $\ll W\text{-}Access, s, w ;1 \gg$: situation s has weak access to situation w.

This constraint can explain how parameter $*f_2$ in the parametric content, (r16), of sentence (s3) convey the intended content, (r14).

4.2.2 Strong accessibility

Next, I consider the usage of the zero pronouns which refer to individuals supported by E-situations already introduced. In dialogue (d2), relevant sentence (s8) is used with a demonstrative adverb, 'sorekara'. The usage of the demonstrative adverb enhances the accessibility of the individual, I_1, of being a registration form, which is supported by E-situation E_1, which has been introduced by sentence (s7) . The function of the demonstrative adverb is to relate E-situation E_2, which is to be described by sentence (s8), to E-situation E_1. Namely, E-situation E_2 is interpreted as an extension of E-situation E_1. In this case, E-situation E_2 is said to be subordinate to E-situation E_1. This implies that (1) individual I_1 gets to be supported by E-situation E_2, and (2) individual I_1 is regarded as existentially quantified within E-situation E_2. Namely, the scope of the existential quantifier is also extended. This subordinate relationship is indicated by virtue of the linguistic convention associated with the demonstrative adverb. A demonstrative pronoun, 'sochira' in sentence (s10) has the same force. Therefore, the parametric content of sentence (s8) must be written as follows.

(r20) $(IA_2 : T_{13})$.
     $(E_2 : T_{14})$.
     $T_{13} \stackrel{\text{def}}{=} [*s \mid *s \models \ll Requesting, S, Q, T_{14} ;1 \gg]$.
     $T_{14} \stackrel{\text{def}}{=} [*s \mid *s_{C_1(*s, *e)} \models \ll Send, Q, Conf, *f_3 ;1 \gg]$.
     $C_1(*s, *e) \stackrel{\text{def}}{=} \ll Subordinate, *s, *e_{\ll Ref\text{-}Sit, sorekara, *e ;1 \gg} ;1 \gg$.

Parameter $*f_3$ is for a zero pronoun. In the above, the following representations are used.

(r21) ≪Subordinate, s, e ;1≫: situation s is subordinate to situation e.

(r22) ≪Ref-Sit, Demo, e ;1≫: demonstrative adverb Demo is used to refer to situation e.

From the above consideration, I propose the notion of strong accessibility to explain the use of the zero pronouns which refer to the entities supported by E-situations.

(c2) An E-situation, e_1, has strong access to another E-situation, e_2, when E-situation e_2 is in focus of attention and E-situation e_1 can be taken as subordinate to E-situation e_2.

Consequently, a zero pronoun can refer to an entity already introduced, when the E-situation, e_1, which contains the parameter denoted by the zero pronoun has strong access to the E-situation, e_2, which supports the entity. It is especially crucial that, in this case, some linguistic expressions must be used to indicate that E-situation e_1 is subordinate to E-situation e_2.

Zero pronouns are not associated with linguistic conventions to indicate such subordinate relationships. For zero pronouns to refer to entities, the other linguistic expressions such as demonstrative adverbs must be used with zero pronouns to indicate the subordinate relationships. A zero pronoun appearing in sentence (s9) is irrelevant, because such linguistic cues are not used with the zero pronoun.

The following constraint (r23) is used to account for the usage of zero pronouns to refer to entities. This constraint can account for how parameter $*f_3$ in the parametric content, (r20), of sentence (s8) convey the intended content, (r13).

(r23) $(*s \ni *x) \Leftrightarrow (*s \ni *i_{(*sae \models *i)})$
under $(*wae \ni *i) \wedge (\models ≪\text{W-Access}, *s, *wae ;1≫) \wedge (\models ≪\text{Ident}, *i ;1≫) \wedge$
$(\models ≪\text{Subordinate}, *s, *sae ;1≫)$,
where both $*sae$ and $*wae$ are event situations.

As a special case, an E-situation, e_1, has access to individuals supported by dialogue situation DS and contained by another E-situation, e_2, when E-situation e_2 is in the focus of attention. Because dialogue situation is larger than any E-situation. Therefore, the parameter, $*x$, in parametric content (r16) of sentence (s3) has access to the questioner Q according to the weak accessibility.

5 Conclusion

In this paper, I provided an account of the use of Japanese zero pronouns which the existent models have not captured. First, I presented a model to account for the appropriate use of Japanese zero pronouns in terms of the notions of accessibility and identifiability. Secondly, I show that pragmatic constraints on the use of honorific expressions can be used as a criteria by which to identify the referents of zero pronouns. Secondly, I investigated the notion of accessibility by exploiting the notion of subordinate relationships between E-situations. I propose two different notions of accessibility (i.e.) weak accessibility and strong accessibility. The former is sufficient for explaining the use of zero pronouns which exploit only types already introduced. The latter is necessary to account for the use of the zero pronouns which refer to the individuals that are existentially quantified in the E-situations already introduced. The latter notion has not been captured in the existent models.

