

Anaphora Resolution and Discourse Structure: A Controlled Information Packaging Approach

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Ik-Hwan Lee and Minhaeng Lee. 2000. *Anaphora Resolution and Discourse Structure: A Controlled Information Packaging Approach*. *Language and Information* 4.1, 67–82. The purpose of the paper is twofold. First, we revise the well-known Centering Theory of anaphora resolution and propose the Controlled Information Packaging Theory (for short, CIPT). Second, we suggest a solution to the resolution of the antecedents of pronouns within the framework of CIPT. For this purpose, we select a dialogue of hotel reservation as a domain-restricted discourse, and discuss the characteristics of the distribution of pronouns. We suggest that we need to place the Slot-Link element on the top of the forward centering list. We claim that we need to establish a constraint on conceptual compatibility. As for the pronouns in the global dialogue, we propose a constraint of discourse command. (Yonsei University)

1. Introduction

In Korean, the zero anaphora is very common in a domain restricted dialogue such as the one found in the situation of hotel reservation as follows:

- (1) U1: iss e-yo?
exist
(Is there a room free?)
- U2: nalcca encey-sip-nikka?
date when
(For what date are you going to make a reservation?)
- U3: onul cenyek-ey.
tonight

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† We are very grateful to anonymous reviewers for their valuable comments and detailed suggestions. They helped us improve the quality of this paper.

‡ This paper was partly supported by Non-Directed Research Fund, Korea Research Foundation, 1999. We thank Professor Jungyun Seo of Sogang University and Professor Hyunho Lee of Tongyang Technical College for allowing us to use the corpus they constructed for the Soft Science Project.

(I'd like to make a reservation for tonight)
[U=Utterance]

The above example exhibits a long-debated issue of how to establish the antecedent of a zero anaphor. In this study we propose a reasonable and reliable solution to the problem.

To this end we take a Controlled Information Packaging approach. In which the following types of information structures are assumed:

- (2) a. Link - Tail - Focus structure (L-T-F structure)
- b. Link - Focus structure (L-F structure)
- c. Tail - Focus structure (T-F structure)
- d. Focus structure (F structure)
- e. Slot Link - Focus structure (SL-F structure)

The information structures in(2a-d) are the ones advanced in the original theory of information packaging by Vallduvi (1994). Employing the concept of the frame theory devised in the Artificial Intelligence, Lee and Lee (1998) proposed that the SL-F structure in(2e) be added to them.

Given the theoretical framework assumed in(2), we claim that the sentences with zero anaphors tend to exhibit the SL-F structure, on the basis of empirical evidence from actual dialogue corpora found in situations such as hotel reservation, theater talk, etc. As a next step we propose a revised ranking of the forward-looking centers in the sense of centering theory. It is claimed that the componential status of the information structure of the relevant utterance is revealed in the form of a hierarchy as follows:

- (3) SL-component > { Speaker, Hearer } > Subject > Indirect Object > Direct Object > Others

With this hierarchy, we can calculate the reference of zero anaphora in any form of domain restricted dialogues.

As for the overt anaphor, Lee (1998) postulates a constraint for the recovery of its antecedent at the moment when a sentence is uttered after returning from a subdialogue. He observes that an overt pronoun must have its antecedent in the subdialogue when it appears in the first utterance immediately after the subdialogue. Look at the example in (4).

- (4) U1: Seoul ollawa-se-nun mayn cheum-ey incey ku naksan
 came-after at first well Mt. Naksan
kkoktayki -ey ku acu ku chenmakchon kathun tey inca.
the top at the tent like place well
(When I arrived in Seoul, I (went) to the top of Mt. Naksan,
well, to the poor village)

< *Subdialogue*

U2(S1): naksan-imyen ce Tongtaymun ccok?
 the East Gate direction
 (Do you mean the Nagsan mountain near
 East Gate?)

U3(S2): yey ... Tongtaymun -ey iss-supni-ta.
 yes the Esat Gate at exist
 (Yes, it is. It is located near Tongtaymun.)

U4(S3): yey, yey.
 yes, yes
 (I see. I see.)

