An Acoustic Study of the Perceptual Significance of F2 Transition of /w/ in English and Korean*

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ABSTRACT

The intent of the present study is to investigate the acoustic properties of Korean /w/ in various phonological contexts, compare them with those of English /w/, and attempt to explain why English /w/'s are perceived differently by Korean speakers depending on the phonological contexts. Experiments 1 and 2 present the acoustic measure of F2 of Korean /w/ in various linguistic positions and show that unlike English /w/, Korean /w/ shows quite a strong coarticulation with the following vowel. Based on these experiments, Experiment 3 investigates why English /w/ is adapted differently into Korean. Specifically, it discusses why English /wain/ is adapted as /wain/ whereas English /twin/ is adapted into Korean as /tʰɨwin/ with an extra vowel. This study argues that the different perception of English /w/ by Korean and English speakers is due to the different F2 transitional pattern of /w/ in Korean and English in various phonological contexts. It also argues that the F2 transitional pattern is an important factor in the perception of /w/.

Keywords: Korean/English /w/, coarticulation, F2 transitional pattern, perception

1. Introduction

It is known that both Korean and English contain two glides, /w/ and /j/. In both languages, /w/ and /j/ can appear either as the first or the second member in the syllable. There are some peculiarities: in Korean, vowel /i/ cannot follow /j/, and vowels /u/ and /o/ cannot follow /w/. In English, Davis and Hammond (1995) argue that /w/ is a member of a consonant cluster but /j/ is a member of a nucleus. Still, these approximants are phonologically considered to be [w] and [j] in both languages. However, this does not mean that they are acoustically near identical to their respective counterpart in the other language. This paper focuses on the labial glide /w/ in Korean, investigates its acoustic properties, compares them with English /w/, and attempts to explain why Korean speakers have different perception of English /w/'s in various phonological positions.

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It is known among linguists that English /w/ is perceived differently by Korean speakers in different phonological contexts. Loanword adaptation reflects perceptual similarities and differences of sounds between the donor language and the recipient language. Therefore, it is instructive to compare English words that contain /w/ with their adapted forms in Korean and observe what pattern emerges. Consider (1).

(1)	English	Loanwords
a. wine	/wayn/	/wain/
b. whisky	/wɪskɪ/	/wisɨkʰi/
c. queen	/kwin/	/kʰwin/
d. quiz	/kwɪz/	/kʰwidʒi/
e. twins	/twɪnz/	/tʰɨwindʒi/
f. twist	/twɪst/	/tʰɨwisɨtʰɨ/

Syllable-initial English /wV-/ sequence is adapted as Korean /wV-/ sequence as we see in (1a, b). English /CwV-/ sequence, however, is sometimes adapted as Korean /CwV-/ as in (1c-d) and other times as /CɨwV/ with an intervening vowel between /w/ and its preceding consonant as in (1e-f). To be specific, if the consonant that precedes /w/ is /t/ as in English 'twin,' a default vowel /ɨ/ is inserted between /t/ and /w/ but if /k/ precedes /w/ as in 'quiz,' /kw/ is adapted as /khw/ in Korean. This way of adaptation raises the following question: what makes English /w/ sometimes be adapted as Korean /w/ and other times as Korean /ɨw/?

Since loanword adaptation reflects the differences and similarities of the sounds between the donor and the recipient languages, investigating acoustic similarities and differences of the segment that exists in the phonological systems of two languages would be instructive. There has been some previous research on the acoustic nature of /w/ in Korean. Some researchers (K-D. Lee 1973, K.-O. Kim 1978, and etc.) suggested that Korean /wV/ in /(C)wi-/ and /(C)we-/ are in free variation with front round monophthongs, [y] and [ø] respectively, while many others have assumed that they are diphthongs, not monophthongs. Most of the suggestion, however, is not based on experimental studies, but rather based on the intuition of each linguist.

There are, however, some papers that investigated the acoustic nature of Korean /w/ with the experimental tests. Assuming that /wi-/ and /we-/ are monophthongs, Yang (1996) measured the F2 of these segments at one third of the vocalic portion and showed that F2s of these two segments at this time point are quite different from those of /i/ and /e/, respectively and thus suggested that they are front round monophthongs, /y/ and /ø/ respectively.

Yun (2005), on the contrary, assumed that /wi-/ and /we-/ are diphthongs and to support his argument, he measured the F2s of these segments at two time points: F2 onset at the initial

point of /w/ and F2 vowel at the steady-state of the vowel in these sequences. More specifically, he measured F2 onsets and F2 vowels of tokens such as /wi-/ and /we-/ and tokens such as /hwi-/ and /hwe-/. He suggested that by measuring F2 onsets (glides) and F2 vowels this way, he can measure F2 onsets (glides) and F2 vowels of diphthongs occurring at syllable-initial position (cf. /wi-/ and /we-/) and those after a tauto-syllabic consonant (cf. /hwi-/ and /hwe-/). Based on the results of the experiments, he argued that Korean labial glide in syllable-initial position is /w/ and that Korean labial glide after a tauto-syllabic consonant is [y] if the following vowel is a front vowel.

