



# Hyperarticulated production of Korean glides by age group

*Seung-Eun Chang, Minsook Kim*

University of California, Berkeley

sechang71@berkeley.edu, minskim@berkeley.edu

## Abstract

This research uses the hyperspace effect (Johnson, Flemming, & Wright, 1993; Lindblom, 1990) of Korean glides to address the issues triggered by the diachronic sound change of some Korean vowels. Specifically, we examine whether there is any difference between Korean ‘wae [wɛ]’ versus ‘oe [we]’ by speech style (casual and clear speech) and speakers’ age. Twenty adults from Seoul and the Kyunggi area participated: (i) a younger group (21-34 years old) and (ii) an older group (44-71 years old). The first and second formant frequencies (Hz) were measured at two time points: (i) onset of test syllable and (ii) vowel midpoint. The results showed that the transitional trait of glides “wae [wɛ]” and “oe [we]” at initial timing of syllable was more enhanced in clear speech than in casual speech, as predicted. However, no phonetic evidence was found for the difference between “wae [wɛ]” and “oe [we]” in terms of F1 and F2, even in clear speech. Also, no systematic difference of age group depending on vowel type was found. Therefore, we argue that the diachronic sound merge between “wae [wɛ]” and “oe [we]” is now completed even in the Seoul area and for older groups.

**Index Terms:** Korean glides, clear speech effect, Korean vowels, diachronic sound change, age group

## 1. Introduction

This research provides phonetic analysis of issues surrounding Korean glides triggered by the diachronic sound change of some Korean vowels (“ae [ɛ]” and “e [e]”). The production of glides involves a slow and smooth transition from the target (starting at /u/ for /w/ and at /i/ for /j/) to the immediately following vowel. Korean glides are also called semivowels since this articulation does not include sound disturbance or friction and the semivowels may follow a consonant, as in /kwɑn/ ‘coffin’ and /mjɔn/ ‘noodle’ like vowels. At the same time, they occur in the syllable-initial position before a vowel, as in /wi/ ‘up’ and /jɔk/ ‘station’, and length difference is not available as with consonants (Sohn, 2001, pp. 158-159).

The Korean vowel system has been under much debate mainly due to the treatment of three front vowels, /y, ø, ɛ/ (으, 오, 얘). That is, the traditional description includes all 10 vowels (i.e., /i, e, ɛ, ə, ʌ, u, o, ɨ, ø, y/) in a simple vowel system [1], but claims vary depending on how the three front vowels are treated: (i) /y/ is glide /iy/ [3], (ii) /y/ and /ø/ are glides /iy/ and /we/ [4], and (iii) a front vowel /ɛ/ has been merged into /e/, and /y/ and /ø/ are glides /iy/ and /we/ [9].

Although we assume that the pronunciation of vowels [ɛ] and [e] is merged diachronically as in Kang (2014), we still have two separate characters with different spellings, “ae, 얘” and “e, 예”, respectively, so this difference in vowel spellings with the same pronunciation is one of the most difficult and confusing aspects of acquiring a vocabulary for Korean learners. The same confusion exists in Korean glides. In Korean, glide /w/ can occur before the vowels /i, e (and ɛ), ə, ʌ/ and glide /j/ can occur before the vowels, /e (and ɛ), ə, ʌ, u, o/. Therefore, if /ɛ/ and /e/ have been merged as claimed, “wae [wɛ]” and “oe [we]” would be also merged, and the same merge would occur with /jɛ/ and /je/; however, “wae, 얘 [wɛ]” and “we, 웨 [we]” still have different Korean characters, along with another /we/, which is “oe, 오”. As a result, mixed phonetic descriptions appear in research as well as Korean textbooks and online learning resources (and presumably in classroom teaching as well) for the Korean characters for “ae, e, wae, we, oe, yae, and ye”. Despite the inconsistent descriptions of glides, little phonetic work has been done on Korean glides.

