A Corpus-Based Study of Positional Variation in Seoul Korean Vowels[1]

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1 Introduction

It is a well-established observation that certain positions—stressed as opposed to unstressed syllables, initial as opposed to non-initial syllables, roots as opposed to affixes, and onsets as opposed to codas—have a privileged status phonologically and the phonological patterns found in these positions can differ from the patterns found in other positions (Beckman 1998, Steriade 2001, Crosswhite 2004, Smith 2002, Barnes 2006, Walker 2011, etc.). For vowels in particular, such privileged status is manifested in the form of resistance to deletion or contrast neutralization, which affect vowels in other positions, as well as a propensity to act as a trigger of harmony.

There are two general lines of explanation for such positional effects. One line of explanation is that the special status is due to the phonetic properties of the position. For example, stressed vowels tend to allow contrasts that are reduced or neutralized in unstressed vowels. This asymmetry can be explained in large part by the longer duration of stressed vowels, which allows more complete and unreduced realization of the underlying vowel quality (Lindblom 1963, Lehiste 1970, Flemming 2004, 2005, Barnes 2006, Giavazzi 2010). Another line of explanation attributes positional prominence to certain positions' psycholinguistic prominence. For example, it is argued that word-initial segments or segments in a root resist phonological contrast neutralization due to the importance of these positions in lexical access and retrieval (Beckman 1998, Smith 2002).

While the phonetics of stress-conditioned asymmetry in vowel realization is relatively well understood, far less is known about the phonetics of the word-initial syllable effect on vowel realization. We know that segments in the initial position of various prosodic domains are subject to domain-initial strengthening in terms of duration and articulatory strength (Fougeron 2001, Cho and Keating 2001), but these effects are mainly limited to segments in absolute initial position, not to all segments in the initial syllable. Studies that specifically examine the phonetics of vowels in word-initial syllables are very limited. Barnes (2006) found that in Turkish, vowels in initial syllables are longer than those in non-initial syllables, but the effect size was small. Johnson and Martin (2003) found that in Creek, vowels in word-initial syllables are realized with a more peripheral quality than vowels in final syllables; however, it is unclear whether this finding of positional asymmetry can be attributed to a special property of word-initial syllables or of word-final syllables.

Korean vowels exhibit a number of phonological properties of initial syllable prominence, as will be illustrated in Section 2. The goal of the current paper is to provide a detailed case study of the word-initial syllable

effects on the phonetic realization of Korean vowels. Specifically, I will examine if the spectral realization of vowels in initial as opposed to non-initial syllables differs such that vowels in initial syllables are realized with more peripheral vowel quality and that these vowels exhibit clearer contrasts than those in non-initial position. I will also examine if spectral differences in vowel realization (if found) are byproducts of differences in duration between these positions—i.e. whether the longer duration of vowels in word-initial syllables results indirectly in their more peripheral realization—or whether spectral differences in vowel realization instead cannot be attributed to differences in vowel duration. The latter outcome would provide evidence that positional difference is due to an inherent difference in the phonetic target of the vowel quality, not to a physical restriction of articulation.

The paper is organized as follows. Section 2 presents phonological evidence of initial syllable prominence effects in Korean vowels. Section 3 introduces the corpus data for phonetic analysis and the analysis methods. Section 4 provides an overview of the vowel system and age-dependent variation uncovered in the data. Section 5 examines the effect of duration on vowel quality and Section 6 examines the positional effect on vowel quality. Section 7 concludes the paper.

2 Korean Vowels and Initial Syllable Prominence

Korean vowels exhibit a number of word initial syllable prominence effects. The first type of prominence effect is that contrast reduction, in certain synchronic alternations and diachronic sound changes, is blocked in word-initial position. The second type of prominence effect is that vowels in word-initial syllables are robust triggers of harmony while those in non-initial positions may be neutral with respect to vowel harmony. I review the relevant Korean facts below.

Vowel length is contrastive in Korean as illustrated by the minimal pairs listed in (1a), but this contrast is limited to word-initial syllables only because underlying long vowels shorten when they occur in non-initial syllables, as shown in (1b) (Han 1964, Sohn 1991).

(1) a. Vowel length contrast in word-initial syllables

/nun/	'eye'	/nu:n/	'snow'
/pɛ/	'pear'	/pɛ:/	'double'
/pɑm/	'night'	/pɑ:m/	'chestnut'
/il/	'one'	/i:l/	'work'
/tsʌk-ta/	'to write'	/tsʌ:k-ta/	'not plenty'

b. Vowel shortening in non-initial syllables

/**nu:n**-s'ʌlmɛ/	[nu:ns'ulmɛ]	'toboggan'
/tsʰʌs-**nu:n**/	[tsʰʌnnun]	'first snow'
/**so:k**-sɑtsʌŋ/	[so:ks'ɑdzʌŋ]	'behind story'
/mɑɨm-**so:k**/	[mɑɨms'ok]	'one's mind'
/**pʌ:llita**/	[pʌ:llida]	'open, spread'
/t'ʌ-**pʌ:llita**/	[t'ʌbʌllida]	'brag'

The Middle Korean vowel /ɔ/ underwent a two-stage merger process whereby the merger in non-initial syllables preceded the merger in initial syllables. First, /ɔ/ merged with /ɨ/ in non-initial syllables in the 15th-16th century, as illustrated in (2a), and then with /ɑ/ in initial syllable a few centuries later, as shown in (2b). The positional asymmetry is retained in the speech of older speakers of the Jeju dialect among whom /ɔ/ is retained in word-initial position, as shown in (2c). (Lee 1972, Lee and Ramsey 2011, Ko 2012).

