Glottalization in Nuu-chah-nulth (Nootka): A module interaction case

Eun-Sook Kim
University of British Columbia

This paper investigates glottalization in Ahousaht Nuu-chah-nulth. To understand the phenomenon, it is necessary to look at the morphology of the language and phonetic properties of glottalized consonants. I provide a constraint-based account of unique properties of glottalization of the language.

1 Introduction

One of the geographical areas with the highest concentration of glottalized sounds is the Pacific coast area ranging from California to Alaska. In the Wakashan languages, spoken in the West Cost and interior areas in Canada, each plain consonant has its glottalized counterpart except for the fricative sounds. Nuu-chah-nulth, which along with Ditidaht and Makah constitutes the Southern Wakashan branch of the Wakashan language family, has almost the same phonemic inventory regarding glottalized sounds as other Wakashan languages but exhibits relatively complex properties with respect to glottalization. First, a stop/affricate is glottalized before a glottalizing suffix. Second, there are no glottalized fricatives and thus no glottalization of fricatives. Third, there is no derived glottalized resonant, i.e. no glottalization of resonants, although the Nuu-chah-nulth phonemic inventory has glottalized resonants. Finally, there are some exceptions in the classes of fricatives and resonants with respect to glottalization.

Previous studies (Sapir 1938, Jacobsen 1969, Gamble 1973, and Rose 1976) deal with only some properties of glottalization in Nuu-chah-nulth. The goal of this research is to provide a complete account of characteristics of glottalized consonants and glottalization in Nuu-chah-nulth, using Optimality Theory (Cf. McCarthy & Prince 1993a, 1995, Prince & Smolensky 1993, Pulleyblank 1996 etc.). Section 2 illustrates examples at issue, and section 3 discusses basic mechanisms for the analysis of glottalization in Nuu-chah-nulth. Section 4 shows tableaux providing an analysis for each case: glottalization and non-glottalization. In section 5, some theoretical possibilities under which exceptional cases can be treated are discussed. Finally, section 6 summarizes the key ideas of this study and mentions some remaining issues.

2 Data

The phonemic inventory of consonants in Nuu-chah-nulth reflects not only the fact that glottalized consonants are independently phonemic but also which kinds of consonants can be glottalized.[1] Therefore, it is necessary to illustrate it before data are shown.

2.1 The consonant inventory of Nuu-chah-nulth

Consonants show contrasts in quite extensive places of articulation in Nuu-chah-nulth, which, in fact, is one of the phonological properties of the Northwest Indigenous languages. The consonant chart (1) shows that each stop (except for the uvular and the labio-uvular stop), affricate, and resonant has its glottalized counterpart but a fricative doesn't.[2]

[1] Nuu-chah-nulth (Nootka) is spoken on the West Coast of Vancouver Island from Barkely Sound north to Quatsino Sound and consists of 13 dialects. The data in the paper are from the Ahousaht dialect.

[2] In Nuu-chah-nulth, there is no glottalized uvular and labio-ubular stop and instead they are realized as a pharyngeal stop /ʕ/, which is mentioned in Jacobsen 1969 as well. Although this needs further research, I will not discuss this issue, since it is beyond the scope of this study.

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

	Labial	Alveo-lar	Palatal	Lateral	Velar	Labio-Velar	Uvular	Labio-Uvular	Pharyn-geal	Glottal
Stops/ Affricates	p	t c	č	ƛ	k	k^w	q	q^w		
Glottalized	p̓	t̓ c̓	č̓	ƛ̓	k̓	$k̓^w$			ʕ	ʔ
Fricatives		s	š	ɬ	x	x^w	x	x^w	ḥ	h
Resonants	m	n	y			w				
Glottalized	m̓	n̓	y̓			w̓				

2.2 Data

Nuu-chah-nulth is what is called a 'polysynthetic' language where ideas are mainly delivered by morphologically complex, long word-forms by suffixation. Some suffixes in the language trigger glottalization, where a preceding plain consonant becomes its glottalized counterpart. However, not every preceding consonant is affected. A stop and an affricate only become glottalized as in (2) but a fricative and a resonant usually doesn't as in (3-4).

