

The Phrase-initial High in Korean

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Park, Kwang Chul. 2004. The Phrase-initial High in Korean. *Studies in Phonetics, Phonology and Morphology*. 10.2. 203-223. The current article focuses on how the segmental features interact with tonal realization in F0 in three Korean dialects. The experimental results show that segmental features such as laryngeal type of an onset consonant and the vowel quantity and coda presence in the first vowel of an AP have different effects on the F0 pattern in each dialect. Based on these segmental effects, hypotheses for the alignment of the phrasal-initial High tone in an accentual phrase (hereafter AP) have been tested for each dialect. The study seeks to locate the phrase-initial H tone in an AP and also tries to establish the nature and some parts of the intonational structure in Korean through investigating the prosodic features of three dialects of Korean within an intonation-based approach. The data show that the phrasal-initial H falls on the second syllable of an AP in Kyungsang Korean, irrespective of the syllable structure in the first syllable. Chonnam and Seoul Korean have the phrasal-initial H on the first syllable of an AP if the vowel is long and on the second syllable if there is an intervocalic tensified consonant cluster between the first and second syllable. (Inha University)

Keywords: Accentual Phrase, intonation, laryngeality, F0, syllable structure

1. Introduction

In this article, I present an experimental investigation of accentual pattern in Korean dialects. 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 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.

Voiceless pulmonic egressive stops often, though not universally, result in a higher pitch at the initial edge of the following vowel. After a voiceless aspirated stop, the vocal folds often begin vibrating at a higher rate because of the greater flow of air (Kim 1965). Conversely there may be a drop in the rate of vibration during a voiced consonant when the flow is less. Kingston & Diehl (1994) argue that glottal adjustment can be linked to variation at the beginning of the stop release, influencing the F0 value at the onset of the following vowel. They analyzed fortis stops as involving a gesture of glottal constriction (marked by [+constricted glottis]), while the

aspirated stops involve glottal abduction (marked by [+spread glottis]). However, while a binary distinction between voice and voiceless may be true of English, the situation is different in Korean, where the same place of articulation includes a three-way contrast: aspirated, fortis, and lenis. Furthermore, it is well known that Korean obstruents have been reported to influence the F₀ of a following vowel (Kim 1965), producing a higher F₀ after an initial aspirated or fortis consonant, but a lower F₀ after a lenis consonant.

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. In this article, I explore 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 phrase-initial H tone in an Accentual Phrase (hereafter AP), a prosodic unit which will be explained later in this article, and also tries to establish the nature and some parts of the intonational structure in Korean through investigating the prosodic features of three dialects of Korean within an intonation-based approach.

This study describes the intonational structure and explicates the interaction between segment and suprasegment, focusing on how tonal assignment is related to the segmental features in Korean. Jun's (1989, 1993) and Park's (1997) analyses of fundamental frequency in Chonnam Korean revealed that the F₀ of a vowel was higher when preceded by aspirated or fortis consonants than by lenis consonants. This is most clear in initial position. The current project specifically builds on the previous work by examining the initial boundary marking the AP as it appears in various segmental conditions in the Korean dialects.

For a better understanding of Korean intonational structure in the different dialects, the same tokens of target word were used across the dialects, rather than comparing different data as in the previous works. With more study on the nature of intonational structure in Seoul and Chonnam Korean, I will consider whether Kyungsang Korean, which has been argued to be a tone language, fits into this approach.

The rest of this study is organized as follows: Section 2 introduces intonation-based approach to prosody and reviewing past studies on this in Korean. Section 3 presents the experimental design of the study. In Section 4 four hypotheses concerning the location of the phrasal-initial H in an AP are presented and tested in order to establish how internal syllable structure affects the alignment of a phrasal-initial High in the given phrase. Section 5 presents the details of statistical checks for the effects of the variables on the time between the phrasal-initial High and the offset of the first vowel and syllable. Section 6 winds up this study.

2. Intonation-based approach to prosody

Based on the intonation of an utterance, the intonation-based theory of prosodic hierarchy (Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988) tries to determine prosodic constituents. Beckman & Pierrehumbert argue that not only syntactic factors but also non-syntactic factors are needed to determine the prosodic constituent. Beckman & Pierrehumbert (1986), building on Pierrehumbert (1980), distinguish two types of boundary tones, one associated with the edge of the intonational phrase and another with a smaller, intermediate-level phrase. Boundary tones appear to be employed crosslinguistically. In English, as well as in many other languages such as Japanese and Serbo-Croatian, a sentence-final boundary tone may signal whether a sentence is an assertion, a contradiction, or a question.

Beckman and Pierrehumbert used the AP domain in analyzing Japanese data (Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988). The AP was proposed from the observation of the inadequacy of the existing proposals of predicting the observed prosodic domains based on syntactic information. According to Pierrehumbert (1980), H and L tones in the phonological representation signal the targets of movements in fundamental frequency. In her analysis, an AP is indicated by two delimiting tones: a L + H with the phrasal-initial H usually associated with the second mora, and a L at the end of every AP.

