

The phonological and phonetic aspects of labialization: a crosslinguistic study*

Eun-Sook Kim
(Hannam University)

Kim, Eun-Sook. 2010. The phonological and phonetic aspects of labialization: a crosslinguistic study. *Studies in Phonetics, Phonology and Morphology* 16.1. 41-64. Labialization involves lip rounding as a secondary articulation on consonants or as a sequence of Cw. It exhibits interesting phonetic and phonological characteristics crosslinguistically. In this paper, I investigate labialization in English, Korean and Nuuchahnulth with respect to the phonemic status of labialization, its relationship with delabialization, and the co-occurrence of labialization with features/segments. By examining the properties of labialization, I present insights into the typological, theoretical, and pedagogical aspects of this process. (Hannam University)

Keywords: labialization, delabialization, typology, Optimality Theory, pedagogy

1. Introduction

The term 'labialization' is used to refer to the addition of a lip rounding gesture to a segment with the accompanying elevation of the tongue back (Maddieson 1984, Ladefoged and Maddieson 1996, Stonham and Kim 2008). This process may occur when a primary articulation is accompanied by lip rounding. In addition, Ladefoged and Maddieson (1996:368) note that 'labialization may be used to describe a sequence of a consonant and w'. Hence, it may include labialized consonants such as /k^w, t^w, etc/ as well as sequences of the form Cw.

One challenge for Korean learners of English is the acquisition of distinctive labialization on various segments. This collocation presents great difficulties for the Korean learner, with consequent mispronunciations of phonetic minimal pairs such as *queen* vs. *keen* or *woos* vs. *ooze* (see also Cho, Park and Lee 2001, Kim and Cho 2002, Cho 2004, Seo, Kim and Stonham 2009 for discussion of related issues). This study aims to investigate the challenges inherent in this contrast from the perspective of linguistic typology, comparing three typologically distinct languages: English, Nuuchahnulth, and Korean. All three languages exhibit labialization, but to varying extents. We will see what kinds of common properties they share and what distinct characteristics they exhibit with respect to labialization.

In what follows, I investigate the phonological and phonetic characteristics of labialization in the three languages mentioned above. Then, I explore

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the typological, theoretical, and pedagogical implications of the results of this study and the cross-linguistic description of labial interactions. I examine labialization with respect to the ways in which and degrees to which languages can develop typological commonalities and variation. Also, this work provides support for the use of certain constraints employed in linguistic work from the perspective of Optimality Theory. Furthermore, the examination of the inherent complexities involved in the interaction of labialization and vowel rounding provides a diagnostic measure for the degree of difficulty in the acquisition of English forms of this type.

2. The phonological characteristics of labialization

English, Korean, and Nuuchahnulth all possess labialized consonants phonetically, but the combinatorial possibilities and range of consonants involved vary from language to language. In this section I discuss the phonological properties of labialization of each language, beginning with English.¹

2.1 English

English does not have a separate labialized series of consonants, but when a consonant is followed by /w/, it becomes labialized. I illustrate English labialization with examples from the voiceless velar consonant. The examples in (1) provide voiceless velar stops combined with /w/ followed by a series of different vowels (see also Davis and Hammond 1995).

(1) a. queen	/kwɪn/	[k ^w ɪn]
b. quick	/kwɪk/	[k ^w ɪk]
c. quail	/kwel/	[k ^w eɪl]
d. quell	/kwel/	[k ^w eɪl]
e. quack	/kwæk/	[k ^w æk]
f. qua	/kwa/	[k ^w ɑ]
g. quote	/kwot/	[k ^w out]
h. quantity	/kwɒntəti/	[k ^w ɒntəti]
i. quite	/kwat/	[k ^w at]

As indicated by the data in (1), a labialized velar stop can co-occur with a wide range of vowels. However, there is a condition against the co-occurrence of a labialized stop with a [+High, +Round] segment. This is why a /w/ labializes the previous velar stop, merging with it, instead of resulting in [k^ww] (cf. *woo* [wu]). (We will see, in section 3, how the merger of [k] and [w] affects both sounds phonetically.) We can find no

¹ For the purpose of this work, I do not include labialized consonants which undergo secondary labiality by being adjacent to a round vowel.

English words co-occurring with the following sound sequences, either phonetically or phonologically.

- (2) a. *[k^wu] or [kwu]
 b. *[k^wʊ] or [kwʊ]

This reflects a common, crosslinguistic prohibition against the adjacency of similar sounds, which I will discuss in detail in section 4.

On the other hand, English /w/, as an independent phoneme, can be followed by all of the vowels in (1) and also by the high back round vowels, as shown in (3).

- (3) a. woed [wud]
 b. woos [wuz]
 c. would/wood [wud]
 d. wool [wʊl]
 e. wound [wʊnd]

Although the [wʊ/ʊ] sequence is not very frequent, we can still find English words such as those in example (3). This attests to the absence of a constraint against the co-occurrence of a labiovelar approximant with high back vowels in English.

Another property of English bearing on the issue of labialization is that this language does not allow delabialization, at least synchronically. If a labialized consonant loses its labiality, it will lose its original meaning, resulting in a different word. This is a particularly important point for L2 learners to note. Compare (3a-b) and (4a-b), and the further examples in (5): the only difference in each pair of words, e.g. *woed* vs. *oohed*, is the presence/absence of labiality, whether primary or secondary.

