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Processing, Pragmatics, and Scope in Korean and English*

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1. Introduction

It is commonly observed that English sentences such as (1) are potentially ambiguous.

(1) Mary didn't read all the books.

On the preferred reading, *not* has scope over *all*, giving an interpretation that can be paraphrased as 'Mary read (only) some of the books.' As illustrated by the diagram in figure 1, this reading divides the set of books into two subsets—those that have been read by Mary and those that she did not read. We will henceforth refer to this as the 'partitioned set interpretation.'

* We acknowledge with gratitude the helpful comments provided by Kevin Gregg and by various members of the audience at the Japanese-Korean Linguistics Conference.

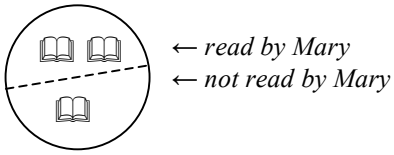


Figure 1. The partitioned set interpretation: 'Mary read some of the books.'

In contrast, on the 'full set reading' of (1), *all* has wide scope, giving the interpretation that can be paraphrased as 'All of the books were unread.' On this reading, depicted in figure 2, all members of the set of books are assigned the property of being unread by Mary.

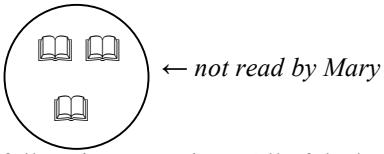


Figure 2. The full set interpretation: 'All of the books were unread.'

Interestingly, the opposite preference has been reported for Korean sentences such as (2) (Han, Lidz, & Musolino 2007, O'Grady, Lee, & Kwak 2009).

(2) Mary-ka motun chayk-ul an ilk-ess-ta.
Mary-Nom all book-Acc not read-Pst-Decl
'Mary didn't read all the books.'

In this paper, we focus on three questions raised by these facts.

i. Why is the partitioned set interpretation of sentences such as (1) strongly preferred in English?
ii. Why does Korean manifest a preference in the opposite direction?
iii. Does bilingualism affect these scope preferences?

We will address each of these questions in turn in the sections that follow.

2. Why English Prefers the Partitioned Set Interpretation

One well known explanation for why English speakers prefer the partitioned set interpretation of *not–all* sentences comes from Musolino & Lidz (2006:834). The key idea is that when speakers of English hear a sentence

such as (1), they reason as follows: if the speaker had intended to express the full set interpretation, s/he would have done so more directly, via an unambiguous pattern such as (3).

(3) Mary didn't read any of the books.
(full set interpretation only—all of the books were unread.)

Because the speaker uttered (1) rather than (3), so the reasoning goes, s/he must have intended to express the partitioned set interpretation. Hence the preference on the part of listeners for that interpretation.

We will henceforth refer to this chain of reasoning as the 'pragmatic calculus.' Although this proposal is not uncontroversial (see, e.g., Noveck et al. 2007 for an alternative proposal involving relevance theory), we will assume its essential correctness for the purposes of our discussion. This brings us to our second question, which has to do with why Korean differs from English in its interpretive preferences in scopal patterns that appear to fall within the purview of the pragmatic calculus.

3. Why Korean Prefers the Full Set Interpretation

As illustrated in (2), repeated here as (4), Korean permits sentences in which a negated verb takes a universally quantified direct object.

(4) Mary-ka motun chayk-ul an ilk-ess-ta.
Mary-Nom all book-Acc not read-Pst-Decl
'Mary didn't read all the books.'

Yet, as noted at the outset, Korean speakers strongly prefer the full set interpretation of this sentence (all of the books were unread)—the precise opposite of what we find in English. This is somewhat puzzling since, like English, Korean has a competing pattern that permits only the full set interpretation.

(5) Mary-ka amwu chayk-to an ilk-ess-ta.
Mary-Nom any book-even not read-Pst-Decl
'Mary didn't read any books.' (i.e., All the books were unread.)

