Meaning and Prosody of *Wh*-Indeterminates in Korean

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This article 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 interpreted as interrogative or indefinite. Prosodic prominence on the *wh*-indeterminate does not contribute to such a distinction; rather, it increases the possibility of a wide scope reading. The results support the 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* (see 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) Ne **nwukwu** cohaha-ni?[1]
    you WH/IND   like-Q[2]
    a. 'Who do you like?'
    b. 'Do you like anyone?'

Wh-indeterminates are attested in many languages in the world (Haspelmath 1997), and several crosslinguistic 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 that spans the *wh*-indeterminate and the corresponding complementizer is created by removing the prosodic phrase boundaries between them (Richards 2010),

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

    [2] The following abbreviations are used in this article: ACC = accusative case, DCL = declarative sentence ending, DCL/Q = neutral sentence ending, LOC = locative case, IND = indefinite marker, NOM = nominative case, TOP = topic, Q = question ending, WH/IND = *wh*-indeterminate.

while an indefinite reading does not involve such a "dephrasing" effect. Another crosslinguistic observation on *wh*-indeterminates concerns the relation between their *morphology* when they are used as indefinites and the possible *scope configuration*: indefinites that have exactly the same form as interrogatives (henceforth, bare *wh*-indefinites; 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 (henceforth, complex *wh*-indefinites; 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 2000). Second, there are conflicting judgments on the possible scope configuration of bare *wh*-indefinites in Korean. While some argue 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 article, I present an experiment showing that it is prosodic phrasing that distinguishes *wh*-interrogatives from *wh*-indefinites in Korean. When not accompanied by dephrasing, prominence on the *wh*-word does not induce an interrogative reading; rather, it increases the possibility of a wide scope indefinite reading. The experimental results in Korean reinforce the importance of the prosodic domain of *wh*-questions crosslinguistically and call for consideration of the influence of prosody when studying the semantics of *wh*-indefinites in other languages.

2 Generalizations regarding *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: Deguchi and Kitagawa 2002, Ishihara 2002). One prosodic property that has been crosslinguistically 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 does not develop this argument in the context of disambiguating *wh*-indeterminates; however, 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 regarding 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 (henceforth, post-*wh* dephrasing). However, much of the literature has described the *prominence* (especially high pitch) on *wh*-indeterminates as the distinctive prosodic property that distinguishes their interrogative use from their indefinite use in Korean (e.g., Chang 1973, Choe 1985, Kang 1988, Suh 1989, Kim 2000). A few scholars have noted that Korean *wh*-interrogatives also involve a dephrasing effect (Cho 1990, Jun and 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 the *wh*-word and the complementizer. Jun and Oh's (1996) experimental results indicate that deleting the Accentual Phrase (AP) boundary between a *wh*-indeterminate and the immediately following word is the most reliably adopted cue to an interrogative reading of the *wh*-indeterminate in production. However, Jun and Oh's stimuli were limited to sentences that had only one word after the *wh*-word, a factor that obscured whether dephrasing includes only the following word or continues to the end of the sentence. 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).

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

However, the scope-taking properties of indefinites with the same form as interrogatives (bare *wh*-indefinites) 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 as in (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: "[*W*]*h*-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)."

(4) *Generalization regarding scope in Bruening 2007*
    a. Bare *wh*-indefinites do not take wide scope.[3] (e.g., if > some, *some > if)
    b. Complex *wh*-indefinites can freely take wide scope. (e.g., if > some, some > if)

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[3] The term *wide scope* in Bruening 2007 should be interpreted as '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).

Table 1
Judgments on the scope configuration of (5)

Preferred reading	*some* > *if*	*if* > *some*	Both[a]	Neither[b]	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

[a] *Both* means that the speaker found the two interpretations equally good.
[b] *Neither* indicates that the speaker abstained from making any judgment on (5).

Korean is not discussed in Bruening 2007; however, 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 asked 37 linguistically naive Korean speakers to read the sentence in (5) and say whether 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)

3 Experiment

The questions from section 2 can be summarized as follows: (a) Which prosodic factor is crucial in deciding the meaning of the *wh*-indeterminates: prominence or dephrasing? (b) Can bare *wh*-indefinites take wide scope? Why are there different judgments on the scope configuration of *wh*-indefinites? In the rest of the article, I will show that the answers to these 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 behavior (e.g., Milsark 1974, Lohndal 2010), supporting the 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.

