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Ambiguity and Priming in Silent Structures

Evidence from Comprehension of Null Objects*

Kang, Chorong**
Kim, Hyunwoo***
Ko, Heejeong****

ABSTRACT It has been demonstrated that structural priming affects ambiguity resolution. However, whether structural priming affects the processing of silent ambiguous structures has not been discussed in depth. This study investigates the impact of structural priming on the comprehension of silent ambiguous structures, focusing on null object constructions in Korean. These constructions are ambiguous in terms of how the null object is linked to its referent. An experiment was conducted to examine how Korean native speakers interpret null object constructions, and the results show that they are likely to interpret a null object in the target sentence in a manner consistent with how they processed a null object in the preceding prime sentence when both the prime and target sentences include a null object. Compared to a previous study that did not observe priming effects, we conclude that priming effects in comprehending a null object could be restricted within the context where the source

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** First Author, Lecturer, Department of Linguistics, Seoul National University, chfhd2@snu.ac.kr

*** Associate Professor, Department of English Language and Literature, Yonsei University, hyunwoo2@yonsei.ac.kr

**** Corresponding Author, Professor, Department of Linguistics, Seoul National University, hko@snu.ac.kr

of ambiguity is repeated between the prime and the target.

Keywords Null Objects, Structural Priming, Priming in Comprehension, Lexicon Repetition, Processing of Silent Ambiguous Structures

1. Introduction

One of the basic theses in linguistics is that some types of ambiguity in sentence interpretation have their origin in different semantic representations. It is also generally assumed that these different semantic representations arise from structural differences in most cases. For example, the sentence *James saw a boy with binoculars* can be read in two different ways. One reading is that James is the one who uses binoculars in the seeing event, and the other is that the boy seen by James held binoculars. The former reading is derived from a syntactic structure in which the prepositional phrase *with binoculars* is combined with the verb phrase, indicating that the event described by the verb phrase occurred with (in the sense of "by the use of") binoculars. The latter reading is based on a syntactic structure in which the prepositional phrase is combined with the object noun phrase *a boy*, yielding the interpretation that the boy was holding binoculars.

Given the close association between syntactic structures and semantic representations, research in psycholinguistics has investigated how a specific syntactic structure is chosen and represented among the available options. Numerous studies have revealed that multiple factors (e.g., verb bias, frequency of a given structure, contextual constraints, etc.) influence ambiguity resolution (Gibson and Pearlmutter 1998). Among these factors, one this

study will focus on is the effect of previous processing. Researchers have observed that the syntactic structure of a previously spoken, heard, or read sentence can impact the interpretation of subsequent sentences. This effect results in a preference for the interpretation encountered recently during the processing of ambiguous sentences (Boudewyn et al. 2014; Branigan et al. 2005; Havron et al. 2020). When coupled with the idea that semantic interpretations are closely linked to distinct syntactic structures, this biased inclination toward a specific reading in ambiguity resolution is discussed under the broader umbrella of *structural priming effects*.[1]

In this study, we aim to investigate priming effects in silent structures, specifically focusing on null object constructions in Korean. Although structural priming has been discussed in depth, research on syntactic priming in ellipsis contexts is scarce. Recently, Xiang et al. (2019) found syntactic priming effects in VP ellipsis constructions in English. In their experiment, English native speakers were asked to read a prime sentence and describe a target picture. A prime trial consisted of two sentences. The first sentence included a ditransitive predicate and the second sentence included VP ellipsis or an intransitive predicate depending on the condition. They found that when participants read prime sentences with VP ellipsis in prepositional dative constructions (e.g., *First Ralph sang a song to Sheila, and then Marcus did*), they were more likely to describe target pictures in prepositional dative construction (e.g., *A girl is passing a ball to*

1 There has been a debate over the terminology. We will use *structural priming* in this paper, following Pickering and Ferreira (2008). Pickering and Ferreira suggest using the term, *structural priming* rather than *syntactic priming* since the terminology nowadays is used in a broad sense including abstract linguistic priming that is not necessarily syntactic in nature (e.g., Bock, Loebell, and Morey, 1992).

a boy). On the other hand, when they read prime sentences in double object constructions (e.g., *First Ralph sang Sheila a song, and then Marcus did*), they were more likely to describe target pictures with a double object construction (e.g., *A girl is passing a boy a ball*). What is interesting is that such a priming effect was absent when the second sentence in the prime was an intransitive verb (e.g., *First, Ralph sang a song to Sheila, and then Marcus groaned*). The results from the VP-ellipsis experiment suggest that participants do process elided structures, and exposure to a silent structure influences the subsequent production of sentences.

Languages allow various types of null expressions including VP ellipsis, sluicing, NP ellipsis, and more. In the current study, we are interested in priming effects in null arguments. Null arguments are observed are observed in many East Asian languages (Ahn and Cho 2011, 2020; Han et al. 2020; Hoji 1998; Kim 1999; Landau 2018; Li 2014; Oku 1998; Otani and Whitman 1991; Saito 2007; Sakamoto 2016; Sato 2015; Şener and Takahashi, 2010; Simpson et al. 2013; Takahashi 2008a, b). Null arguments in these languages are subject to ambiguity in certain contexts. We aim to investigate whether the priming effects observed in ambiguity resolution can apply to null arguments as well. The paper is organized as follows: In Section 2, we will summarize the main findings of the priming literature and previous studies on priming effects in the processing of null arguments and introduce the research questions of the present study. In Section 3, we will present an experimental study designed to investigate the effects of structural priming on null argument interpretation. Section 4 summarizes the results of the experiment and discusses its implications, and Section 5 concludes the paper.

