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Interference effects on the processing of Korean double relative clauses

Myung Hye Yoo & So Young Lee*

Abstract. The current investigates the parsing process and its utilization of various linguistic information to resolve dependencies in Korean double relative clauses. While previous research has revealed evidence of interference effects of a distractor during dependency formations, a distractor involving dependency formations by itself has not been thoroughly explored. In light of this, we aimed to explore how the grammatical-role parallelism of a distractor modulates multiple filler-gap dependencies and examine the role of case marking in the resolution of these dependencies. In a self-paced reading experiment, we discovered that the parallelism effects of both head nouns were instrumental in the resolution of longer dependencies of a higher head noun and its gap. The non-parallel role of a distractor (i.e., low head noun) was reanalyzed before the integration of higher head noun and its gap. This finding suggests that parallelism effects play a critical role in the resolution of complex dependency structures. Additionally, our experiments investigated the role of case marking as a morphosyntactic cue in predicting the syntactic encoding of upcoming noun phrases. Our results demonstrated the immediate processing difficulty of conditions with double nominative markers, suggesting that parsers are selectively sensitive to case marking. Overall, our study contributes to our understanding of the parsing process and the selective use of linguistic cues in the resolution of complex dependency structures.

Keywords. Double relative clauses; multiple filler-gap dependencies; parallelism; case mismatch

1. Introduction. Long-distance dependencies have been studied a lot to understand the processing mechanism of complex sentences in general. For the successful comprehension of the long-distance dependency, the parser needs to store the information on the filler NP in working memory, while searching for its gap site, and eventually integrate it with the filler.

(1) The dog which *the kid* liked $\_\__i$ died.
FILLER distractor GAP

For instance, the filler, 'the dog', must form its dependency with its gap, as an object of the verb 'liked' in (1), so-called filler-gap dependency. During the dependency formation, if there is another NP intervening between them may cause additional processing load due to memory constraints.

Research on filler-gap dependency formation (FGD) shows that interference effects arise if there is a distractor that has partially or wholly matching features with a target noun phrase (NP), intervening between the filler and gap (Dillon et al. 2013; Wagers & Phillips 2009). 'The kid' in (1), for instance, has partially matching features to be retrieved (e.g., NP), and, thus, may interfere the retrieval of *the dog* at its gap site.

The present study investigates how a previously unexplored type of distractor, which involves the FGD by itself, affects the longer FGD in multiple FGD constructions. Double relative clauses

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(DRC) in Korean provide a useful tool to investigate the interferences of a distractor during the processing of multiple FGD. Korean allows relativization out of another relative clause where an adnominal marker *-(n)un* is used to modify a noun, although it appears to violate an island constraint (Ross, 1967). For instance, in (2), the object NP that is associated with 'dog$_j$' is relativized in the lower relative clause, and then the subject NP that is associated with 'kid$_i$' is relativized as the higher relative clause.

(2) [$_{RC1}$[$_{RC2}$ __$_i$ __$_j$ coaha-nun] **kangaci-ka$_j$** cwuk-un] **ai$_i$**
__$_i$ __$_j$ like-ADN **dog-NOM$_j$** die-ADN **kid$_i$**
'the kid who the dog which [he] liked died'
(An adnominal marker '*-(n)un'* is used to modify a noun.)

In brief, DRCs contain two head nouns that need to form dependencies with their own gaps: the low head noun (e.g., *dog*) and the high head noun (e.g., *kid*). We refer to the low head noun (e.g., *dog*) as a *distracto*r, linearly intervening between the dependencies between the high head noun and its gap. Note that the low head noun, as a distractor, involves dependency formation by itself. In this paper, we attempt to address two primary questions:

> i) How does the parallelism of the grammatical roles between the low head noun and gap positions, as a distractor, plays a role in the processing of the longer filler-gap dependencies (i.e., high head nouns)?
>
> ii) Will the overt case marker, as a morphosyntactic cue, interacts with the parallel role of the head nouns during incremental processing?

First, the grammatical roles of head nouns can be different depending on the positions (the surface position *vs* its original (gap) position). We mainly examined how parallelism effects of the grammatical roles between its gap and surface positions modulate the formation of the dependencies between the high head noun and its gap.

(3) a. Parallel [$_{RC1}$…[$_{RC2}$ __$_{i(Subj)}$ __$_{j(Obj)}$ … v] NP$_{j(Obj\text{-}ACC)}$ .. v] NP$_{i(Subj\text{-}NOM)}$ …

b. Non-parallel [$_{RC1}$…[$_{RC2}$ __$_{i(Subj)}$ __$_{j(Obj)}$ … v] NP$_{j(Subj\text{-}NOM)}$ .. v] NP$_{i(Obj\text{-}ACC)}$ …

We manipulated the grammatical roles of the filler and its gap to be either parallel or non-parallel. (3a) presents the schematization of parallel conditions in which the grammatical role of both low and high head nouns at surface position are parallel to the grammatical role of their own gap positions, respectively. That is, a *low* head noun (NP$_j$) is displaced from an object position and became an accusative-marked object in the structure. A *high* head noun (NP$_i$) is displaced from a subject position and placed to a nominative-marked subject position in the structure. In (3b), each head noun is placed in the reversed position at the surface position: the low head noun is a nominative-marked subject and the high head noun is an accusative-marked object.

