Volume 6
Issue 3 *Current Work in Linguistics*

Article 9

1-1-2000

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1 Background

It is well-known that voicing distinctions in prevocalic position can affect the fundamental frequency (F0) of following vowels (Hombert 1977, Kingston & Diehl 1994, among others). Most of the literature on this issue, however, has dealt only with how the segmental effects of the binary voicing distinction between 'voiced' and 'voiceless' are different on the F0 of the following vowel. The question arises how this effect would be realized in languages like Korean where obstruents with the same place of articulation can contrast in more than binary ways.

Korean obstruents are generally grouped into three series, referred to as lenis (/p, t, k, c, s/), aspirate (/p^h, t^h, k^h, c^h/) and fortis (/p', t', k', c', s'/). Since each of the consonants in these groups can cause meaning contrasts, what exactly characterizes the featural specification of these series has been an issue. Generally the lenis is considered the least marked with no laryngeal specification at the underlying level, while the aspirate and the fortis are specified with [+spread glottis] and [+constricted glottis], respectively, under the laryngeal node.[1]

Korean obstruents have also been reported to influence the F0 of a following vowel (Kim 1965, Kagaya 1974, etc.). Specifically, a higher F0 is found after aspirate and tense consonants but a lower F0 after lenis consonants. The following picture illustrates these effects.

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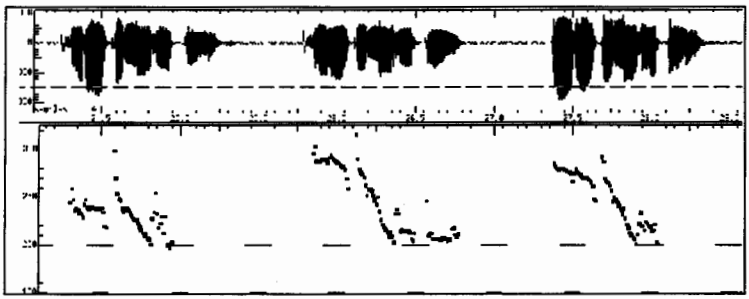
*This paper has grown out of an experiment conducted while taking Ling 521 in Spring 1998. I thank Mark Liberman, Gene Buckley, Rolf Noyer, John Kingston, Steven Bird, Kazuaki Maeda, and John Bell for their help. Usual disclaimers apply. A revised and expanded version of this paper will appear in the proceedings of the Holland Institute of Linguistics Phonology Conference 4. Readers who are interested in a more phonological approach to the prosodic prominence system of Korean are referred to Ko (1999b).

[1]The fortis consonant is phonetically realized as identical as geminated lenis consonants. Therefore, it has been argued whether the Korean fortis is a geminated lenis or a singleton. Since the argument is not directly related to the issues raised in this paper, I will not discuss the nature of the fortis consonants in this paper. However, I have argued elsewhere (Ko 1999a) that the fortis series are actually geminated lenis consonants.

(1) Laryngeal effects on the F0 in Korean



[**pa**-lako malhay-pwa] [**p^{h}a**-lako malhay-pwa][**p'a**-lako malhay-pwa]
('say *pa*') ('say *p^{h}a*') ('say *p'a*')

In a study of the prosodic system of Korean, Jun (1993) argued that this segmental effect has been phonologized to a H tone in Korean. Were this correct, the situation in Korean would be unusual. While the phonologization of F0 *depression* is cross-linguistically common, there are very few cases where *boosting* of F0 under the influence of preceding consonants has been analyzed as a phonologized effect. We should therefore be wary of accepting Jun's theory, as it posits for Korean a typologically marked sort of phonology. A more direct problem is the incompatability between Jun's account and other phonological phenomena in Korean. I will show, on both phonetic and phonological grounds, that Jun's way of interpreting the F0 boosting cannot adequately explain the accentual H tone (H*) assignment in the realization of 'the calling contour' in Korean.

This paper does not intend to provide an articulatory explanation of the segmental effect that causes variable manifestation of the F0 perturbation in different languages. Rather, it will be focused on clarifying the phonetic or phonological status of the F0 enhancement induced by non-lenis consonants in Korean. In the remainder of this paper, I will first examine Jun's analysis of this phenomenon in detail (section 2). I will then describe the phenomena and relevant problems in the realization of the 'calling contour' in Seoul and Chonnam dialects of Korean (section 3). The results of an experiment on vocative chant[2] will be reported (section 4) with discussion and analysis of the phenomenon. Section 5 concludes.

[2]The terms 'vocative chant' and 'calling contour' are used interchangably throughout this paper.

2 Previous Studies and Problems

2.1 Phonologization of the Laryngeal Effect: Jun (1993, 1996, 1997)

In a study of the intonational pattern in Korean, Jun (1993) argued that an Intonational Phrase in Korean consists of smaller units, viz. Accentual Phrases (APs), which are also tonally marked. Noting that the F0 of a vowel preceded by a laryngeal consonant (i.e., aspirate or tense consonant) is substantially high and stable, Jun (1993) states that the segmental effect has been phonologized in Korean. Consequently, she contends that, if an AP begins with an aspirate or tense consonant, the tonal pattern of the phrase begins with a H tone, and otherwise a L tone. Thus, she suggests that the AP in Seoul has a tonal pattern of either LHLH or HHLH and that in Chonnam either LHL or HHL, depending on the laryngeal specification of the AP-initial segment.

