Meaning and Prosody of *Wh*-Indeterminates in Korean

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Abstract

This paper presents an experiment investigating the relative contribution of two different prosodic properties to the interpretation and scope configuration of *wh*-indeterminates in Korean. The experiment shows that it is prosodic phrasing after the *wh*-indeterminate that determines whether it is interrogative or indefinite, while prosodic prominence on the *wh*-indeterminate does not contribute to such a distinction but rather increases the probability of a wide scope reading. The results support a theory that prosodic phrasing is crucial in forming *wh*-questions, and call for consideration of the influence of prosody on scope-taking properties of *wh*-indefinites.

Keywords

intonation, interrogative, indefinite, scope, focus, *wh*-question

1 Introduction

The term *wh-indeterminate* (cf. Kuroda 1965) refers to a class of words that can be used to yield interrogative and indefinite readings, as illustrated in the following Korean example:[1]

(1) *ne* *<u>nwukwu</u>* *cohaha-ni?*
you WH/IND like-Q
i) 'Who do you like?'
ii) 'Do you like anyone?'

[1] A modified Yale system (cf. Martin 1992) with a strict one-to-one mapping between Korean and Roman scripts is adopted for transliterating Korean data in the text of the paper in order to clearly indicate morphosyntactic units. In the annotation of sound files, phonetic transcripts based on IPA are used.

Wh-indeterminates are attested in many languages in the world (Haspelmath 1997), and several cross-linguistic patterns have been observed regarding their properties. One such observation is that the different readings of *wh*-indeterminates are marked by different *prosody*: for an interrogative reading, a prosodic domain is created from the *wh*-indeterminate to the corresponding complementizer by removing the prosodic phrase boundaries between them (cf. Richards 2010), while an indefinite reading does not involve such a 'dephrasing' effect. Another cross-linguistic observation on *wh*-indeterminates is on the relation between their *morphology* when they are used as indefinites and the possible *scope configuration*: indefinites that have the exactly same form as interrogatives (bare *wh*-indefinites henceforth; e.g. *shenme* 'what/something' in Chinese) are fairly limited in their scope configuration, while indefinites that are marked explicitly by attaching a certain affix to the interrogative form (complex *wh*-indefinites henceforth; e.g. *nani* 'what' vs. *nani-ka* 'something' in Japanese) take free scope (Bruening 2007).

Wh-indeterminates in Korean present a challenge to the above two generalizations. First, most of the literature on Korean *wh*-indeterminates has not identified prosodic phrasing as key to their interpretation; rather, *prominence* on the *wh*-word has been noted as the mark of an interrogative reading (e.g. Chang 1973, Choe 1985, Kang 1988, Suh 1989, Kim 2002). Second, there are conflicting judgments on the possible scope configuration of bare *wh*-indefinites in Korean. While some argues that Korean bare *wh*-indefinites can only take narrow scope with respect to other scope-taking elements in the sentence (e.g. Ha 2004), my own empirical observations suggest that they can take wide scope, even out of a scope island such as a conditional clause.

In this paper, I present an experiment which shows that it is prosodic phrasing that distinguishes *wh*-interrogatives from *wh*-indefinites in Korean, and when dephrasing is not accompanied, prominence on the *wh*-word does not induce an interrogative reading but rather increases a possibility of a wide scope indefinite reading. The experimental results in Korean reinforce the importance of creating a prosodic domain for *wh*-questions cross-linguistically, and call for consideration of the influence of prosody in studying the semantics of *wh*-indefinites in other languages.

2 Cross-linguistic generalizations on *wh*-indeterminates and the Korean challenge

2.1 Prosodic disambiguation

Studies on *wh*-indeterminates have noted that the interrogative and indefinite readings are distinguished by prosody (e.g. Chinese: Hu 2002, Dong 2009; Japanese: Ishihara 2002, Deguchi & Kitagawa 2002). One prosodic property that has been cross-linguistically attested as characterizing *wh*-interrogatives is *prosodic phrasing*. Richards (2010: 145) argues that "every language tries to create a prosodic structure for *wh*-questions in which the *wh*-phrase and the corresponding complementizer are separated by as few prosodic boundaries as possible." According to him, *wh*-movement languages achieve this goal by moving the *wh*-word adjacent to its matching complementizer, whereas *wh*-in-situ languages do so by deleting prosodic phrase boundaries between the *wh*-word and the complementizer. He did not develop this argument in the context of disambiguating *wh*-indeterminates, but if dephrasing is the characteristic property of interrogatives as he

argues, the natural expectation is that phrasing should play a crucial role in disambiguating *wh*-indeterminates.

(2) Generalization on prosody based on Richards (2010)
Wh-interrogatives induce prosodic dephrasing up to their corresponding complementizer, while *wh*-indefinites do not.

Since Korean is a head-final, *wh*-in-situ language, it is expected to mark its *wh*-questions by removing prosodic phrase boundaries after the *wh*-word until the end of the interrogative clause (post-*wh* dephrasing henceforth). However, much of the literature has described the *prominence* (especially high pitch) on the *wh*-indeterminate word as the distinctive prosodic property that distinguishes their interrogative use from indefinite use in Korean (e.g. Chang 1973, Choe 1985, Kang 1988, Suh 1989, Kim 2002). A few scholars have noticed that Korean *wh*-interrogatives also involve a dephrasing effect (Cho 1990, Jun & Oh 1996), but the relative significance of prominence and phrasing is yet to be investigated. Moreover, previous discussions on post-*wh* dephrasing have been limited to a local effect. Cho (1990: 56) argues that *wh*-interrogatives "form a phonological phrase with *the following word*," which does not guarantee a complete prosodic domain between a *wh*-word and the complementizer. Jun & Oh (1996)'s experimental results indicate that deleting the Accentual Phrase (AP) boundary between a *wh*-indeterminate and the immediately following word was the most reliably adopted cue to its interrogative reading in production, but their stimuli were limited to sentences in which there was only one word after the *wh*-word in the sentence, thus whether dephrasing includes only the following word or continues to the end of the sentence is obscured. This calls for an experimental

study to investigate how the presence or absence of global post-*wh* dephrasing affects the interpretation of *wh*-indeterminates.

