

# An Acoustic Study on the Pronunciation of English [kw] Sequences by Korean EFL Students

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## ABSTRACT

The aim of this study is to find out how the labiovelar onglide /w/ in English kwV sequences that have minimal pairs with kV sequences is pronounced differently among Korean EFL learners based on acoustic evidence. This study tries to identify /w/ sound in English kwV sequences through spectrograms and to examine the duration ratios of each segment in kwV words to compare the patterns of an English native speaker with those of Korean speakers of English. In spectrographic analyses, the complete deletion of /w/ and partial pronunciation of /w/ dubbed [k<sup>w</sup>] were identified as well as the target-appropriate production of /w/. The general production patterns with respect to the duration ratios in English [kw] sequence words showed that the subjects who produced /w/ had similar ratio patterns that the native speaker had in that the vowel duration ratio in kwV sequences was shorter than that in kV sequences. By contrast, the subjects who deleted [w] had a long ratio of the onset [k<sup>h</sup>] while the speaker with a partial pronunciation of /w/ had a long ratio of the following vowel.

**Keywords:** Labiovelar Onglide, Spectrogram, Formants, Duration Ratio, /w/ deletion

## 1. Introduction

The labiovelar onglide /w/ in English as well as in Korean has been studied by many scholars due to its special behavior. Specifically, Davis and Hammond (1995) have claimed that [w] behaves like a consonant in English preceded by a velar or coronal obstruent in onset position. Also, /w/ deletion tendency in Korean has been noticed by many scholars such as Kang (1997) and Koo and Han (1999). Interestingly, Cho, Park, and Lee (2001) observed that Korean EFL students showed nearly 0% of the accuracy rate for English words with [kw] sequence.

Thus, this paper deals with the labiovelar onglide /w/ in English [kw] sequences which has a tendency to be frequently deleted by Korean EFL learners. We will

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attempt to compare the differences between the native speakers of English and Korean speakers of English in pronouncing the /w/ sound through an phonetic experiment. The experiment aims at finding out how Korean speakers produce the English onglide /w/ based on acoustic evidence. In addition, the general production patterns of /w/ in kwV sequences in terms of duration ratios will be demonstrated.

## 2. Acoustic Characteristics of the Onglides

Unlike other vowels or consonants, glides show unique acoustic characteristics. The durations of glides are much shorter than other sounds because glides require a quick movement of the tongue and lips to change the vocal tract shape from their own positions to the following vowel position. According to Gimson (1962), the transition duration of the second formant frequency (F2) is of the order of 50-100 msec. for /y/ and /w/. By contrast, other sounds involve long-lasting durations as compared with glides. In addition, as can be gleaned by the term 'glide', these sounds glide up or down adjacent sounds. Therefore, glides do not make an abrupt transition. Diphthongs also move from one vowel to another vowel. However, a movement is identified from the starting configuration to target one exactly in the case of diphthongs. Also, they do not glide the adjacent sounds.

All voiced phonemes have formants, which involve large concentrations of energy. Glides also have a formant like monophthong and diphthong. Glides are all voiced and are characterized by changing formant frequencies, referred to as transitions. That is, glides are similar to diphthongs but the difference lies in a faster transition of the glide sound. These formant transitions play an important acoustic cue for distinguishing glides from other sounds. In particular, F2 or F3 is critical in identifying glides (Borden, Harris & Raphael, 1994). In addition, glides have an unstable form of formants. Generally, glides have a strong voicing bar but F2 and F3 is not stable or regular. Even though F2 and F3 appear, the shape is not clear.

The F1 of /w/, which is related with the height of the tongue, is slightly lower than that of /u/. In addition, the duration of the /w/ is shorter than that of the vowel /u/. The existence of F2 and F3 is not stable and the shape of the formant is not clear. Specifically, /w/ glides the next vowel so the F2 of the following vowel appears in a lower position. This lowerness of F2 is acquired by the lip rounding (Catford, 1977: 173; Stevens, Keyser, and Kawasaki, 1986: 429).