- (4) a. oohed [ud]
 b. ooze [uz]

- (5) a. twin [t^wɪn] vs. tin [tɪn]
 b. queen [k^wɪn] vs. keen [kɪn]
 c. sweat [s^wɛt] vs. set [set]
 d. dwell [d^wɛl] vs. dell [dɛl]

Historical remnants of a process of delabialization, however, suggest that this process was active at an earlier stage of the language, as shown by the cases in (6).

- (6) a. two /tu/ - twin /twin/ - twelve /twelv/
 b. sword /sɔ:d/ cf. swear /swɛ:ɹ/
 c. choir /kwaɪ/ - choral /kɔ:əl/

These examples show that etymologically-related words have lost their labiality diachronically (see section 4.1.4 for more detailed discussion).

Another property of labialization in English (and in Korean as well) is that it applies to consonants with various places of articulation, as shown in (7).

- (7) a. twin [t^wm]
 b. queen [k^win]
 c. Bwana [b^wanə]
 d. memoir [mɛm^wɑ:
 e. pueblo [p^wɛblou]
 f. which [h^wɪtʃ]

Interestingly, (7c-e) shows that the co-occurrence of labial with labialization is possible, although all the words of this type are loanwords from different linguistic sources. (7f) is an example of dialectal/idiolectal variation within English.

Unlike Korean, on the other hand, English does not generally allow contrastive labiality on palatal sounds such as /ʃ/, /ʒ/, /tʃ/, and /dʒ/. There are exceptions, for instance, *schwa* [ʃ^wə], which is a loanword from Hebrew.

To sum up, labialization in English co-occurs mainly with labial, alveolar and velar consonants, and with most vowels, including high back round vowels in the case of [w] only. Also, there are cases of delabialization, although only as remnants of an earlier (regular) process.

2.2 Korean

Korean, like English, does not have a distinct series of phonologically labialized consonants, but when a consonant is followed by /w/, it is labialized, as shown in (8).

- (8) a. /kwatʃa/ [k^watʃa] 'biscuit'
 b. /kwantʃu/ [k^wantʃu] 'name of a city'
 c. /kwentʃ^hana/ [k^wentʃ^hana] 'all right'
 d. /kwijəun/ [k^wijəun] 'cute'
 e. /kwə/ [k^wə] 'bake!' (<ku-ə)

Phonetically labialized consonants can appear before any vowel except the back round vowels /u, o/. Moreover, unlike English, Korean does not

allow a /wu/ or /wo/ sequence (see also Jang and Cho 2005 for discussion of related issues).

- (9) a. *[k^wu] or [k^wo]²
 b. *[wu] or [wo]

With respect to delabialization, unlike English, labialized consonants optionally lose their labiality in casual speech (see also Silva 1991, Kang 1998, Koo and Han 1999, and Lee 2004 for discussion of related issues). Therefore, the words in (8) may be pronounced without labiality, as shown in (10).

- (10) a. [katʃa] ‘biscuit’
 b. [kaŋtʃu] ‘name of a city’
 c. [kɛntʃ^hana] ‘all right’
 d. [kijəun] ‘cute’
 e. [kə] ‘bake!’

As in English, labialization in Korean can co-occur with different places of articulation, as shown in (11).

- (11) a. [t^wi] ‘back’
 b. [s^wiɸ] ‘easy’
 c. [tʃ^wi] ‘rat’
 d. [k^wi] ‘ear’
 e. [h^wi] ‘to bend’
 f. [m^wə] ‘what’
 g. [p^wa] ‘look!’

As indicated by (11c), while both English and Korean exhibit labiality for various places of articulation, only Korean regularly has palatals with labialization.

Finally, Korean may have labials with labialization, but in many cases as the result of the contraction of forms, as in (12a), or in the context of a syllable-final labial followed by /w/-initial syllable, as in (12b). However, unlike the words in (10), these derived forms are more often subject to delabialization. I will discuss this issue in detail in section 4.1.4.

- (12) a. [p^wa] < po-a
 b. [kam^wən] < /kam+/wən/ ‘reducing the number of employees’

To sum up, labialization in Korean co-occurs with labial, alveolar, palatal, and velar consonants, and with all vowels excepting back round

² One reviewer points out that not only these two cases, but also examples of impossible sequences, *[kwø] and *[wø], exist. This issue is discussed in section 4.2.

vowels. In addition, there is an optional process of delabialization, but more likely with labials. Finally, Korean does not allow /w/ followed by back round vowels.

2.3 Nuuchahnulth

Nuuchahnulth, a Wakashan language spoken along the west coast of Vancouver Island in Canada, also has distinct labialization. Unlike Korean and English, it has a phonologically labialized series of consonants, as seen in (13-15).

- (13) a. /k^wa/ ‘moving backwards’
 b. /ka/ ‘to pinch’
- (14) a. /k^wits/ ‘to scratch away dirt’
 b. /kits/ ‘to dive under water’
- (15) a. /q^waḥ/ ‘red clay or red-colored paint’
 b. /qaḥ/ ‘to die’

(from Stonham 2005)

These examples show that, in the language, labiality plays an important role in forming distinct, contrasting phonemes. However, notice that in (13-15), labialized consonants appear only before /a/ or /i/. The language has only 3 vowels, /i, a, u/, with a vocal length distinction, and any non-labialized consonant can appear before any of these vowels. There are, however, no cases of words where a labialized consonant, C^w, precedes /u/. Hence, if a morpheme ending with a labialized consonant is followed by a suffix beginning with /u/, it becomes plain as shown in (16) (see Kim 2003, Stonham and Kim 2008 for phonetic differences between [k^w] and [ku] and also Barrie 2003 for a case of a language, Cantonese, where [k^wu] and [ku] are contrastive).

