Some QPs, but Not All, Interact with Prosody

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1. Introduction

Unlike English, many scrambling languages including German, Russian and Japanese, have been acknowledged as showing scope rigidity. Thus, a sentence with multiple quantifiers as schematized in (1) is not ambiguous and surface scope (i.e. subject-wide scope) reading is only available. However, it has been also observed that inverse scope (i.e. object-wide scope) reading is also possible when the sentence is pronounced with certain prosody. In German, rising pitch accent on the subject QP and falling pitch accent on the object QP allows inverse scope reading (Büring 1994, Krifka 1998). In Russian, inverse scope is available when the pitch accent of the determiner of an in-situ object QP is removed (Antonyuk-Yudina 2011) or when the subject QP has contrastive focus accents (Ionin and Luchkina 2015). In Japanese, when a prominent accent is assigned on the subject quantifier followed by a pause (Kitagawa 1990), inverse reading is reported to be available. Even though the specific characteristic of prosody that ameliorates scope rigidity is different language by language, there seems a crucial common property in the inverse-reading inducing prosody: subject QP is prosodically accented (mostly by raising pitch range) and object QP is less (or de-) accented.

(1) $QP_{subj.}$ … $QP_{obj.}$: $^{OKAY}QP_{subj.} > QP_{obj.}$, $^{NO}QP_{obj.} > QP_{subj.}$

The prosodic property described above reminds us information structure notions of *focus* and *given/topic*. Focus has been known to be realized by prominence in its focus domain (i.e. Focus Prominence), but a given phrase is prosodically non-prominent (i.e. Destress–Given) (Jackendoff 1972, Truckenbrodt 1995, Féry and Ishihara 2010 among many others). Prosodic properties of topic show various aspects depending on whether it has contrast or not. In this paper, I use the term "topic" to refer to discourse-topic, which can be defined by [+familiarity], [+aboutness], [-contrast]. I assume that in-situ topic show *de-stress* due to its discourse familiarity (as a given element) in some languages that allows in-situ topic. If this is the case, a less (or de-) accented QP in (1) can be either given or topic. Based on such relation between information structure and prosody, two possible hypotheses to account the scope inversion in (1) can be postulated. One is PF-LF direct communication. This hypothesis assumes that a focus QP (with prominent accent) has narrow scope and a given/topic QP (with less (or de-) accent) has wide scope, regardless of their syntactic hierarchy. Under this hypothesis, we predict that any type of QPs that are less (or de-) accented can scope over the prominently focused QP that precedes it. Another possible hypothesis assumes that a prosodically less (or de-) accented element undergoes covert topic movement to a syntactically higher position than the focused element, so it can scope over the focus QP that precedes it. This scopal relation is determined by the widely accepted scope assignment principle in (2). Under this hypothesis, we predict that only restricted set of QPs that can be topic can scope over a focused QP that precedes it while QPs that cannot be topic (thus, only interpreted as given) cannot scope overt a focused QP even when it is posodically non-prominent.

(2) A scopes over B iff A c-commands B or A c-commands a trace of B at LF (Frey 1993).

This paper experimentally investigates selective prosody effects on inverse scope availability in Korean. Korean is a rigid-scope language, but has rarely been discussed with respect to the prosody-scope interaction. In section 2, I will describe the method of the experiment I used to explore the

following two questions: 1. Does Korean allow scope inversion with the help of a specific prosody as observed in other rigid-scope languages? 2. If yes, does prosody affect every QP or a certain set of QPs? In section 3, I will demonstrate the results that support the covert topic movement hypothesis and discuss the theoretical implication of this experiment. Section 4 concludes the paper.

2. Method

2.1. Design and Materials

I tested two factors with three levels each: (i) quantifier types (*motun* 'all/every' NP, numeral NP, modified numeral NP) and (ii) prosody (focus accent on quantifier, focus accent on NP, no accent), for a total of nine conditions as shown in Table 1.

