Interpretation of Scope by Korean L2 Learners of English: A Self-Paced Reading Study

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This study investigates the interpretation of scopally ambiguous sentences involving a universally quantified direct object NP and negation (e.g., *The boy didn’t eat every cookie*) from a processing perspective. Using an online truth-value judgment task implemented with a self-paced reading technique, data were collected from native Korean speakers, native English speakers, and Korean L2 learners of English. The results indicate that native Korean speakers strongly preferred the full set interpretation (every > not). In contrast, native English speakers strongly preferred the partitioned set interpretation (not > every). L2 learners showed a developmental divergence according to the learners’ L2 proficiency; the low proficiency group showed a strong preference for the full set interpretation, whereas the advanced L2 learners showed no preference for either of the patterns. The main findings were examined within the framework outlined by O’Grady (2005), who proposes that the nature and acquisition of scopal contrasts are best understood with reference to the operation of an efficiency-based processor.

I. INTRODUCTION

Quantifiers and their scope interpretations create difficulties for the language learner because they involve the interaction of different modules of linguistic analysis: the syntax, the semantics as well as the pragmatics. Recently, a number of studies have been focused on how children comprehend sentences containing quantified expressions in the field of child language acquisition (Gualmini, 2004, 2008; Krämer, 2000; Lidz & Musolino, 2002; Musolino, 1998; Musolino, Crain, & Thornton, 2000; Musolino & Lidz, 2003, 2006, and many others). These studies of language development have been mostly concerned with
children’s grammatical knowledge, addressing the issues whether children show different interpretive preferences from those of adults, and why the differences, if any, emerge.

In contrast, comparatively little is known about non-native speakers’ interpretation of scopally ambiguous sentences. The present paper explores L1-Korean L2-English adult learners’ interpretation of scopally ambiguous sentences between negation and a universal quantifier in object position, from an on-line processing perspective (e.g., *The boy did not eat every cookie*). Although there is a considerable body of processing research on scope relations, those studies have been concerned mostly with doubly quantified sentences such as *A climber scaled every cliff* in monolingual languages (Anderson, 2004). What is lacking are studies of other type of scope ambiguity (e.g., sentences with quantifiers and negation), which is our focus here. In addition, sentence processing in the second language (L2) has only recently become a topic of interest, and little systematic research in this field has been done with regard to scope interpretation. Therefore, how and to what extent L1 affects the processing of the L2 scope interpretation and how L2 proficiency might influence the learners’ scope interpretation of the L2 processing remain open.

In order to better understand what is happening in the acquisition and the processing of scope by the L2 learners, an on-line truth-value judgment task was implemented with a self-paced reading technique. These methods allow us to identify whether learners show their particular scope preference in ambiguous sentences, but also to observe the locus of processing difficulty in the time course of scope ambiguity resolution. The results of the study will be examined with the general theoretical framework outlined by O’Grady (2005), O’Grady and Lee (2008) and O’Grady, Lee, and Kwak (2009), who propose that the nature and acquisition of scopal contrasts are best understood with reference to the operation of an efficiency-based processor. We return to the details of this proposal in Section 2.2.

The paper is organized as follows. We begin by introducing some background information concerning the target phenomenon along with previous studies (section 2.1). Then, an overview of the theoretical analysis of processing-based approach follows (section 2.2). Section 3 presents the experimental methodology of the paper. Section 4 reports the main results. Section 5 provides an integrated discussion of the findings presented in previous section, examining what implications the current study has for the investigation of scope interpretation in L2 research. The conclusion followed by issues of further research is presented in Section 6.
II. BACKGROUND

1. Negation and Universally Quantified NPs in English and Korean

When a sentence includes two quantifiers or operators, it often creates scope ambiguity (Horn, 1989; Jackendoff, 1972; May, 1985, among others). To illustrate this, consider how a universal quantifier in subject position is interpreted with respect to sentential negation in English as in (1).

(1) Every boy didn’t eat the cookies.
   a. $\forall x \left[ \text{boy} (x) \rightarrow \neg \text{ate the cookies} (x) \right]$ (= None of the boys ate)
   b. $\neg \forall x \left[ \text{boy} (x) \rightarrow \text{ate the cookies} (x) \right]$ (= Not every boy ate)

According to the reading where the universally quantified NP is interpreted outside the scope of negation (every > not), the sentence means that every boy is such that he didn’t eat the cookies (1a). According to the alternative reading where the universally quantified NP is interpreted within the scope of negation (not > every), the sentence can be paraphrased as not every boy ate the cookies (1b). In the traditional linguistic literature, interpretation (1a) has been named the ‘surface scope’ interpretation of (1), while (1b) is referred to as the ‘inverse scope’ interpretation of (1). This is because the scope interpretation of the elements, such as every and not in (1a), corresponds to their surface syntactic position, whereas in (1b) they are interpreted in the opposite order. In the current study, for expository purposes, the terms ‘full set’ interpretation and ‘partitioned set’ interpretation, which are neutral and transparent in their intended meanings, will be used to refer to the cases in (1a) and (1b), respectively.1

Crucially, when a universally quantified NP in direct object position interacts with negation in English as in (2), the ambiguity seems to disappear. Here, the most natural interpretation is the partitioned set reading with negation taking scope over the quantified NP (not > every), that is, not all the cookies were eaten by the boy as in (2).

