Segmental Effects on Intonation[1)]

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Park, Kwang Chul. (2007). Segmental Effects on Intonation. ***Modern English Education, 8*****(1), 24-37.**

This paper explores the interaction between segmental and suprasegmental features by examining how intonation is realized in the Korean language. This article examines the relative effects of the variables to determine the effects on the F0 rise in the first two syllables in an accentual phrase. The independent variables are onset consonant type, the number of syllables in an accentual phrase, the presence of a coda in the first syllable, and the length of the first vowel. The results in this article show that the laryngeal effect is very strong in Korean. Tokens with heavy syllable structures, either from a long vowel or a coda in the first vowel, have a similar pattern in the effects on F0 rise between the first and second vowels in an accentual phrase, with their presence incurring the smaller F0 rise.

Keywords: [intonation/ accentual phrase/ F0 pattern/ L2 prosody/ 인토네이션/ 강세구/ 기본주파수 패턴/ 제 2 언어 운율]

1. Introduction

It is now widely accepted that teaching pronunciation involves attention not just to the segmental level but to the suprasegmental level as well, which includes those features which span across the phonemes and operate at sentence, discourse or language level. The segmental and suprasegmental dimensions of the speech signal do not function independently. In particular, there are important interactions between the segmental structure and its accompanying pitch pattern

[1)] This paper was supported by Korea Nazarene University in 2006. I would like to thank anonymous reviewers for their suggestions and comments.

as shown by Hombert (1978) and Kingston & Diehl (1994), among others.

Several studies have been devoted to the effects of voiceless and voiced consonants on the pitch of adjacent vowels (Lisker & Abramson, 1964). Many factors may interact to affect the acoustic realization of a phonological contrast in laryngeal features, especially prosodic factors, which are a primary source of pitch variation in many languages. The Intonation-based approach (Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988) claims that languages signal prosodic constituents, sometimes with boundary tones marking the edges of a unit or with a pitch accent tone marking the head of a unit.

Jun (1993) argues that the intonation-based approach is more effective in accounting for phonological phenomena in Korean than the purely syntactic approaches such as Cho (1990), Silva (1992), and Kang (1992). Jun (1993) also has shown that there is a strong correlation between segmental and suprasegmental features in Korean, specifically focusing on the voicing quality of the initial consonant types: if the initial consonant types in an accentual phrase are voiceless aspirated or voiceless tense, the accentual phrase has the H tonal pattern otherwise the word has the LH tonal pattern.

The current article specifically builds on the previous work by examining the initial boundary marking the accentual phrase as it appears in various segmental conditions in the Korean dialect. An accentual phrase is the lowest level of phrasing which is determined on the basis of observable movements in the F0 realization of an utterance. This movement includes peaks which generally appear in the first part of an accentual phrase.

In this article, I seek to explain the interaction between segmental and suprasegmental features by examining how tonal assignment is related to segmental factors in the Korean language reporting on experiments in which segmental structure was varied. The study seeks to locate the peak H tone in an accentual phrase and also tries to establish the nature and some parts of the intonational structure in Korean through investigating the prosodic features of a dialect of Korean within an intonation-based approach.

The outline of this article is as follows. Section 2 provides experimental design. Section 3 presents detailed descriptive statistics of the F0 rise data sets from each of the onset consonant type and accent ual phrase size. Section 4

summarizes this article and tries to give pedagogical implication on teaching intonation to Korean learners of English as a second language.

2. Experimental Design

2.1 Subjects

For this research, subjects were 4 speakers of the Chonnam Korean dialects. The subjects were each born in their dialectal area and had stayed in the dialectal region until they moved to the United States. Two of the subjects were male and two were female. The subjects were similar in age, all being in their late twenties or early thirties. All of them had stayed in the United States less than one year. They were graduate students and reported no speaking or hearing impairment. They had not had any phonetic training for this kind of experiment.

2.2 Research Methods

The stimuli consisted of words with various syllable structures in which the initial C was either a lenis or tense consonant. To reduce variation from the vowel context, an identical vowel /a/ for the first vowel and the same place of articulation /t/ for onset consonant was used for all stimuli. Each subject was asked to read a sentence with the target word three times with a normal rate of speech.

The carrier sentences with the target words were given in a random order in Korean characters and speakers were asked to repeat them three times, with a small pause between each sentence. The utterances produced by the subjects were tape-recorded with a microphone located about 30 cm from the subjects' mouth. Five extra sentences were given at the beginning and at the end of the sentence list and eliminated from the analysis. Utterances were digitally recorded on a Sony MZ-R3 mini-disc. Soundscope implemented on a Mac was used to analyze the recorded materials. Broad-band spectrograms were used to

determine the segmentation.

