Linguistic Research 34(1), 133-161
DOI: 10.17250/khisli.34.1.201703.005

Prosodic focus in Seoul Korean and South Kyungsang Korean*

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Lee, Yong-cheol. Prosodic focus in Seoul Korean and South Kyungsang Korean. *Linguistic Research* 34(1), 133-161. This study employed production and perception experiments in an exploration of whether "purely" prosodic marking of focus is weak and ambiguous in Seoul Korean and South Kyungsang Korean. Production data presented two important characteristics in the use of prosodic focus in both languages. Prosodic modulation by focus was weak, and focus effects spread to the adjacent position within a phrase as a function of focus. As a result, listeners had difficulty identifying the position of prosodic focus in perception-overall identification rates were about 37% for Seoul Korean and about 48% for South Kyungsang Korean. Additionally, incorrect answers often appeared within the same phrase before or after focus positions. The results of this study suggest that prosodic marking of focus is neither automatic nor universal, which is in contrast to the common claim that a focused element is maximally prominent in a sentence (Büring 2010; Samek-Lodovici 2005; Truckenbrodt 1995). Instead, this study claims that prosodic marking of focus differs according to a language's prosodic structure, and that it can be weak and ambiguous in certain languages. **(Cheongju University)**

Keywords prosody, corrective focus, weak, ambiguous, Seoul Korean, South Kyungsang Korean

1. Introduction

The primary purpose of communication is to convey information. The delivery of this information is expected to be systematic and understandable. A speaker makes assumptions about the hearer's knowledge and behaves accordingly and then

* This work is a further developed version of part of the author's dissertation. Some of this work was presented at ICASSP 2015 and appeared in the proceedings (Lee *et al.* 2015). Special thanks to Mark Liberman, Florian Schwarz, and Jianjing Kuang, whose guidance, feedback, and comments shaped an earlier draft of this study. Special appreciation is also extended to the two anonymous reviewers of this journal for their useful comments. This work was supported by the research grant of Cheongju University (2015.09.01-2017.08.31).

structures sentences to integrate new information with given information the speaker believes the hearer is familiar with. This kind of structure is known as information structure (e.g., Halliday 1967; Krifka 2008; Lambrecht 1994; Vallduví 1990). Consider the brief dialogue in (1).

(1) a. What does John drink?
b. John drinks beer.

In (1b), *John drinks* is given information since it repeats content from the question, and *beer*-the answer to the question-is new information. In the context of the dialogue, the informative part (*beer*) is the focus, which indicates a discourse function that emphasizes a particular piece of information in a sentence (Ladd 1984; Xu and Xu 2005).

Conventional wisdom about the prosodic reflex of focus is that a focused element attracts prominence-related effects by suprasegmental features. However, languages display various prosodic properties of focus cross-linguistically (Jun 2011; Selkirk 2007; Zerbian 2006). For example, languages like English (Cooper *et al.* 1985; Xu and Xu 2005), German (Baumann *et al.* 2006), and Dutch (Swerts *et al.* 2002) mark prosodic focus with a nuclear pitch accent aligning it with a primary stressed syllable. Languages like Seoul Korean (Jun and Lee 1998; Lee and Xu 2010), South Kyungsang Korean (Kim and Jun 2009), and Japanese (Pierrehumbert and Beckman 1988) use prosodic phrasing to express prosodic focus by manipulating an accentual phrase (AP). Languages like European Portuguese (Frota 2002) and Bengali (Selkirk 2007) employ a combination of pitch accent and prosodic phrasing to signal prosodic focus.

Although languages use different means in marking prosodic focus, the widely accepted assumption is that a focused element is "maximally prominent" in a sentence (Büring 2010; Samek-Lodovici 2005; Truckenbrodt 1995), as reflected by longer duration, greater intensity, and higher pitch in the phonetic implementation. Previous studies have examined the prosodic effects of focus in many languages to prove such a focus-to-prominence relationship. Some representative work includes: Cooper *et al.* (1985) and Xu and Xu (2005) for English; Jun and Lee (1998) and Lee and Xu (2010) for Korean; Xu (1999) for Mandarin; Lee and Xu (2012) for Japanese; and Dohen and Lœvenbruck (2004) for French.

Recently, however, a growing body of evidence demonstrates that focus is not always correlated with maximal prominence (e.g., Downing 2008; Fiedler and Jannedy 2013; Gordon 2007; Maskikit and Gussenhoven 2016). For example, Gordon (2007) found that focus is not primarily encoded by prosody in the American Indian Language of Chickasaw, but rather it is the morphology that plays a primary role due to the presence of focus morphemes. Downing (2008) analyzed three Bantu languages (Chichewa, Durban Zulu, and Chitumbuka), in which prominence is conditioned by position within a sentence-phrasal prominence occurs on the last word of a phrase and sentence prominence occurs on the last word of a sentence. Downing found a mismatch between prominence and the position of prosodic focus in these languages. Although a phrase-initial or phrase-medial word was focused, these focused words did not receive prominence. Instead, prominence occurred on the phrase-final word, since phrasal prominence is fixed at the last word of a phrase. These findings suggest that there is no direct relationship between prominence and the position of prosodic focus.

In addition, it has been observed that "purely" prosodic marking of focus may be weaker in one language compared to the other. Figure 1 displays broad focus (BF) and discourse-new focus (DF) conditions in American English (left panel) and Seoul Korean (right panel).[1] These focus conditions were produced in an experimental setting, where six native speakers of each language produced target sentences in isolation for broad focus and the same sentences in a Q&A dialogue for discourse-new focus.[2] The stimuli were repeated six times for both conditions.

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1 In this figure, the dotted vertical line demarcates each AP in the sentence. Unless otherwise stated, a dotted vertical line always refers to an AP boundary throughout the paper. Each word was time-normalized and averaged with ten equidistant points using Xu's ProsodyPro Praat script (Xu 2013).

2 The questions used are *Who remembered Jessica?* (English) and *Who is eating dumplings?* (Korean), and the Korean sentence is Romanized using IPA.