This raises an obvious question: why doesn't the availability of (5), with its exclusive full set interpretation, lead to a preference for the partitioned set interpretation in the case of (4), in accordance with the pragmatic calculus? Put another way, why isn't Korean just like English? We believe that the answer lies in processing considerations.

3.1. A Processing Explanation

Our approach to processing is guided by the following two uncontroversial assumptions (e.g., Grodner & Gibson 2005: 262-63).

- As the processor works its way through a sentence, it immediately assigns each word and phrase an interpretation.
- The revision of a previously assigned interpretation is costly since it disrupts the normal linear operation of the processor, forcing it to go back and redo its work.

Consider in this regard how the processor goes about deriving the partitioned set interpretation in an English sentence such as *Mary didn't read all the books*. Two steps are of crucial importance:

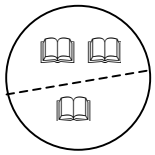
(6) Mary didn't read all the books.

a. As the processor moves through the sentence, it encounters the negative on the auxiliary verb *did*.

Mary did**n't**

b. Subsequently, upon encountering the quantified NP, the processor can immediately assign the partitioned set interpretation—in compliance with the pragmatic calculus and without backtracking.

Mary didn't read **all** the books.


← *partitioned set interpretation*

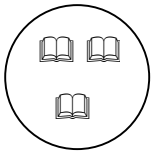
In sum, because the negative precedes the direct object in English, the partitioned set interpretation can be derived without the need for the processor to retrace its steps and modify an earlier interpretation.

Now consider how the processor will have to proceed if it is to derive the partitioned set interpretation for the equivalent sentence type in Korean. Once again, two steps are crucially important.

(7) Mary-ka motun chayk-ul an ilkessta. ('Mary didn't read all the books.')

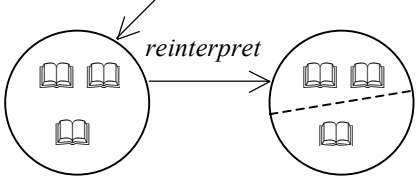
a. As the processor moves through the sentence, it quickly encounters the quantified NP and assigns it the default full set interpretation:

Mary-ka **motun** chayk-ul ...
Mary-Nom all book-Acc



b. Subsequently, the negative is encountered. If it is allowed to trigger the partitioned set reading, the previous interpretation of the quantified NP must be recomputed.

Mary-ka motun chayk-ul **an** ilk-ess-ta
Mary-Nom all book-Acc not read-Pst-Decl



The need for backtracking makes the partitioned set interpretation hard to process, in comparison to the full set alternative. On our view, this then nullifies the effects of the pragmatic calculus, which would otherwise favor the partitioned set interpretation, as it does in English.

A crucial feature of this proposal is the proposition that the partitioned set interpretation does in fact incur extra processing cost in Korean. As we will see next, experimental work by Lee (2009) provides independent evidence for this claim.

3.2. A Processing Experiment

Subjects

Thirty-eight native Korean-speaking adults (mean age 22;9) participated in Lee's experiment. They were all life-long residents of Korea.

Materials

Test sentences contained a universally quantified direct object and short-form (preverbal) negation, as illustrated by the sample item in (8).

(8) Ecey pamey, Seyhee-ka motun chospwul-ul an khyessta ko
last night Seyhee-Nom all candle-Acc not light that
iyaki-nun malhaycwunta.
story-Top says
'The story says that Seyhee didn't light all the candles last night.'

All test sentences were preceded by one of two contexts—one supporting a full set interpretation and the other supporting a partitioned set interpretation, as illustrated below.

Sample context favoring the full set interpretation:
Last night Sehee 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. However, since she was so tired, she didn't light the candles but went to sleep right away in the dark. [Test sentence is true on the full set interpretation, because all the candles were unlit.]

Sample context favoring the partitioned set interpretation:
Last night Sehee 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 is true on the partitioned set interpretation, because one of the candles was lit, and two weren't.]