(2) The boy didn’t eat every cookie.
   $\neg \forall x \left[ \text{cookie} (x) \rightarrow \text{The boy ate} (x) \right]$ (= The boy ate only some cookies)

In this case, however, notice that the full set interpretation is also permissible given an inference referred to as a \textit{scalar implicature} (Horn, 1989). A scalar implicature is an extension of Grice’s theory of conversational implicature, an account of how

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1 These two terms were borrowed from O’Grady and Lee (2008).
communicators are expected to conduct conversational exchanges which are cooperative, informative, and relevant to the purposes of the conversation (Grice, 1989).\footnote{Grice (1989) believed that people communicate efficiently based on a shared cooperative principle. The principle was fleshed out in four conversational maxims that he asserted people generally follow; maxim of quantity (be informative), maxim of quality (be truthful), maxim of relation (be relevant) and maxim of manner (be perspicuous).} Implicatures occur when a speaker’s use of a weak term such as \textit{some} allows the listener to understand that the speaker has chosen not to express a stronger term such as \textit{all}.

In this regard let us consider example (2) above. If the boy ate none of the cookies, it follows that not all cookies were eaten by the boy. Of course, the converse is not true: if the boy ate only some of the cookies, it does not follow that none of the cookies were eaten by him. This is because the ‘none’ reading is a subset of the ‘not every’ reading. The entailment relation between the two readings can be explained in terms of scalar implicatures. When a speaker uses a weaker interpretation (not > every), a listener is entitled to infer that a stronger reading (every > not) is not intended. This is because the listener understands that the speaker communicates as informatively as possible, by virtue of Grice’s maxim of quantity. Thus, although both interpretations are compatible with the context, the partitioned set reading is preferred because it leads to the inference that the full set reading does not hold (Musolino & Lidz, 2006).

Keeping this in mind, let us now turn to Korean. Korean is syntactically a head-final language, and its basic word order for a transitive sentence is subject-object-verb. Also, one must note that there are two different ways to form sentential negation in Korean—short form negation (SFN) and long form negation (LFN). In SFN, the negative morpheme \textit{an} is placed right before the verb, that is, preverbally, while in LFN, the nominalizer \textit{ci} is suffixed to the verb and the negative morpheme \textit{an}, accompanied by the auxiliary verb \textit{ha-ta} appropriately inflected, is placed after it, that is, postverbally. Regardless of the syntactic position of a universal quantifier (subject vs. object), the universal quantifier precedes the negative predicate in linear order as represented below.

\begin{align*}
\text{(3) motun sonyen-i kwukhi-lul an -mek-ess-ta} & \quad \text{SFN} \\
\text{every boy -NOM cookie -ACC NEG -eat-PST-DECL} & \quad \text{‘Every boy didn’t eat cookies.’} \\
\text{(4) sonyen-i motun kwukhi-lul mek- ci anh- ass-ta} & \quad \text{LFN} \\
\text{boy -NOM every cookie -ACC eat -CI NEG do -PST-DECL} & \quad \text{‘The boy didn’t eat every cookie.’}
\end{align*}
availability of the partitioned set interpretation seems unsettled, depending on the types of negation (short form vs. long form) or the position of the quantifiers (subject vs. object). Crucially, a general agreement from the findings among researchers is that a full set interpretation (every > not) is acceptable (Baek, 1998; Cho, 1975; Hagstrom, 2002; Song, 1982; Suh, 1990). Recently, a few empirical studies also confirmed that Korean adult speakers strongly accepted the full set interpretation in the pattern of ambiguous sentences we are investigating (Han, Lidz, & Musolino, 2007; O’Grady et al., 2009).

To summarize, in English, when a universal quantifier in subject position interacting with negation appears, it gives rise to two possible scope assignments leading to either a full set or a partitioned set interpretation. On the other hand, when a universal quantifier occurs in object position, even though the two scope interpretations are in principle possible, the partitioned set reading is pragmatically more natural. In Korean, despite a great deal of disagreement in the literature, most studies agree with the availability of full set interpretation where a universal quantifier takes a wide scope over negation. In the current study, we investigate the pattern where negation interacts with a universal quantifier in direct object position, since notable differences in scope availability between English and Korean in this pattern would predict difficulty for the L1-Korean learners of English in their scope interpretation in English.

