

Morphophonological Variation in Back Vowels in Seoul and Jeolla Korean

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1 Introduction

The behavior of /h/ towards neighboring segments adds additional insights to the nature of this phoneme in Korean. This paper aims to investigate whether the voiceless glottal fricative /h/ triggers vowel devoicing in adjacent back vowels, as the other fricative in Korean, /ç/, does. There are two hypotheses about the phonetic nature of /h/; one that it is a voiceless glottal fricative and second, that it is a voiceless vowel. By investigating the relationship between vowel devoicing and this segment, we seek to investigate which one of these hypotheses may be supported for /h/ in Korean.

1.1 Regional Variation This study focuses on two specific dialects of Korean: the variety spoken in Seoul and the variety spoken in the South Jeolla province, also known as Chonnam. The most salient differences between these two dialects lie in phonetics, lexical items, and prestige. In terms of phonetics, vowels undergo different processes in these two varieties. Jeolla Korean maintains vowel length distinctions for certain lexical items, while this has been lost in younger generations of Seoul Korean (Kim and Duanmu, 2000). In addition, Jeolla Korean exhibits vowel raising of /ə/ to /i/ (Kang 2017, 2018 cited in Park 2021).

Jeolla Korean and Seoul Korean differ in their pitch accent. Jun (1989) finds that in the variety of Jeolla Korean spoken in Gwangju, the capital of the South Jeolla province, there are two main pitch accent patterns, Low-High-Low and High-High-Low. This pitch accent pattern distribution is predictable depending on the laryngeal feature of the first word's onset. Seoul Korean does not use pitch accent and instead relies on the prosody patterns of phrases (Jun et al. 2006). The prosody of these phrases also differs between varieties. Jun (2005) investigates the accentual phrase (AP) patterns in Seoul Korean, where either a LHLH or HHLH tone marks the end of an AP. In contrast, Oh (2019) finds that in Jeolla Korean, the only possible tone marking to mark the end of an AP is LHLL.

Jeolla Korean	Seoul Korean	English Gloss
새비 [sɛ.pi]	새우 [sɛ.u]	'shrimp'
구녁 [ku.njək̚]	구멍 [ku.məŋ]	'hole'
빼치다 [p*ə. tɕi.ta]	피곤하다 [pʰi.kon.ha.ta]	'to be tired, exhausted'

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-라 [-ra]	-요 [-jo]	'honorific marking'
-(으)시 룡 [-im.ei.ron]	-(으)면서 [-i,mjən.sə]	'while V-ing'

Table 1: Comparison of Lexical Items between Jeolla and Seoul Korean

Lexical items also differ between these two dialects of Korean. Some examples of lexical items differing are provided in Table 1. While many of the lexical items of nouns appear to be quite similar, the verb endings exhibit more diversity.

Lastly, a key difference between Jeolla and Seoul Korean lies in prestige. Seoul Korean is treated as the standard variety in contexts such as official translations and language teaching (Silva 2011). In addition, perception studies show that native speakers associate older Korean speakers' speech as coming from rural regions and younger speakers' speech as coming from Seoul, even if both speech sets are unmarked (Shin et al. 2020). The interaction between dialect and speech perception is an important factor to take into consideration in phonetics analysis.

1.2 The Voiceless Glottal Fricative [h] The voiceless glottal fricative [h] patterns differently in Korean than other consonants do. It patterns differently from other obstruents in its phonetic realizations (Lee, 2008). For example, h in the coda position can induce tensification of neighboring obstruents (Lee, 2008). In addition, /h/ in the onset position may trigger aspiration of the following coda-consonant in Seoul Korean, whereas one of the features of Jeolla Korean is non-aspiration. Example (1) shows the underlying form for both Seoul and Jeolla Korean. This example shows the process in Seoul Korean where the /h/ triggers the previously unreleased /p/ to be articulated as an aspirated onset of the following consonant. In Jeolla Korean, the resyllabified

- (1) /kophaki/ → [ko.p^ha.gi] 'multiplication' (Seoul Korean)
 → [ko.ba.gi] 'multiplication' (Jeolla Korean)

There is no consensus on the nature of [h] in Korean. There are two main hypotheses: one is that [h] is a voiceless glottal fricative. The other hypothesis is that [h] is a voiceless vowel (Kloster-Jensen, 1991). Seeing how [h] affects other vowels can provide evidence for one of these analyses.

