1 Vowels and Consonants

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1 Introduction

The characteristics of vowels and consonants in Korean are discussed in this chapter. Specifically, this chapter introduces which vowels and consonants are phonemes in Korean and what their phonetic characteristics are and also examines how often they are used. In this discussion, reference is chiefly made to the Seoul dialect, which is more commonly known as Standard Korean.

Section 2 introduces the phoneme inventories of vowels and consonants. Though there is generally a consensus regarding the constituents of the Korean consonant system, this is not matched by that of the Korean vowel system, about which phonologists tend to disagree. The debate in the literature is centered on the number of monophthongs in the Korean vowel system, with some scholars claiming that there are only seven and others claiming that there could be as many as ten. Some other issues related to the vowel system of Korean are also discussed in detail.

Section 3 examines the phonetic properties of Korean vowels and consonants. For the purposes of investigating the phonetic properties of Korean vowels, the results of acoustic analysis of simple vowels produced by twenty speakers of Standard Korean are presented in comparison with the acoustic properties of cardinal vowels. Spectrograms in various phonetic environments are displayed, and there is a review of the results of previous studies, allowing for an examination of the properties of Korean consonants.

Section 4 provides information regarding the frequency of Korean vowels and consonants to uncover the relative usage frequency of different vowels and consonants in Korean. The frequencies of occurrence of Korean sounds are examined through reference to dictionary data and spontaneous speech data. The results of the two data sets are compared and discussed. A summary of this discussion is then presented in Section 5.

The Handbook of Korean Linguistics, First Edition. Edited by Lucien Brown and Jaehoon Yeon.

2 Phoneme inventory

2.1 Vowel inventory

Vowels are divided into two categories according to their articulatory movement pattern: monophthongs and diphthongs. Monophthongs (or simple vowels) are vowels with a single articulatory movement. In other words, monophthongs do not have an articulatory change from beginning to end. On the other hand, diphthongs are vowels with an articulatory change during their production. Diphthongs contain two elements: a glide and a monophthong. They can be categorized according to the order of these two elements as on-glide diphthongs (glide followed by monophthong) and off-glide diphthongs (monophthong followed by glide).

2.1.1 Monophthongs (simple vowels) There is some disagreement among Korean phonologists concerning how many simple vowels there are in the phoneme inventory. The largest inventory offered has ten simple vowels, while the smallest inventory has seven. Several scholars have proposed an eight or nine simple vowel system. This divergence in simple vowel inventories reveals two essential issues: firstly, whether Korean has two front rounded vowels (i. e. /ø/ and /y/); and, secondly, whether Korean has three levels of front vowels in terms of vowel height (i.e. whether /e/ and /æ/ are distinctive).

Those who propose the ten simple vowel system insist that both front and back vowels have a roundness/non-roundness contrast and that both front and back vowels can be classified into three levels: high, mid, and low, depending on tongue height. Accordingly, /i, e, æ, y, ø, ɯ, ʌ, ɑ, u, o/ are phonemes of Korean put forward in the ten-vowel system. Many Korean phonologists support the ten-vowel system (Kuklo Lee 1932; Hi Seung Lee 1955; W. Kim 1963; Huh 1965; M. Kim 1992; Ho Young Lee 1996; P. Lee and M. Choi 1997; I. Lee and Ramsey 2000; O. Kang 2003; J. Lee 2005).

On the other hand, those who propose the nine-simple vowel system do not regard /y/ as a phoneme, discounting it from the ten vowels listed above. Hyon Pai Choi (1937) and Oh (1993) support the nine-vowel system. T. Kim (1916), Yoon Kyong Kim (1948), Yi (1954), Bae (1996), and Z. Kim (1998) propose an eight-vowel system, reasoning that the two front rounded vowels are not phonemes in Korean. Indeed, they insist that there is no front rounded vowel in the phoneme inventory of Korean. Shin (2000a), Shin and Cha (2003), and Shin et al. (2012) have suggested a seven-vowel system in which there are two front unrounded vowels and five back vowels based on acoustic data.

According to the surveys of pronunciation of Speakers of Standard Korean conducted by the National Institute of Korean Language (Hye-Won Choi 2002; Seoncheol Kim 2003) and acoustic analysis of their speech data (Hwang and Moon 2005; Jang and Shin 2006; Moon 2007), Standard Korean has the seven-vowel system. Hye-Won Choi (2002) finds that only 3.37% of 210 speakers of Standard Korean aged between 21 to 79 pronounce '외' as monophthong [ø] and that /e/ and /æ/ tend to merge together in all age groups. Seoncheol Kim (2003) surveys 350 speakers of Standard Korean aged between over 20 and