2. Efficiency-based Processing Approach

A number of explanations have been proposed to account for scope phenomena. For instance, linguists working in the framework of generative grammar argue that scope ambiguity is treated by a syntactic operation such as quantifier raising (QR) and is syntactically determined by the c-command relationship associated with multiple quantifiers (Aoun & Li, 1989; Hornstein, 1995; May, 1985). Some other linguists argue that quantified expressions and their scope properties can be determined from an interaction of different principles, not from structural facts (Fodor, 1982; Ioup, 1975).

In the present study, as stated at the outset, we adopt an efficiency-based processing proposal outlined by O’Grady (2005), O’Grady and Lee (2008) and O’Grady et al. (2009). The remainder of this section is set out to describe in detail how the proposal works for scope relation involving negation and a universally quantified NP in object position.

The key idea underlying the processing-based approach to scope is that less accessible

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3 Arguably, researchers who are working on structural analyses sometimes use data based on the intuitions of a few informants. In addition, those sentences are usually presented not in discourse context but in isolation, and they are often taken from unfamiliar, formal, written sources. For these reasons, it is necessary to provide empirical evidence based on systematically controlled experiments.
interpretations create a heavier burden on working memory as the processor works its way through a sentence that it is attempting to interpret. As a point of departure, the proposal adopts two efficiency assumptions about the operations of the processor (O’Grady & Lee, 2008):

i. As the processor works its way through a sentence, it immediately assigns each NP an interpretation, based on available clues such as position, determiner type, case marker, context, and so forth.

ii. The revision of a previously assigned interpretation is costly since it disrupts the normal linear operation of the processor, which forms and interprets sentences in real time under conditions that value quickness.

Let us now consider how the efficiency-based processing approach can apply to the scope interaction under investigation. The following sentence is what we are concerned with in the study.

(5) The boy didn’t eat every cookie.

In (5), a negator not precedes the direct object and the possibility of negation wide scope (not > every) is available immediately at the point where the processor encounters the quantified NP. There is no need to revise a previously assigned interpretation and there is no added processing cost (see Figure 1). Interestingly, the full set interpretation (every > not) can also be derived without the need to revise a previously assigned interpretation. This is because processing-related considerations do not require the processor to assign a partitioned set interpretation to the universally quantified direct object of a negated verb in English—nothing prevents the assignment of the full set interpretation associated with this sort of quantified phrase in other sentences.

**FIGURE 1**
Partitioned Set Interpretation (English)
The boys didn’t eat every cookie.

Some cookies were eaten.
Other cookies were not eaten.

Thus, according to the theory of scope interpretation that we have adopted, the
processor can assign either interpretation to the patterns in which the negative precedes the quantified NP without having to retract its steps. From this point of view at least, the two interpretations should therefore be on equal footing. Why is then the partitioned set interpretation preferred in this sort of pattern? The point is simply that it is not preferred for processing-based reasons. Rather, it is arguably favored simply because there are alternative, non-ambiguous ways to express the full set interpretation—*The boys ate no cookies* and *The boys didn’t eat any cookies*.

Conversely, when the quantified NP precedes the negation in Korean as in (6), a crucial prediction based on our efficiency assumptions is that the full set interpretation will be computationally easier to arrive at than the partitioned set interpretation.

(6) sonyen-i motun kwukhi-lul mek- ci anh- ass-ta
   boy-NOM every cookie-ACC eat-CI NEG do-PST-DECL
   ‘The boy didn’t eat every cookie.’

In Korean the full set interpretation where the universal quantifier takes a wide scope over negation (every > not) can be processed without any kind of backtracking. That is, a universally quantified NP receives the default full set interpretation, which can then be maintained at no extra cost through the rest of the sentence. Crucially, in order to derive a partitioned set interpretation where negation takes a wide scope over the universal quantifier (not > every), the previously computed full set interpretation for the quantified noun must be revised when the negative is encountered. Through this procedure, the burden on working memory resources is added (see Figure 2).

**FIGURE 2**

Partitioned Set Interpretation (Korean)

Initial Step

<table>
<thead>
<tr>
<th>sonyen-i</th>
<th>motun</th>
<th>kwukhi-lul</th>
</tr>
</thead>
<tbody>
<tr>
<td>boy-NOM</td>
<td>every</td>
<td>cookie-ACC</td>
</tr>
</tbody>
</table>

[Full Set Interpretation]
Given that there exist notably different predictions in scope interpretations between English and Korean, investigating this type of construction by Korean L2 learners of English allows for a test whether non-native speakers transfer their processing strategies used in their L1s to interpret L2 sentences or whether they can acquire target-like strategies.

