



An acoustic and perceptual investigation of the vowel length contrast in Korean

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Abstract

The goal of the current study is to investigate how the sound change is reflected in production or in perception, and what the effect of lexical frequency is on the loss of sound contrasts. Specifically, the current study examined whether the vowel length contrasts are retained in Korean speakers' productions, and whether Korean listeners can distinguish vowel length minimal pairs in their perception. Two production experiments and two perception experiments investigated this. For production tests, twelve Korean native speakers in their 20s and 40s completed a read-aloud task as well as a map-task. The results showed that, regardless of their age group, all Korean speakers produced vowel length contrasts with a small but significant differences in the read-aloud test. Interestingly, the difference between long and short vowels has disappeared in the map task, indicating that the speech mode affects producing vowel length contrasts. For perception tests, thirty-three Korean listeners completed a discrimination and a forced-choice identification test. The results showed that Korean listeners still have a perceptual sensitivity to distinguish lexical meaning of the vowel length minimal pair. We also found that the identification accuracy was affected by the word frequency, showing a higher identification accuracy in high- and mid- frequency words than low frequency words. Taken together, the current study demonstrated that the speech mode (read-aloud vs. spontaneous) affects the production of the sound undergoing a language change; and word frequency affects the sound change in speech perception.

Keywords: sound change, vowel length contrast, production and perception, speech mode, discrimination test, identification test

1. Introduction

The current study investigates how the language change of a sound lenition emerges in production and perception. Specifically, we examined the production and perception of the loss of vowel length distinction in contemporary Seoul Korean (hereafter Korean). Korean has been known to have a contrastive vowel length distinction in all vowel contexts (Lee, 1960); the appearance of the long vowels are restricted to syllable-initial positions, making underlying long vowels shortened in non-syllable initial positions

(Lee & Ramsey, 2011). Although studies attested the vowel length contrasts in Korean have demonstrated that duration contrasts were distinctive in Seoul speakers' speech (e.g., Cha, 2005), recent studies have shown similar results that the duration contrasts have been lost among younger Korean speakers except speakers of North Kyungsang dialect (Kenstowicz & Park, 2006) and Chonnam dialect (Ko, 2013). For example, Park (1985) recorded 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 words. The results showed that the percentage of production of long vowel

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declined as a function of age group. While speakers in their 40s to 60s produced long vowels with the accuracy of over 60%, speakers under the age of 30s showed a substantially lower percentage of long vowel production (50% for 30s, 31% for 20s, and 17% for 10s).

When examining the productions of the speakers who reported they still retained vowel length contrasts, the proportion has increased up to 90% for older speakers (in 50s and 60s), up to 50% (in 20s), and up to 30% (in 10s) for younger speakers. Considering that self-reported retainers' productions of long vowel was relatively high for younger speakers, Park claimed that the exposure to older speakers' productions might contribute to halt progressing language changes. Park also notes that the ratio between long and short vowels has gradually declined as a function of age group, and also some words contained larger durational difference than other lexical items, suggesting that vowel shortening may occur item by item.

Jung & Hwang (2000) examined 12 Korean speakers' production of long vowels in 24 disyllabic minimal pairs stratified by gender and age group, and found a gender difference in middle age speaker groups, showing a greater durational difference in male speakers' productions than in female speakers. This gender effect on vowel shortening seems to suggest that male speakers are more conservative than female speakers in language change. In addition, the durational differences in long and short vowels did not show a gradual change as a function of vowel contexts, suggesting that the lenition of vowel length contrasts is not phonetically driven.

The effect of lexical items on the loss of vowel length contrasts in Korean seems to suggest that lexical frequency might affect the sound lenition, making high frequency words more resistant to sound change than words with lower frequency words. According to the exemplar-based language change theories, more exemplars with high frequency words are gathered and updated more frequently than words with low frequency words, and therefore, lexical representation of words with high frequency are stronger in sound changes than low frequency words (Bybee, 2001; Bybee & Hopper 2001; Pierrehumbert, 2001; 2002).