< /*Subdialogue*

U5: *kuli* kass-ess-nun-tey,
 t iere went...
 (I went there, ...)

In Lee's (1998) analysis, the overt anaphor *kuli* 'there' in the utterance U5 has its antecedent Naksan in the previous subdialogue (namely, U2(S1)). We, however, claim that the proposed analysis is not convincing because the same antecedent can also be found in the utterance U1, which is in the main dialogue.

In this paper we show that H. Lee's hypothesis is not correct and we propose a general constraint on the interpretation of the overt anaphor, on the basis of the analysis of the realistic corpus. The constraint is stated as follows:

- (5) The overt anaphor has its antecedent in the discourse segment of the same or higher level.

This paper is organized as follows. In section 2, we point out some relevant features of the Information Packaging Theory. Section 3 deals with the two aspects of the Controlled Information Packaging Theory. Section 4 is concerned with the distribution of zero anaphor in Korean dialogues. In section 5, we discuss how to handle an anaphor in subdialogues and propose a constraint of discourse command to deal with the pronouns in the global dialogue.

2. Information Packaging Theory

In (2) above we mentioned five types of dialogue structures. We now discuss the ideas using Vallduvi (1994) examples. Let us first examine the Link-Tail-Focus structure depicted in (2a). Examine the dialogue in (6).

- (6) a. A: In the Netherlands I got the president a big Delft china tray that matches the set he has in the living room. Was that a good idea?

b. B: No. [_L The president][_F HATES][_T the Delft china set]

Abbreviations: L = Link; F = Focus; T = Tail.

In a dialogue such as (6), when the sentence "The president hates the Delft china set" is uttered, only the verb 'hates' becomes the focus. The phrase 'the president' is a link component and 'the Delft china set' a tail component. Accordingly, the cognitive processing will go on as in (7).

- (7) a. Look up the information card of 'the president'.
 b. Replace any previous information concerning the relation between the president and the Delft china set with the new information 'HATES'. (Information updating)

If the same sentence is uttered in a different context, the information structure will be different as shown in (8).

- (8) a. A: I'm arranging things for the president's dinner.
 Anything I should know?
 b. B: Yes. [_L The president][_F hates the Delft CHINA SET].

In this case, 'the president' is a link component and 'hates the Delft china set' becomes the focus component. Here, in the cognitive process, the first step is to look up the information card of the noun phrase 'the president'. Then we are supposed to add the information 'hates the Delft china set' to the card.

In the example in (9) we see that no explicit link component appears.

- (9) a. A: In the Netherlands I got the president a big Delft china tray that matches the set he has in the living room. Was that a good idea?
 b. B: No. [_F (He) HATES] [_T the Delft china set]¹.

Here only 'hates' becomes the focus component, and the noun phrase 'the Delft china set' functions as the tail component. We do not have the link component 'the president'. In this case, we assume that the information card for 'the president' has been activated and continues to be in the activated state. In the card we replace any previous information related to the relation between the president and the Delft china set with 'hates'.

Let us now examine a situation where the example (8) is uttered in a different context as in (10).

- (10) a. A: I'm arranging things for the president's dinner.
 Anything I should know?
 b. B: Yes. The president always uses plastic dishes. [_F (He) hates the Delft CHINA SET].

Here the whole verb phrase 'hates the Delft china set' is the focus component. This information is added to the activated card of 'the president'.

1. The pronoun 'he' is not overtly pronounced. This is just to show the place where 'the president' is assumed to appear

3. Controlled Information Packaging Theory (CIPT)

In this section, we discuss the two characteristics of the Controlled Information Packaging Theory. The CIPT is distinguished from Vallduvi's Information Packaging Theory in two respects.

First, in our CIPT we postulate the fifth information structure, namely SL-F structure. Vallduvi (1994: 16) discusses dialogues like the one given in (11).