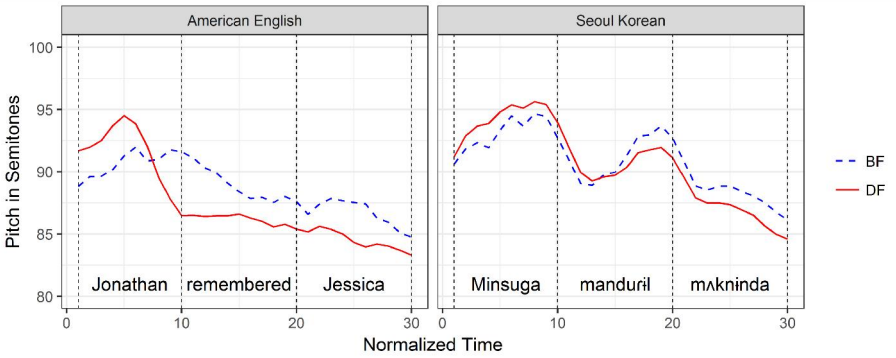

Figure 1. Time-normalized average pitch contours of 36 repetitions of the sentence *Jonathan remembered Jessica (left panel) and Minsuga manduɾil mʌkninda* ('Minswu is eating dumplings') (right panel) by six speakers. The first area of each panel contains a target word (Raw data from Lee (2009) for the left panel and from Lee and Xu (2010) for the right panel)

In both languages, discourse-new focus produced a more expanded pitch range than broad focus. However, we observe that modulation by focus is greater in American English than in Seoul Korean. To test this observation, we conducted a pairwise *t*-test analysis comparing the difference in maximum pitch between the focus conditions in each language (the peak difference: 2.52 st in American English; 1.18 st in Seoul Korean). The result demonstrated that American English employed a more expanded pitch range ($p < 0.05$). An important point here is that the pitch expansion via focus is fairly small in Seoul Korean-just 1.18 st increase in pitch in marking prosodic focus. Prosodic marking of focus, then, is less than half as strong in Seoul Korean as in American English. The result leads us to speculate that prosodic marking of focus is neither universal nor automatic, but differs by the prosodic system of each language.

The main purpose of the current study is to determine whether and why Seoul Korean's prosodic marking of focus is weak. This study also looks at South Kyungsang Korean-another variety of Korean-to identify if its prosodic marking of focus is similar to Seoul Korean. In the remaining of this section, we first depict the basic prosodic structure of each language-a key component-in order to ensure clear understanding of the details of the study. We then briefly describe prosodic focus effects in both languages. Finally, two research hypotheses are proposed.

1.1 Prosodic structure of Seoul Korean

Seoul Korean has neither lexical stress nor lexical pitch accents (Jun 1998, 2005; Song 2005)-different stress patterns (e.g., *GAL.bi* vs. *gal.BI*) do not indicate a difference in meaning (Song 2005: 40). The Seoul Korean tonal pattern instead comes from a combination of phrasal and boundary tones. In default prosodic phrasing, each content word can form a small prosodic unit, an Accentual Phrase (AP) that is post-lexically marked. In normal speech, the sentence *Minsuga manduɾil mʌkninda* 'Minsu is eating dumplings' consists of three APs, *(Minsuga)(manduɾ il)(mʌkninda)*, where parentheses represent each AP. As Figure 2 shows, each AP, except the sentence-final one, exhibits a rising pitch contour towards the edge of the phrase. The rising tonal pattern marks an AP boundary tone in Seoul Korean. The sentence-final falling tonal pattern marks a declarative sentence.

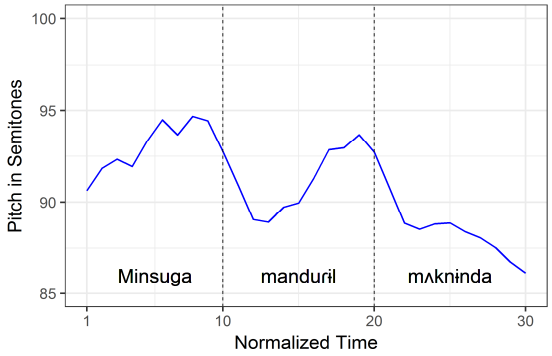

Figure 2. Time-normalized mean pitch contours of 36 repetitions by six speakers. The sentence is *Minsuga manduɾil mʌkninda* (Raw data from Lee and Xu 2010)

The AP's basic melody is typically THLH and is fixed at the phrase level. The initial tone (T) differs by the laryngeal feature of the AP-initial segment (Jun 1993, 1998, 2005, 2006). When the initial consonant is aspirated/tensed, the AP begins with H, and elsewhere with L. Furthermore, a recent sound change has revealed that the AP begins with H when a digit *1* [il] is in AP-initial position (Jun and Cha 2015). When the AP has fewer than four syllables, the second or third tone, or both, may not be realized.

1.2 Prosodic structure of South Kyungsang Korean

South Kyungsang Korean is different from Seoul Korean in that different tonal patterns cause a difference in meaning. The examples in (2) show three tonal patterns as a minimal triplet (Kim and Jun 2009: 44).

(2) a. ga.dzi HL 'type'
b. ga.dzi HH 'branch'
c. ga.dzi LH 'eggplant'

Unlike a tonal language like Mandarin Chinese, South Kyungsang Korean does not allow all the possible tonal patterns over each syllable of a word, so it is considered a lexical pitch accent language (Kim and Jun 2009; Lee and Davis 2009; Lee and Zhang 2014). The initial syllable of a prosodic word begins with either L or H, but a LL sequence cannot occur word-initially. Once a falling pitch contour occurs from H to L, another H tone is not allowed within the same word or phrase. In addition, three consecutive H or L tones (i.e., HHH, LLL) are not allowed either in this language (Lee and Davis 2009; Lee and Zhang 2014). Table 1 displays the possible tonal patterns over monosyllabic, disyllablic, trisyllabic, and quadrisyllabic words (Lee and Davis 2009: 6).

Table 1. The possible tone patterns of monosyllabic, disyllabic, trisyllabic, and quadrisyllabic words in South Kyungsang Korean

Monosyllabic	Disyllabic	Trisyllabic	Quadrisyllabic
H	HH	HHL	HHLL
L	HL	HLL	LHHL
		LHL	
		LHH	

An Accentual Phrase (AP) is the lowest tonally defined prosodic unit and is marked by a low boundary tone at its initial edge (Kim and Jun 2009; Kim 2009). Although the tonal pattern of an AP depends on the number of syllables and the combination of tones, the surface tonal patterns of South Kyungsang Korean are generally predictable within a phrase. As previously stated, South Kyungsang Korean

does not allow three consecutive H tones. When a three-digit string *333* forms a phrase, it is realized with HHL, not with HHH, although the underlying tone of each digit is H.[3] When a string *555* forms a phrase, it is realized with LHL, not LLL, since three consecutive L tones cannot occur in this language. When there is a three-digit string like *329*, the surface tonal pattern of this string is HLL, not HLH, since a H tone cannot appear again within the same phrase once there occurs a falling pitch contour from H to L.

