

Diachronic change in vowel length contrast in North Kyungsang Korean*

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This study investigates the phonemic status of the vowel length contrast in North Kyungsang Korean (NKK), responding to the vowel length contrast merger in contemporary Seoul Korean. A phonetic study was designed to examine whether the vowel length contrast is maintained phonemically in the speech of younger NKK speakers by comparing their vowel production with that of older NKK speakers at two different speech rates. The results showed that younger NKK speakers produced long vowels with the same length as their corresponding short vowels, differing from older NKK speakers, whose long vowels were significantly longer than their short ones. The differences in vowel duration and in vowel-to-word ratios between long and short vowels were unaffected by different speech rates. These findings suggest that the vowel length contrast has been losing its phonemic status in younger NKK speakers, and that this change is robust and nearing completion. The loss of the vowel length contrast should involve changes in NKK accent patterns, since the vowel length distinction is crucial in NKK accent assignment, which is sensitive to syllable weight as long vowels attract a high tone in the accent system. It is also suggested that word frequency plays a role in the accent change triggered by the loss of long vowels. (The State University of New York, Korea, Assistant Professor)

Keywords: vowel length contrast, speech rate, vowel duration, vowel-to-word ratio, age group, accent patterns, word frequency

1. Introduction

This study investigates the vowel-length contrast in North Kyungsang Korean (henceforth, NKK). Vowel length is described as phonemic as it differentiates meanings in Korean (Huh 1960, Lee 1993, Lee and Ramsey 2000). However, many

* I thank anonymous reviewers for their valuable comments on the paper. Any remaining errors are of my own responsibility.

studies have observed that the contrast is reduced in younger speakers, at least in Seoul Korean (Lee 1960, Park 1985, Magen and Blumstein 1993, Sohn 1999, Kang et al 2015). Examples of this vowel-length contrast are given in (1).

(1)	pam	‘night’	pa:m	‘chestnut’
	nun	‘eye’	nu:n	‘snow’
	kan	‘seasoning’	ka:n	‘liver’
	sakwa	‘apple’	sa:kwa	‘apology’
	kwacaj	‘section chief’	kwa:caŋ	‘exaggeration’

Despite their phonemic status, long vowels are restricted to phrase-initial syllables only: underlying long vowels become shortened when a syllable containing a long vowel is placed in non-initial position in Seoul Korean (Sohn 1999, Lee and Ramsey 2011), as in *hin-nun* ‘white snow’ and *nu:n-saram* ‘snowman’, compound of *nu:n* ‘snow’ + *sa:ram* ‘person’. In younger speakers, long vowels are lost even in initial position. Sohn (1999: 157) speculates that “unable to distinguish phonemic vowel length, younger generation speakers tend to pronounce phonemically long syllables short and utilize vowel length for stress or rhythmic purposes.” Magen and Blumstein (1993) also reported younger Korean speakers’ tendency toward the reduced vowel-length contrast, showing that the duration of historically long vs. short vowels was not consistent across speech rates, and that the phonemic status of the vowel-length contrast was unstable.

Vowel length contrast in Seoul Korean has come under close scrutiny by many researchers, but in-depth research has yet to be conducted on this issue in other regional dialects. This is presumably because of the assumption that dialects would be more conservative in such sound changes; thus, other Korean dialects such as Kyungsang or Chonnan should maintain the vowel length contrast (e.g., Chung 1991, Kim 1997, Kenstowicz and Sohn 2001, Ko 2013). This study presents empirical evidence that the vowel length contrast merger is also taking place in younger NKK speakers. An acoustic study of NKK speaker vowel production revealed that they produced long vowels as short as their corresponding short vowels, which differed from older NKK speakers, whose long vowels were significantly longer than were their short ones. This study will demonstrate that this change is robust and near completion by showing that the duration difference between long and short vowels is stable across different speech rates, which suggests that the vowel-length contrast has

lost its phonemic status in younger NKK speakers' speech. Subsequent changes after loss of long vowels and its impact on the NKK accent system will be discussed.

The rest of the paper is organized as follows: Section 2 discusses previous findings and presents the background of tone and vowel length in NKK. Section 3 presents an acoustic study of the vowel-length contrast in NKK. Section 4 presents its results and Section 5 discusses the effect of the vowel-length contrast merger on the NKK accent system. Section 6 is the conclusion.

2. Background

2.1 Previous research

The unstable phonemic status of long vowels in younger speakers in Seoul Korean has been observed and reported by many researchers. Park (1985) examined production patterns of the vowel-length contrast by different age groups: 30 Korean native speakers of 6 age groups in each age decade (20s, 30s, 40s, 50s, and 60s), and examined the duration of the long vowels in 227 commonly used words. The results showed that younger speakers in their twenties were less likely to include long vowels in their production and showed the significantly lower accuracy. The proportion of words having a long vowel decreased in younger speakers: 31% for speakers in their 20s vs. 60% for speakers in their 40s or older. The accuracy rate in younger speaker production of long vowels also dropped significantly and mismatched their judgments of long vowels: 50% for speakers in their 20s vs. 95% for speakers in their 60s. In addition, the substantial difference in the ratio of long vs. short vowels was noted for different age groups, e.g., 2.0:1 for older speakers vs. 1.5~1.7:1 for younger speakers. Park's (1985) result clearly showed that the vowel-length distinction was being lost and unstable in younger generations. Kang et al. (2015) added confirming evidence of the vowel-length contrast merger in contemporary Seoul Korean. Their extensive corpus study examined a range of age groups from 19 to 71 years and showed that the vowel length contrast merger in Seoul Korean is almost complete; further, it was demonstrated that lexical frequency has been a significant factor in this sound change—long vowels are significantly shorter in high-frequency words than in low-frequency words. The change is more apparent in young speakers than in older speakers.