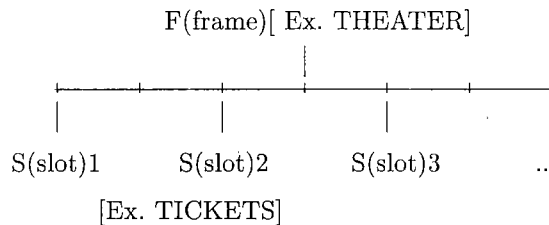
- (11) a. A: Why don't you go to the theater more often?
 b. B: TICKETS are expensive.

He notes that the sentence in (11b) is not about any particular referent. He observes that in this case no particular focus of update is designated. He suggests that a salient general temporary situation file card be used to record the new information. This sentence is sometimes termed to be reporting a situation.

If we look at the situation closely, however, we can clearly see that the noun phrase 'tickets' in (11b) is referentially related to the noun phrase 'the theater' in (11a). If we use the notion of frame suggested by Minsky (1975) to represent our cognitive knowledge of the actual world, we can naturally relate 'tickets' to 'the theater'. Minsky assumes that our knowledge about the world is represented in terms of frames, each of which in turn consists of many slots. The theater provides us a frame of world knowledge and the noun phrase 'tickets' fills in one of the slots.

The idea can be represented as in (12).

- (12) Structure of the 'Frame and Slots'



In this frame and slot analysis, we can say that when (11a) is uttered, the information card of 'the theater' is activated in the cognitive structure of the hearer, and the noun phrase 'tickets' can be triggered by this activation, which is exemplified in [] in (12).

By introducing this idea of frame and slot representation, we extend Vallduvi's theory and postulate the fifth information structure, namely Slot Link-Focus structure. We now analyze (11b) as in (13).

- (13) [_{SL} TICKETS] [_F are expensive].

As shown in (13) we treat the noun phrase in (11b) as a kind of link component. We now introduce a new notion of Hyper-link. The new information 'is expensive' is not directly linked to the noun phrase 'the theater' in (11a). We assume there to be a hyper-link between 'the theater' and 'tickets' by making an additional information card. The information conveyed by the verb phrase 'is expensive' is indirectly linked to the theater through this hyper-linking card.

The new Slot Link-Focus device can naturally explain the so-called bridging phenomena discussed by I.-H.Lee (1994). Look at the examples in (14).

- (14) a. John entered a large dining room.
 b. The chandelier hung by an imported gold chain.

The noun phrase 'a large dining room' in (14a) needs to be related in some way to the noun phrase 'the chandelier' in (14b). This referential relation can be properly captured by the hyper-link structure, which may be represented by the sentence in (15).

- (15) The large dining room has a chandelier.

The sentence in (15) bridges (14a) to (14b). We see that Vallduvi's original information packaging theory cannot appropriately handle examples like (11) and (14). We see that our extended information packaging theory, including the Slot-Link Focus structure, can provide a proper account of the data in question.

Second, our CIPT assumes a center controlling file card that includes the information about the discourse structure and ordinary file cards. A center controlling card is assumed to have the structure depicted in (16).

- (16) A Center Controlling Card (CCC)

Card Number
The set of discourse referents on the same level
Forward-looking center list of the immediately previous utterance
Hyper link with the center controlling card of the immediately higher level
Hyper link with the center controlling card of the immediately lower level

An example of the center controlling card is shown in (17).

- (17) An example of a CCC

3
7 9 10 14 15
[14 15]
1
4

With the center controlling card, we also have to assume that the ordinary file card must have the information about the discourse level which it belongs to. Accordingly, we assume that an ordinary file card has the structure given in (18).

(18) An Ordinary File Card

Card Number
Special information about the discourse objects
Hyper link with the center controlling card of the same discourse level

This idea of the center controlling card enables us to deal with the anaphor in the global discourses. Detailed examples will be discussed in Section 5 below.

4. Zero Anaphor

In a series of utterances, there is a list of items, each of which may become the center of the dialogue (Walker (1997)). According to Choe and Lee (1999), this notion of center is useful in establishing the antecedent of zero anaphor in Korean. Let us examine the discourse in (19).