In Korean language with a rich morphological system, the overt case marker is a reliable cue for the grammatical role of the *filler* at surface structure; the nominative case indicates that the filler is a subject and the accusative case indicates that the filler is an object at the surface

structure. The investigation of parallelism effects allows us to further examine the role of surface case markers in multiple dependency formations. It has been wisely observed that parsers use case information to predict an upcoming argument structure. That is, parsers tend to show slow-down in processing the second overt NP with the same case marker as the first overt NP case marker because they predict a different case marker of the upcoming arguments from that of the previous argument. The manipulation of parallelism in DRCs generates case-mismatch conditions. Therefore, we examine whether the same case marking of the higher head noun to the lower head noun induces processing load due to the same case marking.

2. Experiment

2.1. PARTICIPANTS. Fifty-three native Korean speakers were recruited using social network in South Korea. They participated in the experiment, receiving $5 or 5,000 won.

2.2. MATERIALS. A self-paced reading experiment had a 2 x 2 design, crossing two types of the fillers, the *distractor* (i.e., low head noun) and the *target* (i.e., high head noun), and the of argument statuses between the fillers and their own gaps as shown in Table 1: [distracter, target] x [parallel/non-parallel roles at surface and gap positions]. The grammatical role of each filler at its gap site was held constant; the low head noun (e.g., *kid*), as a distractor, was always object and the high head noun was always subject in the lower relative clause. Therefore, the *accusative* case marker of the *low* head noun indicates it is an object, which is *parallel* to its role at the gap position. Likewise, the high head noun with the *nominative* case marker indicates that it is a subject in the surface structure, which is *parallel* to its role at the gap position. The reversed overt case markers—a nominative-marked low head noun followed by an accusative-marked high head noun—indicates the non-parallel role for both nouns. We used the filler NPs that are typically assigned their own thematic roles to prevent parsers from misinterpretations (e.g., *sponsor-agent*; *kid-theme in Table 1*). We manipulated the argument statuses of the distractor (i.e., low head noun) and the target (i.e., high head noun) to be either a subject or an object in surface structure. Experimental materials consisted of 16 sets of 4 conditions, and each item was followed by a comprehension question.

	Role of a distractor (low head noun in low RC: object)	**Role of a target (high head noun in low RC: subject)**	**Case mismatch**	
(a)	Parallel (ACC-object)	Parallel (NOM-subject)	Mismatch (ACC-NOM)	[$_{RC1}$[$_{RC2}$__$_i$ __$_j$ phyenci-lo kyeklyeha-yesste-n] *ai$_j$*-lul machimnay manna-n] hwuwenca$_i$-ka … letter-with encourage-PST-ADN kid-**ACC** finally meet-ADN sponsor-**NOM**…
(b)	Parallel (ACC-object)	Non-Parallel (ACC-object)	Match (ACC-ACC)	[$_{RC1}$[$_{RC2}$__$_i$ __$_j$ phyenci-lo kyeklyeha-yesste-n] *ai$_j$*-lul machimnay manna-n] hwuwenca$_i$-lul … letter-with encourage-PST-ADN kid-**ACC** finally meet-ADN sponsor-**ACC**… 'the sponsor$_i$ [who finally met the kid$_j$ [who (the sponsor)$_i$ encouraged__$_j$ with letters]]'
(c)	Non-Parallel (NOM-subject)	Parallel (NOM-subject)	Match (NOM-NOM)	[$_{RC1}$[$_{RC2}$__$_i$ __$_j$ phyenci-lo kyeklyeha-yesste-n] *ai$_j$*-ka machimnay manna-n] hwuwenca$_i$-ka … letter-with encourage-PST-ADN kid-**NOM** finally meet-ADN sponsor-**NOM**…
(d)	Non-Parallel (NOM-subject)	Non-Parallel (ACC-subject)	Mismatch (NOM-ACC)	[$_{RC1}$[$_{RC2}$__$_i$ __$_j$ phyenci-lo kyeklyeha-yesste-n] *ai$_j$*-ka machimnay manna-n] hwuwenca$_i$-lul … letter-with encourage-PST-ADN kid-**NOM** finally meet-ADN sponsor-**ACC**… 'the sponsor$_i$ [who the kid$_j$ [who (the sponsor)$_i$ encouraged __$_j$ with letters] finally met]'

Table 1. A sample set of items: critical region = 'sponsor-NOM' (high head nouns)

2.3. RESULTS. The average word-by-word reading times for sentences are shown in Figure1. The critical region is the target (high head nouns), which is associated with the final integration of the gap to its filler in DRCs. The reading time revealed a robust parallelism effect of a distractor (low head noun). For instance, reading times were longer when the grammatical role of a distractor (i.e., low head noun) was not parallel than when it was parallel at the critical region and the

two spillover regions (p<.05). At the critical region, it was driven by condition (c) where both the distractor and the target were nominative-marked (t=2.98, p<.05). This suggests that case-mismatch effect was only observed in DRCs with double nominative markers, not double accusative markers. At the Spillover 1 region, we found that the reading time was significantly faster when the grammatical role of a distractor was parallel than when it was not parallel. We also observed a strong ease in processing when the statuses of both head nouns are parallel (t=-2.62, p=.01), compared to other conditions. The parallelism effects of both a distractor and the target were significant in the Spillover 2 region.