Kang et al. (2015) examined the effect of higher frequency on the vowel length merger in Korean by examining 403 sentences in read-speech corpus produced by 120 speakers (60 female). These speakers are divided into 2 gender groups (female vs. male) and 6 different age groups (20s, 30s, 40s, 50s, 60s, and 70s), and the duration of the initial syllable in variety of vowel contexts was measured and then compared to the duration of the short vowels as a function of age groups, after considering other intrinsic phonetic factors such as speech rate and syllable structures. Kang et al. (2015) found that words with high-frequency retained greater durational differences than words with lower frequencies, however, while mid- and low- frequency words show continuous decline in duration ratio as the age group decreases, high-frequency words stopped the shortening trend, suggesting that the lenition of the vowel length contrast has already been completed in high frequency words. In order to compare the shortening trend of words with different frequencies before the lenition of vowel shortening has ended, Kang et al. further examined the productions of the speakers in 40s to 60s only, and found no effect of frequency on the language changes, suggesting that the sound change does not occur based on the stored exemplars of each word. Based on these findings, Kang et al. (2015) concluded that effect of word frequency on the language change is phonetically driven, such that high frequency words are

more easily accessed in mental lexicons and convenient to make articulatory gestures; therefore, more reductions may occur in high frequency words than low frequency words (Ernestus, 2014; Pierrehumbert, 2002).

Although Kang et al. (2015) showed no effect of frequency on the loss of vowel length contrasts in production, it cannot tease apart what the relationship is between production and perception when sound change occurs. According to Ohala (1981)'s misperception-based sound change model, it is assumed that sound change is driven from misperception of the speech errors made by listeners, such that listeners assimilate mispronounced speech sounds as acceptable phonemic categories. Thus, misperception-based sound change model would predict that listeners might have production distinction although they have lost their perceptual distinction. However, exemplar-based sound change model states that the language change in the production might not go hand in hand with perception, since the lexical representations of each word differ depending on the exposure that the each listener receives (Bybee, 2001; Bybee & Hopper, 2001; Kirchner, 2012; Pierrehumbert, 2001). Thus, the one of the goals of the current paper is to examine whether sound changes in perception are influenced by word frequency.

However, to our knowledge, not many studies have examined perception on the vowel length contrasts in Korean. Lee (2015) examined the effect of duration correlates between younger and older Korean listeners in their 20s and 70s in distinguishing a vowel length minimal pair (e.g. /sakwa/ 'apple' vs. /sa:kwa/ 'apology') in which duration, intensity, and F0 are orthogonally manipulated. The results found that, similarly to older speakers, younger Korean listeners are also sensitive to the duration correlates in identifying vowel length minimal pairs, although the effect of duration correlates were weaker in younger listeners. However, since only one pair was used in Lee (2015), it is hard to conclude yet if younger listeners can distinguish word meanings based on the duration correlates, although their production contrasts have disappeared. Thus, the current paper aims to examine whether younger Korean listeners have the perceptual sensitivity to duration correlates and distinguish word meanings. If younger Korean listeners distinguish word meanings between long and short vowel based on the semantic context of the carrier sentences, younger Korean listeners would fail to identify word meaning, although they might be able to distinguish long vowels from the short vowels in phonetic level. On the other hand, if the language changes are undergoing based on the different exemplars, and higher frequent words are more resistant to language change than low frequency words, Korean listeners might be able to identify words based on the duration correlates but the accuracy rate will differ as a function of frequency of the words. Thus, the current paper aims to investigate whether Korean speakers have vowel length contrasts in both the production and perception or only in the perception; and whether Korean listeners are able to identify words meaning of the vowel length contrasts minimal pairs.

In addition to the effect of speaker gender and age, intrinsic characteristic such as speech style can also influence distinctive vowels. For example, different speech style (spontaneous vs. elicited citation) affects to reduce vowel duration, with shorter duration in spontaneous speech than in citation form (DiCanio, Nam, Amith, García, & Whalen, 2015). In a study of Arapaho comparing the effect of speech style on distinctive vowels, DiCanio et al. (2015)

found that long vowels in narrative speech had greater durational compression than short vowels, while short vowels were more affected by vowel quality, with more centralized vowel space in narrative form. Considering that productions made in spontaneous speech are generally faster than in elicited citation, speech style can contribute to shorter duration and reduced vowel quality, since speakers tend to hyperarticulate when speaking in citation speech (DiCanio et al., 2015; Koopmans-Van Beinum, 1980). Based on these findings, the current study also aims to investigate how different speech style (read-aloud vs. spontaneous) affects durational correlates in distinctive vowels in Korean. We predict that if vowel length contrast is still retained, the durational difference will be greater in read-aloud speech than in spontaneous speech.

