A CORPUS-BASED APPROACH TO DIALECTAL VARIATION IN KOREAN VOWELS

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ABSTRACT

This paper provides an acoustic study of monophthongal vowels (i e ɛ ɨ ʌ a u o) in eight South Korean dialects based on a dialectal speech corpus created by the National Institute of the Korean Language (2004-2011). The spontaneous speech data were automatically segmented by force-aligning them with phonemic transcriptions. Multiple formant values using different LPC formant ceiling settings were extracted and the formant values that maximize the speaker's vowel space, as calculated by Heron's method, were selected as optimal. The resulting vowel space of the eight dialects, extracted using minimal manual correction, shows patterns that are largely consistent with the traditional impressionistic descriptions. The study lays a foundation for further acoustic exploration of the spontaneous dialectal speech using computational tools. The study makes empirical and methodological contributions to the study of Korean dialects and corpus-based dialect study more generally.

Keywords: vowels, Korean, dialects, spontaneous speech, corpus

1. INTRODUCTION

The studies rooted in the Korean dialectology tradition provide an insightful description of Korean vowel patterns and dialectal variation from the perspective of historical sound change [11]. As steps of historical sound changes are often mirrored in dialectal variation of the present, dialect variation can present a rare window into the language's past and enrich our understanding of sound change [22]. However, the bulk of work on Korean dialects is based on impressionistic descriptions. While there are a number of acoustic studies on Korean vowels including some on non-standard dialects [2, 7, 8, 15, 16], studies that compare multiple dialects using a consistent methodology are rare and even rarer are studies that examine vowel production in spontaneous speech [6].

Spontaneous speech corpora obviate the issue of authenticity and naturalness of speech samples that often arise with data collected in controlled lab experiments, a problem particularly acute for non-standard dialects. But spontaneous speech brings additional challenges in analysis due to the uncontrolled distribution of data. Also, the sheer volume of data in spontaneous speech corpora makes acoustic analysis based on manual segmentation and correction unrealistic. But, recent studies have begun to make use of new computational techniques to analyze vowels in large speech corpora [8, 12, 17, 19].

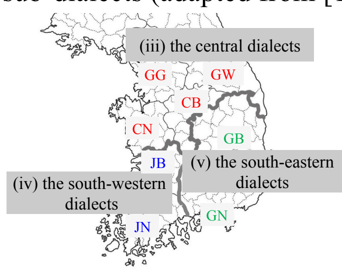
As part of a larger acoustic study of Korean dialects based on a corpus of spontaneous speech, this study compares the vowel system of eight dialects of Korean using a custom-made force-alignment system and a formant selection algorithm that selects formant measurement settings that maximize individual speakers' vowel spaces.

2. BACKGROUND

Korean dialects are divided into six major dialectal zones. These are (i) the north-western dialects, (ii) the north-eastern dialects, (iii) the central dialects, (iv) the south-western dialects, (v) the south-eastern dialects and (vi) the Cheju dialect [23, 24]. The current study focuses on the dialect areas in the mainland South Korea, i.e., (iii), (iv), and (v).

The major dialect zones are further divided into sub-dialect areas which correspond to administrative regions. The central dialects included Gyounggi (GG), Gangwon (GW), Chungbuk (CB), and Chungnam (CN) dialects. The south-western dialects include Jeonbuk (JB) and Jeonnam (JN) dialects while the south-eastern dialects include Gyeongbuk (GB) and Gyeongnam (GN) dialects. The locations of the sub-dialects are indicated in Figure 1.

Figure 1: Dialect map of mainland South Korea with 8 sub-dialects (adapted from [10])



The inventory of monophthongal vowels of Korean is provided in Table 1. /y/ and /ø/ have diphthongized in most dialects and are not included in the current study.

Table 1: Korean monophthongal vowels

i	(y)	ɨ ②	u ④
e	(ø)	ʌ	o
ɛ ①		a ③	

In his overview of dialectal variation of Korean vowels, [11] observes that South Korean dialects are characterized by vowel merger and compression along the height dimension (while North Korean dialects show compression along the rounding/backness dimension). Specifically, the mid and low front vowels, /e/ and /ɛ/, are undergoing a merger in most South Korean dialects (①) and this change is considered to have originated from the south and spread northward. The south-eastern dialects show further compression of height contrast by merging high and mid central vowels /ɨ/ and /ʌ/ (②), more pronounced in GN than GB, although younger speakers seem to be reversing this change, presumably due to the influence of the standard dialect.

In the central dialects, on the other hand, the position of /ʌ/ is lower and more back (and rounded) (③) than the southern dialects, showing a change in the opposite direction from that found in the south-eastern dialects [9]. Recent studies also show that /o/ is raising to /u/ (④) in Seoul Korean, although unlike the raising of the other vowels, /o/ raising seems to be a shift, not a merger [4, 8, 21].