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

Then, conflicting judgments on the scope configuration of *wh*-indefinites can be attributed to the lack of consideration of prosody (see 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 cited in section 2.1, *wh*-interrogative prosody involves both pitch raising on a *wh*-indeterminate and dephrasing after it, whereas neither is found in *wh*-indefinite prosody. Since these two factors (*wh*-pitch raising and post-*wh* dephrasing) pattern together in 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 2 × 2 design as shown in table 2, where an uppercase acronym indicates the presence of a property and a lowercase acronym indicates its absence. The [rd] contour indicates canonical indefinite prosody, while [RD] indicates canonical interrogative prosody. The main purpose of the experiment was to see how listeners interpret the noncanonical cases [rD] and [Rd]. Hypothesis (6a) predicts that [rD] must be interpreted as a *wh*-question more often than [Rd]. If *wh*-pitch raising is the more important factor, on the other hand, [Rd] must be interpreted as a *wh*-question more often than [rD]. In addition, the experiment investigated whether scope configuration can be affected by prosody. Hypothesis (6b) predicts that the stimuli with pitch raising on the *wh*-word (coded as "R") will be perceived as having a wide scope reading more often than the stimuli without such pitch raising (coded as "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 shown in (7). A neutral sentence ending was used to render the sentence ambiguous between an assertion and a question, and 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] In theory, a yes/no question reading was also available; however, that possibility was ruled out in the experiment because all the stimuli were constructed to have falling intonation

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

a. Declarative
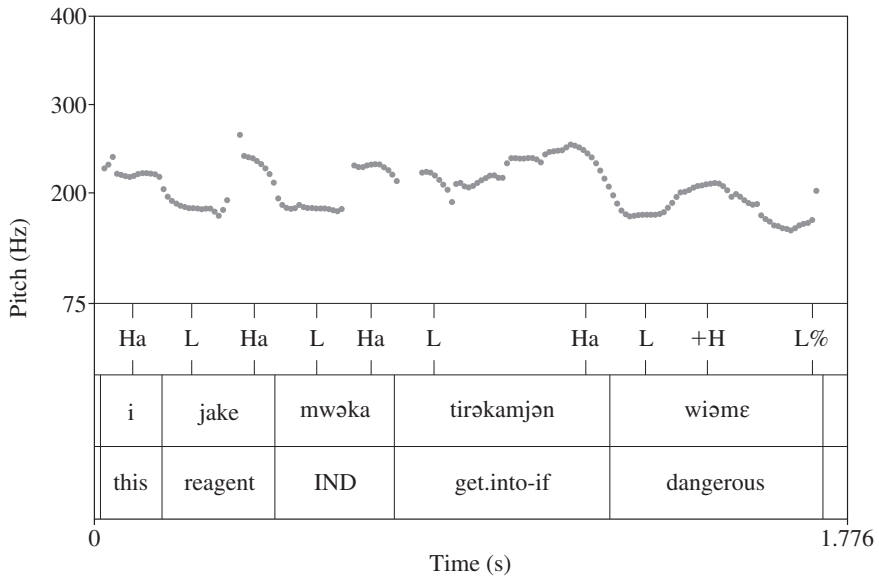
b. *Wh*-interrogative
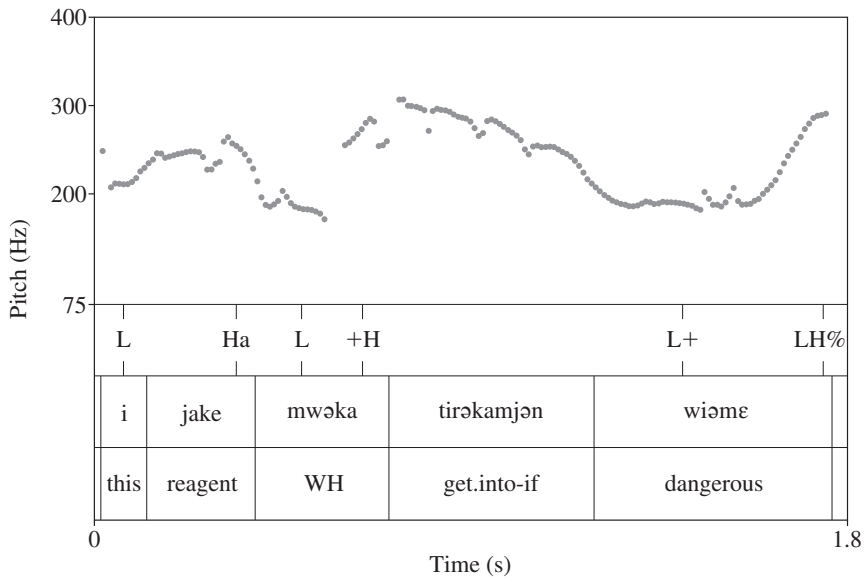
Figure 1
Pitch tracks of two different readings of the sentence (7). The annotation follows the K-ToBI convention (Jun 2000), but for simplicity only surface tones are marked here. For the notation of tones, let T indicate L (Low) or H (High) or their combination. Then T: AP-initial tone; +T, T+: AP-medial tone; Ta: AP-final tone; T%: IP boundary tone. The AP-final tone in the sentence-final AP (Aspectual Phrase) is overridden by the IP (Intonation Phrase) boundary tone.