Table 1. Experiment Design

QP types		Prosody		
		NP focus	Q focus	No accent
	motun	motun [NP]$_{foc}$	[motun]$_{foc}$ NP	motun NP
	#	[NP]$_{foc}$ # CL	NP [# CL]$_{foc}$	NP # CL
	# or more	[NP]$_{foc}$ # or more	NP [# or more]$_{foc}$	NP # or more

Two factors were manipulated on object QPs only. The subject was QPs modified by a focus particle, either *at least one NP* or *at least two NP* (counter-balanced), throughout the test. According to the previous studies on other languages, scope inversion is observed when the subject is focused but the object is less (or de-) stressed. Since Korean shows down step-wise pitch decreasing throughout a sentence, subjects are assigned high pitch as the first element in a sentence in general. By maintaining the QP type and prosody on subjects as focus, this experiment is designed to see whether different prosodic accents, prominency vs. lack of prominency, on objects are responsible for scope inversion if it exists.

Three different quantifier types were tested, *motun* NP, numeral NP, and modified numeral NP as exemplified in (2).

(2) a. *Motun* NP (every/all NP)
   Choisohan   uysa   han myeng-i   motun   kanhosa-lul   chingchanhay-ss-ta.
   At least   doctor one CL-nom   motun   nurse-acc   compliment-past-decl.
   At least one doctor complimented every/all nurse(s).
 b. Numeral NP
   Choisohan   uysa han myeng-i   kanhosa   sey myeng-ul   chingchanhay-ss-ta.
   At least   doctor one CL-nom   nurse   three CL-acc   compliment-past-decl.
   At least one doctor complimented three nurses.
 c. Modified numeral NP (*three/four or more* NP)
   Choisohan uysa han myeng-i   kanhosa sey myeng isang-ul   chingchanhay-ss-ta.
   At least   doctor one CL-nom   nurse three CL more-acc   compliment-past-decl.
   At least one doctor complimented three or more nurses.

The quantifier *motun* can be translated either as *every* or *all* in English. In English and many other languages, *every* NP in object position is the most widely studied QP regarding scope inversion. As a distributive quantifier, *every* NP in English and many other languages can take wide scope relatively freely. However, *all* is not distributed over by other quantifiers. Since it is good to investigate patterns that can be compared with other languages, *motun* NP was selected for the test. The choice of the other two QP type is crucial to investigate the hypotheses. Numeral NP in object position can scope over a subject QP, but *N and more* NP (i.e. modified numeral QP) cannot (Liu 1990, Beghelli and Stowell 1997) in many languages. Beghelli and Stowell classify modified numeral quantifier as Counting quantifiers that resist specific readings. However, a topic phrase must be specific (É Kiss 1998). The
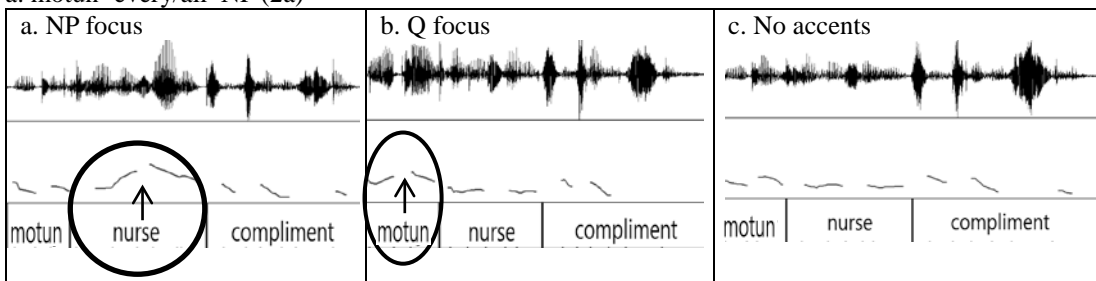
combination of these premises predicts that modified numeral quantifiers cannot occur as topic phrases. This prediction is born out in Korean as in (3). Korean has a topic marker –*nun*, which can mark a topic when it is attached to a subject. However, if the subject is a modified numeral quantifier as in (3a), -*nun* cannot cause thematic-topic reading, but only a contrastive-list reading. This is contrary to the numeral quantifier with topic marker in (3b), which can have thematic-topic reading. Therefore, I assume that numeral quantifiers can be topic phrases, while modified numeral quantifiers cannot in Korean. Thus, if certain prosody allows a wide-scope reading of both types of quantifiers in object position, it implies that the wide-scope reading is irrelevant to syntactic movement. In that case, we experiment results support the direct prosody-scope matching or other non-syntactic mechanisms. By way of contrast, if there is difference in the possibility of the wide scope reading between the two quantifier types, it implies that the scope taking with respect to prosody is relevant to topicality, namely (I argue) topic-driven movement.