(2) When a stop/affricate precedes a glottalizing suffix

a. hapt-ʔaaʔa → hap̓aaʔa
hide-rock 'to hide among the rocks'

b. maƛ-ʔaaʔa → maƛ̓'aaʔa
tied-rock 'to be tied to the rock'

c. hiist-ʔiƛ → hisst̓iƛ
from-take 'to take (something) from (somewhere)'

d. hiniic-ʔiƛ → hiniic̓iƛ
(take) away-take 'to take (something) away'

(3) When a fricative precedes a glottalizing suffix

a. c̓ax-ʔaaʔa → c̓axʔaaʔa
strike-rock 'to strike the rock'

b. ɬaḥ-ʔaaʔa → ɬaḥʔaaʔa
lie-rock 'to lie on the rock'

c. c̓uš-ʔiƛ → c̓uušʔiƛ
new-take 'to take (something) new'

d. λuɬ-ʔiƛ → λuuɬʔiƛ
nice-take 'to take (something) nice'

(4) When a resonant (nasal) precedes a glottalizing suffix[3]

a. čim-ʔaaʔa → čimʔaaʔa
comfortable-rock 'to be comfortable on the rock'

b. husmin-ʔaaʔa → husminʔaaʔa
kelp-rock 'kelp on the rock'

c. haʔum-ʔiƛ → haʔumʔiƛ
food-take '(going somewhere) to get food'

[3] In Nuu-chah-nulth, a glide does not appear morpheme-finally or in coda position, and thus it is not available to test glottalization of a glide. So a resonant means only a nasal here.

The inventory of glottalized consonants and glottalization in Nuu-chah-nulth are notable in three respects. First, glottalization is driven by a morphological factor: only some specific suffixes cause glottalization. Second, there are no glottalized fricatives, which is closely associated with no glottalization of fricatives. Third, there is no derived glottalized resonant, i.e. no glottalization of resonants, although Nuu-chah-nulth has underlying glottalized resonants. These complex aspects show that the Nuu-chah-nulth glottalization is an example where phonology interacts with other linguistic modules, i.e. phonetics and morphology, to produce output forms in the phonological phenomenon. In the next section, I suggest several mechanisms by which the complex aspects of the Nuu-chah-nulth glottalization are analyzed.

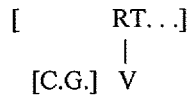
3 Proposal

In this section, basic mechanisms, under the Optimality Theory (henceforth OT), to deal with the issues raised in the end of section 2 will be discussed. Section 3.1 treats a morphological aspect of glottalization, section 3.2 and 3.3 discuss fricatives and resonants in terms of their phonetics regarding glottalization, respectively.

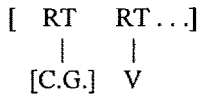
3.1 A floating feature [Constricted Glottis]

In Nuu-chah-nulth, glottalization occurs only between morphemes. That is, when a specific morpheme with a glottalization triggering factor is attached to another morpheme, a glottalization phenomenon occurs, and also the triggering factor is not a glottal stop /ʔ/ itself. For some suffixes do not cause glottalization even if they have a glottal stop in their initial position. Therefore, I suggest that a glottalizing suffix includes a floating feature [Constricted Glottis] (henceforth [C.G.]), while a non-glottalizing suffix has a glottal stop, and that they can be represented as in (5) (Here, RT represents a root node and V represents a vowel, simplifying a feature geometry of any vowel). (6) is the example where both a glottalizing and a non-glottalizing suffix appear.

(5) a. Glottalizing Suffix: [C.G.]. . .



b. Non-glottalizing Suffix: /ʔ/. . .



(6) yaaʔak-[C.G.]ap-ʔiš → yaaʔaḵapʔiš
like-CAUS-3sg S/he likes ....

In (5), the floating feature of a glottalizing suffix must link to a root node in order to appear on the surface: as glottalization on a preceding segment or as a full glottal stop, depending on the phonological context, while a feature already linked to a root node, as in a non-glottalizing suffix, does not have to link to another root node. This explains why only some suffixes cause glottalization in Nuu-chah-nulth straightforwardly, solving the problem with an analysis which assumes that both a glottalizing and non-glottalizing suffix have a glottal stop (Cf. Sapir (1938) and Rose (1976). This assumption does not provide an answer to the question of why, if both kinds of suffixes have a glottal stop, only one kind of suffix causes glottalization.