The construction of the current study is as follows; first, we will illustrate the production study of 12 Korean native speakers examining the duration contrasts of 14 vowel length minimal pairs. The production study is conducted to examine whether any age difference between 20s and 40s will show any difference in producing vowel length contrast minimal pairs. Then, we will present the results of two perception tests examining the perceptual sensitivity to durational correlates (Oddity test) and identification (Forced-choice identification).

2. Methods

2.1. Production study

2.1.1. Stimuli

All 14 vowel-length minimal pairs were monosyllabic real words in Korean ending with a nasal stop. The list of the target word is illustrated in Table 1.

Table 1. Fourteen vowel length minimal pairs used for the production studies.

	Short	Long
/kim/	'Kim (family name)'	'seaweed'
/cim/	'burden'	'king (reflective form)'
/nun/	'eye'	'snow'
/kun/	'military'	'town'
/kin/	'a unit of weight'	'approximately'
/son/	'hand'	'offspring'
/c ^h ʌn/	'1,000'	'fabric'
/sʌn/	'line'	'goodness'
/man/	'bay'	'10,000'
/pan/	'a class'	'half'
/pam/	'night'	'chestnut'
/kan/	'seasoning'	'liver'
/nan/	'orchid'	'strife'
/tam/	'fence'	'gall'

2.1.2. Participants

Twelve Korean native speakers divided in two groups (6 in 20s (3 males, mean age = 25.7, sd = 1.5); 6 in 40s (3 males, mean age =

42.7, sd = 1.2) at the time of the recording) participated in a reading aloud task as well as a map task for the production experiment. All the subjects were recruited in Edinburgh, UK, but were born and raised in Korea until they hit the critical age (12 years old). All subjects were literate in Korean and none of the subjects reported any speech or hearing disorder.

2.1.3. Procedures

First, the subjects participated in a read-aloud task, in which the participants were asked to read aloud 14 vowel length minimal pairs embedded in a carrier sentence. The semantic meaning of the target words were presented in the parentheses. Twenty-one filler items were also recorded with the target items. These sentences were presented in a randomized order with 3 repetitions. Thus, a total of 49 sentences (target: 14 x 2, filler 21) were recorded for each repetition.

Then, the same speakers also participated in a map task in order to get natural productions of vowel length contrasts in a conversational speech. One subject was paired together with the experimenter as a group in which one participant served as an instruction giver while the other participant served as an instruction follower. Half of the subjects were given the map for the instructor giver and the other half were given the map for the instruction follower. In this task, the instruction giver asked the instruction follower to draw a route based on the landmarks on the map. The landmarks used in the map task were consisted of 12 vowel length minimal pairs (See appendix B).

The production experiments were conducted in a quiet room using a solid state recorder for general lending m-audiomicrotrack and two types of microphone; an Audio Technica ATM 73A headset microphone and a Shure Easyflex PZM distance microphone. The choice of the microphone was dependent on the recording circumstances and the preference for the subjects. The recordings were digitized to 16-bit mono sound at 44,100Hz. Praat was used for the acoustic analysis. Data analysis and statistical analysis were conducted by R.

2.2. Perception study

Two perception experiments were conducted for the perception study. An oddity test were adopted to investigate whether the listeners have perceptual sensitivity to the duration correlates, and a force-choice identification test were used in order to investigate whether the subjects can distinguish the lexical meaning based on the duration differences when the semantic contexts were not provided in the carrier sentence.

2.2.1. Stimuli

The same 14 vowel length minimal pairs were used for the perception study. One male native speaker of Seoul Korean (age 33) recorded target words embedded in contextually-neutral sentence ("I say ___"), and then, the target words were excised for the manipulation. Since the target words were produced with focus, the vowels in target words were longer than the vowels in the carrier sentence. Since the listeners might perceive the focused words as long vowel, we decided to shorten the duration instead of lengthening them. The ratio between the short and long vowels were also controlled to be 0.3:1, based on the maximum durational difference between the long and short vowel from Lee (2015). The

duration manipulation was conducted with PSOLA in Praat (Boersma & Weenink, 2016). For the oddity test, the manipulated tokens were used as isolated words; and for the identification test, the manipulated tokens embedded in the carrier sentence were used.

