The time course of long-distance anaphor processing in Korean

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While early studies on the Korean long distance anaphor *caki* describe it to be subject-oriented in that it can only take subject antecedents, similarly to long distance anaphors in many other languages, more recent studies observe that it can take non-subject antecedents as well, especially in the context of certain verbs. This paper presents a visual-world eye-tracking study that tested whether the antecedent potential of *caki* in an embedded subject position is a function of the matrix subject, the matrix verb, or both, and whether the subject and the verb effects constrain the interpretation of *caki* in the same way as null pronouns, a commonly used pronominal form in Korean. These questions were addressed through an investigation of how the subject effect and the verb effect were manifested in processing these pronouns. We found that when *caki*, but not null pronouns, was first processed, there were more fixations to the images representing the matrix subject than the images representing the matrix object regardless of the matrix verb. We further found that the proportions of fixations to the images in both *caki* and null trials changed after the processing of some sentential verbs. These findings demonstrate that while null pronoun interpretation is a function of the verb effect only, *caki*-interpretation is a function of both the subject and the verb effect, supporting a multiple-constraints approach to anaphor resolution.

Keywords: Long-distance anaphor, Visual-world eye-tracking, Korean, reference resolution, anaphor processing

1. Introduction

Long-distance anaphors (LDAs) are pronouns that generally depend on other nominal expressions in the same sentence, called the antecedents, for their

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meaning, but the required antecedents can occur outside the clause that contains the anaphors. For example, in (1), Norwegian LDA *seg* occurs in the most deeply embedded non-finite clause, and its antecedent is the subject in the matrix (highest) clause, while in (2), Mandarin Chinese *ziji* occurs in the most deeply embedded clause as well, while its antecedent can be the subject of the clause containing *ziji* or one of the subjects of the higher clauses. In brief, LDAs allow for long-distance antecedents.

(1) Jon$_1$ bad oss [førske å få deg til å snakke pent om **seg**$_{1]}$.
Jon asked us try to get you towards to talk nicely about self
'Jon asked us to try to get you to talk nicely about self.' (Hellan 1988)

(2) Zhangsan$_1$ renwei [Lisi$_2$ zhidao [Wangwu$_3$ xihuan **ziji**$_{1/2/3}$]].
Zhangsan think Lisi know wangwu like self
'Zhangsan thinks Lisi knows Wangwu likes self.' (Cole and Sung 1994)

Such LDAs are found in many languages, including Germanic languages, as in Dutch *zich*, Icelandic *sig*, and Norwegian *seg*, and East Asian languages, as in Chinese *ziji*, Japanese *zibun*, and Korean *caki*. Although the details of the structural constraints on the relationship between the LDA and its antecedent may differ from language to language (Büring, 2005), one defining property of LDAs across languages widely observed in the literature is that they are subject-oriented in that they can only take subject antecedents (Sigurðsson, 1986; Pica, 1987; Hermon, 1992; Cole et al., 1990; Cole and Sung, 1994; Cole et al., 2001). (3) and (4) illustrate the subject-orientation of Icelandic *sig* and Chinese *ziji* respectively. In (3), only the matrix subject can be the antecedent of *sig*, and in (4), the embedded subject or the matrix subject, but not the indirect object, can be the antecedent of *ziji*.

(3) Jón$_1$ sagði Maríu$_2$ [að þú elskaðir **sig**$_{1/*2}$].
Jon told Maria that you loved self
'Jon told Maria that you loved self.' (Sigurðsson 1986)

(4) Wangwu$_1$ shuo [Zhangsan$_2$ zengsong gei Lisi$_3$ yipian guanyu **ziji**$_{1/2/*3}$ de wenzhang].
Wangwu say Zhangsan give to Lisi one about self DE article
'Wangwu says that Zhangsan gave an article about self to Lisi.' (Cole and Sung 1994)

Another property of LDAs often noted in the literature for many languages is that they are logophoric, being sensitive to a logophoric centre, which can be described as 'the source of information' as in Büring (2005). In Icelandic for example, the antecedent of the LDA *sig* not only must be the grammatical subject, but must also

be the source of information (Maling, 1984; Sells, 1987; Thráinsson, 1992). In (3), *Jón* can be the antecedent of *sig* because it is a grammatical subject as well as the logophoric centre, the source of information in the embedded clause, but *Jón* in (5) cannot be the antecedent of *sig* because, even though it is a grammatical subject, it is not the source of information in the embedded clause.

(5) *Jón$_1$ var sagt [að **sig**$_1$ vantabði hæfileika].
John was said that self lacked ability
John was told that self lacked ability.' (Maling 1984)

In Japanese, it has been argued that the logphoric centre must be the antecedent of the LDA *zibun*, whether it is a grammatical subject or not (Sells, 1987). In (6a), the matrix subject *Takasi* must be the antecedent of *zibun* because it is the logophoric centre, but in (6b), the matrix object *Taroo* must be the antecedent of *zibun* as it is the logophoric centre.[1]

(6) a. Takasi$_1$-wa Taroo$_2$-ni [Yosiko-ga **zibun**$_{1/*2}$-o nikundeiru-koto-o]
Takasi-TOP Taroo-DAT Yosiko-NOM self-ACC hate-COMP-ACC
hansita.
told
'Takasi told Taroo that Yosiko hated self.' (Sells 1987)
b. Takasi$_1$-wa Taroo$_2$-kara [Yosiko-ga **zibun**$_{*1/2}$-o nikundeiru-koto-o]
Takasi-TOP Taroo-from Yosiko-NOM self-ACC hate-COMP-ACC
kiita.
heard
'Takasi heard from Taroo that Yosiko hated self.' (Sells 1987)

Korean *caki* allows for long-distance antecedents, just as LDAs of other languages. In (7), the antecedent of *caki* can be the embedded subject *Mary* or the matrix subject *John* (O'Grady, 1987; Yoon, 1989; Cho, 1994; Gill, 1999; Kim, 2000; Kang, 2001; Sohng, 2004; Kim et al., 2009).

(7) John$_1$-i [Mary$_2$-ka **caki**$_{1/2}$-lul salangha-n-tako] sanygkakha-n-ta.
John-NOM Mary-NOM self-ACC love-PRES-COMP think-PRES-DECL
'John thinks that Mary loves self.' (Yoon 1989)

Korean, however, is different from Icelandic and Chinese type languages in that the antecedent of *caki* does not seem to be restricted to a subject, and it is different from Japanese type languages in that it is not restricted to the source of

1. Abbreviations used in the glosses are as follows: ACC: accusative, ADN: adnominal, CAUSE: causative, COMP: complementizer, CONN: connective, COP: copula, DAT: dative, DECL: declarative, GEN: genitive, INT: interrogative, NEG: negation, NOM: nominative, NOMINAL: nominalizer, PRES: present, PAST: past, TOP: topic.

information. While early studies on *caki* describe it as subject-oriented (Lee, 1973; Chang, 1977), the view that *caki* has the potential for non-subject antecedents has been gaining ground (Park, 1986; Yoon, 1989; Cho, 1994; Sohng, 2004; Madigan, 2006). Yoon (1989), for example, provides (8), and observes that *caki* in an embedded clause has the potential to take the matrix subject or the matrix indirect object as its antecedent, depending on the matrix verb: that is, in (8a) with *malha-* ('say') as the matrix verb, only the matrix subject can be the antecedent of *caki* in the embedded clause, whereas in (8b) with *tut-* ('hear') as the matrix verb, either the matrix subject or the matrix indirect object can be the antecedent of *caki*.

(8) a. John$_1$-i Mary$_2$-eykey [**caki**$_{1/*2}$-ka am-i-lako] malha-yess-ta.
John-NOM Mary-to self-NOM cancer-be-COMP say-PAST-DECL
'John said to Mary that self has cancer.' (Yoon 1989)

b. John$_1$-i Mary$_2$-lopwute [**caki**$_{1/2}$-ka am-i-lako] tul-ess-ta.
John-NOM Mary-from self-NOM cancer-be-COMP hear-PAST-DECL
'John heard from Mary that self has cancer.' (Yoon 1989)

To account for the non-subject antecedent potential of *caki*, Yoon takes the position that *caki* is logophoric, as in Kuno (1987). According to Yoon, in (8a), only the matrix subject *John* can be the antecedent of *caki*, because it is the source of information as the matrix verb is *malha-* ('say'), whereas in (8b) with *tut-* ('hear') as the matrix verb, the matrix indirect object *Mary* is the source of information, and so it can be the antecedent of *caki*. However, under the view that *caki* is a logophor, the matrix subject *John* would not be predicted to be a possible antecedent of *caki* in (8b), as it is not a source of information, contrary to the observed fact. The fact that the matrix subject *John* remains as a possible antecedent in (8b) indicates that subject-orientation is still a factor in determining the antecedent of *caki*. This intuition that the subject factor is not dismissible is noted by Sohng (2004). He argues that *caki* manifests weak subject-orientation in the sense that a subject antecedent, either the local or the non-local one, is preferred over an object antecedent, although the object is nevertheless a possible antecedent, even in sentences with *malha-* ('say') as the matrix verb, contra Yoon (1989), providing examples such as (9).[2]

(9) John$_1$-i Mary$_2$-eykey [Tom$_3$-i **caki**$_{1/?2/3}$-lul coaha-n-tako]
John-NOM Mary-DAT Tom-NOM self-ACC like-PRES-COMP
malha-yess-ta.
say-PAST-DECL
'John told Mary that Tom likes self.' (Sohng 2004)

2. A reviewer notes that according to Joo (2014), adding a benefactive suffix *-cwu* to *malha-* in (9) would increase the likelihood of the object, *Mary-eykey*, being an antecedent of *caki*.