2.2 Scope configuration

It has long been noticed that indefinites take free scope, even out of syntactic islands such as a conditional clause as shown in (3) (e.g. May 1985). When it comes to indefinites with the same form as interrogatives (bare *wh*-indefinites), however, their scope-taking properties are known to be limited (e.g. Chinese: Cheng 1991; Dutch and German: Postma 1994; Russian: Yanovich 2005): only a narrow scope reading ('if > some') is available when they appear in conditional clauses such as (3). On the other hand, indefinites that are derived from interrogatives by attaching an affix (complex *wh*-indefinites) exhibit the same free scope taking property as regular indefinites. Bruening (2007: 159) compares the two types of *wh*-indefinites in a number of languages and presents the following generalization: "*wh*-indefinites that do not include additional morphology are precluded from taking wide scope (and in fact usually take only narrowest scope), but *wh*-indefinites that do include additional morphology may take wide scope and may even be interpreted referentially (as specific indefinites)."

(3) John will be happy if someone comes to the party. (if > some, some > if)

(4) Generalization on scope in Bruening (2007)
a. Bare *wh*-indefinites do not take wide scope.[2] (e.g. if > some, *some > if)
b. Complex *wh*-indefinites can freely take wide scope. (e.g. if > some, some > if)

[2] The term "wide scope" in Bruening (2007) should be interpreted as 'the widest scope' when there are more than two scope-bearing elements in the sentence because an intermediate scope reading is possible for bare *wh*-indefinites (Lin 2004).

Korean was not included in the discussion in Bruening (2007), but it provides an interesting test case because it exhibits both types of *wh*-indefinites (e.g. *nwukwu* 'who/someone', *nwukwu-nka* 'someone'). Ha (2004) argues that in Korean bare *wh*-indefinites cannot take wide scope whereas complex *wh*-indefinites can, which coincides with Bruening's generalization. However, my own judgment and observation suggest that both types of *wh*-indefinites can take wide scope. For example, I have asked 37 linguistically naive Korean speakers to read the sentence (5) and tell if they interpreted it as 'Chelswu will be glad if a specific person comes' or 'Chelswu will be glad if someone comes (it doesn't matter who comes).' The responses summarized in Table 1 indicate that a wide scope reading (some > if) of the bare *wh*-indefinite was indeed possible and even preferred for many speakers, which is an unexpected result according to Ha (2004) and Bruening (2007). This calls for a controlled experiment to investigate the possible scope configurations of bare *wh*-indefinites.

(5) *nwukwu*(*-nka*)*-ka* *o-myen* *Chelswu-ka* *cohaha-lke-ta.*
WH/IND(-IND)-NOM come-if Chelswu-NOM glad-will-DCL
'Chelswu will be glad if someone comes.' (cf. Ha 2004: 92)

Table 1. Judgments on the scope configuration of (5)[3]

Preferred reading / *Wh*-indeterminate	some > if	if > some	Both	Neither	Total
nwukwu	15 (40.5%)	14 (37.8%)	6 (16.2%)	2 (5.4%)	37
nwukwu-nka	12 (32.4%)	19 (51.4%)	6 (16.2%)	0 (0.0%)	37

[3] 'Both' means the preference was equal, and 'neither' indicates that the speakers abstained from making any judgment on it.

3 Experiment

The questions from the previous section are summarized as follows. i) Between prominence and dephrasing, which prosodic factor is crucial in deciding the meaning of the *wh*-indeterminates? ii) Can bare *wh*-indefinites take wide scope? Why are there different judgments on the scope configuration? In the rest of the paper, I will show that the answers to the two kinds of questions are interrelated. Let us first consider regular indefinite expressions such as *some* in English. It has long been reported that stressed and unstressed *some* have different semantic properties that can affect their scopal behaviors (e.g. Milsark 1974, Lohndal 2010), supporting an analysis that stress correlates with a wide scope reading of regular indefinites. Extending this line of analysis from regular indefinites to *wh*-indefinites, I propose the following hypotheses:

(6) Hypotheses
    a. *Prosodic phrasing* determines the *meaning* of *wh*-indeterminates.
    b. *Prosodic prominence* affects the *scope* configuration of *wh*-indeterminates.

Then, conflicting judgments on scope configuration of *wh*-indefinites may be attributed to the lack of prosody in consideration (cf. Fodor 2002). The rest of this section introduces an experiment to test the hypotheses.

3.1 Overview and Predictions

According to the literature on the prosody of Korean *wh*-indeterminates in Section 2.1, *wh*-interrogative prosody involves both pitch raising on the *wh*-indeterminate word and

dephrasing after a *wh*-indeterminate, whereas neither of them are found in *wh*-indefinite prosody. Since these two factors (i.e. *wh-pitch raising* and *post-wh dephrasing*) pattern together in a natural speech, I detached them and created synthesized stimuli to assess their relative contribution. The prosodic factors in the stimuli were manipulated to create a 2x2 design as shown in Table 2, where an upper case acronym indicates the presence of such a property and a lower case acronym indicates the absence. The [rd] contour indicates a canonical indefinite prosody, while [RD] indicates a canonical interrogative prosody. The main purpose of the experiment was to see how listeners interpret the non-canonical cases such as [rD] and [Rd]. The hypothesis (6a) predicts that [rD] must be interpreted as *wh*-questions more often than [Rd]. If *wh*-pitch raising is a more important factor, on the other hand, [Rd] must be interpreted as *wh*-questions more often than [rD].

Table 2. Factors crossed in design of stimuli

		wh-pitch raising	
		no raising (r)	raising (R)
post-wh dephrasing	no dephrasing (d)	rd	Rd
	dephrasing (D)	rD	RD

In addition, the experiment investigated whether scope configuration can be affected by prosody. The hypothesis (6b) predicts that the stimuli with pitch raising on the *wh*-word (coded as having 'R') are perceived as a wide scope reading more often than the stimuli without such pitch raising (coded as having 'r'). The hypothesis should be rejected if there is no difference in perceiving scope configuration whether there is *wh*-pitch raising or not.

