The Role of Complementizers in Korean Subject and Object Control Constructions*

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1 Introduction

Control constructions involve a dependency between two argument positions: controller and controllee (Kwon and Polinsky 2006). The former is overt and determines the referential properties of the latter, represented as PRO, which is an invisible subject in the embedded infinitival clause:

(1) a. John$_1$ promised Mary$_2$ [PRO$_{1/*2}$ to wash].
b. John$_1$ persuaded Mary$_2$ [PRO$_{*1/2}$ to wash].

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Despite having the same superficial structure, the interpretation of a pair in (1) varies depending on the matrix verb predicates. When an infinitival clause is embedded under predicates like *promise*, as shown in (1a), a subject control interpretation arises, where the referent of PRO is the matrix subject NP (i.e., John). On the other hand, when an infinitival clause is embedded under predicates like *persuade*, as in (1b), an object control interpretation emerges, with the referent of PRO being the matrix object NP (i.e., Mary). Therefore, in English control constructions, the matrix verbs play a crucial role in identifying the antecedent of PRO.

Previous studies on incremental sentence processing have primarily focused on verbs (Pollard and Sag 1994). Specifically, verbs facilitate the predictive processing of argument structure and upcoming information, just as lexical heads do in verb-initial languages (Altmann 1999). Boland et al. (1990) discovered that comprehenders immediately utilize verb information for dependency formation during the online comprehension of English control constructions. However, this is not possible in verb-final languages such as Korean, where matrix verb information is delayed until the end of the sentence, as demonstrated in (2):

(2) a. John-i Mary-eykey [PRO ssis-*kilo*] yaksokhae-ss-ta
J.-NOM M.-DAT [PRO wash-COMP] promise-PST-DECL
'John promised Mary to wash.'

b. John-i Mary-eykey [PRO ssis-*tolok*] seltukhae-ss-ta
J.-NOM M.-DAT [PRO wash-COMP] persuade-PST-DECL
'John persuaded Mary to wash.'

In addition to control verbs, Korean counterparts of (1) have different complementizers: *kilo* for subject control construction (i.e., 2a) and *tolok* for object control construction (i.e., 2b). According to the Standard Korean Language Dictionary by the National Institute of Korean Language, *kilo* attaches to the verb root, indicates a promise or decision, and is limited to certain verb types (e.g., *kyelsimha-* 'determine', *kyeyhoykha-* 'plan', *yaksokha-* 'promise'). On the other hand, *tolok* is used with a limited set of verb predicates (e.g., *cwungkoha-* 'advise', *kwenkoha-* 'recommend', *myenglyengha-* 'order') (Gamerschlag 2007; Park 2011; Yang 1985).

While there is robust evidence supporting the use by parsers of preverbal constituents in head-final languages (Inoue and Fodor 1995; Kamide, Yuki, Altmann, and Haywood 2003), the extent to which they rely on this information remains unclear. This study aims to explore whether and to what extent native speakers of Korean rely on alternative cues, such as the complementizer, before encountering the control verb to interpret control relations in online sentence comprehension.

The remainder of this article is organized as follows: Section 2 provides a brief review of previous findings from the processing of control constructions. Section 3 presents the methodological details of the current study. Section 4 reports the results. Finally, in Section 5, I conclude with the discussion of the findings and their implications.

2 Processing of Control Constructions

Empirical research on control sentence comprehension has yielded various findings, explained by the notion of 'filler-gap dependency.' That is, in processing of (3a) and (3c), for example, parsers initially assign the fronted wh-phrase 'which horse' (a filler) to an object of the matrix verb 'signal' (the potential gap) at the matrix verb 'signal' but revise the assignment at the embedded verb 'surrender' due to the implausibility of the context (i.e., the horse cannot surrender to the authority).