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   **mwe-ka**   tuleka-myen wihemhay
    this reagent-LOC WH/IND-NOM get.into-if   dangerous.DCL/Q
    '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?'

Stimuli were 12 sentences similar in structure to (7). (For the complete list, see the online appendix at https://www.mitpressjournals.org/doi/suppl/10.1162/ling_a_00318.) They were recorded by a female native speaker of Seoul Korean in her twenties, who had training in linguistics in 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 interpretation. No further context was provided in this setting, in order to induce an utterance that bore no focus on any particular item. In the second setting, the sentences were presented with a question mark at the end and followed by an answer that facilitated a *wh*-question interpretation. The recording was made in the sound-attenuated booth of the Phonetics Lab at Seoul National University.

Figure 1 presents the pitch tracks of the sentence (7). The two readings exhibited prosodic differences in terms of both *wh*-pitch raising and post-*wh* dephrasing across all recorded pairs of sentences.[5] Wh-*pitch raising*: For the *wh*-interrogative reading, the highest pitch point in the sentence was observed within the *wh*-phrase; for the declarative reading, it was observed outside the *wh*-phrase (specifically, on the morpheme *-myen* 'if'). 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 (see figure 1a); in the *wh*-question reading, the *wh*-word and all following words were in the same, large AP, showing fewer AP tones and smoother pitch contour after the *wh*-word (see figure 1b).[7]

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.[8] The first type of stimulus (figure 2a) was created by stylizing the pitch contours to points that represented AP tonal targets (Jun 2005). It was supposed to maintain the overall shape of the

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[5] 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 is L% in (a) but LH% in (b). These differences were ignored in designing the perception experiment because the difference in the pre-*wh* region did not consistently appear in the other stimulus sentences, and because the choice of sentence-final intonation is known to be a tendency and not a decisive factor for identifying the type of sentence, except for yes/no questions (Lee 1997). Furthermore, an experimental study reported in Yun 2015 suggests that the influence of sentence-final intonation is not as strong as that of prosodic phrasing in perceiving *wh*-questions.

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

[7] An 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.

[8] *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 has a more unnatural-sounding result than removing tonal targets to replicate the *wh*-question prosody.