2.1 Jun's analysis (1989, 1993, 1995, 1996, 1998, and 2000)

In a series of papers on Korean prosody, Jun has tried to account for accentual phenomena in Korean within an intonation-based approach. She proposed to define a Prosodic Hierarchy based on the tonal pattern in the Chonnam and Seoul dialects of Korean. Based on the observation that there are two signs for prosodic domains, the F₀ contour and lenis stop voicing, she proposes that the domain of Lenis Stop Voicing be defined by the intonational pattern of the utterance, rather than by syntactic criteria. Thus, she suggests that the domain of lenis stop voicing is not the Phonological Phrase, but the AP. She 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).

Unlike in Japanese (cf. Pierrehumbert & Beckman 1988, Beckman & Pierrehumbert 1986), lexical information does not play any role in Chonnam and Seoul Korean in deciding tonal realization. Jun also demonstrates that there are some interactions between segmental and suprasegmental components of speech in Chonnam Korean. According to her, pitch accent functions to demarcate the higher level groupings of words.

- (1) The Accentual Phrasing rules (Jun 1996: 187)
- A. Every prosodic word may be an Accentual Phrase.
 - B. A focused word must be the left-most word in an Accentual Phrase.
 - C. An Accentual Phrase can include any number of prosodic words as long as:
 - i) The last prosodic word is not the left element of a branching constituent
 - ii) All the prosodic words are not focused.

An AP 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 AP. Focus, speech rate, and the length of the utterance as well as the syntactic structure of the utterance influence this prosodic constituent. The smallest unit to form the AP is a lexical content word (noun, verb, adjective, and adverb) and any following suffix, case markers, postpositions, or clitics.

She argues that the heightened pitch at the phrase-initial position is a result of perturbation by aspirated or fortis consonants in the phrase-initial position. For Chonnam Korean, Jun (1993) claims that there are two kinds of accentual patterns for the APs: LHL and HHL. The first mora of the AP is either high or low, depending on the laryngeal features of the first consonant of the phrase. She argues that, in Chonnam Korean, the second mora of the AP is associated with a H tone underlyingly, regardless of the laryngeal features of the onset consonant.

However, Jun (1995) argues that the second syllable is the locus of the phrasal prominence in Seoul Korean. This argument is based on the fact that the high pitch on the second syllable in a nonsense word “mamama” moves to the first syllable when a demonstrative *ce* ‘that’ is placed before the nonsense word. She (1993) argues that the Tone Bearing Unit (TBU) in Chonnam Korean is a mora, based on the fact that the second mora of the first syllable always gets the phrasal-initial H along with the phonemic vowel length contrast in this dialect. Thus, she argues that the TBU in Seoul Korean is a syllable, based on the fact that Seoul Korean is losing the vowel length distinction which Chonnam Korean is said to retain.

2.2 Follow-up studies

Park (1997) provides evidence for total laryngeal underspecification of lenis stops in Korean. The laryngeal representation with underspecification is argued to account for the distributional facts in Chonnam Korean without involving derivational processes. A combination of a phrasal-initial H linked with the second syllable and segmental H for fortis-onset consonant plus default L for lenis onset consonant will produce the tonal patterns in Chonnam Korean.

Park (1997) also points out that High F₀ can be understood to enhance

the laryngeal contrast between the laryngeally marked features [constricted glottis] or [spread glottis] and the laryngeally unmarked feature [], in which nothing is specified for the laryngeal features. Besides the effects from both the onset position of a syllable and prosody, Park (1997) also shows that the intrinsic F0 of different vowels influences the tonal realization of AP in Chonnam Korean. It also showed that there is the tonal effect from the onset consonants on third syllables, although the effect becomes weaker as it appears in the later parts of the phrase.

Ko (1999) argues that Jun's phrasal analysis is not enough to explain the realization of H tone in vocative chants in Chonnam Korean and that it is necessary to posit a lexical property of metrical constituency. In vocative chant in Chonnam, she argues that some names with the laryngeal features in the onset position (e.g., Hyun-cheol, Sangwon) do not show an HHL pattern, while some names without the laryngeal features (e.g., Young-sun, Byung Chul) show an HHL pattern as the previous analysis would predict. It leads her to argue that the tonal difference in this dialect would not be predictable by segmental material and so must be lexically specified.

Kim (2000) provides empirical support for the intonation-based model of Korean prosodic structure by arguing that this model best characterizes the domains of Lateralization, Delateralization, and N-insertion in Korean. By doing this, she shows that each of the rules is best characterized as an accentual phrase phenomenon. She argues that prosodic structure higher than the word in Korean is best modeled in terms of intonationally marked units such as developed by Jun (1993, 1998).

Kim (2000) also reports experimental results which show that F0 perturbation after stop release cues the identification of the laryngeal stop category in the Chonnam and Seoul dialects of Korean. She argues that lax consonants are voiced underlyingly and that the consonant-tone correlation is the familiar voiceless-high and voiced-low relationship. Kim also argues that the consonant and tone correlation can be explained by way of tonogenesis in Korean. Hombert (1978) argues that tone has arisen where pitch differences, originally controlled by consonants, have become distinctive when the consonants have been changed or lost.

Choi (2002) examines the acoustic cues of VOT (voice onset time) and F0 (fundamental frequency) in marking the laryngeal contrast in stops in Chonnam Korean and Seoul Korean. She shows that Chonnam Korean involves a 3-way distinction in VOT range between lenis, fortis and aspirated stops. Meanwhile Seoul Korean shows a substantial overlap for lenis and aspirated stops in VOT range, while the ranges for fortis stops are more separated from the other two categories.