In this paper, we present a visual-world paradigm eye-tracking study that tested whether and how the subject effect and the verb effect are manifested in processing Korean LDA *caki*. As a point of comparison, we also tested how the subject and the verb effects are manifested in processing null pronouns, a commonly used pronominal form in Korean (Sohn 1999). In (10), for example, the embedded clause has an unpronounced subject, a null pronoun, represented by an underscore, whose antecedent can be the matrix subject or the matrix indirect object.

(10) Toli-ka Cheli-hanthey [_ chwukkwu-lul cal ha-n-tako]
Toli-NOM Cheli-DAT soccer-ACC well play-PRES-COMP
malha-yess-ta.
say-PAST-DECL
'Toli told Cheli that he plays soccer well.'

We thus addressed two research questions: (i) Is *caki*-interpretation a function of the subject, the verb, or both? and (ii) Do the verb and the subject effect constrain the interpretation of *caki* in the same way as null pronouns?

It has been demonstrated by existing research that eye movements to objects that are potential referents of a referring expressions are closely time-locked to the linguistic input (Cooper, 1974; Tanenhaus et al., 1995; Runner et al., 2003, 2006; Kaiser et al., 2009). Visual-world paradigm eye-tracking is thus appropriate in addressing our research questions. As Korean is a verb-final language, *caki* or a null pronoun in an embedded clause linearly follows the potential antecedents, the matrix subject and the matrix indirect object, and linearly precedes the matrix verb, as can be seen in (7)–(10). As such, eye-tracking should be able to identify the antecedent potential of *caki* or a null pronoun as it is first processed, and indicate how that can change (or not) once the matrix verb is processed.

We found that when *caki*, but not the null pronoun, was first processed, there were more fixations to the images representing the matrix subject than the images representing the matrix object regardless of the matrix verb. We further found that the proportions of fixations to the images in both *caki* and null trials changed after the processing of some sentential verbs. These findings demonstrate that while null pronoun interpretation is a function of the verb effect only, *caki*-interpretation is a function of both the subject and the verb effect, supporting the multiple-constraints approach to anaphor resolution in that interpretation of anaphors is determined by multiple interacting constraints.

The rest of the paper is organized as follows. We present the methods we employed in Section 2, followed by the findings of our study in Section 3. Section 4 contains a brief summary and a discussion of further questions arising from our findings and their implications. We conclude in Section 5, identifying the overall

contribution of our study within the larger theory of anaphoric processing and some possible avenues for future research.

2. Methods

2.1 Participants

We tested 40 native speakers of Korean who had normal or corrected vision. The age of the participants ranged from 20 to 46, with the mean age at 25. Thirty four participants were in their twenties, five in their thirties and one in their forties. Each participant was paid $10 for taking part in the experiment.

2.2 Task

Participants were presented with a combination of visual and aural stimuli. In each trial, while viewing a scene image on a computer screen with two characters, one male and one female, participants heard a scene-setting description. They then heard two target sentences: the first sentence contained a pronoun of interest (target pronoun) and the second sentence contained another pronoun intended to co-refer with the target pronoun. A comprehension question on the target sentences was then presented to the participants. Their task was to choose between the two characters as a response by pressing a button on a controller.

2.3 Design

The experiment tested two within-subjects factors: verb and pronoun. The verb factor consisted of three levels, *malha-* ('say'), *tut-* ('hear') and *myenglyengha-* ('order'), and the pronoun factor consisted of two levels, *caki* and null, resulting in six conditions. The experimental design is summarized in Table 1.

Table 1. Summary of the experimental design

Verb	Pronoun
say	*caki*
	null
hear	*caki*
	null
order	*caki*
	null

Within the verb factor, we manipulated *myenglyengha-* ('order'), in addition to *malha-* ('say') and *tut-* ('hear'), to test a fuller range of verb types as well as to ensure the soundness of our method. Comparing *say* and *hear* would tell us the extent to which logophoricity (source of information) and subject effect influence the antecedent potential of the embedded subject pronoun. However, neither logophoricity nor subject effect seem to play any role in the way *order* constrains its antecedent potential. In (11), the matrix verb is *myenglyengha-* ('order') and the embedded subject is a null pronoun. In this example, as *Toli* is the one giving the order, he is the source of information. He is also the matrix subject of the sentence. So, according to the logophoricity and the subject effect, the matrix subject should be the antecedent of the embedded null pronoun subject. However, in our informal survey of native speaker intuition, Korean speakers predominantly judged that the matrix indirect object *Cheli* should be the antecedent here. This suggests that the lexical semantics or syntax of *order* is dictating that the embedded subject pronoun must be bound by the matrix indirect object rather than the subject.

(11) Toli-ka Cheli-hanthey [_ chwukkwukong-ul cha-lako]
Toli-NOM Cheli-DAT soccer ball-ACC kick-COMP
myenglyengha-yess-ta.
order-PAST-DECL
'Toli ordered Cheli that he kick the soccer ball.'

The *order*/null condition thus will serve as a control condition, with the expectation that the participants should predominantly choose the matrix indirect object as the antecedent of the embedded null pronoun subject. This is also expected for *order*/*caki* condition. Comparing *order* with *hear* and *say* conditions will allow us to test the verb effect on the antecedent potential of *caki* and null pronouns beyond logophoricity. Moreover, comparing *caki* with null pronouns within and across verb conditions will allow us to identify any unique properties of *caki* as an LDA.

2.4 Materials

The visual portion of the stimuli consisted of a series of 12 still scene images, a sample of which is given in Figure 1. Each image contained two characters, one male and one female, standing on either side of the scene. Between the characters is a scene-anchoring item, a basketball hoop in Figure 1. Scene-anchoring items in other scene images were such as a stove to suggest a kitchen, a diving board to suggest a swimming pool, or a treadmill to suggest a gym. Each scene was used in four test trials and two filler trials, for a total of six times. The positions of the male and female characters were evenly counterbalanced across the whole set of scenes used.

Figure 1. A sample scene image

The audio portion of the stimuli consisted of a pre-recorded narration that included scene-setting sentences and two target sentences, spoken by a native speaker of Korean. In each trial, the scene-setting sentences name the two characters in the scene image and establish the setting. An example scene-setting used in a trial with the scene image in Figure 1 is given in (12a).

(12) a. Scene-setting sentences:
Jinswu-wa Yenghuy-ka nongkwucang-ey iss-ta.
Jinswu-and Yenghuy-NOM basketball court-at be-DECL
Kutul-un nongkwu-lul ha-leyko ha-n-ta.
they-TOP basketball-ACC do-intend do-PRES-DECL
'Jinswu and Yenghuy are at the basketball court. They are going to play basketball.'

b. Target sentence 1:
Jinswu-ka Yenghuy-**hanthey** nongkwutay yep-eyse **caki**-ka
Jinswu-NOM Yenghuy-to hoop beside-at self-NOM
syus-ul te manhi sengkong-siki-lke-lako **malha**-yess-ta.
shoot-ACC more much success-CAUS-FUT-COMP say-PAST-DECL
'Jinswu said to Yenghuy beside the hoop that self will shoot more baskets.'

c. Target sentence 2:
Haciman silceylo **kyay**-nun syus-ul te manhi
but actually the kid-TOP shoot-ACC more much
sengkong-siki-ci anh-ass-ta.
success-CAUS-CONN NEG-PAST-DECL
'But actually the kid didn't shoot more baskets.'

d. Comprehension question:
Jinswu-nun nwu-ka syus-ul te manhi sengkong-siki-lke-lako
Jinswu-TOP who-NOM shoot-ACC more much success-CAUS-FUT-COMP
malha-yess-supnikka?
say-PAST-INT
'Who did Jinswu say will shoot more baskets?'

