# Delabialisation in Nuu-chah-nulth*

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In Nuu-chah-nulth, labio-velar and labio-uvular consonants are delabialised when they precede a consonant or /u/, or when they are positioned word-finally. In this paper, I investigate the characteristics of Nuu-chah-nulth delabialisation and provide a possible treatment of problems raised by the data within Optimality Theory.

## 1 Introduction

As seen in (1), consonants show extensive contrasts in place of articulation in Nuu-chah-nulth, which is one of the typical phonological properties of indigenous languages spoken on the northwest coast of North America (Sapir 1938, Maddieson 1984). Interestingly, labio-velar and labio-uvular consonants (indicated as bold) show alternation in terms of labiality. In this paper, I examine both phonetic and phonological characteristics of the phenomenon and show how to treat the problems raised by the data. I adopt Optimality Theory (henceforth OT, Prince & Smolensky 1993, McCarthy & Prince 1993, et seq.).

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(1) The phonemic consonant inventory of Nuu-chah-nulth ([nuučaaʔnuɬ])

| Place / Manner | Labial | Alveolar | Alveo-palatal | Velar | Labio-velar | Uvular | Labio-uvular | Pharyn-geal | Glottal |
|---|---|---|---|---|---|---|---|---|---|
| Stops | p | t | | k | $k^w$ | q | $q^w$ | | |
| Glottalised | p̓ | t̓ | | k̓ | $k̓^w$ | | | ʕ | ʔ |
| Affricates | | c[ts]<br>ƛ[tɬ] | č[tʃ] | | | | | | |
| Glottalised | | c̓[ts']<br>ƛ̓[tɬ'] | č̓<br>[tʃ'] | | | | | | |
| Fricatives | | s<br>ɬ[ɬ] | š[ʃ] | x | $x^w$ | x̣[χ] | $x̣^w[χ^w]$ | ḥ<br>[ħ] | h |
| Sonorants | m | n | y [j] | | w | | | | |
| Glottalised | m̓ | n̓ | y̓ [j'] | | ẘ | | | | |

## 2 Data

I provide relevant data according to the contexts where delabialisation is observed.

### 2.1 Delabialisation before a consonant or word-finally

When labio-velars or –uvulars, /$x^w$, $k^w$, $x̣^w$, $q^w$/, precede a consonant as in (2a-d), or are word-finally as in (2e), they lose labiality. Note that when preceding a vowel except /u/, they maintain their labiality on the surface as seen in each compared forms.

(2) The absence of labiality before a consonant or word-finally

a. cap/$x̣^w$/-saap → cap[x]saap
to boil-MOM.CAUS 'to boil'

cf. cap/$x̣^w$/-atuk → cap[$x̣^w$]atuk
to boil-sound 'boiling noise

b. ci/$x^w$/-čuu → ci[x]čuu
to fry-in a state of 'fried'

cf. ci/$x^w$/-aa → ci[$x^w$]aa
to fry-DUR 'frying'

c. c̓u/qʷ/-šiƛ̓ → c̓u[q]šiƛ̓
to stab-MOM 'to stab'

cf. c̓u/qʷ/-aa → c̓u[qʷ]aa
to stab-DUR 'stabbing'

d. ḥii/kʷ/-ḥiikʷ-(y)a → ḥii[k]ḥiikʷa
RED-to wind-CONT 'winding, curved'

cf. ḥiikʷ-ḥii/kʷ/-a → ḥiikḥii[kʷ]a
RED-to wind-CONT 'winding, curved'

e. nuu/kʷ/ → nuu[k]
song 'song'

cf. nuu/kʷ/-iiɬ → nuu[kʷ]iiɬ
song-to make 'to make a song'

## 2.2 Delabialisation before /u/

There is another context in Nuu-chah-nulth where the labial property is deleted. Labio-velar and -uvular consonants become delabialised when preceding a [+Round] vowel, /u/. (Also see Sapir & Swadesh 1939 and Stonham 1999). The following examples illustrate the process:

(3) a. c̓a/xʷ/-uuɬ → c̓a[x]uuɬ
to stab/spear-face 'wrinkles'

cf. c̓a[xʷ]iɬ 'to stab s.t. to the floor'

b. hawi/kʷ/-uk → hawi[k]uk
to eat-doer 'a big eater'

cf. haʔu[kʷ]iɬʔiš 's.o. eats s.t. inside'

c. c̓u/qʷ/-umɬ → c̓u[q]umɬ
to pierce-round 'to pierce some round stuff like a drum'

cf. c̓u[qʷ]iɬ 'to be pierced into the floor'

Interestingly, in other Wakashan languages such as Ditidaht (Klokeid 1977) and Makah (Jacobsen 1969), labiovelars are consistently round both word-finally and before /u/. According to Klokeid (1977), in a variety of Ditidaht, a vowel assimilates in rounding to a preceding labial consonant.

In Ahousaht Nuu-chah-nulth, on the other hand, a preceding /u/ does not affect roundness of a labio-velar or –uvular as shown in (4).

(4) a. haʔu/kʷ/-iɬ-ʔiš → haʔu[kʷ]iɬʔiš (*haʔukiɬʔiš)
to eat-inside-3sg/IND 'S/he eats inside (the house)'

b. tu/xʷ/-iɬ → tu[xʷ]iɬ (*tuxiɬ)
to jump-on the floor 'jumping to the floor'

The following data show that the process of delabialisation is very pervasive. Also, note that native speakers apply glottalisation to the final stop of novel loan words before a glottalising suffix as well, as in (5b) and (6b).[1] In (5), we see that the labial property is maintained before a non-round vowel, whereas in (6), the labial property is lost before a round vowel.

(5) Labials before a non-round vowel
a. ku/kʷ/a-ap-(m)it-siš → ku[kʷ]aʔapitsiš (*kukaʔapitsiš)
Korean bread-to buy-PAST-1sg/IND 'I bought Korean bread (one kind)'

b. ɬu/xʷ/ap-ap-(m)it-siš → ɬu[xʷ]aṗapitsiš (*ɬuxaṗapitsiš)
Korean apple-to buy-PAST-1sg/IND 'I bought Korean apples (one kind)'

(6) Labials before a round vowel
a. ka/kʷ/u-ap-(m)it-siš → ka[k]uʔapitsiš (*kakʷuʔapitsiš)
Korean bread-to buy-PAST-1sg/IND 'I bought Korean bread (another kind)'

b. ɬa/xʷ/up-ap-(m)it-siš → ɬa[x]uṗapitsiš (*ɬaxʷuṗapitsiš)
Korean apple-to buy-PAST-1sg/IND 'I bought Korean apples (another kind)'

The unique properties of Nuu-chah-nulth delabialisation are summarised as follows: i) the trigger is a round vowel, /u/, which is the only round vowel in Nuu-chah-nulth, ii) the targets are labio-velar and labio-uvular consonants, and iii) there is a directional restriction: only a following, and not a preceding, one causes delabialisation.

## 3 Analysis

I propose that for the cases where a labio-velar or -uvular consonant becomes delabialised before a consonant and word-finally, the distributional restriction can be dealt with by the following constraints, (7a-b), and their language-specific ranking, (8).

[1] These are nonsense words designed to test if delabialisation is applied to loan words, too.

(7) a. NoRoundCoda: No [+Round] consonant is in coda.[2]

b. MAX[+Round]: [+Round] in the input must have a correspondent in the output.

(8) Ranking: NoRoundCoda
⇩
MAX[+Round]

A relevant example is illustrated in (9), and the effect of the ranking given in (8) is shown in tableau (10)

(9) cap/x̱ʷ/-saap ➔ cap[x̱]saap
to boil-MOM.CAUS 'to boil'

(10) Tableau

| /capx̱ʷ-saap/ [+R] | NoRoundCoda | MAX[+Round] |
|---|---|---|
| ☞ a. capx̱.saap | | * |
| b. capx̱ʷ.saap [+R] | *! | |

As seen in the tableau, the deletion of underlying labiality is due to the constraint NoRoundCoda, which disallows a labial consonant in a coda, outranking MAX[+Round], which requires an underlying [+Round] to appear on the surface. Candidate b is ruled out by fatally violating NoRoundCoda, although it obeys MAX[+Round] by maintaining the phonological element in question on the surface.