In her analysis, the Tone Bearing Unit (TBU) for the Seoul dialect is the syllable, while that of the Chonnam dialect is the mora. This is because Seoul is generally known to have lost, or is undergoing a complete loss of phonologically distinctive vowel length, which Chonnam still maintains. The loss of vowel length in Seoul is a characteristic of the speech of younger generation (Magen & Blumstein 1993). Ko (1999a), however, suggests that vowel length is not phonologically distinct in Chonnam, either, and that, therefore, the TBU in both dialects is the syllable.

(2) and (3) illustrate how Jun's pitch accent assignment works:

(2)

L (H)L H		L H L
[y ə ŋ s u c ɨ ŋ]	vs	[y ə ə ŋ s u c ɨ ŋ][3]
'receipt'		'receipt'
Seoul		Chonnam

(3)

H (H)L H		HH L
[pʰ a r a ŋ s æ k]	vs	[pʰ a a r a ŋ s æ k]
'blue color'		'blue color'
Seoul		Chonnam

Jun's proposal is interesting, in that segmentally induced F0 perturbation plays an important role in the intonation pattern of Korean; but it is not

[3]A long vowel is represented as a geminate vowel sequence.

entirely clear whether the segmentally triggered phrase-initial H tone is phonetic, due to the undershoot of a L tone, or is phonological, i.e., part of an underlying phrase tone. In other words, although it is possible to consider the high pitch after laryngeal consonants as part of an underlying tonal pattern, it would be also possible that a phrase-initial F0 perturbation stays high due to the effect of the following H tone, in which case the boosting of F0 in vowels following non-lenis consonants would be a purely phonetic effect. One way to test the latter hypothesis would be to see how the segmental effect is realized when it is followed by a L tone instead of a H tone.

In Jun (1996), an experiment is reported which focuses on the effects of consonants on the F0 of a following vowel cross-linguistically. Its goal is explicitly to determine the status of the AP-initial H tone of Korean as either phonetic or phonological. The results of her experiment show that the F0 pattern after Korean consonants is substantially different from that of English and French. For Korean, F0 after an *aspirated* or a *tense* consonant is significantly higher (in average 50-80 Hz) than that after a lenis or a sonorant consonant, and these F0 differences persist until the end of the vowel. In English and French, however, the F0-boosting effect of consonants is not as significant: in both languages, the rise in F0 persists for only 20-40 ms after consonant onset.[4]

Jun states that if the phrase-initial raised pitch in Korean resulted from a L tone undershoot due to the following H tone, we would expect a similar pattern of F0 values both in English and French when the phrase-initial syllable is followed by a H tone. However, her experiment shows that the F0 values of English and French, even in these cases, differ only at phrase-initial position and the difference does not persist longer than 40-60 ms into the vowel. On the other hand, the phrase-initial high F0 in Korean triggered by a laryngeal consonant remains high regardless of the following tone type. Based on these results, she argues that the phrase-initial H tone in Korean is not due to phonetic undershoot but is part of the underlying representation of intonation.

However, Jun's reasoning for determining the phonological or phonetic status of the phrase-initial high F0 in Korean is questionable. It may be *phonetically* true that the effect of the Korean laryngeal consonants shows a significant difference from that of English and French. However, this in itself

[4]Compare, however, Hombert's (1978) observations:

> Although the greatest difference in the F0 curves [in Figure 1] exist at vowel onset, statistical analysis (analysis of variance followed by Duncan's test) reveals that they are still significantly different *100 msec* after vowel onset. (Hombert 1978: 80, emphasis added)

does not comprise a strong argument regarding the phonological or the phonetic status of the laryngeal effect in Korean. What her experiment shows is that the laryngeal effect in Korean is remarkably strong compared with the F0 perturbation phenomena found in other languages, but, strictly speaking, not anything more than that. This unusually strong segmental effect in Korean may be explained phonetically by the fact that the production of Korean aspirate and tense consonants involves different phonetic mechanisms[5] than does the production of their nearest counterparts in English and French.

A more detailed review of Jun's argument will be given in the following section.

2.2 Problems with Jun's Analysis

Jun's analysis of the laryngeal effect in Korean as a phonological H tone seems to make sense as far as declarative utterances are concerned. For example, let us look at the following data, which are citation forms of the name 'Hyun-Cheol [hyənčəl]' in Seoul and Chonnam.

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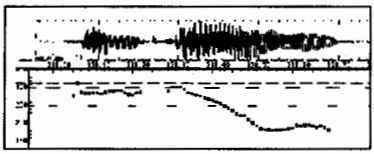
[5]The explanations proposed for such segmental effects can be summarized into two categories (Hombert 1978: 81). The first attributes the F0 perturbations to aerodynamic effects, and the second to differences in vocal cord tension.