2. Research Background

2.1. Issues in Structural Priming in Comprehension

Structural priming was initially identified through production tasks in which participants were prompted to verbally express a sentence. The pioneering work by Bock (1986) and subsequent studies revealed that exposure to a specific syntactic structure (via reading or speaking the sentence) raises the likelihood of employing the same structure in subsequent production (e.g., Bock 1989; Bock and Loebell 1990; Chang, Bock, and Goldberg 2003; Ferreira 2003; Griffin and Weinstein-Tull 2003; Pickering and Branigan 1998; Pickering and Ferreira 2008; Scheepers 2003; Ziegler et al. 2019). Such priming effects occur in the production process independently of lexical overlap or thematic similarities between the sentences (see Pickering and Ferreira 2008, for an overview).

In comparison to production studies, structural priming in comprehension has not been investigated in depth until recently. Typically, such comprehension studies measure participants' behavior in real-time processing. For example, eye movements are tracked (e.g., Arai et al. 2007; Tooley et al. 2019), or changes in language-related event-related potential (ERP) components are measured (e.g., Tooley et al. 2019) as participants read a sentence. Some comprehension studies employ tasks like picture matching or act-out tasks that may invoke production processes as well (Boudewyn et al. 2014; Branigan et al. 2005; Havron et al. 2020; Thothathiri and Snedeker 2008).

Interestingly, some discrepancies have emerged between early comprehension studies and production studies. The most widely discussed disparity is that abstract priming (i.e., structure priming without lexical overlap between the prime and the target) was seldom observed in early comprehension

studies, in contrast to the robust presence of abstract priming effects in production studies. Comprehension studies have identified lexically mediated priming effects (i.e. where structural priming occurred only with lexical overlap between the prime and the target) rather than abstract priming effects (e.g., Arai et al. 2007; Branigan et al. 2005; Carminati et al. 2008; Tooley et al. 2009; cf. Thothathiri and Snedeker 2008). However, recent studies have indicated that abstract priming effects can be observed even in comprehension, so long as the methodology employs a design or task similar to those used in production studies (see Tooley 2023, for an overview). For instance, Arai et al. (2007) utilized eye tracking with a visual word paradigm. In their experiment, participants viewed a picture while simultaneously listening to a ditransitive sentence (e.g., *The pirate gives the princess the necklace/ The pirate gives the necklace to the princess*). The investigation aimed to determine if participants' anticipatory looks were influenced by the prime: when the prime sentence is a double object construction, anticipatory looks at the verb (*gives*) are expected to shift to the indirect object's referent (*the princess*), whereas when the prime sentence is a prepositional dative construction, anticipatory looks at the verb are expected to shift to the direct object (*the necklace*). The anticipatory eye movements toward the target items were significantly impacted by the preceding prime sentence only when the prime and target shared the same verb. When the verbs did not overlap, the expected priming effect was not observed.

However, Ziegler and Snedeker (2019) found abstract priming using a similar task. They also employed eye tracking within a visual word paradigm and tracked participants' eye movements as they listened to ditransitive sentences. The disparity between the two studies is assumed to derive from the design of the visual stimuli. In Arai et al.'s experiment,

the pictures contained simple visual arrays corresponding to the arguments (*the pirate* for agent, *the princess* for recipient, and *the necklace* for theme). According to Ziegler and Snedeker, due to the straightforward visual cues, participants could easily infer the sentence's meaning just from hearing "the pirate gives," potentially bypassing the need to activate structural processing. In Ziegler and Snedeker's experiment, they manipulated the experimental items to be more complex, making it difficult for participants to predict the remainder of the sentence. In this unpredictable context where participants need to process syntactic structure, abstract priming effects were observed.

Ziegler and Snedeker's study is just one of several recent studies on priming and comprehension that have revealed that the presence or absence of abstract priming is dependent on methodology. Pickering et al. (2013) employed a picture-matching task to investigate the structural priming effect in ambiguous sentences. In their experiment, participants were asked to select one picture from a pair that corresponded to a given sentence. The target sentence (e.g., *The waitress is prodding the clown with the umbrella* is ambiguous between two possible interpretations. As previously discussed, the prepositional phrase could be associated with the verb phrase (*high attachment*) or with the object noun phrase (*low attachment*). This method parallels the production process, as participants were compelled to opt for one syntactic representation, mirroring a required step in sentence construction during production. The researchers identified both abstract priming effects (i.e., priming effects when different verbs were used in primes and targets) and lexically mediated priming effects (i.e., priming effects when the same verb was utilized in both primes and targets) even though the latter was stronger than the former. Consequently, participants were more inclined to select the

high attachment interpretation when encountering a prime with high attachment, and similarly favored the low attachment interpretation encountering a prime with low attachment — irrespective of the lexical overlap.

The fundamental question to ask is why observing abstract priming effects is more dependent on methodology, while lexically mediated priming effects are widely observed across various methodologies. Two accounts have been suggested in the literature. The first account is the Residual Activation account, originally proposed by Pickering and Branigan (1998). According to the Residual Activation account, when a particular structural representation is used, that representation is activated, and the residual activation of the structural representation spills over into the structure-building process of a subsequent production. Due to this residual activation, a particular structural representation may become more activated than an alternative representation, resulting in abstract priming effects. Furthermore, Pickering and Branigan argue that the ease of observing lexically mediated priming effects is well accounted for using residual activation as well. They adopt the production model suggested by Levelt (1992) and assume that a structural node is linked to the verbs that can appear in that structure. Thus, if the verb used in the previous sentence is also used in the following sentence, the residual activation of the previously used structural representation can be amplified by the link between the verb and the representation in addition to the structural representation itself. This would evoke stronger priming effects, allowing lexically mediated priming to be observed across various methodologies.