There were six test items per condition, arranged in a Latin square design so that none of the subjects heard the same test item in more than one context. (An additional two conditions, not relevant to the current discussion, tested the interpretation of sentences containing post-verbal negation.)

Procedure

After reading a context, the subjects pressed a button to call up the test sentence on the computer screen one region at a time (a moving-window self-paced reading task), as illustrated below.

(9) 1 2 3 4 5
Ecey pamey / Seyhee-ka / motun / chospwul-ul / an khyessta ko
last night Seyhee- Nom all candle-Acc not light that

6 7
iyaki-nun / malhaycwunta.
story-Top says
'The story says that Seyhee didn't light all the candles last night.'

The subjects then identified the sentence as true or false by pressing the appropriate response key on a response pad.

It is well known that the truth of the full set (*all* > *not*) reading entails the truth of the partitioned set (*not* > *all*) reading: if it is the case that all of the candles are unlit, it must also be true that some of the candles are unlit. Of course, the converse does not hold: the fact that some of the candles are unlit does not entail that all of the candles are unlit. For this reason, judgments of the test items in the partitioned set context are especially important—a judgment of true unequivocally establishes the availability of the partitioned set interpretation.

Results

Three measures are relevant to our hypothesis that the partitioned set interpretation in Korean incurs more processing cost and is therefore less accessible than its full set alternative.

The first measure involves interpretive preference—whether Korean speakers prefer one reading over the other, even when each occurs in a natural context. Table 1 summarizes our results in this regard.

Table 1. Truth value judgments—was the test sentence true or false?

Full set context (all the candles are unlit)		Partitioned set context (one of the three candles is lit)	
True	False	True	False
94.4%	5.6%	54.6%	45.4%

As can be seen here, the full set interpretation is selected almost 95% of the time in contexts that favor it. In comparison, the partitioned set interpretation is adopted just 54.6% of the time in contexts that support it; in the remaining cases, the sentence is judged false—presumably because participants assign it the full set reading. Taken together, these results suggest that although the partitioned set interpretation is possible in Korean, it is the

weaker reading.[1] A comparable asymmetry is reported by Han, Lidz, & Musolino (2007).

The second relevant measure involves the amount of time required to judge a test sentence to be true in each of the two types of contexts. (Response time is measured from the appearance of the final word on the screen to the point at which the subject presses the 'true' button.) Table 2 reports Lee's findings for this measure.

Table 2. Response time for judgments of truth

Full set context (all the candles are unlit)	Partitioned set context (one of the three candles is lit)
1571 ms	2412 ms.

On average, it took 1571 ms to judge a sentence to be true in the context favoring the full set interpretation, compared to 2412 ms in the context that supports the partitioned set reading. The effect of context is significant ($F(1,35) = 93.89$, $p < 0.005$), suggesting that the processing time for the full set interpretation is in fact faster.

The third and final measure of relevance to our hypothesis involves online reading times for each segment of the test sentence (see (9) above). Figure 3 depicts the region-by-region residual reading times.[2]

[1] Because test items are accepted as true far more often in the context supporting the full set interpretation, it is unlikely that this reading is selected simply because a situation in which none of the candles were lit is compatible with a situation in which not all the candles were lit. The full set interpretation appears to exist as an independent (and dominant) reading.

[2] Residual reading times are used to adjust for differences in subjects' reading rates or for differences in word length within conditions. To calculate residual reading times, a linear regression is estimated for each subject with raw reading times as the dependent variable and length in number of characters as the explanatory variable. The reading times predicted by the individual linear regression are then subtracted from the raw reading times. Thus, for a given region, 0 ms would provide average reading speed for the region of differing lengths across participants. A positive number shows that the reading time is slower than predicted on the basis of the length of the word, whereas a negative number shows that reading time is faster than expected.