### 3. Experiment

To examine a pattern of the English onglide /w/ in [kw] sequences acoustically, a production experiment by a native speaker of English and Korean speakers of English was conducted. Spectrograms and formants of each sentence were analyzed by the Computerized Speech Lab (hereafter CSL) program. The main focus was on the patterns of the English onglide /w/ pronunciation in kwV sequences, which are deleted by many Korean speakers of English.

#### 3.1 Subject

One male native speaker and six female Korean speakers participated in the experiment. The native speaker was from Maryland and all Korean speakers were students at a university in Busan. The average age of the subjects was 22. No one had any known speech or hearing disorder that affected language ability. Korean speakers were divided into two students majoring in English and four non-English majors. The four non-English majors were randomly drawn from the same department.

#### 3.2 Procedure

All recordings were made in the CSL recording room at the university. Recordings were made using CSL with a microphone in a soundproof room. All subjects were not given any information about the purpose of the recording and no prior training or practice was given. They were asked to read given sentences at normal speed and in a natural way in front of the microphone. Cases where the speakers misread given sentences were not included in the recording. Each recording lasted approximately 20-30 minutes. In order to identify the characteristics of the onglide, we mainly measured the duration of it and examined the formant transition of each sentence. To examine duration and transition, spectrograms and formants of each sentence were investigated.

#### 3.3 Materials

There were seven minimal pairs of kwV sequence words with kV sequence words. Subjects were asked to produce the following minimal pair words in a carrier sentence, 'Say \_\_\_\_\_ again.' The total number of stimuli was 98 (7 subjects × 14 sentences). A complete list of test words is presented in Table 1.

Table 1. Minimal Pair Words Containing [kw] and [k]

| kwV   | kV   |
|-------|------|
| quail | kale |
| queen | keen |
| quid  | kid  |
| quill | kill |
| quilt | kilt |
| quit  | kit  |
| quote | coat |

## 4. Results

### 4.1 General Results

The subjects were divided into three subgroups based on the different acoustic evidence through spectrograms. Most of the subjects did not make target appropriate [kw] sequences.

Group 1, which contained two Korean students, showed the target-appropriate pronunciation of the onglide /w/ as compared to the native speaker. In producing [kw] sequences, Group 2 and Group 3 both pronounced the /w/ sound incorrectly. However, there was a difference between the two groups. Group 2 completely deleted the /w/ sound while Group 3 showed a partial pronunciation of /w/. Therefore, /w/ deletion caused a similar pronunciation between kwV sequences and kV sequences in Group 2. In Group 3, the incomplete pronunciation of [w] involved a partial lip rounding which transcribed as [k<sup>w</sup>]. This junctural [w] glide is rarely equivalent in nature to a phonemic /w/, the finishing point not being sufficiently prominent, nor the glide long enough as noted by Gimson (1982).

#### 4.1.1 Target-appropriate [w]

The two students that belonged to Group 1 showed the target-appropriate [w] pronunciation, like the native speaker. They generally presented similar spectrograms and formants patterns. Figures 1-2 are the spectrograms and formants of the native speaker. The spectrogram and formants of the kwV sequence, *queen*, was shown in Figure 1 and the spectrogram and formants of the kV sequence, *keen*, was shown in Figure 2. Figures 3-4 are from one of the two Korean speakers belonging to Group 1 who showed the target-appropriate pronunciation of /w/. The words were the same as the native speaker. The duration of the [w] sound was fairly short as compared to the other vowels and consonants, which was similar to the acoustic characteristics of the native speaker. For spectrograms of the onglide /w/, it glided the following sound and the faster transition occurred. In addition, the F2 of the following vowels started in a lower position. In other

words, the F2 of the following sounds were lowered by gliding effects of /w/. Therefore, the abrupt formant transition was not observed in kwV sequences, unlike kV sequences. The strong voicing bar of the onglide /w/ was clearly presented in each sentence, but the F2 and F3 of the onglide /w/ were not clear.