Therefore, this study aims to examine the phonetic targets of Korean glides, focusing on ‘wae’ and ‘oe’, by age group and determine the phonetic transcriptions of these two syllables. This language-specific inquiry can be better understood in the context of the clear speech effect (also called hyperspace effect) [2, 7] by assessing whether Korean speakers are indeed able to differentiate “wae [wɛ]” versus “oe [we]” in clear speech but the pairs are simply neutralized in casual speech or whether Korean speakers don’t or cannot differentiate the pairs even in clear speech. The clear speech effect proposes that speakers tend to exaggerate phonetic signals in a clear speaking style to maximize the intelligibility of the distinctiveness of phonological categories. Therefore, if the sounds of glides in question are indeed different, then the different phonetic targets of their production are expected to be more enhanced in clear speech than in casual speech. With different age groups, we can examine whether the diachronic change of “wae” and “oe” has already been completed or any difference still exists between the younger group and older group.

## 2. Methodology

### 2.1. Participants

Two groups of 10 adults from Seoul and the Kyunggi area near Seoul were formed for the present study. Because prior studies have reported regional variations between the vowels /ɛ/ and /e/ (the phonemic distinction between /ɛ/ and /e/ is not found in southern dialects) [5, 6], recruitment of speakers

excluded southern-area native speakers of Korean and focused on Seoul and the Kyunggi area near Seoul. Each group had five female and five male speakers. The ages in the “younger” group ranged from 21 to 34 and the participants were all born after 1981 (mean = 25.9 years old). Ages ranged from 44 to 71 for the “older” group and the participants were all born before 1971 (mean = 51.3 years old). The participants were affiliates of the University of California (UC), Berkeley, through either their family members or local Korean church members. All participants were linguistically naïve, and none reported being diagnosed with a language or reading disorder.

## 2.2. Materials

To assess the hypotheses, two different vowel types were included in the test syllable: (i) vowel type “wae” versus “oe”. Words in the word-initial and word-medial position were used. Both vowel-initial and consonant-initial words were considered and the same consonants were used for the two vowel types being compared, for example, “twae – twe”, “kwae – kwe”, “hye – he”, and “pye – pe”. To get a clear indication of syllable boundaries, we attempted to use nasals and liquids for the boundary sounds in a sentence as much as possible. The study included 8 words per each vowel type and all stimuli used as recording materials are presented in the appendix.

## 2.3. Procedure

Each target word was written in Korean orthography and provided on paper. Participants were asked to read the materials, first for practice and then again for recording. For recording, participants read 8 words once in casual speech and once in clear speech. This procedure was repeated two times. For casual speech, the speakers were instructed to read as if they were talking to close friends or family members in daily conversation. For the clear speaking style, the speakers were instructed to read as if they were teaching or talking to a non-native speaker of Korean who had just started to learn Korean. Sentences were randomized for each reading. The stimuli were recorded directly into a laptop, using the software package Praat at a sampling rate of 22,050 Hz, and saved as wave files in the laptop. Recordings were made separately for each speaker with a Sennheiser headset microphone in a quiet office at UC Berkeley or in participants’ home. Overall, 1,280 tokens were obtained: 16 target words \* 2 speaking styles \* 2 repetitions \* 20 participants.

## 2.4. Measurements

The recordings were digitized and analyzed using the software package Praat [8]. Acoustic measurements included the frequencies of first formant (F1) and second formant (F2) measured at two time points in the course of the target syllable: (i) onset of test syllable and (ii) vowel midpoint. The F1 and F2 at the *onset time* of the test syllable were measured because the typical pattern of glides is characterized with a unique transition at the beginning of the utterance. Hence, the values at test syllable onset show whether the transitional feature of glides is more enhanced in the clear speaking style than the casual style. The F1 and F2 at the *vowel midpoint* were measured because the central part of the vowel is less affected by the immediate effects of neighboring consonants than are the transitional portions closer to vowel onset and offset and, thus, relatively stable values can be obtained. The

values at the *vowel midpoint*, therefore, show the representative property of each vowel.