Not only Korean /w/, English /w/ has also attracted attention from many phoneticians (cf. Lisker 1957, O'Connor et al. 1957, Sussman 1994, etc.). Working on intervocalic /w/, Lisker (1957) showed that the direction and the extent of F2 transition are important factors in the perception of an approximant /w/. O'Connor et al. (1957) showed that English /w/ in the syllable initial position has constant low frequencies and Sussman (1994) also showed that English /w/ in the syllable-initial position has approximately 751 Hz across all vowel contexts. That is, English round glide is clearly [w] and shows little coarticulation with the upcoming vowel. These previous studies point to the fact that the sound /w/ in Korean and in English may in fact be acoustically different from each other and this may be why /w/ is perceived differently by Korean and English speakers.

To answer the question, the present study will examine acoustic differences of /(C)wV-/ sequences between Korean and English and show that different temporal relations of /w/s with respect to the preceding segment and the following segment between Korean and English may account for various adaptations of English words with /w/ into Korean. This paper consists of as follows: Experiment 1 computes acoustic measures of F2 onset (glide) and F2 vowel of the syllable-initial /wV/ sequence in Korean and compares them with those of English /wV/ sequences in the same linguistic evnrionment. Experiment 2 computes F2 of /w/ after the stop consonant in Korean and shows its temporal relations with the following segment. Experiment 3 examines the acoustic measure of /w/ after the stop consonant in English. Experiments 1, 2 and 3 will show that there are critical acoustic differences of /w/s in English and Korean in various phonological contexts and that this is why /w/'s are perceived differently by Korean and English speakers.

2. Experiments

To investigate the acoustic properties of a Korean labial glide in various phonological contexts, several experiments were designed.

2.1 Experiment 1

In this experiment, we measured the F2 onset (glide) and the F2 vowel in the sequence of /wV/ at the syllable-initial position in Korean.

2.1.1 Subjects

Four native talkers of Seoul Korean (two males, two females) participated in the production study of Korean labial approximant /w/. Three of these speakers were undergraduate students at Hanyang University in Korea. The remaining one speaker was a graduate student in the same institute. All participants were naïve to the purposes of the study.

2.1.2 Stimuli

The purpose of the study was to examine the F2 values of /w/ and V in the syllable-initial position in Korean. The target words in (2) were given inside the frame sentence (3).

(2) /wi/, /we/, /wa/

(3) ikɨldʒanɨn ____ ta. 'This letter is ____'

The type of vowel that follows the target labial approximant was varied for the purpose of investigating whether the F2 onset(glide) of a labial approximant changes depending on the following vowel. Since [u] and [o] do not occur after a labial approximant in Korean, we tested only three /wV/ sequences such as /wi-/, /we-/ and /wa-/.

2.1.3 Procedure

Talkers were recorded in a quiet room at Hanyang University using a Sennheiser 835S microphone. They were given an instruction to read the sentences in the normal speed. Two male students put a short pause in front of the target word whereas two female students did not. All talkers were asked to read a few sentences for practice. In actual recording, all tokens were repeated 10 times in a randomized order and the first seven renditions of each sentence served as the basis for the analysis. In total, 84 sentences (3 vowel contexts * 7 repetitions * 4 speakers) were analyzed.

Since the CV boundary is nondiscernible for /w/, F2 onset of /w/ was measured at the onset of the first glottal pulse when there is a pause between the first phrase and /w/, or at the minima point of the F2 resonance between /n/ at the end of /ikɨldʒanɨn/ and V of the target word if no pause occurs before it. F2 vowel (Hz) was taken at a point closely corresponding to the midvowel nucleus. In measuring F2 vowel, we followed procedures described in Sussman et al. (1991): If F2 was U-shaped, the 'minima' point was chosen for measurement. If F2 was quasi-steady state or diagonally rising, a visually inspected mid point of the F2 resonance was

chosen.

Two separate measurements of F2 onset (glide) and F2 vowel were obtained for each token for this study: Direct on-screen spectrogram readouts by cursor placement and narrow-band FFTs. This study used Praat software (cf. Boersma and Weenik, 2002) for spectrogram readouts and FFT analysis.

2.1.4 Results

<Figures 1a and 1b> show the average locus equation slope (k), y-intercept (C) and R-Sq for two male talkers and <Figures 1c and 1d> show the same results for two female talkers. Locus equations are straight line regressions fits to data points that are formed by plotting F2 onsets along the y-axis and their corresponding F2 midvowel frequencies along the x axis.