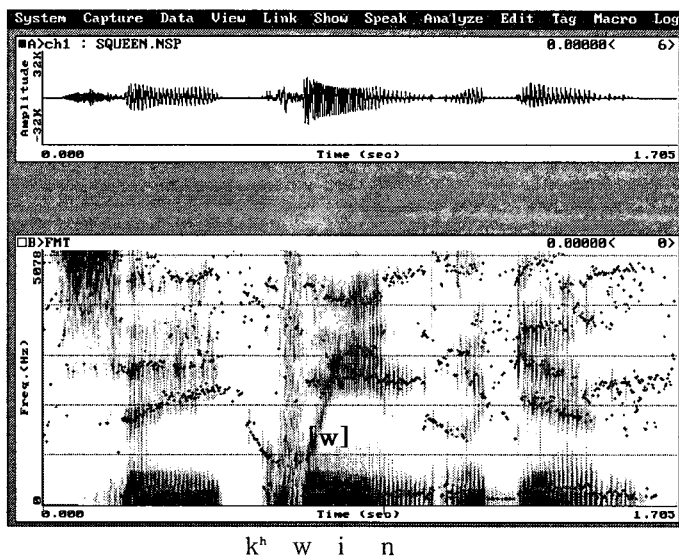


Figure 1. The spectrogram of 'Say queen again' by the native speaker: The [w] sound had a short duration. It glided the following vowel so F2 of the following vowel started in the lower position.

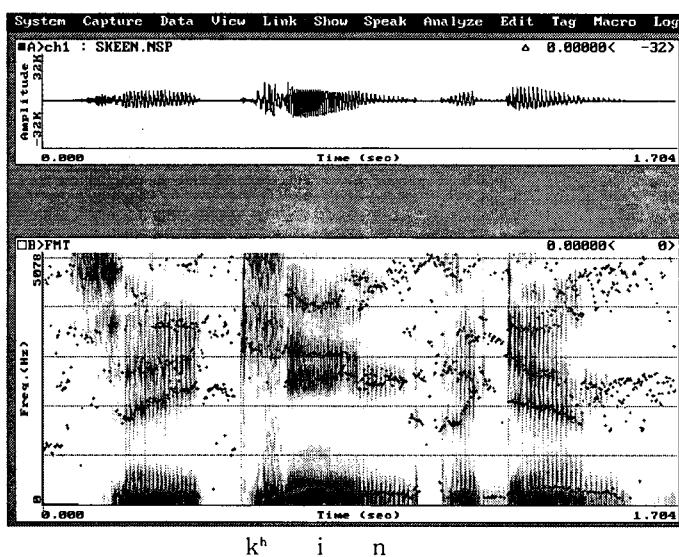


Figure 2. The spectrogram of 'Say keen again' by the native speaker: Gliding effect could not be found in this sequence and the F2 of the following vowel did not show any lowering, unlike Figure 1.

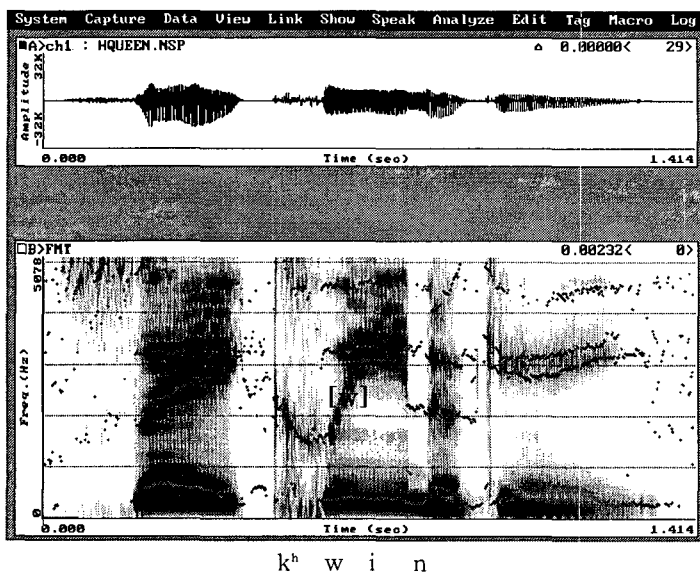


Figure 3. The spectrogram of 'Say queen again' by a Korean speaker of Group 1: This subject had a similar pattern of spectrogram and formants to the native speaker in Figure 1. The faster transition was identified and /w/ glided the following vowel here.

