# Speakers Are Interconnected With Comprehenders: The Asymmetry of Argument Order by Long-before-short Preference in Korean

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**Abstract**

We investigated how closely speakers' production preferences were interconnected with comprehenders' processing difficulty, using dative sentences in Korean, based on the behavioral data that we obtained from a production study and an eye-tracking reading study, respectively. In both studies, we tested the long-before-short preference such that long words/phrases were highly likely to be placed prior to short words/phrases (Yamashita & Chang, 2001). Both speakers and comprehenders preferred dative sentences of which target arguments (i.e., recipients and patients) were canonically ordered when the length of the arguments did not differ and when the length of recipients was longer than that of patients. However, when the length of patients was longer than that of recipients, the canonical order of arguments was not preferred. Our data indicated that speakers and comprehension observed the length constraint, although they eventually violated the canonicality constraint. The asymmetry of argument order modulated by long-before-short preference was further examined in the linear mixed-effect regression model to see the relationship between production and comprehension. The results revealed that comprehenders felt easier to process sentences as the degree of speakers' structural preferences increased. Altogether, we present our results as evidence showing that speakers and comprehenders are closely interconnected each other, supporting the claim that the processes in production and comprehension are not dichotomy (Pickering & Garrod, 2013).

**Keywords**: sentence comprehension, sentence production; long before short preference; head-final language

## Introduction

A successful communication emerges as a function of cooperative coordination between speakers and comprehenders (c.f., Grice, 1975). In this vein, exploring the internal mechanism across production and comprehension is one of the topics that many studies have recently paid attention on. Many previous studies have extensively discussed comprehenders' behaviors within the findings on speakers' behaviors, which have been observed independently, or *vice versa*. However, except the studies that tested communicators' interactive behaviors in a communicative context, few studies have attempted to investigate how speakers' production tendency is substantially related to comprehenders' processing difficulty by simultaneously taking into account both production and comprehension results that are conducted using the same experimental environment (e.g., using the same experimental materials). In this study, we aimed to demonstrate how closely speakers' behaviors (e.g., production preferences) are interconnected with comprehenders' behaviors (e.g., comprehension difficulty). For this purpose, we focus on a cross-linguistic linguistic phenomenon known as long-before-short preference observed in head-final languages like Korean and Japanese.

**Long before short preference in head-final languages**

The length of words or phrases has been known as one of the constraints that have an effect on shifting the order of words or phrases in a sentence. It is of great interest that the effect of length constraint differs typologically across languages. For example, in English, short constituents are often located prior to long constituents (Arnold, Wasow, Losongco, & Ginstrom, 2000; Bresnan, Cueni, Nikitina, & Baayen, 2007). Example (2) in which a short recipient, *Mary*, appears before a long patient, *the antique that was valuable*, is preferred to Example (1) in which the short recipient is located after the long patient. The short-before-long preference was consistent to the claim of the accessibility theory (Bock & Levelt, 1994) indicating that short words are more accessible than long words which in turn more accessible words tend to occur before less accessible words.

(1) I gave [the antique that was valuable] [to Mary].
(2) I gave [Mary] [the antique that was valuable].

On the contrary, in Japanese, long words or phrases are likely to be placed before short ones. Using dative sentences (Experiment 2), Yamashita and Chang (2001) demonstrated that Japanese speakers were more likely to produce sentences like (3) in which long patients are located before short recipients than sentences like (4) in which short recipients are located before long patients. Such a long-before-short preference challenged to the accessibility

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theory and it has been accepted as characteristics of head-final languages (Hawkins, 2004). However, no other studies have tried to replicate the findings of Yamashita and Chang by using other head-final languages like Korean.

(3) Masako-wa [sinbun-de syookai-sarete-ita okasi-o] [otoko-ni] todoketa.
Masako-top [newspaper-in introduced cake-acc] [man-dat] delivered
Masako delivered [the cake [which was] introduced in the newspaper-acc] [to the man-dat].

(4) Masako-wa [otoko-ni] [sinbun-de syookai-sarete-ita okasi-o] todoketa.
Masako-top [man-dat] [newspaper-in introduced cake-acc] delivered
Masako delivered [the man-dat] [the cake [which was] introduced in the newspaper-acc].