2.2.2. Participants

Thirty-three native Korean listeners (10 males, mean age = 26.7 (sd = 3.3)) who did not participate in production experiment completed two perception experiments. None of the participants were native speakers of North Kyungsang dialects (Kenstowicz & Park, 2006) or Chonnam dialects (Ko, 2013), which the vowel length contrasts were known to be retained. None of the participants reported any hearing disorders.

2.2.3. Procedures

First, all subjects participated in an oddity test implemented in Praat MFC. On each trial, listeners heard three stimuli in which two of them are identical and the other differs in terms of the vowel length. While playing the auditory stimulus, numbers such as '1', '2' and '3' were displayed on the computer screen. After hearing three stimuli, the participants were asked to choose which stimulus was different from the three successive words presented. For example, three sequences of the word, '말 /mal/' (e.g., 말: /ma:l/ - 말 /mal/- 말 /mal/) was played through the headphone, and the subjects were instructed to click one of the three buttons of the '1', '2' or '3' presented on a computer monitor that corresponded to the word with a different vowel duration. Subjects can repeat the trial up to 3 times by clicking 'play again' button. After selecting the answer, they confirmed the answer by clicking 'okay' button and moved to the next trial. The total number of trials was 84 (28 words × 3 repetitions). All participants completed a short practice before the experiment. Each trial was conducted once, and no feedback was given.

Immediately after completing the oddity test, the same subjects participated in a forced-choice identification test implemented in Paradigm (Version 2.5). First, the subjects heard a sentence which the target word was embedded in a contextually neutral sentence (e.g., "내가 밤이라고 말합니다."), and then two sentences with the same target words were embedded in a contextually-related sentences were visually presented in a computer screen (e.g., 제사상에 대추와 밤이 올라간다 vs. 일년 중 동짓날에 밤이 가장 길다). After hearing the contextually-neutral sentence, the subjects were asked to click the sentence to which the lexical meaning of the target word was corresponded. The syllable numbers and the position of the target word between the two context sentences were controlled to be identical (See Appendix A). The stimulus sentences were played with 3 repetitions in a randomized order, presenting a total of total of 84 trials for each subject.

The perception experiments were conducted in a quiet room using Samsung Ativ AT 910 laptop and Bose QuietComfort 15/20 Acoustic noise cancelling headphones.

3. Results

3.1. Production study

In order to examine the age effect on the loss of vowel length distinction in read-aloud productions, we ran two separate linear

mixed-effects models (Baayen, Davidson, & Bates, 2008) with Duration (ms) as a dependent variable and Age (older vs. younger), Length (Short vs. Long) as independent variables. Subjects and Repetition were entered as random effects. There are two reasons why we did not construct one model by including Speech style (read-aloud vs. spontaneous) as a predictors, instead ran two separate models for each speech condition: (1) the number of the repetition was different between two condition, since controlling the number of the tokens in the spontaneous speech is not possible. (2) the number of the word pair was also different between the two condition: the word pair, /kin/, was excluded from the spontaneous speech, since /kin/ is used either as a classifier ('a unit of weight') or an adverb ('approximately'), which makes difficult to induce subjects to produce these pairs in the map task.

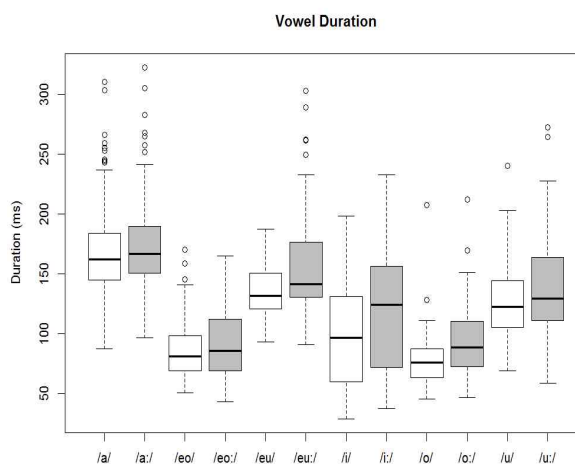


Figure 1. Duration of target vowels between long and short vowels as a function of vowel contexts in read-aloud speech