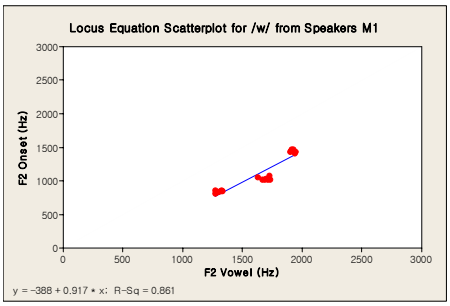

Figure 1a. Speaker M1

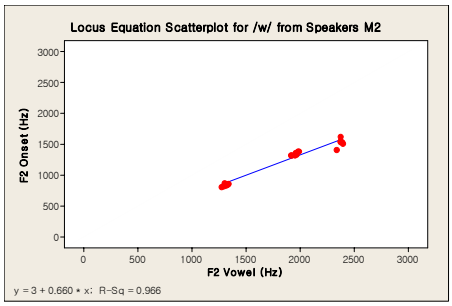

Figure 1b. Speaker M2

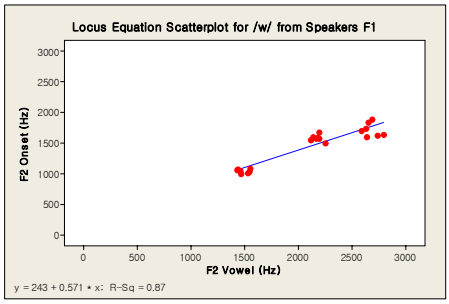

Figure 1c. Speaker F1

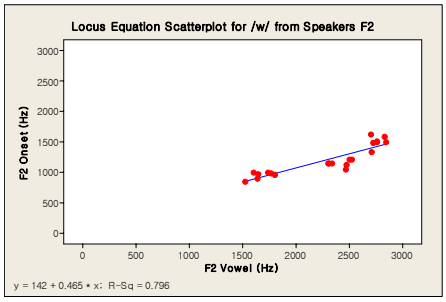

Figure 1d. Speaker F2

Figure 1. Locus Equation Scatterplots for /w/ from Speakers M(ale)1, M2, F(emale)1 and F2

2.1.5 Discussion

Experiment 1 shows that variations in the slope of locus equations occur among speakers: M1 shows the steepest slope of 0.917, M2 shows 0.660, F1 0.571 and F2 shows the flattest slope of 0.465. The degree of a slope is indicative of the degree of CV coarticulation: The steeper the

slope is, the greater degree of CV coarticulation is and the flatter the slope is, the smaller degree of CV coarticulation is because the consonantal locus varies directly with the following vowel target. Therefore, we can conclude that Korean labial approximant /w/ shows modest coarticulation with the upcoming vowel target in the syllable initial position. This means that the heterto assumed labial glide /w/ in Korean tends to be fronted on the acoustic/auditory vowel space when it occurs before the front vowels which have high F2.

Still, there is difference in the degree of locus equations between male speakers and female speakers: This may lie in part in different prosodic environment of /w/. Male speakers put a short pause between the first phrase and the target /wV/ word whereas female speakers did not.: The F2 onset of the /w/ in female speakers' speech may have been affected by both the preceding /n/ and the following V whereas the F2 onset of the /w/ in male speakers' speech may have been affected only by the following V and thus, the greater degree of CV coarticulation may have occurred.

A labiovelar glide /w/ in English, on the contrary, has low F2 (about 763Hz according to Sussman (1994)) across all vowel contexts, revealing essentially zero slope with the following vowel. This indicates that their F2 onset is not affected by the following vowel and thus no coarticulation exists between /w/ and the following vowel (Sussman 1994). Therefore, we can conclude that at the syllable-initial position, different labial glides are employed in English and Korean. Note that the results of this experiment are different from the results of Yang (1996) and Yun (2005): Syllable-initial /wV/ sequence in Korean is /glide-vowel/ sequence, not monophthongs, contrary to Yang's (1996) claim and /w/ in this position shows different F2 depending on the following vowel, not the constant low F2 contrary to Yun's (2005) claim.

2.2 Experiment 2

In Experiment 1, we have shown that there is no front round vowel in Korean unlike the claim by Yang (1996) and that Korean labial glide in /wV/ syllable is modestly coarticulated with the upcoming vowel unlike the claim by Yun (2005). In this experiment, we examine the acoustic properties of the sound /w/ in Korean when it occurs after a tautosyllabic stop and consider how closely /w/ is co-articulated with the following vowel and the preceding consonant.

2.2.1 Subjects:

Four native talkers of Seoul Korean (two males and two females) participated in the production study of Korean labial approximant when it occurs as the second element in the syllable-initial position. All the talkers were graduate students at Hanyang University. All the participants were naïve to the purposes of the study. One speaker (M2) also participated in the production test of a labial glide in /wV/ syllable in Experiment 1.