The other approach is the implicit learning account (Bock and Griffin 2000; Chang et al. 2000; Chang et al. 2012). According to this approach,

abstract priming and lexically mediated priming occur through different mechanisms, so the approach is a dual-mechanism account. Abstract priming effects result from a learning process within repeated exposure, while lexically mediated priming arises from the short-term memory binding between the verb and the structure of a sentence. According to this approach, the two types of structural priming effects occur via different mechanisms. Therefore, it is not surprising that different methodologies have varying sensitivity to these two priming effects. In particular, implicit learning occurs when the system detects an error due to the mismatch between the final representation and the predicted representation. This analysis provides a good explanation for the inverse frequency effect (Hartsuiker and Westenberg 2000; Jaeger and Snider 2008), which refers to the observation that the structural priming effect is larger for lower frequency structures. This is because less frequent structures are more likely to be unpredictable, generating more error signals, which in turn leads to greater learning (i.e., greater priming).

The debate regarding which account better captures what truly occurs in sentence processing is ongoing (see Tooley 2023 for a review). It is noteworthy, however, that the types of structures used in comprehension studies on priming have been fairly limited. For instance, the prepositional phrases have been employed primarily in picture-matching tasks, and ditransitive constructions have been used in most eye-tracking studies (Pickering et al. 2013). In both constructions, ambiguity arises within a verb phrase, and how the sentence is interpreted depends on the constitution of the verb phrase. Consequently, it is not surprising that the repetition of the verb has a large effect, and both approaches assume some form of association between verbs and structures. However, what if the ambiguity

arises independently of the verb phrase? Can we still observe priming effects? If so, how can the two accounts accommodate these new findings? Answering these questions constitutes the main research objective of the current study. In the following section, we will introduce null object constructions in Korean, which carry ambiguous interpretations independent of the verb phrase used in the sentence. This, in turn, establishes the research background for our priming experiment using null object constructions.

2.2. Null Object Constructions

Null arguments are observed in many languages. Romance languages, including Italian and Spanish, have a rich paradigm for subject agreement and allow the subject to be silent (Alexiadou and Anagnostopoulou 1998; Rizzi 1986 among many others). In these languages, silent arguments can be recovered from the agreement morphology. In contrast, there are languages that permit silent arguments without agreement morphologies. East Asian languages, such as Korean, Chinese, and Japanese, belong to this category. Due to the different syntactic and semantic distributions of null arguments between Romance-type languages and East Asian languages, syntactic literature has assumed that these two types of null arguments have distinct syntactic natures (Huang 1984, 1989; Huang and Yang 2013; Nakamura 1991). The current study focuses on null arguments observed in East Asian languages, particularly null objects in Korean.

As demonstrated in (1), when the antecedent of the null object contains a reflexive possessor, the sentence with a null object may have two interpretations. The null object can refer to a referent corresponding

to the object in the antecedent clause; this interpretation is called a strict reading. In example (1b), the interpretation that *Minki read Jina's diary* is known as the strict reading. On the other hand, the null object can refer to the subject of its own clause, just as the overt object in the antecedent clause refers to the subject of that clause. The interpretation that *Minki read his own (=Minki's) diary* is an example of this alternative reading, which is called the sloppy reading.

(1) a. Jina-ka caki ilki-lul ilk-ess-ta.
Jina-NOM self diary-ACC read-PAST-DECL.
Lit. Jina read self's book.
b. Minki-to 〈e〉 ilk-ess-ta.
Minki-also read-PAST-DECL.
Minki read 〈e〉, too. Lit. Minki read Jina's diary/Minki's diary, too.

Numerous studies have been conducted to explore the mechanisms behind this ambiguity (Ahn and Cho 2011, 2020; Han et al. 2020; Hoji 1998; Kim 1999; Landau 2018; Li 2014; Oku 1998; Otani and Whitman 1991; Saito 2007; Sakamoto 2016; Sato 2015; Şener and Takahashi 2010; Simpson et al. 2013; Takahashi 2008a, b, among many others). While the details vary, most of these studies assume that the ambiguity arises due to the syntactic or semantic nature of null arguments. The ambiguity that arises from null objects differs from the lexical ambiguity observed in homophones. In contrast to ambiguous words, which can be used in isolation the null object cannot receive a strict or sloppy interpretation in isolation due to such interpretations' anaphoric nature. Instead, strict and sloppy interpretations arise in specific contexts that license their use. In addition, since the null object must be

in a certain semantic association with its antecedent to get a reference, the resolution of the referent is dependent on the structure. Crucially, this structural relation has little to do with verbs' properties. In other words, the availability of null objects does not depend on what verb is used in the sentence. In this study, we adopt the general, theory-neutral assumption that a strict reading comes from a structure with coreferential processing, and that a sloppy reading comes from the processing of a bound variable operation, as demonstrated in (2) and (3).