(2) a. /ɔ/-/ɨ/ merger: non-initial syllables (15th-16th century)

/hɑnɔl/	>	/hɑnɨl/	'sky'
/nɑkɔnɑj/	>	/nɑkɨne/	'wanderer'
/tɑlɔ-/	>	/tɑlɨ-/	'different'

b. /ɔ/-/ɑ/ merger: initial syllables (18th century)

/pɔlɑm/	>	/pɑlɑm/	'wind'
/tɔl/	>	/tɑl/	'moon'
/hɔ-/	>	/hɑ-/	'do'

c. Older speakers of Jeju dialect: /ɔ/ retained in word-initial syllables

/nɔmɔl/	>	/nɔmʌl/	'vegetables'

In many dialects of Korean—the central, southern, and Jeju dialects specifically—the front mid vowel /e/ and the front low vowel /ɛ/ are undergoing a merger similar to the diachronic /ɔ/ merger. The merger in initial syllables lags behind the merger in non-initial syllables. As a result, some speakers and dialects show an intermediate pattern where the /e/-/ɛ/ merger is complete in non-initial syllables while the contrast is retained in initial syllables (Jung 2002, The Dialectology Society 2001).

The initial syllable also shows a privileged status in vowel harmony. In ideophone vowel harmony, 'dark' (D) vowels /e, ʌ, u/ and 'light' (L) vowels /ɛ, ɑ, o/ do not co-occur in a word, as shown in (3a). High vowels /ɨ, i/ show dual patterns: when they occur in word-initial syllables they trigger dark vowel harmony, as shown in (3b); however, when they occur in non-initial position they are 'neutral' (N) and occur with both dark and light

vowels, as shown in (3c) (Kim-Renaud 1976, Cho 1994, Larsen and Heinz 2012).

(3) a. Ideophone vowel harmony
/ʌluk tʌluk/ ~ /ɑlok tɑlok/
D D D D L L L L
b. Dark /ɨ, i/ in initial position
/k'ɨcʌk k'ɨcʌk/ ~ */k'ɨcɑk k'ɨcɑk/
D D D D D L D L
/k'icʌk k'icʌk/ ~ */k'icɑk k'icɑk/
D D D D D L D L
c. Neutral /ɨ, i/ in non-initial position
/tɑlkɨlɑk/ ~ /tʌkɨkʌk/
L **N** L D **N** D
/nɑmsil nɑmsil/ ~ /nʌmsil nʌmsil/
L **N** L **N** D **N** D **N**

Such positional asymmetry is also attested in verb suffix harmony. In Standard Korean, the last stem vowel determines the initial vowel of a group of vowel-initial suffixes. Dark stem vowels /i, ɨ, u, e, ɛ, ʌ/ take the [-ʌ] allomorph while light stem vowels /o, ɑ/ take the [-ɑ] allomorph, as shown in (4). There is a fair amount of variation, however, especially for /ɑ/ stems, such that /ɑ/ stems optionally take the disharmonic [-ʌ] allomorph (Kim-Renaud 1976, H. Kang 2012). On the other hand, /o/ stems tend to take the [-ɑ] allomorph more consistently. The only case where /o/ stems optionally allow a disharmonic [-ʌ] allomorph is when the /o/ occurs in the non-initial syllable of p-irregular verbs, as shown in (5b). In contrast, monosyllabic p-irregular verbs with stem vowel /o/ do not allow a disharmonic allomorph, as shown in (5a) (Kim 2000). In other words, /o/ in a word-initial syllable always triggers harmony while /o/ in a non-initial syllable may not.

(4) a. Dark stem vowel: [-ʌ]
/mʌk-ʌ/ 'eat'
D D
b. Light stem vowel /o/: [-ɑ]
/cop-ɑ/ 'narrow'
L L
c. Light stem vowel /ɑ/: [-ɑ] ~ [-ʌ]
/cɑp-ɑ/ ~ /cɑp-ʌ/ 'hold'
L L L D

(5) a. Monosyllabic p-irregular /o/ stem: [-ɑ]
/tow-ɑ/, */tow-ʌ/ 'help'
L L L D

b. Polysyllabic p-irregular /o/ stem: [-ɑ] ~ [-ʌ]
/sɛlow-ɑ/ ~ /sɛlow-ʌ/ 'new'
L L L D

This section summarized the phonological evidence of a word-initial prominence for vowels in Korean. In the rest of the paper, I will examine if and how this positional effect is manifested in the phonetic realization of Korean vowels.