Hawkins (2004) accounted for the long-before-short preference in terms of distance minimization mechanism. In this mechanism, processors tend to arrange word/phrases in a way that minimizes the distance between verbs and their arguments, so that they could integrate arguments into sentences easily (see also Gibson, 1998). Because the heads of phrases (e.g., verbs of Verb Phrase) appear sentence finally, long arguments should occur before short arguments. As a result, arguments are located closely to verbs. Note that Hawkins' idea on the long-before-short preferences in sentence production is based on sentence comprehension. In addition, Hawkins's proposal is as similar as Levelt's (1989) idea that speakers might monitor their own speech through comprehension processes. However, there is no relevant empirical evidence supporting why speakers' preferences are motivated by comprehenders' behaviors, and few studies have yet attempted to extend the results of the long-before-short preference observed in production into the context of comprehension.

Taking a learning-based account, Chang (2009) ran a connectionist model showing that speakers in different languages (English and Japanese, respectively) could learn the bias of word order by length within an incremental processing architecture. Given his focus on the role of statistical experiences, Chang's claim is in the similar vein with MacDonald's (2013) proposal that language production processes contribute to form how language comprehension works and further how one language typologically differs from other language.

By and large, we noticed that many studies take it for granted that production system is considerably related to comprehension system. Nonetheless, few studies have provided substantial evidence demonstrating the close relationship between production and comprehension. In this study, we had three goals; 1) In Experiment 1, we examined whether Korean speakers, like Japanese speakers, would prefer to locate long constituents prior to short constituents when they produce sentences. 2) In Experiment 2, we investigated whether Korean comprehenders, like Korean speakers, would have less difficulty in the processing of sentences in which long constituents appear prior to short constituents. 3) Finally, we demonstrated how strongly speakers' processing preferences would be interconnected with comprehenders' processing difficulty.

## Experiment 1

The goal of Experiment 1 was to investigate whether Korean speakers, like Japanese speakers in Yamashita and Chang (2001), would prefer to locate long constituents prior to short constituents when they construct sentences. If the long-before-short preference would be the primary characteristic in the processing of head-final languages, we expected to replicate the results of Yamashita and Chang with Korean speakers. For our test, we used dative sentence structures in which the order of recipients and patients could be alternated, although the order of recipients occurring before patients was canonical (Choi, 2007).

**Participants** Thirty undergraduate students at Konkuk University participated in this experiment. They were all paid at 5,000 won (approximately equivalent to U.S. $5).

**Materials and procedures** Thirty sets of experimental sentences were used. All of them had dative argument structures as shown in sentences (5a-c). Each sentence differed by the length types of target arguments (i.e., recipients associated with dative case markers and patients associated with accusative case markers): when the two target arguments were equally short, as in (5a), when recipients were longer than patients, as in (5b), and finally when patients were longer than recipients, as in (5c). The experimental stimuli were counterbalanced across 4 presentation lists. Each list included additional 60 filler sentences with various syntactic structures in order to obscure any systematicities in experimental materials.

(5a) Chelswu-nun [chinkwu-eykey] [meymo-lul] namky-ess-ta
Chelswu-top [friend-dat] [memo-acc] leave-past-decl
Chelswu left a friend a memo

(5b) Chelswu-nun [cokyo-ka pwull-ess-ten chinkwu-eykey] [meymo-lul] namky-ess-ta
Chelswu-top [cokyo-nom call-past-rel friend-dat] [memo-acc] left-past-decl
Chelswu left the friend that an assistant called a memo.

(5c) Chelswu-nun [chinkwu-eykey] [cokyo-ka caksengha-n meymo-lul] namky-ess-ta
Chelswu-top [friend-dat] [assistant-nom write-rel memo-acc] leave-past-decl
Chelswu left a friend the memo that an assistant wrote.

We used the same paradigm that Yamashita and Chang used. Figure 1 illustrates the procedure of this experiment. At first, participants fixated their attention on + (STEP 1), and then they gazed at two target arguments (i.e., a patient and a recipient) and a verb that were located in each corner

of a square for a short time (STEP 2). Next, a blank page was presented for 1500 ms (STEP 3), followed by a simple math question (STEP 4). Finally, a screen with a subject and the verb that had appeared in Step 2 was displayed and participants were asked to produce a sentence by using the subject, the verb and the two target arguments that had been shown in Step 2 (STEP 5).