I do not claim that the proposed model must entirely replace the existent models, although I revealed the problems with the existent models. In fact, I assumed that the notion of the focus of attention in the existent model of discourse structure can be used to define the notion of weak accessibility. The notion of subordinate can be regarded as extended compared to that of modal subordinate proposed by Roberts [17]. Ariel explored the notion of accessibility to analyze referring expressions[1]. He claimed that zero pronouns have access to referents introduced explicitly into linguistic context, although the access of general knowledge context and physical context is difficult. However, I showed that the accessibility conditions on the usage of Japanese zero pronouns must be defined in terms of subordinate relationships between E-situations, even though the referents have been introduced into linguistic context. Finally, the notion of identifiability is not equal to the notion of relative uniqueness [10] on the usage of definite [17]. In this model, the antecedent of a zero pronoun does not necessarily exist uniquely, it need only be identified according to some criteria.

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[17]Kadmon used the notion of relative uniqueness to explain uniqueness implicature on the occasion of using a definite rather than presupposed conditions on the appropriate use of a definite. My remarks apply when the notion is taken as the condition on the appropriate usage.

References

[1] Ariel, M. "Referring and accessibility", *Journal of Liguistics*, vol.24(1980), 65-87.

[2] Barwise, J. *The Situation in Logic*, CSLI Lecture Notes, Number 17(1989).

[3] Carberry, S. "A pragmatics-based approach to understanding intersentential ellipsis", in: *Proc. of 23rd Annual Meetings of the Association for Computational Linguistics*(1985), 188-197.

[4] Dale, R. "Cooking up referring expressions", in:*Proc. of 27th Annual Meetings of the Association for Computational Linguistics*(1989), 68-75.

[5] Dohsaka, K. "Identifying the referents of zero-pronouns in Japanese dialogues", in: *Proc. of 9th European Conference on Artificial Intelligence*(1990), 240-245.

[6] Fauconnier, G. *Mental Spaces*, MIT press (1985).

[7] Gawron, J. M. and S. Peters. *Anaphora, Quantification in Situation Semantics*, CSLI Lecture Notes, Number 19 (1990).

[8] Grosz, B. J. and A. K. Joshi and S. Weinstein. "Providing a unified account of definite noun phrase in discourse", in: Proc. of 21th Annual Meetings of the Association for Computational Linguistics(1983), 44-49.

[9] Grosz, B. J. and C. L. Sidner. "Attention, intentions, and the structure of discourse", *Computational Linguistics*, **12** (1986), 175-204.

[10] Kadmon, N. "Uniqueness", *Linguistic and Philosophy* **13**(3) (1990), 273-324.

[11] Kamp, H. "A theory of truth and semantic representation", in: J. Groenendijk, T. M. V. Janssen and M. Stokhof (eds.), *Formal Methods in the Study of Language*, Vol. I, Matematisch Centrum, Amsterdam (1981), 277-322.

[12] Karttunen, L. "Discourse referents", in: J. McCawley (ed.), *Syntax and Semantics 7: Notes from the Linguistic Ground*, Academic Press (1976), 363-385.

[13] Kameyama, M. "A property-sharing constraint in centering", in: *Proc. of 24th Annual Meetings of the Association for Computational Linguistics*(1986), 200-206.

[14] Kamio, A. *Proximal and Distal Information: a Theory of Territory of Information in English and Japanese,* Dissertation, Univ. of Tsukuba (1986).

[15] Kuno, S. and E. Kaburaki. "Empathy and syntax", *Linguistic Inquiry*, **8**(4) (1977), 627-672.

[16] Litman, D. J. "Understanding plan ellipsis", in: *Proc. of 7th National Conference on Artificial Intelligence*(1986), 619-624.

[17] Roberts, C. "Modal subordination and pronominal anaphora in discourse", *Linguistics and Philosophy*, **12** (1989), 683-721.

[18] Searle, J. *Expression and Meaning.* Cambridge University Press (1979).

[19] Sells, P. "Disjoint reference into NP", *Linguistics and Philosophy*, **14**(2) (1991), 151-169.

[20] Walker, M., M. Iida and S. Cote. "Centering in Japanese discourse", in: *Proc. of 13th International Conference on Computational Linguistics* (1990).

[21] Webber, B. L. "Tense as discourse anaphor", *Computational Linguistics*, 12(2) (1988), 61-73.

Appendix : Glossary

Situations and Individuals

A situation is a portion of the world. It supports infons and individuals. The infons supported by a situation represent the information that the situation conveys. The individuals supported by a situation exist relative to the situation. Namely, individuals supported by a situation are existentially quantified within the situation.