- (19) a. Tokkocwun un ssuki lul memchwu -essta.
tokkocwun TOP writing ACC stop PAST DECL
(Tokkocwun stopped writing.)
- b. han kay nam-un kamca lul cip-ese ip ey neh-essta.
one remain Rel. potato AccP pick mouth at put in
(picked up one remaining potato and put it in the mouth.)
- c. son ul ppet-ese pyekcang mun ul yenta.
hand stretch closet door open
(stretched out (his) hand and open the closet door.)
- d. wi alay twu khan ulo nanwi-ecin pyekcang an un tachaylop-ta.
up down two part divided closet in colorful
(The inside divided into two parts is colorful.)

This series of utterances may produce the centers given in (20). Here C_b means the backward center — similar to the traditional notion of Topic — which may function as the antecedent of the zero/explicit anaphor, while C_f means the list of forward-looking centers.

- (20) a. C_b = [?] C_f = [Tokkocwun]
- b. C_b = Tokkocwun C_f = [Tokkocwun, kamca ‘potato’, ip ‘mouth’]
- c. C_b = Tokkocwun C_f = [Tokkocwun, son ‘hand’, pyekcangmun ‘closet door’]

d. Cb = (?) pyekcang 'closet' Cf = [pyekcang 'closet']

As shown in (20b), the zero anaphor in (19b) is interpreted as having *Tokkocwun* as its antecedent, because *Tokkocwun* is the backward center in (20b), namely in (19b). Now, let's examine a dialogue for hotel reservation.

- (21) U1G: Os iss e-yo?
 exist
 (Is there a room free?)
- U2H: nalcca encey-sip-nikka?
 date when
 (For what date are you going to make a reservation?)
- U3G: Os onul cenyek-ey.
 today night
 (I'd like to make a reservation for tonight)
- U4H: ney?
 yes?
 (I didn't understand, what you said.)
- U5G: Os onul cenyek
 today night
 (I'd like to make a reservation for tonight)
- U6H: yey, Os kanunghanteyyo.
 Yes possible
 (Yes, It's possible to make reservation for tonight.)
- U7G: yey?
 Really?
 (Is it really possible?)
- U8H: chwaci nun sipiman chen wen i-nteyyo.
 price TOP 120,000 1,000 be
 (The price is 121,000 Won.)
- U9G: yey
 yes
 (I see.)
- U10H: e- Os cebuy hotheyl khatu kathun kes soci hako
 Well us hotel card like thing have
 kneysin kes iss-usipnikka?
 HON thing HON
 (Well, do you have any credit card for this hotel?)

- U11 G:Os epseyo.
Nothing.
(I have nothing like that.)
- U12 H:kuleseyyo.
so
(I understand.)
- U13 G:ney.
Yes
(It's so.)
- U14 H:kulayto cehuyka ttokkathi yo, Os Oo samsip phulo
though we in the same way 30 Percent
tisukhawunthu hay tuli-lkkeyyo.
discount do do-the-favor I will
(Anyway, we will discount 30% for you in the same way as you
you might have a hotel card.)
[U = Utterance, G=Guest, H=Hotel Os/ Oo= zero pro-form]

In the above dialogue, we see frequent appearance of null anaphor. If we recover the antecedent of each of the null anaphor, we obtain the following.

- (22) U1 Os = empty room
U3 Os = dates of stay
U5 Os = dates of stay
U6 Os = reservation
U10 Os = hearer
U11 Os = speaker
U14 Os = speaker, Oo = hearer

The antecedents of the null anaphors in the above dialogue are related to the hotel reservation. Thus, viewing from the notion of frame, we can say that the hotel reservation frame is activated and that such slots as 'empty room,' 'dates of stay,' and 'reservation' are also activated in the frame. In this way the antecedents of the null anaphors are interpreted. Accordingly, we claim that the fifth utterance U5: *Os onul cenyek* 'Os tonight' has the following information structure.

- (23) [Os]_{SL} [onul cenyek]_F

In this way, the null anaphors appearing in a restricted dialogue such as a hotel reservation dialogue show the Slot Link-Focus structure. Thus, we propose a revision of the centering forward information structure as shown in (24), so that the notion of information structure is included in the centering theory, following Choe and Lee (1999):

- (24) Slot Link component > {Speaker, Hearer} > Subject > Indirect Object
> Direct Object > Others

From this point of view, as the slots in the frame of hotel reservation, we will have 'empty room,' 'rate,' 'period of stay,' 'reservation,' etc. We need to have a process of deciding on the proper antecedent of the null anaphor in the dialogue (e.g., U5). The relevant constraint for the decision is postulated as in (25), following Chung (1998)².