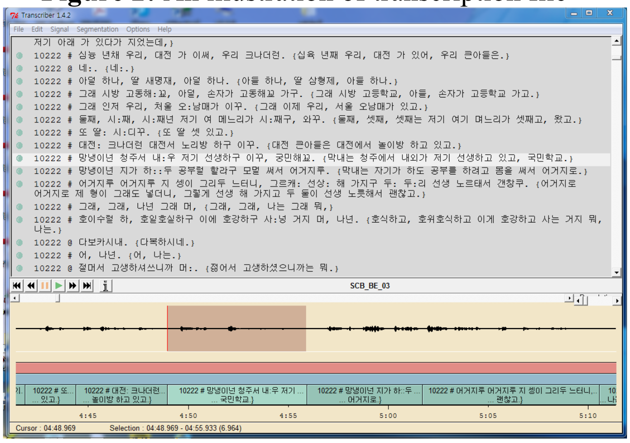
3. DATA

The data for this study come from *The Korean Dialect Survey Project*, conceived in 2003 jointly by the National Institute of the Korean Language (NIKL) in South Korea and the Linguistics Institute of the Chosun Academy of Sciences in North Korea. The collaboration with the North Korea halted due to the political climate but the data collection for South Korean dialects (from 61 cities/towns) and some overseas diaspora dialects (from 13 cities/towns) are completed (data collection: 2004-2011). For each town, one or two informants were chosen, who had spent most of their lives in the region, to ensure that their language exhibited the traditional dialectal traits as much as possible with minimum influence from other dialects. As a result, the informants tend to be in their 60's or older.

The speech data included elicited productions designed to probe lexical and grammatical characteristics of each dialect as well as spontaneous conversational speech elicited through an ethnographic interview. This resulted in around 10-14 hours of recording per speaker, a subset of which have been transcribed. The data collection, transcription, and the descriptive analysis for each dialect was carried out by leading experts on respective dialect areas.

While the exact transcription convention varies from dialect to dialect, the transcribers abided by the convention of transcribing phonemically using *Hangul*. The phonemic transcription is accompanied by the translation in the Standard Korean. Figure 2 illustrates an example of transcription file from the corpus.

Figure 2: An illustration of transcription file



For our current study, we selected eight towns/speakers, one from each of the eight sub-dialect areas summarized in Figure 1. The recording quality was not as optimal as one might hope for acoustic analyses, which presents a challenge. For this initial study, we selected the towns that had the best recording quality for each sub-dialect area.

Table 1: Information on each informant

Province	Town	Gender	Birth year	Recording year	Age
경기(GG)	강화	M	1931	2011	81
충북(CB)	청원	F	1929	2006	78
충남(CN)	논산	F	1930	2006	77
강원(GW)	평창	M	1925	2008	79
전북(JB)	군산	M	1934	2007	74
전남(JN)	보성	M	1932	2008	77
경북(GB)	의성	M	1930	2009	79
경남(GN)	하동	F	1944	2011	68

The speech files were processed using a custom-made HMM-based forced-alignment system [18, 19]. A pronunciation dictionary, which is an essential element of a forced alignment system ([20]), was created based on the transcribed texts. The alignment was manually inspected and corrected to ensure the accuracy. Table 2 summarizes the total number of vowel tokens extracted from the data. The number of tokens for [e] in SJN is left blank, because the transcription for this dialect did not distinguish [ɛ] and [e], due to the fact that the two vowels are completely merged in this dialect.

Table 2: Number of vowel tokens analysed

	[a]	[ɛ]	[e]	[ʌ]	[ɨ]	[i]	[o]	[u]
GG	465	161	216	336	365	568	216	277
CB	541	165	193	538	346	460	140	348
CN	535	107	67	280	240	379	128	212
GW	114	32	45	87	76	154	63	42
JB	663	177	196	457	485	558	352	164
JN	626	219		356	375	449	294	111
GB	636	111	163	374	306	420	297	173
GN	350	70	112	254	196	312	255	78

4. ACOUSTIC ANALYSIS

To improve the accuracy of the formant measurements, the formants for each vowel token were measured 26 times using an LPC method, as implemented in the "To Formant (burg)" function of *Praat*, varying the formant ceiling setting from 4,000 Hz to 6,500 Hz by 100 Hz increments [3]. Formant values that fell outside 1.5 standard deviations from the mean were excluded as outliers. Out of the 26 different measurement settings, a ceiling that brought about the maximum area in the vowel space was chosen as optimal for the speaker. The size of the acoustic vowel space was defined as a triangular area marked by the corner vowels /i/, /a/, and /u/. The average F1 and F2 values of the three corner vowels of each speaker were used to calculate the vowel area using Heron's method [5, 13]