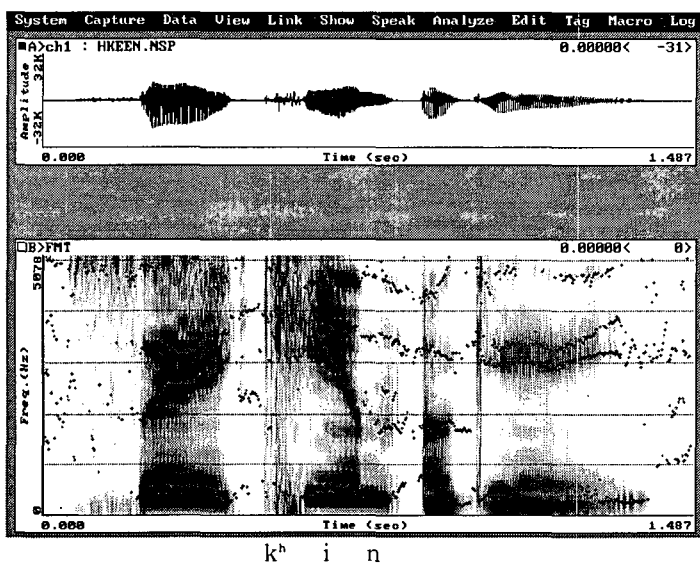


Figure 4. The spectrogram of 'Say keen again' by a Korean speaker of Group 1: The spectrogram also showed a similar pattern to the native speaker's *keen* sequence as shown in Figure 2. It did not include any faster transition that labiovelar /w/ had.

#### 4.1.2 Target-inappropriate Production of /w/ by Deleting It

Three students belonged to Group 2. This group showed the complete deletion of the

[w] sound. They pronounced the kwV sequences similar to kV sequences, for example, 'queen' [kwɪn] was pronounced as [kɪn], thus causing speech errors. Regarding spectrograms and formants, the characteristics that distinguish kwV sequences with kV sequences were not present as shown in Figure 5-6. Spectrograms and formants of both sequences in Figure 5-6 were much alike in Group 2. Therefore, it was difficult to identify whether each sequence contained [w] or not through spectrograms of each sentence. The F2 of the following vowel in kwV sequences was not lowered but started as a similar position to the F2 of the following vowel in kV sequences as shown in Figure 6. Therefore, the existence of /w/ could not be determined by examining the spectrograms and formants.

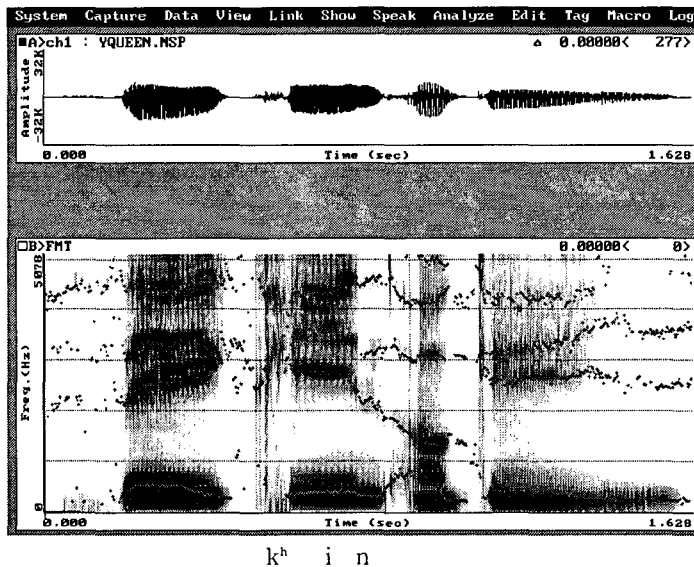


Figure 5. The spectrogram of 'Say queen again' by a Korean speaker of Group 2: The /w/ sound was completely dropped in this spectrogram. Therefore, by this spectrogram, it was difficult to identify this sequence as kwV sequence and the spectrogram and formants were much like those of the kV sequence as shown in Figure 6.