In this paper, the following situations are used.

1. Dialogue Situation: DS

2. Utterance Situation: US

3. Social Situation: SS

4. Situations about illocutionary acts: IA_i

5. Situations about events in the dialogue domain (E-situations): E_i

6. Situations containing types referred to in individual utterances (LR-situations): LR_i

In addition, the following individuals are used.

1. Q (for the questioner)

2. S (for the secretary)

3. Conf (for the conference office)

4. I_i (for the other individuals)

Dialogue situation DS supports individuals such as questioner Q, the secretary S and the conference office, which are assumed to exist in the dialogue domain. In this model, these individuals are regarded as existentially quantified by dialogue situation DS. Situations about events in the dialogue domain supports individuals, which are existentially quantified within the situations. These situations are called E-situations. Dialogue situation DS is a larger situation than any E-situation. A situation containing types referred to by an utterance is called an LR-situation.

Supporting and Containing

It is important to distinguish two different propositions: *(i.e.)* the proposition that a situation contains an individual and the proposition that a situation supports an individual. The former proposition means that the individual is mentioned in the situation and is an element of the situation. The latter proposition means that the individual exists relative to the situation and is existentially quantified within the situation. The latter implies the former. However, the former does not necessarily imply the latter.

LR-situations only contain types, and do not support them, because types can be regarded as linguistic resources, which are not relative to any situations. E-situations can support the individuals that are existentially quantified within the E-situations. However, E-situations do not support individuals such as the questioner, the secretary or the conference office. They only contain these individuals. These individuals are supported by dialogue situation DS. This is not

a contradictory claim, since dialogue situation DS is larger than any E-situation, and the scope of the existential quantifier associated with dialogue situation DS contains any E-situation. Therefore E-situations can contain individuals supported by dialogue situation DS.

For example, consider the following dialogue.

Dialogue (d4)

(s16) S:Touroku-yousi   ni   kinyusuru-hituyougaari-masu.
  registration form Obj2 fill-need-Polite

(You need to fill in the registration form.)

(s17) S:Sorekara   kaigi-jimukyoku ni   okut-tekudasai.
  Demonstrative adverb conference-office Obj2 send-please
  (then)

(Then send it to the conference office.)

In using a sentence, (s16), an individual, I_3, introduced by a noun phrase 'touroku-yousi (registration form)' supported by an E-situation, E_4, corresponding to an event 'Q fills in I_3'. The E-situation does not support individual Q for the questioner, although the E-situation contains individual Q. Individual Q is supported by dialogue situation DS. Namely, questioner Q exists out of the scope of a necessary modal operator, and individual I_3 is existentially quantified within E-situation E_4.

Subordination Relationships Between Situations

Subordinate relationships between E-situations plays a crucial role in accounting for the usage of the zero pronouns that refer to individuals that are supported by another E-situation already introduced into a dialogue.

That an E-situation, s_1, is subordinate to another E-situation, s_2, means that E-situation s_1 can be regarded as an extension of E-situation s_2. In this case, E-situation s_1 supports individuals supported by E-situation s_2.

See dialogue example (d4). In using a sentence, (s17), an E-situation, E_5, is introduced, which corresponds to event 'Q send I_3 to Conf'. Reference to individual I_3 is zero pronominalized in sentence (s17). Although E-situation E_5 contains both individual Q and Conf (for the conference office), it does not support them. They are supported by dialogue situation DS. In addition, individual I_3 of being a registration form is supported by both E-situation E_4 and E_5. This is not a contradictory claim. Because E-situation E_5 is regarded as subordinate to E-situation E_4: *(i.e.)* E-situation E_5 is taken as an extension of E-situation E_4. This implies not only that E-situation E_5 is a larger situation than E_4, but also individual I_3 is regarded as existentially quantified within E-situation E_5. Namely, the scope of the existential quantifier is also extended. This subordinate relationship between two E-situations is indicated by using a demonstrative adverb, 'sorekara' in sentence (s17). Without such linguistic cues to indicate the subordinate relationship, sentence (s17) can not be used with a zero pronoun referring to individual I_3. Namely, the zero pronoun can not have access to individual I_3 without linguistic devices encoding the subordinate relationship.

Accessibility of E-situations

The accessibility of E-situations is stated in terms of (1) subordinate relationships between E-situations, and (2) supporting and containing relationships between situations and either

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individuals or types. Namely, an E-situation, e_1, has access to types contained by an LR-situation, lr_1, if LR-situation lr_1 is in the participants' focus of attention [9]. On the other hand, an E-situation, e_1, has access to individuals supported by another E-situation, e_2, when E-situation e_2 is in the focus of attention and E-situation e_1 can be taken as subordinate to E-situation e_2. As a special case, an E-situation, e_1, has access to individuals supported by dialogue situation DS and contained by another E-situation, e_2, when E-situation e_2 is in the focus of attention. This is because the dialogue situation is larger than any E-situation, and the scope of the existential quantifier quantifying over individuals such as the questioner, the secretary and the conference office contains any E-situations.