Table 2. Results of linear effect model fitted for read-aloud production data (SE=Standard Error)

Variable	Estimate (SE)	t	P
(intercept)	142.30 (11.22)	12.68	< .01
Agegroup_Young	-1.67 (8.55)	-0.20	= .085
Length_Short	-9.55 (2.98)	-3.20	= .001
Agegroup_Young : Length_Short	-0.35 (4.22)	-0.08	= .093

For the analysis of the read-aloud speech, we found a main effect of Length ($p = .001$), showing that the durational difference between the long and short vowels was 10 ms for both older and younger speakers. Figure 1 represents vowel duration of long and short vowels produced in a read-aloud test, and Table 2 represents the results of linear effect model.

For the analysis of the spontaneous speech, the results found no main effects nor interactions ($p > .05$). Table 3 represents mean duration of the long and short vowels (ms) produced by both speaker groups in different speech modes.

Table 3. Mean duration of the long and short vowels (in ms) in careful speech (read-aloud) and in spontaneous speech (map-task). Numbers in parenthesis indicate standard deviations.

	Speaker group	Long	Short
Read-aloud	Older	142 (51)	133 (50)
	Younger	141 (50)	132 (46)
Map-task	Older	131 (59)	131 (61)
	Younger	113 (53)	118 (51)

3.2. Perception study

The results showed that Korean subjects showed a high accuracy in discrimination test (mean = 89%, median = 94.5%, sd = 12). The high standard deviation was due to the four outliers, as presented in Figure 2. The results of the identification test showed that Korean participants were correct between 40% and 80% (mean = 62%, median = 59%, sd = 9.4), demonstrating that identification task was more difficult than the discrimination task. Figure 2 is a boxplot of the proportion correct of two tasks. We examined correlation between the discrimination task and the identification task, and found no correlation between two ($p > .05$).

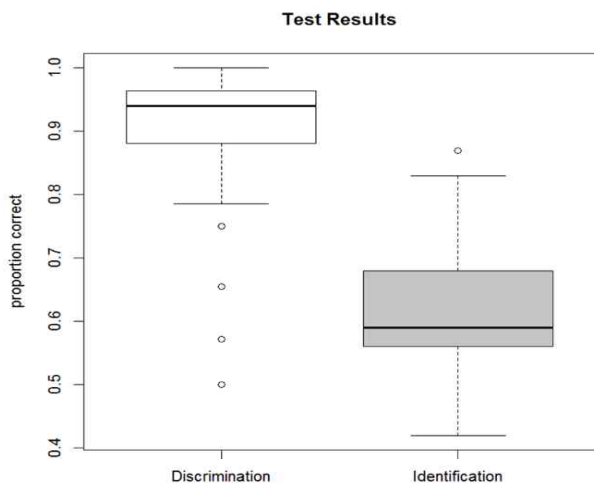


Figure 2. Proportion correct of the discrimination and identification tests.

In order to examine whether Korean listeners can distinguish the word meaning by duration correlates we ran two statistical models. First, we ran one sample Wilcoxon Signed Rank test and revealed that the identification accuracy was significantly higher than the chance level ($V = 547, p < .001$). This result indicates that the participants were perceptually sensitive enough to distinguish the semantic meaning of the distinctive vowel length contrasts only by relying on the duration correlates. We further examined the subjects' perceptual sensitivity by running a mixed effect logistic regressions. Participants' Accuracy was entered as a dependent variable (1=correct), and Length (Short vs. Long) and Frequency (High vs. Mid vs. Low) were used as independent variables. Long vowel and High frequency were used as baseline category. Following Kang et al. (2015), lemma frequency published by National Institute of Korean Language (Kim, 2005) was converted

into three categories as High (higher than 13,330-higher), Mid (68~1,281), and Low (0~67). Items and Subjects were entered as random effects.

Each analysis was evaluated by using the ANOVA function of the Companion to Applied Regression package in R. The statistical model included two fixed effects and two way interaction which was proven to be the most stringent fit to the data.