On the other hand, Lee and Shin (2016) presented deviant results in their study of

the production and perception of the vowel-length contrasts in Seoul Korean. They examined the sensitivity of Korean speakers to the vowel length distinction, both in production and in perception. Twelve speakers were tested, comparing two generations—20s vs. 40s; the results revealed that in the spontaneous speaking task Korean speakers did not distinguish long vs. short vowels. However, both groups maintained the vowel-length contrast in the read-aloud task. For perception tests, discrimination and force-choice identification tests were conducted. Lee and Shin (2016) found that participants were sensitive to vowel length, showing a high accuracy rate (mean = 89%) in discrimination tasks where they were to choose the item differing in length among three tokens they heard, while their performance became poorer in identification task, showing a lower accuracy rate of 62%. The deviant results might have been ascribed to mode effects by differences in task type: several tasks were performed for the same purpose by the same participants in their study, producing inconsistent results. It is probable that participants may have been aware of the purpose of the study, and thus were more conscious of the vowel-length contrast as they were presented with several tasks on the same topic. As Lee and Shin noted “...we found larger durational differences between long and short vowels from 3 speakers in older groups, which all of them were found to be an elementary school teacher or Korean instructor who have the experience in teaching Korean vowel length contrasts.” (Lee and Shin 2016: 42), the results might not be representative of the general tendency or natural performance of their generation but rather conscious responses to such specific tasks like reading or discrimination.

As for dialects other than Seoul Korean, Yang (2015) conducted a phonetic study of the vowel-length contrast in South Kyungsang Korean (SKK). He recorded vowel production of 30 younger speakers, all of whom were college students (mean age: 22 for male; 19.7 for female) and reported that SKK college students do not produce long vowels distinctively from short vowels. This result confirms the previous description of SKK tone patterns with a rising tone at the expense of long vowels: e.g., *mál-i* HL ‘horse’ nom. (nominative), *mál-í* HH ‘quart’ nom., *mal-í* RH ‘language’ nom. (e.g., Do et al. 2014)¹. No other phonetic studies on Kyungsang Korean vowel-length distinction have been found yet.

¹ H is used for a high tone; L for a low tone; and R for a rising tone in the SKK tone system.

2.2 Long vowels and tone in North Kyungsang Korean

North Kyungsang Korean (NKK) is described as having both tone and vowel length as a distinctive feature (Chung 1991, Kim 1997, Lee and Ramsey 2000). For example, *mal* ‘quart’ and *mal* ‘horse’ contrast by tone, and both form a contrast with *ma:l* ‘language’ which has a long vowel, as illustrated in (2).

(2)	<i>mal</i>	H(L)	‘horse’	<i>mál-i</i> nom.
	<i>mal</i>	H(H)	‘quart’	<i>mál-í</i> nom.
	<i>ma:l</i>	H(H)	‘language’	<i>má:l-í</i> nom.

The NKK accent system has been described as weight sensitive: syllables with a long vowel are always given a high tone, e.g., *maɲné*: ‘the youngest’, *kó:kúma* ‘sweet potato’ (Chung 1991, Kim 1997). When an initial syllable contains a long vowel, double high tone (HH) is always assigned over the initial two syllables as in the following examples, *kó:kúma* ‘sweet potato’, *hó:ráɲi* ‘tiger’. Gim (1994) describes that the pattern of double high tone (HH) in words containing a long vowel like *má:l-í* ‘language’ nom. is distinct from that of double high tone (HH) in words with no long vowels such as *mál-í* ‘quart’ nom.: a long tone (historically developed from a rising (LH) tone in Middle Korean): e.g., *hó:ráɲi* ‘tiger’ vs. a short tone (historically developed from a high tone in Middle Korean): e.g., *múcike* ‘rainbow’. However, Gim (1994) noted a generational change in tonal patterns of words with long vowels and reported that NKK accent patterns in word groups with long vowels in younger speakers (in their 20s) were distinct from those in older speakers (in their 60s). He reported that the contrast of tone length between the two double high tone groups was not maintained in the younger dialect, while tone distinction was preserved in the older dialect: the younger NKK speakers produced both word groups (words with long vowels; words with no long vowels) with a short tone pattern unlike the older NKK speakers. His study was based on the researcher’s impressionistic judgment, so further systematic phonetic research on the production of long vowels among NKK different age groups is necessary to confirm this observation. I speculate that the diversity of patterns between the two age groups is attributable to the different production of long vowels by the two different generations: the long vowels produced by younger NKK speakers are probably produced with shorter duration than are the corresponding long vowels produced by

the older NKK speakers. The purpose of this study is to fill this gap by providing an empirical contribution to this question by examining the temporal distinction of NKK vowels across age groups.