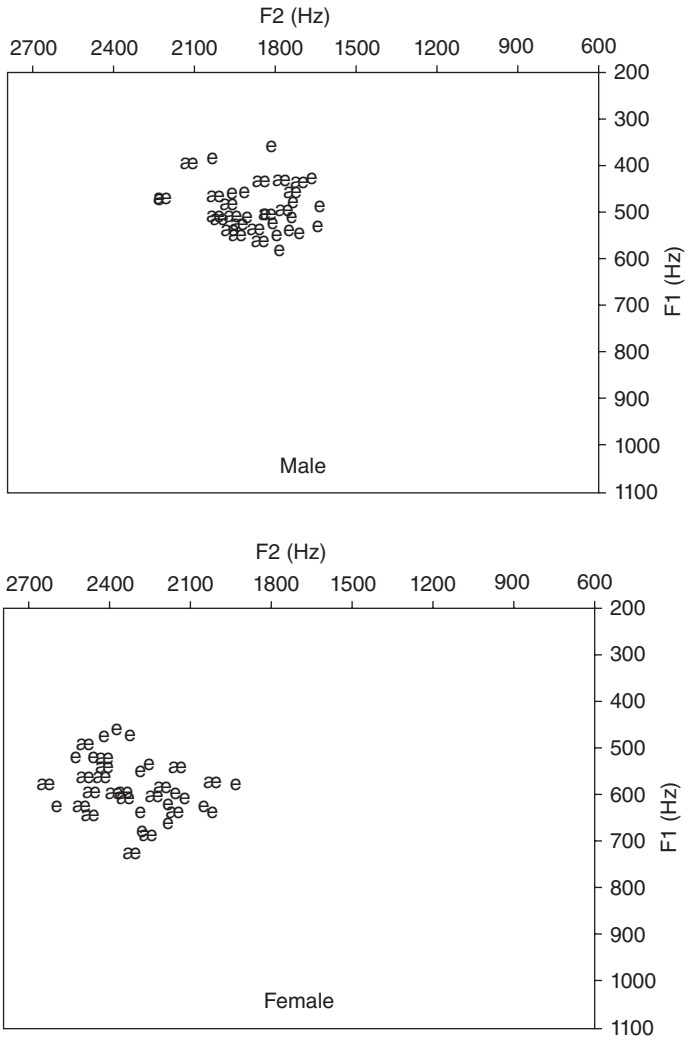

Figure 1.1 Formant plot of ‘ㅔ’ and ‘ㅐ’ (i.e. /e/ and /æ/).

under 70 and finds that monophthong [y] is observed in only about 5% of the data having ‘ㅟ’ in Korean orthography. The merger of /e/ and /æ/ can also be identified from the acoustic studies by Hwang and Moon (2005), Jang and Shin (2006), and Moon (2007).

The formant charts shown in Figure 1.1 confirm the observation. Each chart shows the results from ten speakers of Standard Korean. As shown, there is no significant difference observed between the pronunciations of words containing the Hangul vowel graphemes ‘ㅔ’ and ‘ㅐ’ (i.e. /e/, and /æ/).

The data shows that most speakers of contemporary Seoul Korean have a seven-vowel system. The table below displays these seven vowels, plus the other three vowels present in the traditional ten-vowel system.

Table 1.1 Monophthongs of Standard Korean in real speech and traditional ten-vowel system (orthography).

	Real speech			*Traditional ten-vowel system*			
	Front	*Back*		*Front*		*Back*	
	Unrounded	*Unrounded*	*Rounded*	*Unrounded*	*Rounded*	*Unrounded*	*Rounded*
High	i (ㅣ)	ɯ (ㅡ)	u (ㅜ)	i (ㅣ)	y (ㅟ)	ɯ (ㅡ)	u (ㅜ)
Mid	ɛ (ㅔ / ㅐ)	ʌ (ㅓ)	o (ㅗ)	e (ㅔ)	ø (ㅚ)	ʌ (ㅓ)	o (ㅗ)
Low		ɑ (ㅏ)		æ (ㅐ)		ɑ (ㅏ)	

Table 1.2 Diphthongs in Standard Korean in real speech (orthography).

	i	ɛ	ɯ	ʌ	ɑ	*u*	*o*
j		jɛ (ㅖ / ㅒ)		jʌ (ㅕ)	jɑ (ㅑ)	ju (ㅠ)	jo (ㅛ)
w	wi (ㅟ)	wɛ (ㅙ/ㅞ/ㅙ)		wʌ (ㅝ)	wɑ (ㅘ)		
ɯj			ɯi (ㅢ)				

2.1.2 Diphthongs If the seven-monophthong system is adopted, in which there is assumed to be no distinction between /e (ㅔ)/ and /æ (ㅐ)/, then both /je (ㅖ)/ and /jæ (ㅒ)/ as well as /we (ㅞ)/ and /wæ (ㅙ)/ will also show no distinction. In addition, as the actual pronunciation of 'ㅟ' (previously pronounced as /y/) is /wi/, the diphthong /wi/ should be included in the inventory. This will give us an inventory of Korean diphthongs as shown in Table 1.2.

One more issue in the diphthong inventory is the status of ɯj (ㅢ). Some scholars propose that 'ㅢ' is unique in that it is the only off-glide in Korean: a glide plus a simple vowel. However, research on the phonological behavior and phonetic characteristics of this diphthong suggests that it should actually be categorized as an on-glide /ɯi/ (see Shin 1999 and Shin et al. 2012 for more detail). Classifying 'ㅢ' as an on-glide means that we can avoid the situation in which Korean is described as having one unique off-glide; however, it means that we have to recognize an extra glide /ɯ/ in the phoneme inventory of Korean.

2.2 Consonant inventory

Korean has a consonant inventory of nineteen, as shown in Table 1.3. These nineteen consonants can be classified into bilabial, alveolar, alveolo-palatal, velar, and glottal consonants, according to the place of their articulation. They can also be classified into stops, fricatives, affricates, nasals, and liquids according to the manner of their articulation. Furthermore, obstruents (stops, fricatives, and affricates) can be sub-categorized into three classes for stops and affricates and two classes for fricatives.

Table 1.3 Consonants in Standard Korean (orthography).

			Bilabial	*Alveolar*	*Alveolo-palatal*	*Velar*	*Glottal*
Obstruent	Stop (Plosive)	Lax	p (ㅂ)	t (ㄷ)		k (ㄱ)	
		Tense	p* (ㅃ)[1]	t* (ㄸ)		k* (ㄲ)	
		Aspirated	p^h (ㅍ)	t^h (ㅌ)		k^h (ㅋ)	
	Fricative	Lax		s (ㅅ)			h (ㅎ)
		Tense		s* (ㅆ)			
	Affricate	Lax			tɕ (ㅈ)		
		Tense			tɕ* (ㅉ)		
		Aspirated			$tɕ^h$ (ㅊ)		
Sonorant	Nasal		m (ㅁ)	n (ㄴ)		ŋ (ㅇ)	
	Liquid (Lateral approximant)			l (ㄹ)			

Korean has a rich inventory of obstruent sounds, with 15 out of 19 consonants belonging to the obstruent class. Korean obstruents have two or three series of sounds according to their type of phonation, with these categories being named lax, tense, and aspirated. Interestingly, all are voiceless without exception. Therefore, in the case of Korean, we can say that obstruents are all voiceless while sonorants are all voiced. This is one of the main characteristics of the Korean consonant system. A simple inventory of fricatives is another characteristic of Korean consonants. Fricatives are articulated in only two places in Korean: alveolar and glottal positions. In contrast to the case of the vowel inventory, phonologists do not tend to hold a divergent view on the consonant inventory in Korean. There are few differences in the inventory of consonants between generations or even regional dialects.

