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GLOTTALIZATION IN NUU-CHAH-NULTH IN OPTIMALITY THEORY*

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Abstract: Nootka and Ditidaht (Nuu-chah-nulth), which belong to the Southern Wakashan branch of the Wakashan language family, exhibit complex properties with respect to glottalization. Although they have the same phoneme inventory, these two sister languages have different results in glottalization depending on manners of articulation of the affected consonant. Also, their glottalization is sensitive to morphological categories. The triggering factor of glottalization is a suffix with a glottal in its initial position, and the aspects of glottalization are different depending on the morphological category of the suffix in question, lexical or grammatical. These two properties in terms of glottalization in Nuu-chah-nulth: language variation and interaction between phonology and morphology, will be treated in Optimality Theory in this paper.

1. Introduction

Nootka and Ditidaht, which, with Makah, constitute the Southern Wakashan (or Nootkan) branch of the Wakashan language family, exhibit a unique glottalization process.[1] Glottalization, which is traditionally called "hardening", is common to all Wakashan languages, but I focus on these two languages since they exhibit different properties with respect to glottalization, although the areas where they are spoken are very close to each other compared to the other sister language, Makah, and although they have almost the same phoneme inventory.[2]

In this paper, I attempt to account for glottalization in Nootka and Ditidaht in Optimality Theory (henceforth OT). In Section 2, I illustrate the consonant inventory of the two languages and data, describing how they are different in terms of glottalization. In section 3, I explain unique phenomena these two languages show with respect to glottalization by some constraints and their ranking, and also assume that glottalization triggering suffixes begin with a floating feature [Constricted Glottis] (henceforth [C.G.]). Section 4 summarizes my arguments.

2. Data

The phonemic consonant inventory of each language reflects not only the fact that glottalized consonants are independently phonemic but also which kinds of consonants are glottalized, and thus it is necessary to illustrate it before data are shown.

The Consonant Inventory of Nootka and Ditidaht: Consonants show contrasts in quite extensive places of articulation in both Nootka and Ditidaht as in other Wakashan languages (Bracketed sounds are in Ditidaht only, and parenthesized sounds in Nootka only.):[3]

(1) Consonant Chart (Nootka from Rose 1976, Ditidaht from Thomas & Hess 1981)

	Labial	Dental	Palatal	Lateral	Velar	Labio-Velar	Uvular	Labio-Uvular	Pharyngeal	Glottal
Stops/affricates	p <b>	t c <d>	č	λ	k	k^w	q	q^w	ʕ	ʔ
Glottalized	p' <'b>	t' c' <'d>	č'		k'	k^{w}'				
Fricatives		s	š	ɬ	x	x^w	χ	<χ^w>	ḥ	h
Resonants	m	n	y	<l>		w				
Glottalized	('m)	('n)	'y			'w				

In this chart, Nootka and Ditidaht show only a few differences. Nootka does not have voiced plain and glottalized stops *b/d* and *'b/ 'd*, the lateral *l*, and uvular and labio-uvular fricatives χ ,χ^w, but Ditidaht does. On the other hand, Ditidaht does not have glottalized nasals *'m/'n* and in fact, even plain nasals are rare (present only in loan words from neighboring languages like Nootka), but Nootka does. Both languages, however, commonly lack glottalized uvular and labio-uvular stops *q'/*q^{w}*'*. These differences and similarities are of historical origin. First, nasals *m* and *n* changed into voiced stops *b* and *d* respectively in Ditidaht. This is, in fact, an areal feature of the Northwest coast, affecting languages in three different linguistic families, Wakashan, Chemakuan, and Salishan (Haas 1969).[4] This is related to the absence of glottalized nasals and the presence of glottalized voiced stops in this language. Second, the lateral *l* in Nootka changed into the alveolar nasal *n* (Haas 1969). Finally, in both languages the Proto-Nootkan glottalized uvular and labio-uvular stops **q'* and ***q^{w}*'* were merged into the pharyngeal stop ʕ, and only Makah preserves these two sounds. Also the Proto-Nootkan uvular and labio-uvular fricatives *χ and *χ^w developed into the pharyngeal fricative *ḥ* in Nootka (Jacobsen 1969).

Data: As I mentioned above, Nootka and Ditidaht exhibit some different properties with respect to glottalization, so I illustrate data from each language in different sections.[5]

Nootka (from Rose 1976): Nootka has some suffixes which trigger glottalization, and of such suffixes, only lexical suffixes cause every preceding consonant to become glottalized: they cause preceding stops/affricates or resonants to become their glottalized counterparts as in (2a) and (2b) and cause preceding fricatives to become glottalized glides as in (2c):[6]

(2) Lexical suffixes in glottalization

a. wik-ʔas -> wik'as 'not outside'
   not-outside

b. ʔam-ʔakƛi -> ʔa'makƛi 'in the real'
   LOC-in rear

c. hiɬ-ʔaqƛ -> hi'yaqƛ 'inside'
   LOC-inside

On the other hand, grammatical suffixes cause preceding stops/affricates to become their glottalized counterparts as in (3a), but do not affect preceding fricatives as in (3b):

(3) Grammatical suffixes in glottalization

a. wik-ʔaƛ̓-ʔat -> wikʼaƛ̓ʼat 'it isn't ...ed'
not-SEQ-PASS

b. ƛ̓ʼus-ʔa -> ƛ̓ʼusʔa 'it dried.'
dry-SEQ

Ditidaht (from Thomas & Hess 1981, Haas & Swadesh 1933, Bernice Touchie 1977): The Ditidaht data below show that both lexical (4a) and grammatical (5a) suffixes trigger glottalization in stops/affricates as in Nootka. However, neither lexical nor grammatical suffixes affect fricatives, unlike Nootka, as the examples (4b) and (5b) show. Furthermore, a glottal of grammatical suffixes is deleted when it follows a fricative as shown in (5b). Another difference between Nootka and Ditidaht is that Ditidaht has voiced stops, which are also glottalized before glottalizing suffixes as shown in (6).