Figure 3: Selection of Optimal Ceiling that results in the maximum vowel space

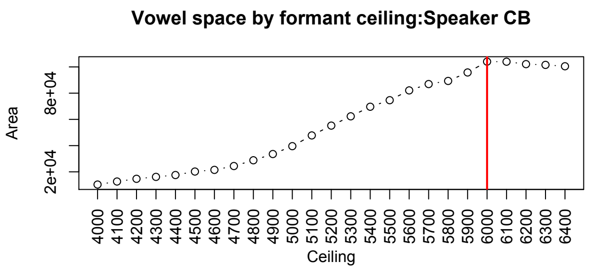
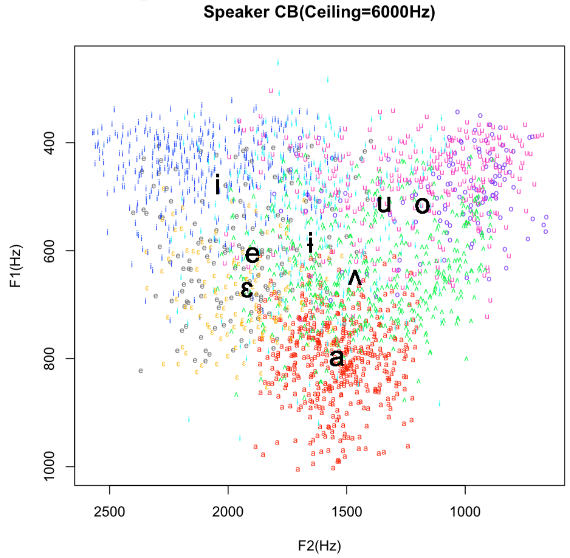


Figure 3 illustrates how the area of vowel space varies depending on the formant ceiling setting for the female CB speaker. The optimal ceiling that results in the maximum vowel space is determined to be 6,000 Hz. The distribution of the vowel tokens for this speaker with this optimal formant ceiling is shown in Figure 4. The formant values were normalized using the Lobanov method [1, 14] to allow for direct comparison of vowels across speakers.

Figure 4: Vowel space with optimal ceiling (6,000 Hz) for Speaker CB. The larger symbols represent the mean for the vowel.



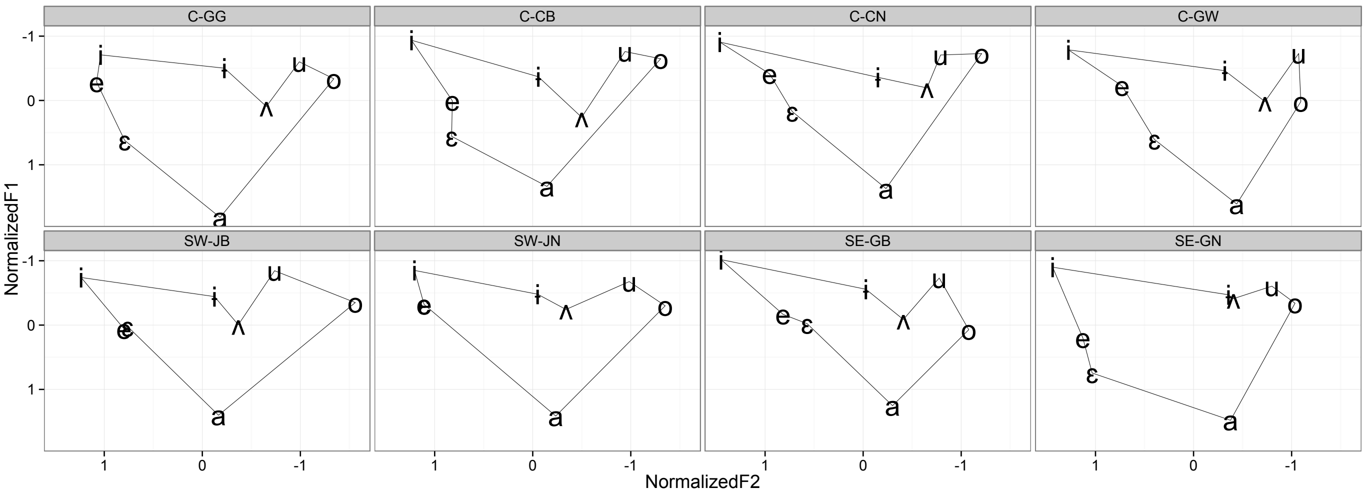
5. RESULTS

We now provide a descriptive summary of the vowel patterns and comparisons across dialects and discuss how the results compare with the dialectal variation observed in the previous literature.

Figure 5 represents the distribution of mean formant values in the normalized scale in the eight dialects. The central dialects are shown in the top row, the south-western dialects are in the bottom left and the south-eastern dialects are in the bottom right. Figure 6 zooms into the three vowel pairs where we expect to observe dialectal variation or sound change based on previous literature.