3 Phonetic characteristics

3.1 Phonetic characteristics of vowels

The acoustic characteristics of Korean vowels have been examined in a number of previous studies, including Yang (1990), Hwang and Moon (2005), Jang and Shin (2006), and Moon (2007). However, most studies are based on acoustic analysis of read speech data rather than spontaneous speech data. For more natural and spontaneous speech data, a small experiment was carried out. Twenty native speakers of Standard Korean (ten male and ten female speakers) were asked to take part in a quiz in which the answers to all of the questions were words which began with the seven monophthongs of Korean. As the quiz was done twice, a total of twenty tokens of each vowel was collected, with the exception of /ɛ/. To investigate the phonological status of /e/ and /æ/, the quiz included questions asking for words which, orthographically speaking, began with either '에' (/e/) or '애' (/æ/). Since all speakers produced both '에' and '애' identically as /ɛ/, this resulted in forty tokens for /ɛ/. Three formant values were measured and are

Table 1.4 Mean and standard deviation of F1, F2, and F3 of seven monophthongs produced by ten male and ten female speakers of standard Korean (forty tokens for / **ɛ** / and twenty tokens for other monophthongs).

		Male			*Female*		
		F1	*F2*	*F3*	*F1*	*F2*	*F3*
i	Mean	234.9	2184.1	3262.8	217.2	2773.5	3664.9
	SD	28.0	146.8	158.1	15.3	146.0	312.0
ɛ	Mean	488.8	1926.3	2647.0	581.4	2372.9	3141.7
	SD	50.8	131.0	119.5	59.1	162.7	186.0
ɑ	Mean	803.9	1314.2	2635.0	1060.4	1594.2	2857.0
	SD	50.4	66.5	134.4	45.7	85.5	187.9
ɯ	Mean	310.9	1360.1	2398.4	333.3	1619.0	2736.2
	SD	35.7	149.1	182.8	74.4	189.7	207.3
ʌ	Mean	521.4	903.7	2698.5	659.8	1182.7	2932.5
	SD	41.1	81.4	137.2	90.4	150.5	172.2
u	Mean	253.3	689.2	2414.9	268.4	652.4	2820.5
	SD	35.5	127.3	153.5	36.7	132.8	287.9
o	Mean	317.7	691.4	2480.9	337.4	686.7	2704.9
	SD	38.7	103.6	134.9	41.9	104.3	254.2

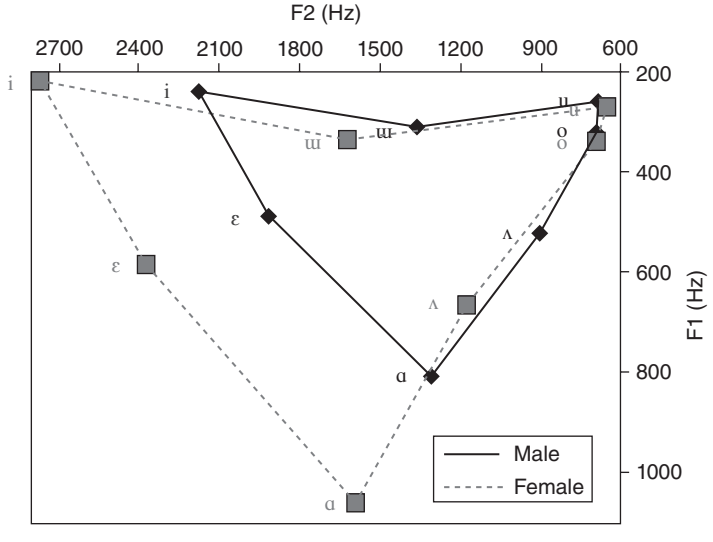

Figure 1.2 Formant chart (ten male and ten female speakers of Standard Korean).

presented in Table 1.4 below. Figure 1.2 shows a formant chart drawn from the data that is summarized in Table 1.4.

To examine the phonetic characteristics of Korean, formant values are compared with Cardinal Vowels (CV) as recorded by Daniel Jones. Figure 1.3 below shows the

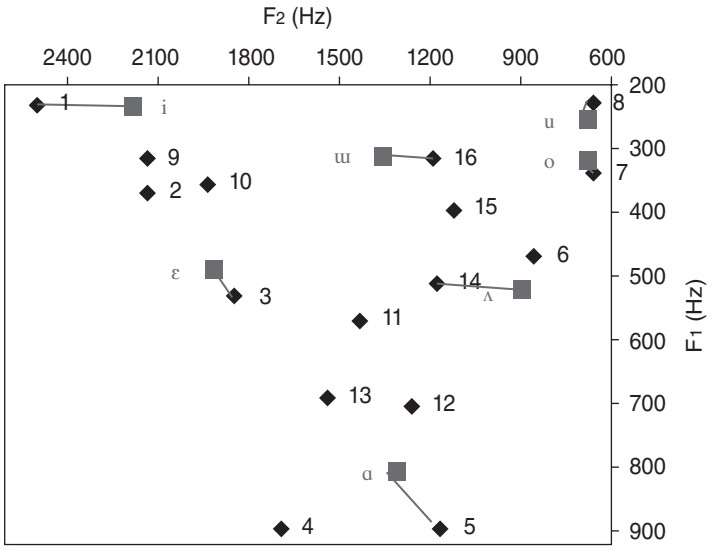

Figure 1.3 Comparison of F1 and F2 between Korean vowels (by ten male speakers) and cardinal vowels (by Daniel Jones).

phonetic distance between the seven monophthongs of Korean and sixteen CVs. It shows that the Korean simple vowels /i, ɛ, ɑ, ʌ, ɯ, o, u/ are, variously, similar to CV1, CV3, CV5, CV14, CV16, CV7, CV8 respectively.[2] However, Korean [i] is produced with a slightly farther back tongue position than CV1, Korean [ɛ] with a higher tongue position than CV3, Korean [ɑ] with a higher tongue position than CV5, Korean [ʌ] with slightly more rounded lips than CV14, Korean [ɯ] with a tongue position that is slightly closer to the front than CV16, Korean [o] with a higher tongue position than CV7, and Korean [u] with a lower tongue position than CV8.