(3) a. Haksayng   sey   myeng   isang-un   manhwachayk-ul   ilk-ess-ta.
          Student   three   CL   more-top   comic book-acc   read-past-decl.
      Contrastive (list) reading: More than three students read comic books (and more than four
                                        students read novel…)
   *Thematic topic reading: There are more than three students who read comic books.
   b. Haksayng   sey   myeng-un   manhwachayk-ul   ilk-ess-ta.
          Student   three   CL-top   comic book-acc   read-past-decl.
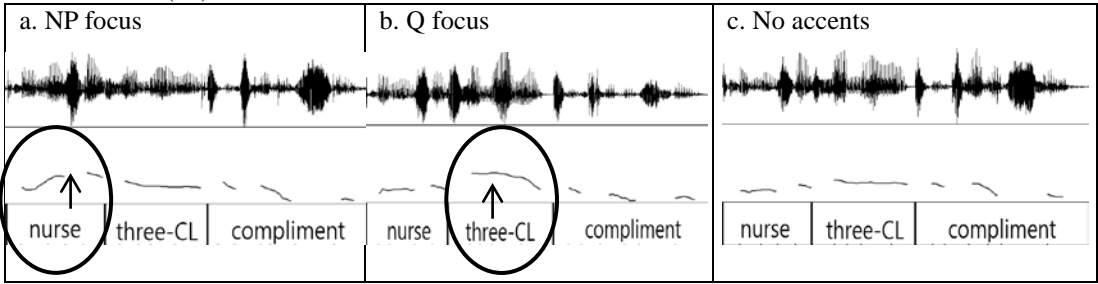   Thematic topic reading: There are three students who read comic books.

   For prosody factors, three different accents on objects were tested. According to previous literature on Korean intonation (Jun 1993, 2005, Jo et al. 2003 among many others), prosodic accent makes focus phrase more prominent than its neighbors, and topic is de-stressed accent-wise, as in Japanese. Even though focus intonation in Korean has been studied intensively, topic intonation has rarely been discussed. Lee (2000) and Oh (2008) explore the intonation of sentence-initial topics with topic marker –*(n)un*, but as far as I know, no research seriously discusses sentence-medial topics without the topic marker. Thus, topic intonation for such case has not been identified. Consequently, in this experiment, under the assumption that topic, as a given element, is de-stressed, I assume that a sentence-medial topic constituent is assigned a lowered f0 as a consequence of downstep-like lowering, as like given phrases. Based on the focus/topic intonation we have discussed, I manipulated prosody conditions in three ways. The first condition assigns a prominent accent on a noun phrase that a quantifier modifies. In the second condition, a prominent accent occurs on a quantifier. To see whether there is any effect of positions where prominent accent is assigned, two different types of focus condition were tested. In the third condition, a prominent accent does not occur on any part of an object QP. Figure 1 shows samples of target audio stimuli. Each target sentence was recorded using a head-mounted microphone in a sound-attenuated booth by a male native speaker of Korean. Speakers were trained to make a clear distinction between different prosody conditions. Recording was conducted using Praat and saved as separate wave files.