III. METHOD

1. Participants

Forty-two participants at a university in Korea originally participated in the experiment. Among these participants, however, some were omitted from the data analysis: four based on results from the comprehension questions on filler items in the self-paced reading task and two based on cloze test results. The data analysis thus included 36 participants. These 36 were divided into two groups according to their English proficiency measured by the cloze test (Brown, 1980): high level (High-L2) and low level (Low-L2). The participants’ biographic information and the cloze test scores for each of the groups are given in Table 1.4

4 As seen in Table 1, more participants in the High-L2 group have studied linguistics, compared to those in the Low-L2 group. A reviewer suggested that if the performance of the high-level L2 learners shows a native-like pattern in the resolution of the scope ambiguity under investigation, while the lower group does not, the knowledge of the high-L2 group learners might have come via the linguistic classes. However, the participants’ self-reported data about which linguistics classes they had taken, show that the classes were typically the introductory courses to general linguistics, not a formal semantics or syntax. Therefore, knowledge about theoretical linguistics cannot be the only factor contributing to their knowledge about the scope interaction. Despite concerns over any possible instruction effect, the High-L2 group didn’t show a native-like pattern as seen in the results (see Section 4).
TABLE 1
Background Information for the L2 Learner Groups

<table>
<thead>
<tr>
<th></th>
<th>L1 Korean-L2 English learners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High-L2</td>
</tr>
<tr>
<td>Total N</td>
<td>18</td>
</tr>
<tr>
<td>Age</td>
<td>M(SD) 24.7 (1.52)</td>
</tr>
<tr>
<td>Gender</td>
<td>Female/Male 11/7</td>
</tr>
<tr>
<td>Have you studied linguistics?</td>
<td>Yes/No 12/6</td>
</tr>
<tr>
<td>Age of first learning English</td>
<td>M(SD) 11.4 (1.75)</td>
</tr>
<tr>
<td>Length of living in English-speaking countries (months)</td>
<td>M(SD) 7.4 (6.81)</td>
</tr>
<tr>
<td>Cloze test score (Max: 50)</td>
<td>M(SD) 39.9 (2.19)</td>
</tr>
<tr>
<td>Score Range</td>
<td>7.4 (6.81)</td>
</tr>
</tbody>
</table>

In addition to these Korean L2 learners of English, 24 adult native speakers of English living in the US were also included in the experiment, to establish a base-line comparison as a control group (11 females, mean age = 20.5; SD = 1.18). All participants received a course credit or a small fee in exchange for their participation. They were naïve with respect to the purpose of the experiment.

2. Stimuli

Twenty-four sets of experimental items were used in the experiment, which manipulated the supporting context (full set bias vs. partitioned set bias). The stimulus sentences were preceded by contexts that favored either the full set interpretation or the partitioned set interpretation such that the role of preceding discourse context can be taken into consideration. The test items were divided into six regions: a prepositional phrase (Region 1 = R1), a subject NP (Region 2), negated verb (Region 3), a universal quantifier every (Region 4), an object NP (Region 5) and a prepositional phrase or an adverbial phrase (Region 6). An example of the two contexts for a target sentence is given below. The segmentation, indicated with slashes in the ambiguous sentence, was the actual segmentation used in the presentation. The 24 experimental sets of two conditions each were distributed in a Latin Square design, such that each participant would see one condition for each item.5

**Full set context: Every > Neg**

Last night Cindy worked late and came back home around midnight. Right after she

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5 The Latin square design is used in experimental research when there are repeated treatments. With the Latin square design, the researcher can control the various sequences in which the levels of an independent variable may occur.
took a shower, the electric lights suddenly went out. She found three candles on the table near the bed. However, since she was so tired, she didn’t light the candles but went to sleep right away in the dark.

**Partitioned set context: Neg > Every**
Last night Cindy worked late and came back home around midnight. Right after she took a shower, the electric lights suddenly went out. She found three candles on the table near the bed. She took out one candle and lit it. Then she started reading a novel until she fell asleep.

**Test Sentence in English**
According to the story, / Cindy / didn’t light / every / candle / last night.

<table>
<thead>
<tr>
<th>R1</th>
<th>R2</th>
<th>R3</th>
<th>R4</th>
<th>R5</th>
<th>R6</th>
</tr>
</thead>
<tbody>
<tr>
<td>last night</td>
<td>Sehee-NOM</td>
<td>every</td>
<td>candle-ACC</td>
<td>NEG light-PST-DECL-COMP</td>
<td></td>
</tr>
</tbody>
</table>

There were also 48 fillers, which consisted of 12 ambiguous sentences involving different types of ambiguity from the experimental target items, and 36 unambiguous sentences. Thus each participant read a total of seventy-two sentences from one of two lists. The order of the sentences in each list was presented in a pseudo-random order.

In order to test how Korean speakers make judgments about scope assignment in their native language and whether a transfer of L1 processing strategies occurs in scope interpretation of an L2, a Korean version was also conducted. For the Korean version, proper names or place names were modified, so that native speakers of Korean would feel comfortable in understanding the contexts. One sample of experimental sentences in Korean is provided below.