The results also show that there is a 2-way distinction in F0 distribution, with lenis stops separated from fortis and aspirated stops, which overlap. Comparatively, Seoul speakers show a more evenly separated 3-way distribution of F0 values for the three laryngeal categories. The two acoustic cues of VOT and F0 are complementary in the two dialects in that

one cue is rather faithful in marking a 3-way contrast, while the other cue only separates one segment from the other two.

Choi (2002) also argues that a 3-way distribution in Chonnam Korean can be understood as durational sensitivity, because this dialect still has phonemic vowel length. She also argues that the initial accentual realization in the AP is expected to be more salient and tends to minimize the F0 perturbation effect from the preceding consonant by taking more overlaps in F0 distribution.

3. Methodology

In this section, the experimental design of the study testing the main research goals is presented. The experiment examined in detail the interaction between segmental features and tonal realization in the AP. The F0 for six different points in the first two syllables in an AP were examined. The experiment also investigates the locus of the phrasal-initial High in an AP. The duration between the phrasal-initial H and the end of first vowel or syllable were examined.

After the information about the subjects in the experiments is given, the main issues for the experiment are presented: dialect, onset consonant, AP size and syllable structure. The procedure of the experiment and the measurement are given in the next sections. Finally, the design of the statistical models used in this article is given in the last section.

3.1 Subjects

Subjects were 12 Korean speakers, four each from the Chonnam, Kyungsang and Seoul Korean dialects. The subjects were each born in the their dialectal area and had stayed in the dialectal region until they moved to the United States. In each dialectal group, 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 1 year. They were graduate students or their spouses and reported no speaking or hearing impairment. They had not had any phonetic training for this kind of experiment.

3.2 Stimuli

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. All target words are indigenous Korean¹.

¹ The vocabulary of the Korean language is composed of indigenous words and loan-words, the latter being the result of contacts with other languages. The majority of the loan-words are

3.2.1 Dialect

In this project, three Korean dialects were used for data elicitation. Chonnam Korean is spoken in the southwestern part of the Korean peninsula, and it is widely accepted that this dialect still has vowel length as a distinctive feature. The Kyungsang dialect is spoken in the southeastern part of the peninsula and this dialect is well known for its lexically distinctive tonal property, which seems to have been retained from middle Korean. Seoul Korean is mainly spoken in the Seoul metropolitan area. However, this dialect is considered to be the standard language of the country and students are encouraged from an early age to use this dialect. While Kyungsang and Chonnam speakers tend to use the ‘standard’ Seoul Korean in school, they keep their native dialect in most activities of life.

3.2.2 Consonant

There has been much speculation and many studies on the effect of consonantal types on the F0 realization of a following vowel. The test words in Table 1 contrast laryngeal features of the onset of the first syllable. In this study, we concentrated on lenis consonants and tense consonants. Table 1 below shows target items divided into two categories by the place of the onset stop. Within the set, the words were different in the laryngeal feature of onset consonant and the syllable number in the target word as shown in Table 1.

Table 1. Items of different word length based on laryngeal type of onset consonant

Lenis onset		Tense onset	
<i>tal</i>	‘moon’	<i>t'al</i>	‘a daughter’
<i>tali</i>	‘a leg’	<i>t'ake</i>	‘an opener’
<i>taktali</i>	‘chicken wing’	<i>t'alaci</i>	‘a shorty’
<i>tasulita</i>	‘to rule’	<i>t'a lot'alo</i>	‘separately’

3.2.3 AP size

The target words in Table 1 are of different syllable number to see how the tonal association is realized in an AP. Each column contains words of one to four syllables. The high peak generally appears on the early part of the AP. Here we see whether the number of syllables in an AP affects the realization of the phrasal tone. One hypothesis concerning the location of initial H in an AP is that the high peak will appear on a specific location regardless of the number of syllable in the AP. The location can be either a specific time in the utterance or a specific linguistic unit. The other

of Chinese origin, often called Sino-Korean words, a reflection of Chinese cultural influence on Korea.

hypothesis is that the whole phrase will be reorganized depending on the length of the AP. For instance, shorter phrases will provide the pressure which will push tones to an earlier location.

Since tone association has been claimed to be sensitive to mora count, we need to consider the syllabic structure of the first syllable in an AP. For this purpose, Table 2 includes various items with basically two different syllabic structures in the first syllable: heavy or light. The heavy syllable consists of either a syllable closed with a coda consonant or a syllable with a long vowel.

Table 2. Items with different weight for the first syllable

CVCV-	<i>tali</i>	'a leg'	<i>t'a laci</i>	'a shorty'
CVCCV-	<i>taktali</i>	'chicken wing'	<i>t'akt'akuli</i>	'woodpecker'
CV:CV	<i>taa</i>	'altogether'	<i>t'a:gwi</i>	'a slap on face'

One hypothesis regarding the first syllable structure is that the heavy first syllable of an AP attracts higher f_0 . However, the first syllable can get only the tonal realization expected from the first consonant in the AP. We will examine the effect of duration on tonal alignment as well as whether Korean words have long vs. short differences in the three dialects.