a. Base
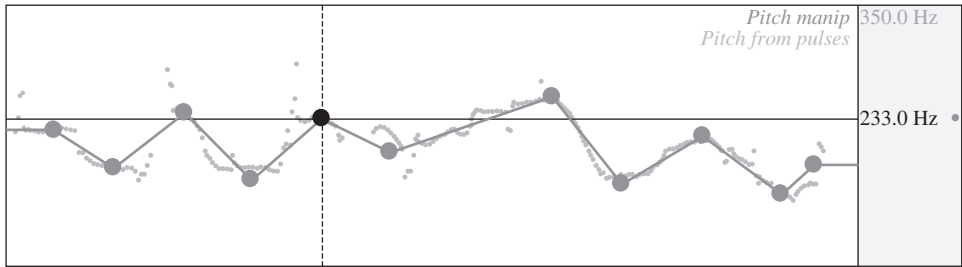
b. *Wh*-pitch raising
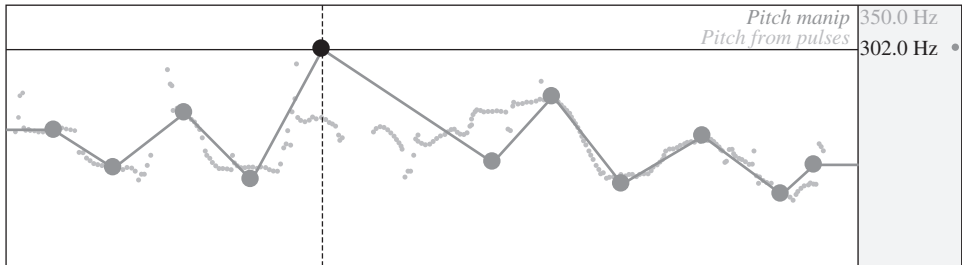
c. Post-*wh* dephrasing
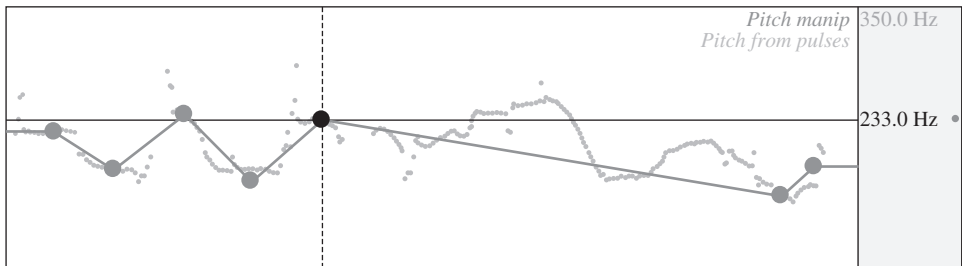
d. *Wh*-pitch raising + post-*wh* dephrasing
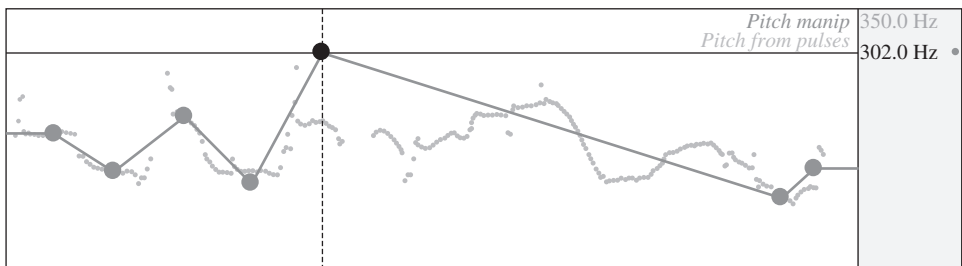
Figure 2
Pitch tracks of auditory stimuli based on the sentence in (7). The intersection point of the two guidelines indicates the point of highest pitch in the *wh*-indeterminate phrase.

base contour. The second type of stimulus (figure 2b) was obtained by raising the highest pitch of the *wh*-indeterminate phrase to the same point as the highest pitch value in the corresponding *wh*-question recorded by the speaker. As a result, the highest pitch point of the entire sentence fell on the *wh*-indeterminate phrase. While this stimulus type was created to replicate the effect of pitch raising on the *wh*-phrase, a slight amount of 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.[9] The third type of stimulus (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 (see Jun 1993 for dephrasing in terms of deleting AP tones). The fourth type of stimulus (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 stimuli; thus, the sentence-final intonation was always kept the same.

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 survey described in section 2.2.