**Test Sentence in Korean**
eced pam-ey / Sehee -ka / motun / chospwul-ul / an khye-(e)ss-ta-ko / iyaki-nun / malhaycwunta / story-TOP tell

‘The story tells that Sehee did not light every candle last night.’

3. **Procedure**

The experiment was administered using the psycholinguistic experiment software SuperLab 4.0 with an RB-834 response pad (www.cedrus.com). The experimental
paradigm involved self-paced reading in a moving-window format (Just, Carpenter & Woolley, 1982) combined with a Truth-Value judgment task (Crain & Thornton, 1998).

Participants first read a short story which favored either a full set interpretation or a partitioned set interpretation, as illustrated in the previous section. The story was presented as a single chunk in the center of the computer monitor. Participants were asked to take sufficient time to understand the story. Then, a test statement appeared in a region-by-region fashion. All regions except for the one that was currently being read were covered by dashes. Participants pressed a button on the response pad to reveal each region of the statement at their own pace. The time in milliseconds was recorded for each button press and these together served as the measurement of reading time per region. After finishing the end of the statement, they entered their response when the prompt “Is it True or False?” appeared on the screen. They entered an answer by pressing the appropriate response key (T or F). The rationale of the self-paced reading paradigm is that increased processing load can be detected locally in slower reading times on a critical segment compared to the same segment in a counterpart condition. The judgments of truth or falsity show whether the participant can access an interpretation that makes the sentence true in the context under consideration.

Before the actual experiment, a practice session with five trials was conducted with careful instructions from the researcher. When it was clear that participants understood the procedure, the actual experiment began. The participants were tested individually in a quiet room. After the experiment, subjects completed a background questionnaire and a cloze test. The whole session took approximately one hour and a half.

Due to the possibility that various individual differences may invalidate cross-experiment comparisons particularly in L2 research, the same group of Korean participants took part in both the English and the Korean versions. An interval of about four weeks separated the two experiments, and the English materials were first tested. The time span between the administrations of the two versions was intended to avoid any possible priming effect of language.

4. Data Analysis

All raw reading times for a target sentence before the truth-value judgment were transformed into residual reading times. Raw reading times may show some noise due to the participants’ reading rates or the differences in word length. In other words, it is not easy to understand factual differences between conditions if word length differs. Estimating residual reading times is one of the best ways to factor out this effect of length. In order to adjust for differences in length of word or phrase as well as the overall differences in subjects’ reading rates, a regression equation predicting reading times from
length is derived for each subject, using all target and filler items (see Ferreira & Clifton, 1986 for discussion). A word read at average reading rate would have a residual reading time of about 0 ms, while a word that is read relatively quickly would have a negative residual reading time. A positive number shows that the reading time is slower than predicted on the basis of the length of the word.

In order to exclude outliers, reading times beyond 3 standard deviations from the mean for a given condition and position were replaced by the value of 3 standard deviations. This procedure was done for the ambiguous sentences and for the times needed for the interpretive judgments separately, and the data replacement affected 3.12% and 1.74% of the data, respectively.

The dependent measures included the subject’s response of true or false, the times spent for the truth-value judgment, and reading times in the course of reading the test items. For each dependent variable, a repeated measures ANOVA was conducted with context (full set vs. partitioned set interpretation) as the within-subject variable and with English proficiency (Low-L2 vs. High-L2) as the between-subject variable. Furthermore, following a convention in sentence processing research, two analyses were conducted for each group; one treating participants as a random factor (i.e., subject analysis, $F_1$ or $t_1$) and the other treating test items as a random factor (i.e., item analysis, $F_2$ or $t_2$).

**IV. RESULTS**

1. Comprehension Task Accuracy on Fillers

The Korean participants judged the filler items correctly 88.5% (SD = 2.67) of the time in Korean, and English control group’s accuracy with fillers was 87.96% (SD = 5.29) of the time in English. Among the L2 participants included in the analysis, the average comprehension accuracy on filler items was 86.95% (SD = 3.62), ranging from 80.6% to 94.4%. The difference in the comprehension accuracy between the two proficiency group means was not statistically significant ($F(1, 34) = 2.031, p = 0.163$).

2. Truth-Value Judgments

Beginning with the Korean speakers’ truth value judgment of the ambiguous statements in Korean, native Korean subjects strongly preferred the full set interpretation. That is, in contexts that supported the full set interpretation, over 90% of the trials were accepted as true. In contrast, a partitioned set interpretation was assigned only around 54% of the time in the partitioned set supporting context. The difference was statistically different ($F(1,35)$}
We now turn to our target language, English. The results from truth-value judgments for English by the two learner groups and native speakers of English are reported in Table 2. As can be shown in the table, in the proportions of responses to the truth-value judgment of the native English speakers, the natives accepted the ambiguous sentences in a partitioned set interpretation (around 91%) more predominantly than in a full set interpretation (around 45%). This difference was statistically significant ($t_{1}(23) = 10.466, p < 0.005; t_{2}(23) = 12.990, p < 0.005$).