3 Data and Analysis

The data for this study come from *The Reading-Style Speech Corpus of Standard Korean* (The National Institute of the Korean Language 2005), which contains read speech of 60 male and 60 female speakers of Korean residing in the Seoul metropolitan area. The age of the speakers ranged from 19 to 71 at the time of recording in 2003. The distribution of the speakers by gender and year of birth is given in Table 1.

Table 1. Age and gender of speakers in the NIKL Corpus

	1930s	1940s	1950s	1960s	1970s	1980s	Total
Male	4	12	4	8	27	5	60
Female	2	10	25	3	11	9	60

The speech material consists of well-known short stories and essays. Table 2 provides the number of instances of each vowel in the portion of the text material that was read by all of the speakers in the NIKL corpus.

Table 2. Vowel distribution in the read text analyzed for the current study in the NIKL Corpus

ɑ (ㅏ)	ɛ (ㅐ)	e (ㅔ)	ʌ (ㅓ)	ɨ (ㅡ)	i (ㅣ)	o (ㅗ)	u (ㅜ)	Total
2540	421	427	1224	1555	1683	1165	724	9739

The counts in Table 2 represent the number of vowel tokens produced by a single speaker, thus the grand total of vowel tokens for all speakers is well over 1 million. The acoustic analysis of these vowel tokens was aided by the forced alignment system for Korean developed by Tae-Jin Yoon (Yoon and Kang 2012, Yoon, this volume). The automatic aligner takes a sound file and its Korean transcription as input and automatically segments the sound file into component words and phones. The formant measurements (F1 and F2) were extracted using a Linear Predictive Coding (PLC)

method, as implemented in *Praat*'s 'To Formant (burg)' function. To minimize the influence of local formant tracking errors, the average of the measurements from the mid 20% of the vowel duration was used. To improve the accuracy of the formant measurements, the formants for each vowel token were measured with twenty-six different formant ceiling settings, varying from 4,000 Hz to 6,500 Hz by 100 Hz increments. For each vowel type for each speaker, the formant ceiling that yielded the minimum variance in formant values was chosen as optimal (Escudero et al. 2009).[2]

In order to compare formant values across speakers, the format values were normalized using the Labov method (Labov et al., 2006) as implemented in the *vowels* package (Kendall and Thomas 2012) for *R* (R Development Core Team 2011). The Labov method recalibrates formant values based on the by-speaker grand mean of F1 and F2. All formant values in the following discussion refer to values as normalized by the Labov method.

For each vowel token, in addition to F1 and F2 values, duration (ms) and f0 (Hz) at the vowel midpoint were also measured. Tokens where f0 could not be detected were discarded as many of them were either completely devoiced or involved errors in the automatic alignment. The automatic aligner analyzes the input in 10 ms frames and assigns each frame a segment label; therefore, the resolution for duration measurements is 10 ms. In the analyses provided below, only vowels with a duration of less than 200 ms were included. Extreme values are often due to alignment errors or are mostly limited to utterance or phrase final position.

Contextual information, including position within a word (initial, medial, or final), preceding and following segments, and position within a phrase (see Yoon this volume for related discussion) was also recorded for each vowel token. Each vowel token was also coded for its morphological category (root or affix), and underlying vowel length (based on *the Great Standard Korean dictionary*)[3]. Because long vowels only occur in word-initial syllables, and to avoid confounding a vowel-length effect and a positional effect, only phonologically short vowels were included in the analysis. Also, as Korean is a predominantly suffixing language, to avoid the confounding of a morphological effect (root vs. affix) and a positional effect, only roots were included in the analysis.

4 Age and Gender-Based Variation

This section provides an overview of the Korean short vowel system based on the analysis of NIKL corpus data. The graphs in Figure 1 show the by-

[2] Variance was calculated using the following formula: variance(20*log(F1)) + variance(20*log(F2)). See Kang (2013) for more details on the formant measurement method.
[3] Available online at http://korean.go.kr/.

speaker mean formant values for each vowel for female speakers (left panel) and for male speakers (right panel). The phonetic symbols in the graphs represent the grand mean for that vowel for the respective gender group. It is notable that the two non-high front vowels, /e/ and /ɛ/, are practically identical. When the data are partitioned by age and gender, the contrast appears to be marginally retained by older male speakers (born before 1962, the mean year of birth of all speakers). Figure 2 summarizes the mean F1 values of the two vowels as produced by older male speakers in word-initial, word-medial, and word-final syllables. This group retains the /e/-/ɛ/ contrast in word-initial position only and merges the two vowels in non-initial position as noted in previous studies (Jung 2002) and discussed above.