3.2 *Phonetic characteristics of consonants*

3.2.1 Obstruents As noted above, Korean has a rich inventory of obstruents. Korean stops and affricates are defined as either lax, tense, or aspirated, while fricatives are either lax or tense according to their type of phonation. All phonation types are voiceless. This is one of the main characteristics of Korean.

All obstruents are distinctive only at the syllable-initial (onset) position, while neutralization processes take place at the syllable-final (coda) position. Since only unreleased sounds can be realized at the coda position, distinctions in manner of articulation and phonation types all become neutralized. Hence, the only phonation type of obstruents that can occur in the coda position are lax stops. In addition, lax sounds have allophonic variation according to their position within a word.

Figure 1.4 shows the phonetic realization of /t, t*, t^h/ in (a) word-initial, (b) word-medial, and (c) word-final position. As shown in the figure, stops display distinctive acoustic characteristics according to their phonation types. In the word-initial position, the lax and aspirated sounds have a relatively long VOT (Voice Onset Time), while tense sounds have a short VOT.[3] However, in the word-medial position, lax stops are not produced with an aspiration period at all and are instead realized as

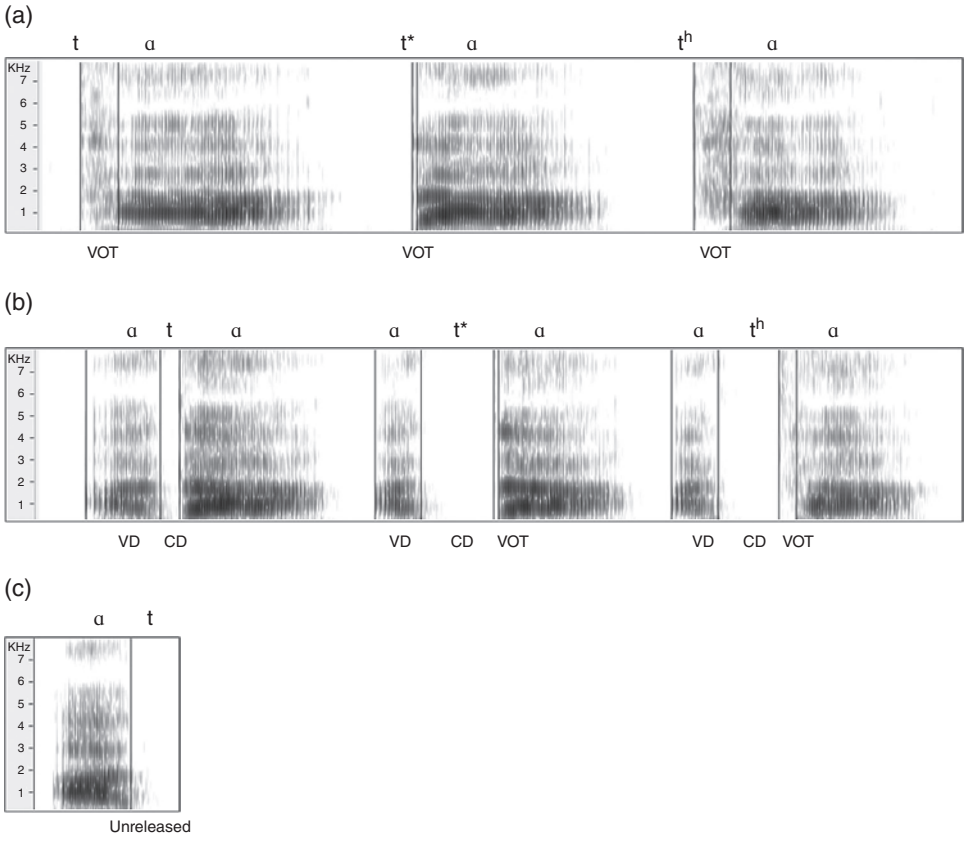

Figure 1.4 Spectrograms of three types of stops in (a) word-initial, (b) word-medial (intervocalic), and (c) word-final position (VOT = voice onset time; CD = closure duration).

voiced sounds in the majority of cases. In contrast to the lax sounds, the tense and aspirated sounds are different in terms of VOT, regardless of their position within a word.[4] The tense stop is produced with short VOT and the aspirated stop is produced with long VOT in both positions. Due to the allophonic variation of the lax stop, the lax and tense stops are not distinctive in terms of VOT in word-medial position. Instead, the closure duration of the two classes is noticeably different. The tense stop displays a far longer closure duration than the lax stop.[5] In addition, the duration of the preceding vowel is also distinctive in word-medial position. The vowel preceding a lax stop is far longer than a vowel that precedes a tense or aspirated stop.[6]

The majority of previous studies on stops in Korean have tended to focus on the phonetic differences of the series of three stops (Lisker and Abramson 1964; C. Kim 1965; Han and Weizman 1970; Kim 1970; Hardcastle 1973, Hirose et al. 1974; Kagaya 1974; Dart 1987; Shin 1997; Pae et al. 1999; Ahn 1999; Cho et al. 2002; Kim et al. 2005; Kang and Guion 2008; Jang 2011). In word-initial position, VOT is longest for aspirated stops, intermediate length for lax stops, and shortest for tense stops. VOT of the tense stop is significantly shorter than that of the lax and the aspirated stops, but the difference in VOT between the lax and the aspirated stops has not been found to be significant (Lisker and Abramson 1964; C. Kim 1965; Han

and Weizman 1970; Jang 2011). Vowels following a word-initial stop display the highest f0 (fundamental frequency) for aspirated stops, followed by tense stops, and display the lowest for lax stops. While the difference in f0 between the lax and the other two classes is significant, the difference in f0 between the tense and aspirated stops is not significant (C. Kim 1965; Han and Weizman 1970; Cho et al. 2002; Jang 2011). Thus, f0 rather than VOT is the main acoustic cue distinguishing aspirated from lax in word-initial position. The phonation types of the following vowels also show a difference in word-initial position. Vowels following a lax or an aspirated stop have what has been described as a breathier phonation (i.e. higher H1-H2 or H1-F2[7]), while vowels following a tense stop have what has been described as a creakier phonation (i.e. lower H1-H2 or H1-F2, see Han and Weizman 1970; Abberton 1972; Ahn 1999; Cho et al. 2002; Kang and Guion 2008). The aerodynamic properties of the three types of stops can be summarized as follows: greater air flow but lower air pressure for the lax stop and a smaller air flow but higher air pressure for the tense stop (Dart 1987; Cho et al. 2002). The order of glottal width during the stop production is aspirated > lax > tense (C. Kim 1970; Hirose et al. 1974; Kim et al. 2005).