1.3 Prosodic focus effects in Seoul Korean and South Kyungsang Korean

Although Seoul Korean and South Kyungsang Korean have different prosodic structures, the two languages show similar prosodic focus effects. When a word is in focus, a strong phrase boundary occurs at the beginning of an AP, in which pitch range is expanded and continues to be seen at the end of the AP (Kim and Jun 2009; Lee 2012; Lee and Xu 2010). In other words, the focus effect appears throughout the AP containing the focused word. Moreover, the focus effect affects post-focus words, which are known to exhibit dephrasing, a deletion of the AP boundary (Kim and Jun 2009; Kim 2015; Oh 2008).

1.4 Setting the stage

From Figure 1, we have observed that Seoul Korean's prosodic marking of focus was very weak, whereas prosodic marking of focus was strong in English. As stated before, in languages such as English (Cooper *et al.* 1985; Xu and Xu 2005), German (Baumann *et al.* 2006), and Dutch (Swerts *et al.* 2002), prosodic focus is marked by a nuclear pitch accent aligning it with a primary stressed syllable. Therefore, a focused element takes on the greatest prominence in a sentence (Kim and Jun 2009). But because Seoul Korean and South Kyungsang Korean are not stress accent languages, instead expressing prosodic focus by phrasing, we hypothesize that prosodic marking of focus is not salient. This is different from English, and is the first hypothesis of the current study.

According to the prosodic structures of Seoul Korean and South Kyungsang

[3] Tone patterns of each digit are as follows: 0 (High), 1 (High), 2 (Low), 3 (High), 4 (Low), 5 (Low), 6 (High), 7 (High), 8 (High), and 9 (High).

Korean, although these languages certainly show different prosodic structures, the commonality between the two languages is that tonal melodies are more or less fixed within a phrase. This characteristic enables us to test which of the phonological units-word vs. phrase-carries prosodic prominence in marking prosodic focus. Consider the situation in (3), in which the underlined digit *2* is used to correct the wrong digit *1* in the question.

(3) Q: Is the number 367-810-8717?
A: No, it is 367-8<u>2</u>0-8717.

As discussed earlier, focus is expressed by phrasing in both languages; thus, it is not clear whether only the single digit *2* carries prosodic prominence or if the focus effect spans the entire phrase (that is, *820*). If only the single digit carries prosodic prominence, then the phonological unit of carrying prosodic focus would be a word (that is, each digit) rather than a phrase. In comparison, if prominence spans the entire phrase, the phonological unit carrying prosodic focus would be a phrase. If this is the case, then we hypothesize that both Seoul Korean and South Kyungsang Korean will exhibit an ambiguous marking of focus, which is the second hypothesis of the current study.

To summarize, the purpose of this study is to test the two hypotheses above by selecting two languages, Seoul Korean and South Kyungsang Korean, that are not stress accent languages. This study first examines whether or not "purely" prosodic marking of focus is weak in both Seoul Korean and South Kyungsang Korean. It also focuses on whether modulation by focus spans the entire phrase rather than a single digit in both languages. We conducted production and perception experiments with digit strings as speech material in order to accomplish our twofold purpose.

2. Production

2.1 Speech materials

A Python script created a set of 100 10-digit number strings based on two criteria: i) every digit (0-9) occurs equally often in every position, and ii) every pair of digits occur equally often across every pair of positions.[4] To further illustrate the second

criterion, there are nine pairs of adjacent digits in a 10-digit number string, for example, 0-1, 1-2, 2-3, ..., 8-9. These pairs of digits were designed to occur equally often in the number strings. During the experiment, the target number strings were produced in two focus conditions: broad focus and corrective focus. The broad-focus condition was produced in isolation. The corrective-focus condition was elicited in a Q&A structure, as illustrated in (4). A question asked if the number string was correct, and the answer corrected a single digit, 7, that was incorrect in the question.

(4) A: mina-ɯi bʌnho-ga 737-686-7664-ja. matɕi?
Mina-Poss number-Nom 737-686-7664-Dec right
'Mina's number is 737-686-7664. Right?'
B: anija, mina-ɯi bʌnho-nin **6**37-686-7664-ja.
no Mina-Poss number-Top **6**37-686-7664-Dec
'No, Mina's number is **6**37-686-7664.'

2.2 Participants

Table 2 presents the number of speakers who participated in the production experiment for both Seoul Korean and South Kyungsang Korean. The mean age and the standard deviation (SD) were calculated based on the time of recording. Speakers of Seoul Korean were either from Seoul or from the Seoul metropolitan area, and those of South Kyungsang Korean were all from Busan. All of the speakers in each language were recruited at the University of Pennsylvania. Participants were either graduate students or post-doc researchers. They reported that they had been in the US for less than a year at the time of recording. Neither particular accents nor hearing disorders were not found from the participants.

Table 2. The number of speakers and the mean age (SD) of each language

Language	Speakers	Mean age (SD)
Seoul Korean	2 males, 3 females	29.4 years (3.8)
South Kyungsang Korean	2 males, 3 females	29.2 years (5.4)

4 A similar method of approach was found in Cho and Lee (2016).

2.3 Recording procedure

The experimenter conducted recordings for both languages in a sound-proof booth at the Linguistics Department of the University of Pennsylvania. Recordings were directly made in Praat (44.1 kHz sampling rate, 16-bit resolution) and were directly saved onto a laptop. Speakers wore a Plantronics headset microphone and were seated before a laptop monitor. Before recording test stimuli for both broad-focus and corrective-focus conditions, speakers had an opportunity to practice three sample phone-number strings to familiarize them with the recording procedure. As Figure 3 demonstrates, target stimuli were presented in isolation for the broad-focus condition and in a Q&A dialogue for the corrective-focus condition. In the broad-focus condition, speakers were instructed to read the stimuli as naturally as possible, and in the corrective-focus condition, they first listened to pre-recorded questions and then responded to the questions as answers by correcting the wrong digit. During the recordings, the broad-focus condition was always recorded earlier than the corrective-focus condition for all speakers and both languages. The duration of the recordings was about 45 minutes-15 minutes for broad focus, 25 minutes for corrective focus, and 5 minutes for a short break between the two focus conditions.

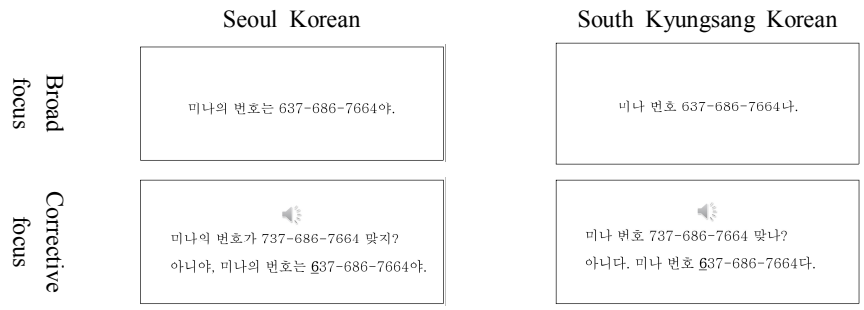

Figure 3. Screenshots of the production experiment for both Seoul Korean (left panel) and South Kyungsang Korean (right panel). The top panel shows a broad-focus condition, where the sentence is 'Mina's number is 887-412-4699' in English and the bottom panel exhibits a corrective-focus condition, where the upper sentence is a question ('Mina's number is 887-412-4699. Right?'), and the lower sentence is the response to the question ('No, Mina's number is 787-412-4699.')