- (16) a. /hawik^w-uk/ → [hawikuk] (*hawik^wuk)
 b. /ts^wuq^w-umɬ/ → [ts^wuqumɬ] (*ts^wuq^wumɬ)

(from Kim 2003)

Compared to English and Korean, this kind of delabialization is strictly phonologically-based and automatic.

Another property of labialization in Nuuchahnulth is that it allows the /wu/ sequence, unlike Korean, although there are not many examples, as is also the case for English.

- (17) a. /ts^waawumɬ/ ‘one left’
 b. /nawuqumɬ/ ‘tardy’

- c. /tʰaawuɫʃitʰ/ 'got close'
 d. /tʰawubaj/ 'Tlawubay (place name)'

Finally, while English and Korean make use of labialization at various places of articulation, Nuuchahnulth has a more restricted place distribution. That is, labialization co-occurs only with dorsal consonants, velar and uvular, including /k, q, x, χ/. (13-15) illustrate velar and uvular stops, and (18a-b) provide examples of labialized velar and uvular fricatives, respectively.

- (18) a. /x^wakak/ 'swollen'
 b. /ʃuχ^wak/ 'rusty'

To sum up, Nuuchahnulth has contrastive labialized consonants at only the velar and uvular places of articulation, as well as a /wu/ sequence. In addition, the language has an obligatory process of delabialization which may neutralize the contrast between plain and labial consonants in the appropriate context.

In sum, we have examined three typologically different and unrelated languages with respect to labialization. They have both shared and contrasting properties. I will discuss the implications of these characteristics in section 4. Before doing so, in support of my phonological arguments and to provide additional information of labialized consonants, I supply some phonetic insights into labialized consonants in each language.

3. The phonetic aspects of labialization

Crosslinguistically, many languages employ lip rounding as a secondary articulation. Typically when lip rounding occurs, a raising of the back of the tongue accompanies it (Ladefoged and Maddieson 1996: 356). Acoustically, labial consonants show the effect of a lower second formant transition in adjoining vowels and when consonants are labialized, the second formant of adjacent vowels is even lower (ibid: 357f).

I examine here the general phonetic properties of labialization in each of the three languages mentioned above, comparing them to the fundamental characteristics of labialization observed crosslinguistically. I will not provide a detailed phonetic examination of each individual language, since the purpose of this study is to introduce the crosslinguistically common phonetic properties of labialization, and not to provide a comprehensive study of the phonetic properties of three unrelated languages (see Ladefoged and Maddieson 1996 for the general phonetic properties of labialized sounds, Suh 2007 for Spanish and Korean, and Kim 2003 and Stonham and Kim 2008 for Nuuchahnulth).

First, English, Nuuchahnulth, and Korean all have /w/ in their sound inventories, but only English and Nuuchahnulth have a tautosyllabic /wu/ sequence. To illustrate the phonetic aspects of the sounds under investigation, I provide evidence from one female speaker for each language. Consider the following examples and their corresponding spectrograms in Figures 1 and 2.

(19) English: wood [wʊd]

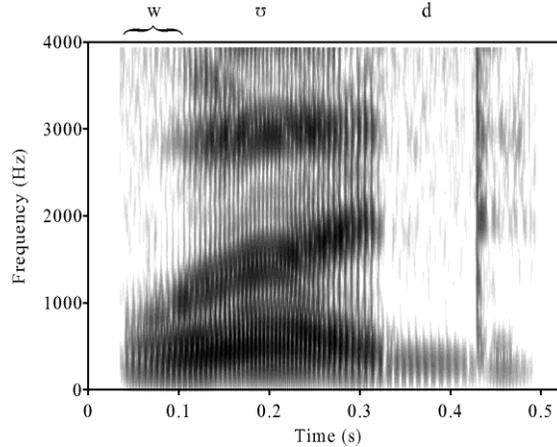


Figure 1. Spectrogram of English *wood* [wʊd]

(20) Nuuchahnulth: [tʰa:wuʃitʰ] ‘got close’

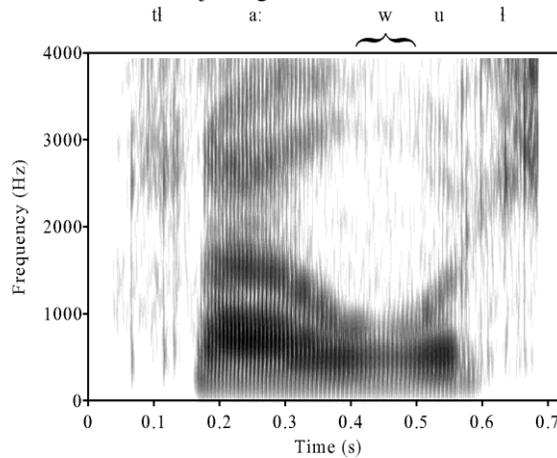


Figure 2. Spectrogram of Nuuchahnulth [tʰa:wuʃitʰ]

In both Figures 1 and 2, the transition of the second formant between /w/ and the following vowel /u/, which is typically observed in a glide and

vowel sequence crosslinguistically, is clearly observable. In English *wood* [wud], the second formant for /w/ starts at about 300ms and 900 Hz, rising into the following vowel /u/ at 1500Hz. In Nuuchahnulth [tʰa:wuʃitʰ] ‘got close,’ the second formant for /w/ starts at about 400ms and 900 Hz, and rises into the following vowel /u/ at 1100 Hz. Interestingly, the glide causes lowering of the second formant of the preceding vowel /a:/ at about 300ms.