The three types of stops also differ in tongue contact pattern. Linguopalatal contact varies from wide to narrow in the order of tense > aspirated > lax (Hyun Bok Lee 1980; Shin 1997). The area of the tongue in contact with the roof of the mouth for alveolar stops also contains several differences, namely, that of the tongue tip for the lax stop and both the tongue tip and tongue blade for the aspirated and tense stops (Kim et al. 2005). Meanwhile, the closure duration of the three types of stops differ in word-medial position. Closure duration varies from long to short in the order of tense > aspirated > lax (Shin 1997; Pae et al. 1999). The findings of previous studies on Korean stops are summarized in Table 1.5.[8]

I now review the phonetic characteristics of Korean affricates. Figure 1.5 shows the phonetic realization of three types of Korean affricates in word-initial

Table 1.5 Phonetic characteristics of three types of stops.

Acoustic	VOT	tense < lax ≤ aspirated (initial); tense < aspirated (medial)
	f0	lax < tense ≤ aspirated (intitial)
	Intensity build-up velocity	lax < aspirated < tense (initial)
	H1-H2/F2	tense < lax ≤ apirated (initial); creakier for tense, breathier for lax and aspirated
	Closure duration	lax < aspirated < tense (medial)
Articulatory	Glottal opening	tense < lax < aspirated (initial)
	Tongue	lax: apico-dental; aspirated: apico-laminal; tense: extensive apico-laminal (initial)
	Linguopalatal contact area	lax < aspirated < tense (initial)
Aerodynamic	Intraoral air pressure	{aspirated = tense} < lax (initial)
	Intraoral airflow	tense < lax < aspirated (initial)

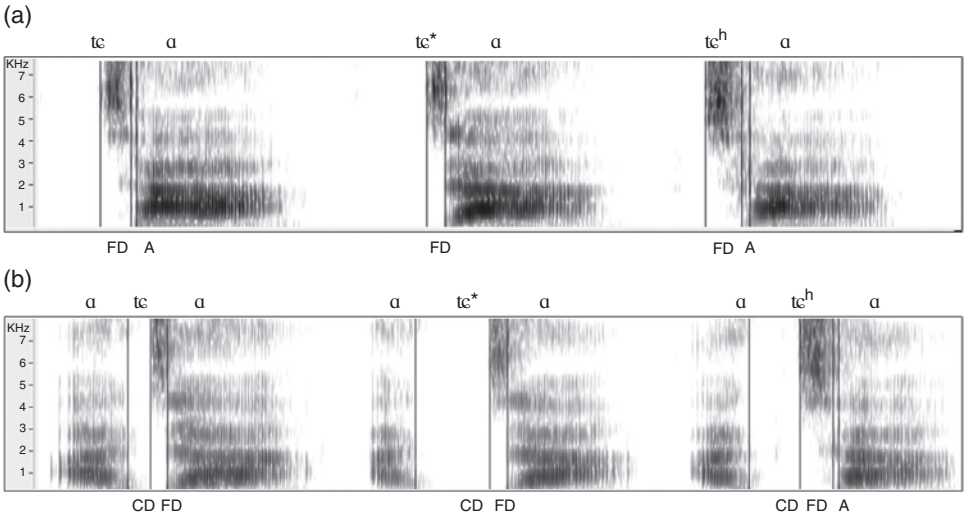

Figure 1.5 Spectrograms of three types of affricates in (a) word-initial and (b) word-medial (intervocalic) position (FD = friction duration; A = aspiration; CD = closure duration).

(a), word-medial (b), and word-final (c) position. As shown in the figure, in word-initial position, the lax affricate is produced with a medium length friction duration followed by an aspiration period after the release of the closure, while the tense affricate is produced with the shortest friction duration and without the aspiration period. The aspirated affricate in word-initial position is produced with the longest friction duration followed by an aspiration period after the release of the closure. However, in word-medial position, the lax affricate is produced with shortest closure duration, followed by a friction duration, and a vowel follows immediately without aspiration. In contrast to its behavior in word-initial position, in word-medial position the lax affricate is produced without the aspiration period. In the word-medial position, the tense affricate is observed with the longest closure duration followed by the shortest friction duration without aspiration. By contrast, the aspirated affricate is observed with a medium length closure duration followed by the longest friction duration with a long period of aspiration.

There are few existing studies on Korean affricates compared with the research carried out on Korean stops, although the phonetic characteristics of the three types of affricates are similar to those of stops. Kagaya (1974), Shin (1997), Kim et al. (2005) and Jang (2011) provide the main phonetic studies on Korean affricates. The order of friction duration of the three types of affricates is aspirated > lax > tense in both word-initial and word-final position. As for the duration of the aspiration, the order is aspirated > lax > tense in word-initial position and aspirated > tense in word-medial position, which is due to the allophonic variation of the lax affricate (Shin 1997; Jang 2011). Vowels following a word-initial affricate display the highest f0 for aspirated affricates, followed by tense affricates, and display the lowest for lax affricates. While the difference in f0 between the lax and the other two types of affricates is statistically significant, the difference in f0 between the tense and aspirated stops has not been found to be significant (Jang 2011). Closure duration varies from long to short in the order of tense > aspirated > lax, just as with the stop series. The glottal

width of affricates has also been found to display the same tendency observed in stops: aspirated > lax > tense (Kagya 1974; Kim et al. 2005). The height of the tongue blade is higher in the order of tense > aspirated > lax (Kim et al. 2005) and the tongue contact area is larger in the order of tense > aspirated > lax (Shin 1997). Table 1.6 summarizes the findings of the previous studies on affricates in Korean.