Infons

An infon (state of affairs, SOA for short) is an issue of whether objects stand in a relation or not. An infon is regarded as a unit of information, and is written as follows.

(r24) $\ll R, r_1 : o_1, \ldots, r_n : o_n ; p \gg$.

The infon shows the fact that objects $o_1, \ldots, o_n$ stand in relation R when the polarity, p, is 1, and the objects do not stand in that relation when the polarity, p, is 0. $r_1, \ldots, r_n$ are argument roles, which are omitted when they are obvious. In addition, polarity can be omitted when it is 1. The infon supported by a situation is a fact. Otherwise, it is not a fact.

In this model, the following infons are used.

1. $\ll$Honor-rel, x, y, z ;1$\gg$: person x treat person y higher in social relationships than person z.

2. $\ll$Respect, sp, x ;1$\gg$: speaker sp respects person x.

3. $\ll$Requesting, x, y, t ;1$\gg$: participant x requests participant y to achieve a situation classified by situation type t.

4. $\ll$Asserting, x, y, T ;1$\gg$: participant x asserts to participant y the existence of a situation classified by situation type T .

5. $\ll$Asserting, x, y $\ll$Need, T ;1$\gg$;1$\gg$: participant x asserts to participant y that a situation classified by situation type T must exist.

6. $\ll$Have, x, y ;1$\gg$ person x has object y.

7. $\ll$Send, x, y, z ;1$\gg$ person x send object z to person y.

8. $\ll$Fill-in, x, y ;1$\gg$ person x fill in object y such as registration form.

9. $\ll$R-form, f ;1$\gg$: individual f is a registration form

10. $\ll$Subordinate, s, e ;1$\gg$: situation s is subordinate to situation e. This means that situation s is regarded as an extension of situation e.

11. $\ll$Ref-Sit, Demo, e ;1$\gg$: demonstrative adverb Demo is used to refer to situation e.

12. $\ll$Ref-Ind, Demo, i ;1$\gg$: demonstrative Demo is used to refer to individual i.

13. $\ll$Ident, x ;1$\gg$: entity x is identifiable.

14. $\ll$W-Access, s, w ;1$\gg$: situation s has weak access to situation w. This means that situation w is in the participants' focus of attention on the occurrence of situation s.

Propositions

Propositions are used to talk about what a portion of the world, a situation, is like. Propositions and infons are different objects. Propositions are either true or false. Infons are either facts or not facts.

The following propositions are used in the model.

1. $(x : T(x))$: object x is classified by type $T(x)$.

2. $(s \models \sigma)$: situation s supports infon σ.

3. $(\models \sigma)$: there is a situation supporting infon σ. In other words, σ is a fact independent of situations.

4. $(s \models i)$: situation s supports individual i.

5. $(s \ni i)$: situation s contains individual i.

Parameters

Parameters are labels that are assigned to argument roles in infons. Parameters are depicted as symbols starting with the character '*'. Parameters are used to represent the contents of objects assigned to the parameters

Restricted parameters

Parameters can be restricted by either infons or propositions.

1. ${}^*x_{\sigma(*x)}$: ${}^*x$ is a parameter such as infon sigma(*x) is a fact. In this description, we do not care about situations that support the infon.

2. ${}^*x_{(s \models \sigma(*x))}$: ${}^*x$ is a parameter such as proposition $(s \models \sigma(*x))$ is true. Situation s is called the resource situation of parameter ${}^*x$.

3. ${}^*x_{(s \models *x)}$: ${}^*x$ is a parameter such as proposition $(s \models {}^*x)$ is true. Situation s is called the resource situation of parameter ${}^*x$. This means that an individual assigned to parameter ${}^*x$ is supported by situation s.

Types

Types are abstract objects to represent the content of real objects that are classified by the types. For example, the content of situations is represented as types that classify them. The type of situations (situation type) shows what kind of infons and individuals should be supported by those situations.

In this model, the following types are used.

1. $[{}^*s \mid {}^*s \models \sigma]$: a type of situation ${}^*s$ such that proposition $({}^*s \models \sigma)$ holds true, where σ is an infon.

2. $[{}^*s \mid {}^*s \models i]$: a type of situation ${}^*s$ such that proposition $({}^*s \models i)$ holds true, where i is an individual.

3. $[{}^*x \mid s \models \sigma(*x)]$: a type of object ${}^*x$ such that proposition $(s \models \sigma(*x))$ holds true.

4. $[{}^*x \mid \sigma(*x)]$: a type of object ${}^*x$ such that proposition $(\models \sigma(*x))$ holds true.

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