(2) (simplified) Semantic structure for the strict reading of (1)

a. Jina [$_{VP}$ λx (x read x's diary)]

b. Minki [$_{VP}$ read e (=Jina' diary)]

(3) (simplified) Semantic structure for the sloppy reading of (1)

a. Jina [$_{VP}$ λx (x read x's diary)]

b. Minki [$_{VP}$ λx (x read x's diary)]

As a starting point of our discussion, we note Kang's (2023) findings on the processing of null objects. Kang (2023) employed a picture-matching experiment that investigates priming effects in the processing of null objects in Korean. In the experiment, participants were asked to read a sentence with a null object (like (1)) and choose a picture that matched the sentence they read. The results showed that the pictures compatible with strict readings were more likely to be selected when the prime condition was interpreted with a strict reading, while the pictures compatible with the sloppy reading were more likely to be selected if the prime was interpreted with a sloppy reading. It remains unclear, however,

whether the priming effects were observed only due to the usage of the same verb in the prime and target conditions, which would constitute lexically mediated priming effects rather than abstract priming effects.

In that vein, Kang et al.'s (in this volume) experiment suggests an interesting twist. Kang et al. showed that priming effects for null objects were not observed when the primes did not contain a null object. In Kang et al.'s experiment, participants were asked to read a target sentence with a null object and indicate what the null object referred to. Crucially, the prime sentences did not include a null object but an overt object that required either a bound variable operation or coreferential processing, as represented in (4). In the Self–Self condition, the object in the second sentence contained an anaphoric possessor. Thus, a bound variable operation was forced. On the other hand, in the Self–Pronoun condition, the object in the second sentence was a pronoun, so coreferential processing was required. In the target condition, participants read sentences with a null object, as shown in (5), and indicated what the null object refers to. What is noteworthy is that the same verb was used in the prime and the target in their experiment. Surprisingly, priming effects were not found. Contrary to Kang (2023), the interpretation of null objects in the target trials was not affected by the primes. This lack of priming effects, even with verb repetition, suggests that the overlap of verb and structural processing between the prime and the target is insufficient to evoke priming effects when the source of ambiguity is independent of the verb. It requires further study as to why priming effects are sometimes present and sometimes absent in the processing of null objects. We aim to address this issue in the current experiment.

(4) Prime sentences used in Kang et al. (in this volume)

a. Self-Self condition

Mina-ka caki-uy peykay-lul nwul-ess-ta.

Mina-NOM self-POSS pillow-ACC press-PAST-DECL.

(lit.) Mina pressed self's pillow.

Arin-ito caki-uy peykay-ul nwul-ess-ta.

Arin-also self-POSS pillow-ACC press-PAST-DECL.

(lit.) Arin pressed self's pillow, too.

b. Self_Pronoun condition

Mina-ka caki-uy peykay-lul nwul-ess-ta.

Mina-NOM self-POSS pillow-ACC press-PAST-DECL.

(lit.) Mina pressed self's pillow.

Arin-ito kukes-ul nwul-ess-ta.

Arin-also it-ACC press-PAST-DECL.

(lit.) Arin pressed it, too.

(5) Target sentences used in Kang et al. (in this volume)

Wuyeng-ika **caki-uy** **khwusyen-ul** nwul-ess-ta.

Wuyeng-NOM self-POSS cushion-ACC press-PAST-DECL.

(lit). Wuyeng pressed self's cushion.

Sangmin-ito 〈e〉 nwul-ess-ta.

Sangmin-also press-PAST-DECL.

(lit.) Sangmin pressed 〈**e**〉, too.

We conducted a new experiment intended to tease apart and explain the conflicting results from Kang (2023) and Kang et al. We used the same experimental design as Kang et al., but included a null object in the

prime, following the model of Kang (2023). Put differently, we used the same task and experimental paradigm as Kang et al., but the composition of the stimuli in the prime is comparable to Kang (2023). This allows us to test which of the two conflicting results regarding the priming of null objects will replicate. On the basis of our experiment, we will discuss how the presence or absence of repetition of the source of ambiguity leads to the conflicting results of these previous studies on priming in the comprehension of null objects.

3. Experiment

3.1. Participants

Twenty-one adult Korean native speakers (aged 20-37) participated in the experiment. They were all Korean native speakers, who were born and raised in Korea, except one participant who self-reported as a Korean-Japanese bilingual. The responses from the one Korean-Japanese bilingual speaker were excluded from the analysis.

3.2. Design and Materials

The experiment has two conditions: the strict reading priming condition and the sloppy reading priming condition. Each item consists of a prime trial and a target trial. A prime trial consists of prime sentences with a comprehension question, and a target trial consists of a target sentence with a comprehension question.

Let us first illustrate the prime trials. The prime trials have two conditions, depending on whether the comprehension question forces a strict reading or a sloppy reading. The sample stimuli in (6) illustrate a prime trial with two types of comprehension questions. As exemplified in (6A), the second prime sentence contains a null object which corresponds to the object in the preceding sentence. The participants were asked to read the sentence in the prime trial and answer the following question, indicating their interpretation of the null object. The comprehension questions come in two types: one that forces a strict reading, as in (6B1), and another that requires a sloppy reading, as in (6B2). We also allowed the participants to answer the comprehension question with 'both' or 'I don't know' options in case they did not want to make a decision as to the interpretation of the null object. In the strict condition such as (6B1), participants were expected to select the option that indicates a strict reading. In the sloppy condition such as (6B2), participants were expected to choose the option that indicates a sloppy reading. The participants faced one of the two types of comprehension questions in the prime trial, which may potentially prime either a strict or a sloppy reading for the target trial.

(6) Sample prime trial

A. Prime sentence

Mina-ka caki-uy peykay-lul nwul-ess-ta.

Mina-NOM self-POSS pillow-ACC press-PAST-DECL

(lit.) Mina pressed self's pillow.

Arin-ito 〈e〉 nwul-ess-ta.

Arin-also press-PAST-DECL.