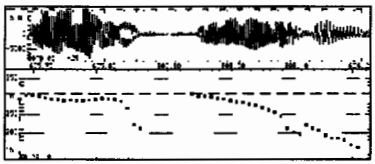
According to Hombert, researchers following the aerodynamic theory would explain the phenomenon in the following terms: after the closure of a voiced consonant, voicing continues, but since the oral pressure increases (because of the closure), the pressure drop decreases, leading to a lower frequency. In the case of voiceless consonants, since the rate of airflow is supposed to be high, a strong Bernoulli effect will draw the vocal folds together very rapidly; they will be pushed apart very rapidly as well because the subglottal pressure is high. Consequently, the rate of vibration of the vocal folds will be high at the onset of the vowel and will return gradually to the intrinsic value of the vowel being realized.

On the other hand, proponents of vocal fold tension theory claim that this perturbatory effect is too long to be attributed to aerodynamic factors. Halle and Stevens (1971) suggest that these intrinsic variations are the result of horizontal vocal cord tension, and they propose the features [stiff] and [slack] vocal cords to capture the relationship between low tone and voiced consonants (where the vocal cords are supposed to be slack in order to facilitate voicing) on the one hand, and high tone and voiceless consonants on the other hand.

Since Korean aspirate and tense consonants, both of which show an F0 boosting effect, do not share a [voice] feature, but they are both characterized by a [stiff] vocal fold (Kim 1965), it seems that the second position is more plausible as an explanation of the Korean data. However, Hombert notes that Halle and Steven's position is not supported by experimental data by Hirose, Lisker, and Abramson (1973). Here, I will not discuss these issues further.

(4) a. Seoul b. Chonnam





Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

In the above pictures, it appears to be true that each phrase begins with a high pitch in both dialects. However, this in itself does not constitute a sufficient condition for its status as a phonological H tone; it is usually true that phonological H tones are realized with a high pitch,[6] but it is not always the case that a high pitch is a phonological H tone. This assumption can be schematized as follows:

(5)

phonetics phonology

In Jun's framework, each AP assigns one of the two tonal patterns (LHLH & HHLH in Seoul, and LHL & HHL in Chonnam) out of the phrasal tonal inventory. Importantly, however, all and only instances of the initial H tone in both Seoul and Chonnam occur if and only if the initial consonant is laryngeal. Therefore, there is no independent evidence in the phrasal tonology of Korean that there is an inventory with an initial H tone apart from the cases of the laryngeal-initial AP. To argue for a phonological inventory of tonal patterns such as HHLH for Seoul and HHL for Chonnam, one would want examples of such tonal pattern independent of the segmental effect. If we could find a tonal pattern of an AP with no phrase-initial laryngeal consonant realized similarly to such examples, then we could argue more convincingly for a 'phonologization' of the segmental effect.

Another problem with treating the laryngeal effect as a phonological rule arises from the unique property of the phoneme /s/ in Korean. Unlike other obstruents, this fricative does not have a three-way distinction, but only a two-way one between lenis (/s/) and fortis (/s'/).

[6]Downdrift or other phonetic renderings of H tone are not considered.

In the following, I will show properties of /s/ which show a lenis-like behavior with regard to a phonological rule, but an 'aspirated'-like patterning regarding a phonetic phenomena.

Although /s/ phonetically involves a strong aspiration in production, thus patterning with other aspirate consonants in terms of F0 boosting, phonologically it is classified as one of the series of lenis consonants. Evidence can be found from the morphophonology of compounding, where /s/ patterns with lenis instead of aspirated consonants. The following data illustrate:

(6) Morphological gemination in compounding

a. /i + mom/	→	[immom]	'tooth + body'	→ 'gum'
b. /pom + palam/	→	[pomppalam]	'spring + wind'	→ 'warm wind'
c. /mal + sori/	→	[malssori]	'words + sound'	→ 'speech'
d. /p^{h}ul + p^{h}ili/	→	[p^{h}ulp^{h}ili] (*[p^{h}ulp^{h}p^{h}ili])	'grass + whistle'	→ 'grass whistle'

In co-compounding, the second constituent of a compound undergoes gemination[7] in Korean if it starts with a sonorant or a lenis consonant. Thus, the sonorant in (6a) and the lenis in (6b) are geminated, but the aspirated consonant in (6d) is not. We see here that /s/ phonologically patterns with the lenis consonant, instead of the aspirated consonant.

On the other hand, there is also a strong tendency for /s/ to pattern with aspirated consonants when the phenomenon is phonetic in nature. Let's take an intervocalic vocing rule in Korean, for example. Korean lenis consonants undergo voicing when in intervocalic position (7a). However, aspirate consonants and /s/, as well as fortis consonants, do not undergo voicing in the same environment (7b-d). The following examples illustrate:

(7)					
	a.	/aki/	→	[agi]	'baby'
	b.	/isa/	→	[isa] *[iza]	'moving'
	c.	/kit^{h}a/	→	[kit^{h}a] *[kid^{h}a]	'etc.'
	d.	/op'a/	→	[op'a] *[ob'a]	'elder brother'

Silva (1992) has shown that this intervocalic voicing rule in Korean is phonetic in nature. The following example illustrates that the lenis stop voicing is sensitive to the phrasal domain:

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[7]Or tensification in the case of obstruents, depending on one's view. See footnote 1. Regardless, the point holds that /s/ patterns with other lenis consonants, i.e., it becomes phonetically fortis whether via gemination or tensification.