Figure 1. By-speaker mean formant values (Hz, normalized)

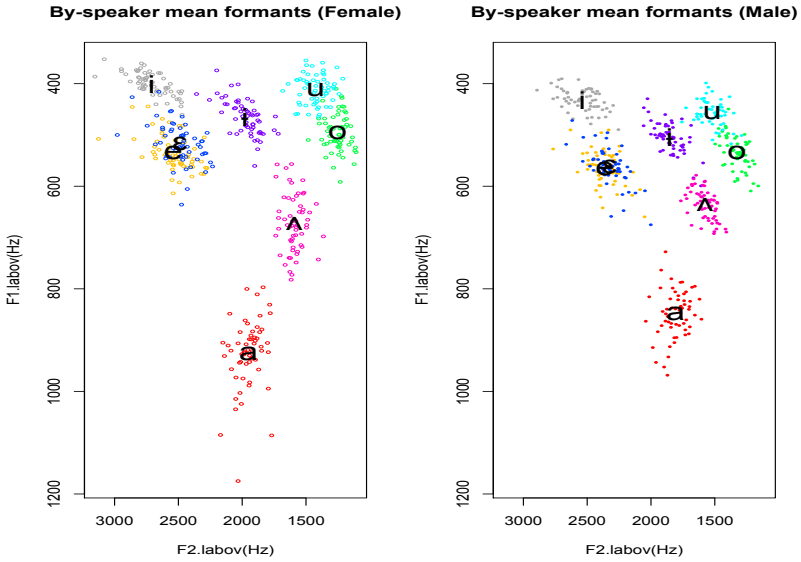
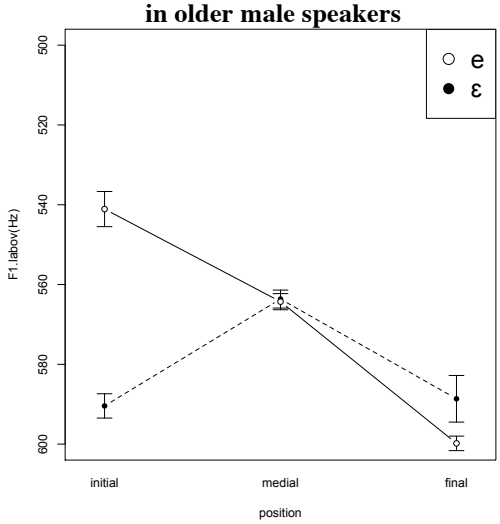
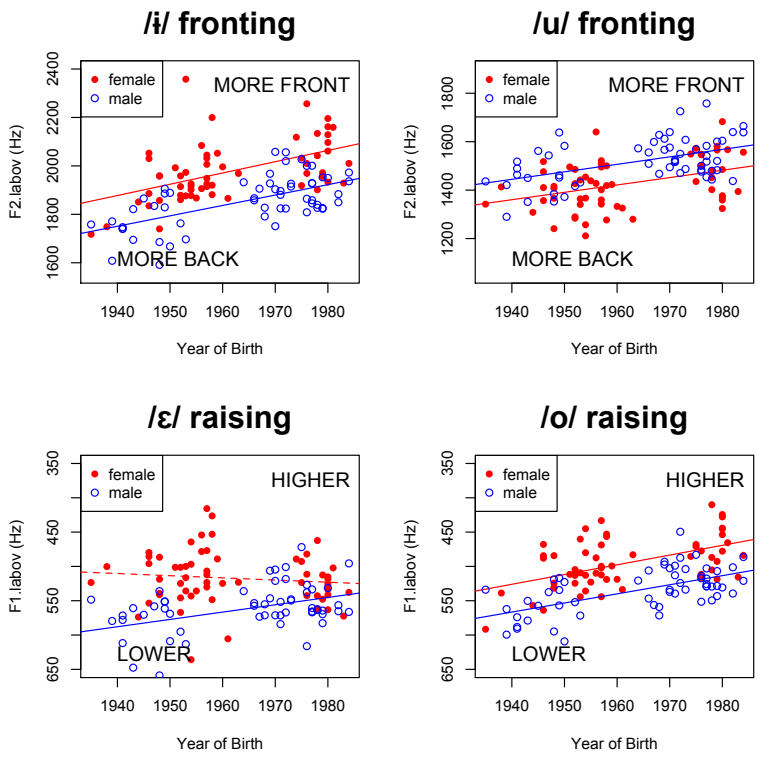


Figure 2. Positional neutralization of the /e/-/ɛ/ contrast in older male speakers



A number of age-dependent trends were also observed. Figure 3 shows four plots of by-speaker mean formant values by speaker year of birth. The four vowels, /ɨ, u, ɛ, o/ in Figure 3 all showed a significant age effect. Separate trend lines are provided for male and female speakers. Solid trend lines indicate a statistically significant correlation between the particular formant measurement (on the y-axis) and year of birth (on the x-axis). For the purpose of this study, these age-dependent trends will be interpreted as indications of sound changes in progress (cf. Bailey et al. 1991). For dashed lines, there is a not a significant correlation between the relevant formant measurement and speaker year of birth.

Figure 3. Age-dependent trends in vowel realization

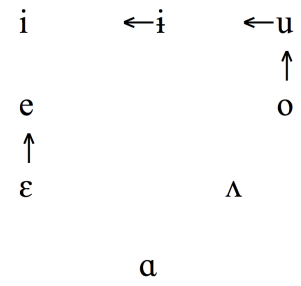


The bottom left panel of Figure 3 ('/ɛ/ raising') shows that for male speakers there is a significant age-dependent trend of F1 lowering (equivalent to tongue body raising), with younger men producing /ɛ/ higher than older men. This is another illustration of the /e/-/ɛ/ merger discussed above. For female speakers, on the other hand, there is not a significant correlation between /ɛ/ height and age. Also, females' /ɛ/ pronunciations are generally higher than the males. This suggests that the merger of /ɛ/ and /e/ is complete among women but that this change is still making its way through the male speakers and is nearing its completion.