(lit.) Arin pressed ⟨e⟩, too.

B1. Comprehension question that forces the strict reading

What did Arin press? [given in Korean]

1. **Mina's pillow** (strict reading)

2. Mina's piano (wrong answer)

3. Both

4. I do not know.

B2. Comprehension question that forces the sloppy reading

What did Arin press? [given in Korean]

1. **Arin's pillow** (sloppy reading)

2. Arin's piano (wrong answer)

3. Both

4. I do not know.

In the target trials, participants were presented with a target sentence and a comprehension question. In the target trials, the response options included both the strict reading and the sloppy reading, in addition to "both" and "I do not know," as illustrated in (7B). The order of response options was counterbalanced within each experiment list. Therefore, half of the target trials had the strict reading option as the first choice, while the other half had the sloppy reading option as the first choice. Similar to the prime trials, the "both" and "I do not know" options were consistently presented as the third and fourth choices in all target trials.

(7) Sample target trial

A. Target sentence

Wuyeng-ika caki-uy khwusyen-ul nwul-ess-ta.

Wuyeng-NOM self-POSS cushion-ACC press-PAST-DECL.

(lit). Wuyeng pressed self's cushion.

Sangmin-ito 〈e〉 nwul-ess-ta.

Sangmin-also press-PAST-DECL.

(lit.) Sangmin pressed 〈e〉, too.

B. Comprehension question that follows the target sentence

What did Sangmin press? [given in Korean]

1. Wuyeng's cushion (Strict reading preference)
2. Sangmin's cushion (Sloppy reading preference)
3. Both
4. I do not know.

A total of 32 prime items (16 items × 2 conditions) and 16 target items were utilized in the experiment. Following a factorial design, two lists were created, each encompassing all 16 target items. Within each list, the sixteen items (i.e., 16 pairs of the prime and the target) were pseudo-randomized with the stipulation that at least two filler trials intervened between consecutive experimental items. We added a filler item between each pair of prime and target items to deter participants from easily discerning the experiment's purpose and responding strategically to the target items. This design does still allow for the observation of priming effects, as previous comprehension studies have demonstrated that both abstract priming effects and lexically mediated priming effects can manifest across a filler item positioned between a prime and a target (Carminati and van Gompel 2009; Ledoux et al. 2007; Tooley et al. 2014).

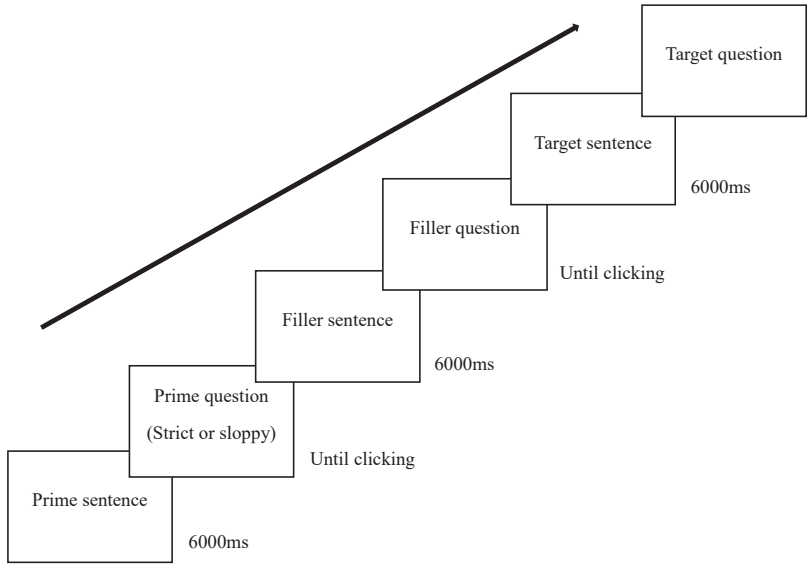
In total, 64 filler items (16 between prime-target fillers and 48 intra-items) were used. The format of the filler items was the same as that of

experimental items. Comprehension questions in some filler items were asked about the subject instead of the object, guiding participants not to solely focus on the object. None of the filler items included null objects or were relevant to the strict or sloppy interpretation. As with Kang et al., we used four boy names and four girl names as subjects in random order. The names used in the prime trial differed from those in the target trial within a single prime-target pair.

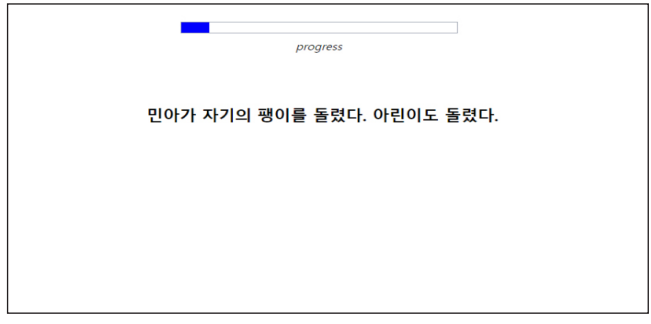
3.3. Procedure

The procedure overall follows Kang et al.'s. The experiment was conducted online using the web-based survey platform PCIbex Farm (Zehr and Schwarz 2018). Participants began by providing informed consent after which they answered six demographic questions covering age, gender, vision, native language, bilingualism status, and handedness. Following this, participants were directed to an instruction page where they were informed that they would be presented with Korean sentences and asked to select an answer to a subsequent question from multiple options. Before starting the main experiment, participants completed four practice trials. The overall presentation of the stimuli proceeded as demonstrated in Figure 1.