3.2 Method

3.2.1 Stimuli

An example stimulus is in (7). A neutral sentence ending was used to render the sentence type ambiguous between assertion and question. A *wh*-indeterminate phrase was placed in a conditional clause, thus three different readings of the sentence were available: a declarative sentence with a narrow scope indefinite or a wide scope indefinite, or a *wh*-question.[4] A yes-no question reading was also available in theory, but that possibility was ruled out in the experiment because all the stimuli in the experiment were kept to have falling intonation at the end of the sentence, while sharp rising sentence-final intonation (H%) is a distinctive property of yes-no questions that contain *wh*-indefinites (Lee 1997).

(7) *i* *yak-ey* *<u>mwe-ka</u>* *tuleka-myen* *wihemhay*
this reagent-LOC WH/IND-NOM get.into-if dangerous
'It is dangerous if something gets into this reagent.' (if > some, some > if)
or 'What is the thing such that it is dangerous if it gets into this reagent?'

A total of twelve sentences in a similar structure were chosen to create the targets of the experiment. The list of all sentences is in the Appendix. They were recorded by a female native speaker of Seoul Korean in her twenties, who had training in linguistics at college. The speaker read written sentences in two different settings. In the first setting, the sentences were presented with a period at the end to facilitate a declarative sentence reading. No further context was provided in this setting in order to induce an utterance that bears no focus on any particular item. In the second setting, the sentences were presented

[4] A *wh*-question reading was available because a conditional clause is not a *wh*-island in Korean.

with a question mark at the end and followed by an answer that facilitated a *wh*-question reading. The recording was conducted in the sound-attenuated booth of the Phonetics Lab at Seoul National University.

Figure 1 presents the pitch tracks of the sentence (7).[5] As argued in the literature, the two readings exhibited prosodic differences in terms of both *wh*-pitch raising and post-*wh* dephrasing across all recorded pairs of sentences. *Wh-pitch raising*: the highest pitch point in the sentence was observed within the *wh*-phrase for the *wh*-interrogative reading, whereas it was observed out of the *wh*-phrase (specifically, on the morpheme *-myen* 'if') for the declarative reading. The highest pitch value in the *wh*-region was also different for the two readings (declarative: 250.3 Hz, *wh*-question: 278.9 Hz on average; paired *t*-test: $p < .001$).[6] *Post-wh dephrasing*: in the declarative reading, each word consisted of one AP, while in the *wh*-question reading, the *wh*-word and all the following words were in the same, large AP, showing less AP tones and smoother pitch contour after the *wh*-word as in Figure 1b.[7]

[5] The annotation follows the K-ToBI convention (Jun 2000) but only surface tones are marked here for simplicity. For the notation of tones, let T indicate L (Low) or H (High) or their combination, then T: AP-initial tone; +T, T+: AP-medial tone; Ta: AP-final tone; T%: IP boundary tone. The AP-final tone in the sentence-final AP is overridden by the IP (Intonation Phrase) boundary tone.

[6] There was no statistically significant difference between the two readings in the *wh*-region in terms of duration or amplitude.

[7] An Accentual Phrase (AP) is manifested by a sequence of tones, THLH (T for L or H) (Jun 1998). All four tones can be fully realized if the AP consists of four or more syllables; otherwise intermediate tones tend not to be realized on the surface.

a. declarative b. *wh*-interrogative

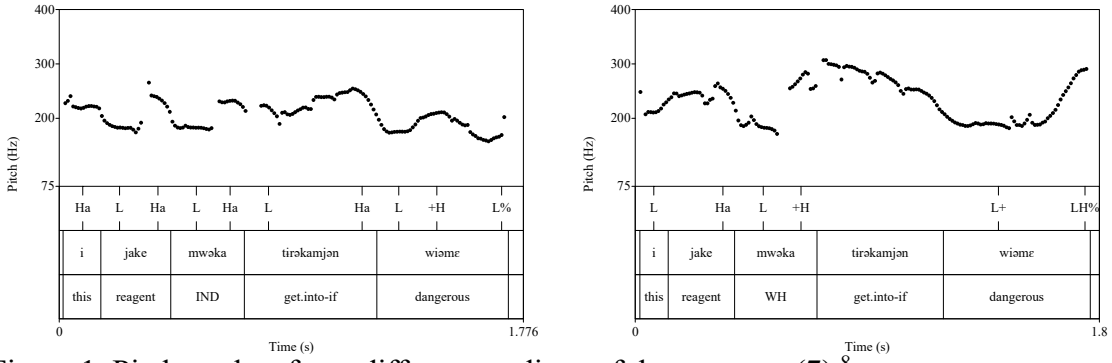


Figure 1. Pitch tracks of two different readings of the sentence (7).[8]

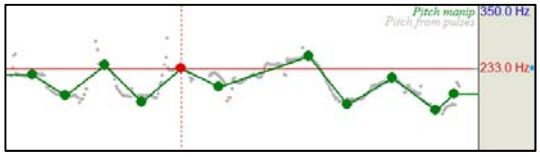
To create the actual stimuli used in the experiment, the recording of declarative sentences was chosen as the base and manipulated with Praat (Boersma 2001), as illustrated in Figure 2.[9] The first type of stimuli (Figure 2a) was created by stylizing the pitch contours to points that represent AP tonal targets (Jun 2005). It was supposed to maintain the overall shape of the base contour. The second type of stimuli (Figure 2b) was obtained by raising the highest pitch point of the *wh*-indeterminate phrase to the same degree as the highest pitch value in the corresponding *wh*-question recorded by the same speaker. As a result, the highest pitch point of the entire sentence fell on the *wh*-indeterminate phrase. While it was created to replicate the effect of pitch raising on the *wh*-phrase, a slight amount of

[8] Two additional differences are observed in Figure 1: The pre-*wh* words belong to separate APs in (a) but the same AP in (b), and the sentence-final tone was L% in (a) but LH% in (b). These differences were not considered in designing the perception experiment because the difference in the pre-*wh* region did not consistently appear in the other sentences, and the choice of sentence-final intonation is known to be rather a tendency and not a decisive factor to tell the type of sentences, except for yes-no questions (Lee 1997). Furthermore, an experimental study in Yun (2015) suggests that the influence of the sentence-final intonation is not as strong as that of prosodic phrasing in perceiving *wh*-questions.