3.2.3 Procedure   A total of 48 stimuli (12 sentences $\times$ 4 intonation types) were created through manipulation, and they were divided into four sets so that each set included only one version of each of the 12 sentences to avoid presenting the same strings repeatedly.[10] For each set, the 12 target stimuli were arranged in a pseudorandom 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 the base of the target materials. Five filler sentences were presented at the beginning of the experiment as a training session.

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[9] I had 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. Apparently, this is because when pitch raising occurs in natural speech due to focus, it is usually followed by a certain degree of pitch smoothing (Jun and Lee 1998). The additional manipulation produces an effect similar to local post-*wh* dephrasing (i.e., a dephrasing effect in the immediate post-*wh* word only); the implication of this subtle prosodic requirement will be discussed in section 4.1.

[10] The contours for the stimuli in each set were counterbalanced using a modified Latin square to make all four contours 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

REMARKS AND REPLIES

The experiment was delivered through Qualtrics (online survey software). All materials were presented in Korean. Using the randomizer of Qualtrics with the Evenly Present Elements option, 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, delivered through headphones. The stimulus was provided only aurally; no text was given. Then the participants pressed an option 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 that the participants saw depended on their response to the first choice form. If they chose Question in the first form, in the second form they were asked to choose whether it was a yes/no question or a *wh*-question. If they chose Statement in the first form, in the second form they were asked to choose whether it was about a specific entity (i.e., a wide scope indefinite) or an arbitrary entity (i.e., a narrow scope indefinite). The participants were allowed to listen to the stimulus repeatedly and change their responses freely at any time until they moved to the next stimulus. Figure 3 illustrates the flow of the task, taking the sentence in (7) as an example.

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 of choosing between the two groups so that the participants always made a binary choice. I did this to reduce the cognitive load during the experiment and prevent dropout due to the complicated nature of the task.

Since (as mentioned earlier) the target stimuli were not expected to receive a yes/no question response because of their final falling intonation, the filler stimuli included nine 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 (see Cowart 1997): 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 from the analysis.[11]

3.3 Results and Analysis

Table 3 presents the number of responses for each intonation type.[12] As expected, yes/no question responses were very infrequent (3 out of 636). Null responses were also rare (4 out of 636) and are excluded from the analyses below.

[11] The overall response patterns of those four participants were indeed quite different from the general pattern. Two participants never chose questions in their responses, and a third never chose statements. The response pattern of the fourth was rather arbitrary.
[12] 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).

| Audio stimulus | 'It is dangerous if [*what/something*] gets into this reagent' |

Choice form 1

> Is this a question or a statement?
> a. Question
> b. Statement

a.   b.

Choice form 2

> What does it ask about?
> a. 'Whether or not it is dangerous if anything gets into the reagent'
> b. 'What is the thing such that it is dangerous if it gets into the reagent'

> What does it make a statement about?
> a. 'It is dangerous if some specific thing gets into the reagent'
> b. 'It is dangerous if anything gets into the reagent'

a.   b.   a.   b.

Response encoding   YNQ   WHQ   WS   NS
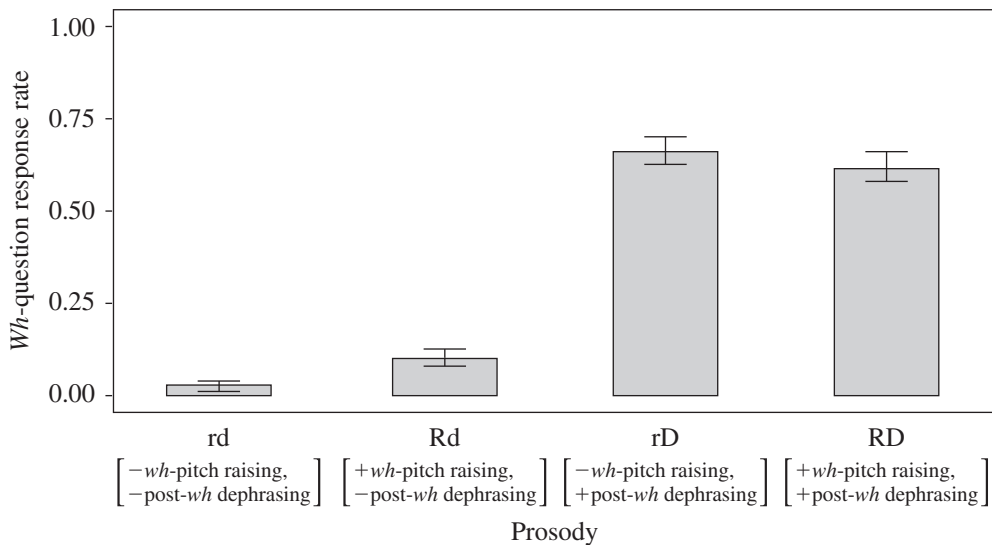
Figure 3
Flow of the forced-choice task. (YNQ = yes/no question; WHQ = *wh*-question; WS = wide scope; NS = narrow scope)