(4) Lexical suffixes in glottalization

a. hiyo-ʔaƛ̓-ʔcʼdicx -> hiyoʔaƛ̓ʼcʼdicx 'let's finish now.'
finish-now-let us ground'

b. ʔiyax-ʔitɬ -> ʔiyaxʔitɬ 'got to be there on the ground'
there-on the ground

(5) Grammatical suffixes in glottalization

a. kaceʻyk-ʔa -> kaceʻykʼa 'it is a tally stick.'
tally stick-he/she/it (is)
b. kʷiqaʻbɬ -ʔa -> kʷiqaʻbɬa 'it is a whale harpoon head.'
whale harpoon head-she/she/it (is)

(6) ɬicɬib-ʔa -> ɬicɬiʻba 'it is a mat.'
mat-he/she/it (is)

There is no difference between voiced stops and voiceless stops with respect to glottalization. But there is a different pattern of glottalization with voiced stops in Ditidaht, which is dealt with in the following section.

Glottalization of voiced stops in Thomas & Hess (1981): Thomas & Hess (1981) wrote that when a voiced stop is before a glottalizing suffix, it is metathesized with the initial glottal of the suffix as in (7):

(7)=(6) ɬicɬib-ʔa -> ɬicɬiʔba 'it is a mat.'

If they are right, it means that the voiced stop and the glottal are just a sequence of two consonants, and they exchange their position for some reason. This assumption, however, has a problem. Now that every stop/affricate/resonant (except fricatives) undergoes glottalization before both lexical and grammatical suffixes, what prevents voiced stops from undergoing glottalization? There are no phonetic and phonological reasons why only voiced stops do not undergo glottalization but undergo metathesis, though Ditidaht has glottalized voiced stops as shown in the consonant chart in (1). Evidence for the fact that Ditidaht has glottalized voiced stops is as

follows. In Ditidaht as well as in Nootka, every stem begins with one and only one consonant (Haas 1972), and only one consonant can occupy onset position in the syllable (Haas 1969). If a glottalized consonant were a sequence of two consonants, it could not be in onset position, but every glottalized consonant including glottalized voiced stops can occupy onset position as in (8):

(8) Thomas & Hess (1981) and Gamble (1977)

ƛ'ul 'touch'
p'a.ci 'pay a potlatch witness'
'bit 'son of ...'
ba.**'b**iqs 'older sibling'
hu.**'d**i 'drift whale'
(. is a syllable boundary)

This is good evidence for the argument that a glottalized consonant is not a consonant cluster but a consonant with secondary articulation, and thus from the fact that Ditidaht has glottalized voiced stops we can assume that the example in (7) is not an example that shows metathesis, but one that shows glottalization just as voiceless stops are glottalized in the same environment.[7] In addition, according to Hume (1998), a perceptibly vulnerable consonant commonly shifts to a position where the phonetic cues to its identification are more robust, thereby enhancing the consonant's vulnerable consonants. If we accept her theory, we cannot explain why only voiced stops, but not voiceless stops, are metathesized in Ditidaht.[8] Consequently, they wrongly deal with a preglottalized voiced stop as a sequence of two segments.

3. Analysis in OT

Only limited research on glottalization in Nootka and Ditidaht has been conducted so far and in fact there are not enough linguistic studies of these languages, although there has been a lot of anthropological work. Sapir (1938) and Rose (1976) are the only scholars who have dealt with glottalization in Nootka in detail. I review their analyses briefly and point out problems with them before I deal with this phenomenon in OT.

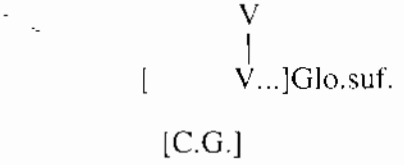
Problems with the analyses of Sapir (1938) and Rose (1976): Sapir (1938) and Rose (1976) commonly assume that there is a sequence of the glottal stop *ʔ* and the glottal fricative *h* in the initial position of a lexical suffix which triggers glottalization in Nootka and argue that it is a combination of the glottal and the glottal fricative that causes stops/affricates and resonants to become their glottalized counterparts and causes fricatives to become glottalized glides. Their analyses, however, raise two problems. First, it raises the problem of abstractness, which has been an issue since SPE (Sound Pattern of English 1968). That is, a combination of the glottal and the fricative triggers only glottalization of preceding stops/affricates and resonants, but softening (a process by which fricatives are changed to glides) and glottalization of preceding fricatives. Then the two consonants are always deleted since they do not appear on the surface. So Rose does need two deletion rules: *ʔ*-deletion rule and *h*-deletion rule.