This study comprised a total of 1,000 digit-strings for each language. The number of strings was calculated as follows: 5 speakers x 2 focus conditions (broad and corrective focus) x 10 digits (0 to 9) x 10 string positions (1 to 10).

2.4 A sketch of pitch contours

We shall first visualize some pitch contours in an attempt to identify the prosodic differences between the broad-focus and the corrective-focus conditions for each language. In this study, each digit of the digit strings was hand-labeled, and ten equidistant points of each labeled digit were then automatically obtained using ProsodyPro-a Praat script designed for a large-scale prosodic analysis (Xu 2013). Pitches in Hertz were converted to semitones (st)-a logarithmic musical scale-with this formula (Lee *et al.* 2016; Xu and Wang 2009): $st = 12 \log_2 Hz$.

Figure 4 illustrates the time-normalized pitch contours for broad focus and corrective focus. For the sake of simplicity, the figure shows only the phrase containing the corrected digit; other phrases are omitted. The area shaded in gray refers to a target focus position with the corrected digit 6 in the left panel and 8 in the right panel. Both Seoul Korean and South Kyungsang Korean display similar characteristics for prosodic marking of focus. The amount of modulation by prosodic focus seems small or weak, and the effect of prosodic focus spreads to the next positions.[5] Therefore, we expect listeners of both languages to have difficulty recognizing the corrected digit in perception, given that prosodic marking of focus is considered weak and ambiguous.

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5 One of the reviewers was concerned that it is unclear whether the domain of prosodic focus is a word or a phrase. To answer this concern, we provide two sample pitch contours-among many similar examples in both Seoul Korean and South Kyungsang Korean-in Figure 5(a-b). Note that each digit refers to a digit string position, and that position 1 (shaded in gray) contains the target digit produced with corrective focus. As is clearly seen in both plots, when position 1 is in focus, positions 2 and 3 also show an increase in pitch. Put differently, not only does the focus effect fall on the corrected digit, but it also spreads to the next positions within the same phrase. This supports the understanding that the domain of prosodic focus is not a word but a phrase. Another question from the reviewer was why dephrasing was not included in describing prosodic focus effects. Dephrasing is not clearly evident in Figure 5(a-b); instead, a (very) weak level of suppressed pitch range is seen toward the end of the second AP, which is very far from the target focus position. This phenomenon is different from the claim made in the previous literature. Identifying the precise nature of dephrasing is not the intent of the current research; thus, we leave it to a future study.

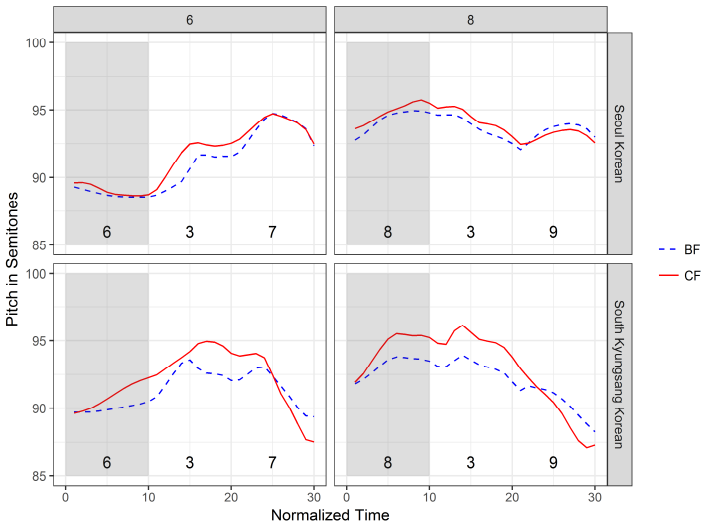

Figure 4. Sample pitch contours for the broad-focus (BF) and the corrective-focus (CF) conditions in each language

2.5 Acoustic measurements

In this study, duration in millisecond (ms), mean intensity in decibels (dB), and mean pitch in semitones (st) were calculated in each labeled focus position (that is, each focused digit), as a measure of the amount of modulation by prosodic focus. Furthermore, in order to determine whether or not prosodic marking of focus is actually ambiguous, duration (ms), mean intensity (dB), and mean pitch (st) were obtained from the adjacent positions of the target focus position within the same phrase. To be more specific about the adjacent positions: in the digit string (NNN)-(NNN)-(NNNN), when the first digit was in focus, the second and third digits

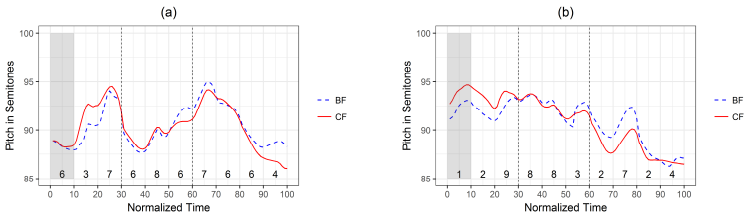

Figure 5. Two sample pitch contours

were adjacent positions within the same phrase, demarcated by parentheses. We label these positions as post-focus positions. When the second digit was in focus, the first and the third digits were adjacent positions. In this case, the first and third digits are labeled as pre-focus and post-focus positions, respectively. And when the third digit was in focus, the first two positions were deemed adjacent, which are labeled as pre-focus positions. The same method then applied to the second and third phrases. It should be noted that the last digit in the IP-final position, however, was excluded from this analysis, since it normally shows an IP-final declarative falling tone.

2.6 Analysis and results

In order to identify whether prosodic marking of focus is both weak and ambiguous in Seoul Korean and South Kyungsang Korean, we directly compared the digit strings in the broad-focus condition with the same sequences in the corrective-focus condition by the aggregate measures of duration (ms), mean intensity (dB), and mean pitch (st). For simplicity, we will hereafter refer to each respective parameter as duration, intensity, and pitch. In what follows, we describe the results of the focus effect in the focus position and, subsequently, those in the adjacent positions.