2.2.2 Stimuli

The purpose of the study was to examine the F2 values of /w/ when it occurs as the second element in Korean /CwV/ sequence. The target words in (4) and (5) were given inside the frame sentence in (6). The [T] and [K] in (4) and (5) respectively represent three types of a Korean stop with the same place of articulation: [T] represents lax [t], tense [T*] and aspirated [tʰ], and [K] represents lax [k], tense [K*] and aspirated [kʰ].

(4) Twi, Twe

(5) Kwi, Kwe, Kwa

(6) ikɨldʒanɨn _____ta. 'This letter is _____.'

The type of vowel following the target labial approximant was varied for the purpose of investigating whether the initial F2 value of the labial approximant /w/ in a /CwV/ sequence changes depending on the following vowel. Since back vowels [u] and [o] do not occur after a labial glide in Korean and a low vowel [a] does not occur after the /Tw-/ sequence, we examined two /TwV/ sequences and three /KwV-/ sequences. For simplification, we excluded /Pw-/ sequence since it does not occur in the Standard Seoul dialect except /pwa/.

2.2.3 Procedure

Talkers were recorded in a quiet room at Hanyang University using a Sennheiser 835S microphone. They were given an instruction to read the sentence at a normal speed. All the tokens were repeated 10 times in a randomized order. For all talkers, the first seven renditions of each sentence served as the basis for the analysis. In total, 168 sentences (2 vowel contexts *3 stop types * 7 repetitions * 4 speakers) were analyzed for the /Tw-/ sequence and 252 sentences (3 vowel contexts *3 stop types * 7repetitions * 4 speakers) were analyzed for the /Kw-/ sequence.

Talkers' productions were examined for the target consonant cluster. In particular, it was evaluated whether talkers produced correct /Tw-/ and /Kw-/ sequences in each sentence. Of four talkers, one failed to produce the desired /w/ in both /Tw-/ and /Kw-/, precluding an examination of /stop-w-V/ sequence in the syllable initial position. This talker's tokens were discarded. Another talker failed to produce /twe-/ sequence but correctly produced all the other /T*wi-/, /tʰwi-/ and /Kwi-/ sequences. Only /twe-/ tokens were discarded from this speaker.

Two criteria were employed in determining whether each token contained the target sound /w/ or not. First, the tokens were evaluated by 2 native speakers (the author and one naïve speaker) whether they contained /w/ sound. Second, the measures of F2 onset (the onset values of the F2 transition from the stop to the following glide), glide and F2 vowel of the token were used in determining the correct tokens: The measures of F2 onset and F2 vowel of /Ti/ and

/Te/ are fairly higher than the average measures of the F2 onset, glide and F2 vowel of /Twi/ and /Twe/.

In this experiment, three F2 values were measured from the tokens, such as F2 onset (stop release), F2 glide and F2 vowel. F2 onsets (stop release) were measured at the release of the obstruent (/T/ and /K/). F2 glides were measured for a labial consonant after the tense stop. They were measured around 20 msec after the release of consonant when the regular wave form of an approximant begins. This time point was determined after listening to all the tokens and having inspected visually the F2 transitions. F2 vowels (Hz) were measured at a point which corresponded closely to the mid-vowel nucleus. Other procedures are same as those in Experiment 1.

2.2.4 Results:

<Figure 2a> shows the average locus equation slope (k), y-intercept (C) and R-Sq of /T/ with the upcoming vowel for /TwV-/ sequence across all the talkers. For this, we analyzed all 168 sentences (2 vowel contexts * 3 stop types * 7 repetitions * 4 speakers). Among these, only 119 tokens were valid since one talker could not produce /TwV-/ sequence and another /twi-/ token. The mean slope across 3 talkers is 0.779 and R-Sq is 93.5%. Figure 2b shows the average locus equation slope (k), y-intercept (C) and R-Sq of /w/ across all the talkers with the upcoming vowel in /TwV-/ sequence. For this, we analyzed only 56 sentences (2 vowel contexts *1 stop types * 7 repetitions * 4 speakers), which contained target words starting with a tense stop. Among these, only 42 tokens were valid for the analysis. The mean slope across 3 talkers is 1.04 and R-Sq is 91.7%. F2 glide were plotted along the y-axis, and F2 midvowel frequencies were plotted along the x-axis in <Figure 2b>.