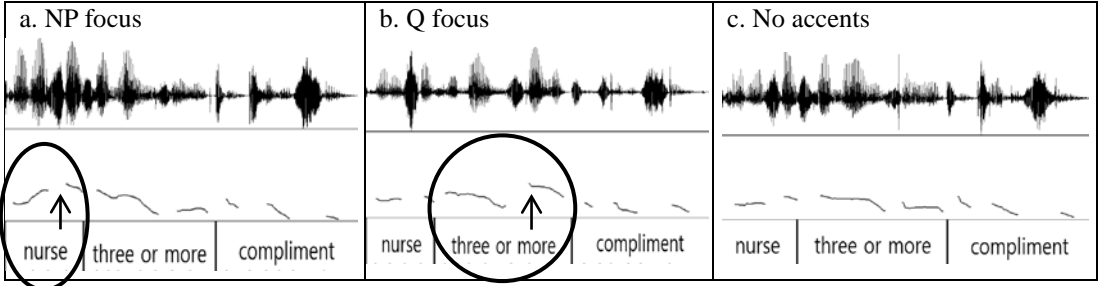**Figure 1. Samples of target audio stimuli**

a. motun 'every/all' NP (2a)

b. numeral NP (2b)

| a. NP focus | b. Q focus | c. No accents |

c. modified numeral NP (2c)

| a. NP focus | b. Q focus | c. No accents |

Jun and Lee (1998) argue that Seoul Korean speakers manipulate the pitch range difference between a focused word and the following word to enhance the prominence of a focused item. Thus, the pitch range between a focused word and the following word is larger than the pitch range between two non-focused words. Phonetic analysis of the audio stimuli was conducted based on this observation. Figure 2 shows the results of phonetic analysis of audio stimuli.
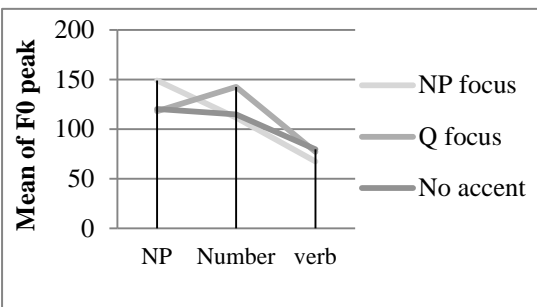
Figure 2. Changes of peak f0 value over the sentence
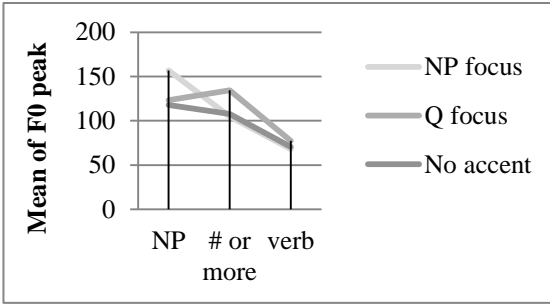
a. The *motun* NP condition
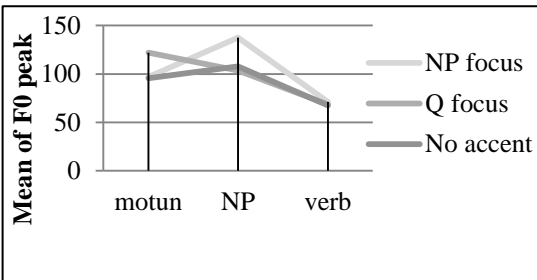
The pitch range between *motun* and the following NP is more enhanced (sudden falling) in the Q focus condition than in the no accent condition (the NP focus condition cannot be compared here because in that case, the following word is focused). The pitch range between the NP and the following verb is more enhanced in the NP focus condition than in the other conditions.

b. The numeral NP condition

The pitch range between the NP and the following numeral phrase is more enhanced (sudden falling) in the NP focus condition than in the no accent condition (the Q focus condition cannot be compared here because in that case, the following word is focused). The pitch range between a numeral phrase and the following verb is more enhanced in the Q focus condition than in the other conditions.