3. Experiment Method

3.1 Participants

I recruited ten older NKK speakers and ten younger NKK speakers: six male (4 old; 2 young) and fourteen female speakers (6 old; 8 young), all of whom have lived in Daegu most of their lives. All were born and grew up in Daegu, except for one speaker who was born in Gyeonggi province but moved to Daegu when he was young. The ages of the older speaker group ranged from 62 to 76 years (mean = 68; sd = 3.47). The length of their residence in Daegu ranged from 74 years to 50 years. The ages of the younger speaker group ranged from 24 to 44 years (mean = 30; sd = 5.66); length of residence in Daegu ranged from 16 to 32 years. None of the participants reported hearing problems.

3.2 Materials

The word list consisted of 42 Korean real words: 9 monosyllabic and 4 disyllabic vowel-length minimal pairs, and 16 fillers². The first vowel was a target vowel to be measured (long vs. short). The list of target words was as follows:

Table 1. Test Word Set³

Item	Meaning with short vowel	Meaning with long vowel
/sakwa/	apple	apology
/kocʌn/	hardships	classic
/kwacʌŋ/	section chief	exaggeration
/jʌŋkam/	inspiration	old man

² The sentences used in the experiment are given in Appendix.

³ Test words are taken from Lee and Shin (2016) and Yang (2015) since the length-contrast of these words is attested in previous studies. Bold letters indicate the target vowel which differs in length phonemically.

/kim/	Kim (family name)	seaweed
/nun/	eye	snow
/pan/	class	half
/son/	hand	offspring
/nan/	orchid	strife
/cim/	burden	King (reflective form)
/san/	line	goodness
/kan/	seasoning	liver
/pam/	night	chestnut

3.3 Procedures

Participants were recorded in a quiet room by a cardioid condenser lavalier microphone and a Zoom H4 digital recorder at 44.1 kHz sampling rate. They read a randomized list of words given in a Korean carrier sentence with 3 repetitions. Participants were instructed to read at a comfortable speed first, to read faster the second time, and then to return to a slower speed the third time. Only the second and third readings were analyzed. All speakers previewed the word list to familiarize themselves with all the words before recording began; they were asked to read in their own dialectal accent⁴.

3.4 Measures taken and analysis

A total of 1040 tokens (26 test words x 20 subjects x 2 reps) were collected, but only 1024 tokens were analyzed; 16 mispronounced tokens were excluded⁵. Two acoustic measures were taken automatically using Praat (Boersma and Weenink 2016)—the duration of the target word and the duration of each target vowel (the first vowel in each test word). Target words and vowels were segmented manually by examining their spectrograms and waveforms. Target word duration was measured from the abrupt termination of all visible formants for the final segment of the preceding word

⁴ A short interview session was given to participants in NKK accent by the experimenter, a NK K speaker to let them naturally produce their speech in their dialectal accent.

⁵ Some older participants mispronounced several target words. For example, *nu:n* ‘snow’ was misread as *pam* ‘night’ by Subject 3, and *sa:kwa* ‘apology’ in *sa:kwa-lil hara* ‘to make an apology’ was misread as *sakwa* ‘apple’ with a short vowel by changing the meaning of the whole phrase into *sakwa-lil sara* ‘to buy apples’ by Subject 5.

in the carrier sentence to the abrupt termination of all visible formants of the final segment of the target word. The vowel boundary was determined by the presence of clear formant structure and a sharp change of waveform: vowel duration was measured from the onset of the second formant to the offset of the second formant. In addition to the absolute duration of the words and vowels, log-ratios of the target vowel to the word for each token were calculated, transformed from ratios of the target vowel to the word. Measurements were analyzed by running linear mixed-effects models (Baayen et al. 2008) to examine the relationships between the duration and the age group and the phonemic vowel length; and the relationships between the log-ratio and the age group and the phonemic vowel length.

Mean duration and log-ratios of the target vowel to the word were compared between the two word groups, words with long vowels vs. those with short vowels, and between the two subject groups, the older speaker group vs. the younger, using the linear mixed-effects model. In addition, mean duration of the target vowel and log-ratios of the target vowel to the word were compared between fast and slow speaking rates. The target words consist of 4 bisyllabic and 9 monosyllabic words, so word type was also included as a variable to ascertain if word size is a factor affecting the duration of the target vowel. Thus, the independent variables were the phonemic vowel length (long vs. short), subject group (old vs. young), speech rate (fast vs. slow), word type (monosyllabic vs. bisyllabic) and gender (male vs. female). The dependent variables were measurements of vowel duration and duration ratios of vowel to word.

3.5 Hypothesis and prediction

The hypothesis that the vowel length contrast merger is also underway in NKK as observed in other dialects of Korean (Park 1985, Magen and Blumstein 1993, Kang et al. 2015, Yang 2015) predicts that long vowels produced by younger NKK speakers are produced with shorter duration than those produced by older NKK speakers. Since participants were asked to read at two different rates: slow vs. fast, it will be examined whether the speech rate will affect the vowel duration. As Magen and Blumstein (1993) show that the duration of long vs. short vowels was not consistent in Seoul Korean speakers' production across speech rates under the process of the vowel length contrast's being lost, this hypothesis also predicts that the younger group's production of the vowel distinction be unstable across different

speech rates: for example, younger NKK speakers may not produce long vowels long enough to keep the contrast when reading fast, even if their production may be still sensitive to the length contrast of the vowels when they read at normal or slower speed.