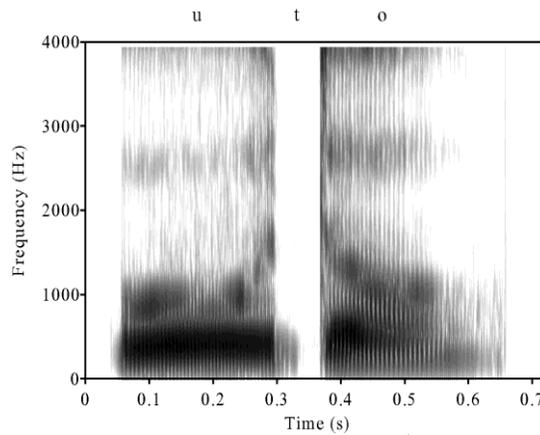


Figure 3. Spectrogram of Korean 우도 [uto]

Compared to these two languages, the initial phase of the spectrogram in the Korean word 우도 [uto] ‘name of an island,’ as seen in Figure 3 demonstrates that it clearly starts with /u/, without the accompanying aspect of transition exhibited by the cases of English and Nuuchahnulth in Figures 1 and 2.

Figures. 4-6 provide spectrograms of a labialized velar from English, Nuuchahnulth, and Korean, respectively, corresponding to the examples in (21-23).

(21) English: queen [k^win]

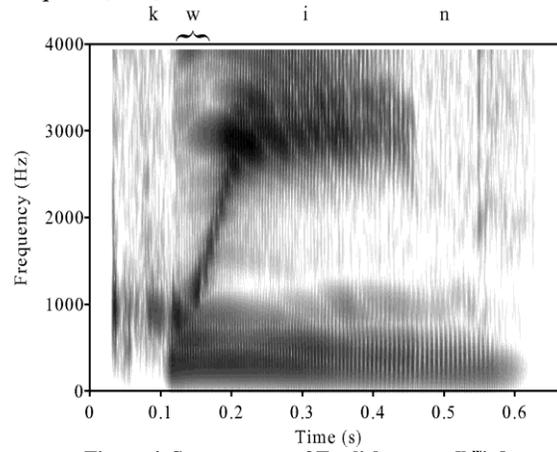


Figure 4. Spectrogram of English *queen* [k^win]

(22) Nuuchahnulth: [ʔuʔu:quk^wija] 'at the time of good weather'

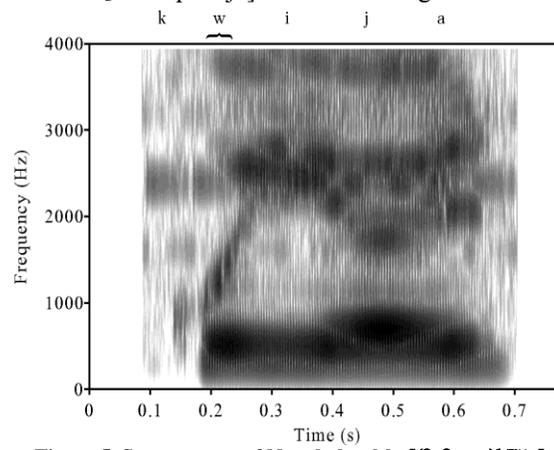
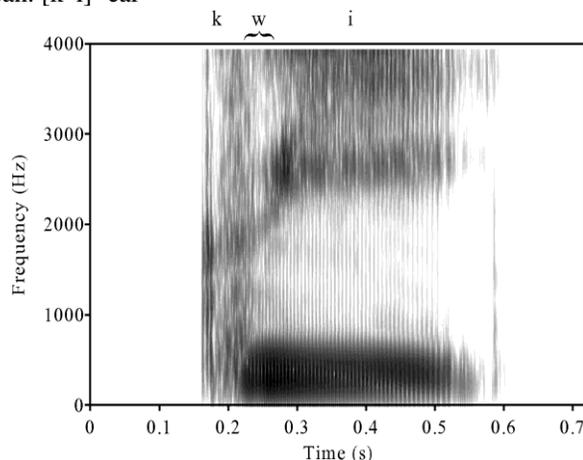


Figure 5. Spectrogram of Nuuchahnulth [(ʔuʔu:qu)k^wija]

(23) Korean: [k^wi] ‘ear’Figure. 6 Spectrogram of Korean [k^wi]

While the locus of the stop burst in Korean is a little higher than that in English or Nuuchahnulth, the initial part of the second formant of each /i/ is consistently lowered by the previous labial aspect (see Dorman et al. 1977, Kent and Read 2002, Ladefoged 2003, and Zue 1976 for discussion of the properties of stop bursts). Also note that, compared to the primary labiality of /w/, whose duration ranges from 70ms to 150ms from the onset of /w/ to the vowel transition, as will be seen shortly, the secondary labiality exhibits shorter duration, ranging from 40ms to 50ms from the onset of secondary labiality to the vowel transition. In addition, the merger of [k] and [w] affects the acoustic property of [k] as well. The aspiration associated with the release of [k] exhibits, due to features of the labiality, stronger acoustic energy through all the frequencies, which is not shown with the [kw] sequence below (See Ladefoged 2003).

Finally, we will examine the acoustic aspects of the [kw] sequence. Given that labiality as a primary articulation has a greater duration than labialization as a secondary articulation, we should expect that the [kw] sequence and [k^w] exhibit differences with respect to their spectrographic profiles. Consider the following examples and spectrograms.