For the L2 learners, the Low-L2 group accepted the full set interpretation significantly more often than the partitioned set interpretation ($t_{1}(1, 17) = 7.005, p < 0.005; t_{2}(1, 23) = 7.436, p < 0.005$). However, for the High-L2 group no effect of context was found (all $p$’s $> 0.1$). The rates of TRUE responses for each condition in the L2 groups were entered into a repeated measures ANOVA. A significant main effect for context was observed ($F_{1}(1, 34) = 40.993, p < 0.005; F_{2}(1, 22) = 42.667, p < 0.005$). The interaction of context and proficiency was significant ($F_{1}(1, 34) = 30.518, p < 0.005 ; F_{2}(1, 46) = 31.910, p < 0.005$).

### Table 2

<table>
<thead>
<tr>
<th></th>
<th>Full Set Interpretation</th>
<th>Partitioned Set Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-L2</td>
<td>TRUE 86.58 (14.61)</td>
<td>37.51 (15.96)</td>
</tr>
<tr>
<td></td>
<td>FALSE 13.42 (15.96)</td>
<td>62.49 (15.96)</td>
</tr>
<tr>
<td>High-L2</td>
<td>TRUE 78.53 (15.93)</td>
<td>75.17 (15.61)</td>
</tr>
<tr>
<td></td>
<td>FALSE 21.47 (15.61)</td>
<td>24.83 (15.61)</td>
</tr>
<tr>
<td>Natives</td>
<td>TRUE 45.14 (12.02)</td>
<td>90.63 (9.30)</td>
</tr>
<tr>
<td></td>
<td>FALSE 54.86 (9.30)</td>
<td>9.37 (9.30)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are in parentheses.

3. Judgment Times for the Truth-Value Judgments

Following the results from the truth value judgment portion, this section presents participants’ mean judgment timing for the truth-value in each interpretation for English. For the Korean experimental sets, as expected, our Korean participants took substantially longer to reach a judgment regarding the truth of the partitioned set interpretation. We do not discuss the details further here.
TABLE 3
Judgment Times (ms) for Truth-Value Judgments

<table>
<thead>
<tr>
<th></th>
<th>Full Set Interpretation</th>
<th>Partitioned Set Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-L2</td>
<td>1701</td>
<td>2508</td>
</tr>
<tr>
<td></td>
<td>(467)</td>
<td>(472)</td>
</tr>
<tr>
<td>High-L2</td>
<td>1675</td>
<td>1930</td>
</tr>
<tr>
<td></td>
<td>(393)</td>
<td>(541)</td>
</tr>
<tr>
<td>Natives</td>
<td>1779</td>
<td>1382</td>
</tr>
<tr>
<td></td>
<td>(591.19)</td>
<td>(564.38)</td>
</tr>
</tbody>
</table>

Note: Standard deviations are in parentheses.

The native English speakers took reliably longer to reach a judgment regarding the TRUE or FALSE response of the full set interpretation, showing a main effect of context for the timing results for the truth-value judgments ($t_1(1, 23)=3.766, p=0.001$; $t_2(1, 23)=3.033, p=0.006$). A follow-up analysis was conducted to compare the native speakers’ TRUE responses only associated with the full set interpretation to those for the partitioned set reading. The reading times yielded here can be taken to be direct reflections of interpretive processing when it comes to the access to an ambiguous sentence with its matching context. The subset analysis too showed a main effect of context (1794 ms for the full set vs. 1232 ms for the partitioned set, $t_1(1, 22)=4.700, p<0.005$; $t_2(1, 20)=3.851, p=0.001$). That is, TRUE judgment times in sentences with a full set interpretation were slower than those for sentences with a partitioned set interpretation.

Turning to the L2 groups, the Low-L2 learners took significantly longer judging the truth-value of the partitioned set interpretation, compared to the full set reading ($t_1(1, 17)=5.608, p<0.005$; $t_2(1, 23)=4.632, p<0.005$). Importantly, however, such a main effect of context was not found in the High-L2 group (all $p$’s < 0.1). In the partitioned set context, the Low-L2 group took significantly longer judging the truth-value of the sentence than the High-L2 group ($t_1(1, 34)=3.393, p=0.002$; $t_2(1, 46)=2.415, p=0.02$). The times required for the truth-value judgments were entered into a repeated measures ANOVA. There was a main effect of context ($F_1(1, 34)=26.344, p<0.005$; $F_2(1, 46)=21.669, p<0.005$), largely due to the performance of the Low-L2 group. The interaction of context and proficiency was also significant ($F_1(1, 34)=7.103, p=0.012$; $F_2(1, 46)=7.393, p=0.009$).