For each sentence, synchronized displays of the sound waveform and a wide-band spectrogram were produced and then a target syllable was extracted from each sentence. The F1 and F2 were measured in the spectrogram and expanded so that each formant was clearly distinguishable and each measurement was confirmed by a comparison with the expanded waveform. The formants of test syllable onset were measured at the beginning of the amplitude in the waveform, confirmed by comparison with the spectrogram, and the vowel midpoint was determined around the central part of the vowel, showing a relatively steady state. The formant values were collected with a Praat script designed for this measurement and if a formant had been mistracked, measurements were taken manually.

## 3. Results

### 3.1. F1 and F2 at the onset of test syllable

The formant frequencies at the onset timing of the test syllable provide the data for the initial transition of the glide. Therefore, the relevant measurement here concerns mainly F2 values. We predict that the speakers make more effort to produce the distinctive glide sound, yielding a greater initial transition in clear speech and the word-initial position than in casual speech. Therefore, the F2 transition is expected to be enhanced and, thus, the F2 values will be lower for both “wae” and “oe” in clear speech than in casual speech.

To assess this prediction, the data were evaluated based on the general linear model (GLM) univariate analysis of variance (ANOVA). A univariate test for the dependent measure F2 was performed with the following factors: (i) speaking style (clear and casual), (ii) vowel type (“wae” and “oe”), and (iii) age group (younger and older), with the first two factors treated as repeated measures. A significant main effect was found for speaking style [F (1, 1272) = 29.3,  $p < 0.001$ ] and for age [F (1, 1272) = 9.2,  $p = 0.002$ ]. However, no significant interaction was found. As expected, F2 was lower in clear speech than in casual speech.

Overall, it is worth mentioning that no significant effect was found for vowel types “wae” and “oe” for either F1 or F2, indicating no substantial difference in F1 and F2 at the onset of the test syllable for the two sounds of “wae” and “oe”. The detailed values are provided in Table 1.

Table 1. Means of F1 and F2 at the onset of the test syllable for “wae” and “oe”.

	Younger		Older		total
	casual	clear	casual	clear	
F1 wae	429	416	431	434	427
oe	421	410	446	432	427
F2 wae	1894	1762	1917	1809	1846
oe	1857	1777	1951	1849	1858

### 3.2. F1 and F2 at the vowel midpoint

The formant frequencies at the vowel midpoint show the representative vowel property for each sound. In this analysis, we test for any difference between the two sounds of “wae”

and “oe” based on age and speaking style. The following predictions are tested in this measurement: (i) If the older group still reserves the difference between the two sounds of “wae” and “oe” as /wɛ/ and /we/, respectively, then they show higher F1 for “wae” /wɛ/ than for “oe” /we/ and higher F2 for “oe” /we/ than for “wae” /wɛ/ at the vowel midpoint, unlike younger group, and (ii) F1 and F2 increase in clear speech due to enhancement of the vowel space in clear speech.

To test these predictions, univariate tests for each of the dependent measures F1 and F2 were performed with the following factors: (i) speaking style (clear and casual), (ii) vowel type (“wae” /wɛ/ and “oe” /we/), and (iii) age group (younger and older), with the first two factors treated as repeated measures

The mean values of F1 and F2 at the vowel midpoint for “wae” and “oe” are given in Table 2. As for F1 at the vowel midpoint, significant main effects were found for all except vowel type: speaking style [ $F(1, 1272) = 19.0, p < 0.001$ ] and age [ $F(1, 1272) = 10.2, p = 0.001$ ]. As expected, F1 values were higher in clear speech than in casual speech and higher for the older group than for the younger group. Note that no significant effect exists for vowel types “wae” and “oe” in F1 at the vowel midpoint. Although the vowel type showed slightly different values, as in Table 2, the values were confusing because the F1 is normally higher for /wɛ/ than for /we/, but the current result is opposite; that is, the average values of F1 were higher for “oe” than for “wae”, which can be interpreted to suggest that the speakers do not differentiate the two sounds systematically. In sum, the result of F1 values at the vowel midpoint also indicates no difference in F1 values between the two sounds of “wae” and “oe” and no interactions of age and vowel type was found, suggesting that the older group also might not differentiate these two sounds.