2.6.1 Focus effects in the focus positions

Figure 6 exhibits the means and 95% confidence intervals of the three measurements (duration, intensity, and pitch) as a function of focus, stratified by language. First, in Seoul Korean, we observe that corrective-focus conditions produce a longer duration, greater intensity, and higher pitch than broad-focus conditions. Among the three parameters, the difference in duration and intensity between the two focus conditions is quite small, whereas the difference in pitch is relatively large. South Kyungsang Korean shows a somewhat different pattern of results. Corrective-focus conditions produce a larger difference in duration and pitch than the broad-focus counterparts, whereas for intensity, broad-focus conditions display a larger value than corrective-focus ones.

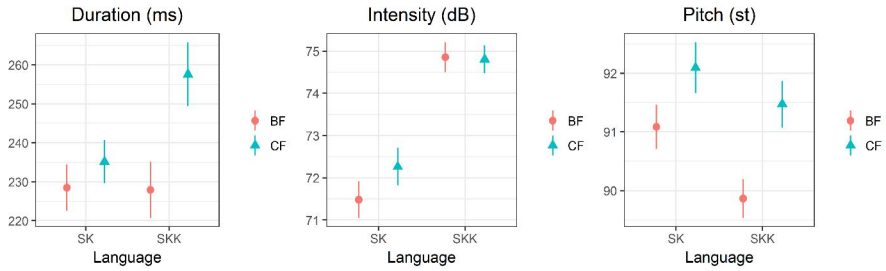

Figure 6. Duration, intensity, and pitch of the two focus conditions in each language. Points represent means and error bars 95% confidence intervals. Abbreviations are defined in Figure 3: BF (broad focus), CF (corrective focus), SK (Seoul Korean), and SKK (South Kyungsang Korean)

In order to statistically confirm our visual observation in Figure 6, we used a linear mixed-effects model analysis, separated for each language, through the *lmerTest* package (Kuznetsova *et al*. 2013) in R (R Core Team 2016). In the model, focus (broad and corrective) was included as a fixed effect, with the three parameters (duration, intensity, and pitch) as dependent variables; subject (five speakers) was treated as a random effect. Following this procedure, we conducted the *Anova* function of the *lmerTest* package in order to determine the significance of the fixed effect. In what follows, we describe the results of the linear mixed-effects model analysis for each language.

In Seoul Korean, the main effect of focus was significant for intensity (X^2 = 8.12, df = 1, $p < 0.01$) and pitch (X^2 = 41.17, df = 1, $p < 0.001$), but focus did not produce a significant effect on duration in the language (X^2 = 2.93, df = 1, p = 0.087). In South Kyungsang Korean, focus had a significant effect on both duration (X^2 = 32.28, df = 1, $p < 0.001$) and pitch (X^2 = 94.56, df = 1, p = 0.001), but not on intensity (X^2 = 0.05, df = 1, p = 0.83). According to the statistical outcomes, the two languages showed a pattern of both similarity and difference in the trends of prosodic marking of focus. The similarity is that pitch was the main correlate of prosodic focus in both languages. The difference is that duration was not an important cue signaling prosodic focus in Seoul Korean, but intensity functioned as that kind of cue in South Kyungsang Korean.

2.6.2 Focus effects in the adjacent positions

In order to illustrate whether prosodic marking of focus is ambiguous in each language, Figure 7 gives the mean differences (with 95% confidence intervals) in duration (ms), intensity (dB), and pitch (st) in the three focus positions for each language. The mean differences were computed by the aggregate measures between corrective focus minus broad focus. In Figure 7, a value over zero means that corrective focus produces a greater value than broad focus; for reference, a horizontal dotted line is provided to indicate the zero level.

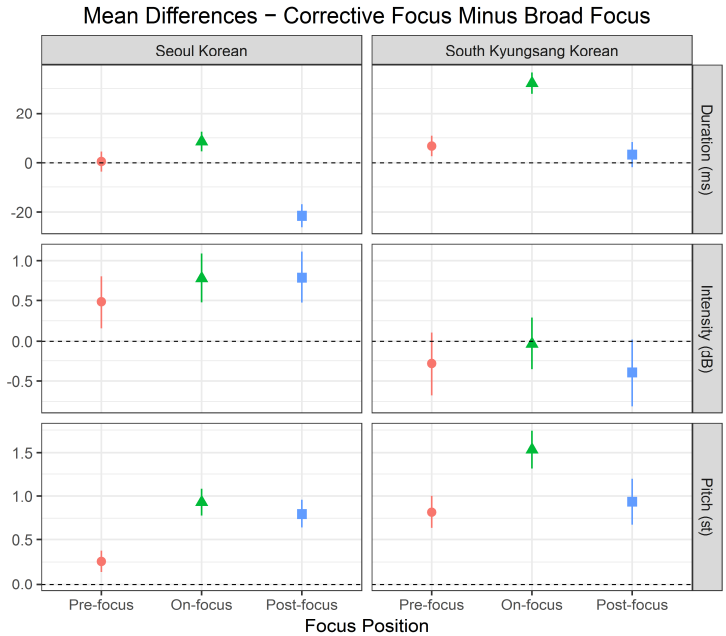

Figure 7. Mean differences in duration (ms), intensity (dB), and pitch (st) of the three focus positions between corrective focus minus broad focus in each language. Points refer to means and error bars to 95% confidence intervals

It seems that both Seoul Korean and South Kyungsang Korean, though somewhat different in the details, exhibit no clear pattern of prosodic marking of focus in the on-focus position. More specifically, Seoul Korean shows all the values of the three

acoustic parameters greater than zero (that is, corrective focus > broad focus). But we observe that the duration cue is minimal, showing an increase of just 8.4 ms to mark corrective focus. For the intensity and pitch cues, although these parameters show values greater than zero, the prosodic focus effects also spread to the adjacent positions. This suggests that Seoul Korean's prosodic marking of focus is, to some extent, ambiguous. Turning to South Kyungsang Korean, corrective focus does not produce a greater value for intensity than broad focus. Furthermore, the on-focus position induces a relatively small increase in intensity, compared to the pre- and post-focus positions. With respect to the duration and pitch cues to focus, the on-focus position shows a relatively larger value than zero and the adjacent positions. What is noteworthy, however, is that the pre- and post-focus positions also show a far greater value than zero for pitch. Based on this visual representation, we speculate that South Kyungsang Korean's prosodic modulation by focus is fairly ambiguous, quite similar to Seoul Korean.

For statistics, we used *lmerTest* (Kuznetsova *et al.* 2013) in R (R Core Team 2016) to conduct a linear mixed-effects model analysis, stratified by language. This model included focus position (pre-focus, on-focus, and post-focus) as a fixed factor, and the three parameters (duration, intensity, and pitch) as dependent variables, and treated subject (five speakers) as a random factor. In addition, because there are three focus positions within the fixed factor (that is, focus position), we conducted a multiple comparison analysis, through the *mcp* function of the *lmerTest* package, in order to identify which of the following positions differ significantly with the three acoustic parameters: post-focus vs. on-focus, pre-focus vs. on-focus, and pre-focus vs. on-focus. What follows is a statistical analysis of the linear mixed-effects model for each language. We first describe the results of Seoul Korean, followed by a description of the results of South Kyungsang Korean.