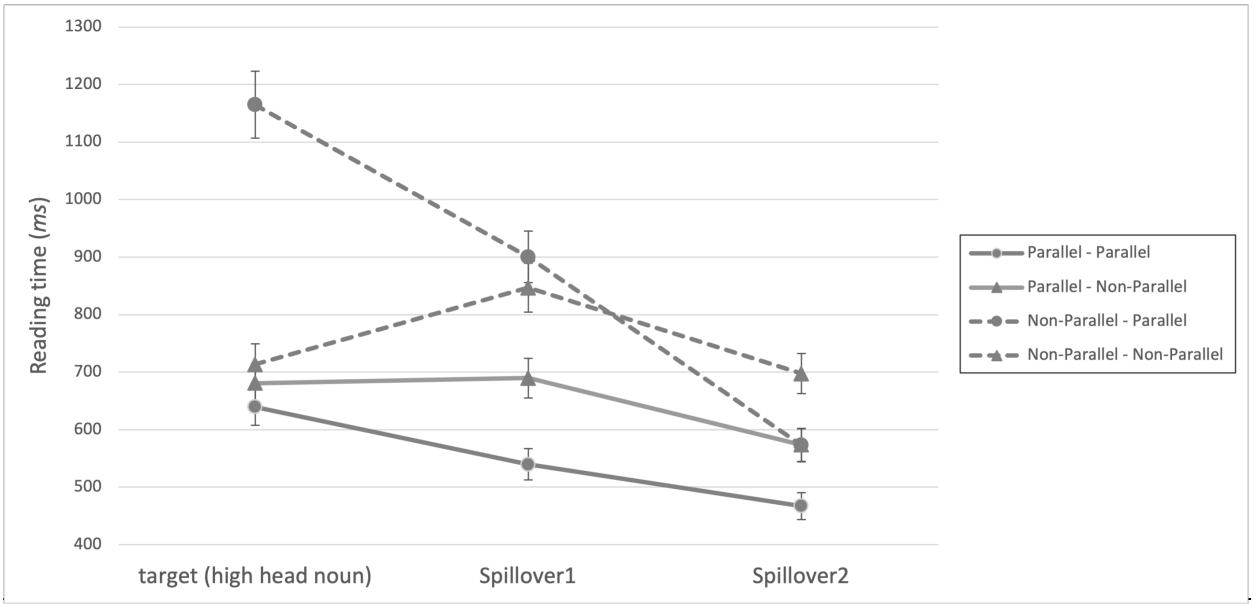

Figure 1. Mean reading time (*ms*) by region by condition. Error bars indicate 95% Confidence intervals.

	Regions		
	Critical	Spillover 1	Spillover 2
Parallel-Parallel (ACC-NOM)	640	540	467
Parallel-Non-parallel (ACC-ACC)	681	690	574
Non-parallel - Parallel (NOM-NOM)	1165	900	573
Non-parallel - Non-parallel (NOM-ACC)	713	847	698

Table 2. Mean reading times (*ms*) by condition at the regions of interest

2.4. DISCUSSION. The result showed a robust difficulty of FGD formation when the target and its gap have different argument statuses. We found the parallelism effect of a distractor at Spillover 1 region and the parallelism effects of both head nouns at Spillover 2 region. These results indicate that the grammatical role of a distractor was reanalyzed before consolidating the representation of the whole sentence meaning at Spillover 2 region toward the end of the sentence (Caplan & Waters, 1999; Warren & Gibson, 2005). In terms of the crucial role of a distractor (i.e., low head noun), this finding is in line with Yoon (2016)'s claim that the low head nouns of DRCs play a role in the interpretation preferences of ambiguous DRCs.

We also found that DRCs with double nominative markers took a significantly longer reading time than the other three conditions once the target was encountered. This kind of case-mismatch

effect of a distractor has been controversial across languages in previous empirical studies (Franck et al., 2010; Hartsuiker et al., 2003; Hartsuiker & Barkhuysen, 2006). The results of this experi-ment are in line with findings of studies in Dutch and German, which showed less interference of a distinctive case-marking of a distractor (Hartsuiker et al, 2003). However, such an effect exhib-ited only in double *nominative* markers, not double accusative markers. We conjecture that this can be also attributed to the difficulty or peculiarity of double nominative constructions where both NPs bear nominative case markers, which makes a different prediction from theoretical ap-proaches. Han & Kim (2004) argued that well-formed DRCs are derived from double nominative constructions. On this view, DRCs including double nominative markers are predicted to be easy to process because the double nominative construction is the underlying structure of DRC, which is opposed to the processing pattern of DRCs observed in this paper. It is likely that parsers might be sensitive to nominative case makers to predict that upcoming NP will not bear another nomina-tive case marker although Korean language allows double nominative constructions.

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