The Prosodic Structure and Pitch Accent of Northern Kyungsang Korean*

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This study investigates the underlying tonal pattern of pitch accent, tone interaction, focus effects, and the prosodic structure of Northern Kyungsang Korean (NKK) by examining tone-syllable alignment and the realization of pitch accent in different tonal/prosodic contexts. Based on quantitative data, we propose that the underlying tone of pitch accent is H*+L and that the left edge of a prosodic word is marked by a low boundary tone (%L). Our observation, with respect to the tone interaction of different lexical classes, shows evidence in favor of the downstep/upstep account (Kenstowicz and Sohn (1997)), as opposed to the H-tone deletion account (e.g., G.R. Kim (1988)). The data also indicate that surface representations of NKK are sparsely specified for tone.

Most importantly, we found that the prosodic cue of focus differs depending on the location of the pitch accent within a prosodic word. We conclude that the prosodic goal of focus in NKK is in the pitch range expansion of the *focused phrase*, which is implemented by expanding the pitch range of the most prominent word within the phrase, regardless of whether it is the focused word or not.

1. Introduction

Northern Kyungsang Korean (NKK) is a dialect spoken in the northern part of the Kyungsang region (i.e., Southeast region) of Korea. Interestingly, it adopts a completely different system for the use of pitch from Seoul Korean, the standard language in Korea. In Seoul Korean, pitch does not distinguish words, and only phrase-level tones are used (see Jun (1998, 2005) for details on the Seoul Korean prosodic system). In contrast, NKK is a lexical pitch accent language just like Tokyo Japanese, and a certain syllable in a word is lexically marked to be prominent in pitch. For example, in the case of tri-syllabic words, the high tone pitch accent may fall on the word-initial, penultimate, word-final, or the first two syllables of a word. In this paper, these classes will be called Initial, Penult, Final, and Double, respectively. An example word of each class is shown in (1) (pitch accent is marked with an acute accent).

(1) a. Initial: /mé.nu.ɾi/ 'daughter-in-law'

b. Penult: /ə.mú.i/ 'mother'

c. Final: /wə.nə.mín/ 'native speaker'

d. Double: /ó.ɾé.pi/ 'older brother'

Previous studies on NKK tones (G.R. Kim (1988); Chung (1991); Kenstowicz and Sohn (1997); N.J. Kim (1997) and others) focus on the tone interaction of

these different lexical classes. The relevant patterns reported in the previous studies can be summarized as in (2):

(2) In a phrase (word1 + word2) …

a. if word1 ≠ Final, word1 has a higher pitch peak than word2.

b. if word1 = Final and word2 ≠ Double, word2 has a higher peak.

c. if word1 = Final and word2 = Double, word1 has a higher peak.

For the analysis of these patterns, two different mechanisms have been employed in the literature. G.R. Kim (1988) proposes the High tone deletion rules in which the H deletes in word2 for the patterns in (2a,c) but in word1 for (2b). In contrast, Kenstowicz and Sohn (1997) propose the downstep/upstep account under the assumption that the second H is lowered in an H-L-H sequence on the tonal tier but raised in an H-H sequence. Specifically, the HL pitch accent of nonFinal word1 triggers downstep in word2 whereas the H pitch accent of Final word1 triggers upstep if word2 has no L tone preceding the accent H. Otherwise, i.e., if word2 has a pre-accent Low tone, downstep will occur. To explain the difference between the patterns in (2b,c), Kenstowicz and Sohn posit the word-initial L tone only for Double class words.

One difficulty here is that neither analysis is based on an in-depth experimental investigation of NKK tones employing multiple speakers. Thus, it seems necessary to check the empirical validity of the patterns reported in

the previous studies before we consider any formal analysis of NKK tones. Furthermore, since most previous studies were primarily concerned with the analysis of tone interactions at the level of a compound or a relatively short phrase, it is not clear what the domain of tone interactions is and how the domain can fit into the prosodic structure of this dialect.

In this study, we aim at determining the underlying tonal pattern of pitch accent, the tone interaction patterns, the prosodic cues of focus, and the prosodic structure of NKK, based on an experimental investigation of tone-syllable alignment and the realization of pitch accent in different tonal/prosodic contexts. In so doing, we will answer the following questions. What are the prosodic units in NKK? What is the tone type of pitch accent: H*, H*+L, or L+H*? Is the surface representation fully or sparsely specified for tone? Which process is involved in tone interaction: high tone deletion or downstep/upstep? What is the domain for tone interaction? And, finally, how does focus affect prosodic structure and tone interaction?

2. Experiment: Methods

Two main datasets were prepared. In Dataset I, we investigated the characteristic pitch contour for each word class whereas Dataset II was employed to examine the tone interaction of different word classes and focus effects. Specifically, Dataset I included the following four experimental

sentences, in which sentence initial and medial positions were filled with words from the different word classes, shown in (1):

(3) a. /mé.nu.ɾi # ə.mú.i # mánna-ninteje/[1] 'Daughter-in-law is meeting Mother'

b. /ə.mú.i # mé.nu.ɾi # mánna-ninteje/ 'Mother is meeting Daughter-in-law'

c. /wə.nə.mín # ó.ɾé.pi # mánna-ninteje/ 'A native speaker is meeting Brother'

d. /ó.ɾé.pi # wə.nə.mín # mánna-ninteje/ 'Brother is meeting a native speaker'

The first and second words, underlined above, of each sentence are the subject and object, respectively, of the sentence with no overt case marker.[2] This syntactic structure, i.e., Subject-Object-Verb, was adopted since, according to previous studies on NKK tones (for example, Kenstowicz and Sohn (1997)), a prosodic phrase boundary normally intervenes between the subject and object NPs, and thus the sentence-medial words would initiate a phrase, not being subject to the tone interactions triggered by the preceding words. In this way, we could explore the characteristic pitch contour for both sentence-initial, phrase-initial words and sentence-medial, phrase-initial words.

In Dataset II, a question-answer pair was employed as shown in (4). A sequence of two words (underlined below) is located in the sentence-medial position. Word1 is a possessive form with no overt marker, and word2 is the head noun of the object noun phrase. Word3 is a verb. In the answer sentence, either word1 or word2 is contrastively focused (in boldface below):

(4) Q: /jáŋmi-ka # <u>əmúi</u> # <u>minári</u> # máŋ-na/

word1 *word2* *word3*

Youngmi-Nom mother dropwort eat-Int SE[3]

'Is Youngmi eating the mother's dropwort?'

A: /əncije # jáŋmi-nɨn # **ménuɾi** # minári # məŋ-nʲínteje/

word 1 *word 2* *word3*

No Youngmi-Top daughter-in-law dropwort eat-DPP SE

'No, Youngmi is eating the daughter-in-law's dropwort.'

Here, a sequence of modifier-head noun was adopted since, according to previous studies (for example, G.R. Kim (1988)), such sequences normally belong to the same prosodic phrase, and thus tone interactions would occur between the two words. Thirty-two sentence pairs of this type were employed: 4 word1 classes x 4 word2 classes x 2 (focused word1 or word2). The entire set of experimental sentences of Dataset II is provided in Appendix I.

The experimental sentences were printed on A4 size paper with focused words marked in boldface. These sentences were read in a quiet office by six native speakers of NKK (three males, KTJ, LIH, LSH, and three females, JH, HY, HJ, all in their 20s) and recorded directly into a computer. Ten repetitions of each Dataset I sentence (examples shown in (3)) were made with approximately a twenty-second break after each set of five repetitions. The sentences of Dataset II were read once with a comparable break after each question-answer pair. The productions were digitized at 11kHz, and the pitch track of each utterance was displayed using *PcQuirer* (Scicon R&D). For each target word, two f0 values were measured, namely the f0 maximum in the accented syllable and the f0 minimum preceding the f0 peak. In the few cases where the f0 peak of an accented syllable appeared on the following syllable, the f0 maximum was measured on the syllable where the late peak was realized. When it was difficult to locate the exact point of the f0 maximum or minimum in the pitch track (for example, a low or high plateau), the measurement was made at the mid point of the vowel. When there were double peaks during the vowel, the f0 maximum was measured from the higher peak.

For Dataset I, measurements were taken from eight repetitions (the first repetition in each set of five-repetitions was not measured). In addition to the two datasets, several sentences were collected to test alternative hypotheses about the prosodic structure of NKK.

3. Results and Discussion

3.1. Word level tones

Several observations about the production of sentences in Dataset I can be made. First, every word in NKK starts with a low f0 regardless of its class, as shown in Figures 1-4 of the pitch tracks of the sentences in (3). The f0 gradually reaches its peak on the accented syllable (sometimes on the following syllable) and, except for Final class words, falls down to the minimum during post-accent syllables. Our measurements show that the word-initial low f0 values as well as the peak values are different among the different lexical classes (the measurement points for the low and peak f0 values for each word are marked as "low" and "peak" in Figure 1). Table 1 shows a summary of relevant f0 values from one female subject (JH). Comparable summaries for the other five subjects are shown in Appendix II.

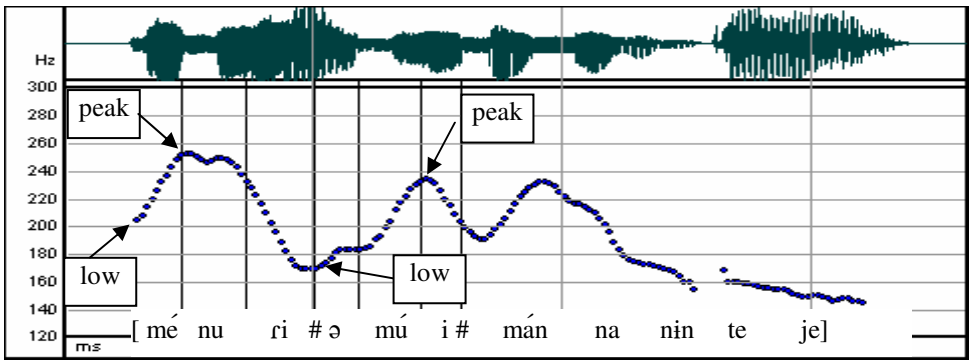


Figure 1: A pitch track of sentence 3a: word1 *Initial* followed by word2 *Penult*

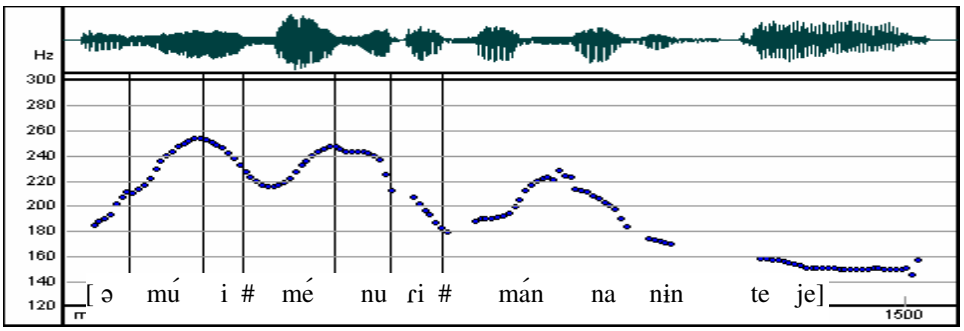


Figure 2: A pitch track of sentence 3b: word1 *Penult* followed by word2 *Initial*