On the other hand, the contrast in the vowel-length stays constant across speech rates, although the duration of long vowels may be influenced more than that of short vowels by speaking rate, if they maintain the phonemic contrast. Hirata (2004) found this to be true in Japanese vowel-length contrast. Hirata (2004) demonstrated relational acoustic invariance of the phonemic vowel length in Japanese by showing that relational measures such as vowel-to-word ratios and long-to-short vowel ratios were stable, although absolute duration of Japanese vowels was significantly affected by speaking rate — the proportion of the vowel to the total word duration and the ratios of long-to-short vowels were found to be stable for the vowel-length distinction. It is expected, then, that the duration ratio of vowel to word for both long and short vowels will be consistently maintained if NKK speakers have not lost the phonemic contrast of the vowel length.

4. Results

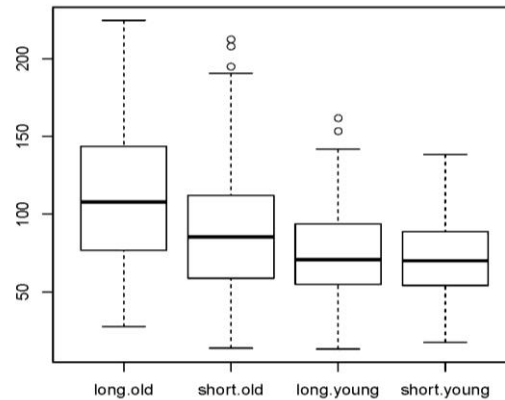
4.1 Vowel duration

The statistical analysis of the data revealed main effects of vowel length, age group, and speech rate. The mean duration of long vowels was significantly longer than that of short vowels in general: $M = 91.73$ ms, $sd = 41.43$ for long vowels; $M = 80.57$ ms, $sd = 33.83$ for short vowels ($p < .001$). However, when we analyzed the data separately for each age group, this vowel length effect was ascribed to the older speaker group since the phonemic vowel length did not serve as a factor affecting vowel duration in the younger speaker group. Younger speakers produced long vowels as short as the corresponding short vowels, resulting in little difference in mean duration between the two vowel types, whereas older speakers produced long vowels significantly longer than the corresponding short vowels as shown in Table 2. A main effect of rate was also found, which indicates that speaking rate affected the vowel duration ($p < .001$). The vowels were longer for slow than fast rate (89 ms vs. 83 ms for the mean duration of all vowels; 83 ms vs. 78 ms for short vowels; 95 ms vs. 88 ms for long vowels). More detailed results are presented in Table 2.

Table 2. Mean vowel duration (ms) by the age group

	Rate	Length	Mean	S.D	N
Old	Fast	short	86.25	37.39	130
		long	106.34	42.82	125
	Slow	short	92.27	40.41	129
		long	115.18	45.58	127
Young	Fast	short	69.28	23.60	127
		long	70.82	27.98	129
	Slow	short	74.20	25.71	127
		long	75.54	27.73	130

As shown in Table 2, the duration of vowels is significantly different in accordance with the speaker group and the vowel length. The interaction of these two independent factors is also significant, confirming that the vowel length production differs by the speaker group ($p < .001$). The main effect of the age group and the interaction between the age group and the vowel length are illustrated in Figure 1: older speakers produced long vowels significantly longer than the corresponding short vowels, while the younger group showed little difference in duration between long and short vowels.

**Figure 1. Mean duration (ms) of target vowels: long vs. short; old vs. young**

The linear mixed-effects model was run with Duration as a dependent variable and Age Group (older vs. younger), Length (short vs. long), Word type (monosyllabic vs.

bisyllabic), and Gender (male vs. female) as independent variables. Subjects and items were entered as random effects. The results confirmed that the aforementioned main effects of Age Group and Length were statistically significant. The interaction between Length and Age Group was also significant. The results of the linear mixed-effects model were presented in Table 3:

Table 3. Results of the linear mixed-effects model

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	113.70 (12.19)	15.39	9.32	<.001***
Length_short	-21.32 (2.25)	989.10	-9.46	<.001***
Rate_slow	6.23 (1.59)	989.05	3.91	<.001***
Agegroup_young	-38.04 (6.08)	19.61	-6.24	<.001***
Gender_male	-2.26 (6.41)	17.01	-0.35	= .728
Wtype_mono	-7.53 (13.40)	11.00	-0.56	= .585
Length*Agegroup	20.07 (3.18)	989.08	6.31	<.001***
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	151.7	12.32	
Word	(Intercept)	489.0	22.11	
Residual		647.3	25.44	

As shown in Table 3, neither gender nor word type affected the vowel production. When the data was scrutinized by gender, both male and female groups showed consistent patterns in which long vowels were longer than short vowels in the old group, although older female speakers tended to produce short vowels longer than older male speakers ($M = 86$ ms, $sd = 41$ for short; $M = 110$ ms, $sd = 47$ for long by male older speakers; $M = 91$ ms, $sd = 38$ for short; $M = 111$ ms, $sd = 42$ for long by female older speakers). In the younger speaker group, females displayed no difference in length between short and long vowels, whereas males produced long vowels slightly longer than short vowels ($M = 69$ ms, $sd = 27$ for short; $M = 75$ ms, $sd = 32$ for long by younger male speakers; $M = 72.3$ ms, $sd = 24.3$ for short; $M = 72.7$ ms, $sd = 26.7$ for long by younger female speakers). This finding coincides with the sociolinguistic tendency that female speakers tend to adopt innovative forms earlier than male speakers. However, the effect of gender didn't reach significance. Moreover, there were only two male speakers in the younger group, so they should not be representative of the population. This issue remains for further research.