Following Kang et al., we deliberately separated the sentence stimuli and the comprehension question within each trial to discourage participants from engaging in a mere word-by-word detection approach. Each sentence stimulus was displayed for a fixed duration of 6000 milliseconds before disappearing (Figure 2, 4), following which the corresponding comprehension question was promptly presented (Figure 3, 5). There was no time limit imposed on participants when the comprehension question was presented,



[Figure 1] Overall Procedure of the Eexperiment



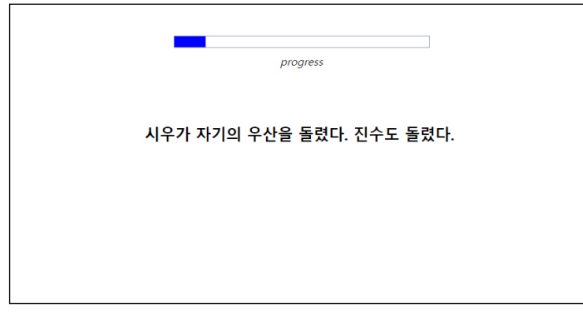
[Figure 2] Screenshot of a Sentence Stimulus (Prime Sentences)

and once they selected an answer option, the next trial began.

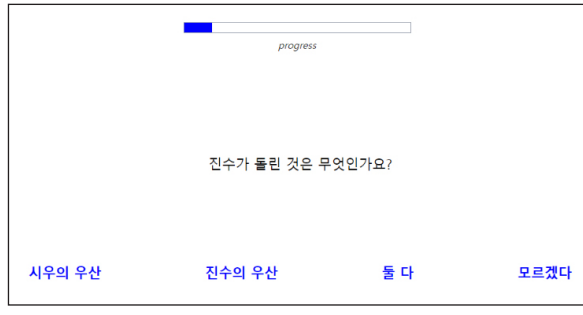
Strict reading prime

Sloppy reading prime

[Figure 3] Screenshot of a Comprehension Question in Each Condition



[Figure 4] Screenshot of a Sentence Stimulus (Target Sentences)

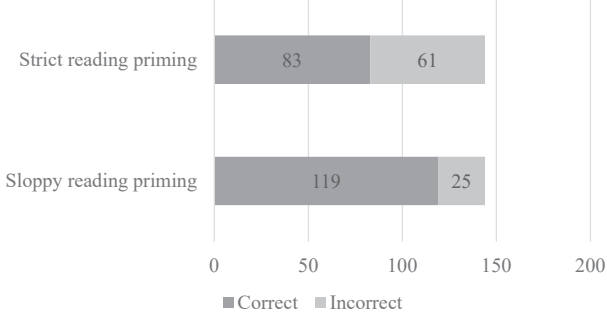


[Figure 5] Screenshot of a Comprehension Question (Same across Conditions)

3.4. Results

We excluded responses from two participants who chose the "I do not know" option in all the trials. Responses from the remaining 18 participants were analyzed in this study. To ensure that the priming items were properly processed, we first excluded the items in which participants did not correctly answer to the comprehension question in prime trials. Among the 288 responses, 86 responses (29.86%) were excluded from analysis. Among the excluded data, 61 responses were from the strict reading condition and 25 responses were from the sloppy reading condition, as illustrated in Figure 6. Since the number of excluded responses is unexpectedly large, however, we return to potential causes for these unexpected choices in the discussion section.

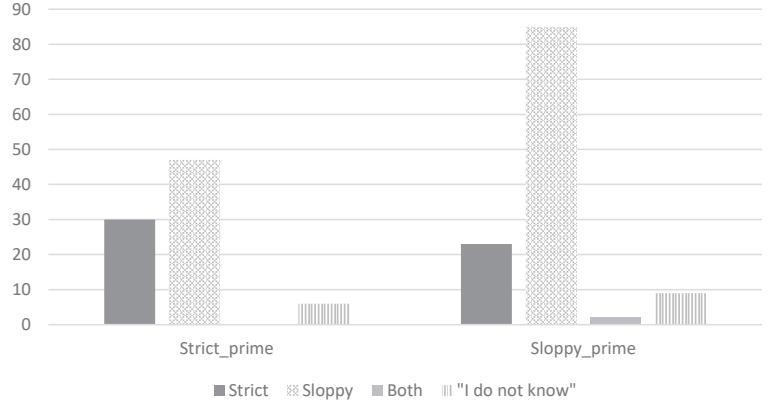
We coded all the remaining 202 responses (83 responses from the strict reading priming condition and 119 responses from the sloppy reading priming condition) according to whether the participant chose the strict reading or sloppy reading in the target trials. Table 1 shows the raw number of



[Figure 6] Number of (in)Correct Responses in Prime Trials

[Table 1] Null Object Interpretation in the Target Trials

# of Responses	Strict reading	Sloppy reading	both	"I do not know"
Strict Reading Priming Condition	30	47	0	6
Sloppy Reading Priming Condition	23	85	2	9



[Figure 7] The (raw) Number of Target Responses

responses for the target trials, followed by a visualization in Figure 7. Overall, the number of sloppy reading responses was higher than the number of strict reading responses in both conditions. However, the difference between the responses for each option was greater in the sloppy reading priming condition.

We calculated the proportions of the strict reading and the sloppy reading in the target responses.[2] The results are summarized in Table 2.