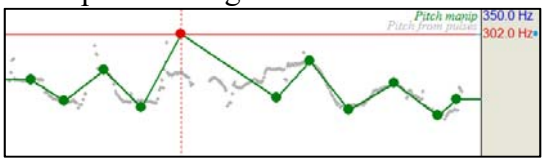
[9] *Wh*-question recordings were used only as a standard for manipulation and not as the actual base of manipulation because creating tonal targets to replicate the declarative prosody is more difficult and results in more unnatural sound than removing tonal targets to replicate the *wh*-question prosody.

manipulation in the post-*wh* region was added: the immediate post-*wh* L tone was moved to a delayed position (i.e. the penultimate syllable of the post-*wh* word) to avoid sharp falling after the pitch peak in the *wh*-indeterminate.[10] The third type of stimuli (Figure 2c) was obtained by erasing pitch points after the *wh*-phrase up to the penultimate syllable of the sentence. It was created to replicate the effect of global post-*wh* dephrasing that deletes post-*wh* AP tones (cf. Jun 1993). The fourth set of stimuli (Figure 2d) was obtained by applying both *wh*-pitch raising and post-*wh* dephrasing as described above. It was created to replicate the canonical intonation pattern of *wh*-questions. The pitch points associated with the last syllable of the sentence remained unchanged across all the stimuli, thus the sentence-final intonation was always kept the same.

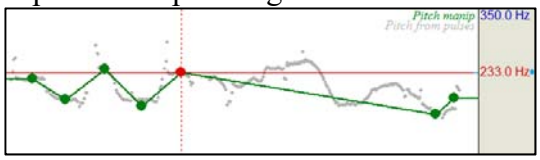
a. base



b. *wh*-pitch raising



c. post-*wh* dephrasing



d. *wh*-pitch raising + post-*wh* dephrasing

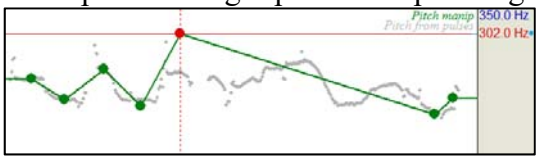


Figure 2. Pitch tracks of auditory stimuli based on the sentence (7). The intersection point of the two guidelines indicates the highest point in the *wh*-indeterminate phrase.

[10] I conducted a pilot study in which this additional manipulation was not employed, and some participants reported that the sharp falling after *wh*-pitch raising made the sentence sound unnatural. It seems because when pitch raising occurs in a natural speech due to focus, it is usually followed by a certain degree of pitch smoothing (cf. Jun & Lee 1998). The additional manipulation brings an effect similar to local post-*wh* dephrasing (i.e. dephrasing effect in the immediate post-*wh* word only), and the implication of this subtle prosodic requirement will be discussed in Section 4.1 in more detail.

3.2.2 Participants

Participants in the experiment were adult native speakers of Korean (N = 57, age > 18), who had lived more than 10 years in Seoul or the vicinity where Seoul Korean is spoken. They were recruited online through various social networking services and volunteered their time (15 minutes on average) without payment. Participation in the experiment was anonymous, but the source of recruitment suggests that participants were mostly college students in Korea, who were different from participants in the informal written survey in Section 2.1.

3.2.3 Procedure

A total of 48 stimuli (12 sentences × 4 intonation types) were created through manipulation, and they were divided into four sets so that each set included all 12 sentences only once in order to avoid presenting the same strings repeatedly.[11] For each set, the 12 target stimuli were arranged in a pseudo-random order and intermingled with 23 filler stimuli. The fillers were sentences containing *wh*-indeterminates in various constructions other than conditional clauses. The filler materials were recorded by the same speaker who produced

[11] The choice of contours of the stimuli in each set was counterbalanced using a modified Latin Square to make all four types appear in each set relatively evenly but not exactly the same number of times:

	[rd]	[Rd]	[rD]	[RD]	Total
Set 1	3	4	2	3	12
Set 2	3	3	4	2	12
Set 3	2	3	3	4	12
Set 4	4	2	3	3	12

the base of the target materials. Five filler sentences were presented at the beginning of the experiment as a training session.

The experiment was delivered through Qualtrics, online survey software. Each participant was randomly but evenly assigned to one of the four sets of stimuli. The stimuli were presented in a self-paced forced-choice task in the following way. For each stimulus, a screen displayed four interactive elements: a button to play the sound of the stimulus, two choice forms to elicit responses, and a button to move to the next stimulus. The participants first pressed the play button to listen to the stimulus using headphones. The stimulus was provided only as sound and no text was given. Then the participants pressed a radio button in the first choice form that was associated with either 'question' or 'statement' to indicate their interpretation of the stimulus. The second choice form appeared only after the participants provided an answer to the first choice form. If they chose 'question' in the first form, the next two choices in the second form were whether it was a yes-no question or a *wh*-question. If they chose 'statement' in the first form, the next two choices were whether it was about a specific entity (i.e. wide scope indefinite) or an arbitrary entity (i.e. narrow scope indefinite). The participants were allowed to listen to the stimulus repeatedly and change their answers freely at any time until they moved to the next stimulus. Figure 3 illustrates the flow of the task, taking the sentence in (7) for example. All materials were presented in Korean during the experiment.