Fundamental frequency values were taken from the onset of the phonation phase after the stop release with the pitch analysis of Soundscope program, using an autocorrelation pitch tracking method. F0 values were measured at six different points: onset, midpoint and offset of the first and second vowels in an accentual phrase, and every 20 ms into the vowel to obtain the tonal contour at the beginning of each Accentual Phrase, where consonantal effects are most apparent.

The peak F0 in an accentual phrase was also measured. Difference in F0 between first and second syllable midpoints indicates a more global measure of the tonal rise in the Accentual Phrase. The time of the peak H and the offset of the first vowel and syllable were measured to see whether the placement of the F0 peak is influenced by syllable length. The difference in time between the phrasal H and the offset of first vowel and syllable were calculated to show the placement of the phrasal H in an accentual phrase with respect to the first two syllables.

In this article, ANOVA (Analysis of Variance) models are used to determine the relative effects of the variables on whether or not the F0 realization is affected by the segmental factors. That is, we can see how much influence each variable had on the F0 realization. In this article, the results of ANOVA tests are examined with emphasis on the variables of onset consonant type, the number of syllables in and the presence of a coda in the first syllable, and the length of the first vowel. General patterns for each independent variable are shown first and the relation between variables is discussed.

In reporting the results of ANOVAs, p-values less than 0.05 are considered significant, and the marginal level of 0.10 is reported as non-significant in order to make note of some tendencies that might otherwise be neglected due to the adjustment of degrees of freedom or data reduction.

3. Research Results

3.1 Effects from onset consonant types and accentual phrase size

Table 1 below shows that for a fixed analysis, Chonnam Korean has strong significant effects on the F0 difference between V1 and V2 from the onset consonant type, the number of syllables, and their interaction at the level of 0.01. The effects from the onset consonant are significant only at the level of 0.05 for the repeated analysis F-value. This significance in the repeated measures analysis indicates that the effects from the consonant types are quite significant for each of the subjects and can reasonably be extended to the larger population in Chonnam Korean.

Table 1
Fixed and repeated F Values with the number of syllable as independent variables and F0 difference between V1 and V2 medial position as dependent variable

Factor	*FmV2-V1*					
	d.f.	*fixed-f-value*		*d.f.*	*repeated-f-value*	
C1 type (A)	*1,64*	*142.23*	**	*1,3*	*12.25*	*
number of syl. (B)	*1,64*	*40.80*	**	*1,3*	*4.10*	
*A*B*	*1,64*	*6.68*	**	*1,3*	*1.07*	

In this article, strong statistical significance at the level of 0.01 is marked with **, while the level of 0.05 and the marginal level of 0.1 are marked with * and ', respectively. The strong effects from the interaction between onset consonant types and the accentual phrase sizes indicates that although the onset consonant has a large influence on F0 rise, the influence is not consistent for each accentual phrase size used in the study. That is to say, the consonant type has a larger effects on F0 rise for some tokens of a certain accentual phrase size. The interaction can be seen in Figures 1 and 2 below, where the timing units in the first two vowels are on the x-axis and F0 in Hz is on the y-axis.

Graphs in Figures 1 and 2 show the effects on F0 rise from the onset consonant. Figure 1 is the F0 pattern of lenis initial consonants, while Figure 2 is that of fortis consonants. These figures show F0 rise plotted by the number of syllables in the target words and onset consonant types. Along with the clear consonant type effects between Figures 1 and 2, there are also effects on F0 rise from the number of syllables in each figure.

Figure 1
Average F0 measures during the first two syllables plotted against accentual phrase size for lenis onset type