**Results and discussion** We analyzed the sentences only when they contained two target arguments. This criterion resulted in removing 4% of the data. For a brief overview, we counted the frequency of how many times speakers produced the sentences that contained recipients and patients in order (i.e., sentences of which target arguments were canonically ordered). Figure 1 displays the frequency means of sentences of which internal arguments were canonically ordered across participants and items.

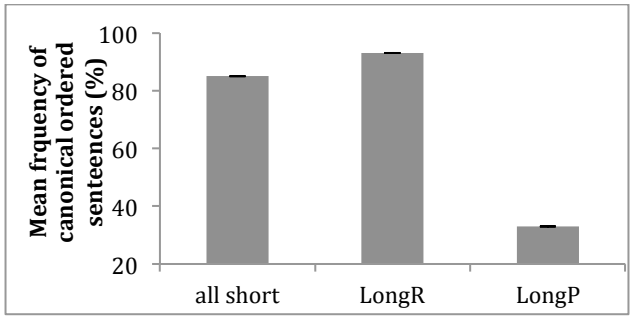


Figure 1: The mean frequencies of sentences that arguments were canonically ordered in each condition: 'All short' referring to the condition in which target arguments were equally short; 'LongR' corresponding to the condition in which recipients were longer than patients; 'LongP' for the condition in which patients were longer than recipients.

For our statistical analysis, we assigned a binary code to the target sentences: 1 corresponding to canonically ordered sentences and 0 corresponding to non-canonically ordered sentences. The binary codes of each sentence that each participant produced were submitted into a linear mixed logistic regression where both participants and items were assigned as random variables and the length type of arguments was a fixed variable. Analyses were conducted using lme4 (version 0.999375-33, Bates & Maechler, 2010) and languageR libraries (version 1.0, Baayen, 2010) for the R statistics program (R Development Core Team, 2010).

We report the results of this logistic model that included the interactions between random variables and fixed variables (see Table 1). Taking the outputs from all short condition as a baseline, the model yielded that the frequencies that canonically ordered sentences were significantly higher when the length of recipients was longer than that of patients (i.e., LongR condition) than when the length of recipients was as short as that of patients (i.e., All short condition) (Estimates = 1.77, S.E. = .40, z-value = 4.46, $p < .01$). The canonical effect became stronger when the length of recipients was longer than that of patients, relative to when the length of recipients was equivalent to that of patients. Crucially, however, the canonical effect disappeared when the length of patients was longer than that of recipients. The short recipients were located after long patients significantly more often, relative to when the two arguments were equally short (Estimates = -3.21, S.E. = .43, z-value = -7.51, $p < .01$). In short, long arguments, both recipients and patients, were highly likely to be fronted before short arguments.

Table 1: The results of the linear mixed effect logistic regression from Study 1

| | Estimates | S.E. | z-score | p-value |
|---|---|---|---|---|
| Intercept | 2.19 | .29 | 7.60 | <.01 * |
| Long P-All short | -3.21 | .43 | -7.51 | <.01 * |
| Long R-All short | 1.77 | .40 | 4.46 | <.01 * |

Experiment 1 replicated Yamashita and Chang (2001), supporting our hypothesis that the long-before-short preference should be observed in other head-final languages like Korean. Korean speakers, like Japanese speakers, preferred to place long arguments prior to short arguments when they produced sentences, regardless of whether target arguments were canonically ordered or not.

## Experiment 2

The goal of Experiment 2 was to examine the long-before-short preference in comprehension by using an eye-tracking reading paradigm. If the preference also played a role in reading sentences, we expected to observe similar results in a way that we observed in Experiment 1; that is, when one argument was longer than the other argument in a sentence, comprehenders would have easier processing of the sentence when the long argument was placed before the short argument than when the short argument was place before the long argument, regardless of whether the target arguments were canonically ordered.

**Participants** Thirty undergraduate students at Konkuk University took part in the experiment. They had normal vision and they were all paid at 5,000 won (about US $5).

**Materials** We recycled the same experimental sentences with slight modification that were used in Experiment 1 (see Table 2). The experimental sentences differed in three aspects. First, sentences differed depending on whether recipients associated with datives were placed prior to patients associated with accusatives. Second, the length of one argument was significantly longer than that of the other argument. We used a relative clause to make the length of an argument longer in comparison to that of the other argument. Third, sentences differed depending upon whether long arguments appeared before short arguments, or *vice versa*.