The results found a significant effect on intercept ($p < .01$), indicating that listeners' identification performance was greater than chance level. This result suggests that Korean listeners still have perceptual sensitivity to distinguish lexical meaning of vowel length contrast minimal pairs. We also found a significant main effect of Length ($p = .03$), suggesting that the identification accuracy was higher when the vowel length of the played token is long (64 %) than the short vowels (60%). The effect of the frequency on the identification accuracy was also found, with a significantly higher accuracy for the word with high frequency (69%) than low frequency (56%) at $p = .03$. There was no significant difference between words with high frequency and mid frequency (67%). Table 4 represents the result of the binominal logistic mixed model.

Table 4. Result of the binominal logistic mixed model fitted for the data of the identification experiment (SE=Standard Error)

Variable	Estimate (SE)	Z	P
(intercept)	0.96 (0.27)	3.59	< .01
LengthShort	-0.23 (0.11)	-2.12	= .03
Frequency_Mid	-0.18 (0.23)	-0.78	= .04
Frequency_Low	-0.50 (0.24)	-2.01	= .04

4. Conclusions and Discussion

The current study showed several main findings: first, inconsistent to the previous studies (Kang et al., 2015), we found a significant durational difference between long and short vowels in the careful speech (read-aloud speech). The insignificant difference between the short and long vowel in map task suggest that, as supported by Hahn (1964), Korean speakers do not use vowel length correlates in the casual speech since the lexical meaning of the words can be easily identified in the contexts. However, considering that the duration ratio between the short and long vowel in read-aloud speech was only 1:1.1, we need to be cautious to interpret the durational differences as the contrastive vowel length distinction, since the difference was reaching out the bottom line of the lenition of the vowel, as shown from Kang et al. (2015). Acoustic studies examining the phonemic vowel length difference in other languages such as Swedish, Japanese and Danish have found that the duration ratio was at least 1:1.5 in all vowel contexts (Elert, 1964; Hirata, 2004). For example, Swedish had been considered as having contrastive vowel duration and the intrinsic duration was approximately 1:1.5 (Elert, 1964). Japanese, another well-known language that maintains vowel length contrasts, have been found to

have longer duration ratio as 1:2.4 to 1:3.2 (Hirata, 2004). Also, the lack of age effect on vowel length contrasts suggests that both younger and older speakers have almost reached out the loss of vowel length distinction, therefore, the changes do not show gradual decline between speaker groups any longer. Thus, the duration ratio of 1:1.1 might not be lexically meaningful anymore for Korean native speakers in their productions, as our observations from other languages containing vowel length contrasts demonstrate higher duration ratio.

However, another question still arises: if the language changes have reached out the bottom line, why do Korean speakers still show a differences? It may be because speakers in younger generation are still exposed to older speakers' productions, contributing to their knowledge in vowel length contrasts. Also, although many previous studies have demonstrated that Korean speakers do not any longer maintain vowel length contrasts descriptively, prescriptive document such as national dictionaries and elementary school textbooks still have instructions about the vowel length contrasts. Therefore, another reason of showing significant differences in production might be due to the prescriptive education to Korean native speakers. In fact, we found a 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. Thus, a further study will be needed to examine whether teachers maintain larger durational differences in the production and retain higher perceptual sensitivity to the vowel length contrasts than non-teacher groups, since teachers are required to learn prescriptive linguistic knowledge in teaching.

With respect to perception, we also found several interesting findings. First, as we predicted, most listeners showed a high accuracy (89 %) in discriminating words based on the duration correlates, indicating that all subjects had the perceptual sensitivity in the phonetic level. Considering that Korean is undergoing a language change of losing vowel length contrasts, we predicted that listeners might not be able to identify lexical meaning by relying on the duration of the target words. The results found that listeners identify word meaning by duration correlates above the chance level, suggesting that the perceptual distinction is still retained. We interpreted that the perceptual sensitivity that we found from Korean listeners might be due to the production contrasts that are still weakly maintained. We also found the effect of lexical frequency on the identification accuracy, with higher accuracy for high- and mid-frequency words than low-frequency words. This result is also in line with exemplar-based model on language change, suggesting that words that are more frequently used are more resistant to language change.

Taken together, the current study found that Korean native speakers can distinguish short vowels from long vowel in a careful speech. Also, results from the perception studies revealed that the sensitivity to distinctive vowels are retained as well. One limitation of the current study is that these experiments are conducted in a controlled situation so it may be plausible that the subjects were very conscious about the vowel length contrasts. As a future research, it might be worthwhile to investigate how explicit instruction affect the retainment of the sound that is undergoing a language change.