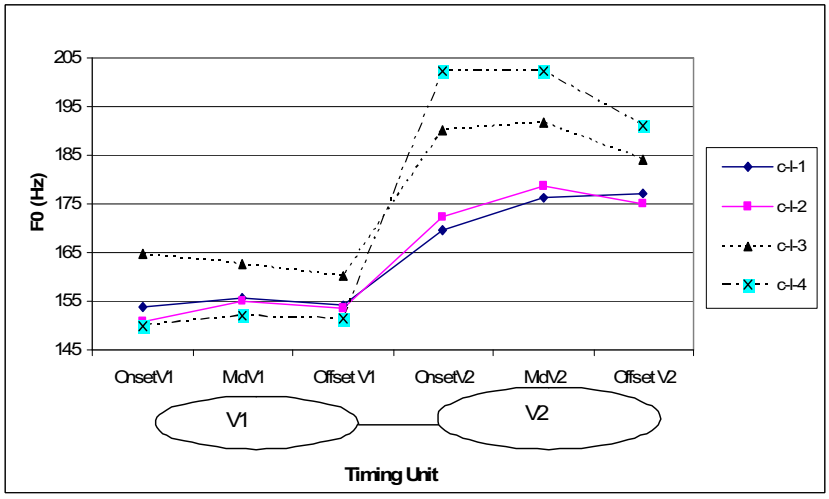


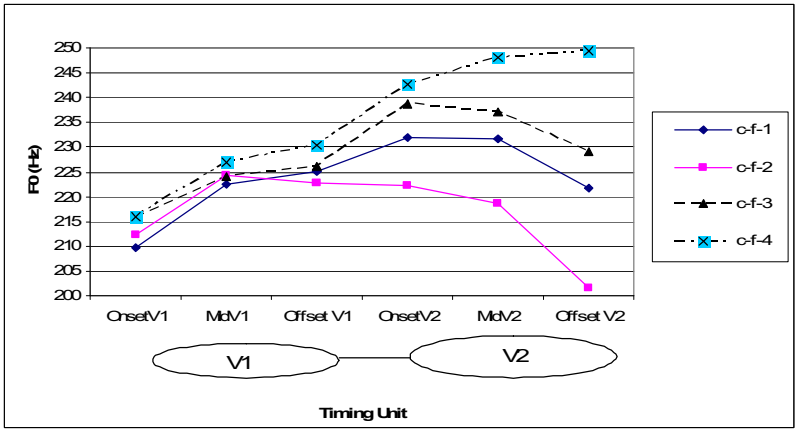
Figure 1 shows the general F0 pattern during the first two syllables in an accentual phrase when the onset consonant is lenis, while Figure 2 shows the general F0 pattern during the first two syllables in an accentual phrase when the onset consonant is fortis. The numbers in the legend shows the number of syllable in an accentual phrase.

The F0 rise difference is clear between the two onset consonant types as contrasted by comparing Figures 1 and 2. While F0 with a lenis onset has a steep rise between the first and second vowels in an accentual phrase as in

Figure 1, F0 with a fortis onset has a rise contour inside the first vowel and the rise between the first and second vowels is not so big as that with a lenis onset as shown in Figure 2. For a lenis onset case, the F0 shows clear rise from the first vowel to the second, with the biggest difference in four syllable-words. However, the rise for a fortis onset case is less steep.

This result is very close to that of Jun (1993) in that the type of the initial onset consonant determines the tonal pattern of an accentual phrase. However, as shown from the interaction effects between the onset type and accentual phrase size in the ANOVA results in Table 1, the laryngeal type of onset consonant has a large effect on the F0 rise for some tokens of certain accentual phrase size. The general pattern in Chonnam Korean is that the longer the accentual phrase is, the bigger the F0 rise. The effects from consonant type are not consistent for tokens of different accentual phrase sizes.

Figure 2
Average F0 measures during the first two syllables plotted against accentual phrase size for fortis onset laryngeal type



3.2 Syllable structure effects

In this section, the F0 rise between the first and second vowels is examined

in different syllable structures. This is to see whether different syllable structure affects the F0 rise pattern Chonnam Korean. The results of an ANOVA test are examined with emphasis on the variables of the presence of a coda in an accentual phrase and a long vowel in the first syllable of an accentual phrase, in addition to onset consonant type. General patterns for each independent variable are shown first and the relation between variables is discussed.

Table 2
P and F Values with coda as independent variable and F0 difference between V1 and V2 medial position as dependent variable

Factor	*FmV2-V1*					
	d.f.	*Fixed F-value*		*d.f.*	*Repeated F-value*	
C1 type (A)	*1,64*	*85.40*	**	*1,3*	*27.18*	*
coda (B)	*1,64*	*13.50*	**	*1,3*	*1.78*	
*A*B*	*1,64*	*13.80*	**	*1,3*	*0.60*	

As in Table 1, strong statistical significance at the level of 0.01 is marked with **, while the level of 0.05 and the marginal level of 0.1 are marked with * and `, respectively. The presence of a coda in the first syllable shows significant effects on the F0 rise between the first and second vowels. Onset consonant type also shows significant effects in repeated measure analysis in Table 2, so that we can extend the results to the larger population of this dialect. There are also effects on F0 rise from the interaction between the consonant type and the presence of a coda in the first syllable.