In Seoul Korean, the statistical results revealed that focus position did not have a significant effect on intensity (X^2 = 2.45, df = 2, p = 0.29). This indicates that the on-focus position did not differ significantly from the adjacent positions with respect to intensity; in other words, the focus effect by intensity was evenly spread over the adjacent positions. However, focus position had a significant effect on both duration (X^2 = 101.61, df = 2, p < 0.001) and pitch (X^2 = 52.11, df = 2, p < 0.001). In Table 3, we then illustrate the details of the multiple comparison analysis. This excludes the output for intensity, because the main effect of focus position was insignificant

for the parameter. Table 3 demonstrates that the on-focus position showed a significantly longer duration than the pre- and post-focus positions. What is notable is that the duration of the on-focus position was only 7.98 ms longer than that of the pre-focus position.

Table 3. The output of the multiple comparison analysis for the main effect of focus position in Seoul Korean. Estimate and SE refer to coefficient estimates and standard errors, respectively

		Estimate	SE	*z*-value	*p*-value	
Duration (ms)	Post-focus vs. On-focus	-30.01	2.93	-10.23	< 0.001	***
	Pre-focus vs. On-focus	-7.98	2.80	-2.85	< 0.05	*
	Pre-focus vs. Post-focus	22.03	3.15	6.97	< 0.001	***
Pitch (st)	Post-focus vs. On-focus	-0.13	0.10	-1.33	= 0.38	
	Pre-focus vs. On-focus	-0.67	0.09	-7.12	< 0.001	***
	Pre-focus vs. Post-focus	-0.54	0.11	-5.08	< 0.001	***

(* $p < 0.05$, *** $p < 0.001$)

Moving on to South Kyungsang Korean, the main effect of focus position was not significant for intensity ($X^2 = 3.78$, $df = 2$, $p = 0.15$), as in Seoul Korean. But focus position had a significant effect on both duration ($X^2 = 109.35$, $df = 2$, $p < 0.001$) and pitch ($X^2 = 36.63$, $df = 2$, $p < 0.001$). Table 4 shows the output of the multiple comparison analysis, excluding intensity for the same reason as above. We observe that the on-focus position showed a significantly greater value for duration than both pre-focus and post-focus positions (25.46 ms and 28.90 ms longer than the pre-focus and post-focus positions, respectively). The on-focus position also showed a similar trend for pitch; it produced a 0.72 st and 0.60 st higher than the pre-focus and post-focus positions, respectively.

Table 4. The output of the multiple comparison analysis for the main effect of focus position in South Kyungsang Korean. Estimate and SE refer to coefficient estimates and standard errors, respectively

		Estimate	SE	*z*-value	*p*-value	
Duration (ms)	Post-focus vs. On-focus	-28.90	3.11	-9.28	< 0.001	***
	Pre-focus vs. On-focus	-25.46	2.97	-8.57	< 0.001	***
	Pre-focus vs. Post-focus	3.439	3.36	1.23	= 0.56	
Pitch (st)	Post-focus vs. On-focus	-0.60	0.13	-4.45	< 0.001	***

Pre-focus vs. On-focus	-0.72	0.13	-5.59	< 0.001	***
Pre-focus vs. Post-focus	-0.12	0.14	-0.82	= 0.69	

(*** $p < 0.001$)

3. Perception experiment

3.1 Audio stimuli

From the production data, we chose a set of 100 phone-number strings produced with corrective focus for each of the languages: Seoul Korean and South Kyungsang Korean. The set of audio stimuli was randomly selected from five speakers (20 strings per speaker) and designed such that every string position included 10 digits from 0-9 and each digit was equally focused in every string position. This design enabled a balanced distribution of focus tokens in every string position.

3.2 Participants

Table 5 presents the number of listeners who participated in the perception experiment in each language. It also shows the mean age and standard deviation (SD) of listeners. The mean age and SD were calculated at the time of participation in the study.

Table 5. The number of listeners and the mean age (SD) of each language

Language	Listeners	Mean age (SD)
Seoul Korean	34	25.6 years (4.6)
South Kyungsang Korean	20	30.3 years (4.7)

3.3 Procedure

We set up the experiment using a web-browser (Qualtrics) in order to recruit listeners of these languages online from the US and to enable ease of access. Before the actual test began, participants were provided with a description of what corrective focus is and how the experiment proceeds, as illustrated in Figure 8.[6]

Furthermore, the survey asked basic demographic information such as participants' name, age, and gender. Participants were provided with a consent form online and agreed to participate as a subject in the perception experiment.

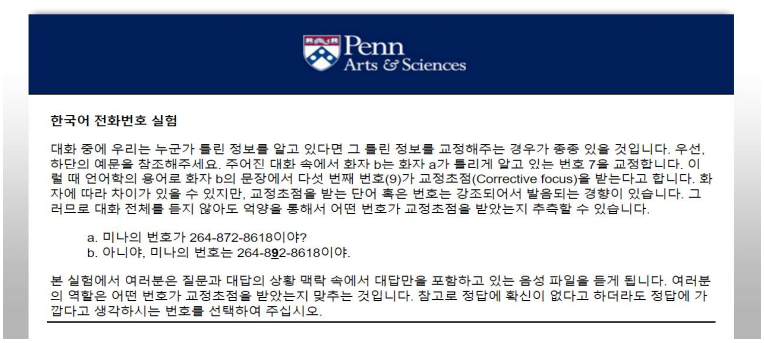

Figure 8. A screenshot of the instructions for the survey in Qualtrics

Figure 9 shows a screenshot of part of the survey in Qualtrics. During the test, participants heard only the phrase with the correction by pressing a play button. They were then asked to select the corrected digit in a ten-choice task, as indicated below, where numerical digits indicate each digit in a digit string. Through this design, each target answer was decontextualized, without the question from the question-answer pair, so participants had to rely only on prosodic information to identify the corrected digit of each target answer. In the experiment, participants were allowed to repeat the audio file as many times as they desired.

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6 Below is the loose English equivalent of the description in Figure 8:

Corrective focus is used to correct wrong information from prior context. For example, the fifth digit *9* (b) is used to correct the wrong digit *7* (a) in the previous sentence. A corrected digit, such as *9* (b), is usually produced with prosodic prominence. Therefore, a speaker in (b) would emphasize the digit *9* in correcting the wrong digit *7*; thus, one can guess which is the corrected digit through prosodic prominence, without listening to the whole question-answer pair.