(8) ϕ[ω[pata] ω[palapwasse]] → [pata balabwasse]
sea looked at
'looked at the sea'

He demonstrates that the voicing of lenis consonants in Korean shows a different degree of voicing depending on its position in the phrase. When located within a prosodic word (ω), it undergoes a complete voicing; but when it occurs between two prosodic words, it is only partially voiced. The following table illustrates:

(9) Positional effect on the lenis stop voicing in Korean (Silva 1992: 166)

	ϕ-Edge	ω-Edge	ω-Internal
Vocing during closure	10 ms	17 ms	33 ms
% of closure that is voiced	23%	36%	77%
Post-release VOT	60 ms	22 ms	3 ms

If the 'laryngeal effect' were truly a phonologized phenomenon, as Jun argues, we would expect /s/ to pattern with the lenis series in terms of laryngeal effect. However, if it were phonetic, it would not be surprising that /s/ once again patterns with aspirate consonants instead of the lenis. In fact, /s/ is one of the most common segments that show such a segmental effect on the F0 boosting, along with other aspirated consonants. Thus, its patterning with aspirated consonants instead of lenis supports the argument that the segmental effect is phonetic.

I contend that a criterion for determining the phonological or phonetic status of a certain phenomenon should be found where the question of categorization is more clearly involved. The phenomenon of calling contour in Seoul and Chonnam dialects of Korean serves as a good test case for this purpose. A detailed discussion of this will follow in the next section.

3 Calling Contour

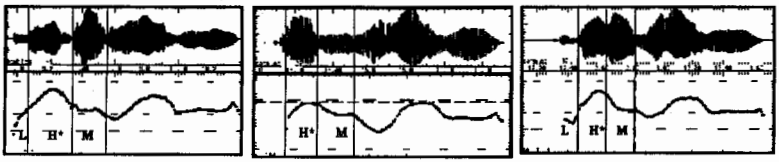
In the present section, the phenomenon of calling contour is examined to clarify the nature of the 'laryngeal effect' in Korean. It is known that each language has one or more fixed tunes used for calling contours (Liberman 1975). For example, in English and German, the calling contour is made of a H tone followed by a M tone.[8] The H tone must be associated with the nu-

[8]Or a downstepped H tone, depending on the interpretation. It is not crucial for the present discussion.

cleus or the most prominent lexically stressed syllable, thus identified as an accentual tone, H* (Ladd 1997). To my knowledge, no research on the realization of calling contour in pitch accent languages like Japanese has been reported. According to some Japanese informants[9] I have consulted, however, the H* aligns with the H pitch accent in the Tokyo, Kansai, and Osaka dialects of Japanese.

In English, the canonical tonal pattern for calling contour is known as LH*M, where only the H* and M tones are obligatory. Thus, in names like *Amanda*, where the stress falls on the second syllable, the H* is realized on the second syllable, followed by a M tone on the third. Since there is a place to dock the L tone, namely the initial syllable, all three tones are realized. In names like *Johnny*, however, the L tone is not realized since the H* is aligned with the stressed initial syllable, and there is no place for it to dock on. On the other hand, in names like *Suzanne*, although it is also a two-syllable name like *Johnny*, all three tones of LH*M are realized. This is achieved by lengthening the stressed second syllable to accommodate both the H* and M tones. The following pictures illustrate:

(10) a. Amanda b. Johnny c. Suzanne



No previous phonetic or phonological research has paid attention to the realization of calling contours in Korean. If the prosodic system of Korean were a lexical stress system similar to English, we would expect the same sort of tonal patterns as English with regard to the alignment of the H* assignment; I will actually argue this for Chonnam in the next section. On the other hand, the system were a phrasal pitch accent one, as Jun has argued for Seoul and Chonnam dialects of Korean, we would expect that the H* aligns with a H tone as in Japanese case, since the syllable/mora with a H tone would be the most prominent syllable/mora in the phrase.

Thus, if the AP-initial H tone in Seoul or Chonnam were truly phonological as Jun argues, we would expect that the accentual H tone would align with the AP-initial H tone. If for some reason the AP-initial H

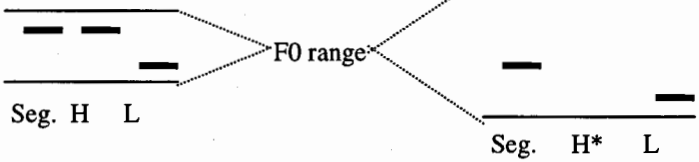
[9]Thanks are due to K. Maeda, K. Nishiyaki, and S. Haraguchi for providing me with their native speakers' intuition on this matter. It has not yet been verified by acoustic analyses.

tone did not count for the purpose of aligning the accentual H tone, perhaps due to its origin as a segmental effect, we would expect at least the same calling contour pattern among the AP's of the same tonal pattern.