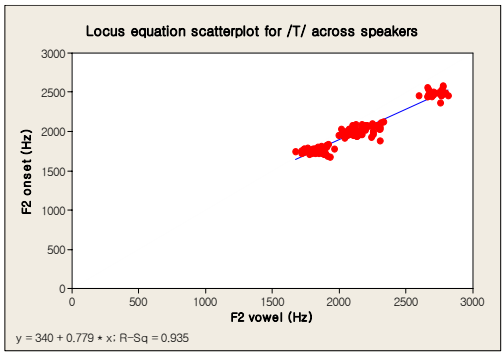

Figure 2a. Locus Equation Scatterplot for /T/ in /TwV/ across Speakers

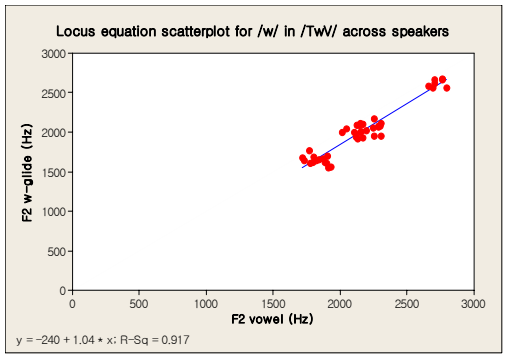

Figure 2b. Locus Equation Scatterplot for /w/ in /TwV/ across Speakers

<Figure 3a> shows the average locus equation slope (k), y-intercept (C) and R-Sq of /K/ with the upcoming vowel across all the talkers. For this, we measured all 252 sentences (3 vowel

contexts * 3 stop types * 7 repetitions * 4 speakers). The mean slope across 3 talkers is 1.40 and R-Sq is 93.4%. <Figure 3b> shows the average locus equation slope (k), y-intercept (C) and R-Sq of /w/ in /KwV-/ sequence with the upcoming vowel across all the talkers. For this, we measured 84 sentences (3 vowel contexts *1 stop types * 7repetitions * 4 speakers) that contained words beginning with a tense stop. The mean slope across 4 talkers is 1.07 and R-Sq is 94.8%. Again, F2 onsets were plotted along the y-axis, and F2 midvowel frequencies were plotted along the x-axis in <Figure 3b>.

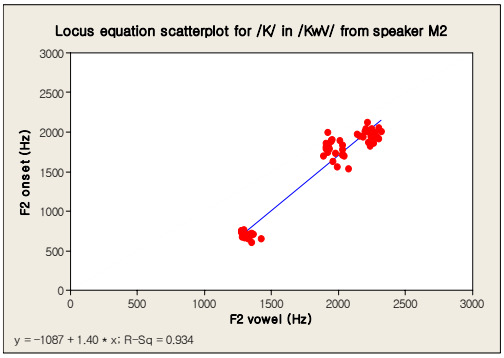

Figure 3a. Locus Equation Scatterplot for /K/ in /KwV/ across Speakers

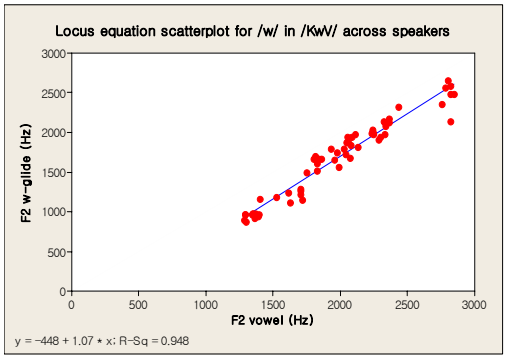

Figure 3b. Locus Equation Scatterplot for /w/ in /KwV/ across Speakers

2.2.4 Discussion

In this experiment, we pooled the data points of the target words if it begins with the stop with the same place of articulation regardless of its manner of articulation. Sussman (1994) examined F2 values of several stop segments with different voicing and concluded that voicing difference in stops do not make difference in locus equation. He also showed that normalization of male and female speakers is not necessary in locus equation of /w/ with the upcoming vowel. In addition, there is no noticeable difference among the speakers. We thus followed his suggestion and used the pooled data.

This experiment shows that labial approximant /w/ in Korean exhibits stronger degree of coarticulation with the upcoming vowel in /CwV/ sequence than it does in /wV/ sequence. Note that the coefficients are 1.04 and 1.07 for /TwV-/ and /KwV-/ sequences, respectively and the coefficient of /wV/ was 0.51: the coefficients 1.04 and 1.07 are much closer to coefficient 1 which reflects perfect CV coarticulation. Furthermore, the stops /T/ and /K/ at the initial position of /CwV/ sequences also show quite strong degree of coarticulation with the upcoming vowel. The mean slopes for /T/ is 0.779 and for /K/ is 1.40 with the upcoming vowel.

Some conclusions can be drawn from these results. First, the labial glide in Korean shows very strong coarticulation with the following vowel when it occurs after a tauto-syllabic stop.

This clearly shows that we need to reconsider what the acoustic nature of the hereto assumed labial glide /w/ is in Korean. That is, the hitherto assumed labial glide /w/ in Korean is strongly fronted on the acoustic/auditory vowel space when it occurs in the environment of front vowels with high F2. In Experiment 1, we have also shown that Korean /w/ at the syllable initial position is in clear contrast with English /w/.