C. The modified numeral NP condition

The pitch range between the NP and the following modified numeral phrase is more enhanced (sudden falling) in the NP focus condition than in the no accent condition (the Q focus condition cannot be compared here because the following word is focused). The pitch range between a modified numeral phrase and the following verb is more enhanced in the Q focus condition than in the other conditions.

For all of the three quantifier conditions, when NP/Qs were focused, the pitch range between the focused NP/Q and the following word was enhanced compared to the no accent (neutral) condition. Thus, focused NP/Qs were seen to be prominent compared to the words following them.

Each auditory target sentence was presented with two pictures which indicated two potential readings of the sentence, a subject-wide scope reading and an object-wide scope reading, as shown in Figure 3 (written in Korean character in the experiment, but here translated in English). To better explicate the design, I will go through an example using the sentences provided in (2). For this item, the *motun* NP condition used image (a) in Figure 3 and the numeral and modified numeral conditions used image (b). This is because in *motun* conditions, circles around the set of teachers were added to ensure that participants interpret the image as depicting a situation where all nurses (every nurse) was complimented by at least one doctor. The subject-wide scope reading image (the left-side image in each condition) depicts a situation where at least one doctor complimented three nurses (every nurse in the *motun* condition). I used arrows to depict the events mentioned in the sentences, and used example items to ensure that participants understood the meaning of the arrows. In addition, the different characters – in this case *doctor* and *nurse* – were labeled in Korean to ensure participants knew which was which. The object-wide scope reading image (right-side image in each condition) for this item shows a situation where three nurses in the picture were complimented by at least one doctor (who could potentially be different for each nurse).

Figure 3. Sample targets
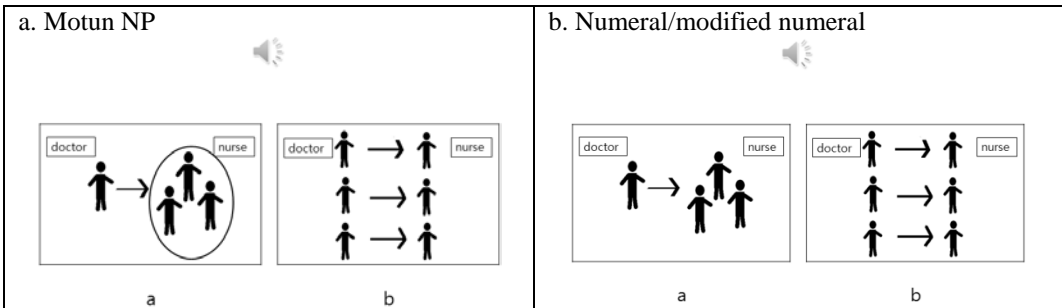
All of the experimental pictures were matched in animacy. Two left/right mirror image versions were created for each target picture. The left-right positions of the subject-wide scope reading and the object-wide scope reading were counterbalanced. I used a Latin-square design such that one participant saw one version of each picture, and each version of each picture was seen an equal number of times across participants.

In addition to target trials, each participant was given 64 fillers, which consisted of two sets, one with anaphora interpretation and the other with time adverb attachment. The fillers were designed to have ambiguous interpretations (not scope-wise), in order to make the potentially ambiguous properties of targets less striking, thereby making it harder for participants to guess the purpose of the experiment. I did not include any scope bearing element in the fillers to avoid any possible interaction between targets and fillers in terms of scope.

2.2. *Participants and procedure*

The experiment was conducted in a sound-attenuated booth. Participants (36 native speakers of Korean) saw 100 Power Point slides - 36 target trials and 64 filler trials. When they clicked a speaker button at the top of each slide, they heard audio stimuli over a head-mounted headset. They were given an answer sheet and were instructed to give scores from 1 to 5 (1 is the worst and 5 is the best) based on how they thought the sentence they heard could be naturally used to describe each picture in a slide.