For concreteness, let us take some examples. Names such as *Sang-Won* and *Hyun-Cheol* all start with a laryngeal consonant, and are thus realized with an initial HH tonal pattern in Seoul and Chonnam, in Jun's framework. On the other hand, names such as *Young-Seon* and *Eon-Suk* will have an initial LH pattern since they do not begin with a laryngeal consonant. Thus, we would expect the calling contours of the names like *Sang-Won* and *Hyun-Cheol* to show the same tonal pattern as those of the names such as *Young-Seon* and *Eon-Suk*. As will be discussed in the next section, however, the actual tonal pattern for the calling contour in Chonnam turns out to be the same for *Sang-Won* and *Eon-Suk* on one hand, with the H* on the second syllable, and *Hyun-Cheol* and *Young-Seon*, on the other, with the H* on the initial syllable. In Seoul, all the names, including the examples given here, are realized with the H* on the second syllable, regardless the existence of the laryngeal onset consonant.

Of interest here is that the accentual H* tone in a calling contour is realized at a substantially higher pitch level than the F0 range of a H tone in a declarative since a vocative chant utilizes a greater degree of pitch range in expressing H and L tones than a declarative. Thus, any perturbed F0 as a result of segmental effect is expected to be distinguishable from a true H* tone in a calling contour since the latter would be realized with a much higher F0 than the boosted F0 due to the segmental effect. The following schematically illustrates this prediction:

(11) a. declarative b. vocative chant

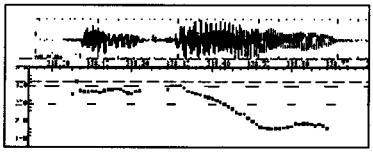


In the picture above, *seg* represents the F0 of an AP-initial syllable with a laryngeal consonant, which Jun has interepreted as a H tone. H and L represent the F0 of the H and L tone, respectively.

Let us take an example and see if the above prediction is borne out. In the previous section, we have seen that the name *Hyun-Cheol* is realized with a high initial pitch (initial HH tonal pattern according to Jun's theory)

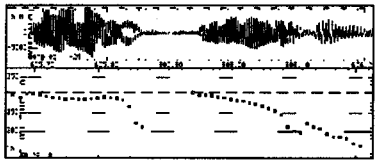
in both Seoul and Chonnam. The pitch contour for these names in a citation form is repeated here:

(12) a. Seoul



Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

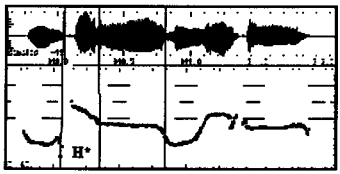
b. Chonnam



Hyun-Cheol-i
'Hyun-Cheol-citation suffix'

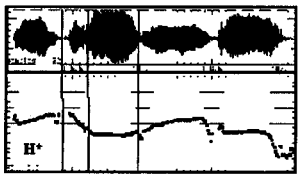
Now, compare the calling contour of the same name in Seoul and Chonnam below:

(13) a. Seoul



Hyun-Cheol-a nol-ca
'Hyun-Cheol, let's play!'

b. Chonnam

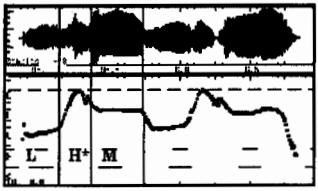


Hyun-Cheol-a nol-ca
'Hyun-Cheol, let's play!'

Contrary to our expectation, we see that the location of H* tone is different in the two dialects although they had a similar pitch contour in declaratives.

One might wonder then whether the phonologization of the laryngeal effect is valid only in Chonnam in calling contour. However, there are counterexamples to such a speculation. That is, names such as *Sang-Won*, although it begins with /s/, does not begin with an initial H*, as in the following example shows:

(14) Pitch track of 'Sang-Won-a (nol-ca)'



In the following section, I will present the results of an experiment which examined acoustic aspects of the calling contours of Korean. It will be shown that the F0 of the initial syllable is correlated with the existence of a laryngeal consonant, but not the F0 of the non-initial syllable. It will be also shown that there is a correlation between the H tone and vowel length in the vocative chant of Korean, but that the high pitch caused by the laryngeal consonant does not correlate with vowel length.

4 Calling Contour Experiment

4.1 Method

An experiment was conducted on the performance of children's vocative chant in Seoul and Chonnam dialects in order to test the assumptions made in the previous section regarding the alignment of the accentual H tone in vocative chants. The basic function of the vocative chant used in this experiment is children calling a friend to come out and play.

Four speakers stratified by dialect and sex were solicited to read and then sing the vocative chant for 60 different names, each twice in random order. Korean names are mostly composed of two syllables, where each syllable corresponds to a sino-Korean morpheme. The frame phrases used are the following:

(15) Frames used for declarative and vocative

a. Name-(i)	'name-citation suffix'
b. Name-(y)a[10] nol-ca	'name-vocative suffix play-commitative' ='Name, let's play'

All names used in the experiment were composed of two syllables, most of which were followed by a citation or a vocative suffix.

The data were digitized at the frequency of 16,000 Hz, and acoustic analyses were conducted using a speech analysis program. The F0 and the

[10]'y' is inserted to avoid hiatus when the name ends in a vowel.