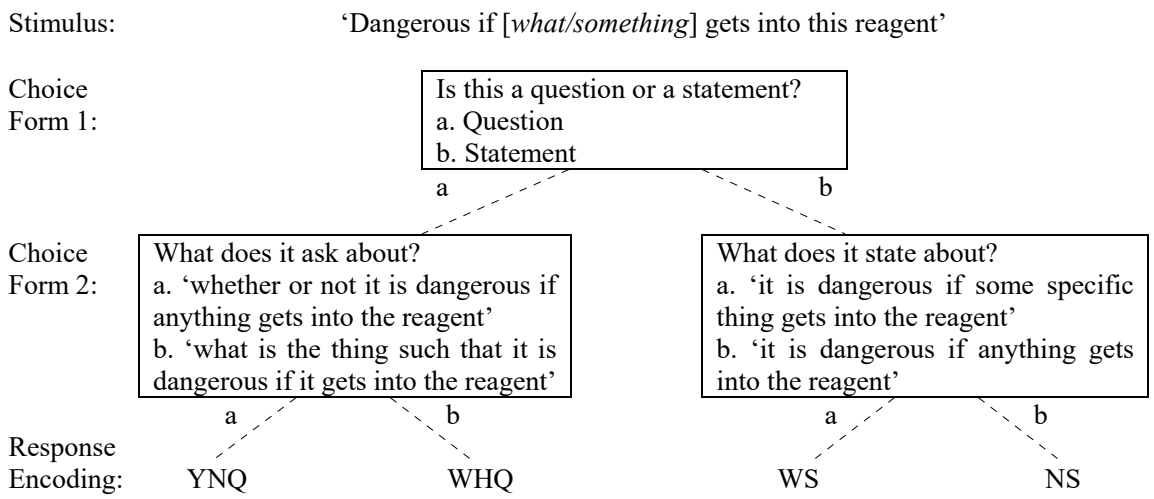


Figure 3. Flow of the forced-choice task.

As shown in Figure 3, the task was in fact choosing among four readings (i.e. yes-no question, *wh*-question, statement with a wide scope indefinite, and statement with a narrow scope indefinite). Instead of presenting the four choices at once, however, I divided them into two groups according to their illocutionary force and added an intermediate step to choose between the two groups so that the participants always made a binary choice. This was to reduce the cognitive load during the experiment and prevent dropout due to the complicated nature of the task.

Since the target stimuli were not expected to receive a yes-no question response because of their final falling intonation as mentioned earlier, the filler stimuli included 9 yes-no questions to balance the response matrix. The yes-no question fillers also served to qualify participants and detect outliers whose responses were suspected to be unreliable (cf. Cowart 1997) because all participants chose the intended reading of yes-no question stimuli quite consistently (90% of the time on average) except for four participants who

recognized yes-no questions less than 50% of the time. The responses from those four participants were excluded in the analysis.[12]

3.3 Results and Analysis

Table 3 presents the number of responses for each intonation type and their percentages rounded up.[13] Responses of a yes-no question were very infrequent (3 out of 636) as expected. Null responses were also rare (4 out of 636) and are excluded in the analyses below.

Table 3. Number of responses for each intonation type

Stimuli	Responses					Total
	Declarative: narrow scope indefinite	Declarative: wide scope indefinite	*Wh*-question	Yes-no question	No Response	
[rd] base contour	114 (73%)	39 (25%)	4 (3%)	0 (0%)	0 (0%)	157 (100%)
[Rd] *wh*-pitch raising	74 (46%)	70 (43%)	16 (10%)	0 (0%)	2 (1%)	162 (100%)
[rD] post-*wh* dephrasing	29 (18%)	25 (16%)	105 (66%)	0 (0%)	1 (1%)	160 (100%)
[RD] *wh*-pitch raising + post-*wh* dephrasing	23 (15%)	34 (22%)	96 (61%)	3 (2%)	1 (1%)	157 (100%)
Total	240	168	221	3	4	636

Meaning of wh-indeterminates (interrogative vs. indefinite): Since all responses except for a *wh*-question response indicate that the *wh*-indeterminates in the stimuli were perceived as indefinite, the proportion of *wh*-question responses was chosen to present in Figure 4 to

[12] The overall response patterns of those four participants were indeed quite different from the general pattern. Two of them never chose questions in their responses, and another never chose statements. The response pattern of the other one was rather arbitrary.

[13] The total number of responses was similar across each intonation type but not exactly the same because the number of participants was not the same for each set (Set 1: 14, Set 2: 15, Set 3: 13, Set 4: 11).

indicate the relation between the intonation type and the meaning of *wh*-indeterminates. The base [rd] contour, which had almost the same contour as a declarative sentence, was rarely interpreted as *wh*-interrogative; it was interpreted as a *wh*-question only 3% of the time (4 out of 157). On the other hand, the [RD] contour, which was obtained by manipulating the base contour to bear two canonical properties of *wh*-questions (i.e. *wh*-pitch raising and post-*wh* dephrasing), was interpreted as a *wh*-question 62% of the time (96 out of 156). When it comes to the stimuli to which only one property of *wh*-questions was added, the [Rd] contour, which had *wh*-pitch raising but lacked post-*wh* dephrasing, was mostly interpreted as involving an indefinite and only 10% of the time was it interpreted as a *wh*-question (16 out of 160), while the [rD] contour, which had post-*wh* dephrasing but lacked *wh*-pitch raising, was interpreted as a *wh*-question 66% of the time (105 out of 159), which is compatible with the results of the [RD] contour. These results are consistent with the hypothesis that post-*wh* dephrasing is the crucial factor in deciding the meaning of *wh*-indeterminates, while *wh*-pitch raising is not.

