韓国語の前置関係節の文処理

Kim, Yoan
Graduate School of Humanities, Kyushu University

Yano, Masataka
Graduate School of Humanities, Kyushu University | Japan Society for the Promotion of Science

Tateyama, Yuki
Graduate School of Humanities, Kyushu University | Japan Society for the Promotion of Science

Sakamoto, Tsutomu
Faculty of Humanities, Kyushu University

KYUSHU UNIVERSITY

Processing of Pre-nominal Relative Clauses in Korean [1]

Yoan Kim[1], Masataka Yano[1,2], Yuki Tateyama[1,2], and Tsutomu Sakamoto[3]
([1] Kyushu University, Graduate School of Humanities,
[2] Japan Society of the Promotion of Science,
[3] Kyushu University, Faculty of Humanities)
masayano@kyudai.jp

1. Introduction

Studies on universal grammar tend to center on common patterns of many languages or idealized linguistic competence. However, processing constraints can be one of the reasons behind universal conventions of language. As such, this study examined Korean sentences with relative clauses (RCs) to determine the universal and specific characteristics of Korean RCs from a processing perspective using an event-related brain potential (ERP) experiment.

(1) Research Question:
    a. What are the processing features of Korean RC comprehension?
    b. What causes processing difficulties with Korean RCs?

2. Previous Studies of Korean Relative Clauses: Kwon et al. (2013)

One of the interesting observations with regard to RCs is that subject RCs (SRs) have been found to be more easily processed than object RCs (ORs) in languages with post-nominal RCs, such as English (King & Just, 1991; ERP: King & Kutas, 1995), Dutch (Frazier, 1987), French (Frauenfelder et al., 1980), and Russian (Polinsky, 2011). The results have been explained in two hypotheses: the

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Structural Distance Hypothesis (SDH) (O'Grady, 1997) and the Linear Distance Hypothesis (LDH) (Gibson, 2000). The SDH assumes that the integration of the filler and its gap becomes more difficult because an object gap is more deeply embedded than a subject gap in its syntactic structure. In the LDH, however, it is the linear distance between the filler and its gap that determines the cost of integration. In an ERP experiment, Kwon et al. (2013) attempted to determine whether the SR preference is observed in pre-nominal RCs and the causes of it in Korean.

(2) Experimental sentences used by Kwon et al. (2013)

a. SR: ___$_i$ newspaper-GEN publisher-ACC secretly politically exploit-ADN senator$_i$-GEN office-to gang-NOM attacked.

'Gangs attacked the office of the senator who secretly exploited the publisher of the newspaper for political reasons'

b. OR: newspaper-GEN publisher-NOM ___$_i$ secretly politically exploit-ADN senator$_i$-GEN office-to gang- NOM attacked.

'Gangs attacked the office of the senator who the publisher of the newspaper secretly exploited for political reasons'

Their results revealed larger Left Anterior Negativity (LAN) at the embedded verb and the two following words (i.e., *iyongha-n uywoni-uy samwusil-ey*, 'exploit-ADN senator-GEN office-to') of ORs compared with SRs. The researchers found LAN with greater working memory costs for ORs than for SRs. The difference in the P600 component was not observed at the embedded verb position or the head noun (HN), which is inconsistent with other pre-nominal languages, such as Japanese (Ueno & Garnsey, 2008) and Chinese (Packard et al., 2011). This inconsistency might have arisen for procedural reasons. The experimental sentences used by Kwon and her colleagues have the following schematic form for RCs.

(3) Schematic form of (2a): [relative clause] NP1-GEN NP2

Their basic assumption is that NP1 is meant to be the HN of the RC. However, that is not necessarily the case because NP1 takes a genitive case marker in their experiment.

(4) a. relative clause attached to NP1   b. relative clause attached to NP2

RC   NP1-GEN   NP2   RC   NP1-GEN   NP2
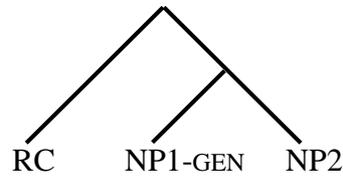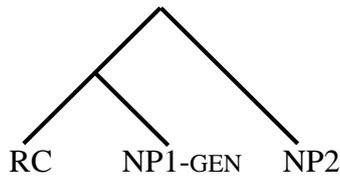
(4) shows that HN selection of 'NP1-GEN NP2' is structurally ambiguous. This claim is supported by experimental evidence from Lee and Kweon (2004), who observed the tendency to interpret NP2 as a modifier NP in Korean 'NP1-GEN NP2' constructions. In short, the processing characteristics of pre-nominal RC sentences of Korean are not yet clear, with the attachment ambiguity unresolved.

3. Experiment

The current study uses the dative maker (bolded and italicized in (5)) for head nouns to avoid the issue of delayed or unfinished gap-filler integration.