For the cases where labio-velars or –uvulars are delabialised before /u/, I argue that delabialisation occurs in order to avoid the clash of [+Round] ([+R]) features, which are immediately adjacent. There might be more than one way to resolve the feature clash cross-linguistically such as deletion of one of the feature occurrences, insertion of another segment, and so on.

Nuu-chah-nulth implements deletion to avoid the feature clash. There are two ways to delete the [+Round] feature: deleting [+Round] linked to either a consonant or a vowel. Considering the feature values of the vowels in (11), if

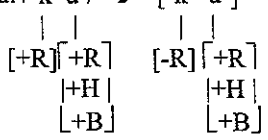
[2] It seems that it is a general property of Nuu-chah-nulth to disallow marked features such as [+C.G.] (all glottal consonants), [-Cons] (glides), and [+Round] (labio-velar and labio-uvular consonants) in coda. Therefore, we might need a general coda condition such as NoMarkedCoda. However, I simply make use of (7a) for the problem under discussion. Thanks to Joe Stemberger for this point.

[+Round] of a consonant is deleted, then (12a) will surface; if [+Round] of a vowel is deleted, then (12b) will surface. I indicate the relevant features only in (12). Note that /u/ is the only [+Round] high vowel in Nuu-chah-nulth, and thus if the feature value is lost, the only remaining feature is its height feature [+High], which would make it indistinguishable from the front vowel /i/.

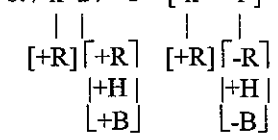
(11) Feature values of Nuu-chah-nulth vowels (cf. Chomsky & Halle 1968)

| | /i/ | /u/ | /a/ | /e/ | /o/ |
|---|---|---|---|---|---|
| H(IGH) | + | + | - | - | - |
| L(OW) | - | - | + | - | - |
| B(ACK) | - | (+) | + | - | (+) |
| R(OUND) | - | + | - | - | + |

(12) a. /-k$^{w}$u-/ ➔ [-k u-]



b. /-k$^{w}$u-/ ➔ [-k$^{w}$ i-]



As we will see below, Nuu-chah-nulth does not allow any change in backness. That is, maintaining input backness of a segment is more significant than maintaining input roundness of a segment. This is guaranteed by the interaction of the faithfulness constraints (13-14), and two markedness constraints NoMulipleLink (15) and OCP$_{\sigma}$[+Round] (16) (OCP is subject to syllable structure for this case), and their language-specific ranking in (17). MAX constraints require the input feature in question, either [+Back] or [+Round], to appear on the surface. MAXPATH[+Round] disallows the input path between a feature in question and its anchor to be deleted. NoMultipleLink prevents a single feature from associating to two anchors. Another aspect of delabialisation in Nuu-chah-nulth is that the trigger must follow, not precede, the target. OCP$_{\sigma}$[+Round] drives this directional restriction.

(13) a. MAX[+Back]: [+Back] in the input must have a correspondent in the output.

b. MAX[+Round]: [+Round] in the input must have a correspondent in the output.

(14) MAXPATH[+Round]: Any input path between [+Round] and an anchor must have a correspondent path in the output.

(15) NoMultipleLink[+Round] (NML[+Round]): No coalescence of a single [+Round] to two anchors is allowed.

(16) $OCP_{\sigma}$[+Round]: Adjacent [+Round] features within a syllable are banned.

(17) Ranking: $OCP_{\sigma}$[+Round], MAX[+Round], NML[+Round]
⇩
MAX[+Round], MAXPATH[+Round]

The following tableaux, (19) and (21), with the relevant examples (18) and (20) respectively, demonstrate the interaction of the constraints and their necessary ranking.