To assess the statistical strength of the prosodic effects, a logistic mixed-effects model was employed in R (R Core Team 2015) using the *glmer* function from the *lme4* package (Bates et al. 2014). The model predicted *WHQ-response* (WHQ: 1, others: 0) with (*pitch*) *raising*, *dephrasing*, and their interaction as fixed effects (R: 0.5, r: -0.5, D: 0.5, d:-0.5). The model also included random intercepts for *subject* and *item* as well as random slopes for *raising* by *subject*, which was the maximal random effects structure justified by the data (Baayen et al. 2008). Table 4 presents the result of logistic regression. The model confirms that *dephrasing* predicted *WHQ-response* ($p < .001$), while there was no main

effect of *raising* ($p = .142$). Rather, the interaction between *raising* and *dephrasing* reached statistical significance ($p < .05$), which indicates that *raising* lowered the probability of WHQ interpretations when it combined with *dephrasing*.[14]

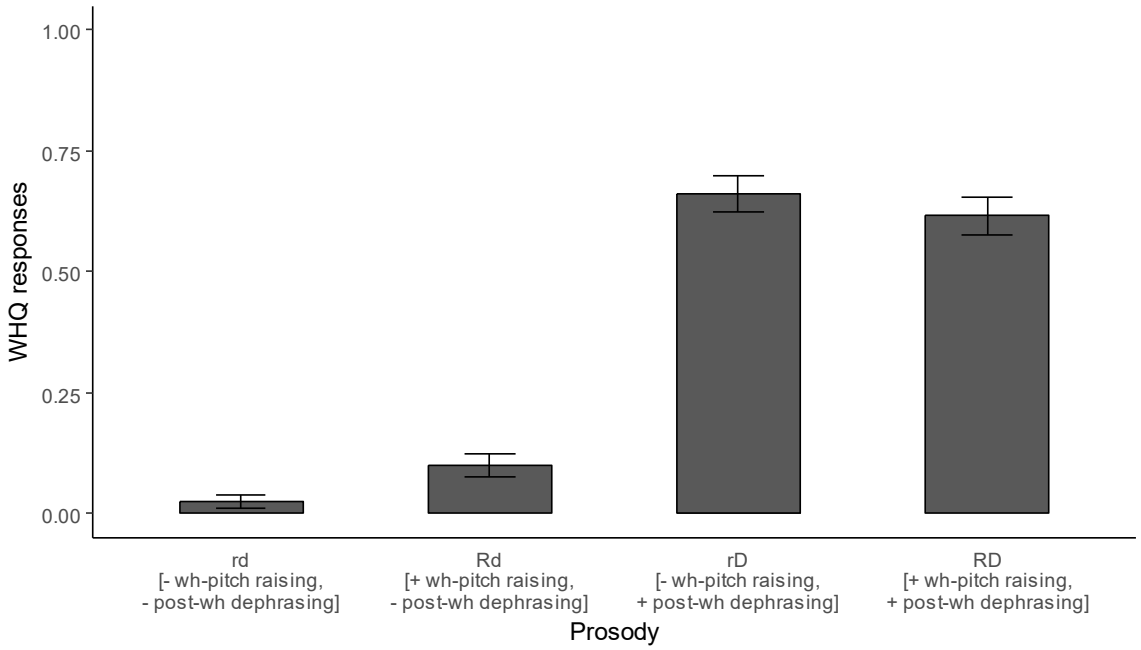


Figure 4. Proportion of *wh*-question responses for each intonation type.

Table 4. Logistic mixed-effects model on *wh*-question responses

Predictor	β	SE(β)	z	$p > \|z\|$
(*intercept*)	-1.57	0.40	-3.91	
raising	0.53	0.36	1.47	.142
dephrasing	4.77	0.43	11.01	< .001
raising:dephrasing	-1.77	0.77	-2.30	.022

[14] This interaction reflects a rather unexpected result that the WHQ-response rate for the [RD] contour was lower than that for the [rD] contour. Another perception study of synthesized speech in Korean (Yun & Lee, in press) reports a similar case where *wh*-indeterminates were interpreted as interrogatives more often when the overall pitch contour of the sentence was closer to a straight line. Since a straight contour implies no phrasing boundaries and no prominence in terms of pitch, this provides another piece of evidence for the argument that what is crucial for a WHQ reading is dephrasing, not pitch raising.

Scope of wh-indefinites (wide vs. narrow): To see the effect of intonation on the scope configuration of *wh*-indefinites, the declarative responses are separated out and their scope readings are presented in Table 5. The base [rd] contour received wide-scope indefinite responses 25% of the time (39 out of 153), whereas the wide scope ratio of the *wh*-prominent [Rd] contour was as high as 49% (70 out of 144). A similar positive correlation between *wh*-pitch raising and wide scope interpretation was observed for the stimuli involving dephrasing, as the wide scope ratio was 46% (25 out of 54) for the [rD] contour but 60% (34 out of 57) for the [RD] contour. Figure 5 presents the proportion of wide-scope indefinite responses out of the declarative responses.

Table 5. Number of declarative responses for each intonation type

Response	Stimuli				Total
	[rd]	[Rd]	[rD]	[RD]	
NS	114 (75%)	74 (51%)	29 (54%)	23 (40%)	240
WS	39 (25%)	70 (49%)	25 (46%)	34 (60%)	168
Total	153 (100%)	144 (100%)	54 (100%)	57 (100%)	408