A subset analysis for judgment times dependent upon TRUE responses was performed only with the data for the High-L2. The Low-L2 learners didn’t provide enough TRUE responses in the partitioned set interpretation and thus the observed numbers per subject and item for this interpretation was not comparable to those of the full set reading. The analysis for the High-L2 group found no effect of context although the times required to

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7 One subject and three items whose true responses were below 30% were excluded in this subset analysis. This exclusion procedure applied to the subset analysis for residual reading times.
accept the partitioned set interpretation (1858 ms) were numerically longer than those of the full set interpretation (1652 ms) (all $p’s>0.1$).

4. Residual Reading Times

For all groups, there were no significant differences between residual reading times at any regions prior to the fifth region (all $p’s>0.5$). First, English speakers read object NP more slowly when they assigned it full set interpretation than when they assigned it the partitioned set interpretation. That is, at the object NP (R5), which corresponds to the first region after the region containing the second operator in the string, a significant effect of context was found ($t_{1}(23)=6.200, p<0.005$; $t_{2}(23)=4.273, p<0.005$). This slowdown suggests that the resolution of scope ambiguity in this pattern takes place at this point upon encountering the direct object NP. A significant main effect of context was also found in the sixth region ($t_{1}(23)=6.114, p<0.005$; $t_{2}(1, 23)=5.919, p<0.005$), possibly reflecting spill-over or sentence wrap-up effects, as can often occur in a self-paced reading.

For the L2 groups, the Low-L2 learners read significantly slower with a context supporting the partitioned set interpretation compared to a context with the full set reading ($t_{1}(1, 17)=2.723, p=0.014$; $t_{2}(1, 23)=2.434, p=0.023$). Again, at the sixth region, significant differences in reading times were found ($t_{1}(1, 17)=2.522, p=0.022$; $t_{2}(1, 23)=2.317, p=0.03$) and this slowdown here may be due to spill-over from slow reading times at the previous region. Interestingly, with the High-L2 group, no reading time differences between the two scope interpretations reached significance at any region of the sentence. Table 4 gives the residual reading times for each region of the ambiguous statements in English.

<table>
<thead>
<tr>
<th>TABLE 4</th>
<th>Residual Reading Times (ms) for Ambiguous Sentence</th>
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<tbody>
<tr>
<td></td>
<td>Group</td>
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<tr>
<td>High-L2</td>
<td>Full Set</td>
</tr>
<tr>
<td></td>
<td>Part Set</td>
</tr>
<tr>
<td>Low-L2</td>
<td>Full Set</td>
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<tr>
<td></td>
<td>Part Set</td>
</tr>
<tr>
<td>Natives</td>
<td>Full Set</td>
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<tr>
<td></td>
<td>Part Set</td>
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</tbody>
</table>

8. Spill-over effect refers to the effect of processing carried over the preceding region. Wrap-up effect typically occurs at sentence (or clause) final words not because of the word’s characteristics but because the entire sentence (or clause) can be comprehended at this point.

9. For the Korean materials, our Korean participants showed an increase in reading times at the point where the negative is encountered in contexts that support the more difficult partitioned set interpretation.
V. GENERAL DISCUSSION

The current experiment was designed to investigate how L1 Korean-L2 English speakers process ambiguous sentences involving a universally quantified direct object NP and negation in English, and whether the time course for interpreting scope varies with respect to the proficiency level of the L2 learners. First, for the native speakers of Korean, the full set interpretation was strongly preferred in Korean. Despite the rich biasing context, participant’s rejection of the partitioned set interpretation half of the time suggests that this reading is more difficult than the full set interpretation in Korean. This is what we would expect according to a processing-based account. A crucial prediction in the processing-based account is that the full set interpretation will be easier to arrive at than the partitioned set interpretation when the quantified NP precedes the negation just as in Korean.

Next, turning to English, for native speakers of English, the truth-value judgment responses bear out a preference for the partitioned set interpretation over the full set reading in sentences containing a universally quantified direct object NP and negation. Furthermore, when the judgment times needed to assign each scope interpretation were compared, times for the full set interpretation were slower than those for the partitioned set reading. In sentences with contexts supporting the full set interpretation, increases in reading times were observed once the second operator was encountered, suggesting that the participants start to integrate the full set interpretation at this point.

At first glance, an increase in reading time after the quantified NP in the case of the full seems surprising. As discussed earlier, it was noted that the processing based account gives equal weight to two interpretations in terms of the degree of processing difficulty. This is so because the processor can assign either interpretation to the patterns in which the negative precedes the quantified NP without having to retract its steps. However, this may not be the only thing that matters. As noted previously, for instance, the full set interpretation in negative sentences is expressed by a construction that does not leave room for ambiguity – usually the ‘not-any’ pattern. It is therefore quite possible that the slowdown in reading time observed for the full set interpretation of sentences such as The boy didn’t eat every cookie comes from the processor’s surprise that this meaning was not expressed in the more common way – as The boy didn’t eat any cookies. As we will see soon, possible support for this idea comes from the behavior of our L2 learners.