The effect of the age group might have been attributed to the natural tendency that older people speak more slowly than the younger. In order to confirm that the interaction between Length and Age Group was due to the vowel-length contrast merger of the younger group, I analyzed the data separately for each group. First, I examined the older group's data for each target vowel in greater detail. As shown in Figure 2, the older speakers have clearly demonstrated their vowel length distinction by producing long vowels clearly longer than the counterpart short vowels: all the pairs of target vowels follow this tendency, except for the vowel /u/ pair⁶.

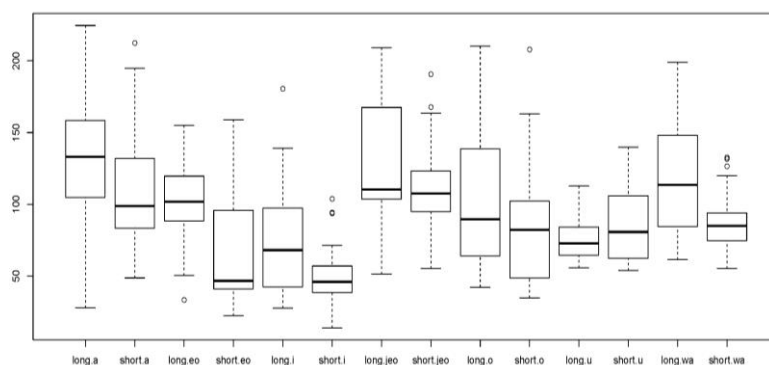


Figure 2. Mean duration (ms) of target vowels: long vs. short vowels by the older group

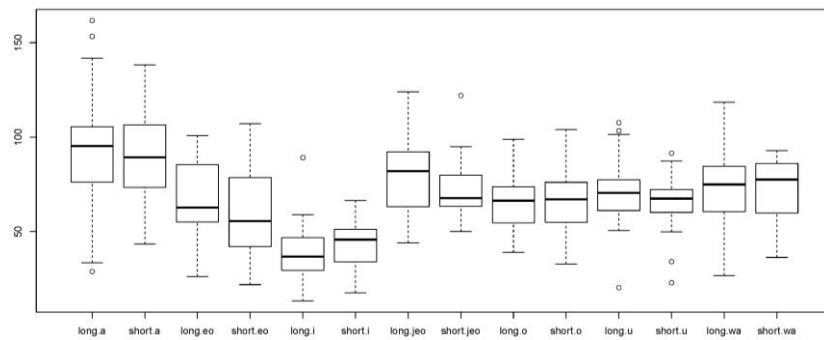
The patterns illustrated in Figure 2 were statistically confirmed by the results of the linear mixed-effects model, shown in Table 4. The results found main effects of Length ($p < .001$) and of Rate ($p = .00365$).

⁶ The differences between long and short vowel of /jʌ/, /o/, and /u/ were relatively smaller than those of other vowels. Some of the words containing these vowels are not ones frequently used: e.g., *jaŋkam* 'inspiration' with short vowel, 'old man' with long vowel; *kocan* 'hardships' with short vowel, 'classic' with long vowel. Even older speakers seemed confused about the vowel length sometimes and even more in these infrequent words. They sometimes mispronounced the vowel length of certain words - the target words with /u/, *nun* 'eye' and *nu:n* 'snow', were often mispronounced by producing the short as the long or vice versa. Thus, these vowels which didn't show much difference for the vowel-length contrast might be ascribed to this confusion in vowel length of these infrequent words. Thanks to the anonymous reviewer for relating this issue to the lexical frequency effect.

Table 4. Results of the linear mixed-effects model for the older group data

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	118.91 (14.93)	16.59	7.96	<.001***
Length_short	-21.25 (2.62)	487.07	-8.08	<.001***
Rate_slow	7.67 (2.62)	487.03	2.92	= .00365 **
Gender_male	-3.54 (11.02)	8.00	-0.32	= .75614
Wtype_mono	-15.44 (15.78)	11.01	-0.97	= .34892
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	274.3	16.56	
Word	(Intercept)	667.1	25.83	
Residual		880.9	29.68	

The scrutiny of the data revealed the difference in patterns between the older group and the younger group. Younger speaker production was rather unstable showing the inconsistency: some vowel pairs such as /o/, /u/, and /wa/ were similar in mean duration, while pairs of /a/, /ʌ/, /i/, and /jʌ/ differed in mean duration, as shown in Figure 3. The results of the statistical analysis, however, found no main effect of Length in the younger group, which confirms that unlike the older group, younger speakers do not maintain the vowel-length contrast.