The reasoning behind the syllabic weight is that the coda consonants or a long vowel may induce the high tonal linking on the syllable, since the coda consonant or a long vowel take up a moraic position. Park (1997) showed that the presence of a coda in the first syllable does not seem to affect the tonal realization in Chonnam Korean. However, Lim & de Jong (1999) showed that the tonal realization of the AP is affected by the presence of a coda in the first syllable in Seoul Korean. We need to see if this is true across the dialects in Korean.

If the moraic claim for a coda in Korean is right, the syllable with a coda or long vowel must have a H on the first syllable from the effect of a coda, regardless of the laryngeal features of the onset consonant in the phrase. Because the coda takes up a mora position, it would have a phrasal-initial H on the coda, attracting the H on the first syllable. This would show that there is a relationship between vowel quantity and the preceding consonants in relation to the laryngeal properties of the preceding consonant.

Jun (1993) argues that the Tone Bearing Unit in Seoul is a syllable and that in Chonnam it is a mora, based on her assumption that Chonnam still keeps a vowel length contrast. However, she does not provide data from different lexical vowel lengths. One hypothesis regarding this first vowel is that, if the first vowel is long, the phrasal-initial H falls on the first syllable.

Table 3 shows target items divided into two categories by the length of the first vowel in the target word. Within the set, the words were different in the place of articulation of the onset consonant and length of the first vowel in the target word.

Table 3. Minimal pairs by V1 length

<i>caang</i>	'sauce'	<i>paal</i>	'blinder'	<i>kaangto</i>	'a burglar'
<i>cang</i>	'traditional market'	<i>pal</i>	'foot'	<i>kangto</i>	'degree of strength'

There is one thing to mention about coding of a coda in the database. Types such as *tal* 'moon' are classified as non-coda in the database because the coda in the base form is resyllabified as the onset of the next syllable. For the long vowel with a coda in the first syllable, the type *caang* 'sauce' is classified as a long vowel in contrast to a short vowel type *cang* 'the market.' These tokens are both coded in the database as having coda, even though the following subjective marker *-i* seems to make it an onset of the next syllable. Korean phonotactics never allows *ng* sound in the onset position and the sound *ng* is not resyllabified as other tokens with coda in the base form.

3.3 Procedure

All stimulus materials were recorded in the recording room of the Linguistics Department at Indiana University. 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.

3.4 Measurements

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. The initial peak F0 in an AP was also measured. Difference in F0 between first and second syllable midpoints indicates a more global measure of the tonal rise in the AP. The peak F0 in an AP was also measured. 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-initial H and the offset of first vowel and syllable were calculated to show the placement of the phrasal-initial H in an AP with respect to the first two syllables.

The target words were placed in a carrier sentence meaning “Pronounce _____” in vernacular ending markers in each dialectal, to elicit natural responses from the subjects. The carrier sentence ‘_____ *malhepayo*’ was used for Seoul Korean, while ‘_____ *malhepuro*,’ and ‘_____ *malhepoiso*’ was used for Chonnang and Kyungsang Korean, respectively. Only the verbal ending parts were modified to elicit the dialect traits, so that the *malhe* part in the carrier sentence is the same in all the dialects. These kinds of different endings indicate each dialect’s characteristic without changing any meaning of the sentence.

In dealing with the verbal expression after the token in the carrier sentence, we need to think about the relation between the syllable structure of the token and the beginning of the following verbal expression. If the verbal expression begins with a consonant, there will be no need for resyllabification. However, if the ending form starts with a vowel, the final consonant of the token may be resyllabified with the following consonant, neutralizing the difference for the syllable structure of the first syllable if the token word is one syllable. For this reason, the verbal expression *malhepayo*, which begins with a consonant *m*, was selected.

3.5 Design of statistical models

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. Evaluation of the systematic influence of various factors is made based on fixed and repeated measures ANOVA models. Fixed measures are controlled by the experiment, while repeated measures are not specifically controlled by the experiment. The reason to have repeated measures is to extend the results to the larger population of each dialects of Korean. The subject variable is considered a random sample of the population of the speakers of the dialects.

This article examines the effects of the variables to determine the effects on location of a phrasal-initial H in AP. The dependent variables to be examined are the duration between the time of the peak H in an AP and the end of first vowel and the duration between the time of peak H in an AP and the end of first syllable. 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.

4. Hypotheses and predictions

In this section, we test four hypotheses concerning the temporal alignment of the accentual high tone: 1) Syllabic Hypothesis: the phrasal-initial H is aligned with the second syllable in an AP. 2) Moraic Hypothesis: the phrasal-initial H is aligned with the second mora in an AP. 3) Laryngeal Hypothesis: First syllables with a long first vowel or second syllables with a consonant cluster intervocalically get the phrasal-initial H. The phrasal-initial H usually falls on the vowel after the consonant cluster; the second part of the intervening consonant cluster is tensified by the preceding consonant and this laryngeal feature of tensivity is assumed to have an F₀ raising effect on the following vowel. 4) No Association Hypothesis: the rise in the F₀ anchors at the left edge of an AP. Therefore, regardless of the segmental organization of an AP, the phrasal-initial H always occurs at a constant time position.