First, we examine the /e/ vs. /ɛ/ contrast. In the central dialects, the two vowels are generally well separated. The vowels are positioned closer together in the southern dialects compared to the central dialects, in line with the previous observation that the merger started in the southern dialects and spread northward. Within the central dialects, GG (경기) and GW (강원), which are located further north, show a larger separation than CB (충북) and CN (충남) dialects. The south-western dialects, JB (전북) and JN (전남) show a complete merger. The south-eastern dialects, GB (경북) and GN (경남), show a better separation than the JN or JB dialects but only GN (경남) shows a height difference. This difference between GN and GB also replicates the observation of previous literature [11].

Figure 5: Normalized mean formant values for the vowels in the eight sub-dialects



As for the /ɨ/ vs. /ʌ/ contrast, the GN dialect, a south-eastern dialect shows a complete merger of the two vowels, while its northern counterpart, the GB dialect shows a clear distinction, as do all the other dialects. When we compare the position of /ʌ/ vowel across dialects, we can observe that the vowel is more back in the central dialects compared to the southern dialects. This also agrees with the observation of the previous literature [9].

Finally, the /u/ vs. /o/ contrast also shows dialectal variation in the expected direction. Two central dialects, CB and CN, show a markedly raised /o/ vowel to the extent that /u/ and /o/ do not differ in their F1 but differ solely in their F2. This is in contrast to other dialects where /u/ and /o/ show a clear difference in their height (i.e., F1).

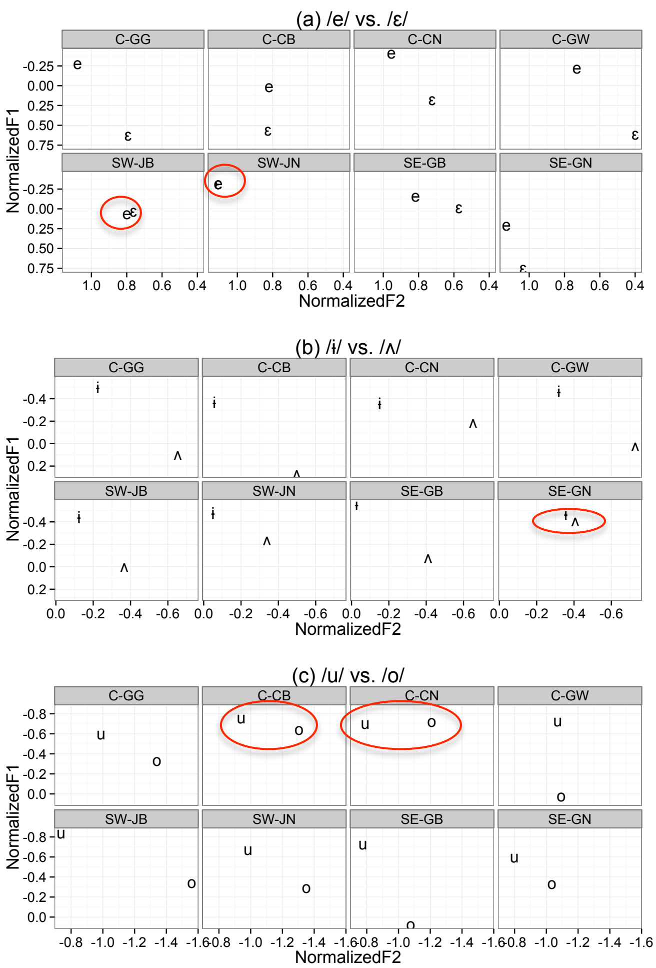
6. DISCUSSIONS AND CONCLUSION

The paper aimed at describing vowel spaces of Korean dialects by processing and extracting acoustic information from a corpus of spontaneous and unscripted speech. The resulting vowel space shows a good fit with the observations of the previous literature, providing support for the validity of the current methodology. The result is all the more encouraging for future application given that the formant extraction and outlier elimination process involved no manual correction.

The findings in this paper confirm a number of observations about dialectal variation of Korean vowels. The dialects in South Korea are marked by changes that reduce contrast along the height dimension but each change originates from different dialect areas. /e/ vs. /ɛ/ merger is more pronounced in the southern dialects, the south-western dialects most specifically, than the northern dialects. /ɨ/ vs. /ʌ/ merger is found in GN, and in central dialects /ʌ/ has a more back realization. /o/ is raised to the same height as /u/ in CN and CB dialects.

The paper is limited in its selection of only one speaker and one town from each sub-dialect areas. Future studies will expand to include additional data from the NIKL dialect corpus. Future studies will also examine the subtle but systematic variation of vowel quality due to prosodic, positional and segmental conditions, which are less accessible by impressionistic observation.

Figure 6: Dialect comparison of three vowel pairs



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