Figure 3 shows the effects from the presence of a coda in the first syllable on the F0 realization during the first two vowels of an accentual phrase. From this graph, we can see that the effects are not only on the F0 difference between the medial positions of the first and second vowels, but also on the general pattern of F0 during the first two vowels, giving the F0 difference. While the F0 of coda cases, marked with diamonds, are higher at the medial position of the first vowel than that of no-coda cases, marked with squares, the F0 of coda cases at the medial position of the second vowel is lower than that of no-coda cases, yielding bigger F0 rise for no-coda cases.

Figure 3
Average F0 during the first syllables in an accentual phrase plotted against the presence of a coda

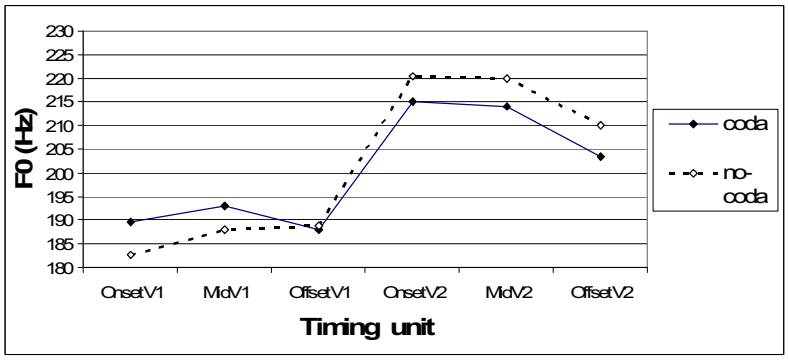
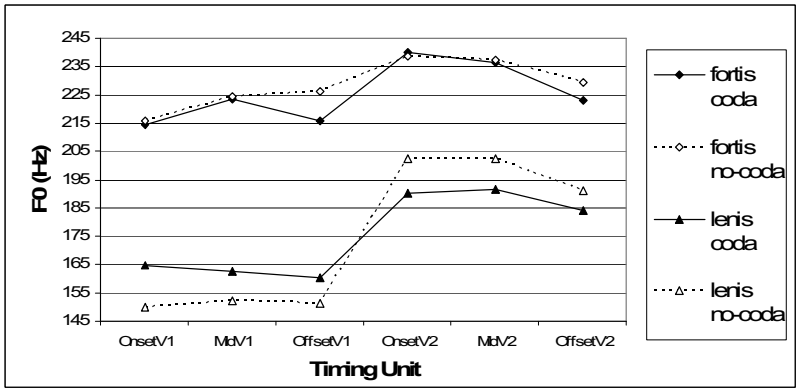


Figure 4
Average F0 during the first syllables in an accentual phrase plotted against the presence of a coda and onset laryngeal feature



The significant effects of the interaction between the onset consonant types and the presence of a coda on the F0 rise in Table 2 above means that the influence of onset consonant on F0 rise is not consistent for either coda or no-coda. Figure 3 shows the effects from the interaction between the onset consonant type and the presence of a coda in the first syllable in an accentual

phrase. As the graph shows, the main difference in F0 is from the onset consonant type; the F0 of fortis conditions, marked with diamonds, is much higher than that of lenis conditions, marked with triangles. The difference between the coda and no-coda conditions is smaller than that between onset consonant types. For fortis conditions in the upper area, the F0 rise does not show any difference between coda and no-coda cases, while the F0 rise is bigger for no-coda cases than coda cases for lenis conditions.

3.3 Effects from the first vowel length

In this section, ANOVA results are given, with the consonant type and the length of the first vowel as within-subject factors. The dependent variable is the F0 difference between the first and second vowels in an accentual phrase.

Table 3
P and F Values with coda as independent variable and F0 difference between V1 and V2 medial position as dependent variable

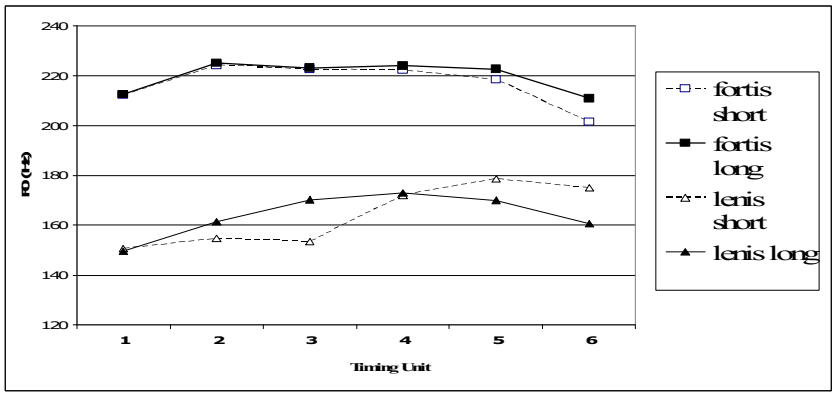
Factor	*FmV2-V1*					
	d.f.	*fixed-f-value*		*d.f.*	*repeated-f*	
C1 type (A)	*1,64*	*79.30*	**	*1,3*	*2.78*	
V1 length(B)	*1,64*	*6.57*	*	*1,3*	*5.04*	
*A*B*	*1,64*	*16.80*	**	*1,3*	*5.90*	*