1.3 Vowel Devoicing One potential effect of the glottal fricative [h] is the process of vowel devoicing on the neighboring vowel. Vowel devoicing is a phenomenon in which a vowel loses formant structure including the voicing bar due to a variety of factors, such as adjacent consonants or absence of stress. While this phenomenon is relatively uncommon, there are well-attested examples in several languages, such as Blackfoot (Prins, 2009), contemporary French (Smith, 2003), and Japanese (Yasuda and Zimmerer, 2013). In general, vowel devoicing is associated with unstressed vowels and phrase-final position (Prins, 2009).

Figure 1 is an example of vowel devoicing in Blackfoot from Prins (2009). The devoiced segment is the vowel /q/, which is highlighted in grey in Figure 1. In the spectrogram, there are no clear formants or voice bar. The waveform also lacks the periodicity characteristic of vowels. Using these three diagnostics, we can identify between voiceless and voiced vowels.

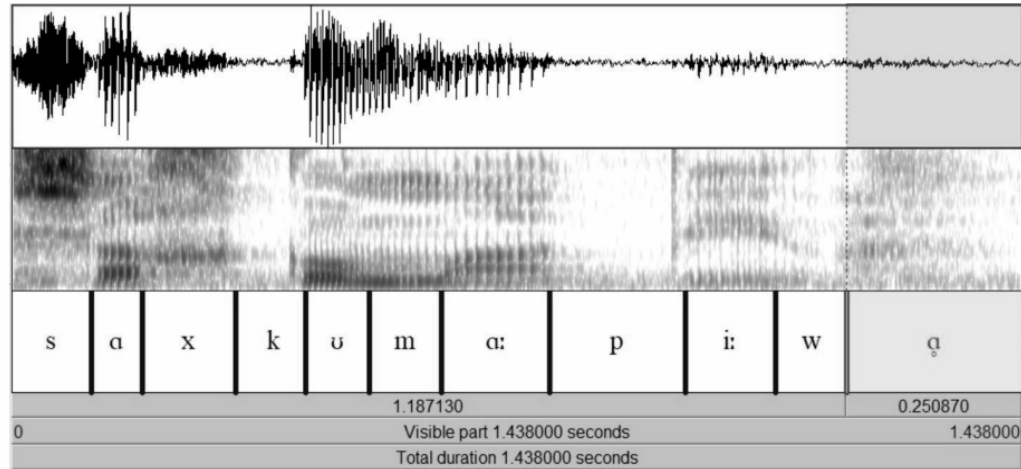
Korean is another language that exhibits vowel devoicing in certain contexts. There has been an increasing focus on investigating how different factors can cause various degrees of vowel devoicing. Example (2) shows that the high front vowel /u/ is devoiced after the voiceless palatal fricative /ç/.

- (2) /t^huçu/ → [t^huçu] 'pitcher' (Jun and Beckman, 1994)

Mo (2007) finds that vowel devoicing is more likely to occur with high vowels rather than low vowels and it is more likely to occur following aspirated consonants rather than unaspirated consonants. Jun and Beckman (1994)

offer an analysis where vowel devoicing is triggered by a vowel's gestures overlapping with the preceding consonant's voiceless quality. Devoicing is more likely to occur with a stop rather than a fricative, suggesting that the complete closure triggers devoicing, and that the length of closure in the glottal tract in phrase-initial position is positively correlated with rates of vowel devoicing (Jun and Beckman, 1994). This contrasts with rates of vowel devoicing in previous languages, where phrase-final position is more associated with vowel devoicing. Lastly, Kim et. al (1993) found that the high front vowel [i] is more likely to be devoiced in Jeolla Korean in fast rather than slow or careful speech. In sum, vowel devoicing is conditioned by numerous factors.