e. Possible answers: Jinswu / Yenghuy

The first target sentences used in each experimental condition contain either *caki* or null as the subject of the embedded clause, and *malha-* ('say'), *tut-* ('hear') or *myenglyengha-* ('order') as the matrix verb. These sentences all include two potential antecedents for the embedded clause subject, the matrix subject and the matrix indirect object, which are names of the male and female characters in the scene image. An example target sentence used in the *say*/*caki* condition, with *caki* as the embedded subject and *malha-* ('say') as the matrix verb, is given in (12b). In all these sentences, the postposition on the matrix indirect object is *-hanthey* regardless of the matrix verb. This postposition is ambiguous between goal and source, and thus could ensure that the participant does not anticipate the matrix verb of the sentence at the time when *caki* or null is first encountered. How *caki*/null is interpreted at this point then would be indicative of its initial interpretation when there is no influence from the verb.[3] These target sentences were constructed to be counterbalanced by gender, with half male and half female matrix subjects. The second target sentences contained an informal gender-neutral pronoun *kyay* ('the kid') that co-refers with *caki* or null in the first target sentences. For example, (12c) was used as the second target sentence in a trial with (12b) as the first target sentence. Crucially, as this gender-neutral pronoun is encountered after the manipulated verb has been processed, how it is interpreted tells us whether the verb changes the initial interpretation of *caki*/null.[4]

Comprehension questions, presented in text visually, asked for the identity of the embedded subject pronoun in the first target sentence, as in (12d). These were forced-choice questions: as an answer, participants had to choose between the names of the two characters in the given scene, as in (12e), which were represented as the matrix subject or the matrix indirect object in the first target sentence. Through the answers to these comprehension questions, we were able to determine the participants' considered judgments as to the antecedent of the potentially ambiguous *caki* or null.

Filler trials used material similar to the test trials. Just as in test trials, each filler trial had two target sentences, with the first one formed with *malha-* ('say'),

3. A reviewer notes that *-hanthey* is likely to be used more often with goals than with sources in Korean discourse, and so its presence could create a bias towards the goal interpretation of the indirect object. We fully acknowledge that this may be the case. Nevertheless, the bias should be present in both the *caki* condition and the null condition and so comparison of the two conditions should still be informative as to the difference or the similarity of the interpretive properties of the two types of pronoun.

4. Two native speakers of Korean read through the stimuli and confirmed that in all trials, *kyay* in the second target sentence is most likely to have the same referent as the pronoun in the first target sentence.

tut- ('hear') or *myenglyengha-* ('order'), and the second one containing *kyay* that co-refers with the pronoun in the first target sentence. The only difference was that the pronoun in the first target sentences was *kunye* ('she') instead of *caki*/null.

Example scene-setting and target sentences used in each experimental condition, along with the comprehension questions and their possible answers, are provided in Appendix A. Examples of material used in filler trials are provided in Appendix B.

2.5 Procedure

The scene images were presented on an iMac using E-Prime (Psychology Software Tools, Pittsburgh, PA), running through a Windows operating system via Boot Camp. The participants' responses to forced-choice questions were also recorded using E-prime. They heard the pre-recorded sound files associated with scene images through the external speakers. Eye-tracking measures were taken using table-top Tobii X100 eye-trackers, sampling at 60 Hz. Experiments were conducted on four different iMacs and eye-trackers, all operating with the same specifications and settings. Participants were tested individually in private testing booths.

Upon arriving at the lab, participants were briefed on the nature of their task, and first introduced to the eye-tracking equipment by way of a calibration routine. After calibration, participants were instructed to remain as still as possible throughout the experiment. They then saw three practice trials using images and narrations which were not repeated during the experiment. These trials were designed to familiarize participants with the audio-visual combination, and to get them accustomed to the self-pacing of the experiment by way of their responses to the comprehension questions. Each participant saw 48 test trials (eight per condition) and 24 filler trials in a uniquely generated random order. At the beginning of each trial, a screen with a fixation cross in the centre was displayed to serve as a cue to draw the participants' gaze back to the centre of the screen. Also, periodically during the experiment, a screen would appear between trials displaying the eye tracker's image of the participants' eyes, as a reminder to return to the position of the original calibration.

Once the entire experiment was completed, participants were given a written debriefing form, as well as an informal verbal debriefing with the experimenter.

2.6 Predictions

We tracked eye-movements of participants from the onset of *caki*/null before the matrix verb has been encountered in the first target sentence, and from the onset of *kyay* after the verb has been encountered in the second target sentence. We will

consider three situations and the pattern of fixations they each predict: (i) the antecedent potential of *caki*/null is a function of the subject only, (ii) the antecedent potential of *caki*/null is a function of the verb only, and (iii) the antecedent potential of *caki*/null is a function of both the subject and the verb.

If the interpretation of *caki*/null is constrained by the subject only, then from the onset of *caki*/null, and also from the onset of *kyay*, there should be more fixations to the subject than the object picture for all three verb conditions. If the interpretation of *caki*/null is constrained by the verb only, then from the onset of *caki*/null, fixations to the subject and the object picture should be randomly distributed in all three verb conditions, as the matrix verb has not been encountered yet, but from the onset of *kyay*, which is encountered after the matrix verb, different patterns in fixations should be seen among the three verb conditions. Finally, if *caki*/null-interpretation is constrained by both the verb and the subject, then from the onset of *caki*/null, there should be more fixations to the subject than the object picture for all three verb conditions, but from the onset of *kyay*, different patterns in fixations should emerge among the three verb conditions.

The predictions for the answers to the forced-choice questions, which measured the participants' considered judgments on the antecedent of *caki*/null, are as follows. If the interpretation of *caki*/null is constrained by the subject only, the name corresponding to the subject should be selected more often than the one corresponding to the object in all three verb conditions; if the interpretation of *caki*/null is constrained by the verb only, then the rate in which the name corresponding to the subject is selected should vary across verb conditions; and if the interpretation of *caki*/null is constrained by both the verb and the subject, then we should also see varying rates in which the name corresponding to the subject is selected across verb conditions but with more selection of the subject name than is expected, in particular in the *order* condition. This is based on the reasoning that although the lexical semantics or the syntax of *order* requires the embedded subject *caki*/null to refer to the matrix indirect object, as illustrated in (11), the conflicting constraint that it refer to the subject may influence the participants to select the subject name, at times against the requirement imposed by the verb, in an experimental setting.

3. Results

3.1 Behavioral data

Answers to the forced-choice questions provided the behavioral data. Forced-choice selection of the antecedent for *caki*/null was scored as 1 if the matrix

subject was chosen, and 0 if the matrix indirect object was chosen. Mean scores of the answers on each of the verb/pronoun combination are summarized in Figure 2. Inspecting the graph visually, the *order*/null condition has the lowest score compared to other conditions, revealing that the indirect object antecedent was predominantly chosen as the antecedent of the embedded null pronoun subject in *order*-sentences. This is as expected, as was observed in Subsection 2.3, and therefore indicates that our forced-choice question method is sound in that it appropriately tests the antecedent potential of pronouns. The mean score in the *say*/null condition is around 0.6, with the participants selecting the subject antecedent slightly more than the object antecedent, and the mean score in the *hear*/null condition is around 0.4, with the participants selecting the subject antecedent slightly less than the object antecedent. Turning to the *caki* conditions, the *say*/*caki* condition has the highest score, revealing that the participants predominantly chose the subject antecedent for embedded subject *caki* in *say*-sentences. The mean scores of *order*/*caki* and *hear*/*caki* conditions are approximately 0.5, revealing that the participants split in their choices between the subject antecedent and the object antecedent.

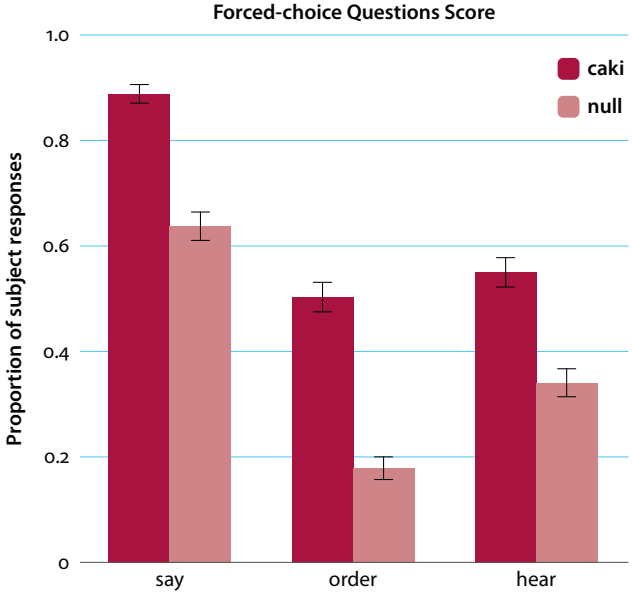

Figure 2. Mean scores on the answers to the forced-choice questions by condition

We constructed generalized linear mixed-effects models, fitted using the *lme4* package in R (Bates et al., 2012), to analyze the scores on the answers as a function of verb and pronoun, with participant and item included as random effects. Upon comparing models with and without an interaction term between verb and

pronoun, the one without the interaction term emerged as a better model. The results of this model are summarized in Table 2.[5]

We found main effects of verb and pronoun. That is, regardless of pronoun type, Korean native speakers are significantly more likely to select the subject antecedent in *say*-sentences than in *hear*- or *order*-sentences (Verb.order and Verb.hear); and regardless of verb type, speakers are significantly more likely to select the subject antecedent for *caki* than for null (Pronoun.null). These findings suggest that while the verb effect is present for both *caki* and null, the subject effect is bigger for *caki*. The findings from the behavioral data, however, do not tell us the time course of the subject effect for *caki*, whether the subject effect emerges when *caki* is initially processed or after the verb has been processed. The eye-tracking data, on the other hand, will be useful in addressing this question.