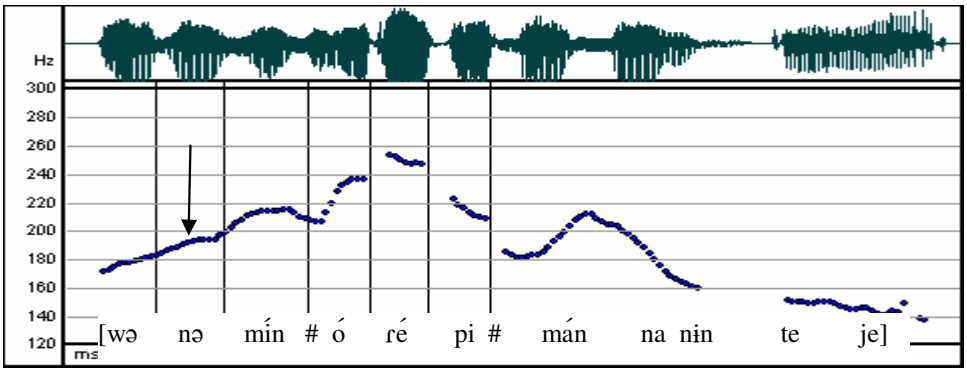


Figure 3: A pitch track of sentence 3c: word1 *Final* followed by word2 *Double*

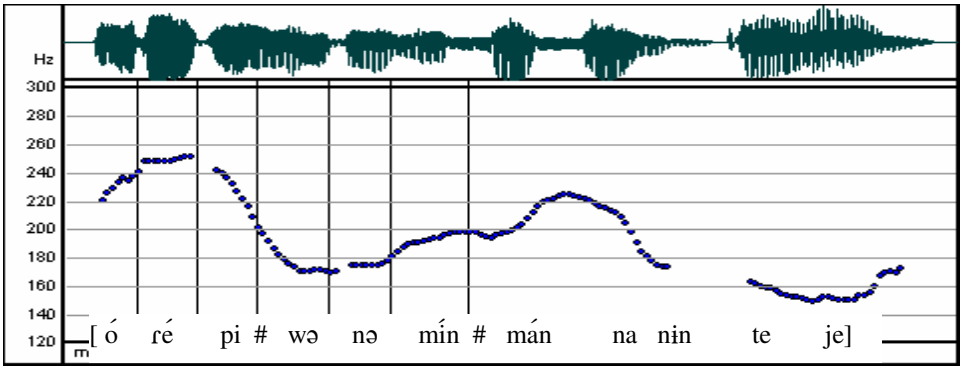


Figure 4: A pitch track of sentence 3d: word1 *Double* followed by word2 *Final*

Table 1: Mean of word-initial Low and Peak f0 values for each word class (subject JH)

	subject position		*object position*	
Word class	Low	Peak	Low	Peak
Initial	211.1 (6.3)	254.6 (4.8)	212.3 (15.4)	248.0 (8.6)
Penult	187.6 (6.1)	253.5 (11.3)	174.1 (5.9)	224.8 (5.7)
Final	180.4 (8.8)	221.4 (6.3)	174.1 (3.7)	194.8 (5.6)
Double	228.9 (15.6)	255.8 (11.4)	225.8 (6.7)	251.8 (5.9)

(unit = Hz; standard deviation is in parentheses)

An analysis of variation (ANOVA) reveals that there is a significant main effect of word class for both Low and Peak values in both sentential positions (subject Low: $F(3, 28) = 39.4124$; subject Peak: $F(3, 28) = 27.3661$; object Low: $F(3, 28) = 66.9144$; object Peak: $F(3, 28) = 125.4283$; $p<.001$ for all F values). This is true for the other five experimental subjects, as well. A post-hoc test (Tukey-Kramer HSD) was carried out to find out which word classes are significantly different from one another. The results of the test for Low values are summarized in Table 2 and those for Peak values are summarized in Table 3.

Table 2: Post-hoc test (Tukey-Kramer HSD) results for word-initial Low f0 values[4]

Subjects	*sentential positions*	*significant differences (indicated by >)*
KTJ	subject	Double > Initial > Penult, Final
	object	Double > Initial > Penult, Final
LIH	subject	Double, Initial > Final, Penult
	object	Initial > Penult, Final
LSH	subject	Double > Initial > Penult > Final
	object	Double, Initial > Final, Penult
HY	subject	Double > Initial > Penult > Final
	object	Double > Initial > Penult > Final
HJ	subject	Initial > Penult, Final
	object	Double > Initial > Final, Penult
JH	subject	Double > Initial > Penult, Final
	object	Double > Initial > Penult, Final

Notice that the values are significantly higher for Initial and Double class words than for Final and Penult words. There is no exception to this pattern. The higher f0 values for Low in Initial and Double class words suggest a partial undershoot of the word-initial L tone when the word-initial syllable has pitch accent. Since every prosodic word begins with a low f0 and rises to a peak, we propose that the L tone is associated with the left edge of a prosodic

word. (The reason why this L boundary tone belongs to a prosodic word, not a prosodic phrase, will be clear in section 3.2 when we discuss downstep cases in which the word-initial low f0 can be observed even phrase-medially.)

Table 3: Post-hoc test (Tukey-Kramer HSD) results for Peak f0 values

subjects	*sentential positions*	*significant differences (indicated by >)*
KTJ	subject	Double > Initial > Final > Penult
	object	Double, Initial > Penult > Final
LIH	subject	Double, Penult, Initial > Final
	object	Initial > Penult > Final
LSH	subject	Double > Initial, Penult > Final
	object	Initial, Double, Penult > Final
HY	subject	Double, Initial > Penult > Final
	object	Double > Initial > Penult > Final
HJ	subject	Initial, Penult > Final
	object	Double > Initial > Penult > Final
JH	subject	Double, Initial, Penult > Final
	object	Double, Initial > Penult > Final

One prominent tendency shown in Table 3 is that the peak f0 values of Final words are the lowest among the different word classes. There is only one exception, speaker KTJ's production in the subject position, in which the peak

value of Final words is higher than that of Penult words although it is still lower than that of Double and Initial words. This asymmetric tendency has also been reported in Chang (2002).

A possibly related observation, mentioned above, is that the f0 after the pitch accent peak falls during the post-accent syllables before the end of the word, suggesting an underlying L tone as a trailing tone of the pitch accent. As in the case with the word-initial Low tone, this trailing Low tone might be undershot when there is no material after the pitch accent as in the Final class word. In fact, the underlying presence of the trailing Low tone was proposed in previous studies (Kenstowicz and Sohn (1997); N.J. Kim (1997); Chang (2002)), based on the fact that when the accented syllable of a Final word becomes non-final by adding a suffix, the Final word behaves like nonFinal words in triggering downstep (or H tone deletion). Kenstowicz and Sohn (1997) further proposed that the underlying tone of pitch accent is HL and that the L tone deletes for Final words at the lexical level (although the L deletion is blocked in the case of di-syllabic Double class words with no post-accent syllables).

The question is then whether the trailing L tone in HL is indeed associated with the pitch accented syllable, i.e., H*+L, or rather is the f0 fall after the peak due to the word-final low boundary tone (L%) or the word-initial low boundary tone of the following word (%L). To resolve this issue, we examined sentences including words with different numbers of post-accent syllables, ranging from one to four, while keeping the rest of the sentence the

same. (5) shows examples where the subject NP, underlined, varied in the number of post-accent syllables. The sentences mean 'Subj. NP is eating dropwort'.

(5) a. [<u>má.ɾ-i</u> # mináɾi # məŋnʲínteje][5]

b. [<u>jə́ŋ.mi-ka</u> # mináɾi # məŋnʲínteje]

c. [<u>jə́ŋ.ma.ni-ka</u> # mináɾi # məŋnʲínteje]

d. [<u>jə́ŋ.ma.ni-ne-ka</u> # mináɾi # məŋnʲínteje]

These sentences were read by five out of the six subjects (JH, HJ, HY, KTJ, LIH) who produced the main datasets. Figures 5-8 show pitch tracks of the sentences in (5a-d), respectively, produced by Subject JH. When word1 has one or two post-accent syllables as in (5a,b), the minimum f0 value after the accent peak was shown during the 1st syllable of word2, /mi.ná.ɾi/. This was true of all subjects except for LIH's production of (5b), where the f0 minimum was shown during the final syllable of word1, /jə́ŋ.mi-ka/. More variations among speakers were found in the production of (5c,d). For Subjects JH and HJ, the f0 minimum was shown during the 4th syllable of word1, i.e., the third syllable from the peak, as can be seen in Figures 7-8. HY's production of (5d) also showed the f0 minimum during the 4th syllable of word1, but her production of (5c) showed the f0 minimum during the third syllable of word1.

KTJ and LIH produced word1 of (5c,d) as /jəŋ.má.ni-ka/ and /jəŋ.má.ni-ne-ka/, locating pitch accent on the second, not first, syllable, and the f0 minimum was shown at the end of the 4th syllable of word1, i.e., the second syllable from the peak. It seems that in general the post-accent L tone is realized on the second or third syllable from the peak. Thus, when the accent peak is on the penultimate syllable of a word, the f0 value of the word final syllable is fairly high, i.e., undershoot of L, as marked with an arrow in Figure 5, and when there are three or more syllables between the accented syllable and the word boundary, a low plateau can be seen, as marked with an arrow in Figures 7-8. If the post-accent pitch fall of word1 were triggered by a boundary L tone marking the end of word 1 or the beginning of word2, we would expect an interpolation of f0 between the accent peak of word1 and the word boundary. The observed low plateau in Figures 7-8 and the even lower f0 value on the initial syllable of word2 in Figures 5-6 suggest that the post-accent Low tone has its own tonal target separate from the word initial Low boundary tone. Furthermore, the fact that the realization of this Low tone is constrained by the number of syllables after the Peak (i.e., two or three syllables away from the Peak) suggests that this Low tone is part of the pitch accent.[6]

The existence of the post-accent Low tone can also be supported by the greater prominence of nonFinal words compared to the Final words where the post-accent Low tone is not realized. As shown in Japanese (Beckman and

Pierrehumbert (1986)), the post-accent Low tone, i.e., the trailing L tone of the pitch accent H*+L, has the effect of raising the peak.[7]

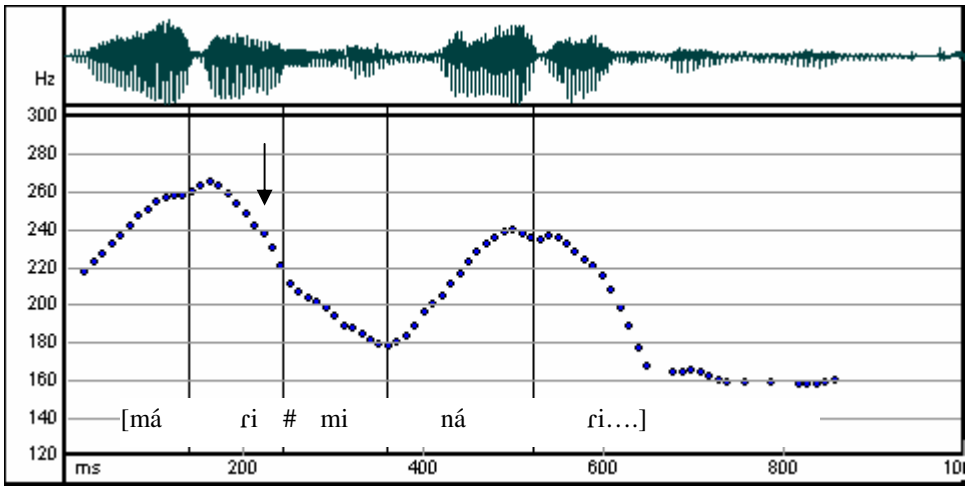


Figure 5: A pitch track of sentence 5a, which has a single post-accent syllable (subject JH)