Figure 1: Vowel Devoicing in Blackfoot from Prins (2009)



While vowel devoicing is relatively well-described in Korean, the salient gap lies in the consonants used as stimuli in these studies. The consonants that were primarily tested in previous studies were either alveolar or palate-alveolar phonemes. As established in 1.2, [h] is both unique in Korean phonology and patterns uniquely in other areas compared to other fricatives. It is important to focus on how sounds pronounced farther back in the vocal tract would affect adjacent vowels, both in terms of quality and vowel devoicing. In addition, analyzing the distribution of vowel devoicing is an important component of both language documentation and language pedagogy. Mastery of when and how to use vowel devoicing may help reduce the presence of a foreign or learner's accent in the target language (Yasuda and Zimmerman, 2013).

2 Methodology

2.1 Stimuli and Participants The data for this study is from a larger project that investigates a variety of phenomena in Jeolla Korean. Five words from the larger corpus of recordings were selected. These targets have a /h/ + V sequence, with five vowels: three unrounded vowels /ə/, /i/ and /a/ and two rounded vowels /u/ and /o/. Back vowels were selected for this study as they are undergoing generational changes and may participate in other new processes with neighboring consonants (Kang and Han 2013, Lee et al. 2017). These target words were embedded in sentences to elicit as natural pronunciation as possible in phrase-initial position.

- (3) Target words
- /a:/ /ha.ma/ 'hippopotamus'
 - /i:/ /him.teap.ta/ 'to find fault with someone'
 - /u:/ /hu.te^hu/ 'pepper'
 - /o:/ /ho.ra.ŋi/ 'tiger'
 - /ə:/ /hə.t^hal.ha.ta/ 'to be let down'

These sentences were elicited from 43 total participants, with 23 native Seoul Korean speakers and 20 native Jeolla Korean speakers. Of the Jeolla speakers, 12 are from Gwangju, the capital city of the South Jeolla province, and 8 are from Mokpo, a city in the southwest. Three of the speakers from Gwangju are over the age of 65. All other speakers participating in the experiment are university students in their early 20's.

2.2 Data Analysis The data was recorded either in a sound booth at a university of Gwangju or in a quiet room at a university in Mokpo. For both instances, participants wore electrodes for an electroglottography with a simultaneous recording of the acoustic signal. Participants read sentences off of PowerPoint slides and were guided by a research assistant who spoke to the participants using Jeolla Korean. Each sentence was recorded with 5 repetitions. In total, there were 1075 recordings (5 vowels * 5 repetitions * 43 participants) that were segmented into 1853 total tokens. The recordings were processed in Praat by the first author who annotated both the /h/ and the vowels. Several Praat scripts were used during the annotation process. The beginning and end of both the fricative and the vowels were marked by audiovisual cues and all boundaries were adjusted to align with the zero crossing in the waveform. After processing the recordings, errors were removed from the data set. The data set for /i/ had to be pruned for nasalization, as there were occurrences of the vowel combining with the nasal coda /m/. In order to avoid this additional factor, only oral instances of /i/ were analysed. In total, the number of tokens examined is 1516 (/h/: 805, /i/: 42, /a/: 159, /u/: 164, /o/: 196, /ə/: 150).

3 Results

The combination of /h/ + back vowel manifested in one of two ways. The first type was where the voiceless glottal fricative /h/ and the vowel surfaced as completely separate segments that were easily segmentable using acoustic cues. An example of the unmerged segment is presented in Figure 2. In Figure 2, the /h/ has no voicing bar and consistent frication noise with no periodicity in the waveform. The vowel in this figure has defined formants and a voicing bar. The amounts of unmerged segments in total were 858 iterations from the recordings, or approximately 80% of the total data set.