Second, Sapir's and Rose's analyses can not really distinguish glottalizing suffixes and non-glottalizing suffixes. In both languages, not all suffixes beginning with the glottal stop cause glottalization and also even glottalizing suffixes exhibit different properties according to morphological categories: lexical or grammatical. Sapir and Rose, however, assume that all those suffixes include the glottal stop in their initial position. This makes Rose suppose that only lexical suffixes which cause glottalization have a sequence *-ʔh-* in their initial position, i.e. a sequence of a glottal stop (responsible for glottalization) and a glottal fricative (responsible for softening), and the fricative *h* has "the effect of throwing the glottal back on the preceding syllable," softening the glottalized fricatives to glottalized glides. Although this assumption can explain different properties of suffixes beginning with a glottal, it is not a natural explanation of glottalization

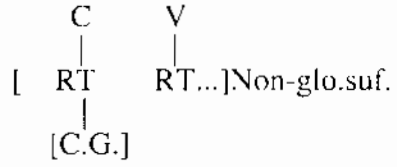
occurring in Nootka. In addition, even if it explains the difference between lexical and grammatical suffixes, how can it explain the difference between grammatical suffixes and non-glottalizing suffixes with a glottal in their initial position? And also how can it prove that the glottal fricative which never appears on the surface has such a phonetic effect? Since the phonetic factor which causes glottalization lies actually in the glottal itself and since both glottalizing suffixes and non-glottalizing suffixes with a glottal have a glottal, or at least the [C.G.] feature, in their initial position, we need to distinguish those suffixes in a both morphologically and phonologically natural way.

The floating feature [C.G.]: I propose that glottalizing suffixes in both languages include a floating feature irrespective of whether they are lexical or grammatical suffixes. This solves the two problems with the existing analyses I point out above. That is, the problem of abstractness no longer occurs, for we do not have to posit any segment in the input which rarely appears in the output, affecting the preceding consonant. By allowing the presence of a floating features we can explain why a specific sound undergoes a change even if there is no segmental factor in the output. Therefore we do not need any kind of mechanism by which we can delete a glottal. The other advantage is that we can distinguish glottalizing suffixes and non-glottalizing suffixes straightforwardly by assuming that a glottalizing suffix has a floating feature [C.G.] in its initial position, while a non-glottalizing suffix, which does not affect any preceding consonant though it has a glottal, has the glottal stop itself in its initial position as follows:

(9) a. Glottalizing suffix



b. Non-glottalizing suffix



(10) a. his-[C.G.]oƛ -> hi'yoƛ 'to hit on the rocks'
to hit-on the rocks

b. his-ʔokt -> hisʔokt 'obtained by violence'
to hit-obtained by...

A floating feature must link to a root node in order to appear on the surface, while a feature already linked to a root node does not have to link to another root node, which explains why only some suffixes cause glottalization in these languages straightforwardly, although both kinds of suffixes have the same feature [C.G.] in their initial position. All glottalizing suffixes have this floating feature, but their influence on the preceding consonant is different depending upon their morphological status, which results from some faithfulness constraints which are morphologically sensitive and their different ranking. Therefore, we just need morphological information about whether a glottalizing suffix at hand is lexical or grammatical. This is very important in selecting the right output forms because according to different morphological categories, the domain where some faithfulness constraints exert their influence is different. Consequently, glottalization in both languages is an example which crucially involves the interaction of phonology with morphology.

Analysis in OT: We need the following three sets of constraints to explain glottalization in Nootka and Ditidaht.

(11) Alignment constraint : ALIGN($[C.G.]_{Glo\ suf.}$, R, Stem, R) : The right edge of the feature $[C.G.]_{Glo.suf.}$ coincides with the right edge of a stem.

(12) Feature cooccurrence constraints :
a. *[C.G.]/[Cont]$_{OBS}$: [C.G.] and [Continuant] in an obstruent cannot cooccur.
b. *[C.G.]/[Stop]$_{OBS}$: [C.G.] and [Stop] in an obstruent cannot cooccur.[9]
c. *[C.G.]/[Son] : [C.G.] and [Sonorant] in an resonant cannot cooccur.

(13) Faithfulness constraints :
a. MAX[C.G.]$_{Stem}$: [C.G.] in the input stem must have a correspondent in the output stem.
b. MAX[C.G.]$_{Word}$: [C.G.] in the input word must have a correspondent in the output word.
c. MAX[Cont] : [Continuant] in the input must have a correspondent in the output.
d. MAX[Fs]$_{Stem}$: Features [F, G, H,...] in the input stem must have a correspondent in the output stem.
e. MAX[Fs]$_{Word}$: Features [F, G, H,...] in the input word must have a correspondent in the output word.
f. DEP[R]$_{Stem}$: Any root node in the output stem must have a correspondent in the input stem.
g. DEP[R]$_{Word}$: Any root node in the output word must have a correspondent in the input word.
h. DEPPATH[C.G.]$_{Stem}$: Any output path between [C.G.] and an anchor in a stem must have a correspondent path in the input stem.
i. DEPPATH[C.G.]$_{Word}$: Any output path between [C.G.] and an anchor in a word must have a correspondent path in the input word.