Secondly, we can also conclude that not only there is strong degree of CV coarticulation between /w/ and the upcoming vowel, but also there is quite strong degree of CV coarticulation between the syllable initial stop and the upcoming vowel across an intervening segment /w/. The CV coarticulation between the stop and the following vowel looks quite strong if the initial stop is /T/. This quite strong degree of coarticulation between C and V across an intervening sound /w/ clearly shows that the intervening sound /w/ greatly overlaps with the preceding consonant C and the following vowel V. This may explain why /w/ in the consonant cluster is very transient and is often dropped out in Korean. In fact, with the results of this experiment, we cannot conclude that there is an independent segment /w/ in Korean after a tauto-syllabic consonant. In fact, we may have to conclude that /Stop+w/ cluster at the syllable initial position is /C^{w}/ with the secondary articulation /w/.

2.3 Experiment 3

In Experiment 2, it is shown that Korean /w/ after a tauto-syllabic consonant shows a very strong degree of CV-coarticulation with the upcoming vowel. Not only that, the experiment has also shown that the initial stop shows quite strong degree of CV-coarticulation with the upcoming vowel across an intervening segment /w/. This is quite an unexpected result since a segment /w/ intervenes between the syllable initial stop and the upcoming vowel.

In Experiment 3, in order to see if there are any acoustic differences/similarities, we compare the English /w/ after a tauto-syllabic stop with Korean /w/'s in the same linguistic environment, /CwV/ and in the context of /C$_{i}$w(V)/, which is the adapted form of an English /Cw(V)/ sequence. This experiment may account for why English /CwV-/ sequences are adapted as /C$_{i}$wV-/ sequence, not as the phoneme-wise identical /CwV-/ sequence in Korean: Korean speakers adapt English words into Korean according to the perceived phonetic properties of English words, not to the phonemic sequences in English.

2.3.1 Subjects:

Two native speakers of American English (males) participated in the production study of English labial glide after a tauto-syllabic stop. These talkers were English teachers at Hanyang University in Korea. One of them was 35 years old and had been in Korea for around 5 years at the time of recording. The other was 45 years old and had been in Korea around 7 years.

2.3.2 Stimuli

The purpose of the experiment was to examine the direction and the extent of F2 transition in the English /CwV-/ sequence and compare it with the Korean /CwV/ sequence. The target words in (7) were given inside the frame sentence in (8).

(7) twin, (Mark) Twain, quiz, quest

(8) Say _____ again.

The type of vowel following the target labial approximant was varied such as [i, e(y), ɛ] for the purpose of investigating whether F2 transition of /CwV/ changes its direction depending on the following vowel. We did not include English /Twa-/ sequence since there is no /Twa-/ sequence in Korean for it to compare to.

2.3.3 Procedure

Talkers were recorded in a quiet room at Hanyang University using a Sennheiser 835S microphone. Talkers were given the same instruction as the one in Experiment 1 and 2. All the stimuli were repeated 10 times in a randomized order. For all talkers, the first seven renditions of each sentence served as the basis for the analysis. In total, 56 sentences (2 vowel contexts * 2 consonant types * 7 repetitions * 2 speakers) were analyzed.

2.3.4 Results

The purpose of this experiment was to determine the F2 transition pattern of the /CwV-/ sequences in English and compare it with that of Korean. Lisker (1957) argued that the direction and the extent of F2 transition is more important than other factors in the perception of intervocalic /w/. To clearly show the direction of the F2 transition in the sequence, the F2 values at the release of the initial consonant (F2 onset), at the minima point of F2 transition (F2 glide) and the following vowel in the steady-state (F2 vowel) were measured using the same method described in earlier experiments. The average F2 values for each time point were given in <Table 1>.

Table 1. The average F2 values of F2 onset, F2 glide and F2 vowel

a. twin

	t	w	ɪ(n)
ED	2036	833	1959
J M	1807	788	1832

b. twain

	t	w	e(yn)
ED	1933	804	1983
JM	1780	655	2036

c. quiz

	t	w	ɪ(n)
ED	1470	917	1941
JM	1202	888	1901

d. quest

	t	w	e(yn)
ED	1284	882	1725
JM	1186	825	1749

Though there is difference between talkers, it is clearly shown that the F2 transition in /twV-/ sequence shows more sharp U-shaped pattern than that of /kwV-/ sequences.

2.3.4 Discussion

The results shows that there is clear difference in the direction and the extent of F2 transition between /twV-/ sequence in English and /TwV-/ sequence in Korean: The /twV-/ sequence in English shows U-shaped F2 transition whereas /TwV-/ sequence in Korean is more or less flat as we have seen in Experiment 2. The F2 transition pattern of English 'twin' by JM and that of Korean /T*win/ by KSK are given in <Figures 4a and 4b>, respectively.