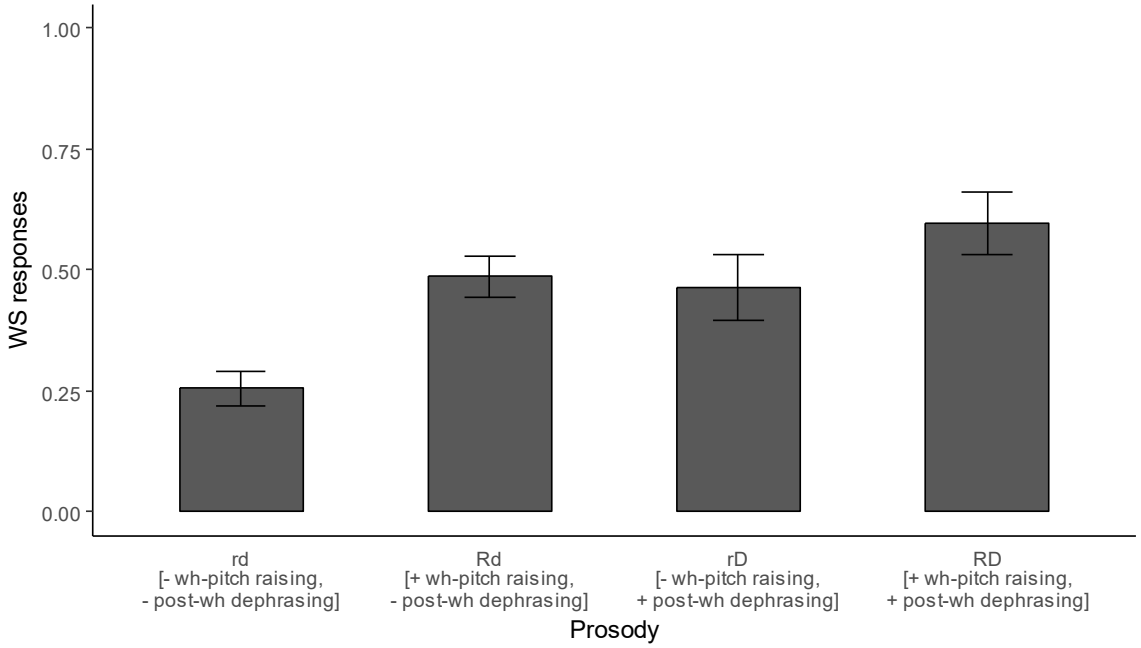


Figure 5. Proportion of wide scope responses out of declarative responses for each intonation type.

Table 6 presents the estimation of a logistic mixed-effects model, which predicted *WS-response* (WS: 1, NS: 0) with the same fixed and random effects as the previous model.[15] The model confirms that there was a significant and positive main effect of *raising* ($p < .01$). The main effect of *dephrasing* was also significant and positive ($p < .001$), while the interaction of *raising* and *dephrasing* was not statistically significant ($p = 082$).[16]

[15] The same random effects were proved to be the maximal random effects structure by a series of likelihood tests.

[16] The effect of dephrasing in scope configuration was not part of the hypothesis (6). A possible explanation (p.c. Michael Wagner) is that post-*wh* dephrasing could enhance the prominence of the *wh*-indeterminate because if all the post-*wh* words lose their AP tones due to dephrasing, the *wh*-word would become perceptually more prominent even if it does not receive high pitch (see Figure 2c). If this is the case, the higher WS rate for the stimuli with dephrasing would still be attributed to the prominence of *wh*-indeterminate.

Table 6. Logistic mixed-effects model on wide-scope indefinite responses

Predictor	β	SE(β)	z	$p > \|z\|$
(*intercept*)	-0.12	0.45	-0.26	
raising	1.01	0.37	2.76	.006
dephrasing	1.32	0.35	3.80	< .001
raising:dephrasing	-1.10	0.63	-1.74	.082

4 Discussion

4.1 Post-wh dephrasing

While a typical *wh*-question contour bears both *wh*-pitch raising and post-*wh* dephrasing, the experimental results indicate that it is only dephrasing that contributes to the perception of a *wh*-question. The stimuli in which the *wh*-indeterminate was boosted but not followed by dephrasing until the end of the sentence were interpreted as *wh*-questions only 10% of the time. On the other hand, the stimuli involving post-*wh* dephrasing received *wh*-question interpretations more than 50% of the time, regardless of whether they involved *wh*-prominence or not.[17]

The experimental results also suggest that post-*wh* dephrasing should be global. Recall that the second set of stimuli (i.e. the [Rd] contour) in the experiment involved not only an expanded pitch range on the *wh*-word but also a slight deviation from the base in the post-*wh* region (i.e. delayed appearance of the post-*wh* L tone). This additional manipulation amounts to a local dephrasing effect because the post-*wh* L tone could have

[17] The percentage of *wh*-question responses to all dephrasing stimuli was 64% (201 out of 315), which is higher than 50% but yet far lower than 100%. Possible reasons why dephrasing did not induce more *wh*-question responses include the following: First, manipulating only the pitch contour might have left other phrasing cues to indefinites in the base recording (such as voicing and segment quality; see Jun 1993). Second, the sentence-final intonation was kept as L% for the entire stimuli to simplify the experiment design but the most frequent sentence-final tone for *wh*-questions is LH% (Jun & Oh 1996). Although L% is possible for *wh*-questions (Jun & Oh 1996, Lee 1997), the use of this non-canonical tone could have lowered the *wh*-question response rate.

marked the beginning of a separate Accentual Phrase if it was not delayed. However, the stimuli manipulated in this way were still interpreted as indefinites 90% of the time. In other words, the results suggest that post-*wh* dephrasing should continue up to the complementizer.

If prominence does not contribute to identifying *wh*-interrogatives in perception, why does typical *wh*-question prosody involve pitch raising of the *wh*-word in production? If we accept the argument that a *wh*-indeterminate word receives the focus of the sentence when it is used as an interrogative (Deguchi & Kitagawa 2002), *wh*-interrogatives are likely to share a prosodic characteristic of focus. Considering a cross-linguistic observation that expanded pitch range is a common property of focus prosody (Flemming 2008), we can think of the boosted pitch on *wh*-interrogatives as an indicator of their focus feature rather than their interrogative feature. Interestingly, there have been observations that focus also induces a certain degree of dephrasing effect (Jun & Lee 1998). However, the status of dephrasing in focus prosody seems rather auxiliary than crucial, unlike in *wh*-interrogative prosody, since post-*wh* dephrasing is consistently observed (Jun & Oh 1996) but post-focus dephrasing is rather optional (Jun & Lee 1998) in Korean.

The apparent similarities of focus prosody and *wh*-prosody have also been observed in Japanese (e.g. Deguchi & Kitagawa 2002, Ishihara 2002), where both involve boosting the pitch on the target word and removing the lexical accents on the following words. However, Sugahara (2005) shows that prosodic phrase boundaries are still observed after a focused item, which suggests that dephrasing is not a necessary property in focus prosody, but rather a side effect of post-focal pitch range compression. In sum, it seems

that focus prosody involves a gradual change of increasing pitch range on the focused item, whereas *wh*-prosody involves a categorical change of deleting post-*wh* AP tones (in Korean) or post-*wh* lexical accents (in Japanese).[18] Further investigation on the interaction of focus prosody and *wh*-prosody in production remains a task for future research.