In sum, the presence of a floating feature [C.G.] distinguishes a glottalizing suffix from a non-glottalizing suffix with a glottal stop in its initial position.

3.2 Fricatives in glottalization

Nuu-chah-nulth does not have glottalized fricatives and thus a fricative is not affected by a glottalizing suffix even if it is in an environment where otherwise it could be. It is not surprising, however, for the lack of glottalized fricatives and no glottalization in that class are due to the physiological mechanism of sound production. When a fricative is produced, an air tunnel is formed by which frication of air energy is made, whereas a glottalic sound is produced by a combination of rapid vertical movement of the glottis and air compression in a small chamber in the mouth. Consequently, the articulatory operations for the former and the latter are against each other, which makes it difficult to make a glottalized frictive (Cf. Wang 1968, Greenberg 1970, Lindau 1984, and Vaux 1998). The articulatory difficulty of a glottalized fricative is

reflected on the fact that typologically its presence is rare. According to Sapir (1938), a very large number of American indigenous languages have glottalized stops/affricates (ejectives) but glottalized fricatives are very rare. Hence, the presence of glottalized fricatives in some languages such as Mazahua (Spotts 1953), and Huautla Mazutec (Gloston & Kehrein) is considered as marked cases.

Let's see how the lack of glottalization in fricatives can be treated under the Optimality Theory. As shown in (3), glottalization does not affect fricatives and the floating [C.G.] feature of a gottalizing suffix surfaces as a full glottal stop. This results from the following universal constraints and their language-specific ranking. Consider the constraints first (Here, I will introduce only major constraints relevant to our discussion):

(7) Faithfulness Constraint: A constraint that requires a correspondence relationship between an input element and its output counterpart.

a. MAX[C.G.]: [C.G.] in the input must have a correspondent in the output.
b. DEP-R(oot): Any root node in the output must have a correspondent in the input.
c. DEPPATH[C.G.]: Any output path between [C.G.] and an anchor must have a correspondent path in the input.

(8) Cooccurrence-Restriction Constraint: A constraint that prevents some specific features from being linked under the same root node.

*[C.G.]/[Cont]$_{OBS}$: [C.G.] and [Continuant] in an obstruent cannot cooccur.[4]

(9) Alignment Constraint: A constraint that requires an alignment relationship between two phonological units or between a phonological and a morphological unit.

ALIGN-R([C.G.], STEM)/ALIGN-R-STEM: [C.G.] is aligned with the right edge of a stem.

(10) shows the ranking of these constraints (>> symbolizes the ranking between constraints; its left side is higher than its right side):

(10) **MAX[C.G.], *[C.G.]/[Cont]$_{OBS}$, >>ALIGN-R-STEM >> DEPPATH[C.G.] >> DEP-R**

This ranking determines both no presence of glottalized fricatives and no glottalization of fricatives in Nuu-chah-nulth. Nuu-chah-nulth does not allow the [C.G.] feature and the [Cont] feature to be linked under the same root node but it does also not allow delete a [C.G.] feature in the input. Therefore, the only way to surface the floating [C.G.] feature is to insert a root node, leading to the realization of the feature as a full glottal stop. This is only possible by ranking the two constraints *[C.G.]/[Cont]$_{OBS}$ and MAX[C.G.] higher than the constraint DEP-R and the constraint DEPPATH[C.G.], which prevents linking or spreading of a feature, is also not crucial in this phenomenon.[5] Finally, the constraint ALIGN-R-STEM restricts the linking location of the [C.G.] feature to a stem-final element.

3.3 Resonants in glottalization

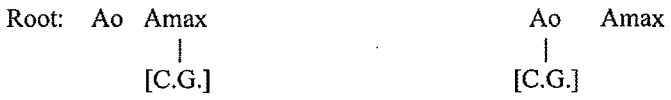
Nuu-chah-nulth does not have a derived glottalized resonant, although it has underlying glottalized resonants as shown in the consonant chart (1). This is a notable phenomenon. In many languages, glottalization affects resonants. For example, in Yowlumne (Steriade 1997) and Coeur d' Alene (Cole 1991), only resonants are glottalized before a glottalizing suffix, and in some Salish languages such as Shuswap, Lushootseed, Saanich and Spokane (Caldecott 1999) glottalization affects both obstruents and resonants. As mentioned in Sapir (1938), typologically glottalized resonants are more frequent than