Table 2. Summary of the statistical analysis of the behavioural data

	Estimate	***SE***	***z***	***p***
(Intercept)	2.13	0.22	10.01	< .001 ***
Verb.order	−2.29	0.22	−10.63	< .001 ***
Verb.hear	−1.71	0.21	−8.09	< .001 ***
Pronoun.null	−1.42	0.17	−8.32	< .001 ***

Significance levels: *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .1$

3.2 Eye-tracking data

As the dependent measure of the eye-tracking data, we used subject-picture advantage scores, which were calculated by subtracting the proportions of fixations to the picture representing the matrix indirect object from the proportions of fixations to the picture representing the matrix subject (Kaiser et al., 2009). A score of 0 indicates no subject-picture or object-picture advantage, scores above 0 indicate the presence of subject-picture advantage, and scores below 0 indicate object-picture advantage.

As a control test, we plotted mean subject-picture advantage scores for the matrix subject proper names and for the matrix indirect object proper names in the first target sentences, from the onset of the proper name up to 1800 ms at every 30

5. The formulae of the two models compared are given in (i) and (ii).

(i) Model with interaction: Selection ~ Verb * Pronoun + (1 | Participant) + (1 | Item), family = "binomial"

(ii) Model without interaction: Selection ~ Verb + Pronoun + (1 | Participant) + (1 | Item), family = "binomial"

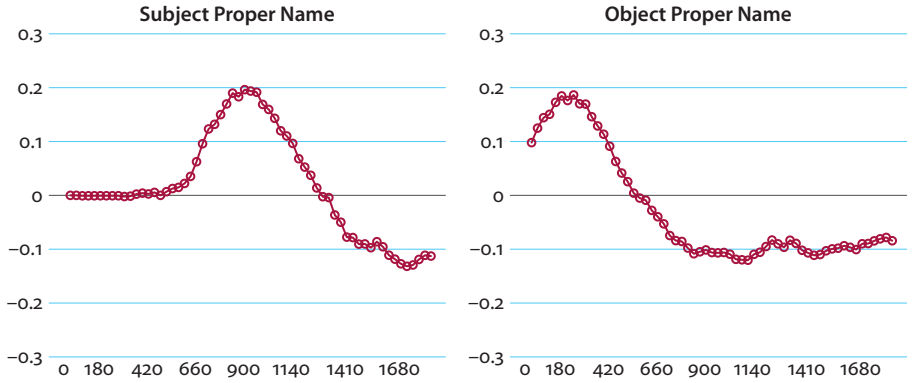

Figure 3. Mean subject-picture advantage scores of the matrix subject (left) and the matrix object (right) at every 30 ms from the onset of the proper name to 1800 ms after the onset

ms, as shown in Figure 3. According to the graph, the subject proper name initially shows no subject-picture advantage but the score starts to rise at approximately 500 ms peaking at around 1000 ms after the onset. On the other hand, the object proper name initially exhibits a subject-picture advantage but starts to show an object-picture advantage approximately at 500 ms after the onset. The delay in the subject-picture advantage and the object-picture advantage for the subject and the object proper names respectively is expected, given that previous studies have found that usually fixations to targets diverge from competitors only after 300 ms after the onset of the relevant word (Allopenna et al., 1998; Dahan and Tanenhaus, 2004; Runner et al., 2006). Relatedly, the fact that the object proper name initially shows a subject-picture advantage is also expected, as this is a delayed response to the subject proper name, which immediately precedes the object proper name in all the input sentences. We take the results with proper names as evidence that the eye-tracking method is sound and that participants' gaze does indeed respond to the audio stimulus as intended.

3.2.1 *First target word: caki or null*

We now turn to the eye-tracking data on our target words: *caki* or null in the first target sentences and *kyay* in the second target sentences. Mean subject-picture advantage scores starting from the onset of *caki* up to 1800 ms at every 30 ms are plotted in Figure 4 (left), and mean subject-picture advantage scores for null are plotted in Figure 4 (right). We took the onset of the null pronoun subject to be the onset of the first word occurring in the embedded clause. For example, in (13), the embedded subject is null and *sukhiliphuthu-lul* is the first word of the embedded clause.

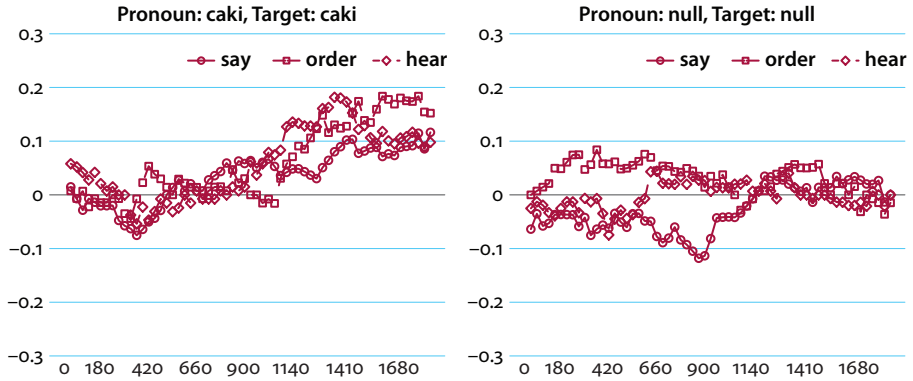

Figure 4. Mean subject-picture advantage scores of *caki* (left) and null (right) at every 30 ms from the onset of the target to 1800 ms after the onset

(13) Eunjoo-ka Hyensik-ihanthey sukhiliphuthu yep-eyse
Eunjoo-NOM Hyensik-from ski lift beside-ACC
[sukhiliphuthu-lul tha-myen ecileweha-lke-lako] tul-ess-ta.
ski lift-ACC ride-when feel dizzy-FUT-COMP hear-PAST-DECL
'Eunjoo heard from Hyensik beside the ski lift that pro will feel dizzy when riding the ski lift.'

All the target sentences with null pronoun subjects had a prosodic cue, a short pause, right before the first word of their embedded clauses, indicating the beginning of another clause. Furthermore, these first words were not marked with a topic marker or a nominative case marker, which is required on a subject in Korean. Taking the two together, we can therefore assume that a null pronoun subject is postulated at this point. It is still possible, however, that fixations at the onset of the first word of embedded clauses in our target sentences are not indicative of null pronoun interpretation, but rather the interpretation of the first words themselves. Even so, the fixation patterns in the null pronoun condition are informative as they depict a picture of anaphoric processing in the absence of *caki*, which in turn illuminates the distinctive properties of *caki* processing by comparing the fixation patterns of *caki* and null conditions.[6]

6. A reviewer notes that listeners may postpone postulating a null subject until further disambiguating information is available later in the sentence. Although this is certainly possible, research on on-line processing of gaps in filler-gap constructions (Phillips 2006 and references therein) suggests otherwise. There is strong evidence in the processing literature that a parser posits a gap as soon as a potential gap site can be identified, engaging in an active search process. If on-line processing of null subjects is in any way similar to on-line processing of gaps, it is quite likely that listeners will posit a null subject early without waiting for any direct evidence for its presence. Testing this experimentally is a task for future research.