The top two graphs in Figure 3 show that the high vowels /ɨ/ and /u/ are realized with a higher F2 (equivalent to a more front vowel quality) among younger speakers, while the bottom right panel shows that among younger speakers the back round vowel /o/ is realized with a more raised vowel quality. When these trends are taken together, the three vowels /ɨ, u, o/ seem to be involved in a chain shift-like change. Figure 4 schematically summa-

rizes the changes that the Seoul Korean vowel system appears to be undergoing, based on the NIKL data.

Figure 4. Seoul Korean Vowel shift



5 Duration and Vowel Quality

This section presents an examination of the effect of vowel duration on vowel quality. Figure 5 plots the mean F1 values of vowels by their duration (ms). The general trend is that at shorter durations F1 values are lower, indicating that vowels are raised. This trend is most pronounced for the low vowel /ɑ/, but also noticeable for the mid vowels /e, ɛ, o, ʌ/. For the high vowels /i, u/, the F1 values remain stable across different durations. The high vowel /ɨ/, which is a phonologically high vowel but is realized with an F1 value similar to that of mid vowels /o, ɛ, e/, shows a raising trend similar to mid vowels, particularly at durations below 100 ms, where over 95 percent of the /ɨ/ tokens are found. In other words, the pattern of reduction seems to depend on phonetic height, not phonological height. At shorter durations, the vertical vowel space (high-low) is compressed, but this is due to the raising of low and mid vowels and not due to the lowering of high vowels. This pattern of vertical contraction of vowel space is also consistent with the duration-conditioned reduction effect found in unstressed vowels (Flemming 2004, 2005).

Figure 6 shows mean F2 values of vowels by their duration (ms). The general trend is that at shorter durations, the vowel space is contracted along the horizontal (front-back) dimension. Front vowels are less front and back vowels are less back at shorter durations, as indicated by their F2 values. Conversely, central vowels show little difference in mean F2 values between shorter and longer durations.

Figure 5. Duration (ms) and F1 (Hz, normalized)

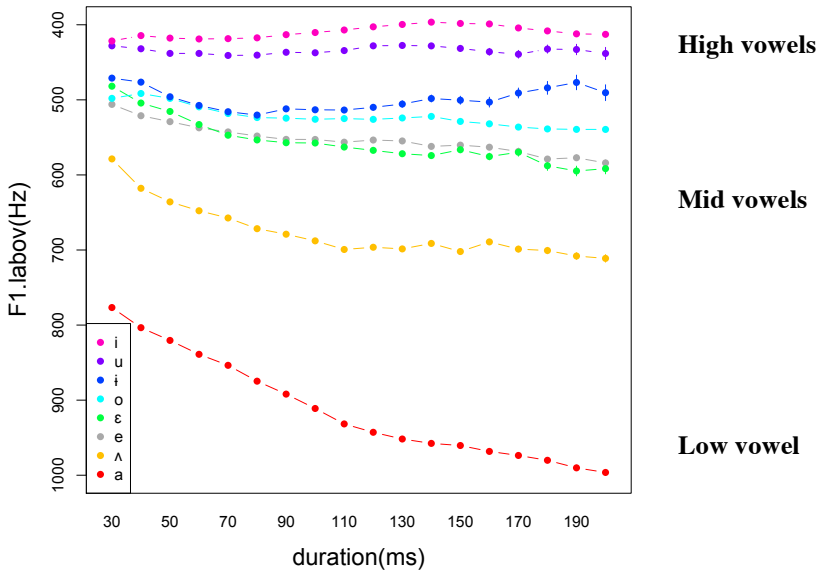
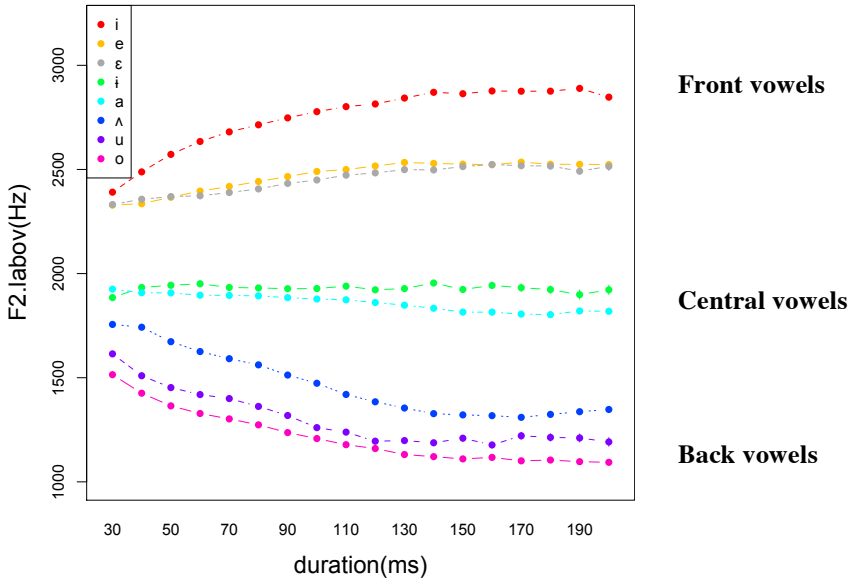


Figure 6. Duration (ms) and F2 (Hz, normalized)



To summarize, there is an observably strong correlation between phonetic duration and vowel realization in Korean. When vowels are shorter, they tend to be raised and also centralized.