The constraint ALIGN([C.G.]$_{Glo\ suf.}$, R, Stem, R) prevents the floating feature [C.G.] from linking to segments other than the final consonant of a morpheme to which a glottalizing suffix including the feature is attached. However, the linking of the feature [C.G.] is further restricted depending on phonological contexts. The three feature cooccurrence constraints respectively disallow the feature [C.G.] and another feature, [Cont], [Stop], or [Son], to be linked to the same root node. That is, obstruents with the feature [Stop] such as stops and affricates, obstruents with the feature [Cont] such as fricatives and resonants like nasals and glides (in which case it does not matter whether the resonant is [Stop] for nasals, or [Cont] for glides) are not allowed to get the feature [C.G.]. According to Sapir (1938), a very large number of First Nations languages have glottalized stops/affricates, and glottalized resonants and fricatives are less common, but still glottalized resonants are more frequent than glottalized fricatives. This observation makes the following ranking of these constraints possible:

(14) Ranking of constraints on cooccurence
*[C.G.]/[Cont]$_{OBS}$ >> *[C.G.]/[Son] >> *[C.G.]/[Stop]$_{OBS}$

The faithfulness constraints in (13) control deletion, insertion, or linking of a feature(s) depending upon morphological domains or generally. For the constraints MAX[Fs]$_{Stem}$ and MAX[Fs]$_{Word}$, for reasons of space, I show different MAX feature violations, except the feature [Cont], of each candidate under the integrated constraint MAX[Fs]$_{Stem/Word}$ as one violation, no matter how many violations it makes. And also even if we might need the constraints DEP[Fs]$_{Stem/Word}$, I will not deal with them, since they do not play any crucial role when we select an optimal output form.

We can account for various properties of glottalization occurring within each language as well as between Nootka and Ditidaht by these constraints and their different rankings. The ranking of constraints in each language is as follows:

(15) Schematic Ranking of Constraints in Nootka
*[C.G.]/[Cont]$_{OBS}$, MAX[Cont], MAX[C.G.]$_{Stem}$, **MAX[C.G.]$_{Word}$**, ALIGN([C.G.]$_{Glo.suf.}$, R, Stem, R), **MAX[Fs]$_{Word}$** >> **DEP[R]$_{Stem}$** >> *[C.G.]/[Son] >> **DEP[R]$_{Word}$** >> DEPPATH[C.G.]$_{Stem}$, DEPPATH[C.G.]$_{Word}$, **MAX[Fs]$_{Stem}$**, *[C.G.]/[Stop]$_{OBS}$

(16) Schematic Ranking of Constraints in Ditidaht

*[C.G.]/[Cont]$_{OBS}$, MAX[Cont], MAX[C.G.]$_{Stem}$, ALIGN([C.G.]$_{Gr.suf.}$, R, Stem, R), **DEP[R]$_{Word}$** >> *[C.G.]/[Son] >> **MAX[C.G.]$_{Word}$** >> **MAX[Fs]$_{Stem/Word}$** >> **DEP[R]$_{Stem}$**, DEPPATH[C.G.]$_{Stem}$, DEPPATH[C.G.]$_{Word}$, *[C.G.]/[Stop]$_{OBS}$

Nootka and Ditidaht have the same set of constraints but the different rankings of the constraints in each language explain why the two languages have different results in terms of glottalization. Furthermore, the different ranking of the bold constraints according to morphological domain will reveal, as we will see from the tableaux below, that among the glottalizing suffixes, lexical and grammatical suffixes show different properties with respect to glottalization in each language.

The following tableaux (Nootka in (17-20) and Ditidaht in (21-24) show how we obtain the optimal output form for each example belonging to different groups. Here I classify glottalization in the two languages into eight categories according to differences each consonant group exhibits with respect to glottalization, so each tableau shows each category and from now on, I only mention constraints that play a crucial role in selecting an optimal output form.[10]

(17) Stops/affricates in Nootka

[wik]$_{Root}$-$_{Gr.suf.}$[[C.G.]as] -> [wik'as]$_{Word}$ 'not outside'

wik=[C.G.]as#	MAX[C.G.]$_{Word}$	>>ALIGN$_{Stem}$	DEP[R]$_{Word}$	>>*[C.G.]/[Son]>>	DEP[R]$_{Stem}$	>>DEPPATH[C.G.]$_{Stem}$	DEPPATH[C.G.]$_{Word}$	*[C.G.]/[Stop]$_{OBS}$
a. ☛wik'=as# [C.G.]						*	*	*
b. wik=ʔas# [C.G.]		*!			*		*	
c. wikʔ=as# [C.G.]			*!		*	*	*	
d. wik'=ʔas# [C.G.]		*!			*	*	**	*
e. wik=as#	*!							
f. 'wik=as# [C.G.]		*!		*		*	*	

This tableau (for (2a)) shows that when a grammatical suffix *[C.G.]as* is attached to a root *wik*, the optimal output form is *wik'as*, which is a word (cf. footnote 6). Candidates **b, d, and f** violate the highest ranking constraint ALIGN which requires the floating feature [C.G.] to coincide with a stem at the right edge. The [C.G.] feature is aligned with an anchor in a suffix, not a stem-final anchor, in **b**, it is linked with not only a stem-final anchor but also with an anchor of a suffix in **d**, and it is linked with the left edge of the stem in **f**. Candidate **c** violates the higher ranking constraint DEP[R]$_{Stem}$, which prevents any root node from being inserted into a stem domain. Finally, candidate **e** violates the highest ranking constraint MAX[C.G.]$_{Word}$, which disallows the feature [C.G.] in the input being deleted in a word domain. Consequently, although candidate **a** violates some lower ranking constraints, it is selected as the optimal output form since it does not violate the higher ranking constraints the other candidates do.

(18) Resonants in Nootka

[ʔam]$_{Stem}$-$_{Lex.suf.}$[[C.G.]akƛi] -> [ʔa'makƛi]$_{Stem}$

ʔam=[C.G.]akƛi=	MAX[C.G.]$_{Stem}$	ALIGN >>	DEP[R]$_{Stem}$ >>	*[C.G.]/[Son] >>	DEPPATH[C.G.]$_{Stem}$
a. ☛ʔa'm=akƛi= [C.G.]				*	*
b. ʔam=ʔakƛi= [C.G.]		*!	*		*
c. ʔa'm=ʔakƛi= [C.G.]		*!	*	*	**
d. ʔamʔ=akƛi= [C.G.]			*!		*
e. ʔam=akƛi=	*!				