Measured durations in this experiment are the time of peak F₀ (hereafter phrasal-initial H) in an AP, the duration of the first vowel, and the duration of the first syllable. To see which proposed hypothesis works best, the time of peak F₀ in AP (the phrasal-initial H) is computed against the duration of the first vowel and syllable, yielding the difference in time between the phrasal-initial H and the end of the first vowel (hereafter H-V1) and the difference in time between the phrasal-initial H and the end of the first syllable (hereafter H-S1).

The two durations, H-V1 and H-S1, were used as dependent variables in the statistical program of SuperANOVA. Independent variables for this experiment are the phonemic length of the first vowel in an AP (whether short or long), the presence of a coda in the first syllable, and dialect. The first two independent variables are included, because a long vowel and a coda are argued to occupy a mora position in Korean and the dependent variables H-V1 and H-S1 can be measured against them.

Syllabic Hypothesis predicts only the positive difference for the duration of H-V1 for tokens with a coda. This hypothesis predicts no difference in distribution for other situations such as H-S1 for tokens with long vowel, H-S1 and H-V1 for tokens with either coda or long vowel. On the other hand, the second hypothesis (the Moraic Hypothesis) predicts the mirror image of the first hypothesis in that all situations except the duration of H-V1 for tokens with coda are predicted to show a negative difference.

While the Syllabic Hypothesis has a positive effect on the duration H-V1 with the presence of a coda, there are no effects from other factors. The mirror image for the Syllabic Hypothesis is found in the Moraic Hypothesis. All factors except a coda for the duration H-V1 have negative effects. The Laryngeal Hypothesis has the combination of both hypotheses, having positive effects on the duration H-V1 for a coda, negative effects on both H-V1 and H-S1 for a long vowel.

Hypothesis 4 looks exactly like Moraic Hypothesis in the distances H-

V1 and H-S1. The way it is distinguished from Moraic Hypothesis is in the exact size of the effects. With Hypothesis 4, the time is fixed, so we predict peaks at the same time, regardless of the structure of the first syllable.

5. Results

In this section, we seek to determine the alignment and association of the phrasal-initial High in an AP in Korean dialects. In order to establish how internal syllable structure affects the alignment of a phrasal-initial High in a given phrase, four hypotheses for the location of the phrasal-initial H are tested.

5.1 Results

The three dialects of Korean show different patterns regarding which hypothesis is supported for the location of the phrasal-initial H in an AP. In each dialect, the presence of a coda or a long vowel in the first syllable in an AP has shown different pattern of main effect on the placement of the phrasal-initial H in an AP. In this section, statistics for the three dialects will be given. ANOVA results for the three dialects are given with first vowel length and the presence of a coda in the first syllable as within-subject factors in addition to dialect. The dependent variables were the durations of H-V1 and H-S1.

5.1.1 The duration H-V1

Results of a three-way factorial ANOVA (dialect by length of the first vowel by coda of first syllable) with the duration between the phrasal-initial H and the offset of the first vowel are summarized in Table 4².

² Residual degree of freedom in Table 4 is the difference between the total and model degrees of freedom. This is the number of degrees of freedom that are not taken up by the model.

Table 4. ANOVA results for all three dialects with the duration between the offset of the first vowel of an AP and the phrasal-initial H as dependent variable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
dialect	2	.124	.062	10.731	.0001
V1 length	1	.222	.222	38.355	.0001
S1 Coda	1	.581	.581	100.216	.0001
dialect * V1 length	2	.045	.023	3.920	.0204
dialect * S1 Coda	2	.041	.020	3.517	.0303
V1 length * S1 Coda	1	7.603E-8	7.603E-8	1.312E-5	.9971
dialect * V1 length * S1 Coda	2	.001	2.963E-4	.051	.9501
Residual	600	3.476	.006		

Dependent: H-V1

The ANOVA results in Table 4 show that all the main factors of dialect, the quantity of first vowel, and the coda of first syllable have significant effects on the duration H-V1. The interactions between dialect and the first vowel length and between dialect and the coda of the first syllable both show significant effects on the duration H-V1 at the level of 0.05. There was no interaction between the first vowel length and coda of the first syllable. No effect was found for the three-way interaction, either.

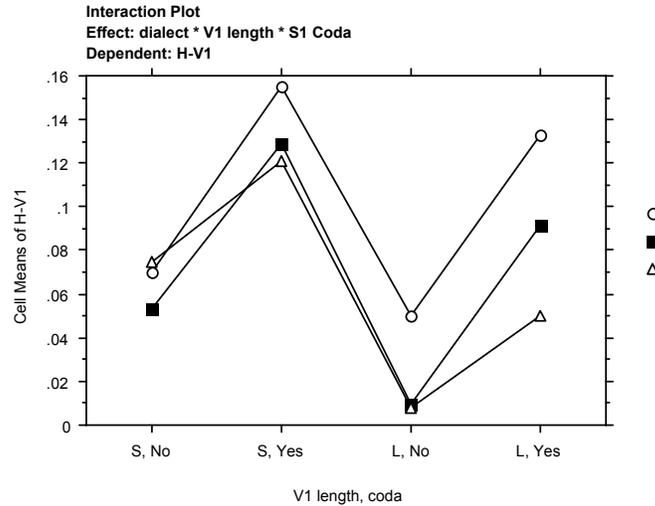


Figure 1. Three-way interaction plots between the length of the first vowel in seconds, the presence of coda and dialect. The dependent variable is the duration H-V1 in milliseconds. Empty circle, filled square and empty triangle in the legend stand for Chonnam, Kyungsang and Seoul Korean, respectively. S, No on the x-axis indicates short first vowel and no coda in the first syllable.