**Figure 3. Mean duration(ms) of target vowels: long vs. short by the younger group**

The following table summarizes the results of the linear mixed-effects model for the younger group. As presented in Table 5, no major effect was found in Length,

Gender, and WordType. Rate was the only significant factor in the younger group, indicating that younger participants produced vowels shorter at fast speed than at slow speed, as was requested.

Table 5. Results of the linear mixed-effects model for the younger group data

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	70.58 (10.42)	12.65	6.77	<.001***
Length_short	-1.39 (1.56)	489.06	-0.89	=.0.37345
Rate_slow	4.72 (1.56)	489.04	3.02	= .00261 **
Gender_male	-0.25 (5.96)	8.03	-0.04	= .96720
Wtype_mono	0.39 (12.07)	10.99	0.03	= .97472
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	50.74	7.12	
Word	(Intercept)	396.08	19.90	
Residual		312.96	17.69	

4.2 Vowel to word duration ratio

The relationship between vowel and word duration was also examined. For clearer presentation of results, log-ratios were taken from ratios of target vowel to target word. This examination was conducted to confirm the stable status of the vowel length contrast: if the phonemic status of long vowels is stable, the relationship between the vowel and the word will be regular—the ratio of long vowel to word duration is consistently higher than the ratio of short vowel to word duration (Hirata 2004). In addition, a change in speech rate does not affect vowel-to-word ratios. Otherwise, the relationship between the vowel and the word will be irregular or inconsistent across rates, so the vowel-to-word ratios might be unstable and affected by speech rates.

The results revealed patterns consistent with those of duration described in the previous section. The main effect of the age group is illustrated in Figure 4: log-ratios of long vowel to word duration were greater than those of the short vowel to the word duration in the older group ($p < .001$), while there was little difference in log-ratios between long and short vowels in the younger group ($p = .345$). These results confirm that the vowel-length contrast is kept stable by the older group, while it is not retained by the younger group.

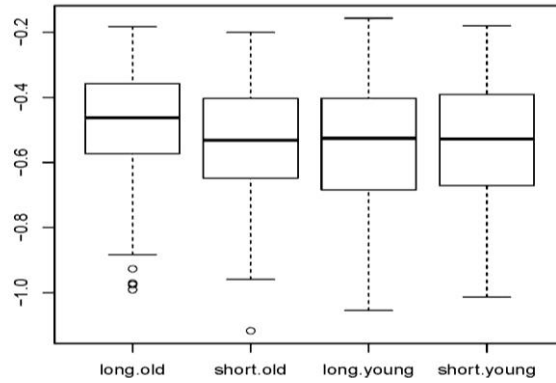


Figure 4. Mean log-ratios of target vowels: long vs. short; old vs. young

The results of the linear mixed-effects model for log-ratios are presented in Table 6.

Table 6. Results of the linear mixed-effects model for log-ratios

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	-0.571 (0.058)	12.592	-9.798	<.001***
Length_short	-0.051 (0.010)	989.196	-4.838	<.001***
Rate_slow	-0.004 (0.007)	989.080	-0.588	=.556524
AgeGroup_young	-0.075 (0.018)	24.035	-4.019	<.001***
Gender_male	-0.010 (0.018)	17.008	-0.577	=.571189
Wtype_mono	0.142 (0.067)	11.002	2.100	=.059554
Length*AgeGroup	0.065 (0.014)	989.163	4.422	<.001***
Length*Rate	0.002 (0.014)	988.109	0.143	=.886470
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	0.001	0.033	
Word	(Intercept)	0.012	0.111	
Residual		0.014	0.119	

As shown in Table 6, the main effect of speech rate was absent ($p=.55652$), while the effect of Age Group and of Length, and the interaction between Length and Age Group were significant ($p <.001$). In addition, the interaction between Length and Rate was not significant ($p = .88647$); this suggests that the vowel-length effect was

unaffected by changes of speech rate. These separate analyses were also conducted for each age group. In the older group, the log-ratios were similarly unaffected by speech rate, although the effect of vowel length was maintained across speech rates. In the older group, average log-ratios of long vowels were -0.478 (sd = 0.163) and -0.479 (sd = 0.169) for the fast and slow rates, respectively, and average log-ratios of short vowels were -0.534 (sd = 0.167) and -0.527 (sd = 0.164) for the fast and slow rates, respectively. The results of the linear mixed-effects model for the older group (shown in Table 7) confirm that older speaker production was stable in vowel-length contrast across speech rates.

Table 7. Results of the linear mixed-effects model for the older group

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	-0.548 (0.059)	13.501	-9.206	<.001***
Length_short	-0.052 (0.014)	486.067	-3.648	<.001***
Rate_slow	0.003 (0.014)	486.043	0.210	=.834121
Gender_male	-0.019 (0.027)	7.984	-0.708	=.499038
Length*Rate	0.003 (0.020)	486.025	0.160	=.872749
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	0.001	0.039	
Word	(Intercept)	0.012	0.111	
Residual		0.013	0.114	

On the other hand, the younger group showed no effect in rate or vowel length ($p = .2960$; $p = .3453$, respectively): the average log-ratios of long vowels were -0.545 (sd = 0.192) and -0.559 (sd = 0.174) for the fast and slow rates, respectively, and the average log-ratios of short vowels were -0.533 (sd = 0.174) and -0.545 (sd = 0.186) for the fast and slow rates, respectively. These results indicate that younger speakers are not sensitive to vowel length contrast, which is consistent across rates, confirmed by the results of the linear mixed-effects model in Table 8. The interaction between vowel length and rate was also absent. These results suggest that younger speakers' lack of sensitivity to the vowel length contrast is also stable and rigid, indicating the vowel-length contrast merger is near complete.