6 Position and Vowel Quality

This section examines how position within a word affects the realization of vowels. Figures 7 and 8 summarize the mean F1 and F2 values of each vowel by vowel duration and by position within a word. The crucial observation in the graphs presented in Figures 7 and 8 is how vowel realization differs depending on whether the vowel occurs in a word-initial (filled circle), word-medial (blank circle), or word-final syllable (square). The vowels in monosyllabic words were excluded as it is ambiguous whether their characteristics are due to their word-initial or word-final position. Similarly, vowels in word-initial syllables that are also IP (Intonational Phrase)-initial were also excluded. IP-initial syllables occur at the beginning of an utterance or are preceded by a silent pause; this position itself may influence vowel quality. Once monosyllabic and IP-initial vowel tokens have been excluded, what remains are non-initial (medial or final) vowel tokens and word-initial vowels tokens whose quality is, in theory, not affected by other positional effects. When duration is controlled, any difference observed between these remaining word-initial and non-initial vowel tokens should be the result of differences in positional prominence.

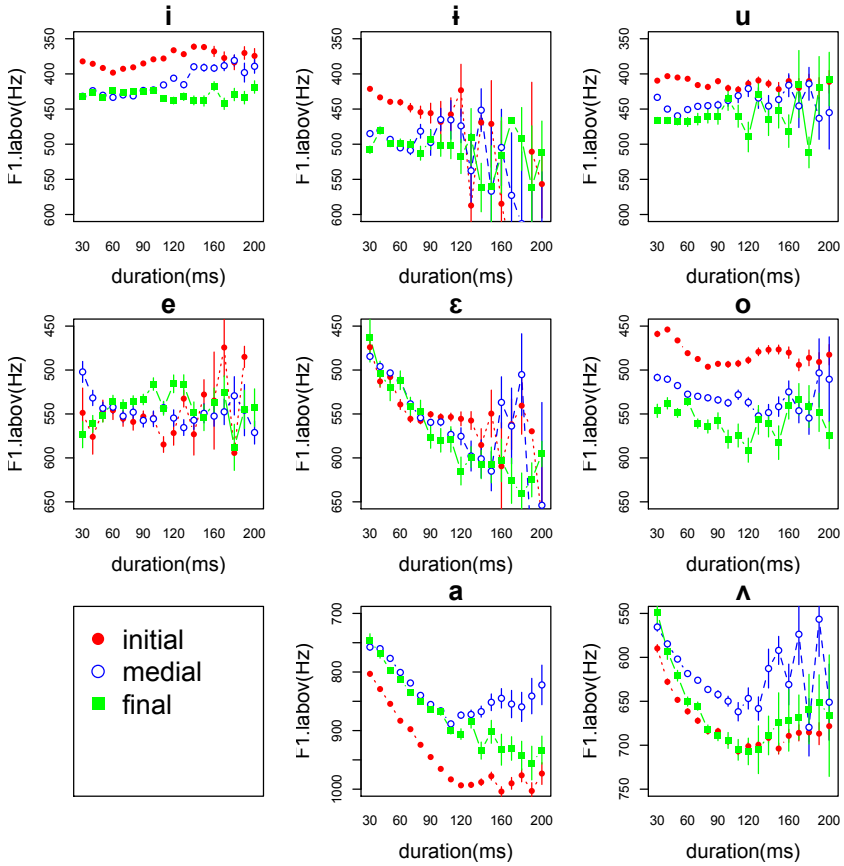
Figure 7 shows that the F1 values for high vowels /i, ɨ, u/ are lower in word-initial syllables compared to word-medial or final syllables, indicating that high vowels are produced with a higher tongue body position in word-initial syllables. This contrast is most noticeable in durations below 100 ms because high vowels tend to be shorter and the data above 100 ms are sparse.

The low vowel /ɑ/, on the other hand, exhibits higher F1 values in word-initial syllables, indicating a lower tongue body in this position compared to when in non-initial syllables. In other words, the vertical vowel space is more compressed in non-initial syllables compared to initial syllables and this compression is achieved by the lowering of high vowels and the raising of low vowels.

The mid vowels show a split pattern; the front mid vowels /e, ɛ/ do not show any clear position effect while the back mid vowel /o/ patterns like a high vowel—F1 values for /o/ are lower in initial position, indicating a higher tongue body position. This difference in mid-vowel patterning could be explained by the /o/ vowel's raising as part of a change in progress (see Figure 3) that leads in initial syllable position. Another way to interpret the result is that the underlying phoneme /o/ is raising diachronically and initial syllables more faithfully realize underlying targets phonetically compared to non-initial syllables. The mid back non-round vowel /ʌ/ patterns similarly

to /ɑ/ and is produced with higher F1 values in initial versus medial syllables.