A number of studies have looked at the phonetics of Korean fricatives, including Kagaya (1974), Kyung-Hee Lee (2001), Sahyang Kim (2001), Cho et al. (2002), Yoon (2002), Chang (2007), and Jang (2011). With the exceptions of Kagaya (1974) and Sahyang Kim (2001), all have been acoustic studies. The duration of friction of /s*/ is far longer both in word-initial and word-medial position, while the duration of aspiration is shorter for /s*/ than for /s/ (Kyung-Hee Lee 2001; Cho et al. 2002; Yoon 2002; Jang 2011). Additionally, the centroid of the fricative noise is higher for /s*/ than for /s/ (Cho et al. 2002). F0 of the following vowel is higher for /s*/ than for /s/ (Cho et al. 2002; Yoon 2002; Jang 2011). H1-H2 and H1-F2 are both higher for the vowel following /s/ than for the one following /s*/, which means

Table 1.6 Phonetic characteristics of three types of affricates.

Acoustic	Friction duration	tense < lax < aspirated
	Aspiration duration	tense < lax < aspirated (initial); tense < aspirated (medial)
	f0	lax < tense < aspirated (initial)
	Closure duration	lax < aspirated < tense (medial)
Articulatory	Glottal opening	tense < lax < aspirated (initial)
	Tongue blade height	lax < aspirated < tense (initial)
	Linguopalatal contact area	lax < aspirated < tense (initial)

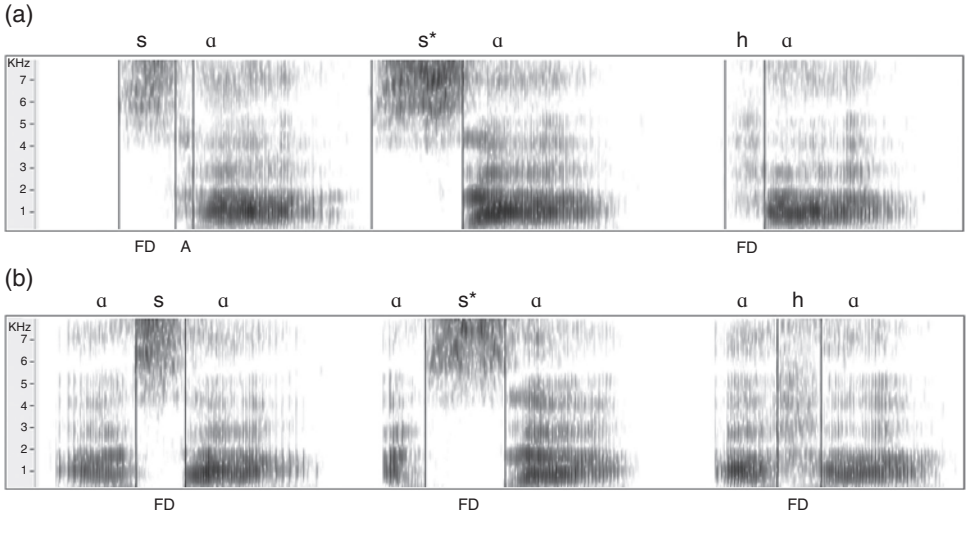

Figure 1.6 Spectrograms of the two types of alveolar fricatives and the glottal fricative in (a) word-initial and (b) word-medial (intervocalic) position (FD = friction duration, A = aspiration).

Table 1.7 Phonetic characteristics of two types of alveolar fricatives.

Acoustic	Friction duration	lax < tense
	Aspiration duration	tense < lax (initial); lax: no aspiration word-medially
	Centroid frequency	lax < tense
	f0	lax < tense
	H1-H2/F2	tense < lax
Articulatory	Glottal opening	tense < lax
	Linguopalatal contact area	lax < tense

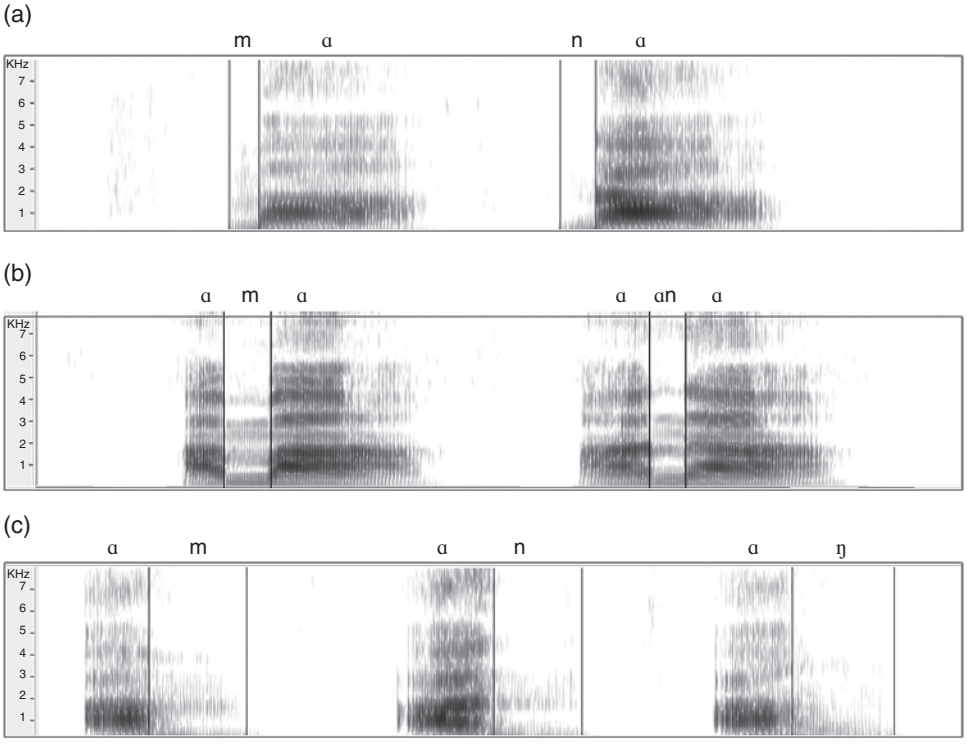

Figure 1.7 Spectrograms of nasals in (a) word-initial, (b) word-medial (intervocalic), and (c) word-final position.

that /s/ is produced in what has been described as a breathier way than in the case of /s*/ (Cho et al. 2002). The width of the glottis is greater for /s/ than for /s*/ (Kagaya 1974) and the tongue contact area is greater for /s*/ than for /s/ (Hyun Bok Lee 1980; Sahyang Kim 2001). Table 1.7 summarizes the phonetic characteristics of Korean alveolar fricatives according to the phonation types.