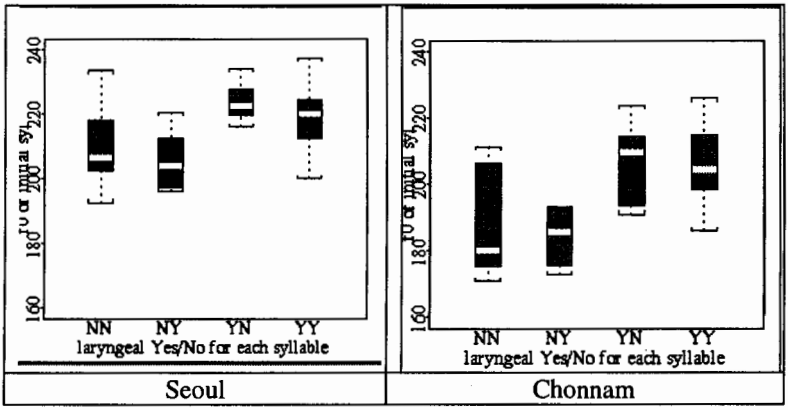
length of each syllable of the names were measured in relation to the variables (1) underlying and surface tonal pattern, (2) existence of a laryngeal onset consonant, and (3) the location of the syllable in the phrase.

4.2 Results and Discussions of the Calling Contour Experiment

4.2.1 Segmental Effect

In names beginning with a laryngeal onset consonant such as *Hyun-Cheol* and *Sang-Won*, it was found that the F0 of the initial syllable is consistently higher than in a name lacking a word-initial laryngeal onset, confirming the laryngeal effect at the phonetic level at least. The following illustrate:

(16) Laryngeal Effect in the Initial Syllable in Seoul and Chonnam

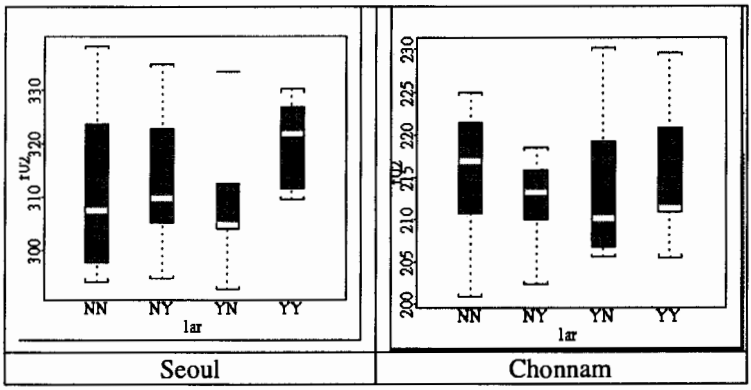


In the above box plot, the Y axis represents the F0 value of the initial syllable for each name of four different types. On the X axis, the data are labeled *Y* and *N* for each of the two syllables, where *Y* indicates the existence of the laryngeal onset and *N* the lack of one. Thus, a name such as *Sang-Won* is labeled as *YN* where as *Jin-Hyun* is labeled as *NY*.

As illustrated, the ones with laryngeal onsets show a consistently higher F0 than the nonlaryngeal onset.

However, such an effect in the non-initial position appears to be absent. The following illustrate:

(17) Laryngeal effect in the Non-initial Syllable in Seoul and Chonnam



Here the Y axis represents the F0 values of the second syllable in each name. The interpretation of the X axis works the same way as in the graphs in (11).

We observe that the F0 value of the syllables with a laryngeal onset consonant is not necessarily higher than that of the initial syllable when the target syllable is in a non-initial position. I found the same result for cases where the target syllable is located in a third syllable in words such as *kikwancha-ka*, 'head-car of a train-NOM'.

The question is why the high F0 in the beginning of an AP changes to a L tone in calling contour in some names but not in others in Chonnam. For example, both the names *Sang-Won* and *Hyun-Cheol* begin with a high pitch in a declarative because of the AP-initial consonant /s/ and /h/, but *Sang-Won* is realized with an initial L tone in calling contour while *Hyun-Cheol* is realized with a H tone. If the phrase-initial H in the declarative were truly a phonological H tone as Jun argues, the non-homogeneous behavior of names beginning with a laryngeal consonant in Chonnam could not be explained.

The tonal patterns of various names in calling contour will be discussed in detail in the following section.

4.2.2 Tonal Patterns and the Tone Bearing Unit of Calling Contour

The results of the experiment show that the canonical calling contour pattern of Korean is also a sequence of a H* tone and a M tone, similar to the LH*M of English. In Seoul, the location of the H* tone is always on the second syllable. In Chonnam, however, its location varies between the initial and the second syllable. Therefore, the initial L tone is realized only when the H* is

on the second syllable in Chonnam. The M tone is always realized on the vocative suffix '-(y)a' in both dialects.