Experimental sentences were counterbalanced across 6 presentation lists. Each list included additional 46 filler sentences organized various syntactic structures to obscure

any systematicities in experimental materials. All sentences were presented in a randomized order. To check whether participants paid attention to reading, comprehension questions were included every 2 or 3 sentences

**Procedure** The experiment was implemented using Experiment Center that the SMI provides. Participants were seated in front of a 19″ display and the distance between the participant's eyes and the monitor display was 70cm (27.55″). They were instructed to minimize their head movements, as possible as they could, during the experiment. Participants' eye movements were recorded by using a SMI RED 500 that had a remote system. The sampling rate was 250Hz from the left eye (viewing was binocular). All sentences started from the left upper corner and were displayed on a single line. A fixation marker (+) at a starting point was presented between trials. Participants were required to read the instruction presented on the screen and move on to the next trial by fixating their eyes for two seconds on an indicator of 'next' depicted on the bottom of the screen. For the comprehension judgment task, yes-no questions were presented in every two or three trials. There were five practice trials before the main experimental session started. A recalibration procedure was performed using a nine-point fixation stimulus.

Table 2: A full set of example sentences used in Study 2

| Condition | Example sentences |
|---|---|
| *Short R-Short P* | Chelswu-nun [**chinkwu-eykey**] [**meymo-lul**] namky-ess-ta<br>Chelswu $_{-TOP}$ [friend$_{-DAT}$] [memo$_{-ACC}$] leave$_{-PAST-DELcl}$<br>Chelswu left a friend a memo. |
| *Short P-Short R* | Chelswu –nun [**meymo-lul**] [**chinkwu-eykey**] namky-ess-ta<br>Chelswu $_{-TOP}$ [memo$_{-ACC}$] [friend$_{-D}$ leave$_{-PAST-DEL}$<br>Chelswu left a memo to a friend. |
| *Long R-Short P* | Chelswu –nun [cokyo-ka pwullesste-n **chinkwu-eykey**] [**meymo-lul**] namky-ess-ta<br>Chelswu-$_{TOP}$ [assistant$_{-NOM}$ called$_{-REL}$ friend$_{-DAT}$] [memo$_{-ACC}$] leave$_{-PAST-DEL}$<br>Chelswu left the friend that an assistant called a memo. |
| *Long P-Short R* | Chelswu –nun [cokyo-ka caksengha-n **meymo-lul**] [**chinkwu-eykey**] namky-ess-ta<br>Chelswu-$_{rTOP}$ [assistant$_{-NOM}$ write$_{-REL}$ memo$_{-ACC}$] [friend$_{-DAT}$] leave$_{-PAST-DEL}$<br>Chelswu left the memo that an assistant wrote to a friend. |
| *Short R-Long P* | Chelswu -nun [**chinkwu-eykey**] [cokyo-ka caksengha-n **meymo-lul**] namky-ess-ta<br>Chelswu-$_{rTOP}$ [friend$_{-DAT}$] [assiatant$_{-NOM}$ write$_{-REL}$ memo$_{-ACC}$] leave$_{-PAST-DEL}$<br>Chelswu left the friend the memo that an assistant wrote. |
| *Short P-Long R* | Chelswu -nun [**meymo-lul**] [cokyo-ka pwullesste-n **chinkwu-eykey**] namky-ess-ta<br>Chelswu-$_{TOP}$ [memo$_{-ACC}$] [assistant$_{-NOM}$ call$_{-REL}$ friend$_{-DAT}$] leave$_{-PAST-DEL}$<br>Chelswu left a memo to the friend that an assistant called. |

Note. In condition, 'R' refers to recipients and 'P' refers to patients. For example, 'Short R-Short P' indicates the condition that both recipients and patients were equally short. Likewise, 'Long R-Short P' indicates the condition that the length of recipients was longer than that of patients.

**Dependent measurements** We measured first-pass RTs that was the sum of first pass fixations on the word before leaving it for the first time. It is often referred to as the early processing measures for detecting an initial processing difficulty (Straub & Rayner, 2007). We also computed second pass RTs and the percentage of regression, which are referred as the late processing measures for the examination of the re-analysis or integration difficulty (Rayner, Sereno, Morris, Schmauder, & Clifton, 1989). The total gaze duration, which was the sum of all fixations in the first pass and second pass reading, was also computed.

**Results and discussion** We first computed eye-movement measurements corresponding to target arguments, and then added up the measurements corresponding to the two arguments. For example, if a reader spent 200 ms in reading a recipient and 300 ms in reading a patient, the RTs of this combined phrase is 500ms.