Table 3
Number of responses for each intonation type

Stimuli	Declarative: Narrow scope indefinite	Declarative: Wide scope indefinite	*Wh*-question	Yes/no question	No response	Total
[rd] Base contour	114	39	4	0	0	157
[Rd] *Wh*-pitch raising	74	70	16	0	2	162
[rD] Post-*wh* dephrasing	29	25	105	0	1	160
[RD] *Wh*-pitch raising + post-*wh* dephrasing	23	34	96	3	1	157
Total	240	168	221	3	4	636

3.3.1 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 be presented in figure 4 to 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 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 interpreted as a *wh*-question only 10% of the time (16 out of 160). 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 *wh-question 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, Davidson,

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

and Bates 2008). Table 4 presents the result of the logistic regression. The model confirms that *dephrasing* predicted *wh-question response* ($p < .001$), while there was no main effect of *raising* ($p = .142$). Rather, the interaction between *raising* and *dephrasing* reached statistical significance ($p < .022$), which indicates that *raising* lowered the probability of *wh*-question interpretations when it combined with *dephrasing*.[13]

3.3.2 Scope of Wh-*Indefinites (Wide vs. Narrow)*   To assess the effect of intonation on the scope configuration of *wh*-indefinites, the declarative responses were separated out; their scope readings are presented in table 5. The base [rd] contour received a wide scope indefinite response 25% of the time (39 out of 153), whereas the wide scope ratio of the *wh*-prominent [Rd] contour was considerably higher, 49% (70 out of 144). A similar positive correlation between *wh*-pitch raising and wide scope interpretation was observed for the stimuli involving dephrasing: 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 6 presents the estimation of a logistic mixed-effects model, which predicted *wide scope response* (WS: 1; NS: 0) with the same fixed and random effects as the previous model.[14] The model confirms that there was a significant and positive main effect of *raising* ($p < .006$). The
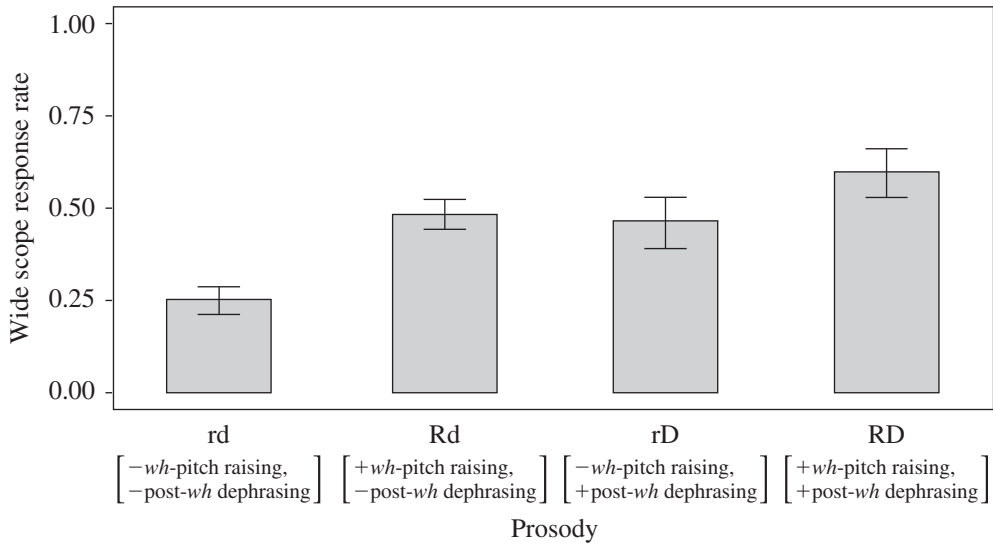
Table 5
Number of declarative responses for each intonation type