4.2 Prominence of wh-indefinites

The experimental results show that prosody can affect the scope configuration of *wh*-indefinites in Korean. For the base stimuli which were obtained by recording declarative sentences without any particular prominence on any word, 75% of the declarative responses indicated a narrow scope indefinite reading (114 out of 153). This suggests that there is a baseline preference for a narrow scope reading for bare *wh*-indefinites in Korean when they are not prosodically prominent. This may explain an impressionistic observation that Korean bare *wh*-indefinites do not take wide scope as in Ha (2004), since a default prosodic contour tends to influence the syntactic judgment (Fodor 2002). Yet, the results also indicate that 25% of the responses preferred a wide scope indefinite reading even without prominence on the *wh*-word. Furthermore, when the *wh*-word was boosted, the wide scope response rate became significantly higher (49%; 70 out of 144).[19] Thus, we can conclude that a wide scope reading is available for Korean bare *wh*-indefinites, and prominence on the *wh*-word increases the possibility of a wide scope reading.

[18] A dialectal variation also supports the argument that focus prosody and *wh*-interrogative prosody are not the same. Hwang (2011) notes that in Kyungsang Korean, post-focus prosody is realized as pitch range reduction while post-*wh* prosody is realized as high plateau.

[19] The narrow scope response ratio for the *wh*-raised stimuli was still high (51%), but this does not mean that the participants who made those responses considered that a wide scope indefinite reading was impossible, since it was a forced-choice task to indicate a *preferred* reading.

What is the cross-linguistic implication of the above conclusion? Recall that many languages have been argued to restrict their bare *wh*-indefinites to a narrow scope interpretation (e.g. Bruening 2007). The experimental results suggest that prosodic prominence can have a similar effect to a morphological affix in deciding scope configuration in that they both make *wh*-indefinites able to take scope freely. If there are languages that never allow a wide scope reading of bare *wh*-indefinites, it might be the case that such languages have a prosodic constraint that bare *wh*-indefinites are never realized as prominent. Indeed, bare *wh*-indefinites in many languages have been reported to be prosodically unmarked or reduced (e.g. Classical Greek: Haspelmath 1997; Mandarin Chinese: Hu 2002, Dong 2009). More evidence for the correlation between prosodic prominence and scope configuration of *wh*-indefinites is likely to be found in other languages.

5 Conclusion

This article has provided empirical and experimental observations in support of the following two arguments. First, in deciding the meaning of a *wh*-indeterminate in Korean, post-*wh* dephrasing is a crucial factor while pitch raising on the *wh*-word is not. The experimental results in this paper coincide with the argument in Cho (1990) and Jun & Oh (1996) that *wh*-questions crucially involve dephrasing after the *wh*-word in Korean, and further suggest that the dephrasing effect should be a global one that continues up to the corresponding question complementizer. The results also support a theory that creating a

prosodic domain between a *wh*-word and the corresponding complementizer is cross-linguistically crucial in forming *wh*-questions (Richards 2010).

Second, Korean bare *wh*-indefinites can take wide scope even out of a scope island, and the island-escaping property is further strengthened when the *wh*-indefinite receives prosodic prominence. The experimental results urge to reconsider the cross-linguistic generalization that bare *wh*-indefinites cannot take wide scope (Bruening 2007), and calls for experimental studies in other languages to investigate whether their bare *wh*-indefinites can receive prosodic prominence, and if so, whether the prosodic prominence enhances a wide scope reading.

6 Appendix

The twelve sentences used as the target stimuli are listed below. Each sentence is paired with its literal translation, while the actual interpretation is highly ambiguous as in (7) due to *wh*-indeterminates, the neutral sentence ending, and rampant *pro*-drop in Korean.

1. *ku* *yak-ey* *mwe-lul* *neh-umyen* *nolaycye*
   that reagent-LOC WH/IND-ACC put-if turn.yellow
   'That reagent will turn yellow if *pro* puts [what/something] in it'

2. *kuke* *eti* *mwutenoh-umyen* *ancenha-l ke katha*
   that.thing WH/IND bury-if safe-MOD
   'It is likely to be safe if *pro* buries that thing [where/somewhere]'

3. *nayngcangko* *an-ey* *mwe-ka* *manh-umyen* *naymsayna*
   refrigerator inside-LOC WH/IND-NOM abundant-if smell
   'It smells if there is too much of [what/something] in the refrigerator'

4. *minwu-ka* *eti-l* *ka-myen* *konlanhay*
Minwu-NOM WH/IND-ACC go-if problematic
'It will be a problem if Minwu goes [where/somewhere]'

5. *yengwu-nun* *nwukwu* *manna-myen* *nul* *kincanghay*
Youngwu-TOP WH/IND meet-if always nervous
'Youngwu always gets nervous if he meets [who/someone]'

6. *olhay* *eti* *ciwenha-myen* *cal* *toy-l ke katha*
this.year WH/IND apply-if well go-MOD
'It is likely to go well if *pro* applies [where/somewhere] this year'

7. *yunanun* *nwuka* *o-la-ko ha-myen* *o-l ke katha*
Yuna-TOP WH/IND.NOM come-IMP-say-if come-MOD
'Yuna is likely to come if [who/someone] tells her to come'

8. *i* *kikyey-nun* *eti-l* *nwulu-myen* *caktonghay*
this machine-TOP WH/IND-ACC press-if work
'This machine will work if *pro* presses [where/somewhere]'

9. *i* *pyeng-un* *mwe-lul* *mek-umyen* *naa*
this illness-TOP WH/IND-ACC eat-if cured
'This illness will be cured if *pro* eats [what/something]'

10. *i* *yak-ey* *mwe-ka* *tuleka-myen* *wihemhay*
this reagent-LOC WH/IND-NOM get.into-if dangerous
'It is dangerous if [what/something] gets into this reagent'

11. *ike* *nwukwu* *cwu-myen* *coh-ul ke katha*
this.thing WH/IND give-if good-MOD
'It will apparently be good if *pro* gives this to [who/someone]'

12. *intheneys-eyse* *nwukwu-l* *yokha-myen* *caphyeka*
Internet-LOC WH/IND-ACC badmouth-if arrested
'*Pro* will be arrested if *pro* speaks ill of [who/someone] on the Internet'

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