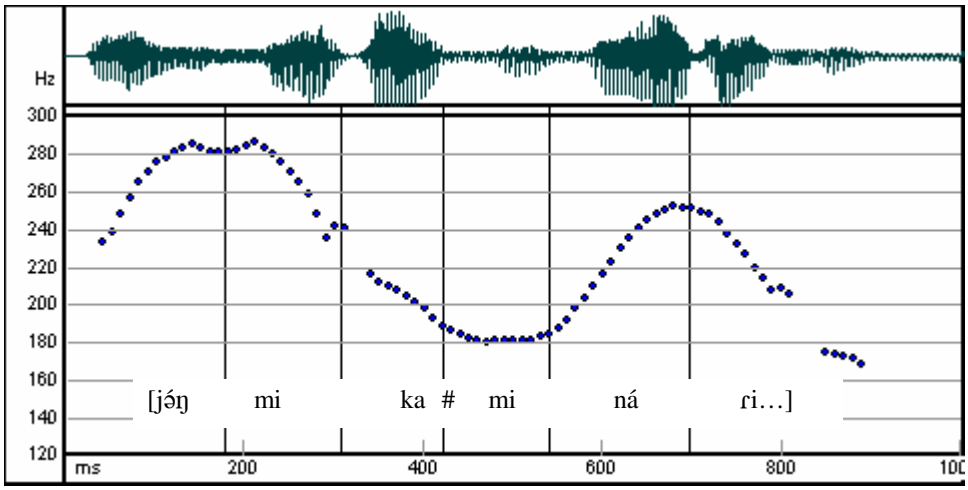


Figure 6: A pitch track of sentence 5b, which has two post-accent syllables (subject JH)

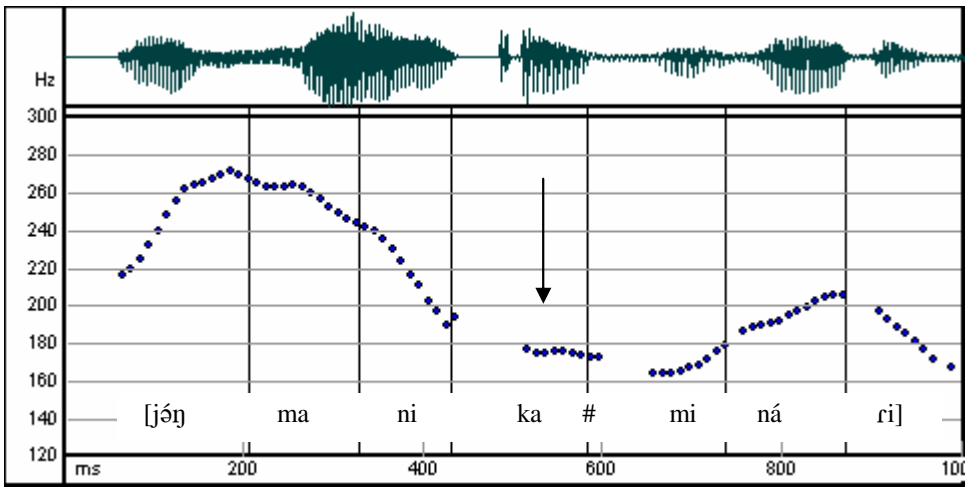


Figure 7: A pitch track of sentence 5c, which has three post-accent syllables (subject JH)

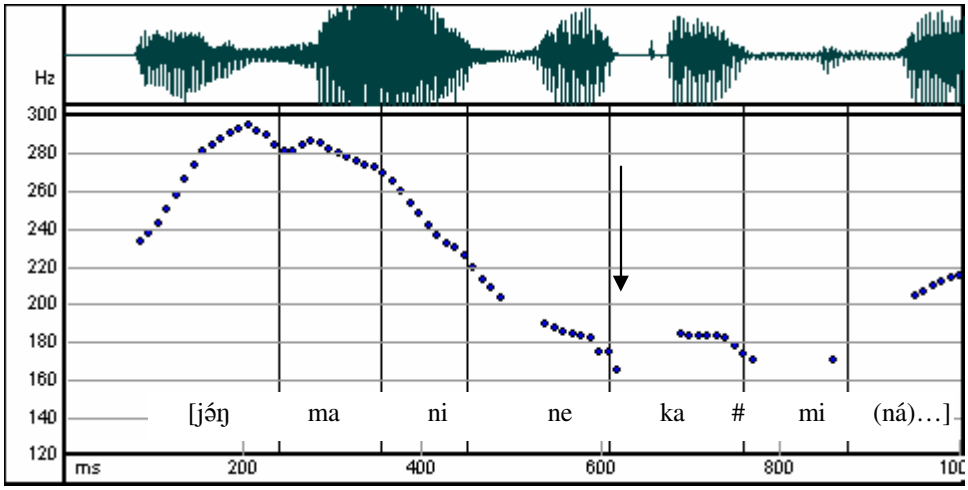


Figure 8: A pitch track of sentence 5d, which has four post-accent syllables (subject JH)

Let us now consider the pitch pattern of the syllables preceding the accented syllable. For this, we examined f0 values for the Final class word /wə.nə.mín/, where the accented syllable is preceded by two syllables. In most cases, the pitch pattern of the two pre-accent syllables was not flat but showed

a gradual rise, which continued to the accented final syllable of the word. In general, the degree of f0 increase was larger between the second and the final syllable than between the first two syllables. Table 4 shows the mean and the standard deviation of the differences in f0 values between the f0 minimum of the word-initial syllable and the vowel-mid point of the second syllable (s2-s1), and the difference between the vowel-mid point of the second syllable and the accent peak on the third syllable (s3-s2). Except for speaker HY, whose s2-s1 values are small and variable (see the grey cell, where the standard deviation is larger than the mean), all show a gradual increase of f0 over the three syllables.

Table 4: Mean (and standard deviation) of the differences in f0 between the word-initial f0 minimum and the vowel-mid point of the second syllable (s2-s1), and between the vowel-mid point of the second syllable and the accent peak on the third syllable (s3-s2).

	Female			Male		
	JH	HJ	HY	KTJ	LIH	LSH
s2-s1	17.5 (5.2)	8.0 (5.0)	3.1 (6.0)	17.6 (5.0)	9.9 (3.1)	7.9 (4.7)
s3-s2	23.5 (5.6)	32.4 (4.9)	21.9 (6.0)	17.9 (1.6)	15.4 (4.2)	11.8 (2.5)

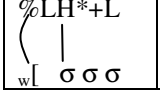
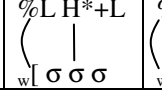
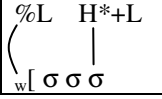
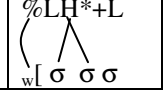
(Unit = Hz; standard deviation is in parentheses)

This gradual rise can be interpreted as the result of an interpolation between the word-initial L tone and the accent H tone of the word-final syllable, with

the penultimate syllable unspecified for tone. This suggests that the surface representation in NKK is sparsely, not fully, specified for tone. Notice that this is not consistent with the previous analyses of NKK tones which assumed full specification of the surface representation. For instance, G.R. Kim (1988: 45) provided a Default L-Insertion rule. The surface underspecification for NKK tones is comparable to the surface underspecification of Tokyo Japanese proposed in Pierrehumbert and Beckman (1988).

In sum, to explain the characteristic pitch contour for each word class observed in Dataset I, we propose that not every syllable in a word is tonally specified in NKK. Instead, each word in NKK is marked by two types of tones, i.e., H*+L pitch accent linked to the accented syllable (or doubly linked to the two accented syllables in the Double word class) and the word-initial L boundary tone, %L, associated with the left edge of a word. (6) shows the tone-syllable association for each word class under our proposal.

(6) Tone-syllable association of each word class

Initial	*Penult*	*Final*	*Double*
			

The H tone of H*+L pitch accent is phonetically realized on, or slightly later than, the accented syllable, and the trailing L tone is realized during the post-accent syllables (generally on the second or third syllable from the peak). But

when there is no post-accent syllable as in Final words, the L tone deletes at the lexical level, and the accent H is phonetically realized as a medium peak.[8] The word-initial L boundary tone is realized on the word-initial syllable, but when the word-initial syllable is accented, the L tone is not fully realized, i.e., partially undershot. Similarly, the trailing L tone is partially undershot when there is only one syllable after the accent.

3.2. Focus and Downstep

An overall observation about the production of sentences in Dataset II is that the prosodic cue of contrastive focus differs depending on whether the lexical class of a word is Final or nonFinal. We will discuss cases involving focused nonFinal words in this section and focused Final words in the next section.

For nonFinal words, the realization of focus is very similar to the focus realization in Seoul Korean: pitch range is expanded during the focused word and is substantially reduced for post-focus words. Examples can be seen in Figures 9-11, which show pitch tracks of almost the same sentence uttered with no focus (Figure 9), with focus on word1 (Figure 10), and focus on word2 (Figure 11). The sentences under consideration basically have the same meaning 'Mother is eating dropwort' and the same segmental sequences, differing only in the sentence enders, *-na* denoting a yes-no question vs. *-ninteje* denoting a statement. In NKK, a yes-no question ends with low pitch just like a statement (G.R. Kim (1988)).[9] Notice that the focused words

(marked in boldface in Figures 10-11) show much higher peaks than their unfocused counterparts and that post-focus words show very small peaks (e.g., /minári/ in Figure 10, marked with a solid arrow).