[4] The scope of application of this constraint needs to be limited to an obstruent since a glide has the feature [Cont] and since Nuu-chah-nulth has glottalized glides. In fact, glottalized glides are quite frequent in American indigenous languages.
[5] Although the lack of glottalized fricatives are a universal tendency cross-linguistically for the physiological reason and thus the cooccurrence constraint is generally higher-ranked in many languages, we expect that in some marked cases like Mazahua and Huautla Mazutec, the constraint will be lower-ranked, which is one of the major principles in OT.

glottalized fricatives. As a result, the lack of glottalization in resonants must be interpreted differently from no glottalization of fricatives in Nuu-chah-nulth.

I suggest that the presence/absence of derived glottalized consonants is associated with the phonetic timing of the glottalic constriction of a glottalized consonant. That is, in Nuu-chah-nulth, a glottalized resonant is preglottalized (Fig. 1 in Appendix) but a glottalized obstruent is postglottalized (Fig. 2) (here, a glottalization phase is shown by silence, i.e. no energy, on the spectrogram). 'Preglottalization' means that when a glottalized consonant is produced, the oral release precedes the glottalic release for the consonant, while 'postglottalization' means that the oral release of the consonant occurs after the glottalic release. The difference between a glottalized obstruent and a glottalized resonant in terms of phonetic timing of the glottalic constriction causes a different realization of the [C.G.] floating feature, which will be discussed in detail in the next section. I represent a glottalized stop and a glottalized resonant as in (11), applying Steriade (1997), where a root node consists of two articulatory gestures, e.g. a stop has a root node which consists of Ao (closure) and Amax (maximally open/release):

(11) a. Glottalized stop (postglottalized) b. Glottalized nasals (preglottalized)



In (11a), the glottalic constriction is released as soon as the oral constriction is released, while in (11b), the glottalic constriction is released before the oral constriction is released. This disintegrated root concept is reflected in the following alignment constraint (Cf. McCarthy and Prince 1993a):

(12) Alignment Constraint

a. ALIGN-R([C.G.], Root)/ALIGN-R: [C.G.] is aligned with the right edge of a root node.[6]
b. ALIGN-L([C.G.], $\text{Root}_{\text{Res.}}$/ALIGN-L-Res.: [C.G.] is aligned with the left edge of a root node in a resonant.

The Nuu-chah-nulth grammar determines the lack of glottalization in resonants, although it allows glottalized resonants in the phonemic inventory, by ranking the constraints above as follows:

(13) The Nuu-chah-nulth grammar
MAX[C.G.] >> ALIGN-R-STEM >> ALIGN-L-Res. >> ALIGN-R >> DEPPATH[C.G.] >> DEP-R

The floating feature [C.G.] is linked to a stem-final element, in particular the right edge of the root node, obeying the constraints ALIGN-R-STEM and ALIGN-R, which is fine with the case of an obstruent since in Nuu-chah-nulth a glottalized obstruent is postglottalized. However, as we saw above, the Nuu-chah-nulth glottalized resonants are preglottalized; the constraint ALIGN-L-Res. restricts the location of the glottalic constriction in a glottalized resonant to the left of a root node. The conflict between two alignment constraints, ALIGN-R and ALIGN-L-Res. is solved by ranking the latter higher than the former. As a result, the higher-ranking status of ALIGN-L-Res. does not allow the floating feature to be linked to the right edge of the stem-final root node. If, however, it is linked to the left edge to avoid violating the constraint, then it will violate the ALIGN-R constraint, which is still higher ranked. Again, the only way for the floating [C.G.] feature to surface is to insert a root node. As in the case of fricatives, the floating feature is realized as a full glottal stop (In order to explain the presence of an underlying glottalized resonant, we need another constraint which we will discuss in section 4.3.2).

4 Analysis

In this section, we will discuss how the distribution of glottalized consonants and glottalization in Nuu-chah-nulth are treated by the constraints suggested above and their ranking. A floating feature is realized

[6] 'Root' in (12) is a phonological term (Cf. 'STEM' in (9), which is a morphological term). To prevent confusion with respect to terminology, I use capital letters only for morphological units in this paper.

differently depending upon the phonological context. A separate section will be given to stops/affricates, fricatives and resonants respectively.