(18) ya/$x^{w}$/-umɬ → ya[x]umɬ (cf. ya[$x^{w}$]iɬ'to brush s.t. on a bed')
to brush-round/surface 'to brush off (e.g. sweater)'

(19) Tableau

| yax$^{w}$-umɬ<br>\| \|<br>[+R][+R,+B] | $OCP_{\sigma}$ [+Round] | MAX [+Back] | NML [+Round] | MAX [+Round] | MAXPATH [+Round] |
|---|---|---|---|---|---|
| ☞ a. ya.xumɬ<br>\|<br>[+R,+B] | | | | * | * |
| b. ya.x$^{w}$ umɬ<br>\/\|<br>[+R][+B] | | | *! | * | |
| c. ya.x$^{w}$ imɬ<br>\| \|<br>[+R][-B] | | *! | | * | |
| d. ya.x$^{w}$umɬ<br>\| \|<br>[+R][+R] | *! | | | | |

In tableau (19), candidate b is ruled out by violating NML[+Round]: the [+Round] feature is linked to two anchors. Candidate c violates MAX[+Back] by deleting the input feature. Candidate d is ruled out by violating OCP, which is due to a sequence of two [+Round] features on adjacent segments within a syllable. Consequently, candidate a is selected as the optimal output. Note that the ranking of MAX[+Round] and MAXPATH[+Round] below MAX[+Back] and NML[+Round] results in this form.

In sum, the constraint ranking given in (17), when a triggering vowel follows the target consonant, causes the consonant to lose its labiality.

Next, consider a context where delabialisation does not occur. These are cases where /u/ precedes the target consonant /$x^w$/.

(20) tu/$x^w$/-iɬ → tu[$x^w$]iɬ (*tuxiɬ)
to jump-on the floor 'to jump to the floor'

(21) Tableau

| t u $x^w$-iɬ<br>\| \|<br>[+R,+B][+R] | $OCP_\sigma$ [+Round] | MAX [+Back] | NML [+Round] | MAX [+Round] | MAXPATH [+Round] |
|---|---|---|---|---|---|
| a. tu. xiɬ<br>\| \|<br>[+R,+B][-R] | | | | *! | * |
| b. tu. $x^w$iɬ<br>\/<br>[+R] | | | *! | * | |
| c. ti. $x^w$iɬ<br>\| \|<br>[-R,-B][+R] | | *! | | * | |
| ☞d. tu. $x^w$iɬ<br>\| \|<br>[+R][+R] | | | | | |

In (21), where the potential triggering vowel precedes a labio-velar consonant, the input labiality surfaces faithfully. This results basically from the OCP constraint which is sensitive to syllable structure. That is, while in (19), candidate d violates this constraint by having two [+Round] features in the same syllable, candidate d in (21) does not, since they belong to different syllables. Therefore, MAX[+Round] (or MAXPATH[+Round] since ranking between them is not crucial) plays a decisive role in determining the optimal output. Candidate a violates the constraint by deleting the input [+Round]. Consequently, candidate d is selected as the optimal output form, which maintains both [+Round] features in the input. In sum, a triggering vowel /u/ does not affect a folowing consonant. The asymmetry between the same vowels with respect to delabialisation can be treated by the domain specified OCP constraint.

## 4 Phonetic aspects

In the previous section, I treat delabialisation as a deletion of a [+Round] feature. However, one might suggest that the phenomenon in fact is not a deletion, but a coalescence of two [+Round] features. In this section, I discuss the phonetic properties of the relevant consonants, thereby providing a piece of evidence for the deletion approach.

Interestingly, while Nuu-chah-nulth (Ahousaht) has no morpheme

starting with /w/ followed by /u/, I have found two tokens of the sequence word-internally as shown in (22).

(22) a. c̓aa[wu]mɬ
b. na[wu]qumɬ

It is impossible to obtain the sequence over morpheme boundaries: recall that the language does not have morphemes ending with a glide. These two morphemes, therefore, will provide very important phonetic cues for potential /C$^{w}$u/ sequences. Appendix Ia-b are the spectrograms of (22a) and (22b), respectively. In the spectrograms, the transition between the glide and the vowel is clearly shown. If an underlying /k$^{w}$u/ sequence exhibits a similar formant transition of this, and differs from an underlying /ku/ sequence in terms of spectrograms and duration, then we should say that this might be coalescence, not deletion.