(25) **The constraint on conceptual compatibility**

The referent of each term that is not explicitly expressed must be determined on the basis of the meaning of the predicate which is predicated of it.

This constraint is supported by the expressions used as slots with the specific predicates in the frame of hotel reservation. The relationship between slots and predicates may be arranged as in (26).

- (26) empty room :: isseyo? 'have?' issupnita 'have', epsupnita 'not have'
rate :: elmayo? 'how much'
period :: ilpak 'one night', ipak 'two nights'
date :: onul 'today', nayil 'tomorrow'

The constraint makes it possible to select the most appropriate candidate for a null pronoun.

5. Main Dialogue and Subdialogues

In general, a dialogue consists of a series of utterances. Some of the utterances may constitute a subdialogue, which may cause a pause in the stream of the main dialogue, as shown in (4), repeated here in (27).

- (27) U1: Seoul ollawa-se-nun mayn cheum-ey incey ku naksan
 came-after at first well Mt. Naksan
 kkoktayki- ey ku acu ku chenmakchon kathun tey inca.
 the top at the tent like place well
(When I arrived in Seoul, I (went) to the top of Mt. Naksan,
well, to the poor village)

2. Following the detailed suggestion of an anonymous reviewer, we improved the definition of the constraint(25). We are very grateful to him.

<Subdialogue1>

U4: kwukminhakkyo sa haknyen?
 the primary school 4th grade
 (Do you mean the 4th grade of the primary school?)

U5: yey.
 Yes
 (Yes.)

U6: yey.
 so
 (It's so)

<Subdialogue2>

U7: punswu nanwuki ilen
 fraction division these
 (The subjects were those like the fraction and
 division.)

U8: [um-um]
 well- well
 (Well!)

U9: kuke ta ic-e pely-essunikkan
 those all forgot because
 (Because I forgot all the mathematical knowl-
 edge.)

U10: yey.
 Yes
 (I see.)

*</Subdialogue2>**</Subdialogue1>*

U11: kuke nun mollay kamchwe nohko incey kukel pomyense
 it TOP secretly hide now it learn
 cakkwu ponikka incey kuken swuipkey toy-telakwuyo.
 often learn now it easy got
 (I learned the book, hiding the book secretly and then I could
 easily understand the contents, because I often learned it.)

U12: yey, yey.
 so
 (It was so.)

U13: kwukminhakkyo keki nun kumpang tetume ponikka toyko,
 Primary school that TOP soon turn fumble in reach
 (I could early reach some goal through just fumbling in the book
 on the primary school level.)

U14: kulehkeyhayse incey hakwenul tunglokul hakey toyn keycyo
 Therefore now private institute enroll PERF
 mollay.
 secretly
 (So, I've secretly enrolled in a private institute.)

In the above dialogue, we see a complex dialogue which includes a subdialogue, which in turn has another subdialogue. Here we call attention to the pronoun *kuke* 'it' in U11. How can we establish the antecedent of this pronoun? If we follow H. Lee's theory, we have to search the antecedent in the immediately preceding subdialogue. In the preceding subdialogue, however, we do not see the phrase *cenkwa 4 haknyen* 'reference book 4th grade'. The antecedent of the pronoun *kuke* 'it' in U11 cannot be found in the subdialogues. We see the antecedent *cenkwa 4 haknyen* 'reference book 4th grade' in U3, which is the utterance just before the first subdialogue. This shows that the antecedent of the pronoun is not necessarily found in the immediately preceding subdialogue. This fact proves that H. Lee's claim is not correct.

Considering the search of the antecedent of pronouns appearing in the global dialogue, as an alternative to Lee's (1998) theory of subdialogue, we propose the discourse command constraint in (29).

(29) **Discourse command constraint**

In a discourse the antecedent of a pronoun must be able to discourse command the pronoun.