Figure 1 shows a general pattern for the duration H-V1 in all three dialects, even though the interaction between all three factors is not significant. The phrasal-initial H in all three dialects tends to happen after the offset of the first vowel. The higher cell means of H-V1 indicates that the phrasal-initial H occurs much later than the offset of the first vowel.

The presence of a coda in the first vowel leads to larger duration of H-V1, meaning a later phrasal-initial H in all three dialects, while the degree of difference is not as strong in Chonnam Korean as in other dialects. The effect of a long vowel in the first syllable is not as strong as that of a coda on the duration H-V1 in all three dialects.

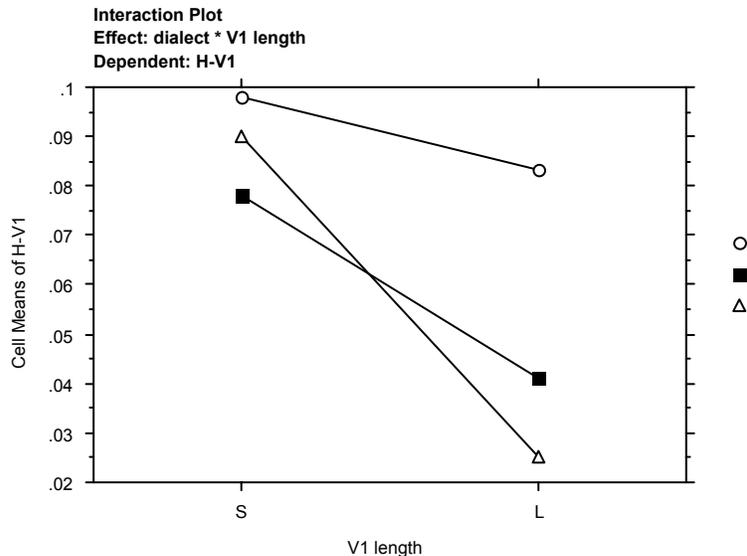


Figure 2. Two-way interaction plots between the length of the first vowel and dialect. The dependent variable is the duration H-V1 in milliseconds. Empty circle, filled square and empty triangle in the legend stand for Chonnam, Kyungsang and Seoul Korean, respectively.

The interaction between dialect and first vowel length has significant effects on the duration between the phrasal-initial H and the offset of the first vowel as shown in Figure 2. The length of first vowel has the greatest effect in the Chonnam dialect, while it is smaller in the Seoul dialect. In Chonnam Korean, it is clear that the presence of a long vowel in the first syllable decreases the duration H-V1, meaning that the phrasal-initial H with a long first vowel falls near the offset of the first vowel (zero on Figure 2's y-axis), while with a short vowel it falls in a later position, in the second syllable.

The less clear effect in Seoul Korean could be understood from the fact

that younger speakers of Seoul dialect are said to be losing the vowel length distinction, while old speakers tend to keep this distinction. The effect from the first vowel length is least clear in the Kyungsang dialect.

These results suggest the Moraic Hypothesis in that the quantity of first vowel has a negative effect. This is not predicted in the Syllabic Hypothesis which predicts that the vowel in the first syllable will not have an effect on the duration H-V1.

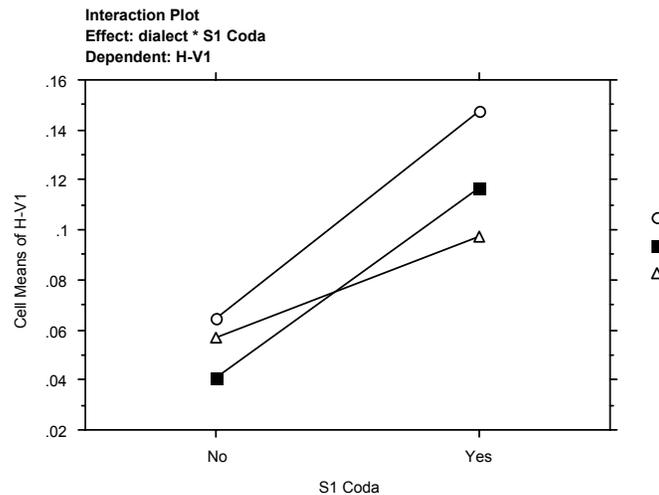


Figure 3: Two-way interaction plots between the presence of coda in the first syllable and dialects. The dependent variable is the duration H-V1 in milliseconds. Empty circle, filled square and empty triangle in the legend stand for Chonnam, Kyungsang and Seoul Korean, respectively.

The interaction between dialect and the presence of coda in the first syllable has a significant effect on the duration between the offset of the first vowel and the phrasal-initial H at the level of 0.05, as shown in Table 4 and plotted in Figure 3. Tokens with a coda in the first syllable show longer durations between the offset of the first vowel and the phrasal-initial H in all three dialects, meaning a later occurrence of the phrasal-initial H. The effect is clearer in Kyungsang and Seoul Korean than in Chonnam Korean.