The following illustrates some of the tonal patterns of various names in calling contour:

(18) Tonal patterns of various names in the calling contour in Seoul and Chonnam

Names	Seoul	Chonnam
a. Eon-Suk, Myung-Joon, Eun-Ah (initial N)	H* on the second σ (LH*M)[11]	H* on the second σ (LH*M)
b. Hyun-Cheol, Seon-Suk, Ho-Jun (initial Y)	H* on the second σ (LH*M)	H* on the initial σ (H*M)
c. Young-Sun, Jae-Hun, Pyung-Chul (initial N)	H* on the second σ (LH*M)	H* on the initial σ (H*M)
d. Sang-Won, P^{h}yung-Geun, Hi-Myung (initial Y)	H* on the second σ (LH*M)	H* on the second σ (LH*M)

As far as the data in (18a) and (18b) are concerned, the 'phonologized segmental effect' theory seems to be applicable to the Chonnam tonal pattern at least: names in (18a) with no laryngeal onset begin with a L tone, but those in (18b) with a laryngeal AP-initial consonant begin with a H tone. However, the data in (18c) and (18d) provide counterexamples and eliminate the possibility of explaining the tonal pattern of calling contour by segmental effect, for the names in (18c) all begin with a H* tone in the absence of a laryngeal onset, while those in (18d) start with a L tone despite the presence of an AP-initial laryngeal consonant.

Interestingly, it appears to be more reasonable to regard the syllable as the TBU in both dialects. If we follow Jun's analysis and consider the mora as the TBU of the Chonnam dialect, it is a puzzle why *Hyu:n*[12]*-Cheol* (HH.L) and *Sang-Won* (H.H) in declarative, according to Jun, are realized differently in calling contour as *Hyu:n-Cheol* (H* on the initial σ) and *Sang-Won* (H* on the second σ), respectively.

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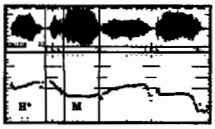
[11]The tonal pattern in parenthesis reflects the M tone that is obligatorily realized on the vocative suffix, although it was not spelled-out in the table for simplicity of representation.

[12]Jun argues that vowel length is distinctive in Chonnam, and assigns two moras for a long vowel. Although later I argue the vowel length difference as an attribute of stress, thus not phonological, I marked the initial vowel as long here to show how her analysis would work in such cases.

(19) Jun's analysis of Chonnam AP tonal pattern vs. their calling contour

	Hyun-Cheol-a	Sang-Won-a
a. Declarative (Jun): TBU: μ	[h y ə ə n č ə l a]	[s a ŋ w ə n a]
	H H L L	H L L
b. Calling contour: TBU: σ	Hyun-Cheol-a	Sang-Won-a
	H* M	L H* M



The data in (18) and (19) above lead to the conclusion that the phrase-initial H tone as a result of segmental F0 perturbation is not a phonological H tone, but is a phonetic effect.

Now the most promising solution to explain the alignment of the H* tone in the calling contour of Chonnam seems to be to bring in the notion of metrical saliency. If we assume that Chonnam is a stress language in the sense of Beckman (1986)[13], and the stress is on the initial syllable in *Hyun-Cheol* but the second in *Sang-Won*, the assignment of the H tone in the calling contour can explained.

The following illustrates the proposed anlysis of the assignment of tones in the calling contour in Seoul and Chonnam:

(20) Tonal assignment in the calling contour of Seoul and Chonnam

a. Seoul: H* on the second syllable, M on the vocative suffix

Eon-Suk-a	Hyun-Cheol-a	Young-Sun-a	Sang-Won-a
L H* M	L H* M	L H* M	L H* M

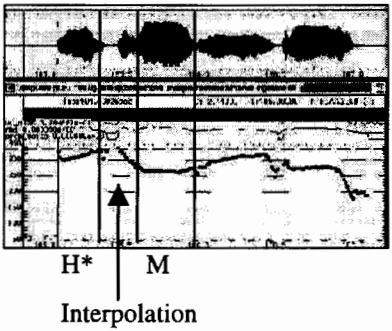
[13]According to Beckman (1986), lexical accent languages differ from pitch accent languages in that the former uses to a greater extent material other than pitch. For convenience, I adopt her definition in this paper to characterize languages that have richer phonetic properties for prominence than others. For a more elaborated phonological approach to the accent/stress/pitch accent to the prominence system of Chonnam and Seoul, see Ko (1999b).

b. Chonnam: H* on the stressed syllable, M on the vocative suffix

Eon-Súk-a	Hyún-Cheol-a	Yóung-Sun-a	Sang-Wón-a
L H* M	H* M	H* M	L H* M

Notice that in Chonnam, names such as *Hyun-Cheol* and *Young-Sun* are realized with only the obligatory tones, i.e., H* and M, and their second syllable is unspecified for any tonal realization. A default assumption would be that its pitch is realized as an interpolation of the surrounding tones, which is borne out as the following picture illustrates:

(21) a. Hyun-Cheol-a (nol-ca)