For this test, I recorded the same token for each case 10 times, since it was hard to obtain enough minimal pairs. The task was to compare the duration of the vowel which follows each relevant consonant. I chose only stops for this test, since it is easier to measure the duration of the vowel after a stop release than after a fricative. The two spectrograms in Appendix II-III are of an underlying /k$^{w}$/ before /i/ and /u/, respectively. Appendix IV and V are the spectrograms of an underlying /k/ before /i/ and /u/, respectively.

The following charts show durations of each vowel in different contexts.

(23) Duration of /$^{w}$i/ vs. /i/

| Token | mamuuk$^{w}$it | taʕikit |
|---|---|---|
| #1 | 131.72 ms | 102.31 ms |
| #2 | 146.17 | 112.34 |
| #3 | 144.81 | 112.02 |
| #4 | 142.72 | 106.35 |
| #5 | 152.34 | 117.01 |
| #6 | 132.97 | 114.69 |
| #7 | 143.90 | 126.26 |
| #8 | 146.44 | 128.12 |
| #9 | 140.77 | 120.07 |
| #10 | 142.04 | 108.30 |
| Average | 142.38 ms | 114.74 ms |

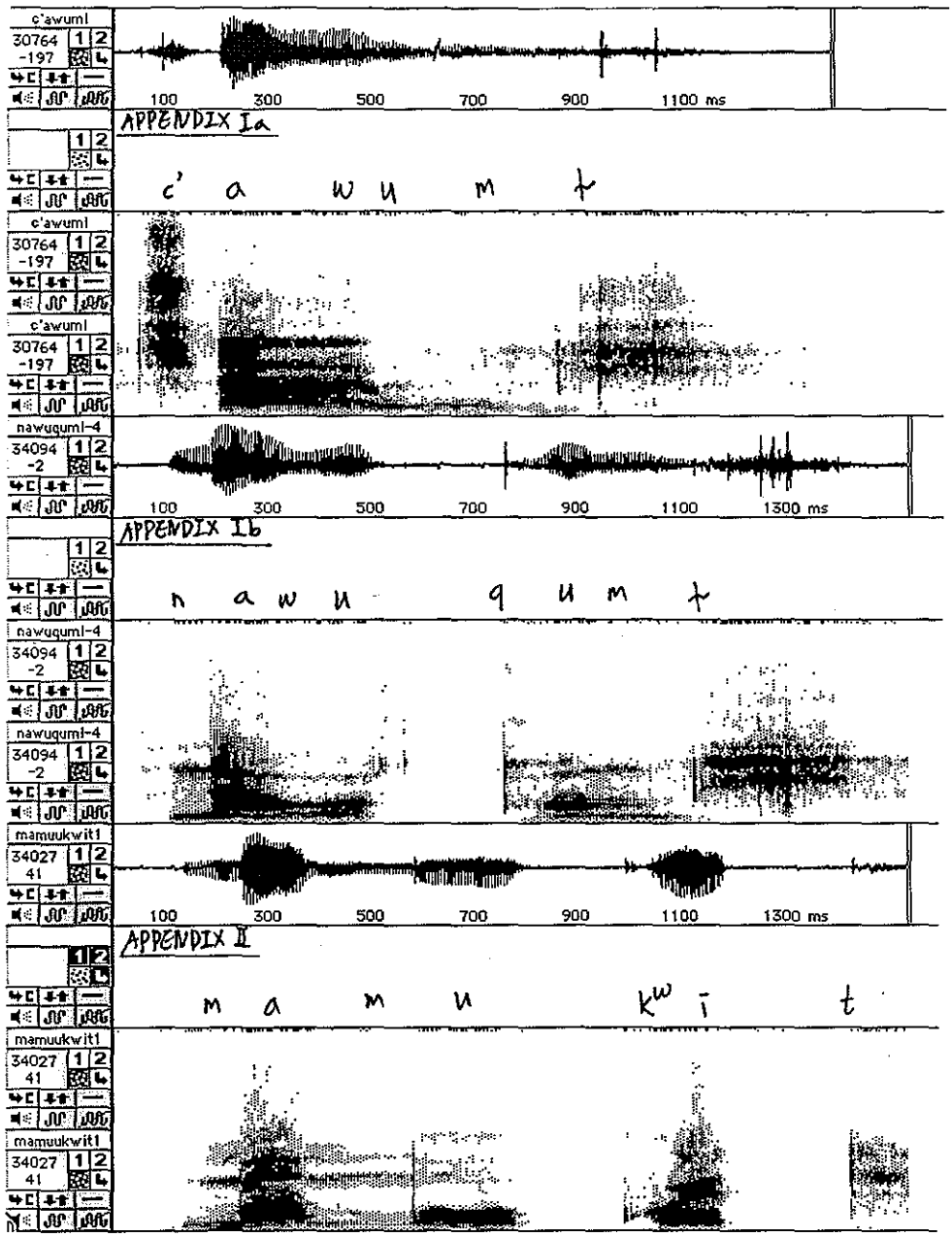
(24) Duration of /ʷu/ vs. /u/

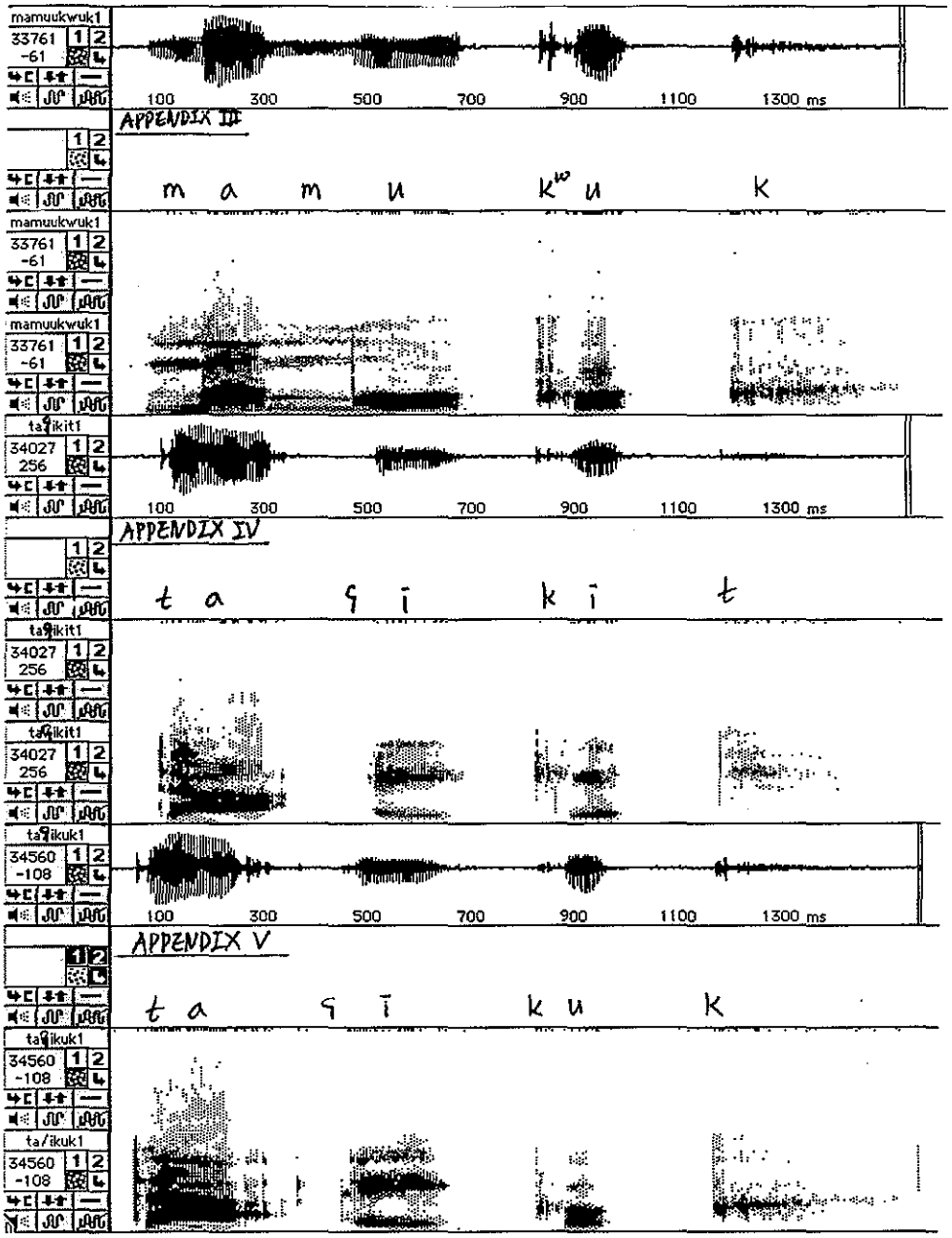
| Token | mamuukʷuk | taʕikuk |
|---|---|---|
| #1 | 98.14 ms | 104.22 ms |
| #2 | 107.55 | 116.78 |
| #3 | 111.97 | 114.33 |
| #4 | 127.01 | 116.15 |
| #5 | 123.27 | 104.58 |
| #6 | 101.36 | 117.37 |
| #7 | 116.37 | 108.25 |
| #8 | 118.28 | 99.73 |
| #9 | 100.73 | 112.47 |
| #10 | 118.23 | 121.63 |
| Average | 112.29 ms | 111.55 ms |