3.2.2 Sonorants This section examines the phonetic characteristics of Korean sonorants. Figure 1.7 below shows Korean nasals in word-initial position (a), word-medial position, (b) and word-final position (c). Figure 1.8 presents Korean

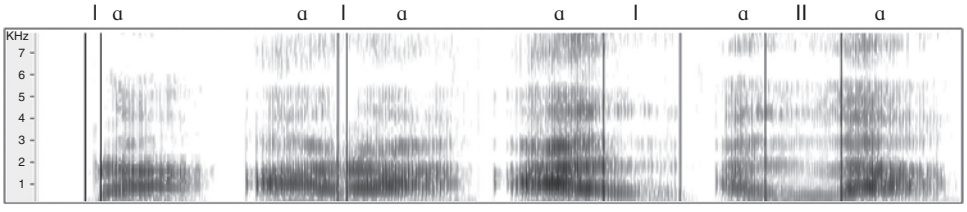

Figure 1.8 Spectrogram of liquids in word-initial, word-medial (intervocalic), word-final position, and after another /l/ (in gemination).

liquids in different phonetic environments. As can be seen, Korean nasals in word-initial position are much shorter in duration and far weaker in nasality. The Korean liquid has two allophonic realizations: /l/ is pronounced [ɾ] in word-initial and intervocalic positions and [l] in the word-final position and when it occurs after another /l/ (i.e. in gemination).

There are few phonetic studies on Korean sonorants. Given this, recent studies that have examined the weak nasality of Korean nasals in word-initial position (Yoshida 2008; Young Shin Kim 2011) are worthy of attention. Based on acoustic and aerodynamic analysis, Young Shin Kim (2011) finds that Korean nasals in word-initial position are denasalized. Through a perception test she conducted, she also finds that word-initial denasalized sounds are perceived to be nasal sounds by Korean speakers, but voiced stops by English speakers (i.e. denasalized /n/ is perceived as /d/ and /m/ as /b/).

4 Frequency of Korean sounds

In this section, dictionary entries and spontaneous speech data are used to examine the frequency of Korean sounds. Dictionary data is based on Shin (2010) and spontaneous speech data is based on Shin (2008). The results from dictionary data are based on 290,131 sounds observed from the pronunciation of the 47,401 entries of the Yonsei Dictionary and those from spontaneous speech data are based on 858,512 sounds observed from 35,439 utterances produced by 57 speakers of Standard Korean. As noted previously in this chapter, Korean contains nineteen consonants, seven monophthongs and ten diphthongs made from seven monophthongs and three glides, meaning that a total of thirty-six sounds exist in the Korean sound inventory. Table 1.8 summarizes the frequency of Korean sounds as represented in the dictionary and found in speech.

The characteristics of sound frequency observed in Table 1.8 are as follows. The most frequent sound is /ɑ/ and the least frequent sound is /ɯi/ both in the dictionary and in speech. Among consonants, the most frequent sound is /k/ while /n/ is the second most frequent. By contrast, /ŋ/ occupies a higher rank in the dictionary (5th in all sounds and 3rd in consonants) but a relatively lower rank in speech (14th in all sounds and 8th in consonants). This is closely linked to the fact that /k/ and /n/ are frequently used both in content words and grammatical morphemes, while /ŋ/ is seldom used in grammatical morphemes. Among phonation types, lax sounds are dominant both in the dictionary and in speech (72.8% and 73.1% respectively). However, tense sounds are observed

Table 1.8 Sound frequency (dictionary and speech).

	Dictionary			*Speech*				*Dictionary*			*Speech*		
Sound	*Rank*	*Frequency*	*%*	*Rank*	*Frequency*	*%*	*Sound*	*Rank*	*Frequency*	*%*	*Rank*	*Frequency*	*%*
ɑ	1	28,844	9.94	1	95,853	11.17	**tɕʰ**	19	5,290	1.82	24	6,349	0.74
k	2	22,284	7.68	3	72,756	8.47	**pʰ**	20	3,289	1.13	29	3,399	0.40
n	3	19,385	6.68	2	92,621	10.79	**tɕ***	21	2,922	1.01	22	7,480	0.87
i	4	19,133	6.59	4	60,318	7.03	**k***	22	2,784	0.96	19	11,355	1.32
ŋ	5	16,726	5.76	14	23,874	2.78	**wɛ**	23	2,772	0.96	27	3,792	0.44
l	6	16,090	5.55	5	54,253	6.32	**s***	24	2,726	0.94	20	10,638	1.24
ʌ	7	14,783	5.10	6	52,414	6.11	**wɑ**	25	2,662	0.92	28	3,628	0.42
tɕ	8	13,205	4.55	12	27,076	3.15	**tʰ**	26	2,609	0.90	25	6,229	0.73
s	9	12,818	4.42	15	22,827	2.66	**kʰ**	27	2,361	0.81	26	5,553	0.65
o	10	12,817	4.42	10	31,268	3.64	**t***	28	1,821	0.63	21	8,873	1.03
u	11	12,557	4.33	13	24,061	2.80	**jo**	29	1,529	0.53	30	2,874	0.33
m	12	11,802	4.07	9	36,132	4.21	**ju**	30	1,329	0.46	34	1,165	0.14
h	13	11,224	3.87	16	16,494	1.92	**jɑ**	31	1,232	0.42	23	6,640	0.77
p	14	10,161	3.50	18	15,837	1.84	**p***	32	1,216	0.42	31	2,457	0.29
ɛ	15	9,309	3.21	8	50,024	5.83	**wi**	33	998	0.34	35	905	0.11
t	16	8,657	2.98	11	30,704	3.58	**wʌ**	34	997	0.34	32	2,345	0.27
ɯ	17	6,882	2.37	7	50,704	5.91	**jɛ**	35	314	0.11	33	1,614	0.19
jʌ	18	6,373	2.20	17	15,915	1.85	**ɥi**	36	230	0.08	36	85	0.01

more in speech (17.6%) and less in the dictionary (12.4%) due to the frequently observed tensification process in grammatical morphemes in speech. On the contrary, aspirated sounds appear more in the dictionary (14.7%) and less in speech (9.3%). This can be interpreted as follows: aspirated sounds are less frequently used in grammatical morphemes and the aspiration process seldom occurs in grammatical morphemes in speech.