4.1 Stops/affricates and glottalization

In Nuu-chah-nulth a plain stop/affricate has its glottalized counterpart and it never fails to be glottalized in the context where it precedes a glottalizing suffix. The following tableau shows how a plain stop surfaces as a glottalized stop before a glottalizing suffix.

(14)=(2a) a. hapt-[C.G.]aa?a → hapt'aa?a
hide-rock 'to hide among the rocks'

b. Tableau[7]

hapt=[C.G.]	MAX-[C.G.]	ALIGN-R-STEM	ALIGN-R	DEPPATH [C.G.]	DEP-R
a. hap't=			*!	*	
b. hapt=	*!				
c. hapt?=				*	*!
d. hap't=		*!		*	
e. ☞hapt'=				*	

In Tableau (14b), candidate **a** has a preglottalized phase in the stop, violating the higher-ranked constraint ALIGN-R, which requires the [C.G.] feature is aligned with the right edge of a root node. Candidate **b** violates another higher-ranked constraint MAX[C.G.], which disallows the input feature [C.G.] to be deleted in the output. Candidate **d** is ruled out by violating the constraint ALIGN-R-STEM, which requires the [C.G.] feature is aligned with the right edge of a stem. Candidates **c** and **e** tie in the constraint DEPPATH[C.G.], which requires an output path between a feature and its anchor to have a correspondent path in the input. Since the feature [C.G.] is not linked any root node in the input, any candidate is supposed to violate this constraint to avoid violating the higher constraint MAX[C.G.]. Eventually, the DEP-R constraint determines candidate **e** as an optimal output. Candidate **c** violates the constraint by inserting a root-node.

In sum, the Nuu-chah-nulth grammar, which consists of universal constraints and their language-specific ranking, requires that when the affected consonant in the glottalization phenomenon is a stop or an affricate, it be glottalized, in particualr postglottalized. Since the restriction on the location of the glottalic constriction in a stop/affricate in terms of phonetic timing applies to an underlying glottalized stop/affricate as well, the constraints and their ranking explains the distribution of glottalized stops/affricates and derived glottalized ones in a unified way.

4.2 Fricatives and glottalization

Nuu-chah-nulth does not have a glottalized fricative, which is associated with the lack of glottalization in the fricative class. As we discussed above, a combination of articulatory gestures for a fricative and a glottalic constriction are not preferred language universally. In Nuu-chah-nulth, the higher ranking status of the constraint *[C.G.]/[Cont] plays a decisive role in selecting an optimal output form. Let's consider the following case:

(15)=(3a) a. c̓ax-[C.G.]aa?a → c̓ax?aa?a
strike-rock 'to strike the rock'

[7] In the tableaux, = signifies a stem boundary, and 'C means a pregottalized consonant and C' a postglottalized consonant. Also, for space reason, I show only the floating [C.G.] feature from a glottalizing suffix.

b. Tableau

c̓ax =[C.G.]	MAX[C.G.] *[C.G.]/[Cont]	ALIGN-R-STEM	DEPPATH [C.G.]	DEP-R
a. c̓a'x=	*!		*	
b. c̓ax'=	*!		*	
c. c̓ax=	*!			
d. c̓a'x=		*!	*	
e. ☞ c̓ax?=			*	*

In Tableau (15b), the alignment constraints concerning a root node are not crucial because anyhow Nuu-chah-nulth does not allow a glottalized fricative; hence I do not include them here. Candidate **a** and **b** violate the higher-ranked constraint *[C.G.]/[Cont], which disallows the features [C.G.] and [Cont] to be linked under the same root node. In candidate **c**, the [C.G.] feature in the input is not realized on the surface, violating MAX[C.G.]. Candidate **d** violates the constraint ALIGN-R-STEM since the [C.G.] feature is not aligned with the right edge of the stem. Candidate **e**, where the [C.G.] feature surfaces as a full stop with the violations of the constraints DEPPATH[C.G.] and DEP-R, is selected as an optimal output.

In sum, the Nuu-chah-nulth grammar, when a fricative is in the context where it can be affected by a glottalizing suffix, chooses no glottalization by surfacing the floating feature as a full glottal stop. This is said to be an unmarked case. However, as mentioned above, Mazahua and Huautla Mazatec have glottalized fricatives. Although they are examples of marked cases, the presence of glottalized fricatives can be explained by the language-specific lower-ranking status of the universal constraint *[C.G.]/[Cont].