3. Results and discussion

For each condition, the dependent measure was the scores participants gave. As can be seen in Figure 4, the subject-wide scope reading had higher scores regardless of QP types or prosody. To see the effects of prosody or quantifier types on the object-wide scope reading acceptability, which this experiment was primarily interested in, the acceptability scores of the object-wide scope reading for each condition were plotted in Figure 5. Here we can see that, in the numeral quantifier condition, the score is higher in the no accent condition than in the NP focus or Q focus conditions. By way of contrast, with the other quantifier types (*motun* and modified numeral quantifier), prosody does not seem to affect the acceptability. To assess these results statistically, I conducted analyses of variance (ANOVAs). Participant and item means were z-score transformed. All ANOVAs had the following two factors: Quantifier types (motun vs. numeral quantifier vs. modified numeral quantifier) and Prosody (NP focus vs. Q focus vs. No accent). ANOVA results show that regardless of prosody, the acceptance rate of the object-wide scope reading was significantly higher in the numeral condition than in the other two quantifier conditions in both by-subjects analysis and by-items analysis (main effect of quantifier types: $F1(2,70)=5.405001$, $p<0.05$, $F2(2,70)=6.177798$, $p<0.01$). There was no significant main effect of prosody. In addition, both by-subject analysis and by-item analysis show that there was a significant interaction between the two factors, QP type and prosody ($F1(4,140)=2.489319$, $p<0.05$, $F2(4,140)=2.520780$, $p<0.05$).
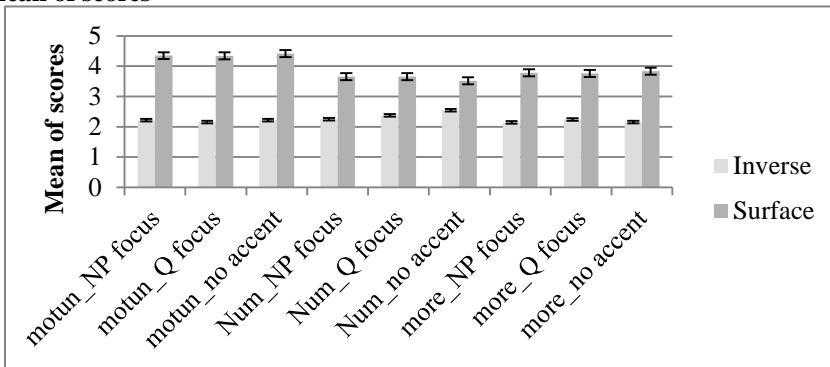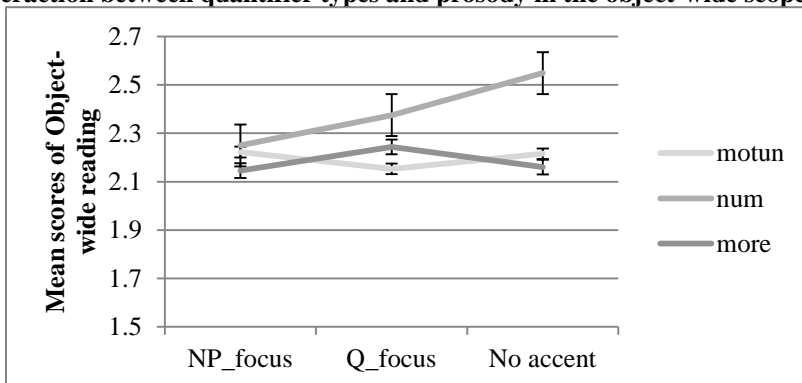
Figure 4. Mean of scores

Figure 5. Interaction between quantifier types and prosody in the object-wide scope reading