A length, an order, and their interaction were included as a set of fixed variables. These fixed variables were dummy coded. As for the length factor, the condition that long constituents occurred before short constituents was coded as 0, while the condition that short constituents occurred before long constituents was coded as 1. As for the order factor, the condition that recipients were placed before patients was coded as 0, whereas the condition that patients were placed before recipients was coded as 1. To avoid concerns that a dummy coding might cause a co-linearity problem in models, all fixed factors were centered. The factor regarding the physical length of target phrases was added to control for the effect associated with comprehenders' perceptual effort (Juhasz & Rayner, 2003). We included participants and items as random variables and the interaction between random variables and fixed variables in all models. As outlined in Baayen (2008), we performed an initial fit for our models. We then removed all data points with residuals greater than 2.5 standard deviations from the mean, before we performed the final fit for our models. This procedure removed about 3% data points of overall data as outliers.

We report our modeling results in two parts. First, we report the results of models when both recipients and patients were equally short. Because it was not possible for the length factor to be manipulated in this condition, we examined the effect of the order factor on each eye-movement measurement. The effect of the argument order was observed only on regressions. Comprehenders' regressive looks occurred more frequently when patients appeared prior to recipients than when recipients occurred prior to patients (Estimate = .22, S.E. = .08, *t*-value = 2.77). This result indicated that comprehenders preferred encountering arguments that were arranged in a canonical order. When the canonical order of arguments was violated, readers tended to regress to previous constituents.

Second, we report the results of the models when one constituent was longer than the other constituent. We tested the effect of an order, a length, and their interaction, while controlling for the physical length associated with

comprehenders' perceptual effort (see Table 3). The effect of the argument order was observed on first pass RTs. The first pass RTs corresponding to target phrases were longer when patients appeared prior to recipients than when recipients occurred prior to patients, suggesting that comprehenders preferred encountering arguments in a canonical order. The effect of the length factor emerged on the measurements of second pass RTs, total gaze durations, and regressions. The second pass RTs for target phrases were longer when short constituents were placed before long constituents than when long constituents were placed before short constituents. The result on the total gaze duration for target phrases showed exactly the same pattern. Regressions occurred more frequently when short constituents were placed before long constituents than when long constituents were placed prior to short constituents.

Table 3: The results from linear mixed-effect regression models on eye-tracking movements from Study 2

| | Estimates | S.E. | *t*-value |
|---|---|---|---|
| First-pass RTs | | | |
| Intercept | 1018.15 | 38.42 | 26.50 |
| TargetLength | 23.06 | 35.65 | 0.65 |
| Order | 74.28 | 23.55 | 3.15* |
| Length | -9.81 | 23.45 | -0.42 |
| Order*Length | -55.58 | 48.32 | -1.15 |
| Second-pass RTs | | | |
| Intercept | 1003.96 | 118.46 | 8.48 |
| TargetLength | 105.76 | 96.97 | 1.09 |
| Order | -51.86 | 50.28 | -1.03 |
| Length | 296.44 | 50.28 | 5.90* |
| Order*Length | -3.19 | 105.44 | -0.03 |
| Total gaze duration | | | |
| Intercept | 2051.44 | 116.65 | 17.59 |
| TargetLength | 221.42 | 107.00 | 2.07* |
| Order | 24.32 | 56.68 | 0.43 |
| Length | 284.66 | 56.36 | 5.05* |
| Order*Length | -117.40 | 118.21 | -0.99 |
| Regression | | | |
| Intercept | 3.71 | 0.34 | 11.01 |
| TargetLength | -0.29 | 0.38 | -0.77 |
| Order | 0.01 | 0.19 | 0.04 |
| Length | 0.70 | 0.19 | 3.67* |
| Order*Length | 0.62 | 0.40 | 1.56 |

Note. If the absolute *t-value* of a fixed factor was over 2, the effect of the factor was considered to be significant at $\alpha < .05$ (Gelman & Hill, 2007).

The findings obtained in Experiment 2 indicated that comprehenders had less difficulty in processing sentences in which long arguments appeared before short arguments than sentences in which short arguments appeared before long arguments, regardless of whether arguments were canonically orders. Interestingly, comprehenders' processing difficulty was observed in the measurements (i.e., second pass RTs, total gaze duration, and regression) corresponding to late processes. This means that when comprehenders encountered unexpected long arguments after short arguments, the nature of comprehenders' difficulty in this experiment might rely on the reanalysis of incoming structures or the integration of arguments into sentences. In short, we showed that the long-before-short preference was also important to understand comprehenders' behaviors as well as speakers' behaviors.