Table 8. Results of the linear mixed-effects model for the younger group

Variable	Estimate (SE)	df	<i>t</i>	<i>P</i>
(Intercept)	-0.667 (0.063)	12.044	-10.533	<.001***
Length_short	0.013 (0.014)	488.127	0.945	= .3453
Rate_slow	-0.014 (0.014)	488.029	-1.046	= .2960
Gender_male	0.003 (0.025)	8.061	0.141	= .8914
Length*Rate	0.001 (0.019)	488.116	0.080	= .9359
<i>Random effects</i>		<i>Variance</i>	<i>Std.Dev.</i>	
Subject	(Intercept)	0.0008	0.028	
Word	(Intercept)	0.015	0.122	
Residual		0.012	0.113	

5. Discussion

The previous section showed that younger NKK speakers are insensitive to the phonemic vowel length contrast as are speakers of other Korean dialects, whereas older NKK speakers maintain the contrast. Younger NKK speakers consistently produced long vowels as short as the counterpart short vowels at slow speed as well as at fast speed, which indicates the vowel length merger is almost complete and stably maintained. The results of log-ratios of vowel to word reinforce this finding; there was little difference in vowel to word log-ratios between the pairs of long and short vowels; this was consistent across speech rates. These findings suggest that younger NKK speakers have lost the vowel-length contrast as a contrastive feature and their production differs from that of older NKK speakers.

The loss of long vowels in younger NKK speakers may give rise to changes in NKK accent patterns. As discussed earlier, NKK accent patterns are weight-sensitive in that syllables with long vowels always attract a high tone. When an initial syllable occurs with a long vowel, double accent (HH) is assigned over the initial two syllables as in the following examples, *sá:kwá* ‘apology’ and *kwá:cáŋ* ‘exaggeration’. Thus, the words containing a long vowel in the stimuli are expected to carry double accent. However, participants produced some variants of the accent patterns of certain words, which were not consistent nor expected patterns, and younger speakers showed more variants than did older speakers. Accent patterns in Table 9 were judged by two native NKK speakers (the author and an experiment assistant). If disagreement occurred between the two judgments, the accent decision was made

based on the pitch contour generated using Praat. The variant accent patterns are illustrated in Table 9.

Table 9. Variant accent patterns by NKK speakers⁷

(Numbers in the parenthesis indicate the total count of the participants for each group)

Target word (expected accent)	Accent patterns by older speakers (10)	Accent patterns by younger speakers (9)
pa:n-i (nom.) (HH) ‘half’	HH(10)	HH (9)
pan -i (nom.) (HL) ‘class’	HL(10)	HH(5); HL(4)
na:n -i (nom.) (HH) ‘strife’	HH(10)	HH(9)
nan -i (nom.) (HL) ‘orchid’	HL(7); HH(3)	HH(9)
sΛ:n -il (acc.) (HH) ‘goodness’	HH(10)	HH(9)
sΛn -il (acc.) (HL) ‘line’	HL(7); HH(3)	HL(4); HH(5)
sa:kwa (HH) ‘apology’	HH(6)	HH(6); LH(3)
sakwa (LH) ‘apple’	LH(10)	LH(9)
kwa:caŋ (HH) ‘exaggeration’	HH(8); HL(2)	HH(6); HL(2); LH(1)
kwacaŋ (HL) ‘section chief’	HL(9); HH(1)	HL(7); HH(2)
jΛ:ŋkam (HH) ‘old man’	HH(10)	HH(5); HL(3); LH(1)
jΛŋkam (HL) ‘inspiration’	HL(7); HH(3)	HL(7); HH(1); LH(1)

As shown in Table 9, older NKK speakers revealed relatively consistent patterns, at least for the words containing long vowels: all the presented words with long vowels in Table 9 were given double accent by older speakers (marked in bold) except for *kwa:caŋ*, whereas words with short vowels showed rather inconsistent patterns. This contrasts with the younger speaker patterns which showed more variants even for words with long vowels as well as for words with short vowels. The accent patterns in bold in the younger speaker column are those that deviated from the expected pattern. All the words except for *sakwa* ‘apple’ with LH would have a chance of being assigned HH by younger speakers; this differs from the older speaker pattern. It is interesting that even a word like *nan* ‘orchid’ which is supposed to receive HL is assigned HH in 100% of the time. I speculate that the overuse of HH by younger NKK speakers might be due to the vowel-length contrast merger. Losing

⁷ For the word *sa:kwa* ‘apology’, only six speakers’ tokens out of ten older speakers were included in the data analysis due to mispronunciation. One participant’s (from the younger speakers) tokens were also excluded from the accent judgment because he produced all the target words with LH accent. Thus, the total number of the younger speakers is 9.