2 Following previous studies (Pickering et al. 2002; Branigan et al. 2005), we computed the relevant proportions by dividing the number of the strict reading selections following the strict reading primes by the sum of the number of the strict reading

[Table 2] Proportions of the Strict Reading Target Selections

After strict reading priming	.36
After sloppy reading priming	.19
Priming effect	**.17**

[Table 3] Proportions of the Sloppy Reading Target Selections

After sloppy reading priming	.71
After strict reading priming	.57
Priming effect	**.14**

The table shows an overall priming effect of 17%, which indicates that participants selected the strict reading options 17% more in the strict reading priming condition than in the sloppy reading priming condition. Given that the experiment offers participants four options, the priming effect of a particular reading selected does not perfectly mirror the other. Although the number of responses opting for "both" or "I do not know" is relatively small,[3] we have also calculated the relevant proportions for the sloppy reading, as presented in Table 3. Table 3 illustrates an overall priming effect of 14%, indicating that participants selected the sloppy reading options 14% more frequently in the sloppy reading priming condition compared to the strict reading priming condition.

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primes (i.e., the strict reading primes followed by the strict reading and the sloppy reading selections), and the number of the strict reading target selections following the sloppy reading primes by the sum of the number of the sloppy reading primes (i.e., the sloppy reading primes followed by the strict reading and the sloppy reading target selections). Such analysis was used to compare prime effects between conditions when the primes completed correctly are not equivalent.

3 Eleven "I don't know" responses came from two participants. The two "both" responses are from a single participant.

To investigate whether participants' responses were significantly affected by the prime types, we constructed generalized logistic mixed-effect models in R (R Core Team, 2020, version 4.0.2) using the lme4 package (Bates, Mächler, and Bolker 2015) and lmerTest (Kuznetsova, Brockhoff, and Christensen 2017). The factor, condition, was entered into the model as fixed effects after being sum-coded and centered. Random intercepts over subjects and items were included in the model and random slopes over subjects were included as well. The model shows that the fixed effect, condition, significantly affected participants' response (β = 466.55, SE = 41.86, $p < 0.01$). The statistical analysis further confirms that the proportions of selections for the sloppy reading or strict reading were significantly influenced by condition (i.e., the type of priming sentence).

4. Discussion

In the experiment performed, participants were presented with sentences containing null objects and were asked to respond to comprehension questions related to these sentences. When a null object has an anaphoric possessor as its antecedent, it can be interpreted in two ways: the strict reading and the sloppy reading. This construction was critically chosen because it has been reported that null objects bear inherent ambiguity, which does not stem from the processing of the verb but rather from the nature of the object itself.[4] When participants were led to select the strict reading option for the prime sentences, they were more likely to choose the strict reading option in the target trials. Similarly, when participants were led to select the sloppy reading option in the prime trials, they showed a

tendency to select the sloppy reading option in the subsequent target trials. In the following discussion, we will discuss our interpretation of these results within the context of prior research.

4.1. Priming Effects in the Processing of Null Objects

The findings of the current experiment replicate the observations reported by Kang (2023). What both experiments share in common is the inclusion of null objects in both prime trials and target trials. As Kang points out, the picture-matching task used in the priming task could potentially induce priming effects due to the similarity in pictures between prime and target trials. In the current experiment, we mitigate this potential confounding factor by employing non-pictorial stimuli. In particular, we followed the methodology used in the experiment conducted by Kang et al. (in this volume), with the sole difference being the repetition of null objects between the primes and the targets. This difference leads to divergent results.

While Kang et al. did not report priming effects (even though the verbs were repeated between the primes and the target), the current experiment demonstrates that participants' choice of a particular interpretation for null objects was significantly influenced by the preceding processing of a null object. In other words, when participants were guided to apply coreferential processing in interpreting null objects, the same coreferential processing was more likely to be applied in the subsequent processing of a

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4 A generalized logistic mixed-effect model was used in which items were entered as fixed effects after being sum-coded and centered. The model shows that items (which equates to variation in object nouns and verbs) do not significantly affect participants' responses (β = −0.204, SE = 1.10, p = 0.852).

null object.[5] Similarly, when participants were guided to apply the bound variable operation, the corresponding processing was more likely to be applied in the subsequent processing of a null object. These effects were found even though there was a filler trial between a prime and a target. Consequently, it appears that the priming effects are linked to the locus of ambiguity (i.e., null object *per se*) rather than specific verbs. In Kang et al., priming effects were not observed, presumably because null objects did not appear in the prime trial. However, our experiment shows that when the source of ambiguity, the null object, was present in both the primes and the targets, priming effects obtain. The discrepancy between the results of the current experiment and those observed by Kang et al. suggests that the priming effects in the current study are strongly associated with the repetition of the source of ambiguity. In Kang et al., structural similarity without lexical repetition did not evoke priming effects, indicating that the observed priming effects in this experiment cannot be considered abstract priming effects. Furthermore, it might be premature to categorize these priming effects as instances of lexically mediated priming, as lexically mediated priming effects typically refer to priming effects with verb repetition.

In Section 2, we introduced two approaches to understanding priming effects in comprehension: the residual activation account and the implicit learning account. Both of these accounts posit a connection between a verb

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5 A reviewer pointed out that participants might be forced to reconstruct the structure or reframe the event in the prime trials. We agree that such a possibility is likely. However, we assume that restructuring or reframing happens in order to obtain the particular syntactic or semantic structure that was required to be processed. For that reason, we assume that participants applied coreferential processing in the prime condition.

and a sentence structure to explain the lexically mediated priming effects. However, neither account has addressed any association between non-verbal linguistic units and semantic structure. The novel data observed in the current experiment may present a challenge to both of these existing approaches. While we believe that each approach could potentially develop its own solution to accommodate these findings, we propose that the implicit learning account is more amenable to extending its framework to account for the current observation. The implicit learning account posits that lexically mediated priming results from short-term memory binding between a verb and the structure of a sentence. If we expand this idea to suggest that short-term memory binding operates not exclusively between a verb and a sentence structure but also between a non-verbal lexical item (such as a null object) and the semantic structures, we can understand the observed priming effects as a type of lexically mediated priming effect. In contrast, the residual activation hypothesis relies on a production model where only verbs are linked to a node at the structure level. As a result, it appears to be more challenging for this hypothesis to incorporate the new findings.