(24) English: [pɪkwɪkɪən] ‘Pickwickian’

(25) Nuuchahnulth: [takwi:ʔa] ‘going first’

(26) Korean: [kakwi] ‘each position, ladies and gentlemen’

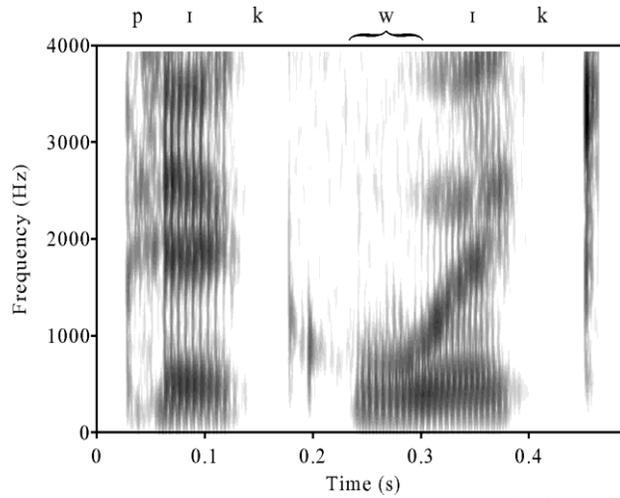


Figure 7. Spectrogram of English *Pickwick(ian)* [pɪkwɪkɪən]

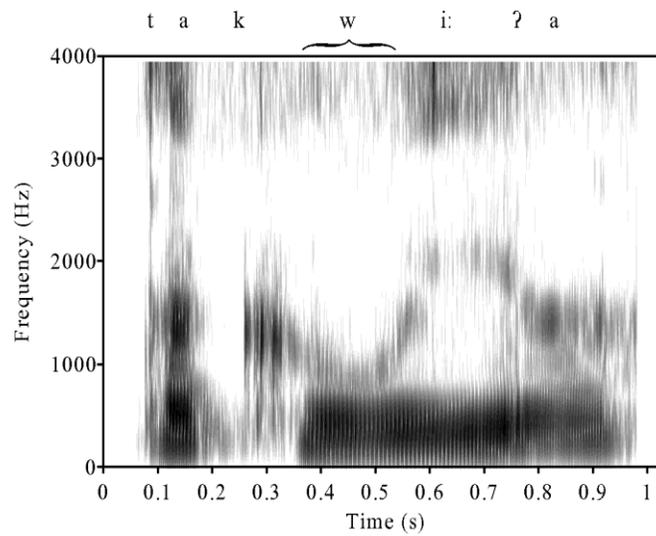


Figure 8. Spectrogram of Nuuchahnulth [takwi:ʔa]

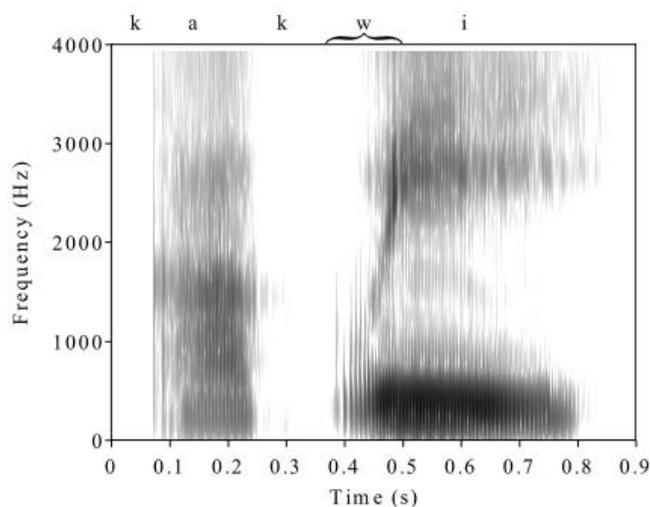


Figure 9. Spectrogram of Korean [kakwi]

In Figures 7-9, each of the [kw] sequence clearly shows different acoustic aspects. First, the duration of the /w/ is greater than the labiality of the labialized consonant, [k^w], as shown in (27).

(27) Comparison of duration of [w] and labiality on [k^w]

	English	Nuuchahnulth	Korean
[w]	70ms	150ms	100ms
[^w]	50ms	50ms	40ms

English has about 70ms (50ms for the labial phase of a labialized velar), Nuuchahnulth has 150ms (50ms for a labialized velar), and Korean has 100ms (40ms for a labialized velar). Although the three languages show different duration of the labiality, their length relation with the labialized velar is consistent: the labiality on labialized consonants has a significantly shorter duration than [w] itself.

Second, notice that the [kw] sequence exhibits weaker noise at higher frequencies. This is due to both the acoustic and the phonological facts that while a labialized stop, occupying a syllable-initial position (onset), releases a strong burst as aspiration, the [k] from the [kw] sequence, occupying a syllable-final position (coda), fails to release a stop burst or has a release with very weak energy. This is reflected in each spectrogram as a weak release of energy at higher frequencies, as in Figures 7-8, or no energy, as in Figure 9.

These two phonetic aspects can provide a clue when we determine whether labiality shown on a spectrogram is primary or secondary for languages that employ both forms of labiality.

On the other hand, Korean /kakwi/ has an alternative articulation. Figure 9 is a spectrogram where the word is pronounced carefully at natural speed. The two segments, [k] and [w], belong to different syllables: [k] to the coda of the first syllable and [w] to the onset of the second syllable. However, in casual speech, Korean coda consonants may occupy the onset of the following syllable, if it does not start with a full consonant (cf. Kim, Seo, and Stonham 2008). The /k/ from /kakwi/ occupies the onset of the following syllable, producing [kak^wi] with the duration of 40ms (cf. Figure 9), as shown in Figure 10.