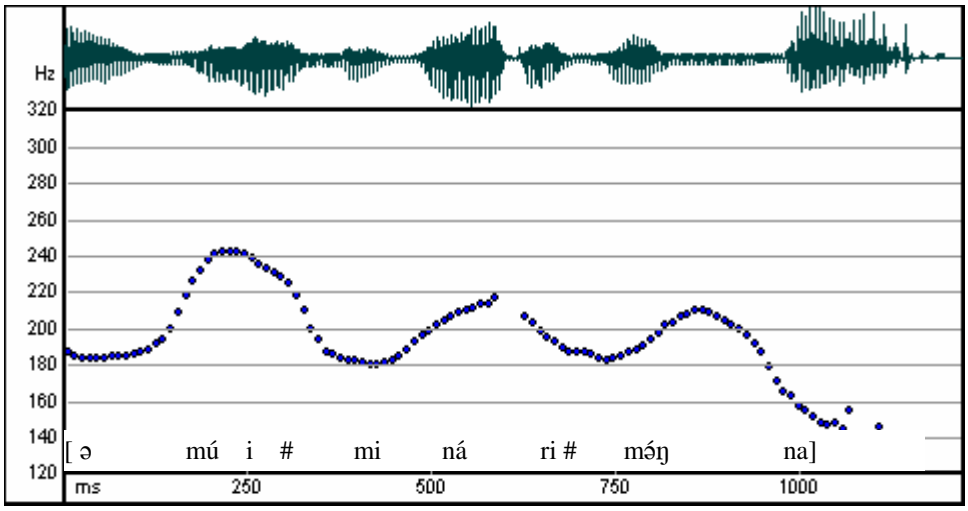


Figure 9: A pitch track of the sentence 'Is mother eating dropwort?' with *no focus*

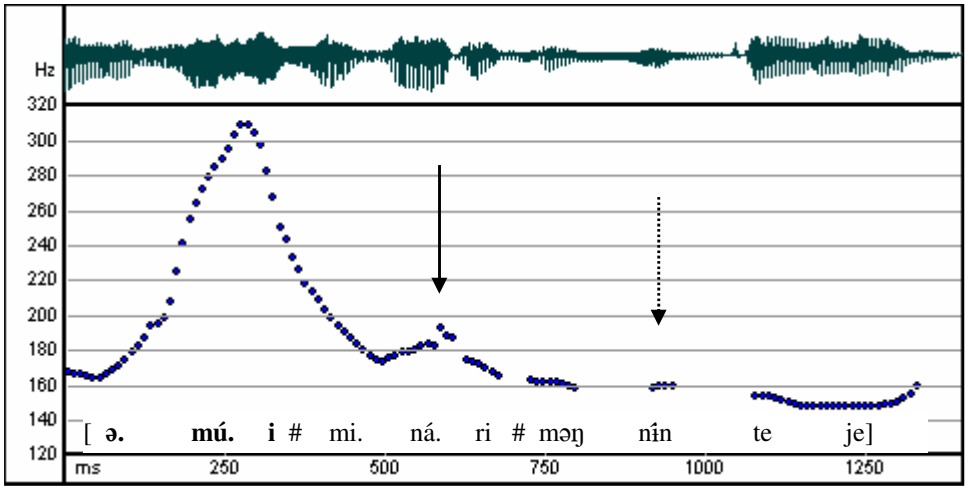


Figure 10: A pitch track of the sentence 'Mother is eating dropwort.' with *focus on word1 ('mother')*

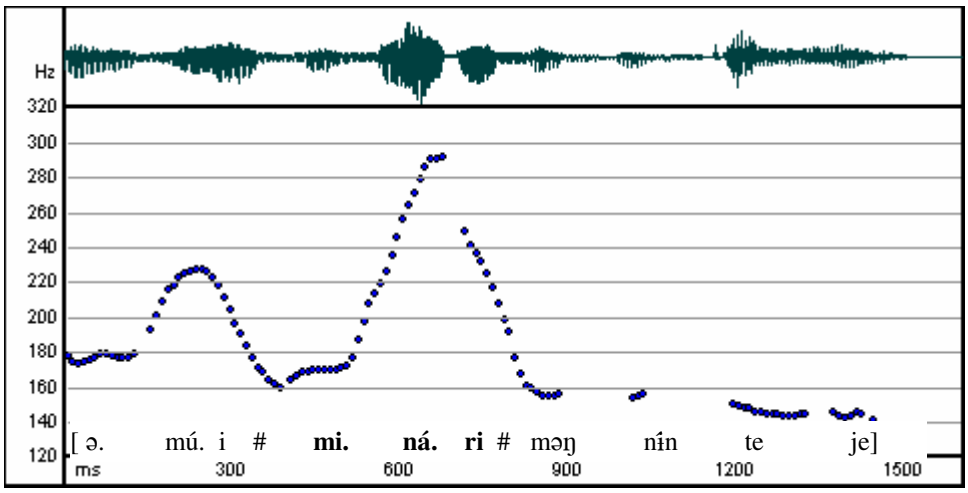


Figure 11: A pitch track of the sentence 'Mother is eating dropwort.' with *focus on word2 ('dropwort')*

To illustrate the effect of focus on pitch range, we compared the pitch range of word1 under focus (e.g., Figure 10) with that of the corresponding word in a neutral sentence (e.g., Figure 9) and that in a pre-focus position (e.g., Figure 11). Table 5 shows pitch range differences between Focus and Neutral conditions (F-N) and between Focus and pre-Focus conditions (F-preF) for all subjects and for all different types of word1 and word2 except for Final. Pitch range is calculated by taking the difference between the accent Peak and the word-initial Low f0 values. Since the speakers produced Dataset II only once, the Focus and Pre-focus condition values are taken from one token while the Neutral condition values are taken from the average of two tokens. The rows enclosed by thick lines include values for cases in which the same word is employed as word1 in all three prosodic conditions: Focus, Neutral, and pre-Focus. For example, when both word1 and word2 belong to the Penult class,

the same word /ə.mú.i/ is employed as word1 in the three conditions. In contrast, when word1 is an Initial word and word2 is a Penult word, /mé.nu.ɾi/ is employed as word1 in the Focus and Neutral condition, but a different, still Initial class, word /á.ci.me/ is used as the corresponding word in the pre-Focus position. Cells are marked with 'n/a' when the relevant pitch tracks were not readable or the speakers failed to provide an intended pitch accent on the target word. Negative values are shaded.

Table 5. Pitch range comparison of word1 between *Focus* and *Neutral* conditions (F-N), and between *Focus* and *pre-Focus* conditions (F-preF).

		Female						Male					
		JH		HJ		HY		KTJ		LIH		LSH	
word1	word2	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF
initial	initial	n/a	n/a	42.5	78	n/a	n/a	30	19	37	27	-3.5	16
	penult	69.5	57	18	9	15	n/a	16	41	5	44	3	3
	final	59.5	56	11.5	39	-17.5	-11	9.5	12	8	3	6.5	10
	double	70.5	67	45	43	36.5	27	19.5	n/a	4	32	-6.5	-1
penult	initial	64	73	51	121	8	25	14	63	-29	35	-6	-5
	penult	81	93	17	86	17	26	3.5	15	18	58	13	14
	final	97	88	27.5	49	33.5	51	-4	14	2	39	-4	-5
	double	34	34	36	84	7	8	10.5	11	3	44	4.5	1
double	initial	26.5	76	60.5	56	6.5	37	n/a	0	n/a	60	-0.5	12
	penult	27.5	73	38	58	10.5	38	20.5	24	n/a	35	9.5	-6
	final	15	13	48.5	53	n/a	n/a	-10.5	24	n/a	7	-9.5	-6
	double	56.5	46	53	50	14.5	29	-9	3	n/a	-7	11.5	-5
	Mean	54.6	61.5	37.4	60.5	13.1	25.6	9.1	20.5	6.0	31.4	1.5	2.3

(unit = Hz)

Most of the cells in Table 5 show positive values, suggesting pitch range expansion under focus. But the frequency and the magnitude of the positive values differ among the subjects. For female subjects, the values are almost always positive, and those for two male subjects KTJ and LIH are in

general positive, with some exceptions. But, there is no indication of pitch range expansion in the male subject LSH's data; the pitch range differences are often very small whether they be negative or positive. From recordings, it is in fact often unclear whether he produced the sentences with contrastive focus or not, and even when he did, the cue to focus seems quite weak.

Data in Table 5 also show that 'F-preF' values are, on average, larger than the corresponding 'F-N' values. In other words, the pitch range in the pre-Focus condition is smaller than that in the Neutral condition, suggesting some degree of pitch range reduction before the focused word. A similar tendency was found in Seoul Korean (Jun and Lee (1998)).

The effect of focus can also be seen in the pitch range of word2 in three prosodic conditions: Focused word2, Neutral word2, and post-Focused word2. Table 6 shows the *Peak* differences of word2 in the three prosodic conditions. The *Peak* differences between Focus and post-Focus conditions (F-postF) and between Neutral and post-Focus conditions (N-postF) are given for all subjects and for all word types except for the Final class. The format of Table 6 is the same as that in Table 5.

Table 6: Peak differences in word2 between *Focus* and *post-Focus* conditions (F-postF) and between *Neutral* and *post-Focus* conditions (N-postF).

a. Female subjects

		JH		HJ		HY	
word1	word2	F-postF	N-postF	F-postF	N-postF	F-postF	N-postF
initial	initial	91	32	108	4.5	51	19.5
penult		108	53.5	110	3.5	44	-8.5
double		74	10.5	80	39	57	-2
initial	penult	113	43.5	186	24	79	25
penult		107	35.5	122	9.5	67	31.5
double		72	35	143	5	96	36
initial	double	113	35.5	150	148	71	23.5
penult		114	43	138	-4	69	37
double		63	61	92	102	43	17.5
	mean	95	38.5	125.4	36.8	64.1	19.9

b. Male subjects

		KTJ		LIH		LSH	
word1	word2	F-postF	N-postF	F-postF	N-postF	F-postF	N-postF
initial	initial	74	8	97	-8	19	4
penult		73	10	77	25	17	1.5
double		43	-9	23	n/a	9	-9.5
initial	penult	92	19	69	53.5	33	15.5
penult		59	17.5	3	5.5	16	4.5
double		77	0.5	33	n/a	15	3.5
initial	double	69	6.5	n/a	1.5	38	20.5
penult		54	19.5	75	24	23	1
double		31	1	3	n/a	12	-4.5
	mean	63.6	8.1	47.5	16.9	20.2	4.1

(unit = Hz)

As shown in Table 6, the peak differences between Focus and post-Focus conditions (F-postF) are always positive and mostly large. The large differences must be due to the pitch range expansion of focused word2 as well as the reduced peak of post-Focus word2 (as can be seen in Figure 10). Notice that here, for subject LSH, who showed little pitch range expansion for focused word1 in Table 5, the peak differences are mostly positive (mean = 20.2), though still smaller than those of the other subjects.

The peak differences between Neutral and post-Focus conditions (N-postF) are also mostly positive, indicating that the peak of word2 in the post-

Focus condition is lower than that in the Neutral condition (see Figures 9 and 10). However, the N-postF values are relatively smaller than the F-postF values because word2 without focus has a lower peak than a focused word2. Furthermore, the peak of word2 in the Neutral condition is usually lower than the peak of word1. The degree of f0 lowering varies, ranging from a slight reduction (for example, Figure 9) to a substantial reduction, as shown in Figure 12 (the sentence means "Does the brother meet the daughter-in-law?"). When the peak is substantially reduced as in Figure 12, N-postF would give a negative value. In sum, data show that focus affects the pitch range of words. It raises the pitch range of the focused word and at the same time reduces the pitch range of post-focus words.