4.3 Resonants and glottalization

Nuu-chah-nulth has glottalized resonants underlyingly, but glottalization does not affect plain resonants. Again, this unusual case can be explained by some universal constaints and their language-specific ranking. The lack of glottalization in the class of resonants and the presence of glottalized resonants in the phonemic inventory will be dealt with in a separate section respectively.

4.3.1 No glottalization of a resonant

When a plain resonant precedes a glottalizing suffix, it is not glottalized. Consider the following tableau:

(16)=(4a) a. č̓im- [C.G.] aa?a → č̓im?aa?a
comfortable-rock 'to be comfortable on the rock'

b. Tableau

č̓im=[C.G.]	MAX-[C.G.]	ALIGN-R-STEM	ALIGN-L-Res.	ALIGN-R	DEP PATH[C.G.]	DEP-R
a. č̓i'm=				*!	*	
b. č̓im'=			*!		*	
c. č̓im=	*!					
d. č̓i'm=		*!			*	
e. ☞ č̓im?=					*	*

In Tableau (16b), candidate **a** is ruled out by violating the relatively higher-ranked constraint ALIGN-R. Candidate **b** violates the constraint ALIGN-L-Res., which requires a [C.G.] feature is aligned with the left edge of the root node in a resonant. Note that the nasal is postglottalized, which is not allowed in Nuu-chah-nulth. Therefore, the language-specific ranking status of this constraint rules out candidate **b**. Candidate **c** and **d** violates the higher ranked constraints MAX[C.G.] and ALIGN-R-STEM respectively. As a result, candidate **e** is selected as an optimal output form. Again, even if the optimal output violates the two lower-ranked constraints DEPPATH[C.G.] and DEP-R, their violations are not crucial now that it obeys all the higher ranked constraints.

4.3.2 Underlying glottalized resonants

Although glottalization does not affect a resonant, this does not mean that Nuu-chah-nulth does not have glottalized resonants in its phonemic inventory. Typologically, glottalized resonants are relatively quite frequent, compared to glottalized fricatives.
In an underlying glottalized resonant, the link of the [C.G.] feature in the input must be preserved in the output. The two MAX constraints, in particular MAXPATH[C.G.] in (17), will play an important role in the preservation of the feature (Cf. Pulleyblank 1996):

(17) MAXPATH[C.G.]: Any input path between [C.G.] and an anchor must have a correspondent path in the output.

The MAXPATH constraint requires a correspondent relationship between input and the output concerning a path between a feature and an anchor, disallowing the path to be deleted or members linked by the path to be changed.

Let's consider the following example:

(18) a. m' aa 'to bite'

b. Tableau

maa | [C.G.]	MAX-[C.G.]	MAXPATH-[C.G.]	ALIGN-R-STEM	ALIGN-L-Res.	ALIGN-R	DEPPATH [C.G.]	DEP-R
a. m'aa=			*	*!		*	
b. maa=	*!	*					
c. m?aa=		*!	*			*	*
d. maa'=		*!				*	
e. ☞'maa=			*		*		

In Tableau (18b), as the violations of candidates **b**, **c**, and **d** on the higher ranked MAX constraints reveal, when a feature is already linked to a root node in the input, it is supposed to violate any MAX constraint if the feature is either deleted or linked to another root node in the output. Candidate **a** and **e** tie in the constraint ALIGN-R-STEM, and the next ranked constraint ALING-R-Res. determines the optimal output, which is candidate **e**. Note that the glottalic phase of an underlying glottalized resonant is preserved in the output, while, as in (16), the glottalic phase is realized as a full glottal stop if the resonant to be affected is a plain consonant even if it immediately precedes a glottal feature. This difference is due to the interaction of the MAX and alignment constraints with other lower ranked constraints.

In sum, OT provides a straightforward answer to the question of why Nuu-chah-nulth exhibits such a unique phonological behavior with respect to the phonemic inventory and glottalization in the case of resonants.

5 Exceptional cases

OT explains cross-linguistic variation in terms of the phonemic inventory of glottalized consonants and glottalization in Nuu-chah-nulth. However, there are some exceptional cases in the classes of fricatives and resonants. In this section, it is discussed how these exceptions can be treated.