a cue which attracts double accent, younger speakers would be more confused, leading to their assigning the double accent more often, even to words that are not supposed to carry it; this is because from hearing older speakers, they may still be aware that one of the pair words carries the double accent. Despite the overall accent inconsistency, the word *sakwa* ‘apple’, frequently used in daily life, has no variant for its accent in younger speakers, which is interesting. This indicates that the accent change triggered by the loss of long vowels may not start with frequently used words but rather impact on infrequent words first or more heavily. This is aligned with frequency effects on sound change that high-frequency words resist changes by forming a stronger mental representation, predicted by the usage-based model of phonology (Bybee 2001) and the exemplar-based model of phonology (Pierrehumbert 2001, 2002).

Although younger NKK speakers’ production is not sensitive to the vowel length contrast, they might still be sensitive to the length contrast since they are regularly exposed to older NKK speakers and interact with those whose vowels are contrastive in length. As Lee and Shin (2016) showed that Seoul Korean speakers are sensitive to vowel length when asked to distinguish the meaning of the vowel-length minimal pairs, it would be instructive to examine how younger NKK speakers perceive and respond to vowel-length contrast in their perception and how their sensitivity or lack thereof to vowel length influences their lexical access.

6. Conclusion

The current study has clearly demonstrated that the vowel-length contrast merger is taking place and nearly complete in younger NKK speakers. It has shown that no distinction was made between long and short vowels by younger NKK speakers, in contrast with that of older NKK speakers, who produced long vowels substantially longer than corresponding short vowels. This change was robust and stable across speech rates, given the result that the differences in vowel duration and in vowel-to-word ratios between long and short vowels were not affected by differences in speech rate. This indicates that the vowel-length contrast has lost its phonemic status, although it may function phonetically. Its consequence should involve changes in NKK accent patterns which closely interact with syllable weight. It is also suggested that word frequency will play a role in the accent change triggered by the loss of long vowels.

Appendix. Stimuli

Sentences used for the production experiment

Target Word	Vowel Length	Sentences
<i>filler</i>	N/A	김장시기여서 배추가 값이 많이 올랐다.
<i>filler</i>	N/A	가재는 게편이라는 말을 들었다.
sa:kwa	long	어제 사과를 하러 친구를 만났다.
<i>filler</i>	N/A	점심 메뉴는 보쌈으로 정했다.
ki:m	long	내가 가장 좋아하는 반찬은 김이다.
<i>filler</i>	N/A	여름동안 전기 요금이 너무 많이 나온다.
nun	short	겨울이 되어서 눈이 건조해졌다.
<i>filler</i>	N/A	가지는 내가 좋아하는 반찬이다.
kocʌn	short	불경기로 고전을 면치 못하고 있다.
pa:n	long	전체 학생중 복학생 수가 반이 된다.
son	short	겨울에는 손이 차고 건조하다.
na:n	long	역사적으로 어려운 시기에 난이 일어났다.
<i>filler</i>	N/A	생일 선물은 보석으로 정했다.
cim	short	지게는 짐을 지라고 가지고 왔다.
kwacʌŋ	short	우리팀은 과장이 제일 열심이다.
<i>filler</i>	N/A	봄에 일주일간 단기 방학이다.
sʌ:n	long	콩쥐는 남에게 선을 많이 행했다.
jʌ:ŋkam	long	나이 많아도 영감이 힘이 가장 세다.
ka:n	long	요즘 간이 안좋아 술을 끊었다.
pam	short	동짓날에 일년중 밤이 가장 길다.
<i>filler</i>	N/A	한국음식 상에는 반찬이 많이 있다고 한다.
<i>filler</i>	N/A	야외활동 때 벌집을 조심해야 한다.
kan	short	요즘 간이 안맞아 국이 맛없다.
<i>filler</i>	N/A	나는 스타벅스 단골 손님이다.
ci:m	long	선왕은 짐의 과오로 졌다고 했다.
pa:m	long	제삿상에 열매중 밤이 올라간다.
nan	short	개업 선물로 수백만원 짜리 난이 들어왔다.
sʌn	short	동생은 똑바로 선을 긋지 못했다.
<i>filler</i>	N/A	자동차 매연의 배출이 미세먼지 주범이다.

nu:n	long	날이 추워지고 눈이 많이 내렸다.
pan	short	우리 학년에 전부 열개의 반이 있다.
filler	N/A	동생이 바보라 해서 화가 났다.
ko:cʌn	long	학생들은 고전을 많이 읽어야 한다.
so:n	long	우리집은 손이 귀한 집안이다.
sakwa	short	어제 사과를 사러 마트로 향했다.
filler	N/A	한식일에는 별초를 하러 많이 간다.
filler	N/A	그 사람은 전과때문에 취업이 잘 안된다.
filler	N/A	동생이 바지를 사러 쇼핑 갔다.
kwa:caŋ	long	어머니는 과장이 심한 편이시다.
kim	short	우리나라에서 흔한 성씨는 김이다.
jaŋkam	short	시를 쓰려면 영감이 가장 중요하다.
filler	N/A	자녀들의 결혼은 반대를 안하는 것이 낫다.

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