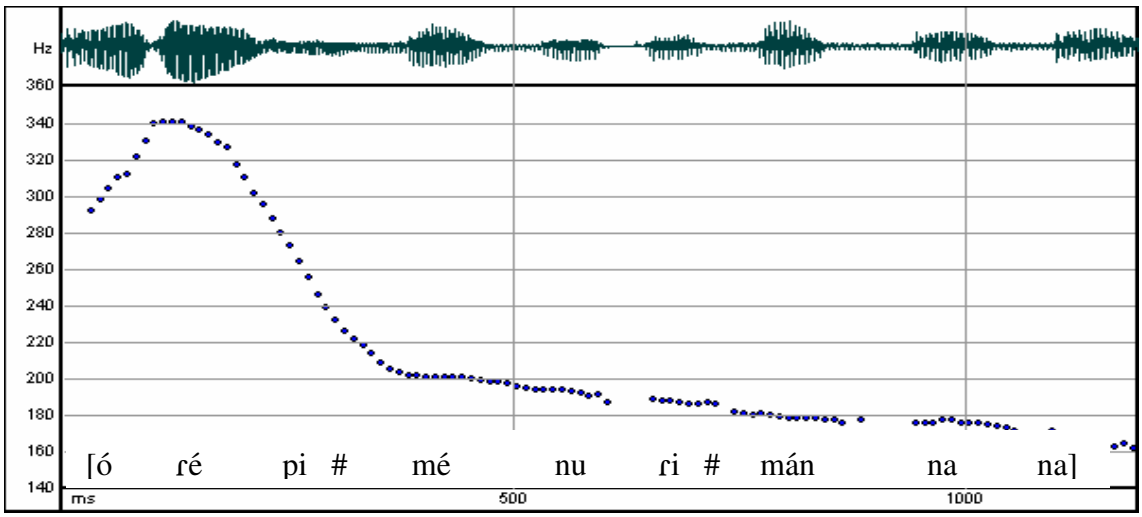


Figure 12: An example a pitch track showing word2 with a substantially reduced peak in a neutral sentence (subject HJ)

Previous literature on NKK tone interactions (e.g., G.R. Kim (1988); Kenstowicz and Sohn (1997); N.J. Kim (1997)) suggested that the lower peak of word2, compared to that of word1, is due to tonal interactions such as H-tone deletion or downstep and that the domain of this tonal reduction is a prosodic phrase. Kenstowicz and Sohn claimed that the tonal reduction is the result of downstep and observed two types of downstep. The first type shows a small rise on the accented syllable, as shown in Figure 13 (and Figure 10). In our current study, this type of downstep was commonly observed when the accented syllable of the downstepped word was farther away from the word onset, i.e., Penult and Final class words. The second type shows no such rise. Instead, it shows a 'shoulder' (which is described as "a noticeable flattening of the descent" in Kenstowicz and Sohn (1997: 4a)). This type is often found in the downstepped Initial and Double words, i.e., when the word-initial syllable is accented. An example is shown in Figure 14, and the shoulder is marked by the arrow.

The fact that the accent peak is still visible in the first type of downstep suggests that the lower peak of word2 cannot be explained by adopting the H-tone deletion account. Furthermore, the fact that the two types of downstep realization depend on the location of accented syllable suggests that the division is not categorical but a result of phonetic realization. That is, it depends on the degree of undershoot of %L tone. Recall that we have proposed in section 3.1 that there is an initial low boundary tone (%L) for each prosodic word and that it is subject to an undershoot (i.e., realized as a high-

ish low) when a word has a pitch accent on the word-initial syllable. Since the pitch range is drastically reduced for post-focus words as shown above, %L of Initial and Double words would not be much different from the reduced accent peak of the post-focus word, creating a shoulder. On the other hand, if the accent is not on the first syllable of a word, the %L would be realized but show a small rise due to the reduced pitch range.

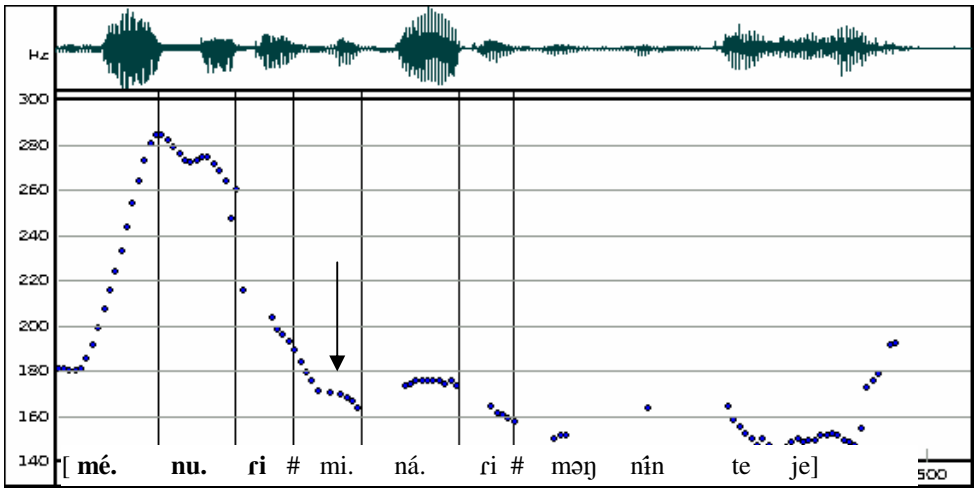


Figure 13: A pitch track of the sentence (‘[Youngmi is] eating the daughter-in-law’s dropwort’) showing downstep with small rise on word2 (‘dropwort’) (subject JH).

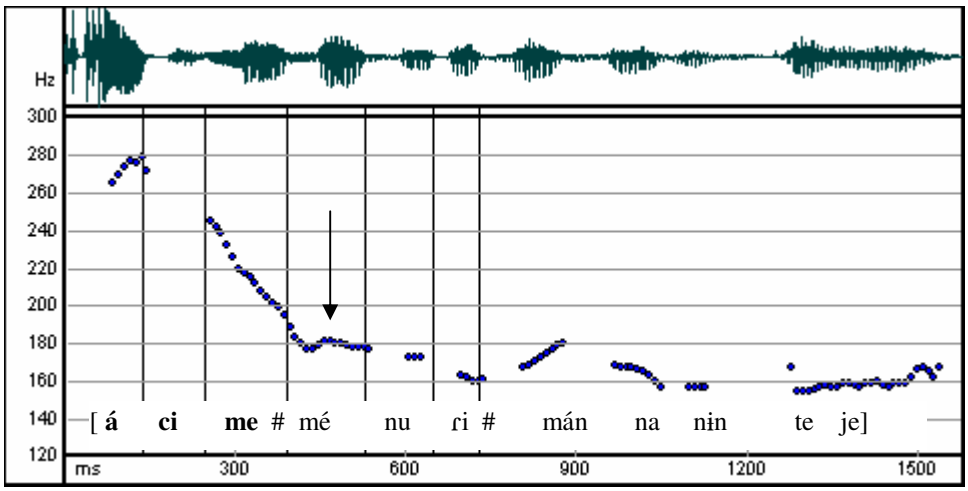


Figure 14: A pitch track of the sentence (‘[Youngmi is] meeting the aunt’s daughter-in-law’) showing downstep with shoulder on word2 (‘daughter-in-law’) (subject JH).

Figures 10 and 13 also show that downstep can happen more than once: the peak of word2 is lower than that of word1, and the peak of word3 is lower than that of word2 (the dotted arrow in Figure 10 points to the second downstepped peak). This is also found in English and Japanese (Beckman and Pierrehumbert (1986)). The downstep chain, however, is broken when word2 is focused as can be seen in Figure 11. To explain this, we may follow previous studies (Beckman and Pierrehumbert (1986); G.R. Kim (1988); Jun (1993); Kenstowicz and Sohn (1997); N.J. Kim (1997)) in assuming that a focused word initiates a new prosodic phrase, and post-focus words are downstepped within this phrase. We call this phrase an Intermediate Phrase (ip). (We do not call it an Accentual Phrase as in Seoul dialect (Jun (1993, 1998)) because it may include more than one pitch accent.) It seems that, as

claimed by Kenstowicz and Sohn, the bitonal pitch accent triggers downstep as in Tokyo Japanese (cf. Beckman and Pierrehumbert (1986); Pierrehumbert and Beckman (1988)). Thus, as will be discussed below, Final class words, where the L tone of pitch accent is not realized, do not trigger downstep.

Finally, since the downstep is blocked across a phrase boundary, the existence of downstep implies no phrase boundary before the downstepped word. Therefore, the L tone at the beginning of a downstepped word2 (e.g., see Figures 10, 13) supports our proposal that the %L boundary tone is not a phrasal tone but a word-level tone.

3.3. Final class and Upstep

In this section, we will discuss the tone interaction and prosodic effects of focus when the Final word is under focus. The notable difference from focused nonFinal words, discussed in the previous section, is that the post-focus pitch accent was neither downstepped nor deaccented. Instead, as can be seen in Figure 15, post-focus word2 (*ménuɾi* 'daughter-in-law') has a higher pitch peak than the peak of focused Final word1 (*namwə́n* 'Namwon, the name of a city'). The sentence means '(Youngmi) is meeting the daughter-in-law from Namwon'.

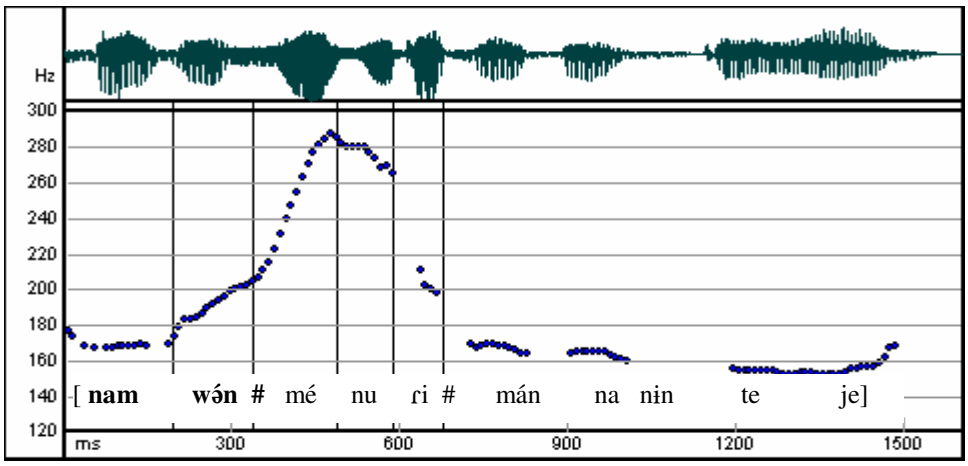


Figure 15: A pitch track of a sentence where the Final word1 is focused (subject JH)

The upstepped peak of word2, compared to word1, was true for all subjects and all word2 types. The peak f0 differences between focused Final word1 and post-focus word2 (word1 *minus* word2) are shown in Table 7.

Table 7: Peak f0 difference from *Focused* word1 minus *post-Focus* word2

		Female			Male		
word1	word2	JH	HJ	HY	KTJ	LIH	LSH
Final	Initial	-96	-164	-63	-59	-63	-10
	Penult	-84	-186	-27	-53	-27	-22
	Final	-70	-45	-31	-30	-31	-4
	Double	-115	-149	-72	-62	-72	-23
	Mean	-91.25	-136	-48.25	-51	-48.25	-14.75

(unit = Hz)

These results are consistent with previous studies on NKK tone interactions except for Final-Double sequences. As provided in (2), Final-Double sequences have been claimed to show a higher peak in Final word1 (G.R. Kim (1988); Kenstowicz and Sohn (1997)). However, this was not found in the current study. Instead, we found a simpler pattern: if word1 = Final, word2 has a higher peak, regardless of word2's class. This discrepancy in data may be due to generational or dialectal differences. Further data need to be examined.

Let us now consider how to explain the prominent peak of the post-focus word. Three different types of accounts need to be discussed. The first is the H-deletion account proposed by G.R. Kim (1988): if the High tone deletes in Final word1, word2 will have a higher peak. Under this account, word1, by not having any accent H, would not have any f0 peak. That is, the final syllable of word1 should not be higher than its preceding syllable.

The second account is the upstep process. Kenstowicz and Sohn (1997) provide the following specific proposals for the analysis of NKK tone interactions under the assumption that in the H-H sequence on the tonal tier, the second H is raised:

(7) Upstep approach by Kenstowicz and Sohn (1997)

a. Underlying HL pitch accent

b. No other word-level tone for Initial, Penult, and Final class words[10]

c. Deletion, in the lexical level, of the accent L tone of Final class words

d. Rightward H tone spreading (which will be blocked by the tone of the following word)

According to this proposal, as shown in (8a), the H tone of Final word1 is adjacent to the H tone of word2 in the phrasal phonology (and through H tone spreading in the case of the Penult word2 as shown in (8b)), and thus the second H will be upstepped, showing a higher peak of word2.