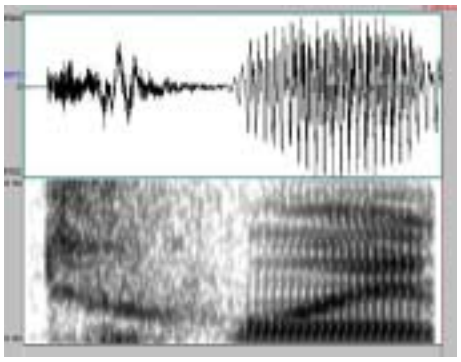

Figure 4a. Spectrogram of English /twi(n)/ by JM

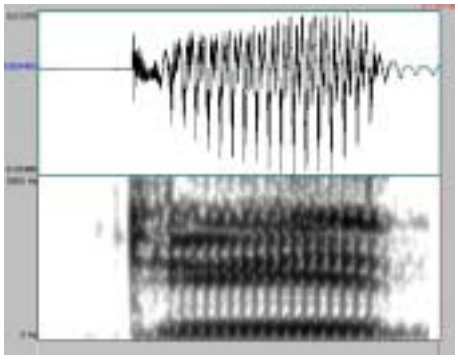

Figure 4b. Spectrogram of Korean [T*wi(n)] by KSK

The F2 transition in /kwV-/ sequence in English can be said to be U-shaped with small degree of falling for Ed but it can be classified as more or less flat for JM. The /KwV-/ sequence in Korean shows slightly rising or flat F2 transition. The F2 transition patterns of English 'quiz' by JM and that of Korean /K*wi/ by KSK are given in <Figures 5a and 5b>, respectively.

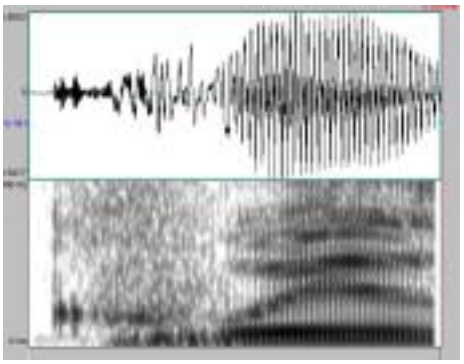

Figure 5a. Spectrogram of English /kwiz/ by JM

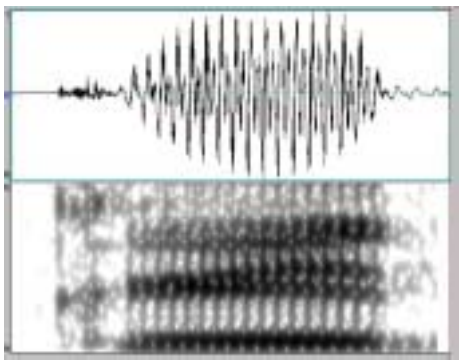

Figure 5b. Spectrogram of Korean /K*wi/ by KSK

If the direction and extent of F2 transition are important cues in perception, it is not difficult to see why Koreans find English /twV-/ sequence more different from Korean /TwV-/ sequence than English /kwV-/ sequence from Korean /KwV-/ sequence. Interestingly, Korean speakers find Korean /tʰɨwin/ is more similar to English /twin/ than Korean counterpart of /tʰwin/. The F2 transition of Korean /tʰɨwin/ is given in <Figure 6>.

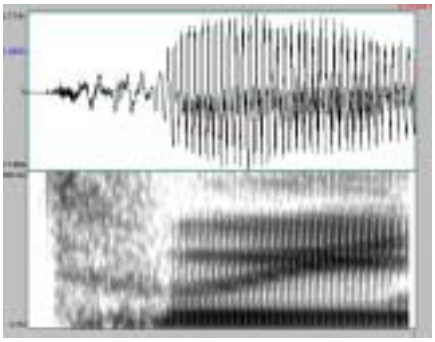

Figure 6. Spectrogram of Korean /tʰɨwi(n)/ by KSK

As we can see, the F2 pattern of English /twin/ in <Figure 4a> is more similar to that of Korean /tʰɨwin/ in <Figure 6> than that of Korean /T*win/ in <Figure 4b>. I would like to argue that this is why English 'twin' is adapted as Korean [tʰɨwin]. As for the adaptation of English words with /kʰwV/ sequence, it may be the case that more or less flat F2 transition (or moderate falling of F2 transition) is responsible for its being adapted as Korean [kʰwV-] sequence.

3. General Discussion

In this paper, we examined the acoustic properties of Korean /w/, compared it with English /w/ in two phonological contexts and showed that acoustically Korean /w/ is very different from English /w/ (cf. Sussman 1994). At the syllable-initial position, Korean /w/ showed a modest degree of coarticulation with the upcoming vowel whereas English /w/ showed no coarticulation with the upcoming vowel. Still, the F2 transition of /wV/ sequence both in Korean and English showed the rising pattern.

After the tauto-syllabic stop, Korean /w/ showed a strong degree of coarticulation with the upcoming vowel and the F2 transition in /CwV/ sequence in Korean was more or less flat. English /CwV/ sequence, however, showed a different F2 pattern: It showed a sharp falling-and-rising, a typical U-shaped pattern. It was particularly true for the case of /alveolar stop-w-vowel/ sequence.