/ɑ/, /i/ and /ʌ/ are the most frequently used vowels both in the dictionary and in speech. However, /ɯ/ is the least observed monophthong in the dictionary but 4th in rank among monophthongs in speech. This result is also related to the frequent use of /ɯ/ in grammatical morphemes and the infrequent use of /ɯ/ in content words. Monophthongs are much more frequently used than diphthongs both in the dictionary and in speech (in the dictionary and speech, monophthongs are 85.0% and 90.3% and diphthongs are 15.0% and 9.7% respectively). Among diphthongs, those that have glide /j/ are more frequently observed than those that have glide /w/ or /ɰ/. Diphthongs that have glides /j/, /w/ and /ɰ/ occupy 58.5%, 40.3%, and 1.2% in the dictionary and 72.4%, 27.4%, and 0.2% in speech respectively. The higher number of the observed /w/ in the dictionary is due to the less frequent use of the sound in grammatical morphemes and the frequent occurrence of /w/-reduction in speech.

5 Summary

The characteristics of Korean vowels and consonants which we have examined are as follows. The phoneme inventory of Korean consists of seven simple vowels, three glides, and nineteen consonants. Korean has two front vowels and five back vowels which have three levels of vowel height: high, mid, and low. Back vowels are distinctive in roundness for high and mid vowels. Korean has ten diphthongs, which are combinations of these seven monophthongs with the three glides. The characteristics of the Korean consonant system are as follows. First, Korean has a rich inventory of obstruents, with 15 out of 19 consonants classed as obstruents. Second, obstruents are all voiceless. Third, Korean has a three-way distinction (lax, tense, and aspirated) among stops and affricates and a two-way distinction (lax and tense) among fricatives.

In terms of further discussion of the phonetic characteristics of Korean vowels as compared to cardinal vowels, Korean [i] is similar to CV1 but with a tongue position that is slightly farther back in the mouth. Korean [ɛ] is similar to CV3 but with a higher tongue position. Korean [ɑ] is similar to CV5 but with a higher tongue position. Korean [ʌ] is similar to CV14 but with slightly more rounded lips. Korean [ɯ] is similar to CV16 but with a tongue position that is slightly closer to the front of the mouth. Korean [o] is similar to CV7 but with a higher tongue position. Korean [u] is similar to CV8 but with a lower tongue position.

This chapter has also provided a summary of the phonetic features of Korean consonants. Lax sounds are produced with aspiration in word-initial position, but without aspiration in the word-medial position. This is observed not only in stops, but also in affricates and fricatives. As a result, in terms of aspiration, the lax and the aspirated sounds are distinguished from the tense sounds in

word-initial position, while the lax and the tense sounds are distinguished from the aspirated sounds in word-medial position. In word-initial position, the lax and the aspirated sounds differ in f0 of the following vowels, which is higher for the aspirated sounds than for the lax sounds. On the other hand, in word-medial position, the lax and the tense sounds differ in temporal aspects. The duration of closure for the lax stops and affricates and the duration of friction for the lax fricatives are far shorter than their tense counterparts. In word-medial position, the aspirated sounds have a longer duration than the lax sounds, but a shorter duration than the tense sounds. However, in word-medial position, aspiration is a more important feature that distinguishes the aspirated sounds from other phonation types. In word-final position, all consonants should be realized as unreleased sounds in Korean. Therefore, of all the obstruents in Korean, only stops can be realized in this position and the phonation types are neutralized. Korean nasals are weak in nasality in word-initial position.

Among the thirty-six Korean sounds, that is, seven monophthongs, ten diphthongs, and nineteen consonants, the most frequently observed sound is the simple vowel /ɑ/ and the least frequently observed sound is the diphthong /ɯi/ both in the dictionary and in speech. Monophthongs are dominant both in the dictionary and speech. Among consonants, /k/ is the most frequent sound and /n/ is the next most frequent. Among phonation types, the lax sounds are dominant both in the dictionary and in speech.

NOTES

1 The most popular notating convention for Korean tense sounds is placing an apostrophe after the lax sounds (i.e. p', t', k'). However, the IPA uses the apostrophe to denote ejectives. One symbol being used to represent two different sounds in this way is a basic flaw within the IPA. In order to get around this problem, Korean tense sounds are often denoted using a capital letter P,T,K (Han and Weizman 1970) or an asterisk p*, t*, k* (Ladefoged and Maddieson 1996; Shin et al. 2012). In this chapter, we adopt this latter convention. Please see Shin et al. (2012, 34–35) for more detailed discussion on the notation convention for Korean tense sounds.

2 For more detailed information on cardinal vowels, visit http://www.let.uu.nl/~audiufon/data/e_cardinal_vowels.html

3 In the example in Figure 1.4(a), the VOTs for the lax, tense and aspirated sounds are 47 ms, 13 ms, and 76 ms respectively.

4 In the example in Figure 1.4(b), the VOTs for the tense and the aspirated sounds are 8 ms and 45 ms respectively.

5 In the example in Figure 1.4(b), the closure durations for the lax, tense, and aspirated stops are 80 ms, 148 ms, and 134 ms respectively.

6 In the example in Figure 1.4(b), the durations of the preceding vowels for the lax, tense and aspirated stops are 132 ms, 72 ms, and 80 ms respectively.

7 Here, H1, H2, F2 means the amplitude of the first harmonic, the second harmonic, and the second formant, respectively.

8 In addition, dialectal differences (Cho et al. 2002; Hansook Choi 2002; Jo and Shin 2003; Lee 2009; Jang 2011) and generational differences (Silva 2006; Kang and Guion 2008) in the phonetic properties of stops have also been investigated more recently.

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