(8)

	word1		*word2*
a.	**nam.wə́n**	#	mé.nu.ɾi
	|		|
	H		H L
b.	**nam.wə́n**	#	ə.mú.i
	|		|
	H		H L

Under this account, the peak of word1 must not be reduced, and thus the final syllable of word1 should be higher in pitch than its preceding syllable. Also, the f0 value for the onset of word2 should be higher than, or at least equal to, that of the accent peak of word1.

The final possible account, which has never been considered in the previous studies, is that no tone interaction occurs in the relevant sequences. This account would be plausible if we consider the fact, reported in section 3.1, that the peak f0 values are significantly higher for nonFinal words than for Final words. Due to this asymmetry in peak f0 values between Final and nonFinal words, even if nothing happens in the Final-nonFinal sequence, nonFinal word2 would have a higher peak than Final word1. This account

agrees with the upstep account in predicting that the peak of word1 must not be reduced and thus the final syllable of word1 should be still higher in pitch than its preceding syllable. But, under this account, the f0 value for the word2 onset may be lower than the accent peak of word1, contrary to the claim of the upstep account.

As illustrated in Figure 15, our data show that the f0 value of the final syllable of the Final word, though not high, is still higher than the f0 of the preceding syllable(s) of the word, suggesting the existence of an H tone. Thus, we may reject the H tone deletion account.

Some additional observations of the present study provide evidence in favor of the upstep account. As shown in Figure 15, the f0 value of the low boundary tone (%L) of word2 is always higher than, or at least equal to, that of the accent peak in Final word1. This suggests the occurrence of an upstepped %L. Moreover, when a Final word comes after another Final word within the same Intermediate Phrase, a chain of upstep happens as shown in Figure 16, where upstepped peaks are marked with up-arrows. This upstep chain provides strong evidence in favor of the upstep account because a chain of raised peak would not be expected from the 'H tone deletion' or the 'no tone interaction' accounts.

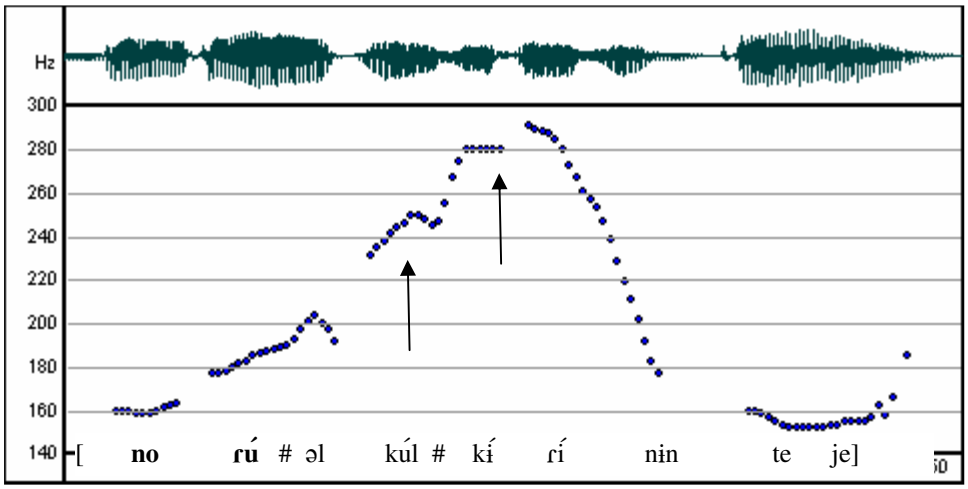


Figure 16: A pitch track of a sentence illustrating an upstep chain (subject JH). Both word1 (*noɾú* 'the roe deer') and word2 (*əlkúl* 'a face') are Final classes. The sentence means '(Youngmi) is drawing the roe deer's face'.

In conclusion, upstep is the process which is responsible for the prominent peak of word2. This conclusion basically supports the idea proposed in Kenstowicz and Sohn (1997). They assumed that the adjacency of two Hs is a necessary condition for the occurrence of upstep and claimed that the H tone of Final word (after deleting L of an HL accent) upsteps the H tone of the following word. This was possible because they did not posit any word-level tones other than pitch accent.

However, the adjacency condition would not work in our model because we have proposed that each NKK prosodic word has an initial low boundary tone (%L) in addition to the pitch accent H*+L, as shown in (9). This suggests that the L tone intervening between two H's does not block the

upstep. Instead, the L tone undergoes upstep, too, though still lower than the following accent H tone. The existence of the %L can be seen better in word3 of Figures 17 and 18 ([məŋnǿinteje] ‘to eat’), where there exists an accentless syllable before the upstepped H, and the timing of f0 rise to the upstepped peak is delayed compared to that in Figure 15 (word2) and Figure 16 (word3), where the word initial syllable is accented.

(9)

nam.wə́n]$_w$	$_w$[	mé.nu.ɾi
|	|	|
H	%L	H*+L

The next question is then what the domain of the upstep is. Notice that as can be seen in Figure 16, if the first two words of a focused phrase belong to a Final class, an upstep chain arises, but the upstep chain is broken if the second Final word is focused as shown in Figure 17 (the sentence means ‘(Youngmi) is eating the dandelion from Namwon’). This indicates that an ip is the domain of upstep as well as downstep.

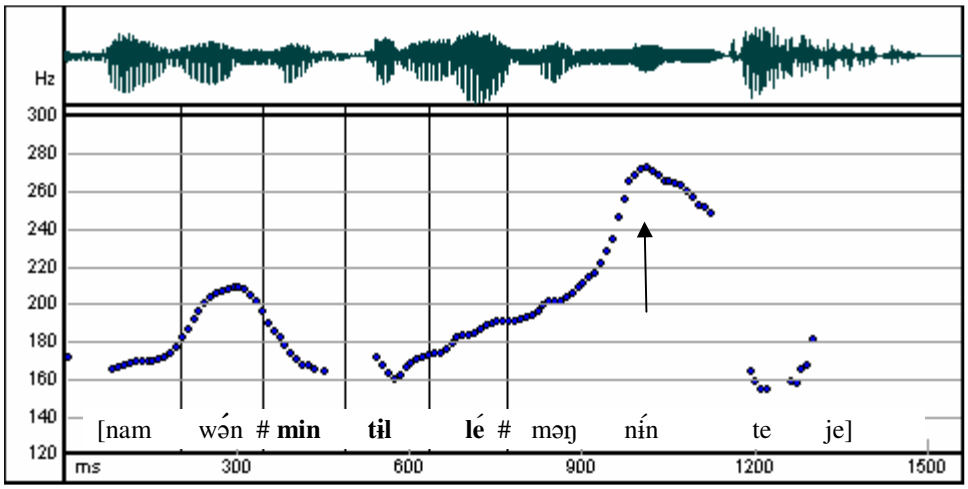


Figure 17: A pitch track of a sentence where Final word2 (*mintɨllé* 'dandelion') is focused. In this case, Final word1 does not trigger upstep of word2. (subject JH)

A sequence of downstep and upstep can occur in the same ip if tonal conditions are met. Figure 18 shows an example. The pitch peak of Final word2 [mintɨllé] is significantly lower after the focused nonFinal word1 [ménuɾi], but the pitch peak of word3 [məŋnɨ́nteje] is upstepped. The occurrence of upstep on word3 is clear if we consider the fact that the sentence-final accent peak is normally very low, as was shown in Figures 10-11.

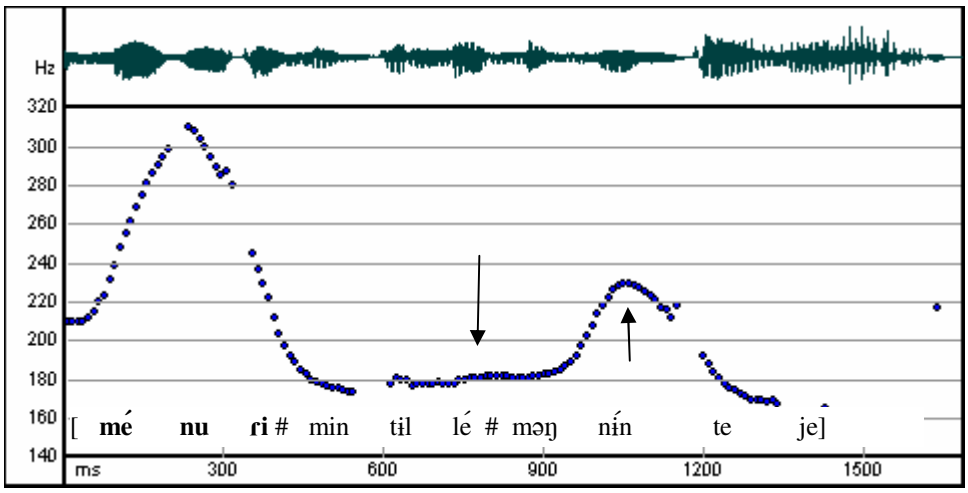


Figure 18: A pitch track of a sentence illustrating a downstep-upstep chain. Word2 *is downstepped after focused* word1, and word3 is upstepped after Final word2 (subject HJ)

The tone interaction of NKK provides unique data in intonational phonology in that accent can trigger downstep or upstep depending on the location of the lexical accent. In other words, the same underlying pitch accent H*+L can trigger downstep or upstep depending on the post-lexical realization of the L tone. If L is realized, the bitonal pitch accent triggers downstep, but if not, a single H tone triggers upstep.

Let us now consider the prosodic cues of an utterance with focus on Final words. The results of the present study indicate that when under focus, the pitch range of the Final word is either reduced or remains the same as that in the neutral condition. The differences in pitch range between focused and neutral Final words are shown in Table 8. As before, F-N stands for the difference in pitch range between the Focus and Neutral conditions, and F-

preF stands for the difference between the Focus and pre-Focus conditions. Here, the negative values (shaded) indicate a case of pitch range reduction under focus. The rows enclosed by thick lines include values for cases in which the same word is employed as word1 in all three different conditions: Focus, Neutral, and pre-Focus position.

Table 8: A pitch range comparison in *Final* word1 between Focus and Neutral conditions (F-N) and between Focus and pre-Focus conditions (F-preF).

		Female						Male					
		JH		HJ		HY		KTJ		LIH		LSH	
word1	word2	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF	F-N	F-preF
final	initial	-29.5	-11	-9	-1	-19	-14	-6	-12	-5	-4	-0.5	-2
	penult	6.5	-16	1.5	8	8	1	4.5	2	-7	1	-1.5	-4
	final	1.5	-18	-4	3	1.5	-5	-1.5	2	5	10	-0.5	-7
	double	0	-25	1	-6	-2.5	-12	-4.5	-5	-3	0	-3.5	0
	mean	-5.4	-17.5	-2.6	1.0	-3.0	-7.5	-1.9	-3.3	-2.5	1.8	-1.5	-3.3

A major difference from the results of nonFinal words reported in Table 5 is that more than half of cells show negative values though the values are mostly small. This suggests that the pitch range of Final words does not expand under focus; instead, it is either reduced or remains the same as the pitch range of the corresponding word in the Neutral condition. Another difference between Final and nonFinal words under focus can be seen in post-

focus words. Recall that when the nonFinal word is under focus, the post-focus words showed pitch range reduction. However, it seems that such pitch range reduction of the post-focus word does not occur after focused Final words.