To better understand the source of the interaction, I conducted paired t-tests for two cases this experiment was interested in: 1. Prosody effects within the same quantifier type, 2. The effects of different quantifier types within the same prosody. The results are summarized in the table 2 and 3. We can find two observations[1] :

1. Numeral quantifiers are the only quantifier type that is affected by prosody. In Table 2, the only significant effect is observed between the NP focus condition and the No accent condition in the Numeral quantifier condition. One marginal effect is observed between the Q focus condition and the No accent condition in the Numeral quantifier condition as well. All the other paired t-tests show no significant p-value. This implies that numeral quantifiers are affected by prosody, but not the other types of quantifiers. In addition, when there is no accent on the object quantifier, it is more likely to have wide scope than the case where any prominent accent is on the object quantifier.

2. When an object quantifier is not assigned any prominent accent, the acceptability of the object-wide scope reading is significantly different depending on the types of object quantifiers. As shown in Table 3, when the object quantifier is a numeral quantifier, then it is significantly more likely to have wide scope than when the object quantifier is another type of quantifier[2].

Table 2. Paired t-test (Prosody factors within the same quantifier type)

Paired conditions			P-value
Motun	NP focus	Q focus	0.1977
	Q focus	No accent	0.4011
	NP focus	No accent	0.6576
Numeral quantifier	NP focus	Q focus	0.1479
	Q focus	*No accent*	*0.09479*
	NP focus	*No accent*	*0.000677****
Modified numeral quantifier	NP focus	Q focus	0.3294
	Q focus	No accent	0.4636
	NP focus	No accent	0.8723

Table 3. Paired t-test (Quantifier type factors within the same prosody)

Paired conditions			P-value
NP focus	*motun*	Numeral	0.696
	Numeral	Modified numeral	0.2099
	motun	Modified numeral	*0.08877*
Q focus	*motun*	Numeral	*0.03929**
	Numeral	Modified numeral	0.1267
	motun	Modified numeral	0.5486
No accent	*motun*	Numeral	*0.001342***
	Numeral	Modified numeral	*3.874e-06****
	motun	Modified numeral	0.3179

Therefore, the findings can be summarized as follows: Korean shows scope inversion when the subject QP is focused and the object QP is de-stressed, as like other rigid scope languages. Furthermore, the insensitivity of prosody for modified numeral QPs indicates that this prosody effect is a reflection of syntactic movement, not just a case of PF-LF communication. One might wonder why the object can rarely scope over the subject QP when the object numeral quantifier phrase is assigned a

[1] Bonferroni-corrected pairwise test also shows the same results.

[2] When Q is focused, numeral quantifiers are significantly more likely to have an object-wide scope reading than *motun* NP, but not than modified numeral quantifiers. I will put this result aside.

focus accent either on the NP or on the quantifier with expanded pitch range assuming covert focus movement. I suspect that this is because even though the object QP undergoes covert focus movement (by hypothesis), it must move to a position lower than where the subject QP is moved to (Tucking-in fashion proposed in Richards 1997) due to Superiority.

Similar to the modified numeral QP condition, the *motun*-NP condition rarely allows an object-wide scope reading regardless of prosody. This implies that at least in cases where the quantifier appears in non-scrambled object positions, Korean *motun* patterns more like the collective quantifier *all* in English, than the distributive quantifier *every*. The overall preference of the subject-wide scope regardless of prosody can be accounted for by many possible different factors like processing cost theory or other analyses.

4. Conclusion

This paper shows that Korean allows scope inversion when the subject QP is focused and the object QP, which is type of QP that can be topical, is de-stressed. I argue that scope inversion is due to covert topic movement of the object QP over the subject QP based on the results that QPs that can be topical can have wide scope with a help of prosody, while QPs that cannot be topical cannot (de-stressed modified numeral QPs can only indicate given, not topic). The results can account for the widely accepted observation that topical elements have wide scope (Sæbø 1997). This study also implies that prosody plays a role as a "marker" of covert movement.

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