The argument that the labiality of an underlying labio-velar or –uvular consonant is deleted when preceding a round vowel /u/, not coarticulated with the vowel, is supported by these acoustic results. First, a typical formant transition shown in the sequence –wV-, as in Appendix Ia-b, is not observed in the sequence –kʷu-. Appendix II and IV show that whether the velar stop is underlyingly /kʷ/ or /k/, the surface forms exhibit identical acoustic properties when preceding /u/. In other words, there is a lack of formant transition for the sequence of /kʷ/-/u/. Second, for a vowel following a labial-velar stop, its voicing duration is longer than a vowel following a velar stop as seen in (23): 142.38 ms vs. 114.74 ms. On the other hand, if the vowel in question is /u/, its duration is almost identical, whether the underlying preceding stop is a labio-velar or a velar as shown in (24): 112.29 ms vs. 111.55 ms. The reason that a vowel following a labio-velar is longer than a vowel following a plain velar seems to be due to the phase of labiality which is phonetically realised as a glide /w/. Given labiality is deleted before /u/, no difference in duration between a vowel following an underlying labio-velar and another token of the same vowel following a plain velar is accounted for in a straightforward manner.

## 5 Conclusion

Nuu-chah-nulth labio-velar and labio-uvular consonants lose their labiality in some contexts. I provide phonetic evidence that the process is not related to coalescence; instead, it is a deletion process. Within OT, I treat the phenomenon as a result of the interaction between markedness and faithfulness constraints.


c'awuml
30764
-197
100
300
500
700
900
1100 ms
APPENDIX Ia
c' a w u m t
c'awuml
30764
-197
c'awuml
30764
-197
nawuqumI-4
34094
-2
100
300
500
700
900
1100
1300 ms
APPENDIX Ib
n a w u q u m t
nawuqumI-4
34094
-2
nawuqumI-4
34094
-2
mamuukwit1
34027
41
100
300
500
700
900
1100
1300 ms
APPENDIX II
m a m u k^w i t
mamuukwit1
34027
41
mamuukwit1
34027
41


mamuukwuk1
33761
-61
100 300 500 700 900 1100 1300 ms
APPENDIX III
m a m u k$^{w}$ u k
mamuukwuk1
33761
-61
mamuukwuk1
33761
-61
taʔikit1
34027
256
100 300 500 700 900 1100 1300 ms
APPENDIX IV
t a ʕ i k i t
taʔikit1
34027
256
taʔikit1
34027
256
taʔikuk1
34560
-108
100 300 500 700 900 1100 1300 ms
APPENDIX V
t a ʕ ī k u K
taʔikuk1
34560
-108
taʔikuk1
34560
-108

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