(i) a. Mary's phone number is 264-872-8618, right?
b. No, Mary's phone number is 264-892-8618.

In this experiment, you will listen to 100 audio files that contain only the answer from the question-answer pair. In each question, you will need to identify which digit represents corrective focus. Even if you are not sure of the answer, please try to select the digit that is the closest to the answer.

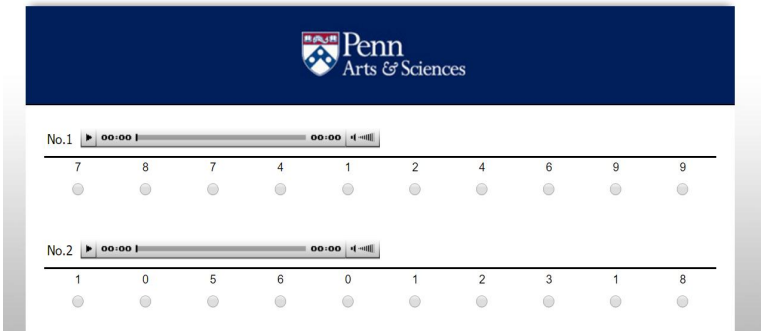

Figure 9. A screenshot of part of the survey in Qualtrics

3.4 Analyses and results

Because our experiment is intended to test whether listeners can successfully identify the corrected digit in each question, we were unable to pursue a statistical test from the perception data, since there is no control group for a comparison. Instead, our approach is to analyze the perception data based on position-by-position identification rates (percentage values) for corrective focus. The identification rates are tabulated into a confusion matrix that evaluates a classification's accuracy. What follows is a description of the identification rates for Seoul Korean and South Kyungsang Korean, one by one.

Overall, focus positions were identified at a rate of 37.3% in Seoul Korean. The confusion matrix of Seoul Korean demonstrated that incorrect answers usually occurred within the same phrase (demarcated by dotted lines) before or after focus positions. For example, when position 1 was focused, positions 2 and 3 were identified at a rate of 16.8% and 22.9%, respectively. When position 2 was focused, positions 1 and 3 were identified at a rate of 16.5% and 22.2%, respectively. Given that the chance level is 10% (=100/10), the rate of incorrect answers is neither random nor negligible. Other focus positions, though slightly different in detail, also showed a similar trend. The identification rates in Table 6 suggest that prosodic marking of focus was actually ambiguous in Seoul Korean.

Table 6. Confusion matrix of corrective focus perception (percentage values) in Seoul Korean. Numbers highlighted in gray indicate correct identification rates. Dotted lines indicate a phrase boundary in a digit string

		Perceived									
		1	2	3	4	5	6	7	8	9	10
Target	1	31.5	16.8	22.9	8.2	4.4	4.7	6.2	1.2	2.4	1.8
	2	16.5	36.5	22.1	5.9	3.2	4.7	6.2	1.5	1.8	1.8
	3	10.6	4.4	51.8	5.6	1.8	7.9	5.6	3.2	7.9	1.2
	4	7.9	5.0	12.9	35.9	5.0	12.6	12.9	1.5	5.3	0.9
	5	8.5	9.1	5.6	18.2	38.5	12.9	4.4	1.2	0.9	0.6
	6	5.3	2.6	7.9	10.9	3.8	45.9	14.4	6.5	2.1	0.6
	7	8.8	5.9	8.2	4.1	0.9	4.4	41.2	7.9	14.4	4.1
	8	15.9	9.1	9.7	7.6	4.1	7.1	20.0	17.9	6.5	2.1
	9	7.1	2.9	8.5	14.4	2.4	5.3	13.5	6.5	36.8	2.6
	10	0.9	4.1	12.6	5.9	2.4	6.2	13.5	2.6	14.1	37.1

Even if we score by phrase rather than by position, the overall identification rate would become 63.4% for Seoul Korean, as indicated by Table 7. It should be noted that this identification rate is still not high, suggesting that prosodic marking of focus was actually weak in Seoul Korean.

Table 7. The phrase-by-phrase confusion matrix for Seoul Korean

		Perceived		
		1st phrase	2nd phrase	3rd phrase
Target	1st phrase	71.0	15.5	13.5
	2nd phrase	21.7	61.3	17.1
	3rd phrase	25.4	16.8	57.8

Table 8 below represents a confusion matrix of corrective focus perception in South Kyungsang Korean. We observed that focused positions were not clearly identified-the overall identification rate was just 48.2%. Similar to Seoul Korean, incorrect answers often appeared within the same phrase before or after focus positions. For example, when position 1 was in focus, position 2 was identified at a rate of 23.0%. When position 2 was in focus, position 1 was identified about 22.5% of the time. When position 5 was focused, position 4 was identified 29.0% of the time. This trend was also observed in other focus positions, suggesting that prosodic

marking of focus was actually ambiguous in South Kyungsang Korean.

Table 8. Confusion matrix of corrective focus perception for South Kyungsang Korean (percentage values). Numbers highlighted in gray indicate correct identification rates. Dotted lines indicate a phrase boundary in a digit string

		Perceived[7]									
		1	2	3	4	5	6	7	8	9	10
Target	1	51.0	23.0	7.0	3.5	3.0	0.5	4.0	1.5	3.0	3.5
	2	22.5	46.0	11.5	8.0	1.0	0.0	3.0	2.5	5.0	0.0
	3	8.0	5.0	72.0	3.0	1.5	2.0	2.5	1.0	4.5	0.5
	4	9.0	7.5	7.5	43.5	13.0	3.5	10.5	1.0	2.0	2.5
	5	6.0	6.0	1.5	29.0	44.5	3.0	3.5	2.0	4.0	0.0
	6	6.0	5.0	5.5	3.5	4.0	57.0	10.5	4.5	2.5	0.5
	7	15.0	0.0	5.5	2.5	4.5	2.5	34.0	10.5	21.5	4.0
	8	6.5	1.5	2.0	0.5	3.0	0.5	27.5	46.0	11.5	1.0
	9	5.3	3.2	5.8	4.2	3.2	1.6	10.0	13.2	50.5	3.2
	10	4.5	4.0	9.0	2.5	0.5	0.0	4.0	2.0	36.5	37.0

Even if we score by phrase, as shown in Table 9, the overall identification rate would increase to 75.5% for South Kyungsang Korean. This identification rate is still not high, meaning that South Kyungsang Korean's prosodic modulation by focus is deemed weak.