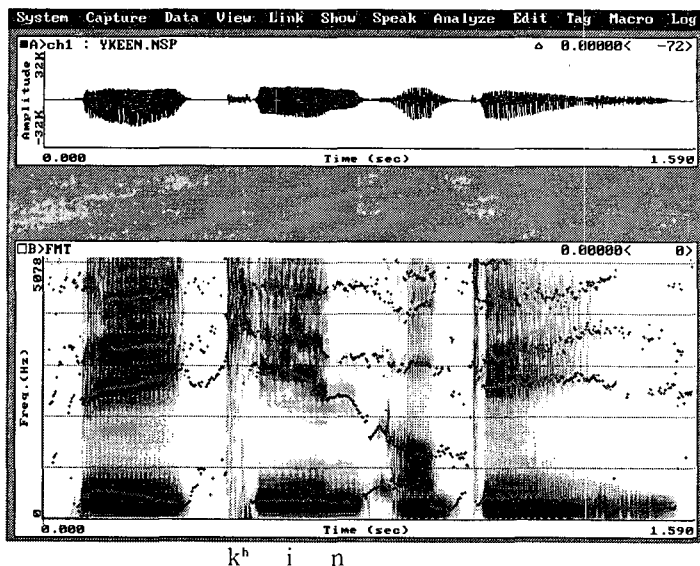


Figure 6. The spectrogram of 'Say keen again' by a Korean speaker of Group 2: It was difficult to distinguish two words *queen* and *keen* only by this spectrogram. The spectrograms of Figures 5-6 presented very similar patterns overall.

#### 4.1.3 Target-inappropriate Production of /w/ with a Partial Lip-rounding

This group showed a partial pronunciation of [w] sounds in kwV sequences. One student showed an intermediate stage of the pronunciation [w̥] that lies between the target-appropriate [w] sound and the complete deletion of the [w] sound. The subject produced the target sequences with a partial lip rounding, which was different from the native speaker and the subjects in Group 1. It should be regarded as inappropriate pronunciation of the [w] sound since it involved an incomplete lip rounding compared to the target [kw] sequences. The F2 of the following vowel was slightly lowered, which produced the early onset of the vowel's voicing. This resulted in the longer duration of the following vowel. However, spectrogram of *queen*, as shown in Figure 7, could not clearly show the gliding effect, unlike the native speaker and the students from Group 1. This slight lowering of the F2 can be achieved by partial lip rounding.



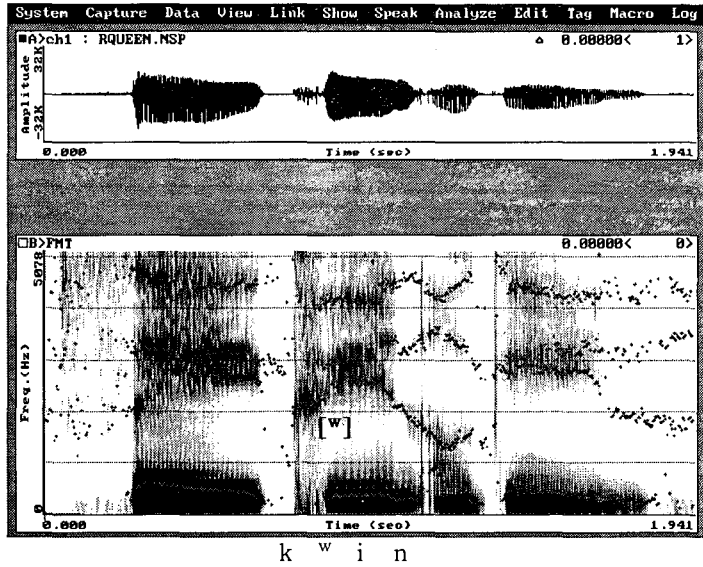


Figure 7. The spectrogram of 'Say queen again' by the Korean speaker of Group 3: The gliding effect could not be found exactly but the F2 of the following vowel was slightly lowered by the partial lip rounding.