The discourse command (d-command) is defined as in (30).³

(30) **Discourse command**

- a. Def.: An expression A belongs to a level of dialogue B iff A is part of language covered by B.
- b. Def.: A level of dialogue A is lower than a level of dialogue B iff if an expression C belongs to A then C belongs to B.
- c. Def.: An expression A discourse commands an expression B iff if C is a level of dialogue which A belongs to and C is not the lowest level of dialogue which A belongs to, then B also belongs to C.

3. The definitions in (30) are based on the detailed suggestion of an anonymous reviewer. We thank him for his cooperation.

According to the discourse command constraint, the antecedent of a pronoun must be sought in the same or higher level of dialogue. As discussed above, the antecedent of the pronoun *kuke* 'it' in the utterance U11 in (28) is in the same level of discourse, not in the subdialogue. As for the pro-form *kuli* 'there' of U5 in (27), its antecedent appears in the subdialogue U2. Thus, this phenomenon seems to support the theory of subdialogue. But the antecedent also appears in U1 which was uttered before the start of the subdialogue. Notice that U1 and U5 are in the same level of dialogue. Therefore, this case observes the discourse command constraint.

Let us now see how the discourse command constraint is incorporated in CIPT. Let us examine an example.

- (31) U1: kulesici malko, cenyong chasen-ul kekise samkakci-seputhe
do so do not car lane ACC there Samkakci from
namyengdong-kkaci-nun com epsay cwusitunka.
Namyengdong to please erase do-the-favor
(Please erase the car lane from Samkakci to Namyengdong.)

U2: ha ha, yey, yey.
Ha ha, Yes, yes.
(Oh, yes! Yes!)

U3: yey, animyen yey, chasen-ul hana te mantule cwuseyyo.
if not car lane one more make do-the-favor
(Yes, otherwise, please make another car lane.)

U4: ney.
(Yes.)

U5: chasen-ul yak 300m nayci 400m te mantul swu-ka isseyo.
car lane about or more make possibility exist
(We can make a car lane of about 300 or 400 meter long.)

⟨*Subdialogue*⟩

U6: chasen-i com nelp-tanun malssum-ikwun yo. kulenikka
car lane little bit wide you say well
ku ccoki
that side
'You mean that the car lane is a little bit wide. Well,
that side'

U7: yey yey
'Yes, yes.'

U8: yey yey
'Yes, yes.'

⟨/Subdialogue⟩

U9: kukes com hay cwu-syessumyen coh-keyse yo.
 it please do do-the-favor if nice
 (It will be nice if you do it.)

U10: yey.
 (Yes.)

In this dialogue the pronoun *kukes* ‘it’ in U9 has an event, namely the event of making the car lane of about 300 or 400 meters long, as its antecedent. This event is one of the centers activated by the utterance U5, because an event may be considered to be one of the centers in the list of forward-looking centers. The noun *chasen* ‘car lane’ in U6 is a backward center only in the subdialogue. Thus, we have to search the antecedent of the pronoun *kukes* ‘it’ in U9 in U5 which belongs to the same level of dialogue. In this case, the event itself is the antecedent. Thus, it cannot be found in the subdialogue U6 through U8. This can be predicted by the discourse command constraint.

6. Conclusion

This paper discussed the searching mechanism of the antecedent of pronouns in Korean dialogues. We discussed the characteristics of zero pronouns appearing in a restricted dialogue of hotel reservation.

In this case we claimed that, viewing from the information structure, the Slot-Link element is the possible antecedent of the null pronoun and that it must be placed on the highest position in the list of forward-looking centers in the centering theory. We suggested the constraint on conceptual compatibility for selection of appropriate antecedent out of many possible ones. Concerning search of antecedent of pronouns in a global dialogue, we introduced a center controlling card to account for the anaphoric relation induced by the hierarchical structure of the global dialogue and the subdialogue. On the basis of the levels we postulated the general discourse command (d-command) constraint to the effect that the antecedent must discourse command its pronoun

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Submitted on: March 4, 2000

Accepted on: May 6, 2000