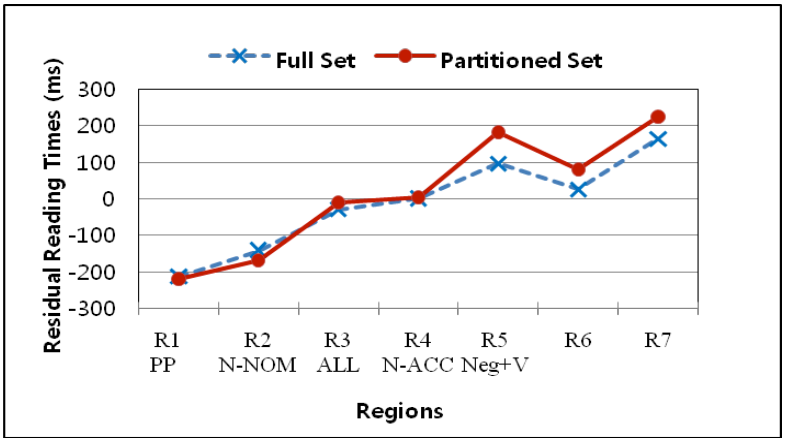


Figure 3. Region-by-region residual reading times

Of special interest here is region 5, which contains the negated verb and therefore constitutes the point at which an opportunity arises to derive the partitioned set interpretation by revising the full set reading that was previously assigned to the quantified NP, as outlined in the discussion of (7) above. As illustrated in figure 3, processing slows down at the negated verb in contexts that favor the partitioned set interpretation compared to those that favor the full set interpretation. (The effect of context is significant: $F(1,35) = 14.74$, $p < 0.005$.) This supports our hypothesis that the processor has to retrace its steps after encountering the negative and revise the earlier default full set interpretation of the quantified NP.

In sum, as predicted by the processing theory that we have put forward, the full set interpretation does indeed appear to be more accessible and less difficult than the partitioned set reading in Korean: it is selected more often, its truth is judged faster, and it manifests a shorter reading time at the region containing the negated verb. All of this is consistent with our proposal that processing considerations nullify the pragmatic calculus, which would otherwise lead to a preference for the partitioned set interpretation in Korean, just as it does in English.

4. The Effect of Bilingualism on Scope Preferences

We turn now to our third question, which focuses on whether bilinguals who learned Korean before English are able to employ the pragmatic calculus in computing scope interpretations in English, despite the irrelevance of this consideration to the comprehension of *not–all* patterns in Korean. We report here on two experiments that we conducted on this subject.

4.1. Experiment Involving Child Bilinguals

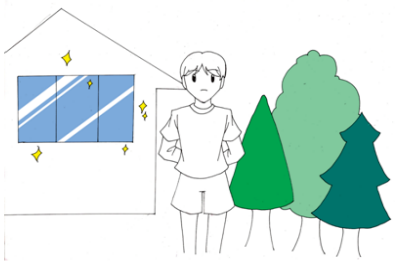
Subjects

Nine children (aged 6;0 to 11;9—mean age, 8;5) of Korean parents living in the United States participated in this experiment. The children had been exposed to English for at least four years; five had been born in the U.S. All were attending English-language schools and in accord with the classic profile of 'heritage language learners' (Montrul 2008) were English-dominant.

Procedure and Materials

The children's interpretive preferences were assessed with the help of short stories such as the ones illustrated below. Each story, which was presented orally and illustrated with pictures on a laptop computer, consisted of a context-setting situation and a test sentence, produced by a puppet. The child's task was to judge whether the sentence offered an accurate summary of the story.

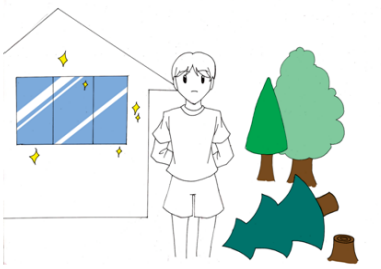
Sample story supporting a full set interpretation:
Robert is working hard at home. His father wants him to clean three windows and to cut down three trees. Robert says, "Okay, I'll do that." Robert cleans the three windows right away. Then, Robert looks at the first tree. It is very big. So he doesn't cut it down. The second tree looks even bigger. So Robert doesn't cut it down either. Then, Robert looks at the third tree. It is smaller than the other trees. So he thinks that he can cut it down. However, when he is about to start, he realizes that it is his sister's favorite tree. So he doesn't cut it down either.