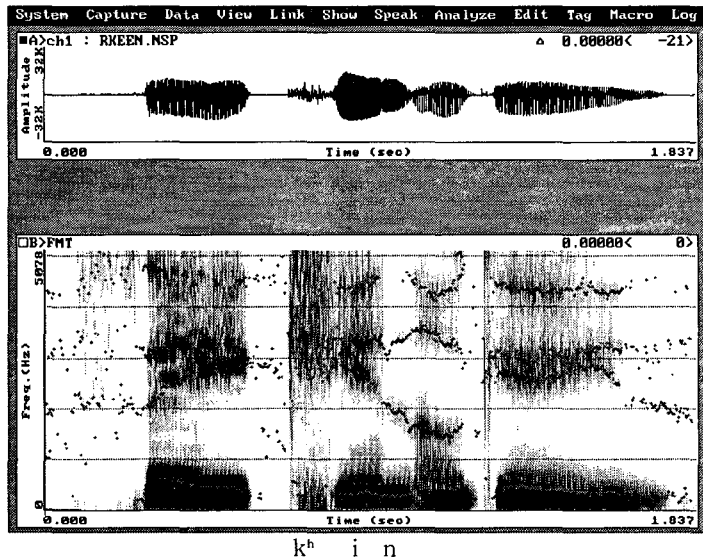


Figure 8. The spectrogram of 'Say keen again' by the Korean speaker of Group 3: The F2 lowering of the following vowel could not be found. This spectrogram was similar to other *keen* sequences of other subjects.

#### 4.2 Durations

To compare more patterns of each group, the duration of each segment was measured. The duration of each [kw] sequence word varied from each subject and word. Nonetheless, one of the findings was that not every kwV sequence did show a longer

duration than kV sequences. That is, with respect to total duration, kV sequences which lacked the /w/ sound sometimes showed longer duration than kwV sequences (for example, 581 msec. for *queen* and 595 msec. for *keen* by the native speaker). The duration could be affected by subjects or words and therefore, only duration ratios will be discussed here.

#### 4.2.1 Mean Duration Ratios of *Queen* and *Keen* by All Subjects

To see the pattern in the duration ratios of kwV sequences and kV sequences, the duration of each segment in the minimal pair, *queen* and *keen* was measured. Afterwards, the duration ratios of all subjects were examined. First, we compared the duration ratio patterns of the native speaker with those of two Korean speakers in Group 1. The duration ratios of the native speaker and Group 1 showed a similar pattern overall. The ratio of /w/ was shorter than other segments; 13% for the native speaker as shown in Figure 9 and 10% for the two Korean speakers of Group 1 as shown in Figure 11. The native speaker and the two Korean speakers showed a longer duration ratio of the following vowel in pronouncing *keen* than *queen*. The vowel length ratio of the native speaker was 33% as in Figure 10 and 26% as in Figure 9 in pronouncing *keen* and *queen* respectively. Similarly, the vowel length ratio of the two subjects in Group 1 showed 36% in *keen* as in Figure 12 and 30% in *queen* as in Figure 11. Therefore, the native speaker and the Group 1 subjects showed a similar pattern with respect to the duration ratio. Second, three Korean speakers of Group 2 showed almost the same mean duration ratio of each segment (i.e., 52% vs. 52% of [k<sup>h</sup>], 30% vs. 31% of [i] and 18% vs. 17% of [n]) between *queen* and *keen*. The mean duration ratio of [k<sup>h</sup>] by Group 2 was longer than other groups. Group 2 showed a strong aspiration overall as shown in Figures 13-14. There was not any critical difference which distinguished the two words *queen* and *keen*, similar to the spectrogram that Group 2 had. Finally, in Figure 15, the speaker of Group 3 presented rather different patterns as compared to the other groups. In particular, the vowel length ratio of *queen* was significantly longer than any other subjects at 43%. On the other hand, the ratio of [k<sup>h</sup>] (i.e., 40%) in *queen* was shorter than that (i.e., 52%) of *keen*. In the case of *keen*, the speaker of Group 3 presented very similar patterns to that of Group 2.