Boland et al. (1990) reported that verb control information guides the interpretation of PRO in online sentence comprehension. They manipulated the plausibility of the controller (i.e., plausible '*outlaw*' vs. implausible '*horse*') and the distance between a controller and PRO (i.e., wh-interrogatives vs. declaratives):

(3) a. Wh-interrogative with an implausible subject:
Which horse$_2$ did the cowboy$_1$ signal PRO$_{*1/2}$ to surrender to the authorities?
b. Declarative with an implausible subject:
The cowboy$_1$ signaled the horse$_2$ to surrender PRO$_{*1/2}$ to the authorities.
c. Wh-interrogative with a plausible subject:
Which outlaw$_2$ did the cowboy$_1$ signal PRO$_{*1/2}$ to surrender to the authorities?
b. Declarative with a plausible subject:
The cowboy$_1$ signaled the outlaw$_2$ PRO$_{*1/2}$ to surrender to the authorities.

The results demonstrated that sentences with implausible subjects were read slower at a control verb compared to sentences with plausible subjects, regardless of whether they were in interrogative and declarative form.

In contrast, it has been reported that comprehenders of verb-final languages predictably utilize morphological, syntactic, and contextual cues in addition to control verbs. Witzel and Witzel (2011) compared the reading times of control sentences by Japanese comprehenders, where an embedded subject is either overt (i.e., *karejishin* 'himself' or *kanojojishin* 'herself') or

omitted (i.e., PRO). They discovered that sentences with overt subjects were read faster than those with null subjects upon encountering a control verb. This indicates that control interpretation is readily available to Japanese comprehenders, enabling them to provisionally identify the referent of PRO.

Considering the rich verbal morphology of Korean, Song and Yun (2016) argued that verb modal or mood suffixes of the embedded clause could serve as cues in online processing of Korean control constructions. They compared the reading times at a control verb by manipulating the verbal suffix attached to the embedded verb, either the volitional modal suffix *-keyss* or the imperative mood suffix *-la*. The results proposed that the suffixes *-keyss* and *-la* provided readers with control information (i.e., subject control information for *-keyss* and object control information for *-la*), triggering the licensing of PRO identity. They also reported that the words before control verb were read more slowly when the controller was a subject than it was an object, indicating that the object control interpretation is more accessible to Korean comprehenders.

3 The Study

This study, inspired by Song and Yun (2016), examined the online processing of control constructions by Korean comprehenders. The research question addressed was: Do Korean comprehenders immediately utilize complementizer information to interpret control constructions?

3.1 Participants

Forty-nine native speakers of Korean (28 males, age range=16-69, *M*=44.2, *SD*=17.32) participated in the study. Four participants were excluded from the analysis due to their performance (for exclusion criteria, see §4).

3.2 Procedure

All the experimental tasks were conducted fully online, implemented using Gorilla. After filling out the consent forms, participants completed the main task, a Stop-making-sense Task (Boland et al. 1990). The experiment began with onscreen instructions that described the task. Participants were informed that they would be reading sentences one word at a time in the center of a computer screen, and that pressing the 'F' key would allow them to proceed to the next word. They were also instructed that they could stop the current trial and move on to the next one as soon as they felt the sentence no longer made sense by pressing the 'J' key. Two types of data were recorded for each participant for each word region: reading times and rejection rates. Reading times were measured in milliseconds for each word.

Following the main task, participants completed two untimed judgment tasks: a Coreference Judgment Task (CJT) and an Acceptability Judgment Task (AJT). In the CJT, participants were asked to select the agent of the event described in the embedded clause from two choices: a subject NP and an object NP. In the AJT, participants were instructed to rate the naturalness of each sentence on a 5-point scale, with 1 indicating 'very unnatural' and 5 indicating 'very natural'. The two untimed judgment tasks were conducted only for target sentences to prevent participant fatigue. The entire experimental session took approximately 30–45 minutes.

3.3 Design and Materials[2]

A total of thirty-two experimental sentences were used. The experiment crossed Complementizer (*kilo* vs. *tolok*) with Context (Match vs. Mismatch) in a Latin square design, resulting in four conditions (k=8 each).[3] Additionally, 64 fillers were included encompassing syntactic structures such as conjunctive constructions, raising, relativized clause, and others.