This paper argued that different F2 transitions involving /w/ in Korean and English are responsible for different ways of adaptation of English /w/ into Korean. The syllable-initial /w/ in English is adapted as Korean /w/ due to the rising F2 transition both in Korean and English despite acoustic differences. F2 transition may have more influence in perception than absolute F2 frequencies of /w/ (cf. Lisker 1957). Likewise, English /alveolar stop-w-vowel/ sequence is perceived as Korean /alveolar stop-default vowel-w-vowel/ again due to F2 transitional patterns. In English, the F2 pattern for /twV/ sequence is falling-and-rising, a typical U-shaped pattern but in Korean it is more or less flat as we have shown in <Figures 4a and 4b>. Therefore, English /alveolar stop-w-vowel/ sequence is not perceived as Korean /alveolar stop-w-vowel/ sequence. Rather, it was perceived as Korean /alveolar stop-default vowel-w-vowel/ sequence whose F2 shows the falling-and rising pattern just like English /alveolar stop-w-vowel/ sequence (cf. <Figure 6>).

The pattern of F2 transition in English /kwV/ sequence is somewhat different from that of English /twV/: it is not as prominently U-shaped as English /twV/ sequence is as is shown in <Figure 5a>. That is, the extent of F2 drop from the initial /k/ to the following /w/ is not as sharp as that from /t/ to /w/ in English /twV/ sequence. This may be one of the reasons that English /kwV/ sequence is adapted as Korean /kʰwV/ sequence rather than /kʰɨwin/.

In addition, we have shown that there are possibly three variants of /w/ in /kwV/ context in Korean, which are [y], [ø] and [w] depending on the following vowel. That is, Korean speakers may register /w/ as a phoneme in this context and blame the phonological contexts (the following front vowels) for the allophones such as [y] and [ø]. Therefore, when they hear [w] in English /kwi/ sequence, for example, they may still match it with /w/ since there is such a variant after /k/ among Korean /kwV/ sequence. This is not possible in /twi/ sequence since Korean have not heard [w] after /t/.

In sum, this paper showed that 1) there are acoustic differences between English and Korean /w/s in various phonological contexts and (2) the direction of F2 transition and extent of F2 change affects the perception of speakers, which results in different adaptation of the same English segment /w/ into various forms in Korean. Some systematic difference on loanword adaptation from a foreign language to Korean, therefore, must be investigated not only in phonological aspects but in phonetic aspects of both a donor language and Korean.

References

Boersma, P. & Weenik, D. 2002. Praat, a system for doing phonetics by computer. Software and manual available online at http://www.praat.org//.

Delattre, P. C., Liberman, A. M. & Cooper, F. S. 1965. “Acoustic loci and transitional cues for

consonants." *Journal of the Acoustical Society of America* 27, 769-773.
Kim, K. 1978. Vowel system of Korean revisited, In Kim, C. (ed.), *Papers in Korean linguistics*, pp. 247-56. Columbia, SC: Hornbeam Press.
Lee, K. 1973. "On the so-called s-irregular and t-irregular verbs in Korean." *University of Hawaii Working Papers in Linguistics* 5, 129-138.
Lisker, L. 1957. "Minimal cues for separating /w, r, l, y/ in intervocalic position." *Word* 13, 256-267.
O'Connor, J. D., Gerstman, L. J., Liberman, A. M., Delattre, P. C. & Cooper, F. A. 1957. "Acoustic cues for the perception of initial /w, j, r, l/ in English." *Word* 13, 24-43.
Ohala, J. 1981. "The listener as a source of sound change." In Masek, C. S., Hendrick, R. A. & Miller, M. F. (eds.), *Papers from the parasession on language and behavior*. Chicago: Chicago Linguistic Society. pp. 178-203.
Sussman, H. M. 1994. "The phonological reality of locus equations across manner class distinctions: preliminary observations." *Phonetica* 51, 119-131.
Sussman, H. M., Joemeke, K. & Ahmed, F. 1993. "A cross-linguistic investigation of locus equations as a relationally invariant descriptor for place of articulation." *Journal of the Acoustical Society of America* 94, 1256-1268.
Sussman, H. M. and Shore, J. 1996. "Locus equation as phonetic descriptors of consonantal place of articulation." *Perception & Psychophysics* 58(6), 936-946.
Yang, B. 1996. "A comparative study of American English and Korean vowels produced by male and female speakers." *Journal of Phonetics* 24(2), 245-261.
Yeou, M. 1997. "Locus equations and the degree of coarticulation of Arabic consonants." *Phonetica* 54, 187-202.
Yun, Y. 2005. "Phonetic Analysis of the Korean Glides [w] and [y]." *Korean Journal of Linguistics* 30(2), 395-421.

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