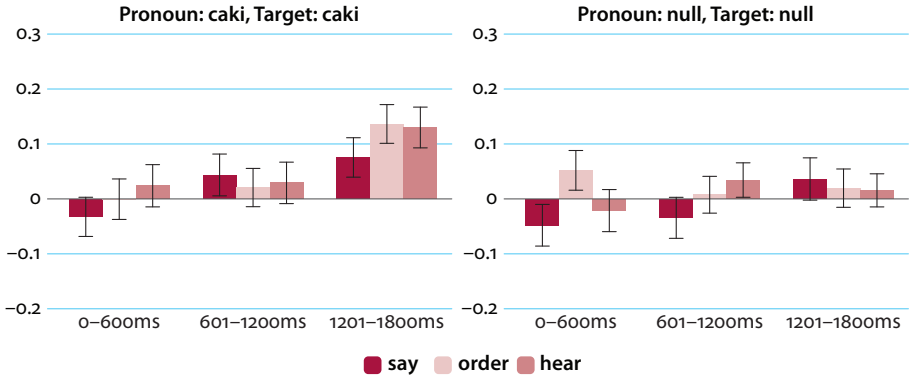

Figure 5. Mean subject-picture advantage scores of *caki* (left) and null (right), grouped into three 600 ms time slices from the onset of the target to 1800 ms after the onset

A visual inspection of the *caki* graph reveals that the three verb conditions (*say*, *hear*, and *order*) pattern together: none of the verbs exhibits a subject-picture advantage initially, but all eventually exhibit a subject-picture advantage. The null graph, however, shows that none of the verbs exhibits a clear subject-picture or object-picture advantage.

To do the statistical analysis, we divided the 1800 ms into three time slices, 0–600 ms, 601–1200 ms and 1201–1800 ms, and reorganized the data so that the subject-picture advantage scores are calculated from aggregated proportions of fixations to the subject picture and aggregated proportions of fixations to the object picture in each time slice. The new mean subject-picture advantage scores for *caki* and null on each combination of verb and time slice can be summarized as in Figure 5. We thus constructed linear mixed-effects models with pronoun, verb and time slice as fixed effects, and participant and item as random effects. Upon model comparison, the model with an interaction term between pronoun and time slice emerged as the best model. The results of this model are summarized in Table 3.[7]

We found a main effect of time slice and an interaction between pronoun and time slice. That is, *caki* showed a significantly higher subject-picture advantage in the third time slice than in the first time slice, regardless of the verb (TimeSlice.1800), and this subject-picture advantage of *caki* is significantly greater than that shown by the null pronouns in the same time slice (Pronoun.null:TimseSlice.1800). In a further analysis, a mixed-effects analysis of the null

7. Here, we provide the formula of the fullest model (i) that we fitted to the data and the best model that emerged from a model comparison (ii). Intermediate models are not provided.

(i) SubjPreference ~ Pronoun * TimeSlice * Verb + (1 | Participant) + (1 | Item)
(ii) SubjPreference ~ Pronoun * TimeSlice + (1 | Participant) + (1 | Item)

Table 3. Summary of the statistical analysis of *caki* and null

	Estimate	***SE***	***t***	***pMCMC***
(Intercept)	0.01	0.03	0.32	.76
Pronoun.null	−0.01	0.03	−0.32	.76
TimeSlice.1200	0.03	0.03	1.17	.24
TimeSlice.1800	0.12	0.03	3.98	< .001 ***
Pronoun.null:TimeSlice.1200	−0.02	0.04	−0.55	.58
Pronoun.null:TimeSlice.1800	−0.08	0.04	−2.06	.04 *

Significance levels: *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .1$

pronoun only with verb and time slice as fixed effects and participant and item as random effects revealed no effect, indicating no subject-picture or object-picture advantage in all time slices regardless of the verb.

3.2.2 *Second target word:* ***kyay***

Recall that *kyay* in the second target sentence is intended to co-refer with *caki* or null in the first target sentence, and so the eye-tracking data on *kyay* should provide a clue as to the interpretation of *caki*/null after the verb has been processed. Inspection of the eye-tracking data for fillers confirms that the pronoun in the first target sentences and *kyay* in the second target sentences indeed co-refer. In filler trials, the first target sentences contained *kunye* ('she') with *mal-* ('say'), *tut-* ('hear') or *myenglyengha-* ('order'). In the *say* and *hear* conditions, half of these target sentences had male matrix subjects and the other half had female matrix subjects, but in the *order* condition, all had male matrix subjects and female matrix indirect objects. This meant that while the antecedent of *kunye* was counterbalanced by grammatical function in *say* and *hear* conditions, it was constrained to be the matrix indirect object in the *order* condition. Examples of filler trials are given in Appendix B. If *kunye* and *kyay* are coreferential in each trial, then the subject-picture advantage score of both should hover around zero in *say* and *hear* conditions, whereas both should show a strong object-picture advantage in the *order* condition. The mean subject-picture advantage scores for *kunye* in the first target sentences, and *kyay* in the second target sentences are summarized by verb type and 600 ms time slices in Figure 6. It can be seen that our expectations are supported by the data. In the *say* and *hear* conditions, both *kunye* and *kyay* show neither a subject- nor an object-picture advantage, and in the *order* condition, a clear object-picture advantage emerges after 600 ms for *kunye*, and is maintained for *kyay*.

Turning to *kyay* in the *caki* and null conditions, its mean subject-picture advantage scores are plotted from the onset of the target word up to 1800 ms at every 30 ms in Figure 7. The *kyay* graph in the *caki* condition shows that the three

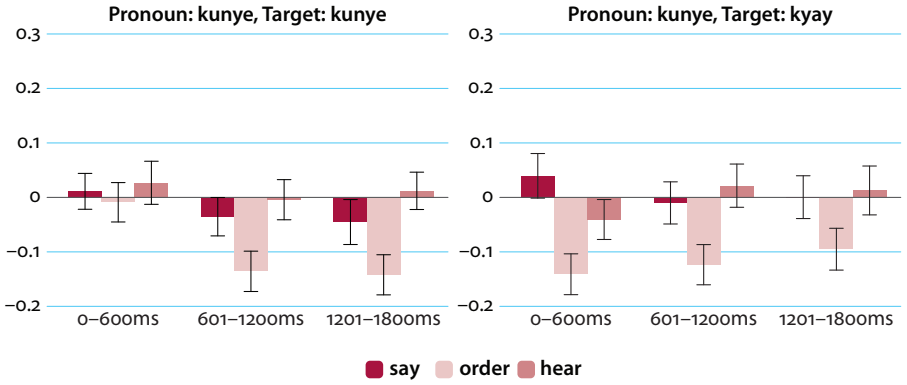

Figure 6. Mean subject-picture advantage scores of *kunye* (left) and *kyay* (right), grouped into three 600 ms time slices from the onset of the target to 1800 ms after the onset

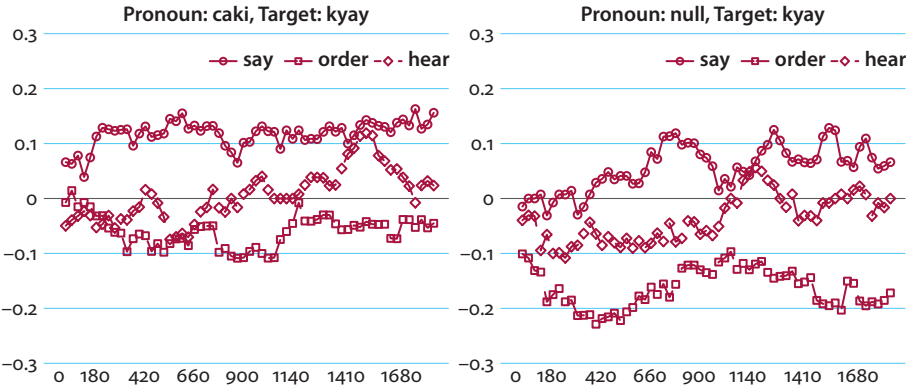

Figure 7. Mean subject-picture advantage scores of *kyay* in the *caki* condition (left) and *kyay* in the null condition (right) at every 30 ms from the onset of the target to 1800 ms after the onset

verbs pattern differently: the *say* condition exhibits a subject-picture advantage, the *hear* condition fluctuates around no advantage, and the *order* condition shows a slight object-picture advantage. The *kyay* graph in the null condition exhibits a similar pattern in that the subject-picture advantage score is the highest in the *say* condition, lower in the *hear* condition, and lowest in the *order* condition. Overall, however, *kyay* in the null condition has a reduced subject-picture advantage than in the *caki* condition across verbs, with the *say* condition showing a slight subject-picture advantage, the *hear* condition a slight object-picture advantage, and the *order* condition a clear object-picture advantage.[8]

8. A reviewer notes that our first target sentences confound sentence-initial NPs with matrix subjects, and recommends that this could be teased apart in future work by having test items

As before, we divided the 1800 ms into three time slices, 0–600 ms, 601–1200 ms and 1201–1800 ms, in order to do statistical analysis. Figure 8 summarizes mean subject-picture advantage scores for *kyay* in the *caki* condition (left) and the null condition (right) on each verb and time slice combination. Results from the linear mixed-effcts models analysis, with pronoun, verb and time slice as fixed effects and participant and item as random effects, are summarized in Table 4. Upon model comparison, the model with pronoun and verb as fixed effects with no interaction emerged as the best model.[9]