The plausibility of Context was manipulated, taking into account previous findings that plausible information (e.g., the subject NP 'waiter' taking a customer's order in (4a)) can be automatically and effortlessly processed based on general world knowledge (Yoon et al. 2015). Similarly, implausible contextual information (e.g., the subject NP 'customer' taking a waiter's order in (4b)) disrupts general knowledge, leading to increased processing demands.

Importantly, to see just the effect of complementizer integration, the specific control verbs at R7 were replaced with a neutral verb *ha-* 'do'. This decision was informed by the results of a preliminary experiment, the Coreference Judgement Task, conducted with 32 native Korean speakers. In this experiment, when the complementizer *kilo* was used, the matrix subject was chosen as the controller 82.98% of the time. On the other hand, when the complementizer *tolok* was used, the matrix object was chosen as the controller 95.31% of the time.

[2] Details of the experimental materials, hypotheses, results (e.g., model outputs), and analysis can be accessed on the Open Science Framework (https://osf.io/4tv2a/).

[3] Twenty-five participants received unbalanced lists (e.g., 7 items in Condition A and 9 items in Condition B, or 9 items in Condition A and 7 in Condition B) as two experimental items in Lists 2 and 3 were mistakenly swapped.

(4) a. *kilo*-Match condition
Today R1 | waiter-NOM R2 | customer-DAT R3 | quickly R4 |
order-ACC R5 | take-**KILO** R6 | do-PST-DECL-COMP R7 |
say-PRS-DECL R8
'It is said that a waiter$_1$ decided PRO$_1$ to take an order quickly from a customer$_2$ today.'

b. *kilo*-Mismatch condition
Today R1 | customer-NOM R2 | waiter-DAT R3 | quickly R4 |
order-ACC R5 | take-**KILO R6** | do-PST-DECL-COMP R7 |
say- PRS-DECL R8
?'It is said that a customer$_1$ decided PRO$_1$ to take an order quickly from a waiter$_2$ today.'

c. *tolok*-Match condition
Today R1 | customer-NOM R2 | waiter-DAT R3 | quickly R4 |
order-ACC R5 | take-**TOLOK R6** | do-PST-DECL-COMP R7 |
say-PRS-DECL R8
'It is said that a customer$_1$ had a waiter$_2$ PRO$_2$ take their order quickly today.'

d. *tolok*-Mismatch condition
Today R1 | waiter-NOM R2 | customer- DAT R3 | quickly R4 |
order-ACC R5 | take-**TOLOK R6** | do-PST-DECL-COMP R7 |
say- PRS-DECL R8
?'It is said that a waiter$_1$ had a customer$_2$ PRO$_2$ take an order quickly today.'

4 Results

Three participants who had accuracy rates below 70% in the Coreference Judgment Task for the target items in the Match conditions (i.e., scoring 12 out of 16 or lower) were excluded from the analysis. Additionally, one participant who had unusual RTs patterns were also excluded. As a result, a total of 45 participants remained for the analysis (25 males, *M*=42.1, *SD*=16.5).

4.1 Stop-making-sense Task

The goal of this task was to investigate the time course of utilizing control information extracted from complementizers in the processing of control constructions. It assessed two types of information: participants' reading times and rejection rates per region. Longer reading times indicate increased processing difficulty for participants, while higher rejection rates suggest an

inability to consider the possibility of a gap in the syntactic structure at a conscious level (Kim et al. 2015). The regions of interest are Region 6 (i.e., where the complementizer appears) and Region 7 (i.e., where the generic verb *ha-* 'do' appears, as a spill-over region).

4.1.1 Rejection Rates

The number of trials in each condition on which a participant rejected the sentence was recorded at each region. These results were analyzed using generalized linear mixed-effects models (Baayen 2008) with the *lme4* package in the statistical software environment R (Bates et al. 2014).[4] The fixed effects included Context and Complementizer, while the random effects included Participants and Items.