Table 3 shows that there are very significant effects from the onset consonant type and significant effects from the V1 length on the F0 rise between the first and second vowels. The interaction between the C1 type and the V1 length also shows very significant effects in both fixed and repeated analyses. The significant F-value in the repeated measures analysis allows us to extend the results to the larger population in this dialect. The significant effects indicate that the effects of consonant type on F0 rise are dependent on the length of the first vowel.

Figure 5 shows that onset consonant type plays a major role with regard to the effects on F0 rise between the first and second vowels in this dialect. While

tokens with fortis consonants, marked with squares in the upper area, are clearly separate from those of lenis consonants, marked with triangles in the lower area, the distinction between the short and long vowels within each consonant group is less strong. Tokens with a lenis consonant and a long vowel have different patterns from those with a lenis consonant and a short vowel, while tokens of both short and long vowels with a fortis consonant display a similar pattern.

Figure 5
Average F0 during the first syllables in an accentual phrase plotted against the presence of a coda and first vowel length



Tokens with a long vowel and lenis consonants have the highest F0 rise between the midpoint of the first and second vowels among the conditions in the graph. Tokens with a lenis onset have room for long vowels to raise F0 along the first two vowels in an accentual phrase. It basically shows that, because of the effects from the fortis consonant, F0s of those fortis consonants are already high and there is little room for the condition of V1 length to affect the F0 rise.

One thing to note is that the highest F0 happens at the midpoint of the second vowel when the first vowel is short, while the highest F0 for a long first vowel happens earlier between the offset of the first vowel and the onset of the second vowel. This suggests that a timing difference might explain the effect of length as an earlier appearance of peak H within the long vowels.

4. Summary and Implications on teaching English intonation

Basic patterns of an accentual phrase in the Chonnam Korean were described in this article, based on the results of ANOVAs, focusing on the F0 rise between the first and second vowels in an accentual phrase. The results showed that the onset consonant type plays an important role in the F0 realization of the following vowel. Not only does the onset consonant affect the following vowel (the first vowel here), it was shown that the consonant effects are also active from the onset of the first vowel through the end of the second vowel in an accentual phrase.

Along with the laryngeal effect on the F0 rise between the first and second vowels in an accentual phrase, the size of an accentual phrase seems to play a role on the F0 realization: the longer an accentual phrase, the bigger the F0 rise between the first and second vowel. The smaller (1-syllable) word may have a conflict with the accentual phrase end boundary tone, leading to a lower F0 as the phrasal H is near the end of an accentual phrase.

In order to teach correct English intonation pattern to Korean students, English teachers need to analyze what problems their students have in English intonation. Differences in the intonation pattern of the Korean speakers and English speakers present possible barriers to communication. In a reaction against the theory and practice prevalent from the 1960s until the early 1980s, good pronunciation skills are now increasingly being seen as important in a communicative approach to teaching English as a Second Language.

Jones and Evans (1995) argue that teaching pronunciation should begin at the level of voice quality and point to the characteristic differences in voice settings in different languages, while Leather (2000) argues, that when L2 has lexical tones the arguments for prosodic training seem all the more compelling. Because of the difference of prosody, Korean learners of English do indeed face great difficulties in producing authentic sounding intonation, and in deciding how to use intonation meaningfully in their speech.

To comprehend better teach English intonation to Korean students, it is necessary to analyze how the intonation pattern works at a higher level of as

well as at a sentence level in both languages. Applying the intonation prosody in the English classroom will help Korean learners notice the contrastive differences of prosodic structure of two languages so that they can monitor their production for the sake of L2 prosody. The current study calls for further experimental research in Korean intonation for a better understanding of a phonological concept such as coda weight in Korean. This will lead to a better training of intonation to Korean learners of English as a second language.

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논문접수일자: 2007. 2. 27
게재확정일자: 2007. 3. 19