As this tableau (for (2b)) shows, when a lexical suffix */C.G.]akλo* is attached to a stem *ʔam*, which is also a lexical suffix, the optimal output is *ʔa'makλi,* which is also a stem (cf. Note 6). Candidate **b and c** violate the higher ranking constraint ALIGN, linking to a suffix-initial anchor. Candidates **d** violates the DEP[R]$_{Stem}$ constraint by inserting a root node in a stem domain. The final candidate **e** violates the MAX[C.G.]$_{Stem}$ constraint by deleting the feature [C.G.] in a stem domain. The optimal output **a** only violates the constraints *[C.G.]/[Son] and DEPPATH[C.G.]$_{Stem}$, which are all lower ranked.

(19) Fricatives preceding a lexical suffix in Nootka

[hiɬ]$_{Stem}$-]$_{Lex.suf.}$[[C.G.]aqƛ] -> [hi'yaqλ]$_{Stem}$

hiɬ=[C.G.]aqƛ= [Cont]	*[C.G.]/[Cont] OBS	MAX[Cont] Stem	MAX[C.G.] Stem	ALIGN>>	DEP[R]>>	*[C.G.]/[Son]>>	DEPPATH [C.G.]$_{Stem}$	MAX]Fs[Stem
a. ☛hi'y=aqƛ= [Cont][C.G.]						*	*	*
b. hiɬ=ʔaqƛ= [Cont][C.G.]				*!	*		*	
c. hiɬʔ=aqƛ= [Cont][C.G.]					*!		*	
d. hiɬ'=ʔaqƛ= [Cont][C.G.]	*!			*	*		**	
e. hiɬ'=aqƛ= [Cont][C.G.]	*!						*	
f. hiɬ=aqƛ= [Cont]		*!						
g. hiyʔ=aqƛ= [Cont][C.G.]					*!		*	*
h. hiy=ʔaqƛ= [Cont][C.G.]				*!	*		*	*
i. hiλ'=aqƛ= [C.G.]		*!					*	
j. hiy=aqƛ= [Cont]			*!					*

As tableaux (19) and (20), which we will see next, show, more complicated aspects appear when the consonant at hand is a fricative. In (19) (for (2c)), when the lexical suffix */C.G.Jaqƛ* is attached to another lexical suffix *hi't.* the output is *hi'yaqƛ*, which is a stem. Candidates **b and h** violate the constraint ALIGN, and candidates **d and e** violate *[C.G.]/[Cont]$_{OBS}$, according to which the feature [C.G.] and [Cont] cannot be linked to a common root node in the case of obstruents. Candidates **f and j** do not observe the constraint MAX[C.G.]$_{Stem}$ and candidate **i** violates the constraint MAX[Cont], whose higher ranking status guarantees the feature [Cont] in the input to be maintained in the output. The remaining candidates **a, c, and g** tie in these higher ranking constraints, but the constraint DEP[R]$_{Stem}$ filters out candidates **c and g**, selecting candidate **a** as an optimal output form, for only **a** observes this higher ranking constraint.

(20) Fricatives preceding a grammatical suffix in Nootka

[ƛ'uš]$_{Stem}$-$_{Gra.suf.}$[[C.G.]a] -> [ƛ'uš?a]$_{Word}$

ƛ'uš=[C.G.]a# [Cont]	*[C.G.]/[Cont]$_{OBS}$	MAX[Cont]	MAX[C.G.]$_{Word}$	ALIGN	MAX[Fs]$_{Word}$	>> DEP[R]$_{Stem}$
a. ☛ƛ'uš?=a# [Cont][C.G.]						*
b. ƛ'uš=?a# [Cont][C.G.]				*!		
c. ƛ'uš'=a# [Cont][C.G.]	*!					
d. ƛ'uš'-?a# [Cont][C.G.]	*!			*		
e. ƛ'u'y=a# [Cont][C.G.]					*!	
f. ƛ'uš=a# [Cont]			*!			
g. ƛ'uč'=a# [C.G.]		*!				
h. ƛ'uy=a# [Cont]			*!		*	

	*[C.G.]/[Son]	DEP[R]$_{Word}$	DEPPATH[C.G.]$_{Stem}$	DEPPATH[C.G.]$_{Word}$	MAX[Fs]$_{Stem}$
a.		*	*	*	
b.		*		*	
c.			*	*	
d.		*	*	**	
e.	*		*	*	*
f.					
g.			*	*	
h.					*

When a grammatical suffix is attached to a stem which ends with a fricative, the suffix does not influence the fricative, and thus the floating feature is realized as the glottal. Tableau (20) (for (3b)) reflects this observation. Candidate **b** violates the ALIGN constraint, and candidates **c and d** violate *[C.G.]/[Cont]$_{OBS}$. Candidate **e** does not obey the MAX[Fs]$_{Word}$, which requires every feature in the input word to appear in the output word. Candidates **f and h** violate the constraint MAX[C.G.]$_{Word}$ and candidate **g** violates the MAX[Cont] constraint. Thus candidate **a** is selected as an optimal output form since it obeys these higher ranking constraints. Here, candidates **a, g, h** and **j** violate the constraint MAX[Fs]$_{Stem}$, which is due to the fact that the consonant in the input *š* is realized as a different consonant in the output, *'y* in **a** and *y* in **g, h, and j**.