Results show significant main effects of Complementizer (β=.33, *SE*=.08, *z*=4.05, *p*<.001) and Context (β=-.77, *SE*=.08, *z*=-9.23, *p*<.001). This indicates that sentences with an incorrect complementizer were rejected more than sentences with a correct complementizer. The interaction between Complementizer and Context was not significant (β=.00, *SE*=.08, *z*=.04, *p*=.97). At the spill-over region, R7, there was an interaction between Complementizer and Context, and it was approaching significance (*p*=.053), although there was no significant Complementizer effect (β=.05, *SE*=.07, *z*=.66, *p*=.51). Specifically, there was a highly significant main effect of Context (β=-.86, *SE*=.07, *z*=-11.64, *p*<.001).

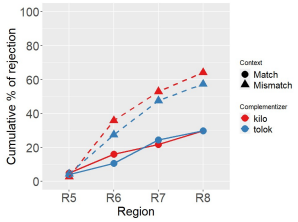

Figure 1. Cumulative percentages of rejections in the critical regions (i.e., R6 and R7).[5]

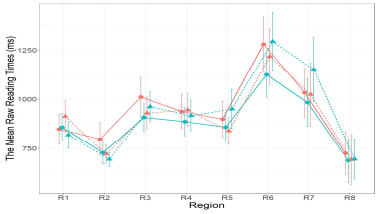

Figure 2. Mean log transformed reading times (R6: complementizer region).

[4] Prior to analysis, the fixed effects were transformed into numerical values by sum coding: Context was coded as 1 for Match and -1 for the Mismatch conditions; Complementizer was coded as 1 for *kilo* and -1 for *tolok* conditions. Starting with the maximal model, random effects were reduced step by step until the model converged. The final model was conducted by using the following code: glmer(Cumulative_Reject ~ 1 + Complementizer * Context + (1 | Participant) + (1 | Item).

[5] Up until R8, participants had rejected 64% of *kilo*-Mismatch sentences, 57% of *tolok*-Mismatch sentences, 29% of *kilo*-Match sentences, and 29% of *tolok*-Match sentences.

The percentage of rejection sharply increases at R6, where a complementizer appeared, and continued to rise until the end of the sentence for Mismatch conditions, as shown in Figure 1.

4.1.2 Reading Times (RTs)

Prior to analysis, the RT data were trimmed in two steps: (1) extreme RTs that were faster than 200 milliseconds or greater than 15,000 milliseconds were removed to prevent misleading results due to inflated estimations. (2) Long reading times were removed based on by-participant standard deviations. After applying the trimming procedure, a total of 868 data points were discarded, which accounted for 8% of the data.RTs were analyzed by region for all the trials that participants accepted by pressing 'yes' key. For example, if a participant terminated a given sentence at region 6, the RTs at regions 1 through 5 were included in the analysis. The raw RTs were then log-transformed to adjust for the skewing that is typical of RT data.[6]

The results show that the complementizer was read significantly slower in Mismatch sentences compared to Match sentences (Figure 2), indicating a main effect of Context. Among the Match conditions, the RTs at R6 were longer when the complementizer was *kilo* compared to *tolok*, indicating a Complementizer effect.

As in the analysis of rejection rates, linear mixed-effects models were employed.[7] At R6, the interaction between Complementizer and Context (β=.05, *SE*=.02, *t*=2.09, *p*<.05) and a main effect of Context (β=-.04, *SE*=.02, *t*=-2.11, *p*<.05) were significant, although the Complementizer effect was not significant (β=.02, *SE*=.02, *t*=1.33, *p*=.19). The Context effect was statistically significant at R7 (β =-.86, S.E.=.07, *t*=-11.64, *p*<.001). The interactions between two factors (β =-.13, S.E.=.07, *t*=-1.93, *p*=.05) and the Complementizer effect (β =.05, S.E.=.07, *t*=.66, *p*=.51) were not significant. This indicates that participants immediately use control information to identify the antecedent of controller as soon as they arrive at the complementizer.