To examine the effect of focus on the pitch range of the post-focus word, the pitch range of post-focus word2 was compared with that of the corresponding word in the Focus and Neutral conditions. Table 9 shows the *pitch range* differences of word2 in the three prosodic conditions. The *pitch range* differences between Focus and post-Focus conditions (F-postF) and between Neutral and post-Focus conditions (N-postF) are given for all subjects and for all word2 types. The format of the table is the same as that in Table 6. Positive values indicate that the pitch range of word2 in the post-focus condition is reduced, compared to that of the corresponding word in the Focus or the Neutral condition. Negative values (shaded) indicate the opposite, i.e., pitch range expansion of post-focus word2.

Table 9: Pitch range comparisons of word2 between *Focus* and *post-Focus* conditions (F-postF) and between *Neutral* and *post-Focus* conditions (N-postF), when it is followed by Final word1.

a. Female subjects

		JH		HJ		HY	
word1	word2	F-postF	N-postF	F-postF	N-postF	F-postF	N-postF
final	initial	-5	-35	-1	-68.5	n/a	-23.5
	penult	39	-25.5	-14	-39.5	50	14
	double	-15	-73	-2	15	-26	-40
	mean	6.3	-44.5	-5.7	-31.0	12.0	-16.5

b. Male subjects

		KTJ		LIH		LSH	
word1	word2	F-postF	N-postF	F-postF	N-postF	F-postF	N-postF
final	initial	0	-12.5	13	-4.5	8	-0.5
	penult	14	6	7	-2.5	7	2.5
	double	0	-12.5	-1	-7	5	-7.5
	mean	4.7	-6.3	6.3	-4.7	6.7	-1.8

Let us first consider the difference between *Neutral* and *post-Focus* conditions (N-postF). Unlike in Table 6 for post-nonFinal words, negative values dominate here (14 out of 18 cells), suggesting that the pitch range of the post-focus word2 is often larger than the corresponding word in the neutral condition. The magnitude of the values differs among the subjects. Notice that

for subject LSH, who showed little expansion of pitch range for focused nonFinal words, the values here (-0.5, 2.5, -7.5) are relatively small and indeed smaller than those of the other subjects. It seems that his strategy for producing focus involves pitch range expansion only in a minor way whether it be a focused word or a post-focus word.

F-postF values show somewhat different distributions: 9 positives, 2 zeros, and 7 negatives. Even negative F-postF values are smaller than their corresponding N-postF values. These observations indicate that the pitch range of the word in the Neutral condition is smallest, and pitch range of the post-Focus word, when it is followed by focused Final word, is closer in size to that of the corresponding word under focus. It is thus suggested that the pitch range of the post-focus nonFinal word is in fact expanded in the same way in which it is expanded under focus.

In summary, when the Final class word is under focus, its pitch range is either reduced or remains the same as that in the neutral condition, and the pitch range of its following word is expanded as much as it is under focus. Reducing, or at least not expanding, the pitch range of a focused Final word provides unique data in the prosodic typology of focus. It seems that the goal of marking focus prosodically in NKK is in pitch range expansion of the focus *phrase*. In other words, pitch range expansion is adopted in NKK to provide prosodic marking for contrastive focus, as in many other languages (Frota (2002)), but NKK differs from other languages including English (Beckman and Pierrehumbert (1986)) and Seoul Korean (Jun (1993); Jun and Lee (1998))

in that the pitch range expansion does not necessarily target the word under focus; when a Final word is under focus, its following unfocused word, not the focused one, is subject to the pitch range expansion. All this indicates that the prosodic goal of focus in NKK is in the pitch range expansion of the *focused phrase*, and it is mainly implemented by expanding the pitch range of the most prominent word in the phrase, regardless of whether it is the focused word or not. When nonFinal words are under focus, the *focused word* has the highest peak within the phrase, and the post-focus words are downstepped, resulting in an even more salient focused accent peak (see section 3.2). However, due to the upstep process, focused Final words do not have the highest peak within the phrase, but the following word is chosen for the pitch range expansion.

3.4. The Prosodic Structure of NKK

The prosodic structure of NKK is quite different from that of Seoul Korean (Jun (1993, 2000)) in that pitch is distinctive in NKK but not in Seoul Korean. This makes NKK quite similar to Tokyo Japanese (Beckman and Pierrehumbert (1986); Pierrehumbert and Beckman (1988)). However, unlike Tokyo Japanese, where a lexical word is either accented or unaccented, all lexical words in NKK are accented (H*+L pitch accent). Each accented word in NKK forms one Prosodic Word whose left edge is marked by a Low boundary tone.

One or more Prosodic Words in NKK form one prosodic unit, called an Intermediate Phrase (ip). This prosodic unit is the domain of downstep and upstep, thus defined by the pitch range difference between the Prosodic Words. Unlike the Prosodic Word, the edge of an ip is not marked by a boundary tone. An ip in our model corresponds to the phonological phrase proposed in Kenstowicz and Sohn (1997) and N.J. Kim (1997) but differs from it in that their phonological phrase is marked by a boundary tone. Our ip is also the domain of focus, similar to the Intermediate Phrase in English and Japanese (Beckman and Pierrehumbert (1986)). A focused word initiates a new ip in NKK; thus it becomes the first accented word in an ip, but in English a focused word does not necessarily begin a new ip, and it becomes the last pitch accented word in the ip.

A sentence can have more than one ip. In Figures 11 and 17, word2 is focused and begins a new ip; thus the prosodic structure of these sentences would be ((word1)ip(word2 word3)ip). However, these two ip's are not realized the same. The last syllable of the second ip, i.e., the last syllable of the sentence, is substantially lengthened. This is true in examples shown in other figures. Following the model of Seoul Korean, we will call the prosodic unit larger than an ip an Intonation Phrase (IP). An IP is the largest prosodic unit in NKK and can have one ip (e.g., Figures 9-10, 12-14) or more. Unlike the ip, however, the right edge of an IP is marked by a boundary tone. This is realized on the final syllable of the phrase and delivers the sentence type information (statement, question, request, etc.) or semantic/pragmatic meaning

(implication, insisting, annoyance, preaching, etc.). The boundary tone of a statement in NKK is often low (L%), as seen in the figures throughout the paper, but can be rising (e.g., LH% in Figure 4) to signal some pragmatic meaning. The description of this phenomenon is beyond the scope of this paper (cf. see Park (2003) for the meaning of boundary tones in Seoul Korean). In sum, the prosodic structure of NKK is hierarchically organized. The largest prosodic unit is an IP which can have one or more ips, which in turn can have one or more Prosodic Words.

4. Conclusions

In the present study, we have provided an experimental investigation of NKK tones, employing multiple speakers. Two main datasets were adopted.

In Dataset I, we have examined the pitch contour for tri-syllabic words of different word classes. Based on quantitative data, we have proposed that the underlying tone of pitch accent in NKK is H*+L, and the left edge of an NKK prosodic word is marked by a Low boundary tone (%L). This proposal is consistent with Kenstowicz and Sohn (1997), who have proposed the underlying HL pitch accent mainly for the formal analysis of the tone interaction patterns. But we differ from them in positing a word-initial Low boundary tone (%L). The %L is undershot when the pitch accent is on the word-initial syllable, and the accent H is realized as a medium high when there is no syllable after the pitch accent. We also found that the surface representation in NKK is sparsely, not fully, specified for tone.

In Dataset II, where the tone interaction and focus effects were explored, we found that focused nonFinal class words downstep the following words whereas focused Final class words upstep the following words. This finding basically supports Kenstowicz and Sohn's downstep/upstep accounts while rejecting the approaches assuming the categorical treatment of pitch accent such as those of G.R. Kim (1988) and Chung (1991). However, our analysis of upstep differs from that of Kenstowicz and Sohn in that the word-final High tone triggers upstep even when a Low tone is present at the beginning of the following word. We have claimed that the domain of downstep and upstep is an Intermediate Phrase (ip), a prosodic unit higher than a prosodic word. We have shown a chain of downstep, a chain of upstep, and a sequence of downstep followed by upstep within an ip.

Finally, we found that the domain of focus is an ip, and the prosodic cue of focus differs depending on the location of the pitch accent within a prosodic word. When a nonFinal word is under focus, the pitch range of the word was expanded while the pitch range of post-focus words was substantially reduced. On the other hand, when a Final word is under focus, the pitch range of the word was either reduced or remained the same as that in the neutral condition while the pitch range of post-focus words was expanded. We concluded that the prosodic goal of focus in NKK is to locate the focused word at the beginning of a phrase (ip) and to expand the pitch range of the *focused phrase*. This is implemented by further raising the highest accent peak within the phrase, regardless of whether it belongs to the focused word or not.

Appendix I: Experimental phrases of Dataset II

Example numbers; word classes involved ([] = focused); experimental phrases

091 11 jə́ŋmi-ka ácime ménuɾi mánna-na

'Is Youngmi meeting the aunt's daughter-in-law?'

[2]1 əncije, jə́ŋmi-nɨn əmúi ménuɾi mánna-nɨnteje

'No, Youngmi is meeting (her) mother's daughter-in-law.'

092 11 jə́ŋmi-ka ácime ménuɾi mánna-na

'Is Youngmi meeting the aunt's daughter-in-law?'

1[2] əncije, jə́ŋmi-nɨn ácime əmúi mánna-nɨnteje

'No, Youngmi is meeting the aunt's mother.'

101 12 jə́ŋmi-ka ménuɾi əmúi mánna-na

'Is Youngmi meeting the daughter-in-law's mother?'

[3]2 əncije, jə́ŋmi-nɨn namwə́n əmúi mánna-nɨnteje

'No, Youngmi is meeting the mother who comes from Namwon.'

102 12 jə́ŋmi-ka ménuɾi əmúi mánna-na

'Is Youngmi meeting the daughter-in-law's mother?'

1[4] əncije, jə́ŋmi-nɨn ménuɾi óɾépi mánna-nɨnteje

'Youngmi is meeting the daughter-in-law's brother.'

111 13 jəŋmi-ka ménuɾi mintɨllé mə́ŋ-na

‘Is Youngmi eating the daughter-in-law’s dandelion?’

[4]3 əncije jəŋmi-nɨn óɾépi mintɨllé məŋ-nɨ́nteje

‘No, Youngmi is eating (her) brother’s dandelion.’

112 13 jəŋmi-ka ménuɾi mintɨllé mə́ŋ-na

‘Is Youngmi eating the daughter-in-law’s dandelion?’

1[3] əncije jəŋmi-nɨn ménuɾi cindallé məŋ-nɨ́nteje

‘No, Youngmi is eating the daughter-in-law’s azalea.’

121 14 jəŋmi-ka ménuɾi óɾépi mánna-na

‘Is Youngmi meeting the daughter-in-law’s brother?’

[2]4 əncije, jəŋmi-nɨn əmúi óɾépi mánna-nɨnteje

‘No, Youngmi is meeting (her) mother’s brother.’

122 14 jəŋmi-ka ménuɾi óɾépi mánna-na

‘Is Youngmi meeting the daughter-in-law’s brother?’