(5) Experimental Sentences

          R1 R2   R3   R4   R5   R6   R7

a. SR: [$_{RC}$ __$_i$ new senator-ACC attack-**ADN**]   persistent reporter$_i$-***DAT*** rumor-NOM continued.

     'The rumor was passed along to the persistent reporter [(who) attacked the new senator]'

          R1 R2   R3   R4   R5   R6   R7

b. OR: [$_{RC}$ new senator-NOM __$_i$ attack-**ADN**]   persistent reporter$_i$-***DAT*** rumor-NOM continued.

     'The rumor was passed along to the persistent reporter [(who) the new senator attacked]'

Ninety sets of subject and object relative clauses with dative head nouns were constructed as test sentences. Thirty sentences from each set were assigned to 3 lists using a Latin square design so that the participants saw either the SRs or ORs of the same set. In addition, 120 distractor sentences were added to the list.

3.1. Predictions

(6) Hypothetical answers to the research questions

  a. The processing mechanism for activation and integration would be universal and reflected as corresponding ERP components of LAN (King & Kutas, 1995) and P600 (Kaan et al., 2000).

  b. The activation and integration cost would be determined by the filler-gap distance, either structural or linear. The SDH predicts a SR preference, while the LDH predicts that ORs are easier to process.

3.2. Procedures and participants

The stimuli were presented randomly among the participants using Presentation 16.3 (Neurobehavioral Systems, Albany, CA, USA) in a non-cumulative manner. The fixation point "+" was presented for 800 ms and was then followed by experimental sentences region by region. Each region was presented for 600 ms, with 800 ms stimulus onset asynchrony. Comprehension checks were given once every 3 sentences on average to ensure that the participants maintained focus. These checks were in the form of a declarative sentence and participants were asked to respond by pressing the YES/NO button.

3.3. Electrophysiological recording

The electroencephalogram (EEG) was recorded from 19 positions, at Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2, F7, F8, T3, T4, T5, T6, Fz, Cz, and Pz according to the international 10–20 system (Jasper, 1958), using Nihon Kohden EEG-1200 and Ag electrodes. Reference electrodes were positioned on earlobes, and EEG was referenced off-line to the mean electrical activity recorded at those two electrodes. To detect blinks and eye movements for later rejection from averaging, additional electrodes were placed on the left side of and beneath the left eye. Impedances were kept below 5 kΩ. The EEG was amplified with a bandpass of 0.01 to 120 Hz, digitalized at 1000 Hz.

3.4. Results
3.4.1. Behavioral data

The data from 4 participants who could not satisfy the minimum averaging times in 25 out of 30 trials in any of the conditions were excluded from further analysis, in addition to the data from 2 participants whose mean accuracy rates were

below 65%. The mean accuracy of the remaining 18 participants was 80%. The mean accuracy difference between the target conditions was significant (SR: 66%, OR: 73%, $t(17) = -3.1827$, $p = .0054$), indicating that SRs were more difficult to comprehend than ORs.

3.4.2. Electrophysiological data

A repeated-measures ANOVA analysis was conducted with the factors Sentence Type (SR, OR) × Electrodes Position (midline, parasagittal and temporal areas for distributional analysis).

Region 3

ANOVAs were performed on the data in the 300–500 ms time window. At the midline, parasagittal, and temporal sites, the ANOVA revealed that the main effect of Sentence Type was significant, indicating greater negativity to SRs than to ORs (Midline: $F(1, 17) = 8.6898$, $p = .0090$, Parasagittal: $F(1, 17) = 6.8771$, $p = .0178$, Temporal: $F(1, 17) = 6.3615$, $p = .0219$). No significant interaction (Sentence Type × Electrodes Position) was observed in any area (all ps > .10).

Region 4

ANOVAs were performed on the data in the 400–900 ms time window. At midline, there was a marginally significant interaction of Sentence Type × Anteriority ($F(2, 34) = 3.6542$, $p = .0608$). Post-hoc analysis showed that the ERP of the SR condition was significantly more positive than that of the OR condition at Pz. At the temporal and parasagittal sites, neither the main effect of Sentence Type nor the interaction of Sentence Type × other factors was significant (all ps > .10).

4. Discussion

4.1. The negativity in R3

R3 marks where the parser recognizes that the sentence being processed could contain a relative clause because of the adnominal marker and the gap information accordingly activated. The greater negativity for SR seems to support the OR preference and the LDH as an explanation. This interpretation, however, requires additional considerations because the previous research of Korean RCs showed the opposite result.

One possibility to account for the SR preference in Kwon et al. (2013) would be the difference power of the case markers before the embedded verbs, that is, the nominative marker '-*i/-ka*' and the accusative marker '-*(l)ul*'. First, the difference causes experimental participants to be 100% certain that transitive verbs that take a human object would follow when they saw the accusative marker of SRs. That is not the case for the nominative marker of ORs, as intransitive verbs or transitive verbs with a non-human object can follow in distractor sentences, as in (7).