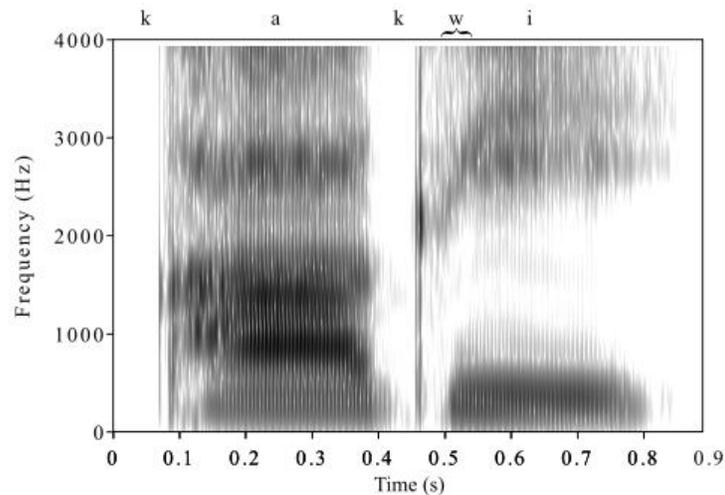


Figure 10. Spectrogram of Korean [kak^wi]

So far, we have examined the phonetic characteristics of labialization. In the following section, I will discuss how understanding both the phonological and phonetic properties of labialization can enhance our knowledge of both theory and practice.

4. Discussion

We have examined the phonological and phonetic characteristics of labialization in English, Korean, and Nuuchahnulth. In this section, I will discuss the significance of this study. All the aspects I have investigated regarding labialization are closely related to theory and pedagogy, as well as to typology.

4.1. Typological implications

4.1.1 Absence of /C^wu/ sequence

All three of the languages under investigation exhibit a gap in the inventory of C^w sequences, i.e. they have no [C^wu] sequence. The question is: why not? This can be explained in terms of phonetic principles and reflected in typological facts. According to Ohala and Kawasaki-Fukumori (1997), some sound sequences are disfavored because they are difficult to articulate. In particular, labialized consonants are disfavored before back, rounded vowels such as /u, o/, since the first segment of the sequence has labiality or rounding as a secondary aspect, /C^w/, and the following vowel, /u/, is also a round segment. Such sequences of the same phonetic value make articulation difficult and this articulatory property marks this kind of sequence as a marked phenomenon universally (cf. Leben 1973, 1978 and Goldsmith 1976 on OCP effects). Hence, the three languages under discussion are representative of the more typologically unmarked cases in the context of /C^wu/.

If a language has labialized consonants and they are in the context of a following round vowel, then labialization on the consonant is typically deleted. Nuuchahnulth exhibits this phenomenon, which will be discussed in more detail later. As a further example, in Chehalis, a Salish language of the American Northwest, labialized velars and uvulars become plain before /o/ or /u/ (Ohala and Kawasaki-Fukumori 1997).

4.1.2 /wu/ sequence

As mentioned above, crosslinguistically, certain sequences of speech sounds are dispreferred when syllables and words are formed. Phonotactic conditions applying within a language show that some sequences are not allowed, while others are very frequent.

Ohala and Kawasaki-Fukumori (1997) mention that /w/ is very rare before back, rounded vowels. We can interpret this typological property based on phonetic principles. That is, it is not easy to repeat the same gesture of articulators sequentially. Therefore, we can find more cases of /wi/ and /we/ than /wu/ crosslinguistically. Both English and Nuuchahnulth have the sequence [wu], placing them in the domain of the very rare cases. The case of Korean is representative of the more typologically common case.

4.1.3 The distribution of labialization

With respect to the places of articulation amenable to labialization, the three languages show significant differences. First, while Nuuchahnulth has labialization only in the position of dorsals such as velars and uvulars, English and Korean have more varied positions with labialization, as

shown in (7) and (11), respectively. Crosslinguistically, labialization co-occurs more often with velars and uvulars. Ohala and Kawasaki-Fukumori (1997) mention that among 40 languages they surveyed with labialization, while only 3 languages had labialized labials and 2 languages had labialized alveolars and palatals, 35 languages had only labialized velars and uvulars, i.e. dorsals.

Although Nuuchahnulth has only dorsal labialization, it is the most unmarked position, and therefore confirms the typological expectations. Furthermore, given that both Korean and English have alveolar labialization, it is expected that they should also have dorsal labialization. This is one case of implicational laws governing language universals.

On the other hand, there is one difference in the latter two languages: only Korean has labialized palatals.

- (28) a. [tʰ^wi] ‘rat’
 b. [tʰ^wi](əp) ‘getting (a job)’

Therefore, Korean is a language where labialization is used more extensively than English.

Finally, notice that both English and Korean have labials with labialization marginally, as shown in (29) and (30), repeated from (7c-e) and (12), respectively.

- (29) a. Bwana [b^wʌnə]
 b. moire [m^wɑr]
 c. pueblo [p^wɛblou]
- (30) a. [p^wa] < po-a
 b. [kam^wən] < /kam/+/wən/ ‘reducing the number of employees’

As mentioned above, the only examples of this type in English are loan words, and the Korean cases are from contracted forms or syllable contact. That is, both languages have restricted use of labialization with respect to some positions of articulation. Crosslinguistically this sequence is not common. Ohala & Kawasaki-Fukumori (1997) note that secondary labialization is disfavored on labials (see also Maddieson 1984). Moreover, with a CC sequence, if the first C is a labial, then /w/ is not common as a second C. Therefore, these two languages provide instances of rare types of labialization.