This result matches with what is predicted in Hypothesis one (Syllable Hypothesis) and Hypothesis three (Laryngeal Hypothesis) in that the presence of a coda has a positive effect on the duration between the first vowel offset and the phrasal-initial H. Hypothesis two (Mora Hypothesis) assumes that the presence of a coda does not have effects on the duration of H-V1.

Both the Chonnam and Seoul dialects show similar patterns in having

the main effects from the presence of a long vowel or a coda in the first syllable on the durations of both H-V1 (the duration between the phrasal-initial H and the offset of the first vowel) and H-S1 (the duration between the phrasal-initial H and the offset of the first syllable). The presence of a coda has a positive effect on the duration H-V1, and the presence of a long vowel a negative effect. The presence of a coda does not affect the duration H-S1, while a long vowel has negative effects on the duration H-S1. These patterns are well explained by the Laryngeal Hypothesis.

The Kyungsang dialect shows a different pattern from the other dialects by having positive effects from the presence of a coda, but no effect from the presence a long vowel on the duration H-V1 (the duration between the phrasal-initial H and the offset of the first vowel). There are no effects from a long vowel or a coda in the first syllable on the duration H-S1 (the duration between the phrasal-initial H and the offset of the first syllable). This is what is predicted by the Syllable Hypothesis

5.1.2 The duration H-S1

Results of a three-way factorial ANOVA (dialect by first vowel length by coda of first syllable) with the duration between the phrasal-initial H and the offset of the first syllable are summarized in Table 5.

Table 5. ANOVA results for all three dialects with the duration H-S1 as dependent variable

Type III Sums of Squares

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
dialect	2	.129	.064	10.805	.0001
V1 length	1	.106	.106	17.815	.0001
S1 Coda	1	.007	.007	1.172	.2795
dialect * V1 length	2	.028	.014	2.350	.0963
dialect * S1 Coda	2	.032	.016	2.649	.0716
V1 length * S1 Coda	1	.031	.031	5.167	.0234
dialect * V1 length * S1 Coda	2	.017	.009	1.458	.2335
Residual	600	3.575	.006		

Dependent: H-S1

While the independent variables of dialect and first vowel length have a main effect on the duration H-S1, the presence of a coda in the first syllable has no significant main effects. The interaction between the first vowel quantity and the coda of the first syllable coda only has a significant effect on the duration H-S1 at the level of 0.05. No other interactions were found between factors.

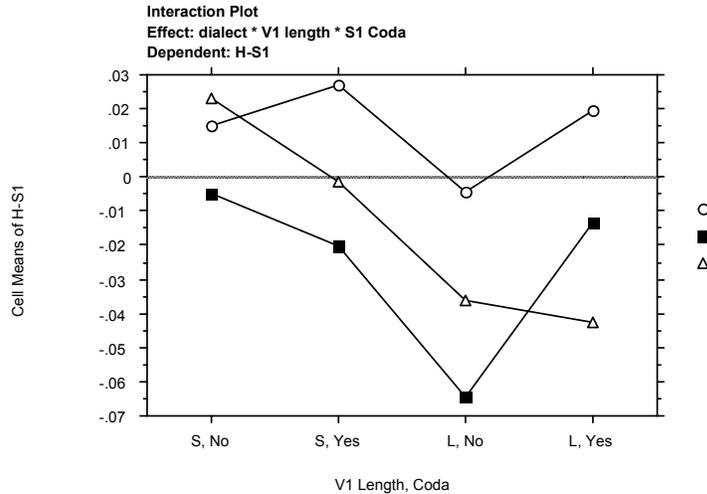


Figure 4. Three-way interaction plots between the length of the first vowel, the presence of coda in the first syllable and dialect. Empty circle, filled square and empty triangle in the legend stand for Chonnam, Kyungsang and Seoul Korean, respectively.

In Figure 4 we see that the cell means here are below or near zero in terms of average H-S1 (the duration between the phrasal-initial H and the offset of the first syllable). This means that the phrasal-initial H tends to happen inside the first syllable, while it falls after the offset of the first vowel. Kyungsang Korean shows different patterns from the other dialects in this respect: the phrasal-initial H tends to fall after the first syllable, while it falls inside the first syllable in both Chonnam and Seoul Korean.

Tokens with a coda in Kyungsang Korean seem to have a longer duration of H-S1 than the codaless cases in a positive way; the phrasal-initial H occurs after the offset of the first syllable. However, the presence of a coda decreases the duration H-S1 for both short and long vowels in Chonnam Korean, while only for short vowels in Seoul Korean.

6. Summary and Discussion

In this article, I have tried to determine the alignment of the phrasal-initial High in an AP in three Korean dialects. The statistical results from ANOVAs showed significant effects on the duration H-V1 (the duration between the peak H and the offset of the first vowel) from the presence of a coda and a long vowel in the first syllable in an AP both in Chonnam Korean and Seoul Korean, while the results showed significant results only from the presence of a coda and no effect from the presence of a long vowel in Kyungsang Korean.