In summary, the duration ratios of *queen* and *keen* of all the subjects were compared. Overall, the native speaker and the subjects from Group 1 presented a similar duration ratio pattern. Speakers of Group 2 dropped the [w] sound had greater ratios of [k<sup>h</sup>] whereas the speaker of Group 3 had longer ratios of the following vowel.

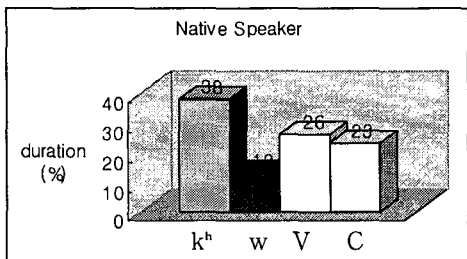


Figure 9. The duration ratio of *queen* by the native speaker: /w/ was shorter than other segments as 13%.

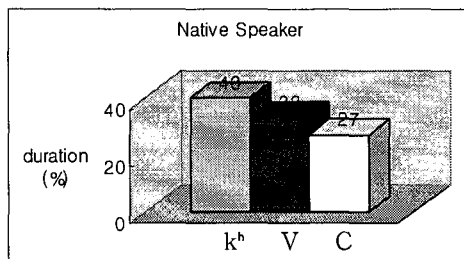


Figure 10. The duration ratio of *keen* by the native speaker: The vowel length of *keen* was longer than that of *queen* (i.e., 33% vs. 26%).

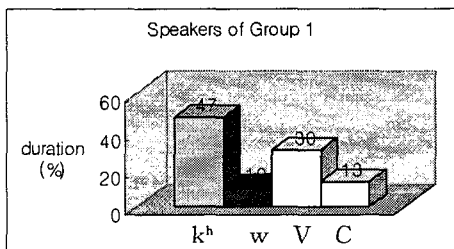


Figure 11. The mean duration ratio of *queen* by two Korean speakers of Group 1: This ratio pattern was similar to that of the native speaker. The /w/ sound was much shorter than other segments at 10%.

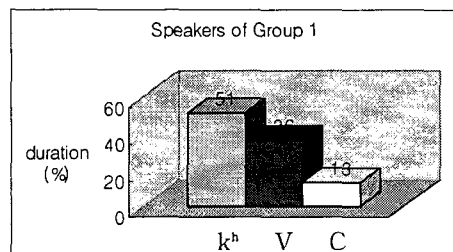


Figure 12. The mean duration ratio of *keen* by two Korean speakers of Group 1: Similar to the pattern of the native speaker, the vowel length ratio of *keen* was longer than that of *queen*.

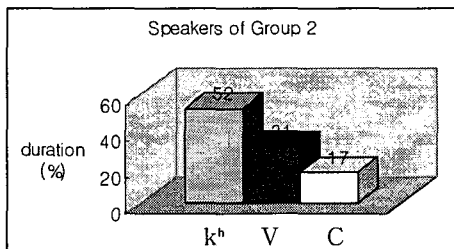


Figure 13. The mean duration ratio of *queen* by three Korean speakers of Group 2: The [k<sup>h</sup>] was significantly longer than other segments at 52%.

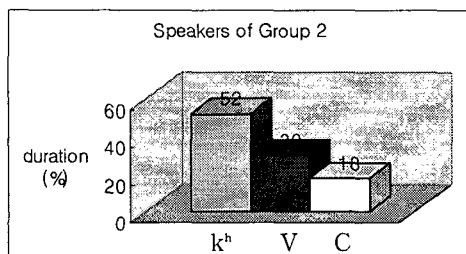


Figure 14. The mean duration ratio of *keen* by three Korean speakers of Group 2: The length of the onset [k<sup>h</sup>] was very long and showed the same ratio at 52% like that of Figure 13.