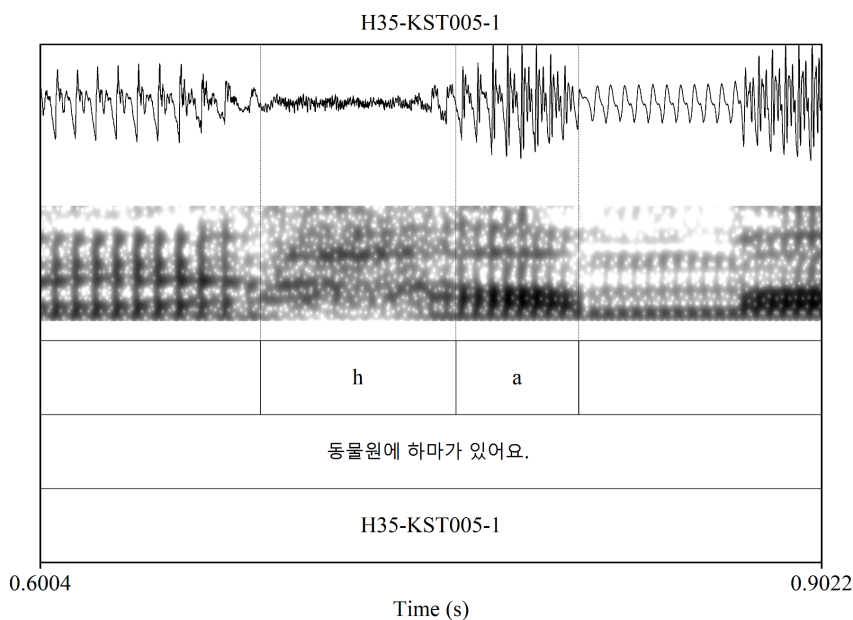


Figure 2: An Unmerged hV Sequence in Seoul Korean

The second type was where the voiceless glottal fricative completely merges with the vowel into a form that is not segmentable. An example of this merged segment is presented in Figure 3, where the merged segment is glossed as /h/. In Figure 3, the first half of the /h/ segment shows a high amount of periodicity, potential formant structure, and a voicing bar, which points against glossing the segment as an /h/. Instead, the consistent formants and strong periodicity show that the segments have merged into one rather than being separable phonemes. The count of merged segments were 217 attestations from the recordings, or roughly 20% of the total data set.

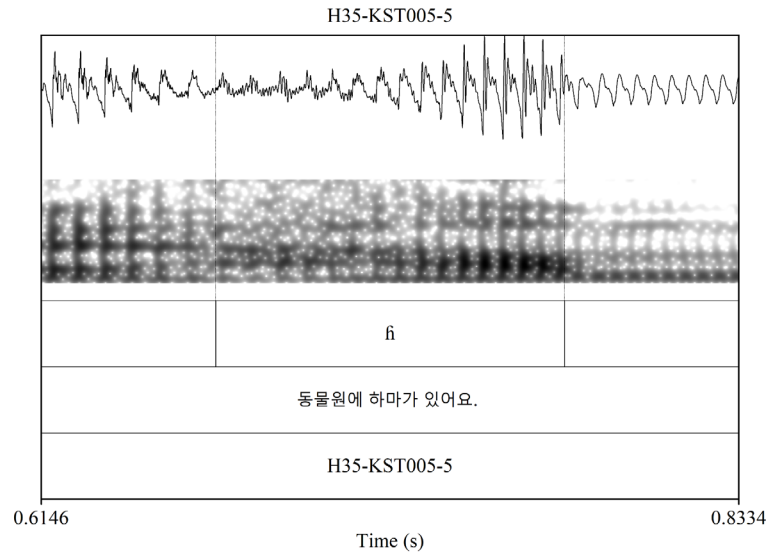


Figure 3: A Merged hV Sequence in Seoul Korean

The duration of /h/ across vowels did not change significantly in non-merged segments, as shown in Figure 4. Almost all of the /h/ segments' lengths lie within 20 to 120 milliseconds. In addition, the duration of the vowel itself did not change markedly in non-merged segments, as represented in Figure 5. Almost all of the vowels' duration lies approximately between 50 to 100 milliseconds in duration. The consistency of duration for both the /h/ and the vowels suggest that there are no adjacency effects for these segments.