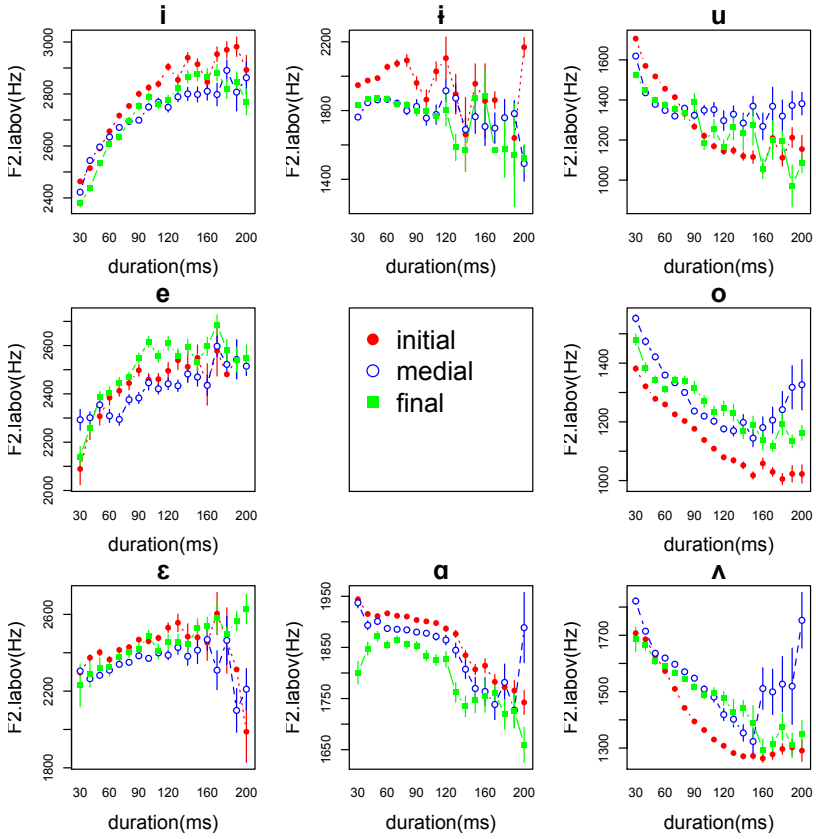
Figure 7. Position in word and F1 (Hz, normalized)



The positional effects on F2 realization of vowels are summarized in Figure 8. Overall, vowels in initial syllables have more peripheral realizations than in non-initial syllables—i.e., front vowels are more front and back vowels are more back in initial syllables than in non-initial syllables—but the positional effect on F2 is less consistent than the effect on F1. The front vowels /i, e, ɛ/ generally show a more front realization in word-initial syllables but the effect is not consistent. The back vowels /o, ʌ/ show a more back realization in word-initial syllables than in non-initial syllables. The back high vowel /u/, on the other hand, shows a more front realization

in initial syllables, especially at shorter durations. This somewhat unexpected pattern for /u/ may be related to the fact the /u/ is fronting as part of a chain shift change in progress, as mentioned in Section 5. The central vowels /ɑ, ɨ/ show a fronting tendency in word-initial syllables. Low vowel /ɑ/ is more front in initial syllables but the effect size is small. The high central vowel /ɨ/ shows a more front realization in initial compared to non-initial syllables and this may also be related to the fact that /ɨ/ is fronting as part of a change in progress.

Figure 8. Position in word and F2 (Hz, normalized)

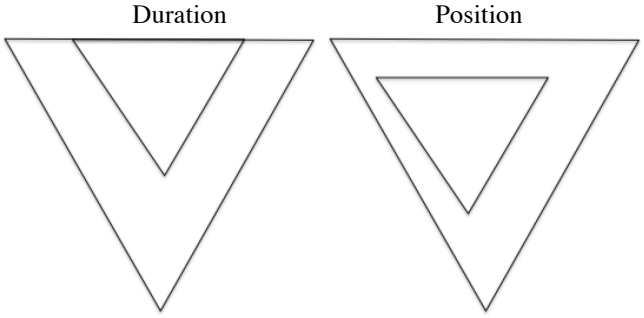


To summarize, the vowel space is more expanded and the vowel targets are more peripheral in word-initial syllables than in non-initial syllables, both along the vertical (F1) and the horizontal (F2) dimensions. This positional effect is not an epiphenomenon of a durational difference, as this contrast holds even when tokens of identical duration are compared. Also, this

positional effect cannot be attributed to a morphological effect (i.e. root versus suffix asymmetry) because the data included in this analysis consisted of only root vowels.