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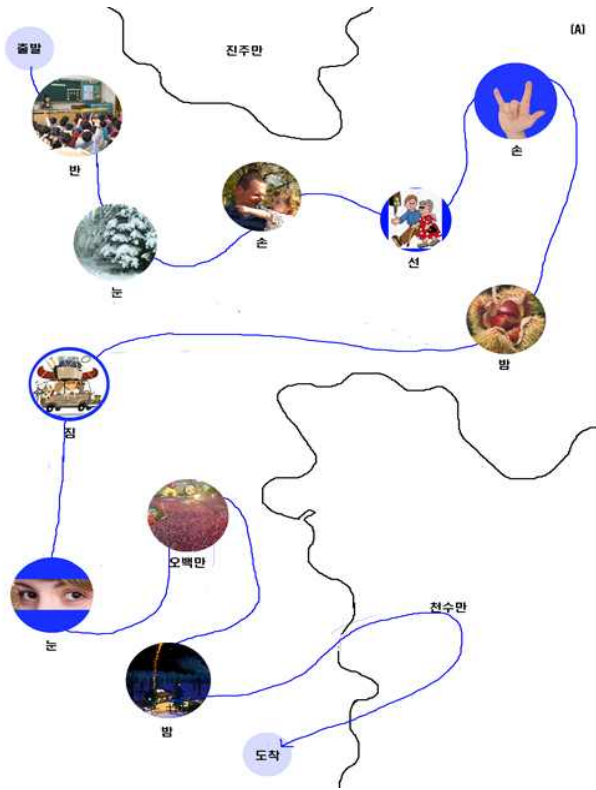
Appendix A. Sentences used for the forced-choice identification task.

Length	Sentences	Syll	Freq
Short	우리나라에서 흔한 성씨는 김 이다.	14	37 (low)
Long	내가 가장 좋아하는 반찬은 김 이다.	14	25 (low)
Short	지계는 짐 을 지기 위한 도구이다.	13	235 (mid)
Long	선왕은 짐 의 과오로 졌다고 했다.	13	3 (low)

Short	겨울이 되니 눈 이 건조해졌다.	12	2759 (high)
Long	기록적 양의 눈 이 어제 내렸다.	12	276 (mid)
Short	동생이 어제 군 에 입대해서 배웅 나갔다.	16	301 (mid)
Long	강원도 횡성 군 수가 개회식에 참석했다.	16	84 (mid)
Short	무계가 약 열 근 인 고기를 샀다.	12	14 (low)
Long	그저께부터 근 삼 일간 못 잤다.	12	29 (low)
Short	겨울이라 손 이 건조해서 크림을 샀다.	15	2050 (high)
Long	내 친구는 손 이 귀한 집에서 태어났다.	15	4 (low)
Short	입학해서 지금까지 논문 천 편을 읽었다.	16	4 (low)
Long	시장에서 다양한 종류의 천 을 살 수 있다.	16	98 (mid)
Short	동생은 똑바로 선 을 굽지 못했었다.	14	382 (mid)
Long	콩쥐는 마음이 선 해서 복을 받았다.	14	76 (mid)
Short	우리지역에 있는 바닷가 만 이 유명하다.	16	3 (low)
Long	지금까지 읽은 책의 수가 만 권이 되었다.	16	23 (low)
Short	우리 학년엔 전부 열 개의 반 이 있다.	14	263 (mid)
Long	전체 학생 중 복학생 수가 반 은 된다.	14	462 (mid)
Short	제사상에 대추와 밤 이 올라간다.	13	124 (mid)
Long	일 년 중 동짓날에 밤 이 가장 길다	13	1349 (high)
Short	요즘 간 을 싱겁게 해서 먹는다.	12	19 (low)
Long	요즘 간 이 안 좋아 술을 끊었다.	12	89 (mid)
Short	개업 선물로 수백만 원짜리 난 이 들어왔다.	17	29 (low)
Long	역사적으로 어려운 시기에 난 이 일어났다.	17	39 (low)
Short	태풍에 담 이 완전히 무너져 버렸다.	14	100 (mid)
Long	짜깁이 담 도 크게 부정행위를 했다.	14	2 (low)

Appendix B. Picture of the map task

Instructor's map



Instruction follower's map