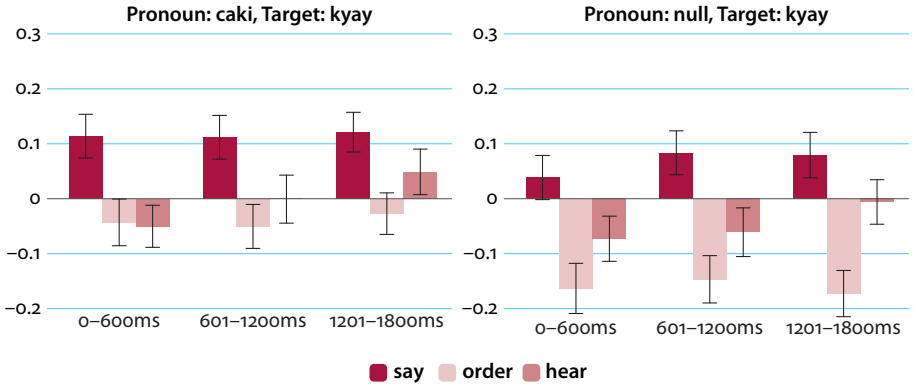

Figure 8. Mean subject-picture advantage scores of *kyay* in the *caki* condition (left) and *kyay* in the null condition (right), grouped into three 600 ms time slices from the onset of the target to 1800 ms after the onset

As can be seen in Table 4, the analysis revealed a main effect of pronoun and a main effect of verb. So, regardless of time slice, *kyay* in *say*-sentences in the *caki* condition shows a significant subject-picture advantage score (Intercept), which is in turn significantly higher than *kyay* in the null/*say* condition (Pronoun.null). In addition, both *kyay* in the *caki* and null conditions pattern together in that *order*- and *hear*-sentences show significantly lower subject-picture advantage scores than *say*-sentences (Verb.order and Verb.hear).

that begin with a non-subject phrase such as *Chelswu-ey uyhamyen* ('in Chelswu's opinion', or 'according to Chelswu'). We thank the reviewer for pointing this out to us.

9. Here, we provide the formula of the fullest model (i) that we fitted to the data and the best model that emerged from a model comparison (ii). Intermediate models are not provided.

(i) SubjPreference ~ Pronoun * TimeSlice * Verb + (1 | Participant) + (1 | Item)
(ii) SubjPreference ~ Pronoun + Verb + (1 | Participant) + (1 | Item)

Table 4. Summary of the statistical analysis of *kyay* in the *caki* and null conditions

	Estimate	***SE***	***t***	***pMCMC***
(Intercept)	0.13	0.03	4.05	< .001 ***
Pronoun.null	−0.07	0.03	−2.30	.02 *
Verb.order	−0.19	0.04	−5.09	< .001 ***
Verb.hear	−0.12	0.04	−3.13	< .01 **

Significance levels: *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .1$

In a further analysis, comparing *kyay* in *hear*- and *order*-sentences in the *caki* condition, neither a subject-picture nor an object-picture advantage was found. However, in an analysis comparing *kyay* in *say*-, *hear*- and *order*-sentences in the null condition, the results of which are summarized in Table 5, while *say*-sentences showed no subject-picture or object-picture advantage (Intercept), *hear*-sentences showed marginally lower subject-picture advantage than *say*-sentences (Verb.hear), hence a marginal object-picture advantage, and *order*-sentences showed a significantly lower subject-picture advantage than *say*-sentneces (Verb.order), hence a significant object-picture advantage.[10]

Table 4. Summary of the statistical analysis of *kyay* in the null condition

	Estimate	***SE***	***t***	***pMCMC***
(Intercept)	0.07	0.05	1.47	.16
Verb.order	−0.22	0.06	−3.52	< .01**
Verb.hear	−0.11	0.062	−1.834	.07^{+}

Significance levels: *** $p < .001$, ** $p < .01$, * $p < .05$, $^{+}$ $p < .1$

4. Discussion

We can now address the two research questions raised in Section 1. First, according to our eye-tracking data, when *caki* is initially processed, speakers prefer to consider the subject rather than the indirect object as the antecedent.[11] However,

10. The formula of the model is given in (i).

(i) SubjPreference ~ Verb + (1 | Participant) + (1 | Item)

11. A question arises as to why the subject effect is not observed earlier. The subject-picture advantage for *caki* was observed in the 1200–1800 ms time slice. But if eye movements to potential referents of a referring expressions are closely time-locked to the linguistic input, the subject-picture advantage for *caki* should emerge earlier, no later than 600–1200 ms time slice. The unexpected delay in the subject effect might be due to the presence of the nominative case marker

once the matrix verb has been processed, while the preference for the subject antecedent stays strong for the *say*-sentences, it weakens for the *hear*- and *order*-sentences. Moreover, according to both the post-verb eye-tracking data and the considered judgments of the behavioral data, speakers show preference for neither the subject nor the object for *order*-sentences, contrary to expectation that the object would be the antecedent here. Recall that according to an informal survey of native speaker intuition, Korean speakers predominantly judged the matrix object to be the only possible antecedent of embedded subject pronoun in *order*-sentences. These findings suggest that *caki*-interpretation is a function of both the subject and the verb effect, and the two effects are in competition with each other. The subject effect persists even after the verb has been processed, and as such in *order*-sentences, it may override the lexical/syntactic requirement of the verb that the matrix indirect object be *caki*'s antecedent.

Second, we found no evidence of preference for the subject or the object antecedent for the null pronoun subject before the processing of the verb, but when the verb has been processed, it shows no preference for the subject antecedent or the indirect object antecedent for *say*-sentences, a slight preference for the indirect object antecedent for *hear*-sentences, and a strong preference for the indirect object antecedent for *order*-sentences. Moreover, both the post-verb eye-tracking data and the behavioral data show that the null pronoun subject shows a strong object antecedent preference in *order*-sentences, in accordance with the native speaker intuition. This suggests that contrary to *caki*, null pronoun interpretation is a function of the verb only. In the absence of the subject effect, the matrix indirect object is selected as the antecedent of the null pronoun subject in *order*-sentences, according to the lexical/syntactic requirement of the verb.

Comparing the post-verb eye-tracking data of *caki* and null pronoun, *caki* has higher preference for the subject antecedent than the null pronoun in *say*- and *hear*-sentences as well as in *order*-sentences. The same pattern is observed in the behavioral data. This again suggests that the initial subject effect persists for *caki*, raising the subject antecedent preference for all three verbs, in comparison to the null pronoun.

The subject effect thus emerges as a unique property of *caki*, in comparison to null pronouns. So, *caki* is indeed 'subject-oriented', but not because it can only take a subject antecedent, as was claimed in the early literature, but because of its unique sensitivity to the subject effect. What then is the source of *caki*'s sensitivity

on *caki* in our target sentences, which has been observed to function as a focus marker (Schutze, 2001; Lee, 2003). Native speakers of Korean then may initially take nominative case marked *caki* to be introducing a new discourse participant, and so may momentarily not consider either of the characters on the screen as a potential referent.

to the subject? One possible answer is that there is a structural requirement that the antecedent of *caki* be in a syntactic subject position. This is essentially the analysis given for LDAs in Germanic in Pica (1987), and Chinese in Cole et al. (1990, 2001) and Cole and Sung (1994). *Caki*, however, is different from these LDAs: as we have seen, although it has a sensitivity to the subject, it can also take an object as its antecedent, depending on the verb it occurs with, whereas LDAs of Germanic and Chinese can only take a subject antecedent. This flexibility in the antecedent potential of *caki* modulated by the verb, in contrast to the LDAs of other languages that are more rigid, therefore suggests that the source of its subject effect is not likely to be structural.