Test sentence: *Robert didn't cut down all the trees.*

Sample story supporting the partitioned set interpretation:
Robert is working hard at home. His father wants him to clean three windows and to cut down three trees. Robert says, "Okay, I'll do that."

Robert cleans the three windows right away. Then, Robert looks at the first tree. It is very big. So he doesn't cut it down. The second tree looks even bigger. So Robert doesn't cut it down either. Then, Robert looks at the third tree. It seems very big too. But he decides to try, and he manages to cut it down.



Test sentence: *Robert didn't cut down all the trees*.

There were three test items per condition, arranged in a Latin square design so that none of the subjects heard the same test item in more than one context. The experimental protocol also included two practice items and four filler items.

Results

Table 3 summarizes our results.

Table 3. Bilingual children's truth value judgments for sentences such as *Robert didn't cut down all the trees*

Full set context (all the trees are uncut)		Partitioned set context (one of three trees was cut down)	
True	False	True	False
100%	0%	59%	41%

As can be seen here, our subjects manifested a strong preference for the full set interpretation in English, comparable to what is found in Korean.[3] Two explanations come to mind. On the one hand, it is possible that our subjects simply extend the interpretive preferences for Korean to English, overriding the pragmatic calculus that would normally favor the partitioned set interpretation in the latter language. On the other hand, it is also possible that our subjects are simply unaware of the pragmatic calculus at this point in

[3] In an independent experiment, not reported here for reasons of space, the same children were tested on Korean, in which they manifested a strong preference for the full set interpretation.

their development, independent of their bilingualism. Evidence that children's pragmatic development can lag behind their syntactic skills comes from a study by Musolino & Lidz (2006), who investigated the ability of monolingual English-speaking children to interpret *not–every* sentences in basic descriptive contexts such as the following.

> Sample test item from Musolino & Lidz (p. 836):
> A strong guy tries to lift three dogs and three elephants one by one and put them on a large table behind him. He begins with the dogs and easily manages to place each of them on the table. He then turns to the elephants and tries to lift the bigger one. Unfortunately, the big elephant is far too heavy for the strong guy who cannot even lift it off the floor. The strong guy then turns to the medium elephant, hoping that it is lighter. Still no luck though—elephants are heavy! Finally, the strong guy tries to pick up the smaller elephant but he still fails to lift it off the ground. In the end therefore, the strong guy was able to put all the dogs on the table but none of the elephants. At this point, the puppet describes what happened by saying that ''The strong guy didn't put every elephant on the table''.

The 20 children in Musolino & Lidz's study (mean age 5;4) accepted the full set interpretation (judging the test sentence to be true) about 75% of the time,[4] suggesting a disregard for the pragmatic calculus. In contrast, adult subjects accepted the full set reading just 20% of the time.

One way to further test the effect of age on the use of the pragmatic calculus is to consider the scope preferences of *adult* bilinguals, for whom the possibility of a pragmatic lag is presumably irrelevant.

4.2. Experiment Involving Adult Bilinguals

Subjects

Seven adults (aged 23;8-30;8) who grew up in Korean immigrant families living in the United States participated in this experiment. All had been born in the U.S. or moved there before puberty. Like the child heritage learners in the experiment described in section 4.1, they spoke Korean to varying degrees at home, but attended English-language schools. All earned undergraduate degrees from English-language universities in the U.S., and considered English to be their stronger language.

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[4] However, Musolino & Lidz's test items involved the quantifier *every* rather than *all*.