So far we have dealt with the Nootka data. Data of Ditidaht which we will deal with below exhibit different properties from those of Nootka with respect to glottalization.

(21) Stops/affricates in Ditidaht

[kace'yk]$_{Stem}$-$_{Gra.suf}$[[C.G.]a] -> [kace'yk'a]$_{Word}$

kace'yk=[C.G.]a#	ALIGN	DEP[R] Word	>> MAX[C.G.] Word	>> DEPPATH [C.G.]$_{Stem}$	DEPPATH [C.G.]$_{Word}$	DEP[R] Stem	*[C.G.]/[Stop] OBS
a. ☛kace'yk'=a# [C.G.]				*	*		*
b. kace'yk =ʔa# [C.G.]	*!	*			*		
c. kace'ykʔ=a# [C.G.]		*!		*	*	*	
d. kace'yk'=ʔa# [C.G.]	*!	*		*	**		*
e. kace'yk=a#			*!				
f. kac'c'yk=a# [C.G.]	*!			*	*		

In (21) (for (4b)), a grammatical suffix *[C.G.]a* is attached to a lexical suffix *kace'yk*, which is a stem. Candidate **a** is selected as an optimal output form since the other candidates **b, c, d, e,** and **f** violate higher ranking constraints ALIGN, DEP[R]$_{Word}$, and MAX[C.G.]$_{Word}$, respectively. When we compare this tableau with the tableau in (17), there is no difference in selecting a glottalized consonant as an optimal output form although the ranking of the constraints is different in these two languages. That is, in the case of stops/affricates, a glottalizing suffix affects a preceding consonant in the same way in both languages.

(22) Fricatives preceding a lexical suffix in Ditidaht

$[ʔiyax]_{Stem}$-$_{Lex.suf.}[[C.G.]it̓ɬ]$ -> $[ʔiyaxʔit̓ɬ]_{Stem}$

ʔiyax=[C.G.]it̓ɬ= [Cont]	*[C.G.]/[Cont] OBS	MAX[Cont] Stem	MAX[C.G.] Stem	ALIGN>>*[C.G.]/[Son]>>MAX[Fs] Stem	DEPPATH [C.G.]Stem	DEP[R] Stem	*[C.G.]/[Stop] OBS
a. ☛ʔiyaxʔ=it̓ɬ= [Cont][C.G.]					*	*	
b. ʔiyax=ʔit̓ɬ= [Cont][C.G.]			*!		*	*	
c. ʔiyax'=ʔit̓ɬ= [Cont][C.G.]	*!		*		**	*	
d. ʔiyax-it̓ɬ= [Cont]		*!					
e. ʔiyaw=it̓ɬ= [Cont]		*!		*			
f. ʔiya'w=it̓ɬ= [Cont][C.G.]				*! *	*		
g. ʔiyax'=it̓ɬ= [Cont][C.G.]	*!				*		
h. ʔiya'w=ʔit̓ɬ= [Cont][C.G.]				*! *	**	*	
i. ʔi'yax=it̓ɬ= [C.G.][Cont]			*!	*	*		
j. ʔiyaƛ'=it̓ɬ= [C.G.]		*!			*		*
k. ʔiyaw=ʔit̓ɬ= [Cont][C.G.]				*!	*	*	*

As tableaux (22) and (23), which we well see below, show, the behavior of fricatives in Ditidaht in terms of glottalization is different from that in Nootka. This results from difference in the ranking of constraints between these two languages (cf. (19) and (20)). In Nootka, when fricatives precede a lexical suffix, only manintaining both glottalic closure and continuancy by sacrificing frication and by tolerating a combination of sonorancy and glottalic closure under one root node is crucial, and so this is reflected in the higher ranking of the constraints concerned, while in Ditidaht, as the tableaux show, both maintaining identity of fricatives and avoiding cooccurence of sonorancy and glottalic closure are also crucial. In (22) (for (5a)), when a lexical suffix *[C.G.]it̓ɬ* is added to a lexical suffix *ʔiyax*, the result is *ʔiyaxʔit̓ɬ*. Candidate **b, c, d, e, g, i, j,** and **k** all violate higher ranking constraints, *[C.G.]/[Cont]$_{OBS}$, MAX[Cont], MAX[C.G.]$_{Stem}$ or ALIGN, but candidates **a, f,** and **h** tie with respect to these constraints. The constraint *[C.G.]/[Son], however, filters out candidate **f** and **h,** selecting candidate **a** as an optimal output form.

(23) Fricatives preceding a grammatical suffix in Ditidaht

$[k^{w}i\underline{q}a\dot{}b\dot{t}]_{Stem}$-$_{Gra.suf}[[C.G.]a]$ -> $[k^{w}i\underline{q}a\dot{}b\dot{t}a]_{Word}$