(7) Distractor sentences taking intransitive verbs or transitive verbs with a non-human object
    a. Mon-NOM morning-at the.park-to walk-ACC go-HON-PST-DECL
      'Mom went to the park for a walk.'
    b. morning-in people-NOM rice-ACC eat-PST-DECL
      'In the morning, people ate a meal.'

The case markers can provide another clue for the following ADN marker of embedded verbs. Both the target sentences have embedded clauses, but it is only the accusative marker of SRs that can signal embedded verbs with the ADN marker. In the case of OR, the sequence of 'NP-GEN NP-NOM' was shared by other distractor sentences, as in (8).

(8) Distractor sentences taking an adverbial ending for embedded verbs
    Gallery-GEN representative-NOM ___ international exhibition-at highly evaluated-because …
    'Because the representative of the gallery evaluated (him) highly at the international exhibition …'

Overall, it can be said that the SR preference in R5 of Kwon et al. might be explained by the greater predicting power of the case markers in R2 of SRs compared with that of ORs. The current experiment controlled the types of verbs and the attached morpheme as (i) all verbs in R3 are transitive verbs taking a human object, (ii) the verbs in R3 of both SRs and ORs evenly take an ADN marker or a declarative ending, and (iii) the same number of arguments drop sentences that are added as distractors to each condition. Given that the possible cause of the opposite result has been explored, the greater negativity in response to SRs can be the result

of differences in activation cost, and the result supports the OR preference and linear distance hypothesis.

4.2. The positivity in R4

The positivity in R4 is the difference from the integration P600 of Kaan et al. (2000) in that the former appears before the filler position, while the latter appears at the integration site. In fact, the type of P600 before the filler position has been observed in other gap-filler dependencies (Japanese: Yano et al., 2014; Chinese: Packard et al., 2011). Yano et al. (2014) found a larger P600 component in the embedded verb position ('*kaihousita-nowa*', nursed-nowa) of object cleft sentences in (9), which can be explained in the following way.

(9) Japanese cleft constructions in Yano et al. (2014)
    a. SCs: Last year <S-gap> Ichiro-ACC carefully nursed-nowa Takeuchi-Ms.-COP.
    'It is Ms. Takeuchi who nursed Ichiro carefully last year.'
    b. OCs: Last year Ichiro-NOM <O-gap> carefully nursed-nowa Takeuchi-Ms.-COP.
    'It is Ms. Takeuchi whom Ichiro nursed carefully last year.'

The cleft marker 'nowa' in (9) within the experimental context signals that the following word is a filler and seems to facilitate theta role assignment incrementally. The same might be true of the personality adjectives in R4 of the current target sentences. Korean adjectives have the same word ending as an adnominal marker, and the marker signals that an NP will follow. Some might say that the embedded verbs in R3 also have the ADN marker but lack the type of P600 effects in R4. Both the presence and absence can be explained as follows: the ADN marker '-*n*' only predicts that an NP will follow but does not care whether the NP is a filler, as in (10a), or not, as in (10b). The personality adjectives of R4, however, do not allow a complementizer to follow in the current context, as in (10b), and thus effectively confirm that the following word will be a filler even before its actual input. For this reason, P600 was assumed to be observed in R4 before the filler and after the embedded verb. In addition, the greater positivity in response to SRs can be said to be the result of a difference in the integration cost, and the result supports the OR preference and the linear distance hypothesis.

(10) a. RC:

[__ᵢ new senator-ACC attacked-**ADN**] persistent reporterᵢ-*DAT* rumor continued

'The rumor was passed along to the persistent reporter [(who) attacked the new senator].'

b. CC:

[reporter-NOM senator-ACC attacked-**ADN**] persistent fact-NOM known.

'*The persistent fact that [the reporter attacked the new senator] became known.'

This research can thus answer research question (1). In sum, first, the processing mechanism for activation and integration is universal and is reflected as corresponding ERP components of LAN and integration P600: it also shows the predictive and incremental processing feature of the parser. Second, the activation and integration cost is determined by the linear distance between a filler and its gap.

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金 ヨアン[1]・矢野 雅貴[1,2]・立山 憂[1,2]・坂本 勉[3]
([1] 九州大学大学院 人文科学府, [2] 日本学術振興会特別研究員
[3] 九州大学大学院人文科学研究院)

　　本研究は、事象関連電位を用いて、韓国語の主語関係節と目的語関係節の処理過程を検討した。実験の結果、主語関係節に対して LAN 及び P600 効果が観察された。この結果は、目的語関係節の方が処理負荷が低いことを示し、gap と filler の統合負荷が、線形的距離によって決まるという仮説とより整合性がある。