4.1.4 Delabialization

We have noted that languages disprefer sharing the same phonetic property in terms of place of articulation, as in the cases of labials with labialization. Linguists have also noticed that when acoustically similar sounds are

adjacent, they are subject to confusion both acoustically and auditorily, which leads to merger of the two sounds or deletion of one of them. In addition, this phonetic consequence is associated with phonemic inventories crosslinguistically (Maddieson 1984, and Ladefoged and Maddieson 1996). In this section, I will discuss the case of delabialization as repair.

The three languages under discussion all exhibit delabialization, where a labialized segment loses its labiality in certain contexts, but in quite different ways.

First, delabialization in Korean is across-the-board and optional; i.e., it occurs in virtually any context. As seen below, repeated from (10), labialized velars, as well as labialized labials as in (12), become plain. This happens when the sequence is articulated in casual speech. The optionality of delabialization in Korean means that the process is not motivated phonologically.

- (31) a. [k^watʃa]~[katʃa] ‘biscuit’
 b. [k^waŋtʃu]~[kaŋtʃu] ‘name of a city’
 c. [k^wentʃ^hana]~[kentʃ^hana] ‘all right’
 d. [k^wijəun]~[kijəun] ‘cute’
 e. [k^wə]~[kə] ‘bake!’

On the other hand, in English, delabialization occurs due to historical change, as suggested in section 2.1. The following words, repeated from (6), originally have labiality on the consonants, but over time, labiality on different reflexes of the same historical root disappears, leading to the current pronunciations. In such cases, the form without [w] is typically followed by a round back vowel such as [u/ʊ] or [o/ɔ]. That is, if /w/ is followed by a round back vowel, it is deleted, while if it is followed by vowels other than a round vowel, it is maintained as shown in (32).

- (32) a. two /tu/ - twin /twin/ - twelve /twelv/
 b. sword /sɔɪd/ cf. swear /swɛɪ/
 c. choir /kwaɪ/ - choral /kɔɪəl/

Wright and Wright (1923) discuss the process of delabialization in Middle English, providing examples that show the instability of /w/ before back, round vowels.

Postconsonantal w disappeared before back-round vowels, as alsō, ase (OE. ealswā), sō (OE. swā), soche such beside swich (OE. swylc), sord beside sword, sōte beside swōte sweet adv., tō beside twō (OE. twā), pong beside p̄wong, hō beside whō (OE. hwā). (Wright & Wright 1923:108)

In Nuuchahnulth, delabialization is also phonologically motivated, as in English. Interestingly, while the process is no longer productive in English, it is still active in Nuuchahnulth, attesting to its validity as a synchronic process. When a morpheme ending with a labialized velar precedes an /u/, it becomes a plain velar as shown in (33), repeated from (16).

- (33) a. /hawik^w-uk/ → [hawikuk] (*hawik^wuk)
 b. /ts'uq^w-umɬ/ → [ts'uqumɬ] (*ts'uq^wumɬ)

In sum, English has labialization at various places of articulation, along with a [wu] sequence. Nuuchahnulth has labialization on only the typologically unmarked place of articulation, and also the [wu] sequence. Korean has labialization on the most varied range of places of articulation, but without the [wu] sequence. None of the three languages have the [C^wu] sequence. In addition, all three languages have a process of delabialization, but their underlying motivations are different: for English, diachronic and obligatory, for Nuuchahnulth, synchronic and obligatory, and for Korean, synchronic and optional.

These languages have both common and distinct properties with respect to labialization. For the common properties, they follow the expected typological tendency, e.g. none of these languages have */k^wu/. With respect to the different properties, they exhibit markedness effects and implicational dependencies, e.g. English and Nuuchahnulth have /wu/ sequence but Korean doesn't, and Korean and English have labialized coronals as well as dorsals but Nuuchahnulth has only labialized dorsals. Whether common or distinct, all the properties are typologically consistent and these languages provide numerous additional examples of each property.

4.2 Theoretical implications

We note that many typological characteristics are grounded in phonetic principles. When theories are developed, they depend on typology. In turn, typological differences are explained by referring to phonetic or cognitive principles. Optimality Theory, which constitutes a major theory in phonology, employs universal constraints as one of its fundamental tools to explain how and why languages are similar or different.³ Given the importance of constraints to explain language facts, the use of proper (universal) constraints is a fundamental prerequisite. To fulfill this purpose, linguists try to employ constraints that are motivated phonetically and/or by cognitive generalizations.

The facts we have observed from the three languages discussed here can be used to determine and/or support universal constraints, if they fit into the characteristics observed crosslinguistically. As I have discussed

³ See McCarthy 2002 for the basic ideas of Optimality Theory.

throughout the paper, we have found that the common or different properties of these languages are due to universal, phonetic principles.

I illustrate some constraints below which reflect the phonetic properties of labialization, showing how these phonetic properties can be phonologized with respect to the distribution of labialization. What we need to be able to specify is the difference between a primary labiality realized as /w/ and a secondary labiality realized on another primary consonant, such as /C^w/. We may distinguish them by employing C-place and V-place to account for place of articulation (see Clements 1985, 1991, Clements and Hume 1995, Halle 1995, Halle, Vaux and Wolfe 2000, and Moren 2003 for relevant issues). As seen in section 3, phonetic differences between these two types of segments regarding labiality should provide basic criteria to define phonological differences of such segments.

Consequently, in English and Nuuchahnulth, the /wu/ sequence is allowed, while /C^wu/ is not allowed. In order to account for this kind of asymmetry, different kinds of constraints should be employed, as suggested in (34-36): here, association of a V-Place[Labial] with a consonant suggests a secondary articulation and association of a C-Place[Labial] with a consonant suggests a primary articulation.