In the case of F2 at the vowel midpoint, significant main effects were found for speaking style [ $F(1, 1272) = 57.0, p < 0.001$ ] and age [ $F(1, 1272) = 34.1, p < 0.001$ ]. F2 was higher for the older group than the younger group and, as expected, F2 was higher in clear speech than in casual speech, suggesting the expansion of vowel space in clear speech. However, no significant effect of vowel difference and interaction with age was found in F2, confirming that no evidence was found in the difference by age between the two sounds “wae” and “oe” in F2.

Table 2. Means of F1 and F2 at the vowel midpoint for “wae” and “oe”.

	Younger		Older		total
	casual	clear	casual	clear	
F1 wae	483	503	491.5	524	500.3
oe	478	507.5	529	522.5	509.2
F2 wae	1969	2044	2033	2140	2046.5
oe	1937	2088.5	2049	2158.5	2058.2

### 3.3. F1 and F2 at two time points for “wae” and “oe”

Based on the data of F1 and F2 at both the onset of test syllable and the vowel midpoint, the visualized distribution of

two formants at two different time points is given in Fig. 1 to show the enhancement effect of clear speech by vowel type and age group. The distributions clearly show that F2 values were lower at the onset and higher at the vowel midpoint in clear speech than in casual speech, confirming the great enhancement in clear speech. If the older group preserves the /wɛ/ for “wae”, then the F2 would be lower than the younger group, but F2 of “wae” was higher for the older group than the younger group, as seen in Figs. 1(a) and (b). Likewise, if the older group preserves the monophthong sound, /ø/, for “oe”, then the F2 would be lower than the younger group, but F2 of “oe” was lower for the younger group than the older group, as seen in Figs. 1(c) and (d). These results indicate that there is no phonetic evidence for the difference by age for “wae” and “oe”.

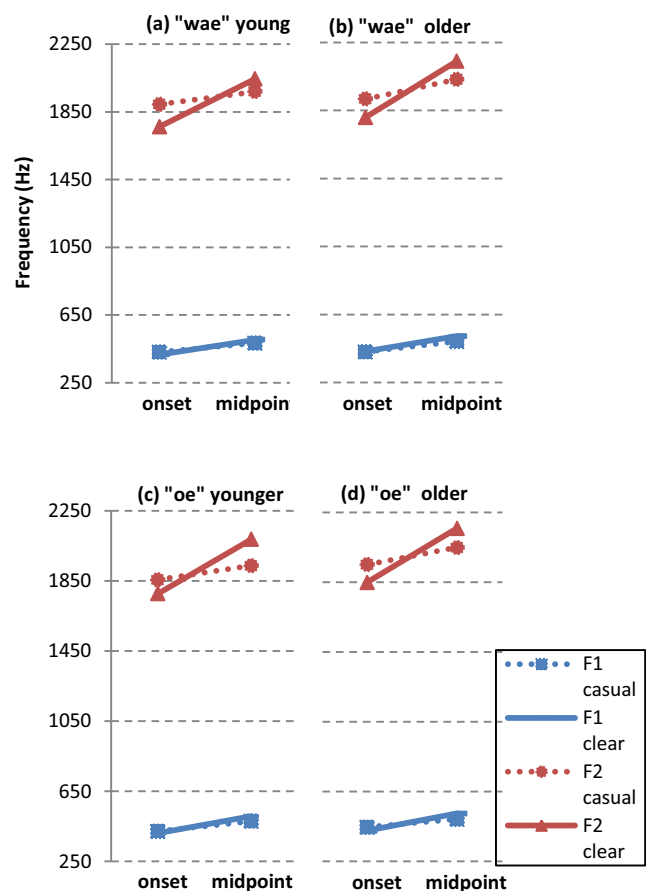


Figure 1. Mean values of F1 and F2 at the timing of the test syllable onset and vowel midpoint of “wae” and “oe” by speaking style and age.