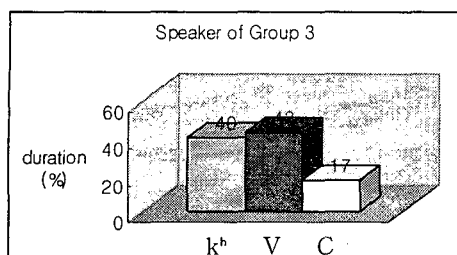


Figure 15. The duration ratio of *queen* by a Korean speaker of Group 3: The vowel length ratio was relatively longer than other subjects at 43%. This length was much longer than that of *keen* in Figure 16.

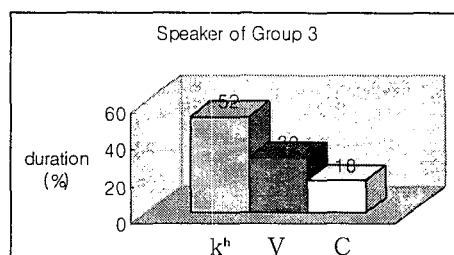


Figure 16. The duration ratio of *keen* by a Korean speaker of Group 3: The vowel length ratio was not long compared to that in Figure 15.

#### 4.2.2 Mean Duration Ratio of the Other Words by All Subjects

The mean duration ratios of other words are examined and the following patterns are emerged. First of all, the native speaker tended to hold the vowel longer in kVC sequences than in kwVC sequences except *coat* and *quote*. In addition, the duration of /w/ was much shorter than other vowels or consonants. The Korean speakers of Group 1, who produced the target-appropriate [w] sound, generally showed similar patterns to those of the native speaker. That is, the vowel length of kVC sequences was longer than that of kwVC sequences. Further, the ratio of /w/ was short as the native speaker. Overall, the native speaker and the speakers of Group 1 showed similar patterns in terms of the duration ratio.

Secondly, the speakers of Group 2, who completely dropped the /w/ sounds, showed roughly similar ratio patterns between kwVC and kVC sequences. /w/ was deleted but the ratio of [k<sup>h</sup>] was longer than other Korean subjects. The speakers of Group 2 specifically had a long release duration because of strong aspiration in pronouncing [k<sup>h</sup>].

Lastly, the speaker of Group 3, who also pronounced /w/ inappropriately, presented rather different patterns as compared to the speaker of Group 2. Both speakers of Group 2 and Group 3 showed the target-inappropriate pronunciation of kwVC sequences, but the ratio of each segment was different. The duration of the /w/ sound was extremely short in Group 3 and therefore it cannot be identified as an individual segment. However, the evidence that the F2 of the following vowel was slightly lowered supported the partial lip rounding. The speaker of Group 3 showed a long ratio in the following vowel, while the speaker of Group 2 showed a long duration ratio in the onset of [k<sup>h</sup>] in kwVC sequences.

## 5. Conclusion

It was shown through spectrographic analyses that Korean speakers of English had difficulties in pronouncing /w/ sounds in kwV sequences. They tended to delete /w/ sounds as Group 2 did or show an incomplete pronunciation of /w/ with a partial lip rounding as Group 3 did, although some students produced the target-appropriate /w/ as Group 1 did. The general production patterns with respect to the duration ratios in English [kw] sequence words are as follows: the native speaker and the speakers of Group 1 had similar ratio patterns in that the vowel duration ratio in kwV sequences was shorter than that in kV sequences. The speakers of Group 2 had a long ratio of the onset [k<sup>h</sup>] dropping the /w/ sound while the speaker of Group 3 had a long ratio of the following vowel.

In this study, however, only a production experiment was conducted so we cannot conjecture as to whether the speakers perceive the /w/ sound appropriately or not. Therefore, further research which combines the production test and the perception test is needed and the number and gender of subjects should be more considered.

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