Procedure and Materials

The interpretive preferences of adults were assessed using a written questionnaire, in which each test item was preceded by a context and accompanied by a picture that summarized the situation described in the context, as in our experiment with child bilinguals. There were four test items per condition, arranged in a Latin square design so that none of the subjects heard the same test item in more than one context. The questionnaire also included two practice items and ten filler items.

Results

The results for our experiment are summarized in table 4.

Table 4. Bilingual adults' truth value judgments for sentences such as *Robert didn't cut down all the trees*

Full set context (all the trees are uncut)		Partitioned set context (one of three trees was cut down)	
True	False	True	False
86%	14%	54%	46%

As shown in table 4, the adult bilinguals resemble their child counterparts in manifesting a strong preference for the full set interpretation, which is accepted 86% of the time, compared to just 54% for the partitioned set interpretation. This preference is similar to one observed for Korean in a separate study with the same subjects, but differs sharply from the interpretive propensities manifested by monolingual speakers of English. Indeed, Lee (2009:126) reports mirror-image results for adult native English speakers—an acceptance rate of 45% in the full set context and of 90% in the partitioned set context.[5] We obtained similar results in a study that we did with nine English-speaking adults: the acceptance rate for our test sentences was 47% in the full set context and 97% in the partitioned set context.

In sum, the data from our adult subjects suggest that bilinguals differ from monolingual native speakers of English in two respects—they over-accept the full set interpretation and they under-accept the partitioned set interpretation. Both propensities point to a disregard for the pragmatic calculus, which favors the partitioned set interpretation in English at the expense of the full set reading. This in turn suggests that prior knowledge of Korean interferes with attention to pragmatic aspects of scope interpretation in English, even after many years of exposure to that language.

[5] Lee's sentences contained the quantifier *every* rather than *all*.

5. Concluding Remarks

We began by considering the question of why English speakers prefer the partitioned set interpretation of sentences such as *Mary didn't read all the books*. Following Musolino & Lidz (2006), we adopted the view that a pragmatic calculus shapes the comprehension of such sentences: listeners assume that the full set interpretation, if intended, will be expressed by an unambiguous pattern such as *Mary didn't read any of the books*, thereby inferring that *Mary didn't read all the books* must have the partitioned set interpretation.

This led us to the question of why Korean doesn't exhibit the same preference in sentences containing a negated verb and a universally quantified direct object. We put forward the hypothesis that the pragmatic calculus is suppressed in Korean by processing considerations, which strongly favor the full set interpretation. We went on to report experimental evidence that offers independent support for the relative difficulty of the partitioned set interpretation in Korean, as predicted by our hypothesis.

Finally, we investigated the possible effect of bilingualism on scope interpretation in English, focusing on children and adults who had learned Korean before English became their dominant language. The key finding was that early exposure to Korean seems to interfere with learners' attention to the pragmatic calculus in English. This in turn suppresses the preference for the partitioned set interpretation that is otherwise characteristic of English, leaving a preference for the full set interpretation parallel to what is observed for Korean. Crucially, however, whereas the preference for the full set interpretation in Korean appears to be motivated by processing considerations, as demonstrated by the experimental work reviewed in section 3.2, there is no comparable motivation for this interpretation in English—the preference seems to come entirely from early exposure to Korean.

This finding raises potentially far-reaching questions about the relationship between processing and pragmatics in the course of language acquisition. Of special interest is the fragility of the pragmatic calculus, whose impact depends on the sensitivity of learners to alternative and more direct ways of expressing particular interpretations. As we have seen, this chain of observation and inference can be suppressed by processing considerations (as happens in Korean) and subsequently ignored in English by Korean-speaking child learners, who are not accustomed to computing its effects. Even more remarkably, the effects of this early inattention seem to last into adulthood, creating interpretive preferences in English-dominant adult speakers that are quite unlike those associated with their monolingual counterparts. It is hoped that research currently underway will shed further light on the nature and generality of this phenomenon.

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