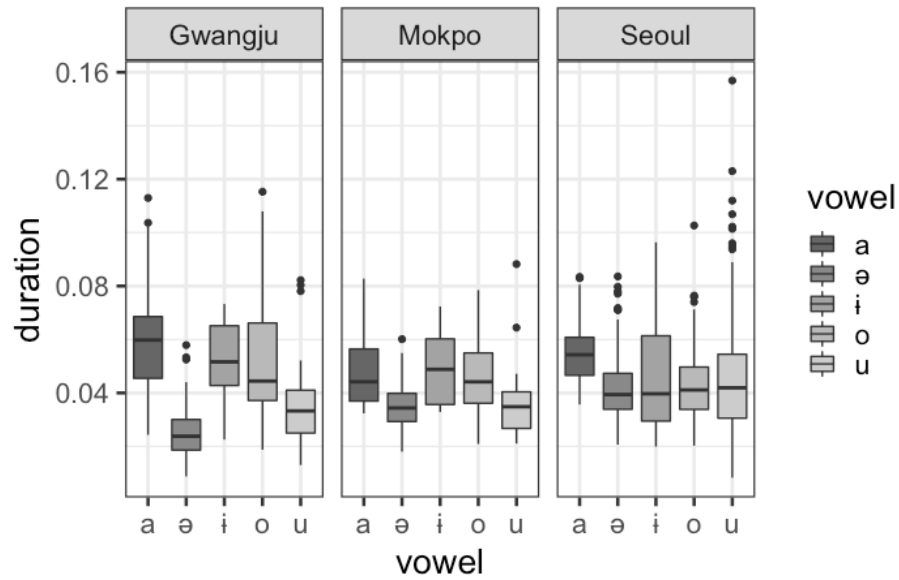


Figure 4: Duration of /h/ in Non-Merged Segments

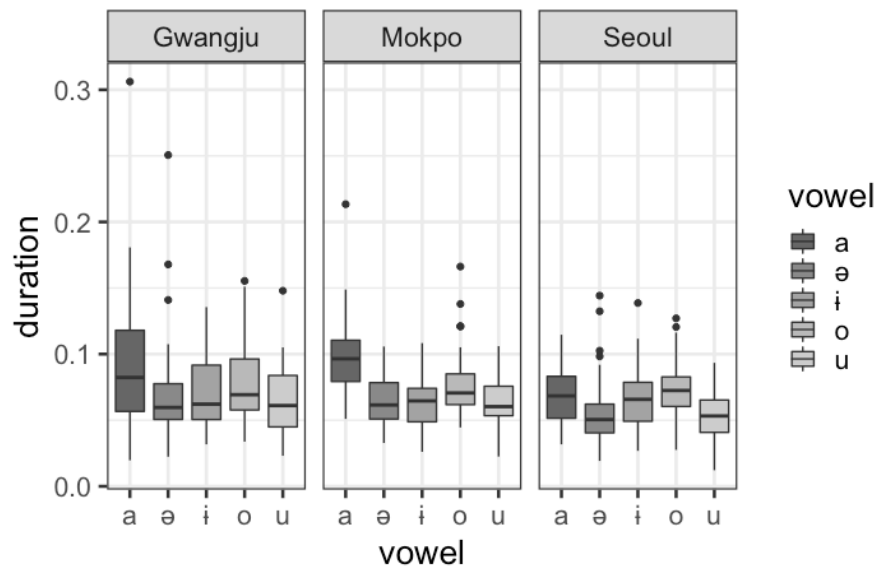


Figure 5: Vowel duration in Non-Merged Segments

Looking at the distribution and count of merged versus non-merged segments tells a different story. While Seoul shows a sizeable number of merged segments with all vowels (around 20 or above), Gwangju shows very low frequency with /a/ and /o/. Mokpo does not have any instances where a merger occurs with /a/ and mergers with /o/ rarely occur, as shown in Figure 6.