	Stimuli				
Response	[rd]	[Rd]	[rD]	[RD]	Total
Narrow scope	114	74	29	23	240
Wide scope	39	70	25	34	168
Total	153	144	54	57	408

[13] This interaction reflects the rather unexpected result that the WHQ-response rate for the [RD] contour was lower than that for the [rD] contour. Another perception study involving synthesized speech in Korean (Yun and Lee to appear) 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 result provides another piece of evidence for the argument that what is crucial for a *wh*-question reading is dephrasing, not pitch raising.
[14] The same random effects were proved to be the maximal random effects structure by a series of likelihood tests.

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

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

main effect of *dephrasing* was also significant and positive ($p < .001$), while the interaction of *raising* and *dephrasing* was not statistically significant ($p = .082$).[15]

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

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

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, whether they involved *wh*-prominence or not.[16]

The experimental results also suggest that post-*wh* dephrasing should be global. Recall that the [Rd] contour stimuli 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 marked the beginning of a separate AP if it had not been 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 and Kitagawa 2002), *wh*-interrogatives are likely to share a prosodic characteristic of focus. Considering the crosslinguistic 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, it has been observed that focus also induces a dephrasing effect, to a certain degree (Jun and Lee 1998). However, the status of dephrasing in focus prosody seems auxiliary rather than crucial, unlike in *wh*-interrogative prosody, since post-*wh* dephrasing is consistently observed (Jun and Oh 1996) but postfocus dephrasing is optional (Jun and Lee 1998) in Korean.

The apparent similarities of focus prosody and *wh*-prosody have also been observed in Japanese (e.g., Deguchi and 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 postfocus pitch range compression. In sum, it seems that focus prosody involves a gradual increase in pitch range on the focused item, whereas *wh*-prosody involves the categorical change of deleting post-*wh* AP tones (in Korean) or post-*wh* lexical accents (in Japanese).[17] Further investigation of the interaction between focus prosody and *wh*-prosody in production remains a task for future research.

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[16] The percentage of *wh*-question responses to all dephrasing stimuli was 64% (201 out of 315), which is higher than 50% 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 L% sentence-final intonation was retained for all stimuli to simplify the experimental design, but the most frequent sentence-final tone for *wh*-questions is LH% (Jun and Oh 1996). Although L% is possible for *wh*-questions (Jun and Oh 1996, Lee 1997), the use of this noncanonical tone could have lowered the *wh*-question response rate.

[17] 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, postfocus prosody is realized as pitch range reduction while post-*wh* prosody is realized as high plateau.

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 that were obtained by recording declarative sentences without particular prominence on any word, 75% of the time, participants who made a declarative response then 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 Ha's (2004) impressionistic observation that Korean bare *wh*-indefinites do not take wide scope, since a default prosodic contour tends to influence the syntactic judgment (Fodor 2002). Yet the results also indicate that 25% of the time, participants 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).[18] Thus, we can conclude that a wide scope reading is available for Korean bare *wh*-indefinites, and that prominence on the *wh*-word increases the possibility of a wide scope reading.

What is the crosslinguistic 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 an effect similar to that of a morphological affix in deciding scope configuration in that they both enable *wh*-indefinites 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 the 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 article coincide with Cho's (1990) and Jun and Oh's (1996) argument 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 the theory that creating a prosodic domain between a *wh*-word and the corresponding complementizer is crosslinguistically 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

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[18] The narrow scope response ratio for the *wh*-raised stimuli was still high (51%); however, 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 asking participants to indicate a *preferred* reading.

prominence. The experimental results urge reconsideration of the crosslinguistic generalization that bare *wh*-indefinites cannot take wide scope (Bruening 2007) and call for experimental studies in other languages to investigate whether their bare *wh*-indefinites can receive prosodic prominence, and if so, whether prosodic prominence enhances a wide scope reading.

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