Another possible source for the subject effect of *caki*, which we think is more promising, is that the antecedent of *caki* is required to be the perspectival centre, the person whose point-of-view the speaker is adopting. Such a notion has been argued to play an important role in the use of reflexives (e.g., *himself, herself, myself*) in English (Kuno, 1987; Zribi-Hertz, 1989), as well as LDAs in Japanese and Chinese (Sells, 1987; Huang and Liu, 2001). For Kuno, a potential antecedent of a reflexive is the person participating in the event or state described by the sentence whom the speaker identifies with or has empathy for. Sells uses the term 'pivot' and places the speaker in the shoes of the potential antecedent, the pivot individual, of Japanese LDA *zibun*.[12] Looking at our target sentences, the matrix subject of *say*-, *hear*- and *order*-sentences can be taken to be the perspectival centre of the proposition expressed by the embedded clause. From the matrix subject's point of view, the content in the embedded clause is said, heard or ordered. It can also be argued that these perspectival centres may shift or even get overridden depending on the matrix verb. In *say*-sentences, the source of the propositional content expressed in the embedded clause is the matrix subject, and therefore speakers may easily assume that the embedded propositional content is reported from the matrix subject's point of view. However, in *hear*-sentences, the source of the embedded propositional content is the matrix indirect object. This may then make the indirect object a potential perspectival centre, allowing the speaker to assume either the point of view of the matrix subject or the matrix indirect object in interpreting

12. Some authors use the term 'logophoricity' interchangeably with 'perspective/point-of-view' (Zribi-Hertz, 1989; Reinhart and Reuland, 1993), while others make a distinction between the two (Kuno, 1987; Culy, 1997), reserving 'logophoric centre' to refer to the speaker of the reported speech, thought, feeling or general state of consciousness, as originally defined in Clements (1975). The distinction between logophoricity and perspective/point-of-view is also made by Sells who uses the terms 'source' and 'self' for the former, and 'pivot' for the latter. We follow the authors that distinguish logophoricity from perspective/point-of-view, adopting Clements' definition of logophoricity, and use the term 'perspectival centre' to refer to the person whose point-of-view the speaker is adopting.

the embedded clause. In *order*-sentences, even though the perspectival centre is the matrix subject as it coincides with the source of embedded propositional content, the one giving the order, the lexical/syntactic property of *order* dictates that the embedded subject pronoun be bound by the matrix indirect object. The conflicting requirements then may be resolved in some cases by satisfying *caki*'s requirement to be bound by the perspectival centre, and in other cases by satisfying the verb's requirement that the embedded subject pronoun be bound by the matrix indirect object.

5. Conclusion

Through our eye-tracking study, we have teased apart the subject effect and the verb effect that constrain the processing and interpretation of Korean LDA *caki*. By testing a range of verbs, *order* as well as *say* and *hear*, we showed that the effect coming from the verb in constraining the interpretation of *caki* and null pronouns is not restricted to logophoricity (source of information), but other lexical or syntactic requirements of the verb can constrain the antecedent potential of anaphors. We also identified the subject effect as a unique property of *caki*, in comparison to null pronouns. Although *caki* appears to be different from LDAs of Germanic and other East Asian languages in that it is able to take a non-subject antecedent modulated by the verb, it shares with LDAs of other languages the strong sensitivity to the subject, which we saw persists throughout the processing of the sentence and in the final interpretation of *caki*. The cross-linguistic variation in the antecedent potential of LDAs then may be the result of the varying ways in which the subject effect is derived, structurally or non-structurally, and the varying ways in which it interacts with other syntactic or semantic effects in anaphor resolution in the language.

Our overall finding that the antecedent potential of Korean LDA *caki* is a function of both the subject effect and the verb effect, whether the source of those effects is structural or non-structural, is compatible with the multiple-constraints approach to anaphor resolution, the view that anaphor-interpretation is determined, not by a single constraint, but by multiple interacting constraints (Ariel, 1990; Arnold, 1998; Kaiser et al., 2009). Thus, our finding implies that any formal theory of *caki*-binding must be flexible enough to admit subject and non-subject antecedents in principle, and when there is the potential for ambiguity, it must take multiple factors into consideration in making predictions about the possible binding alternatives. Moreover, our finding that the subject effect of *caki* emerges early before the verb has been processed, and that it can be reduced or overridden by the subsequent verb, is compatible with the language processing model that

constraints apply as soon as they can, continuously interacting with one another (Macdonald et al., 1994; Trueswell et al., 1994; Badecker and Straub, 2002; Kaiser et al., 2009). Due to the verb-final property of Korean, we were able to identify different factors that contribute in predicting possible antecedents of an anaphor and observe the effect of these factors on anaphor resolution as soon as they become available in the course of sentence processing.

Having identified this time-separated signature of the different effects on anaphor resolution by taking advantage of the unique opportunities provided in Korean word order, we believe that this methodology may open an avenue toward comparisons between LDA languages which share this verb-final property. Firstly, a comparison of our findings for Korean *caki* and parallel experiments on Japanese *zibun* may reveal different degrees of strength for the competing effects between languages. Secondly, having seen that different verbs in Korean triggered different intensities of verb effect, a more detailed cross-linguistic survey may in fact reveal that different verbs yield these effects in different languages. In so doing, we may discover more systematic evidence for the divergent labels of logophoricity (source of information) versus perspectival centre (pivot). Finally, and most speculatively, we suspect that there may be some potential in applying a similar methodology in Germanic V2 languages, where lexical predicates may appear as either the second or the final element in the clause, depending on variations in inflection and embedding. By varying the position of the predicate relative to the anaphor in such a language, it may be possible to detect a predicate effect in those languages as well.

Acknowledgements

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Appendix A. Test stimuli

This appendix provides example scene-setting and target sentences that were used for each experimental condition, along with the comprehension questions and possible answers.

A.1 *Say*/*caki* condition

a. Yengsek-iwa Yujin-ika olaksil-ey iss-ta. Kutul-un olak-ul ha-lyeko ha-n-ta.
Yengsek-and Yujin-NOM arcade-at be-DECL they-TOP game-ACC do-intend do-PRES-DECL
'Yengsek and Yujin are at the arcade. They are going to play a game.'

b. Yujin-ika Yengsek-ihanthey olakki yep-eyse caki-ka olak-eyse noph-un cemswu-lul
Yujin-NOM Yengsek-to game beside-at self-NOM game-on high-ADN score-ACC
et-ulke-lako malha-yess-ta.
get-FUT-COMP say-PAST-DECL
'Yujin said to Yengsek beside the game that self will get a high score on the game.'

c. Haciman silceylo kyay-nun olak-eyse noph-un cemswu-lul et-ci anh-ass-ta.
but actually the kid-TOP game-on high-ADN score-ACC get-CONN NEG-PAST-DECL
'But actually the kid didn't get a high score on the game.'

d. Yujin-inun nwu-ka olak-eyse noph-un cemswu-lul et-ulke-lako malha-yess-supnikka?
Yujin-TOP who-NOM game-on high-ADN score-ACC get-FUT-COMP say-PAST-INT
'Who did Yujin say will get a high score on the game?

e. Yengsek / Yujin

A.2 *Say*/null condition

a. Yengsik-iwa Yuli-ka cheyyukkwan-ey iss-ta. Kutul-un sal-ul ppay-ki
Yengsik-and Yuli-NOM gym-at be-DECL they-TOP weight-ACC lose-NOMINAL
wihaye wuntongha-n-ta.
to exercise-PRES-DECL
'Yengsik and Yuli are at the gym. They are exercising to lose weight.'

b. Yuli-ka Yengsik-ihanthey lenningmesin yep-eyse lenningmesin-ul mence sayongha-nun
Yuli-NOM Yengsik-to treadmill beside-at treadmill-ACC first use-ADN
kes-i coh-ulke-lako malha-yess-ta.
thing-NOM good-FUT-COMP say-PAST-DECL
'Yuli said to Yengsik beside the treadmill that pro should use the treadmill first.'
c. Haciman silceylo kyay-nun lenningmesin-ul mence sayongha-ci anh-ass-ta.
but actually the kid-TOP treadmill-ACC first use-CONN NEG-PAST-DECL
'But actually the kid didn't use the treadmill first.'
d. Yuli-nun nwu-ka lenningmesin-ul mence sayongha-nun kes-i co-ulke-lako
Yuli-TOP who-NOM treadmill-ACC first use-ADN thing-NOM good-FUT-COMP
malha-yess-supnikka?
say-PAST-INT
'Who did Yuli say should use the treadmill first?'
e. Yuli / Yengsik

A.3 *Hear*/*caki* condition

a. Yengchel-iwa Swumi-ka pwuek-ey iss-ta. Kutul-un lamyen-ul kkuli-lyeko
Yengchel-and Swumi-NOM kitchen-at be-DECL they-TOP ramyen-ACC cook-intend
ha-n-ta.
do-PRES-DECL
'Yengchel and Swumi are in the kitchen. They are going to make ramen noodles.'
b. Swumi-ka Yengchel-ihanthey kkasuleynci yep-eyse caki-ka lamyen-ul maypkey
Swumi-NOM Yengchel-from stove beside-at self-NOM ramyen-ACC spicy
cook-FUT-COMP hear-PAST-DECL
kkuli-lke-lako tul-ess-ta.
'Swumi heard from Yengchel beside the stove that self will make ramen spicy.'
c. Haciman silceylo kyay-nun lamyen-ul maypkey kkuli-ci anh-ass-ta.
but actually the kid-TOP ramyen-ACC spicy cook-CONN NEG-PAST-DECL
'But actually the kid didn't make ramyen spicy.'
d. Swumi-nun nwu-ka lamyen-ul maypkey kkuli-lke-lako tul-ess-supnikka?
Swumi-TOP who-NOM ramyen-ACC spicy cook-FUT-COMP hear-PAST-INT
'Who did Swumi hear will make ramen spicy?'
e. Yengchel / Swumi