$k^{w}i\underline{q}a\dot{}b\dot{t}$=[C.G.]a# [Cont]	*[C.G.]/[Cont]$_{OBS}$	MAX[Cont]	ALIGN	DEP[R]$_{Word}$	>> *[C.G.]/[Son]	>> MAX[C.G.]$_{Word}$
a. ☛ $k^{w}i\underline{q}a\dot{}b\dot{t}$=a# [Cont]						*
b. $k^{w}i\underline{q}a\dot{}b\dot{t}$=ʔa# [Cont][C.G.]			*!	*		
c. $k^{w}i\underline{q}a\dot{}b\dot{t}$ʔ=a# [Cont][C.G.]				*!		
d. $k^{w}i\underline{q}a\dot{}b\dot{t}$'=a# [Cont][C.G.]	*!					
e. $k^{w}i\underline{q}a\dot{}b$'y=a# [Cont][C.G.]					*!	
f. $k^{w}i\underline{q}a\dot{}$by=ʔa# [Cont][C.G.]			*!	*		
g. $k^{w}i\underline{q}a\dot{}b$'y=ʔa# [Cont][C.G.]			*!	*	*	
h. $k^{w}i\underline{q}a\dot{}b\dot{t}$'=ʔa# [Cont][C.G.]	*!		*	*		
i. $k^{w}i\underline{q}a\dot{}$by=a# [Cont]						*
j. $k^{w}i\underline{q}a$'$b\dot{t}$=a# [C.G.][Cont]			*!			
k. $k^{w}i\underline{q}a\dot{}b\lambda$'=a# [C.G.]		*!				

	MAX[Fs]$_{Stem}$	DEPPATH[C.G.]$_{Stem}$	DEPPATH[C.G.]$_{Word}$	DEP[R]$_{Stem}$	*[C.G.]/[Stop]$_{OBS}$
a.					
b.			*		
c.		*	*	*	
d.		*	*		
e.	*	*	*		
f.	*		*		
g.	*	*	**		
h.		*	**		
i.	*!				
j.		*	*		*
k.		*	*		*

In tableau (23) (for (5b)), where a grammatical suffix */C.G.]a* is added to a lexical suffix *k*^{w}*iqa bɬ*, the optimal output form is *k*^{w}*iqa bɬa*, in which the floating feature is not realized on the surface. Candidates **b, c, d, f, g, h, j,** and **k** violate the highest ranking constraints. As a result, candidates **a,**

e and **i** tie in these constraints. The constraint *[C.G.]/[Son] filters out candidate **e**, since the resonant *y* is linked to the floating feature [C.G.] and the constraint $MAX[Fs]_{Stem}$ excludes candidate **i**, where the friction property of the fricative in the input stem is deleted in the output. Consequently, candidate **a** is selected as an optimal output form. Here, the constraint $MAX[C.G.]_{Word}$ is low ranked, unlike the situation in Nootka, where it is highest ranked. This is the crucial factor by which each language has a different result in glottalization when the trigger is a grammatical suffix.

(24) Voiced stops in Ditidaht

$[ɬicɬib]_{Stem}$-Gram.suf.[C.G.]a] -> $[ɬicɬi'ba]_{Word}$

ɬicɬib=[C.G.]a#	ALIGN	DEP[R] Word	>> MAX[C.G.] Word	>> DEPPATH $[C.G.]_{Stem}$	DEPPATH $[C.G.]_{Word}$	DEP[R] Stem	*[C.G.]/[Stop]
a. ☞ ɬicɬi'b=a# [C.G.]				*	*		*
b. ɬicɬib=ʔa# [C.G.]	*!	*			*		
c. ɬicɬibʔ=a# [C.G.]		*!		*	*	*	
d. ɬicɬi'b=ʔa# [C.G.]	*!	*		*	**		*
e. ɬicɬib=a#			*!				
f. ɬicɬ'ib=a# [C.G.]	*!			*	*		

Finally, tableau (24) (for (6)) shows glotalization of the voiced stops which exist only in Ditidaht. Their behavior with respect to glottalization is the same as that of voiceless stops, except that voiced stops may be preglottalized. Candidates **b, d,** and **f,** and **c** violate the highest ranking constraints ALIGN and $DEP[R]_{Word}$, respectively. Candidate **e** does not observe the constraint $MAX[C.G.]_{Word}$. Consequently, candidate **a** is selected as an optimal output, which obeys all the higher ranking constraints.

4. Conclusion

We have investigated glottalization in Nootka and Ditidaht. Optimality Theory accounts straightforwardly for the complex properties the two languages exhibit with respect to this phenomenon. I adopted three sets of constraints: the alignment, feature cooccurence, and faithfulness constraints, and ranked them differently for each language. That is, the constraints used are the same, but the ranking is different, by which the two languages show different aspects in terms of glottalization. Also, the differences observed between lexical and grammatical suffixes with respect to glottalization have fallen out from the ranking of morphologically sensitive constraints. These two kinds of variation with respect to glottalization are reflected in the different ranking of some crucial constraints in each language as follows: $MAX[C.G.]_{Word}$, $MAX[Fs]_{Word}$ >> $DEP[R]_{Stem}$ >> $DEP[R]_{Word}$ >> $MAX[Fs]_{Stem}$ in Nootka and $DEP[R]_{Word}$ >> $MAX[C.G.]_{Word}$ >> $MAX[Fs]_{Stem/Word}$, $DEP[R]_{Stem}$ in Ditidaht. In addition, I assume that glottalizing suffixes in both languages begin with a floating feature [C.G.], which enables us to solve the problem of distinguishing between the two types of morphemes: glottalizing suffixes and

non-glottalizing suffixes with a glottal stop. Moreover, it solves the problem of abstractness. The floating feature [C.G.] surfaces as glottalization on a preceding segment or as a full glottal stop, depending on the phonological context. Finally, I end this paper by mentioning three issues in these two languages.