Table 9. The phrase-by-phrase confusion matrix for South Kyungsang Korean

		Perceived		
		1st phrase	2nd phrase	3rd phrase
Target	1st phrase	82.0	7.5	10.3
	2nd phrase	18.0	67.0	14.5
	3rd phrase	14.9	7.5	77.6

[7] We thank the reviewer who pointed out that the identification rate of the AP-final position is the highest within the same phrase in both languages. There may be several confounding factors, such as AP-final lengthening and suppressed pitch range in the post-focus positions, that contribute to the highest identification rate. However, it is unclear which plays the most important role, or whether two factors interact to help listeners identify the focus position. Since it is not the intent of the current research to tease them apart, we will leave it to a future work.

4. Discussion and conclusion

This study used production and perception experiments to explore whether or not prosodic marking of focus is both weak and ambiguous in Seoul Korean and South Kyungsang Korean. The technique described in this paper allowed a systematic and quantitative examination of prosodic marking of focus in both languages. We have shown that this method can be used for the study of perception as well as production, and that the perception and production results were generally congruent.

In regard to the focus effects in the focus positions, the production data showed that the main effect of focus was significant for both intensity and pitch in Seoul Korean. Also, focus produced a significant effect on both duration and pitch in South Kyungsang Korean. The results indicate that two acoustic parameters (out of three) played important roles in marking prosodic focus in each language.[8] Nonetheless, the perception data revealed that the overall identification rates were about 37% for Seoul Korean and about 48% for South Kyungsang Korean. Based on these perception results, we can say that the prosodic modulation by focus was indeed weak in production, leading to a relatively poor identification performance in perception for both languages. In other words, listeners of these languages had difficulty identifying the position of corrective focus, because prosodic marking of focus was not sufficiently strong in both languages.

An important question is why prosodic marking of focus is "weak" in both Seoul Korean and South Kyungsang Korean. We speculate that these languages are not stress accent languages. To illustrate stress accent languages for comparison purpose, such as English (Cooper *et al.* 1985; Xu and Xu 2005), German (Baumann *et al.* 2006), and Dutch (Swerts *et al.* 2002), prosodic focus is signaled with a nuclear pitch accent aligning it with a primary stressed syllable within the focused word. And the stressed syllable via focus becomes the most prominent syllable in a sentence (Beckman and Pierrehumbert 1986). Following the same method using digit strings, Lee (2015) found that English produced a sufficiently strong prosodic marking of focus in production, leading to a high identification rate (about 97%) in perception. We concede, however, that this speculation is premature; we need to test

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8 One reviewer questioned why pitch played an important role in marking prosodic focus in both languages. The current research cannot provide a clear answer, so we note this point as a limitation of the current research and seek to examine it in future research.

more languages to determine whether or not “stress-accent” does play a key role in producing a strong marking of focus.

Looking now at the focus effects in the adjacent positions, both Seoul Korean and South Kyungsang Korean demonstrated an ambiguous prosodic marking of focus. In production, focus effects spread to the neighboring positions around the focus position. For example, in Seoul Korean, pre-focus and post-focus positions produced a larger value than zero for the parameters of intensity and pitch. In South Kyungsang Korean, duration and pitch were increased in the adjacent positions as a function of focus; what is notable is that the pitch cues to the pre-focus and post-focus positions were much larger than zero. As a result, listeners of these languages had difficulty identifying which digit was produced with corrective focus. Thus, incorrect answers often appeared before or after focus positions in perception. The “ambiguous” feature as a function of focus suggests that the domain of prosodic focus is a phrase-not a word-in both languages.

The immediate question is why speakers of Seoul Korean and South Kyungsang Korean produced an ambiguous prosodic marking of focus. Based on the findings, we speculate that the ambiguous distribution of prosodic focus is related to the lower degree of freedom, which leaves little room for variability in the distribution of prosodic focus. As discussed in the Introduction, prosodic patterns are fixed at the phrase level in these languages. For example, Seoul Korean shows only two prosodic patterns (LHLH or HHLH) within a phrase, with the initial tone dependent on the laryngeal feature of an AP-initial segment. South Kyungsang Korean also shows limited prosodic patterns within a phrase; the possible prosodic patterns include HHL, HLL, LHL, and LHH for the trisyllabic phrase, and HHLL and LHHL for the quadrisyllabic phrase. Therefore, speakers of these languages did not seem to control their vocal efforts easily for each focus position (or digit); thus, the focus effects spread to the adjacent positions within a phrase as a function of focus.

In this study, the two varieties of Korean produced different identification rates over the focus positions. As stated previously, Seoul Korean’s identification rate was about 37%, whereas South Kyungsang Korean’s rate was about 48%. From the production data, we observed that, in contrast to other acoustic parameters, South Kyungsang Korean produced particularly longer durations than Seoul Korean. While Seoul Korean showed only a slight increase of 8.6 ms of extra duration for prosodic marking of focus, South Kyungsang Korean actually showed about 32 ms of extra

duration for focus marking. This indicates that the duration cues to the focus positions were 3.7 times longer in South Kyungsang Korean than in Seoul Korean. Therefore, we posit that the large difference in duration cues serves as the main factor accounting for the better identification performance of South Kyungsang Korean.

The findings of this study suggest directions for future research. First, we need to examine other varieties of Korean, such as Chonnam Korean and North Kyungsang Korean, to determine whether there is cross-dialectal variation in the use of prosodic focus. Additionally, future research needs to focus on a cross-linguistic generalization. Jun (2014) avers that accentless dialects of Japanese, Halh Mongolian, Oirat Mongolian, and West Greenlandic are prosodically similar to Seoul Korean, in that these languages have neither lexical stress nor lexical pitch accent. And South Kyungsang Korean is considered prosodically similar to Tokyo Japanese and Leketio Basque-all languages with lexical pitch accent. Given that these languages show more or less regular and fixed tonal melodies at the phrase level, we speculate that these languages also show a weak and ambiguous prosodic marking of focus, if following the experimental paradigm tested in this study. The need for more comprehensive data motivates us to collect a larger body of prosodically similar languages to obtain a clear picture.

To sum up, this study explored the mode of prosodic marking of focus in Seoul Korean and South Kyungsang Korean. From the production data, the results of this study showed that prosodic marking of focus was weak and ambiguous. The perception data revealed that listeners of these languages had difficulty identifying the location of corrective focus, showing a poor identification performance. The results suggest that prosodic marking of focus is neither completely automatic nor universal; this is a contrast to the belief that focus attracts prosodic prominence (Büring 2010; Samek-Lodovici 2005; Truckenbrodt 1995). Instead, we speculate that prosodic marking of focus conforms to the prosodic structure of each language, but further exploration, with a larger and more comprehensive set of languages, is required.

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Received: 2016. 12. 05.
Revised: 2017. 03. 02.
Accepted: 2017. 03. 02.