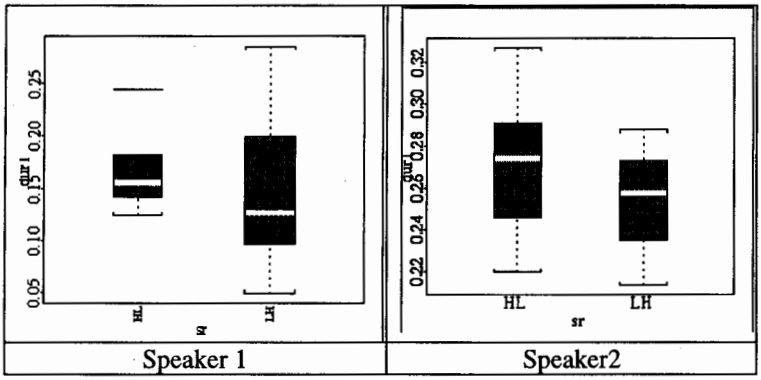


Now, since I have explained the H* alignment of Chonnam based on a lexical stress system like English, it is necessary to show grounds for arguing for a stress system in Chonnam. As mentioned in footnote 13, Beckman (1986) classifies stress-accent languages differently from pitch accent langauges in that the former having richer acoustic properties of prominence such as duration, pitch and amplitude than the latter. In the following section, I will show how high pitch as a result of segmental effect differs from a true H* tone in terms of the correlation between pitch and vowel length.

4.2.3 Correlation between a H* Tone and Vowel Length in Chonnam

In Chonnam, there is additional convincing evidence in support of the claim that the H tone associated with the accentual H tone is different from the high pitch caused by the laryngeal effect: namely, the duration of the syllable associated with the H* tone is greater than that of the L tone, whereas the duration of a syllable associated with a laryngeal onset consonant appears to be arbitrary, as illustrated in (22).

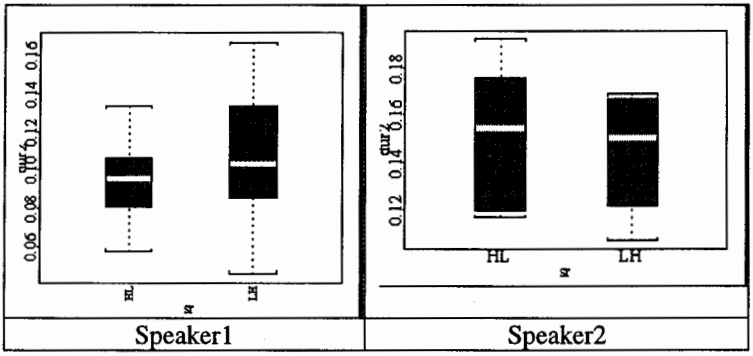
(22) Correlation between the surface H tone and the duration in the initial syllable in Chonnam



In the above, the Y axis represents the duration of the syllable, and each bar is labeled on the X axis with the tonal shape of the corresponding names. These graphs show that there is a correlation between the tone and the duration of the syllable in Chonnam: i.e., syllables with a H tone have longer duration than those with a L tone. Such a tendency was found in both speakers of Chonnam. Especially for speaker 2, the measurements were done only on the vowels of the same quality to control the inherent vowel length difference among vowels. However, the results were consistent.

Also note, however, that the vowel lengthening is not as obvious in the second syllable, as shown in (23). Here, the Y axis represents the duration

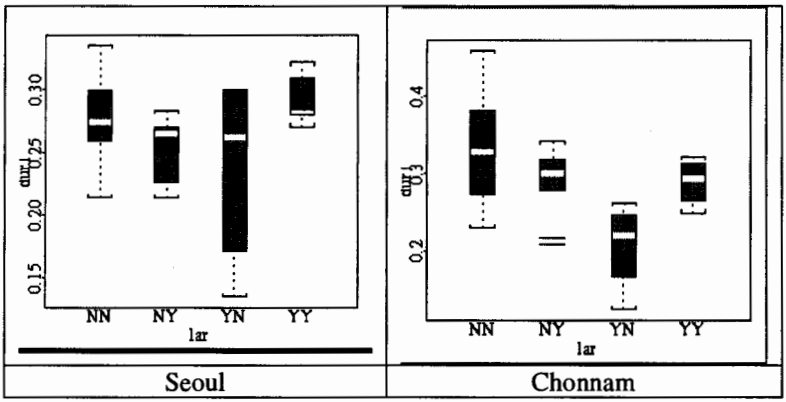
(23) Correlation between a surface H tone and duration in the non-initial syllable in Chonnam



of the second syllable in the two types of tonal patterns. We can observer that the correlation between the tonal type of the second syllable and the duration is not strong in either speaker.

Now, the correlation between the laryngeal effect and the duration seems dubious. The following graph illustrates:

(24) Laryngeal effect and the duration of the syllable



The results of the experiment examined in this section illustrate the following two points: First, the nature of the high pitch caused by the H* tone is different from the high pitch caused by the laryngeal effect. Second, and more interestingly, the high pitch as a reflect of the H* tone in Chonnam is a manifestation of underlying stress, whose acoustic manifestation appears as pitch and duration.

5 Conclusion

In this paper, I have discussed the phonological or phonetic status of the segmental effect associated with laryngeal consonants in Korean. Contrary to the arguments made by Jun (1993, 1996, 1997), I have argued that the effect is still phonetic, although stronger than in other languages. Evidence was drawn from the assignment of the H* tone in calling contour of Seoul and Chonnam dialects of Korean. I have also shown that the realization of tonal pattern in calling contour has a close relationship with the phonological prosodic prominence system of a language.

This paper examines evidence from Sino-Korean morphemes only, mostly personal names. To give a complete picture of the prosodic system of

Korean, much more investigation, including that of native Korean vocabulary, is necessary.

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