1[1] əncije, jəŋmi-nɨn ménuɾi ácime mánna-nɨnteje

‘No, Youngmi is meeting the daughter-in-law’s aunt.’

131 21 jəŋmi-ka əmúi ménuɾi mánna-na

‘Is Youngmi meeting (her) mother’s daughter-in-law?’

[1]1 əncije, jəŋmi-nɨn ácime ménuɾi mánna-nɨnteje

‘No, Youngmi is meeting the aunt’s daughter-in-law.’

132 21 ɔ́ŋmi-ka əmúi ménuɾi mánna-na

‘Is Youngmi meeting the mother’s daughter-in-law?’

2[4] əncije, jəŋmi-nɨn əmúi ɔ́ɾépi mánna-nɨnteje

‘No, Youngmi is meeting the mother’s brother.’

141 22 jəŋmi-ka əmúi minaɾí məŋ-na

‘Is Youngmi eating the mother’s dropwort?’

[1]2 əncije jəŋmi-nɨn ménuɾi minaɾí məŋ-nɨ̂nteje

‘No, Youngmi is eating the daughter-in-law’s dropwort.’

142 22 jəŋmi-ka əmúi minaɾí məŋ-na

‘Is Youngmi eating the mother’s dropwort?’

2[3] əncije jəŋmi-nɨn əmúi mintɨllé məŋ-nɨ̂nteje

‘No, Youngmi is eating the mother’s dandelion.’

151 23 jəŋmi-ka əmúi mintɨllé məŋ-na

‘Is Youngmi eating the mother’s dandelion?’

[1]3 əncije jəŋmi-nɨn ménuɾi mintɨllé məŋ-nɨ̂nteje

‘No, Youngmi is eating the daughter-in-law’s dandelion.’

152 23 jəŋmi-ka əmúi mintɨllé məŋ-na

‘Is Youngmi eating the mother’s dandelion?’

2[2] əncije jəŋmi-nɨn əmúi minaɾí məŋ-nɨ̂nteje

‘No, Youngmi is eating the mother’s dropwort.’

161 24 jəŋmi-ka əmúi órépi mánna-na

‘Is Youngmi meeting the mother’s brother?’

[1]4 əncije, jəŋmi-nɨn ménuɾi órépi mánna-nɨnteje

‘No, Youngmi is meeting the daughter-in-law’s brother.’

162 24 jəŋmi-ka əmúi órépi mánna-na

‘Is Youngmi meeting the mother’s brother?’

2[1] əncije, jəŋmi-nɨn əmúi ménuɾi mánna-nɨnteje

‘No, Youngmi is meeting the mother’s daughter-in-law.’

171 31 jəŋmi-ka namwʌ́n ácime mánna-na

‘Is Youngmi meeting the aunt who comes from Namwon?’

[4]1 əncije, jəŋmi-nɨn jəŋnám ácime mánna-nɨnteje

‘No, Youngmi is meeting the aunt who comes from Yeungnam.’

172 31 jəŋmi-ka namwʌ́n ácime mánna-na

‘Is Youngmi meeting the aunt who comes from Namwon?’

3[2] əncije, jəŋmi-nɨn namwʌ́n əmúi mánna-nɨnteje

‘No, Youngmi is meeting the mother who comes from Namwon.’

181 32 jəŋmi-ka namwʌ́n əmúi mánna-na

‘Is Youngmi meeting the mother who comes from Namwon?’

[4]2 əncije, jəŋmi-nɨn jəŋnám əmúi mánna-nɨnteje

'No, Youngmi is meeting the mother who comes from Yeoungnam.'

182 32 jəŋmi-ka namwə́n əmúi mánna-na

'Is Youngmi meeting the mother who comes from Namwon?'

3[1] əncije, jəŋmi-nɨn namwə́n ácime mánna-nɨnteje

'No, Youngmi is meeting the aunt who comes from Namwon.'

191 33 jəŋmi-ka norú əlkúl kɨ́ɾí-na

'Is Youngmi drawing the roe deer's face?'

[2]3 əncije, jəŋmi-nɨn maŋáci əlkúl kɨ́ɾí-nɨnteje

'No, Youngmi is drawing the foal's face.'

192 33 jəŋmi-ka norú əlkúl kɨ́ɾí-na

'Is Youngmi drawing the roe deer's face?'

3[4] əncije, jəŋmi-nɨn norú əŋtəŋi kɨ́ɾí-nɨnteje

'No, Youngmi is drawing the roe deer's rump.'

201 34 jəŋmi-ka namwə́n kókúma mə́ŋ-na

'Is Youngmi eating a sweet potato produced in Namwon?'

[4]4 əncije jəŋmi-nɨn jəŋnám kókúma məŋ-nɨ́nteje

'No, Youngmi is eating a sweet potato produced in Yeungnam.'

202 34 jəŋmi-ka namwə́n kókúma mə́ŋ-na

‘Is Youngmi eating a sweet potato produced in Namwon?’

3[3] əncije jəŋmi-nɨn namwə́n mintɨllé məŋ-nɨ́nteje

‘No, Youngmi is eating a dandelion produced in Namwon.’

211 41 ə́ŋmi-ka ɔ́ɾépi ménuɾi mánna-na

‘Is Youngmi meeting the brother’s daughter-in-law?’

[3]1 əncije, jəŋmi-nɨn namwə́n ménuɾi mánna-nɨnteje

‘No, Youngmi is meeting the daughter-in-law who comes from Namwon.’

212 41 ə́ŋmi-ka ɔ́ɾépi ménuɾi mánna-na

‘Is Yeungmi meeting the brother’s daughter-in-law?’

4[4] əncije, jəŋmi-nɨn ɔ́ɾépi mánúɾa mánna-nɨnteje

‘No, Youngmi is meeting the brother’s wife.’

221 42 jəŋmi-ka ɔ́ɾépi minaɾí məŋ-na

‘Is Youngmi eating the brother’s dropwort?’

[2]2 əncije jəŋmi-nɨn əmúi mináɾi məŋ-nɨ́nteje

‘No, Youngmi is eating the mother’s dropwort.’

222 42 jəŋmi-ka ɔ́ɾépi mináɾi məŋ-na

‘Is Youngmi eating the brother’s dropwort?’

4[3] əncije jəŋmi-nɨn ɔ́ɾépi mintɨllé məŋ-nɨ́nteje

‘No, Youngmi is eating the brother’s dandelion.’

231 43 jəŋmi-ka órépi əlkúl kɨɾí-na

‘Is Youngmi drawing the brother’s face?’

[3]3 əncije, jəŋmi-nɨn noɾú əlkúl kɨɾí-nɨnteje

‘No, Youngmi is drawing the roe deer’s face.’

232 43 jəŋmi-ka órépi əlkúl kɨɾí-na

‘Is Youngmi drawing the brother’s face?’

4[1] əncije, jəŋmi-nɨn órépi məɾi kɨɾí-nɨnteje

‘No, Youngmi is drawing the brother’s head.’

241 44 jəŋmi-ka órépi əŋtəŋi kɨɾí-na

‘Is Youngmi drawing the brother’s hip?’

[3]4 əncije, jəŋmi-nɨn noɾú əŋtəŋi kɨɾí-nɨnteje

‘No, Youngmi is drawing the roe deer’s hip.’

242 44 jəŋmi-ka órépi əŋtəŋi kɨɾí-na

‘Is Youngmi drawing the brother’s hip?’

4[2] əncije, jəŋmi-nɨn órépi tekáɾi kɨɾí-nɨnteje

‘No, Youngmi is drawing the brother’s head.’

Appendix II: Mean of word-initial Low and Peak f0 values for each word class (five subjects)

Experimental	word	*subject position*	*object position*

subjects	classes	low	peak	low	peak
KTJ	Initial	129.3	151.1	132.1	185.3
	Penult	105.3	132.9	101.6	160.3
	Final	105.5	141	101.9	116.6
	Double	152	168.9	149	187.5
LIH	Initial	135.6	154.4	134.9	181.1
	Penult	119	155.9	112.5	159.6
	Final	119.9	145.1	111.3	137.3
	Double	136.6	160.8	n/a	n/a
LSH	Initial	110.5	121.6	106.1	125.1
	Penult	104.1	120.9	95.8	121.9
	Final	95.6	115.3	97.6	103.6
	Double	125.8	136.0	109.7	123.8
HY	Initial	235.6	261.1	220.3	267.0
	Penult	215.8	249.1	198.3	252.6
	Final	207	232	187.9	205.4
	Double	257	263.6	261.3	286
HJ	Initial	248.3	253.8	238.9	302.5
	Penult	201.8	249.6	178.3	288.3
	Final	195.5	235.9	183.1	204.5
	Double	n/a	n/a	290.6	330.3

Notes

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[1] -ninteje is a declarative present progressive sentence ender.

[2] In all dialects of Korean, case markers denoting 'nominative, accusative, and possessive' are normally omitted in conversational speech. But, due to the lack of a case marker, the function of the sentence-initial word in (3) is ambiguous: it can be either the subject of the sentence or a modifier. For instance, the sentence in (3a) can alternatively mean '(Somebody) is meeting (My) mother's daughter-in-law.' To avoid this ambiguity, we informed the experimental subjects about the intended meaning of the experimental sentences before recording.

[3]Abbreviations used in (4) are the following: Nom = Nominative case marker, Int = Interrogative, SE = Sentence Ender, Top = Topic marker, DPP = Declarative Present Progressive.

[4] The second and third authors of this paper, who are native speakers of NKK, pointed out that two subjects, LIH and HJ, pronounced / órépi / as Penult in one of the two positions, and thus those productions were not considered in the test. (For the same reason, comparable cells in Appendix II are marked with n/a denoting 'not available'.) Subject LIH made the same mistake in producing Double class words in the nonfocus question of Dataset II, and these productions were not considered in the discussion of experimental results in section 3.2. We think that such production of / órépi / as Penult is probably not accidental. It seems that when NKK speakers are not sure about the lexical class of a word, they prefer to produce it as a Penult word (cf. N.J. Kim 1997).

[5] /máɾ/ = 'horse'; /jáŋ.mi/, /jáŋ.ma.ni/ = proper names; /-ne/ = a suffix meaning 'somebody's family'; /-i, -ka/ = nominative case markers.

[6] As suggested by one of the reviewers, it would be interesting to examine the alignment constraint of the trailing L tone, whether it is realized at a fixed time distance from the peak or at a fixed segmental point. Our data seem to suggest that the alignment is constrained by the segmental point, though not tight. However, before abandoning the fixed time-based constraint, we need to examine more data where the segmental types and the syllable structure vary while the syllable count remains the same.

[7] Thanks to the anonymous reviewer for pointing out this to us.

[8] As can be seen in the results of previous studies and the current study, the pitch contour of the last syllable in the di-syllabic Double class words is not the same as that of the Final class words. To exclude di-syllabic Double class words from the target of the L deletion, we need to limit the application of the deletion to the representations where the accent H is singly-linked.

[9] The pitch tracks of the present study mostly confirm this, but some pitch tracks for a statement show a low rise at the end, as can be seen in Figures 4, 10. We think this is a stylistic variant for a statement.

[10] As mentioned in section 1, Kenstowicz and Sohn (1997) posit the word-initial L tone only for Double class words to explain the downstep process which has been claimed to occur in the Final-Double sequence in previous studies. But, such complication would not be needed for the analysis of the data of the present study, which is simpler in that, as long as word1 belongs to the Final class, word2 has a higher peak, regardless of word2's class.

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