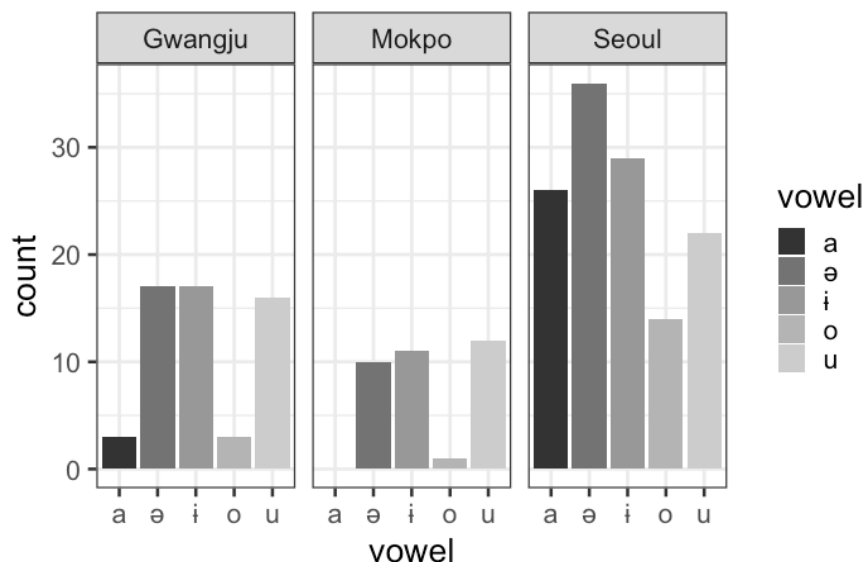


Figure 6: Instances of Merged Segments across Dialects

4 Discussion

While the durational differences of either /h/ or the five back vowels did not differ widely across region or dialect, the number of merged segments varied greatly. Seoul speakers had the greatest number of merged segments total, attested with all possible back vowels. In contrast, both Mokpo and Gwangju speakers had much fewer tokens with merged segments, and these segments were not spread evenly across all back vowels. Gwangju had more merged segments than Mokpo did and had attestations across all back vowels, although there were much fewer tokens for /a/ and /o/ mergers. For Mokpo, there were no attestations of mergers with /a/ and very fewer mergers with /o/.

At first, this pattern seems phonologically unmotivated, as /a/ and /o/ do not form a separate phonological natural class from the other three back vowels investigated. However, there is a morphological phenomenon that may help explain this pattern. Suffixes in Korean exhibit vowel harmony with the vowels in the root. The back vowels form two classes for these vowel harmony rules, one consisting of the two back vowels /a/ and /o/, and the second consisting of /u/, /i/, and /ə/. The examples in (4) show how these five back vowels form two morphophonological patterns with the past tense marker $-V\bar{t}$ (and also other suffixes that follow the vowel harmony pattern). The V in this marker has been bolded. Both /a/ and /o/ harmonize with the /a/ vowel in the past tense marker as in (4a), while /u/, /i/ and /ə/ harmonize with the vowel /ə/ as in (4b).

(4) Examples of Vowel Harmony in Korean Morphology

Vowel	Root	Root + Past Tense
a. /a/	talm.ta ‘to resemble’	tal. ma t.ta ‘resembled’
/o/	nok.ta ‘to melt’	nok. a t.ta ‘melted’
b. /u/	teu.ta ‘to grab’	teu. ə t.ta ‘grabbed’
/i/	man.til.ta ‘to make’	man.til. ə t.ta ‘made’
/ə/	mək.ta ‘to eat’	mək. ə t.ta ‘ate’

The distribution of mergers among the Jeolla speakers reflects the morphological dimension where /a/ and /o/ form their own class compared to other back vowels. This pattern was previously thought to be only represented in morphology, but it appears that this phenomenon is also attested in Jeolla phonetics as well.

5 Conclusion

This study has sought to investigate whether the /h/ vowel induces vowel devoicing, as the voiceless alveolo-palatal fricative /ç/ does. This research found that /h/ behaves differently from /ç/, where vowel devoicing is not triggered in back vowels. This conclusion lends additional support to the hypothesis that /h/ is a voiceless vowel rather than a voiceless fricative, although more research is needed in other contexts to strengthen the hypothesis.

This study also found that there are instances where /h/ may merge with the following vowel to create a single voiced merged segment. Seoul speakers were more likely to merge /h/ with the following vowel to form a voiced glottal fricative than Jeolla speakers were. Jeolla speakers tend to characterize back vowels differently from how Seoul speakers do, as a morphological class of vowels seems to appear in Jeolla merged segments. In contrast, Seoul speakers showed types of all vowels with relatively similar frequencies in merged segments, regardless of the vowel's morphological class. Additional studies that can look at the relationship between high vowels and consonant mergers in these two Korean dialects would be helpful to further understand the effect of /h/ on vowel devoicing. Perception studies to see whether speakers can distinguish between the merged and unmerged segments would also show how speakers may characterize consonant mergers in different dialects.

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