Position-conditioned variation is similar to the duration-conditioned variation discussed in Section 5 in that in the stronger context (initial syllables or longer durations), the vowel space is expanded and the contrasts amongst the vowels are more distinctive than in the weaker context (non-initial syllables or shorter durations). At the same time, the position effect and the duration effect differ in crucial ways. First of all, the vertical space reduction in weaker position is achieved by both high vowel lowering and low vowel raising in non-initial syllables, while the duration-conditioned reduction is due to raising of non-high vowels and does not involve lowering of high vowels. This difference in reduction patterns is schematically summarized in Figure 9. The larger triangles represent the vowel space in the stronger contexts (initial syllables or longer durations) and the smaller triangles represent the vowel space in the weaker contexts (non-initial syllables or shorter durations).

Figure 9. Schematic representation of duration- and position-based vowel space reduction



Another difference between duration-based and position-based vowel variation is that position-based variation interacts with a chain shift change in progress such that word-initial syllables tend to show the vowel quality that is more advanced in the direction of the sound change than non-initial syllable; /ɨ/ and /u/, which are fronting diachronically, are realized as more front in word-initial syllables than in non-initial syllables, while /o/, which is raising diachronically, is realized as more raised in word-initial syllables than in non-initial syllables.

This difference can be interpreted as an indication of the different mechanisms underlying the variation. While the duration-based reduction is due to articulatory undershoot of the vowel target, the position-based reduc-

tion is speaker-controlled. In word-initial syllables, the vowel targets are more peripheral overall and also interact with the direction of sound change.

7 Discussion

This paper examined the positional effect on vowel realization in Korean. It demonstrated that vowels in word-initial syllables show a privileged phonological patterning—they tend to resist neutralization and they are more robust triggers of harmony compared with vowels in non-initial syllables. This special status in phonological patterning is also mirrored in their phonetic realization—vowels tend to have a more peripheral target in word-initial compared to non-initial syllables, and in the case of those vowels involved in a chain shift-like sound change, the vowel targets for word-initial syllables are more advanced in the direction of change compared to the targets for non-initial syllables.

These findings are consistent with a number of different views of the relationship between phonetics and phonology in regards to initial syllable prominence. One of these views is that these types of phonological patterns arose from diachronic phonologicalization of phonetic tendencies (Barnes 2002). An alternative view is that these phonological patterns directly refer to phonetic tendencies in synchronic grammar in the form of phonetically grounded grammatical constraints (Hayes et al. 2004). A third view is that these phonological and phonetic patterns are both expressions of the psycholinguistic prominence of word-initial syllable position, and that the phonetic and the phonological patterns need not be directly related to one another (Smith 2002).

What the findings show is that, at least in Korean, there is a substantial word-initial syllable effect on the phonetic realization of vowels that cannot be explained by morphological effects or durational effects; after controlling for morphological condition and duration, the position effects are clearly observable and the pattern of position-conditioned vowel variation differs from that of duration-conditioned vowel variation.

The current study has a number of limitations. A number of contextual factors that are known to affect realization of vowels—e.g. the features of the preceding and following consonants and vowels—were not taken into account. A statistical model that includes these contextual factors is expected to account for more of the variance currently unaccounted for and also to test some alternative explanations for the observed pattern. For example, word-initial syllables are inherently different from word-medial syllables in that the vowels in word-initial syllables are subject to coarticulatory influence of only one adjacent vowel, i.e. the vowel of the second syllable, while the vowels in word-medial position are affected by vowels on both sides. A future study will examine if the peripherality of

vowel targets in word-initial syllables persists even when the co-articulatory effects are factored out.

Also, a more careful examination of the word position effect in relation to phrasal position may prove insightful. In the current study, in order to examine the possibility of a word-initial syllable position effect on its own, tokens of vowels in IP-initial syllables were excluded. However, the word-initial syllable effect may have arisen from the overgeneralization of a phrase-initial (Intonational Phrase or Accentual Phrase) position effect. Yoon (this volume) shows that vowels in phrase-initial syllables are subject to more substantial lengthening than vowels in word-initial, phrase-medial syllables; therefore, it is plausible that the longer duration of vowels in phrase-initial syllables could have given rise to more peripheral vowel quality realizations as part of the general durational effects on vowel articulation. As IP-initial syllables are always word-initial, learners may attribute the peripheral vowel quality of IP-initial or AP-initial syllables to a property of word-initial syllables in general, which subsequently results in the pattern observed in the above data. Martin (2011) and Myers and Padgett (2014) present evidence for such transfers or 'leaks' of generalization across different prosodic domains. This alternative explanation of the word position effect entails that word position effect is actually an indirect consequence of a duration effect.

The current study and its future developments aim to contribute to our understanding of word position effects in phonology by examining their phonetic underpinnings using Korean vowels as a case study. The tentative finding is that vowels in word-initial syllables do differ in their spectral realization compared to vowels in non-initial syllables, and that the difference cannot be ascribed to articulatory undershoot due to shorter durations or as resulting from differences in morphological status. A more complete model of vowel realization that takes into account the co-articulatory influence of surrounding consonants and vowels as well as phrasal position will help to determine whether the apparent word position effect can be attributed to more general articulatory constraints or if the position effect is instead speaker-controlled and requires distinct underlying vowel targets, resulting in variations that are not attributable to articulatory restrictions of surface phonetic realizations.

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