## Production-Comprehension Model

Finally, we aimed to examine how closely speakers' preferences would be interconnected with comprehenders' processing difficulty. In particular, we demonstrate that comprehenders would have less difficulty in the processing of sentences that speakers are highly likely to produce.

In order to model the relationship between production behaviors and comprehension behaviors, we conducted four linear mixed regression models in which four eye-tracking measurements were submitted as dependent variables, respectively. Our goal was to show that the proportions of canonically ordered sentences that speakers produced in Experiment 1 would predict the reading times that comprehenders spent in the processing of sentences in Experiment 2. The length of target constituents was controlled for to obtain the pure relationship between production preferences and comprehension difficulty.

### Results and discussion

Table 4. The results of linear mixed-effect regressions to model the relationship between production preferences and comprehension difficulties

| | Estimates | S.E. | *t*-value |
|---|---|---|---|
| First-pass RTs | | | |
| Intercept | 843.37 | 29.88 | 28.23 |
| Production rates | -29.95 | 26.01 | -1.15 |
| Length | 79.83 | 3.12 | 25.63 |
| Second-pass RTs | | | |
| Intercept | 806.52 | 86.96 | 9.28 |
| Production rates | -232.64 | 62.27 | -3.74 * |
| Length | 80.70 | 6.66 | 12.12 |
| Total gaze duration | | | |
| Intercept | 1682.95 | 86.96 | 19.35 |
| Production rates | -232.48 | 60.37 | -3.85 * |
| Length | 170.45 | 7.47 | 22.82 |
| Regression | | | |
| Intercept | 3.04 | .26 | 11.72 |
| Production rates | -.69 | .26 | -2.66 * |
| Length | .30 | .02 | 12.55 |

Note. * refers to the significant role of the factor at $\alpha < .05$.

The results of our models are displayed in Table 4. Briefly, the degree of speakers' preferences predicted the degree of comprehension difficulties in the measurements associated with late processes. Second-pass RTs, total gaze duration, and regression decreased in the proportion that the rates of

speakers' preferences increased, indicating that structures that speakers were more likely to say were easier for comprehenders to understand. Given the fact that the measurements associated with late processes predicted the degree of processing difficulty that readers had when they encountered unexpected information, our results index readers' efforts in integrating unexpected information into sentences. This interpretation is consistent with the view that processing difficulty should be understood in terms of expectation-based sentence processing by which the degree of processing difficulty in the integration of words into sentences is determined by how likely those words are likely to occur in a given context (Levy, 2008).

## General Discussion

We observed that Korean speakers were likely to locate long arguments prior to short arguments, and Korean comprehenders had easy processing of sentences that long arguments were placed before short arguments. The results from our linear mixed-effect regression revealed that comprehenders' difficulty was reduced to the degree that speakers preferred to locate long arguments prior to short arguments. Comprehenders' difficulty was caught by the measurements associated with late processes. We think that comprehenders felt difficulty probably because they had to be involved in reanalyzing structures or integrating incoming words into sentences. Of great importance, our findings provided direct evidence that speakers' processing behaviors were closely interconnected with comprehenders' processing behaviors (Pickering & Garrod, 2013).

Our results suggest several underlying aspects with regard to the relationship between speakers and comprehenders: 1) in the aspects of cooperative communication (Grice, 1975), speakers might intend to cooperate comprehenders by observing the length constraint. Consequently, comprehenders might be able to avoid structural reanalysis or unnatural integration. 2) Speakers might not intend to cooperate with comprehenders. However, speakers, as a result of self-monitoring process through comprehension (Levelt, 1989), might result in the cooperative coordination with comprehenders. 3) Speakers' behaviors are closely interconnected with comprehenders' behaviors because speakers and comprehenders both have tendencies to process sentences anticipatorily. That is, speakers plan ahead hierarchically what to say (Lee, Brown-Schmidt, & Watson, 2013) and comprehenders expect what to encounter next. When the expectation between speakers and comprehenders co-works well, overall processing becomes easy. It is our further questions to explore, in detail, why and in which mechanism production and comprehension are interconnected.

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