For the data of the Korean learners of English, let us first consider the Low-L2 learners’ performance. The participants in the Low-L2 group accepted the ambiguous sentences with a full set supporting context at a higher rate than with the partitioned set counterpart. Moreover, the judgment times required to associate with the partitioned set interpretation were slower than with the full set reading. As expected, in the partitioned set context, the
target sentence was read slower at the object NP in the first region after the region containing a universal quantifier *every*, compared to the same region for the full set interpretation. Such findings together reflect that for the Low-L2 learners, the partitioned set interpretation is harder in real time processing than the counterpart reading.

Crucially, the Low-L2 learners did not manifest different processing behavior from their native language, Korean. Recall that the native Korean speakers strongly preferred the full set interpretation over the partitioned set interpretation in sentences containing a universally quantified NP in direct object position and negation in Korean. The combined results of judgment times and reading times for the ambiguous sentences also confirmed a preference for the full set interpretation. Therefore, the observed processing routines of the Low-L2 group in this study are accounted for by the effect of L1 scope properties. That is, the learners followed the preference manifested in L1 scope processing when interpreting scope in L2. More specifically, following O’Grady et al. (2009), the preferred interpretation in the L1 is carried over into L2 if the interpretation is not costly in L2. According to the efficiency-based processing approach, in Korean, the full set interpretation involving no revision is less costly, compared to the partitioned set interpretation, which requires revision during the course of computation. In English, the full set interpretation is as easy as the partitioned set interpretation in the case of a universally quantified object NP, because the full set interpretation can be derived without the need to revise a previously assigned interpretation, as can the partitioned set interpretation. Thus, nothing prevents low proficiency learners from transferring the full set interpretation from their L1 to their L2.

Compared to the Low-L2 speakers, the High-L2 group’s performance appears to be confounding. With respect to the responses of the truth-value judgment, their behavior manifests signs of both the native language and the target languages. The learners in this group exhibited influence from their L1 preference, accepting the full set interpretation around 78% of the time. However, they also accepted the partitioned set interpretation at approximately the same rate (75% of the time) – which was higher than the rate observed with the Low-L2 learners (40%) but lower than the rate by native speakers of English (91%). The judgment times and reading times for the ambiguous sentences did not differ between the two scope interpretations either, presumably due to the similar weight of the two interpretations to the learners.

One possible explanation may relate to a point made earlier with respect to the performance of native speakers of English. There, we noted that what makes the full set interpretation of sentences such as *The boy didn’t eat every cookie* difficult for native speakers is the presence of a ‘better’ way of saying the same thing – normally the full set interpretation is expressed by an unambiguous ‘not-any’ construction such as *The boy didn’t eat any cookies*. Crucially, it seems reasonable to suppose the second language
learners, who have had far less exposure to English than native speakers, are unaware of the extent to which the ‘not-any’ pattern is preferred. They therefore see no reason why the ‘not every’ pattern should not be highly natural with the full set interpretation – a sentiment that is perhaps further reinforced by the strong acceptability of the corresponding interpretation in Korean.

**VI. CONCLUDING REMARKS**

In recent years many developmental studies have focused on young children’s scope interpretation of ambiguous sentences involving a universally quantified NP and negation. The current study has extended the topic at issue to the area of adult sentence processing with Korean speaking learners of English, investigating what interpretation can be accessed in comprehension, and how or when the relevant scope interpretation is resolved in real time. The core findings in the experiment were discussed on the basis of the processing-based account, arguing that the properties and consequence of scope interpretation are understood with reference to the operation of the processor.

To conclude, we outline some suggestions for future direction for research. The present study employed a self-paced reading format combined with a truth-value judgment task. The experimental materials were presented in written texts on a computer monitor, with the auditory bias uncontrolled. It is often argued that scope interpretation is determined by the prosodic representations projected upon processing scopally ambiguous sentences (Horn, 1989; Jackendoff, 1972). Each scope interpretation thus can be realized with a different intonation of the sentence, even in the case of a silent reading. In the current experiments, it is not clear how prosody played a role in encoding scope during the time course of processing, but the issue should be explored further. Another missing component in our study is the presentation of corpus data. A comprehension task enables us to test a complicated phenomenon, such as scopally ambiguous sentences, which speakers rarely produce during spontaneous speech, possibly due to a dispreference or avoidance of the particular construction. However, observations about the distributional patterns of language use in the input might alternatively provide an answer as to why certain expressions are easier or harder to access during comprehension (Gennari & MacDonald, 2005/2006).
REFERENCES


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