The presence of a coda in Chonnam Korean and Seoul Korean has positive effects on the duration H-V1. These effects were predicted by the Syllabic Hypothesis and the Laryngeal Hypothesis. The presence of a long vowel in Chonnam has a negative effect. This effect is consistent with the Moraic Hypothesis and the Laryngeal Hypothesis. In both the Chonnam and Seoul dialects, the effect of syllable structure on the duration on H-V1 is nicely explained by the Laryngeal Hypothesis. Meanwhile, the positive effects from a coda and no effect from a long vowel on the duration H-V1 in the Kyungsang dialect were predicted by the Syllable Hypothesis.

The statistical results from ANOVAs show significant effects on the duration H-S1 (the duration between the peak H and the offset of the first syllable) from the presence of a long vowel in the first syllable in an AP both in Chonnam Korean and Seoul Korean and there was very strong interaction between a coda and vowel in Seoul Korean, while the results show no significant result from either coda or vowel in Kyungsang Korean. The cell means of the duration H-S1 were below or near zero in Chonnam and Seoul Korean. This means that the phrasal-initial H tends to happen inside the first syllable. Kyungsang Korean shows different patterns from the other dialects in this respect: the phrasal-initial H tends to fall after the first syllable, which supports the hypothesis of a H on the second syllable.

In Chonnam Korean, the tokens with a long vowel tend to have an earlier phrasal-initial H than those with a short vowel, which is predicted by both the Mora Hypothesis and the Laryngeal Hypothesis. The non-effect from the presence of a coda is predicted by the Laryngeal Hypothesis. When the effects of both a coda and a long vowel are considered, we can say that the effects on the duration H-S1 in Chonnam Korean are explained by the Laryngeal Hypothesis.

As in Chonnam Korean, the effects of syllable structure on the duration H-S1 in Seoul Korean can be explained by the Laryngeal Hypothesis, along with a strong interaction between the main factors of vowel length and coda. However, there was no effect on the duration H-S1 from the presence of a coda or a long vowel in Kyungsang Korean. This non-effect from the presence of a coda or a long vowel in the first syllable is predicted by the Syllable Hypothesis.

Along with the statistical data on the duration H-V1 and H-S1, the duration H-onset (time from the onset of the first vowel to the peak H) was examined to check whether the fourth hypothesis of constant phrasal-initial H is working. The No Association Hypothesis predicts that there is no effect from the presence of a long vowel in the first syllable in an AP, and it seems to explain the result of no-effect in Seoul Korean. However, the positive effect the duration H-onset on from the presence of a coda in the first syllable in an AP in all three dialects of Korean are not explained by the fourth hypothesis, where the factors are assumed to have no effects.

Comparing the results from the distribution graphs in each dialect, shown in the following table, illustrates which hypothesis best accounts for

a given dialect in Korean. The dialects show different patterns with regard to the hypotheses about the alignment of the phrasal-initial H in an AP. The within-subject factors of coda and vowel length have different patterns in the distribution.

Table 6: Summary of distribution results of the effects from the syllable structure and winning hypothesis in three dialects

	Factor	Chonnam	Seoul	Kyungsang
H-V1	Coda	Positive (Hypo 1 and 3)	Positive (Hypo 1 and 3)	Positive (Hypo 1 and 3)
	Long V1	Negative (Hypo 2 and 3)	Negative (Hypo 2 and 3)	No effect (Hypo 1)
H-S1	Coda	No effect (Hypo 1 and 3)	No effect (Hypo 1 and 3)	No effect (Hypo 1 and 3)
	Long V1	Negative (Hypo 2 and 3)	Negative (Hypo 2 and 3)	No effect (Hypo 1)
Winning Hypothesis		Hypo 3	Hypo 3	Hypo 1

The distribution results summarized in Table 6 show what effects from syllable structure on the alignment of phrasal-initial H in three Korean dialects are predicted and which hypothesis wins out. When we compare all results in the three dialects, we can see that the factor of a coda does not play a role in deciding which one wins out, while the length of the first vowel mainly acts a deciding factor. The results for a coda on the duration H-V1 are the same in that it shows positive effects, which are predicted by the first (syllabic) Hypothesis and the third (Laryngeal) Hypothesis. The results for a coda on the duration H-S1 are the same, in that it has no effects, which are also predicted by the same hypotheses.

The presence of a long vowel is crucial in deciding the winning hypothesis. While a long vowel on the durations H-V1 and H-S1 has negative effects, as predicted in the second (Moraic) hypothesis and the third (Laryngeal) hypothesis, in both Chonnam and Seoul Korean, it has no effects, predicted in the first (syllabic) hypothesis, in Kyungsang Korean.

The consistent appearance of the Laryngeal Hypothesis in both Chonnam and Seoul Korean makes the Hypothesis account for the location of the phrasal-initial H, winning out over the Moraic Hypothesis and Syllabic Hypothesis, which only account for a limited situation in these two dialects. The Syllabic Hypothesis wins out over the Laryngeal Hypothesis because the former can account for all situations in Kyungsang Korean.

The results show that a coda in Korean dialects does not behave as a mora in deciding the location of the phrasal in an AP. The distribution results show that the phrasal-initial H falls on the second syllable of an AP in Kyungsang Korean, irrespective of the syllable structure in the first

syllable. Chonnam and Seoul Korean have the phrasal-initial H on the first syllable of an AP if the vowel is long and on the second syllable if there is an intervocalic tensified consonant cluster between the first and second syllable.

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