Biased preference for the sloppy reading

A noteworthy result from the current experiment is a strong preference for the sloppy reading in the target trials. This finding is quite surprising in that we used similar target items as Kang et al., which reported an overall preference for a strict reading. This difference in preference can be explained if we consider the processing applied by participants during the experiments. In Kang et al.′s experiments, the prime and target sentences used different types of objects. In fact, the participants were not given an

opportunity where a null object was required to be interpreted with the sloppy reading. Given that the strict reading is the preferred interpretation for a null object in Korean in non-priming contexts (as found in Han et al. 2020), Kang et al.'s result is not surprising. However, in the current experiment, participants encountered several prime trials in which they were forced to interpret null objects with sloppy readings. Consequently, once the processing for the sloppy reading was primed, it could be readily applied in the subsequent processing of a null object.[6] This observation aligns with the concept of the inverse frequency effects we introduced in Section 1. The inverse frequency effects pertain to the phenomenon where the structure priming effect is larger for a lower frequency structure. Given that the sloppy reading is the less frequent interpretation for null objects, priming effects may arise more strongly for this reading.

The low proportion of correct answers in the strict reading priming

We observed that the option "I do not know" was selected in a large portion of prime trials. This tendency was greater in the strict reading priming condition where participants were forced to select the strict reading option. Given that a strict reading is generally the preferred interpretation (as discussed earlier), it is surprising that participants were unable to provide a suitable answer to the question when there was an option suggesting the strict reading. At present, we do not have a reasonable explanation for this finding. We suspect that this may be related to the sloppy reading preference in the target items. While participants were willing to interpret

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6 We used the same filler list that was used in Kang et al. Thus, the discrepancy between the two studies may not be attributed to the fillers.

null object constructions with the sloppy reading, a sloppy reading option was not given in the prime question of the strict reading condition. This may explain why they end up selecting the 'I do not know' option as a last resort. However, we leave this issue open for future works.

5. Conclusion

It has been known that the verb phrase plays a central role in processing. Given that various ambiguities arise based on how the verb phrase is constructed, it is understandable that studies on priming effects in ambiguity resolution often focus on the role of the verb in sentence processing. However, this paper proposes that structural priming effects can be observed in constructions where multiple interpretations are available, not due to the verb but because of the lexical properties of non-verbal lexical items, and in particular, of a null object. Ambiguity can stem from various sources, and if ambiguity is contingent on structural factors, we would anticipate structural priming to occur even when the source of ambiguity is not a verb. This study demonstrates that null object constructions in Korean exemplify such a case. In Korean, null objects can be interpreted in two ways depending on their underlying semantic structure. In the experiment, participants' interpretations of null objects were significantly influenced by their interpretation of previous null objects. Importantly, the repetition of the null object, which is the source of ambiguity, appears to be necessary for inducing priming effects (cf. Kang et al. in this volume). These findings suggest that priming effects in comprehension are not contingent on verbs only but may be influenced

by other lexical items, such as a null object, if they function as a source of ambiguity in processing.

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초록

구조적 점화 효과가 영목적어 구문의 중의성 해소에 미치는 영향

강초롱*
김현우**
고희정***

중의적인 문장을 처리할 때, 구조점화 현상이 영향을 미친다는 관찰을 많은 연구에서 보고해 왔다. 하지만 생략현상과 같이 표면상 드러나지 않는 구조에서 발생하는 중의성을 처리할 때에도 구조점화 현상이 영향을 미치는 가는 깊게 논의되어 오지 않았다. 본 연구는 한국어 문장 중 목적어가 표면상 드러나지 않는 영목적어 구문을 한국어 화자들이 해석할 때, 구조점화 현상이 관찰되는가를 알아보기 위해 점화실험연구를 수행하였다. 한국어의 영목적어는 구조상에서 어떠한 방식으로 선행사와 관련을 맺는가에 따라서 한 가지 이상의 의미로 해석될 수 있다. 실험 결과, 한국어 화자들은 이전에 영목적어가 포함된 문장을 어떻게 해석하였는가에 따라서 그에 대응하는 방식으로 이후 제시된 영논항이 포함된 문장을 해석하는 경향을 보였다. 특히, 유사한 실험방식을 사용한 이전 점화 실험 연구와 비교하면, 이러한 구조 점화 현상은 점화 문장으로 사용한 선행문과 표적 문장으로 사용한 후행문에 모두 중의성을 일으키는 요소인 영목적어를 포함하고 있는 경우에 한정하여 관찰할 수 있다는 것을 발견하였다.

주제어 영목적어, 구조점화, 문장이해에 적용되는 점화효과, 어휘반복, 생략구문에서의 중의성 처리

* 제1저자, 서울대학교 언어학과 강사, chfhd2@snu.ac.kr
** 연세대학교 영어영문학과 부교수, hyunwoo2@yonsei.ac.kr
*** 교신저자, 서울대학교 언어학과 교수, hko@snu.ac.kr