A.4 *Hear*/null condition

a. Eunjoo-wa Hyensik-ika sukhicang-ey iss-ta. Kutul-un sukhi-lul tha-lyeko
Eunjoo-and Hyensik-NOM ski hill-at be-DECL they-TOP ski-ACC ride-intend
do-PRES-DECL
ha-n-ta.
'Eunjoo and Hyensik are on a ski hill. They are going to ski.'

b. Eunjoo-ka Hyensik-ihanthey sukhiliphuthu yep-eyse sukhiliphuthu-lul tha-myen
Eunjoo-NOM Hyensik-from ski lift beside-ACC ski lift-ACC ride-when
ecileweha-lke-lako tul-ess-ta.
feel dizzy-FUT-COMP hear-PAST-DECL
'Eunjoo heard from Hyensik beside the ski lift that pro will feel dizzy when riding the ski lift.'
c. Haciman silceylo kyay-nun sukhi liphuthu-lul tha-myen ecileweha-ci
but actually the kid-TOP ski lift-ACC ride-when feel dizzy-CONN
anh-ass-ta.
NEG-PAST-DECL
'But actually the kid didn't feel dizzy when riding the ski lift.'
d. Eunjoo-nun nwu-ka sukhi liphuthu-lul tha-myen ecileweha-lke-lako
Eunjoo-TOP who-NOM ski lift-ACC ride-when feel dizzy-FUT-COMP
tul-ess-supnikka?
hear-PAST-INT
'Who did Eunjoo hear will feel dizzy when riding the ski lift?'
e. Eunjoo / Hyensik

A.5 *Order*/*caki* condition

a. Youngae-wa Byunghen-ika cip yep-ey iss-ta. Kutul-un cip chengso-lul
Youngae-and Byunghen-NOM house beside-at be-DECL they-TOP house cleaning-ACC
ha-lyeko ha-n-ta.
do-intend do-PRES-DECL
'Youngae and Byunghen are near a house. They are going to do house cleaning.'
b. Youngae-ka Byunghen-ihanthey cip yep-eyse caki-ka cip an-ulo tuleka-lako
Youngae-NOM Byunghen-to house beside-at self-NOM house inside-to go-COMP
myenglyengha-yess-ta.
order-PAST-DECL
'Youngae ordered Byunghen beside the house that self go inside the house.'
c. Haciman silceylo kyay-nun cip an-ulo tuleka-ci anh-ass-ta.
but actually the kid-TOP house inside-to go-CONN NEG-PAST-DECL
'But actually the kid didn't go inside the house.'
d. Youngae-nun nwu-ka cip an-ulo tuleka-lako myenglyengha-yess-supnikka?
Youngae-TOP who-NOM house inside-to go-COMP order-PAST-INT
'Who did Youngae order to go inside the house?'
e. Byunghen / Youngae

A.6 *Order*/null condition

a. Chelswu-wa Swuni-ka swuyengcang-ey iss-ta. Kutul-un taiping-ul ha-lyeko
Chelswu-and Swuni-NOM swimming-at be-DECL they-TOP diving-ACC do-intend
ha-n-ta.
do-PRES-DECL
'Chelswu and Swuni are at the swimming pool. They are going to dive.'

b. Swuni-ka Chelswu-hanthey taipingtay yep-eyse ese taipingtay wi-lo
Swuni-NOM Chelswu-to diving board beside-at quickly diving board top-to
ollaka-lako myenglyengha-yess-ta.
go-COMP order-PAST-DECL
'Swuni ordered Chelswu beside the diving board that pro climb up the diving board quickly.'
c. Haciman silceylo kyay-nun ese taipingtay wi-lo ollaka-ci anh-ass-ta.
but actually the kid-TOP quickly diving board top-to go-CONN NEG-PAST-DECL
'But actually the kid didn't climb up the diving board quickly.'
d. Swuni-nun nwu-ka ese taipingtay wi-lo ollaka-lako
Swuni-TOP who-NOM quickly diving board top-to go-COMP
myenglyengha-yess-supnikka?
order-PAST-INT
'Who did Swuni order to climb up the diving board quickly?
e. Swuni / Chelswu

Appendix B. Filler stimuli

This appendix provides example scene-setting sentences, target sentences, and comprehension questions and possible answers that were used in filler trials.

B.1 *Say*/*she* condition

a. Misen-iwa Kyengkyu-ka noli tongsan-ey iss-ta. Kutul-un chengyong
Misen-and Kyengkyu-NOM amusement park-at be-DECL they-TOP roller
yelcha-lul tha-lyeko ha-n-ta.
coaster-ACC ride-intend do-PRES-DECL
'Misen and Kyengkyu are at the amusement park. They are going to ride the roller coaster.'
b. Kyengkyu-ka Misen-ihanthey chengyong yelcha yep-eyse kunye-ka chengyong
Kyengkyu-NOM Misen-to roller coaster beside-at she-NOM roller
yelcha-lul tha-myen soli-lul cilu-lke-lako malha-yess-ta.
coaster-ACC ride-if scream-ACC emit-FUT-COMP say-PAST-DECL
'Kyengkyu said to Misen beside the roller coaster that she will scream when riding a roller coaster.'
c. Haciman silceylo kyay-nun chengyong yelcha-lul tha-myen soli-lul cilu-ci
but actually the kid-TOP roller coaster-ACC ride-if scream-ACC emit-CONN
anh-ass-ta.
NEG-PAST-DECL
'But actually the kid didn't scream when riding a roller coaster.'
d. Kyengkyu-nun nwu-ka chengyong yelcha-lul tha-myen soli-lul cilu-lke-lako
Kyengkyu-TOP who-NOM roller coaster-ACC ride-if scream-ACC emit-FUT-COMP
malha-yess-supnikka?
say-PAST-INT
'Who did Kyengkyu say will scream when riding a roller coaster?'
e. Misen / Kyengkyu

B.2 *Hear*/*she* condition

a. Yengsek-iwa Yujin-ika olaksil-ey iss-ta. Kutul-un olak-ul ha-lyeko ha-n-ta.
Yengsek-and Yujin-NOM arcade-at be-DECL they-TOP game-ACC do-intend do-PRES-DECL
'Yengsek and Yujin are at the arcade. They are going to play a game.'

b. Yujin-ika Yengsek-ihanthey olakki yep-eyse kunye-ka olak-eyse noph-un cemswu-lul
Yujin-NOM Yengsek-from game beside-at she-NOM game-on high-ADN score-ACC
et-ulke-lako tul-ess-ta.
get-FUT-COMP say-PAST-DECL
'Yujin heard from Yengsek beside the game that she will get a high score on the game.'

c. Haciman silceylo kyay-nun olak-eyse noph-un cemswu-lul et-ci anh-ass-ta.
but actually the kid-TOP game-on high-ADN score-ACC get-CONN NEG-PAST-DECL
'But actually the kid didn't get a high score on the game.'

d. Yujin-inun nwu-ka olak-eyse noph-un cemswu-lul et-ulke-lako tul-ess-supnikka?
Yujin-TOP who-NOM game-on high-ADN score-ACC get-FUT-COMP hear-PAST-INT
'Who did Yujin hear will get a high score on the game?

e. Yengsek / Yujin

B.3 *order*/*she* condition

a. Swujin-iwa Yengswu-ka hakkyo censansil-ey iss-ta. Kutul-un khemphyuthe
Swujin-and Yengswu-NOM school computer lab-at be-DECL they-TOP computer
hantay-ka kocangna-n kes-ul alanay-ss-ta.
one-NOM broken-ADN fact-ACC discover-PAST-DECL
'Swujin and Yengswu are in the school computer lab. They discovered that one of the computers is broken.'

b. Yengswu-ka Swujin-ihanthey khemphyuthe yep-eyse kunye-ka khemphyuthe-uy
Yengswu-NOM Swujin-from computer beside-at she-NOM computer-GEN
cenwon-ul kku-lako myenglyengha-yess-ta.
power-ACC turn off-COMP order-PAST-DECL
'Yengswu ordered Swujin beside the computer that she turn the computer power source off.'

c. Haciman silceylo kyay-nun khemphyuthe-uy cenwon-ul kku-ci anh-ass-ta.
but actually the kid-TOP computer-GEN power-ACC turn off-CONN NEG-PAST-DECL
'But actually the kid didn't turn the computer power source off.'

d. Yengswu-nun nwu-ka khemphyuthe-uy cenwon-ul kku-lako
Yengswu-TOP who-NOM computer-GEN power-ACC turn off-COMP
myenglyengha-yess-supnikka?
order-PAST-INT
'Who did Yengswu order to turn the computer power source off?

e. Yengswu / Swujin

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