## 4. Discussion

Based on the H&H theory [2], the current study examined the clear speech effect of Korean glides with consideration of speaker age. Due to the diachronic change of some simple vowels in Korean, the phonetic descriptions of the corresponding glides are also mixed in transcription-based research about Korean, Korean language textbooks, and online

resources. Given that little work provides a phonetic analysis of this issue, the present research was designed to offer acoustic data for the sounds under debate with the prediction that the phonological contrasts of sounds are enhanced in clear speech, and thus the diachronic changes of Korean glides can be better understood through this effect.

These predictions were upheld based on a series of analyses. The initial F2 of the glide, /w/, was significantly lower in clear speech, yielding a greater initial upward transition in clear speech than in casual speech. The F1 was lower for both glides in clear speech than in casual speech.

Concerning the phonetic transcription of the Korean syllables “wae” and “oe”, no phonetic evidence was found for the difference between these two syllables in terms of F1 and F2, even in clear speech. Therefore, it might be safe to describe the two syllables as the same phonetic transcription in Korean language textbooks and online resources. Also, a systematic difference of age group for the two syllables was not found, so from this research, it seems clear that the diachronic change of /we/ to /wae/ is now completed even in the Seoul area and even for older groups.

## 5. References

- [1] B. Lee, “Underlying Segment in Korean Phonology”, Doctoral dissertation, Indiana University, Bloomington, Indiana, 1973.
- [2] B. Lindblom, B. “Explaining Phonetic Variation: A Sketch of the H&H Theory”, In W.J. Hardcastle and A. Marchal (Eds.). *Speech Production and Speech Modelling NATO ASI Series*, vol. 55, pp 403-439, Dordrecht: Kluwer, 1990.
- [3] C.-W. Kim, “The Vowel System of Korean”, *Language*, vol. 44, pp. 516-527, 1968.
- [4] H. Sohn, “*Underspecification in Korean Phonology*”, Doctoral dissertation, University of Illinois Urbana-Champaign. Champaign: IL, 1987.
- [5] H.-M. Sohn, “*The Korean language*”, Cambridge: Cambridge University Press, 2001.
- [6] I. Lee and S.R. Ramsey, “*Korean Language*”, Albany: State University of New York Press, 2000.
- [7] K. Johnson, E. Flemming, and R. Wright, “The hyperspace effect: Phonetic targets are hyperarticulated”, *Language*, vol. 69, pp. 505-528, 1993.
- [8] P. Boersma and D. Weenink, Praat: Doing phonetics by computer [Computer software]. Available from <http://www.Praat.org/>, 2011.
- [9] S. Kang, “*The acquisition of English glides by native speakers of Korean*”, Doctoral dissertation, University of Iowa, Iowa, IA, 2014.

## Appendix

Test materials

(1) “wae”

A. word-initial position

wae.so.ha.ne.yo      “(S)he is small.”  
twae.chi.ne.yo      “It is a pig.”  
kwae.sim.hae.yo      “It is disgraceful.”

swae.kol .i.ne.yo      “It is a collarbone.”

B. word-medial position

im.chin.wae.ran      “It is the Imchin War.”  
an.twae.sə.ki.rə.yo      “It is because that doesn’t work.”  
pal.kwae.ne.yo      “It is an eight-trigram.”  
In.swae.ha.se.yo      “Please print it.”

(2) “oe”

A. word-initial position

we.ro.wə.yo      “I’m lonely.”  
twē.nim.chi.yo      “I wonder if it’s fine.”  
kwe.mul.i.e.yo      “It is a monster.”  
swe.ne.yo      “It is iron.”

B. Word-medial position

cham.we.ne.yo      “It is a melon.”  
ka.ya.twē.chyō      “You need to go.”  
ki.kwe.ha.ne.yo      “It is bizarre.”  
no.swe.ha.ne.yo      “(S)he is old.”