First, I did not deal with the glottalization of glides among resonants in both languages. I have collected data from several sources, but I could not find many morphemes ending with glides *y* or *w*, and moreover, in Ditidaht I can see the suffix-*uw* 'it was said', but it always occupies the word final positon. Most glides I have found start a morpheme, and glottalized glides in Nootka are the result of glottalized fricatives, so I cannot test glottalization of glides here. However, I can suppose from the presence of the glottalized glides in both languages that they may also be glottalized if they precede a glottalizing suffix, although this needs to be confirmed.

Second, as mentioned in section 2.1, the Proto-Nootkan uvular stop *q'* and labio-uvular stop *q*^{w}*'* developed into the pharyngeal stop *ʕ*. Many people, however, do not regard it simply as a pharyngeal stop, but rather as a laryngealized glottal (Sapir & Swadesh 1939), a laryngeal glottal stop (Haas & Swadesh 1933), a pharyngealized glottal stop (Swadesh 1939), or a laryngeated (strangulated) glottal stop (Sapir 1938). That is, they all treat the pharyngeal stop as a type of glottal stop. According to Rose (1976), the glottalized uvular and labio-uvular stop (ultimately through delabialization) and the pharyngeal stop have the same feature specifications in terms of distinctive features in both languages, which means they are not phonologically distinct. If this is right, it is natural that the glottalized uvular *q'* and the glottalized labio-uvular *q*^{w}*'* are realized as the pharyngeal stop before a glottalizing suffix in both languages, since the two languages do not have the glottalized counterparts of the uvular and labio-uvular stops, unlike the other Wakashan languages, e.g. Makah and Kwakwala, one of the Northern Wakashan languages, which maintain the Proto-Wakashan glottalized uvular and labio-uvular stops.

Finally, in the Ditidaht glottalization we found that glottalizing suffixes, whether lexical or grammatical, cause all consonants, except fricatives, to become glottalized in every morphological domain, and also the glottal appears after a fricative if the glottal, i.e. the feature [C.G.], belongs to a lexical suffix, but does not if it belongs to a grammatical suffix as we already saw in 2.2.2. Most of the literature confirms these observations. Thomas & Hess (1981), however, say that glottalization suffixes cannot influence a consonant in a root, so we have the following result: *wik-[C.G.]*(or *ʔ*, according to them)*a* -> *wikʔa* 'it is not...' and that the glottal of glottalizing suffixes does not appear on the surface after a fricative, irrespective of whether it belongs to a lexical or a grammatical suffix. Although these different observations need further research, we might have the answer from Gamble (1977), where Gamble suggests one possibility is that glottalization in Ditidaht is still in progress and so has not settled down, unlike in Nootka. This unstable status of glottalization in Ditidaht may make different observations possible in the two cases above.

NOTES

[*] I would like to thank Doug Pulleyblank and Pat Shaw for many helpful comments and suggestions. I am responsible for any mistakes and errors.

[1] The name Nootka is disliked by the people, but since the preferred name Nuu-chah-nulth includes not only Nootka but also a separate language Ditidaht and since in this paper it is necessary to distinguish the two languages, I use Nootka only for linguistic distinction.

[2] Nootka is spoken on the west coast of Vancouver Island from Barkley Sound north to Quatsino Sound, Ditidaht is spoken on the southwest coast of Vancouver Island south of Barkley Sound, and Makah is spoken on Cape Flattery, the northwest tip of the Olympic Peninsula.

[3] In this chart, I represent graphically the secondary glottalization phase of glottalized voiceless obstruents after the primary consonantal phase, but that of glottalized voiced stops and resonants before their primary consonantal phase, following Haas & Swadesh (1933). I assume that this transcription indicates different realization of glottalic closure depending upon manners of articulation of consonants. That is, resonants and voiced stops, which are both voiced in these languages, are preglottalized, but voiceless obstruents are postglottalized in these languages. My assumption is in part supported by some arguments (Sapir 1938, and Steriade 1997, among others). Steriade argues that glottalic closures of glottalized resonants and obstruents are realized differently in many languages, and Sapir suggests that in many First Nations languages and specially in Wakashan languages, glottalized resonants and voiced stops, and voiceless obstruents are realized differently with respect to glottalic closure. The different written forms of the former and the latter reflect this in the chart. Although this issue is not of my interest in this paper, my assumption is also supported by an arguably incorrect observation that a voiced stop is metathesized with the glottal stop of a glottalizing suffix in Ditidaht, which will be dealt with in detail in section 2.2.3.

[4] In Wakashan, only Ditidaht and Makah underwent this change.

[5] Here I just introduce and describe data, following existing research.

[6] Suffixes are classified into lexical (or derivational) or grammatical (or inflectional) ones. Lexical suffixes provide an independent part of the word's meaning or a dependent meaning which is completed only in conjunction with the total meaning of the root-suffix combination to which it is attached, and are ordered between root and grammatical suffix. On the other hand, grammatical suffixes consist of elements which provide Mode, Modal, and pronominal information. So their schematic order with a root is as follows (cf. Rose 1976):
[[[Root] + [Lexical suffixes]]$_{Stem}$ + [Grammatical suffixes]]$_{Word}$. This morphological structure is very important to my analysis in OT in section 3.

[7] According to Sapir (1938), a pronunciation of a sequence of two consonants, *ʔ* + C, for a glottalized consonant is always resisted by the native's ear as incorrect.

[8] In section 3, I assume that glottalization triggering suffixes begin with a floating feature [C.G.], in which case the metathesis analysis cannot be available since metathesis occurs between two segments, not between a segment and a feature.

[9] The feature [Stop] is used to refer to both stops and affricates, following Rice (1994).

[10] In the tableaux, = signifies a stem boundary, and # a word boundary.

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