4.2 Coreference Judgment Task

As each participant made multiple categorical judgments (i.e., subject NP or object NP) for target sentences, a mixed-effects logistic regression model was

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[6] Reading time data in linguistics are typically positively skewed due to a natural lower limit on reading speed. This limit is determined by cognitive factors such as how quickly the brain can recognize and process a word and initiate a motor response to press a button. As a result, extremely short reading times are not possible, while very long reading times can occur in a stop-making-sense or self-paced reading tasks.

[7] lmer(Log.RT ~ Complementizer * Context + (1 + Complementizer * Context | Participant) + (1 + Complementizer * Context | Item)

conducted.[8] Results show that the percentage of the correct interpretation was higher in Match sentences compared to Mismatch sentences (Figure 3). There were significant main effects of Complementizer (β=.74, SE=.24, z=3.07, p<.01) and Context (β=1.35, SE=.22, z=6.21, p<.001), which supported our hypothesis. However, the interaction between the two predictors was not significant (β=.26, SE=.16, z=1.65, p<1).

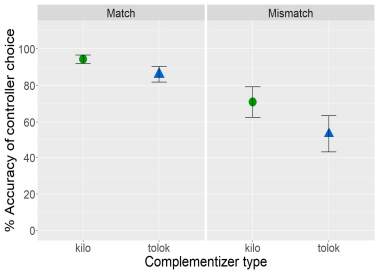

Figure 3. Mean rates (%) of correct judgments by Complementizer and Context. The error bars show standard errors.

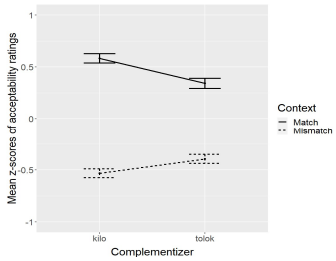

Figure 4. Mean z-scores of acceptability ratings in the AJT. The error bars show standard errors.

4.3 Acceptability Judgment Task

The raw judgment scores were first transformed into standardized z-scores to eliminate any bias (Cowart 1997). These standardized scores indicate how far each rating deviates from the mean score of each participant. If our hypothesis is supported, it was expected that the acceptance rates would be higher in Match sentences than in Mismatch sentences.

For the statistical analysis, cumulative link mixed models were used as they are suitable for handling ordered categorical data (Christensen 2018).[9] The main effect of Context was observed, indicating that Match sentences were rated as more acceptable than Mismatch sentences (Figure 4). Results show that the Context effect appeared to be the significant predictor of the acceptability of the experimental sentences (β=1.32, SE=.14, z=9.25, p<.001). Furthermore, the interaction between Complementizer and Context was found to be statistically significant. (β=.27, SE=.14, z=2.03, p<.05).

[8] glmer(Accuracy ~ 1 + Complementizer * Context + (1 + Complementizer + Context | Participant) + (1 + Complementizer + Context | Item).

[9] clmm(Acceptability ~ Complementizer * Context + (1 + Complementizer * Context | Participant) + (1 + Complementizer * Context | Item)

5 Discussion

This experimental study investigated the effects of complementizers on the interpretation of control constructions by Korean native speakers. The results from the untimed judgment tasks, the Coreference Judgment Task and the Acceptability Judgment Task, indicate that the complementizer alone can influence the interpretation of PRO in Korean control constructions. Specifically, when the complementizer information did not align with the plausibility of Context (evident in cases such as (4b) and (4d) where the control interpretation triggered by the complementizer conflicted with the contextual information), participants exhibited lower accuracy in their interpretations and rated the sentences as less natural.

The interaction between Complementizer and Context reached statistical significance in the online task, the observed increase in reading times and rejections at the point of the complementizer suggests that complementizer may play a role in linking the controller and PRO.

Overall, these findings suggest that complementizers can aid in establishing the dependency between controller and PRO in control constructions, especially in verb-final languages where control verb information would otherwise be delayed. Consequently, the control information conveyed by complementizers serves as a constraint that guides controller choice in the comprehension of control constructions in Korean.

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