(34) Constraint against /C^wu/

*V-Place V-Place: Adjacent V-Place (Lab) features are banned

| |
[Labial] [Labial]

(35) Constraint against the /wu/ sequence

*C-Place V-Place: Adjacent C-Place (Lab) and V-Place (Lab) features is banned.

| |
[Labial] [Labial]

(36) Constraint against co-occurrence of features and their relative ranking

*[Labial, Round] >> *[Coronal, Round] >> *[Dorsal, Round]

These constraints straightforwardly explain the synchronic properties discussed so far: (34) for the discussion in 4.1.1 and 4.1.4, (35) for the discussion in 4.1.2 and (36) for the discussion in 4.1.3. (Since it is not the focus of this paper, I will not provide more detailed OT account of these facts.)

The constraint in (34) disallows two adjacent V-Place-with-[Labial] features. Hence all three languages rank this constraint higher with respect to a MAXIO constraint, which guarantees a direct correspondence between the input and the output, disallowing the presence of /C^wu/, as illustrated in (37).

(37) *V-Place V-Place >> MAXIO

In section 4.1.4, I discussed the process of delabialization. This phenomenon can be treated by means of (37) as well. If the constraint is highly ranked in a language, an underlying /C^w/ followed by /u/ would not be allowed in the output, as in Nuuchahnulth.

The constraint in (35) disallows the /wu/ sequence. Therefore, for languages allowing such sequences such as English and Nuuchahnulth, its ranking with respect to a MAXIO constraint would be as in (38) and for languages disallowing such a sequence, such as Korean, its ranking would be (39).

(38) MAXIO >> *C-Place V-Place

(39) *C-Place V-Place >> MAXIO

Finally, as mentioned above, secondary labialization on labials is disfavored crosslinguistically. This typological property can be treated in Optimality Theory, using constraints such as in (36) together with their associated relative ranking. Therefore, for languages disallowing labialized labials but allowing labialization on other places, the ranking in (36) will work. However, for languages with the opposite facts, which are unattested, the ranking would be opposite.

In sum, constraints should be natural and phonetically plausible, reflecting universal properties of human language. In addition, they should be able to explain why specific structures do not exist or are rare.

4.3 Pedagogical implications

The phonetic and phonological properties of labialization are significant for a better understanding of human language. Furthermore, such linguistic knowledge can be applied to pedagogy. In terms of pedagogy, I will discuss two issues here: teaching English and compiling English dictionaries.

First, with respect to teaching English, we can clarify for Korean learners of English why superficially similar sounds in English and Korean are subject to different conditions. Students need to be aware of the different co-occurrence restrictions in the two languages. For example, Korean students pronounce English words *woos* and *ooze* in a similar fashion. However, as mentioned above, they are words with different initial sounds and different meanings. Given that Korean does not have the /wu/ sequence, speakers may have difficulty in both producing and perceiving it. In addition, optional delabialization in Korean is a significant contributing factor to the difficulties of Korean learners of English dealing with non-optional English labialized consonants. An awareness of these

sometimes subtle differences between the two languages will help learners avoid mistakes. Furthermore, Seo, Kim, and Stonham (2009) has shown that Korean learners of English demonstrate a clear difference in the perception of /k^w/ vs. /t^w/ and /s^w/. This tells us that learners have different recognition capabilities for each labialized consonant, which native English speakers do not appreciate. (cf. Cho, Park and Lee 2001). In the context of teaching English, teachers should ensure that learners understand how and why each sound sequence is different and that they acquire the ability to produce and perceive these differences.

Second, with respect to compiling English dictionaries, most Korean dictionaries of English provide phonological or broad phonetic transcription of each word. In many cases, users of such dictionaries can be confused about the pronunciation of the contrasts discussed in this paper. For example, the words we deal with in this study, e.g. *queen* and *Pickwickian* as repeated in (40), and the further examples in (41), are transcribed in the same way in most dictionaries.

- (40) a. queen [kw̥in]
b. Pickwickian [pikw̥ikiən]

- (41) a. Beckwith [bɛkw̥iθ]
b. bequeath [biqw̥iə]

As I discussed in section 3, although the phonetic aspects of each underlined part are different, they are transcribed equally as /kw/. Without an understanding of the phonetic characteristics of such a sequence, this kind of information may lead students to misinterpret the facts of English pronunciation. Hence, when dictionaries are compiled, although a detailed phonetic exposition cannot be included, special notes of this kind of information should be provided in the form of indications of syllable boundaries (e.g. using a dot) and labialization as well as position of stress. For instance, (40a) could be represented as [k^w.in] and (40b) as [pik.wikiən]; (41a) could be represented as [bɛk.wiθ] and (41b) as [bi.k^wiə] etc.

5. Conclusion

Labialization is, crosslinguistically, the most common secondary consonant articulation. Some phonological characteristics of labialization found in English, Nuuchahnulth, and Korean are representative of the typologically unmarked cases but others are representative of the more marked cases. If we understand the phonetic mechanisms of labialization, we should be able to better understand why some aspects are more common and others are rare. By investigating both phonological and phonetic properties of

specific languages with respect to labialization, this paper provides insights into typological, theoretical, and pedagogical implications of language.

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Eun-Sook Kim
Department of English Language and Literature
Hannam University
133, Ojeong-dong, Daedeok-gu, Daejeon
306-791 Republic of Korea
e-mail: abbakim1@yahoo.co.kr

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