In section 2, we saw glottalization does not affect fricatives and resonants, and in section 4, the lack of glottalization in these classes was straightforwardly explained under OT. However, the following examples (19-20) raise a problem in our analysis:

(19) Fricatives

a. kʷis-[C.G.]aa?a	→	kʷiy'aa?a
snow-rock		'snow on the rock'
b. kʷis-[C.G.]aḥs	→	kʷiy'aḥs
snow-vessel		'snow in a boat'
c. kʷis-[C.G.]as	→	kʷiy'as
snow-ground		'snow on the ground'
d. kʷis-[C.G.]iic	→	kʷiy'iic
snow-eat		'to eat snow'
e. kʷis-[C.G.]iƛ	→	kʷiiy'iƛ
snow-take		'to get snow'

(20) Resonants

a. cam-[C.G.]aqƛ	→	cam'aqƛ
oven-inside		'something in the oven'
b. ?am-[C.G.]akƛi	→	?am'akƛi
?-rear		'buttock'

In (19), a fricative /s/ becomes a glottalized glide /y' / before a glottalizing suffix and in (20), a nasal /m/ becomes its glottalized counterpart /m'/. Also, each morpheme-final fricative in *hiɬ* 'Locative', *hiš* 'all', and *camas* 'sweet' becomes a glottalized glide /y' / before any glottalizing suffix.

We have three scenarios to deal with these exceptional cases. First, only some specific glottalizing suffix causes glottalization of fricatives and resonants. This scenario does not work, for as shown in (3-4), the same glottalizing suffixes do not trigger glottalization in the fricatives and resonants from other morphemes. Second, glottalization has terminated before it affects all lexical items. This scenario is possible, for the presence of glottalization only in some lexical items may tell us that this phenomenon has stopped in Nuu-chah-nulth before it glottalized all fricatives and resonants in the language. Third, glottalization is still in progress even if it is slow: lexical diffusion. This scenario is possible as well, and in fact, many sound change irregularities are explained by the notion of lexical diffusion (Gamble 1973). As in the second scenario, if some lexical items undergo glottalization in certain consonant groups, but some don't, we can expect that this phonological change is lexically gradual.

To find which one is the case, it may be the best way to compare Ahousaht and other dialects or do a diachronic study of Ahousaht. Besides, what needs further research is morphologcal factors that are involved in glottalization. Even if only a fricative in some morphemes becomes a glottalized glide, it is not affected if the glottalizing suffix in question is grammatical, or inflectional, as in (21):[8,9]

(21) a. kʷis-?aƛ-uk-?ick	?aḥnii.	→	kʷis?aƛuk?ick . . . .
Snow-SEQ-POSS-2sg	here		'You have snow here'
b. hiɬ-?aƛ-uk-?ick	?aḥ qʷaa?uuc	→	hiɬ?aƛuk?ick . . .
LOC-SEQ-POSS-2sg	here sister		'Your sister is here'

In the data given in section (2), the morphological categories of a glottalizaing suffix, whether it is derivational or inflectional, do not matter with respect to the presence/ absence of glottalization depending

[8] I have not had any examples of this case in resonants yet.

[9] A grammatical suffix is one that signifies a grammatical relationship between morphemes like tense, mood, aspect, possession, etc., while a lexical, or derivational, suffix is one which provides an additional semantic content to a stem.

on the phonological context. However, in these exceptional cases, morphological categories give an important cue concerning glottalization.

In order to understand glottalization of Nuu-chah-nulth completely, these exceptional cases need to be clearly explained, but I will leave these issues open just for now.

6 Conclusion

The phonemic inventory of glottalized consonants and glottalization in Nuu-chah-nulth exhibit several cross-linguistic variations in that (1) no failure of glottalization in stops/affricates, (2) the lack of glottalized fricatives in the phonemic inventory and no glottalization in fricatives, (3) the lack of derived glottalized resonants but the presence of underlying glottalized resonants and (4) The triggering factor of glottalization is morphologically based. Optimality theory (OT) provides a complete account of these complex properties in Nuu-chah-nulth, with a simple set of universal constraints and their language-specific ranking. Universal constraints occupy one of the key parts in a constraint-based theory like OT, and some of them that are introduced in this study are based on phonetic and morphological information. Therefore, the Nuu-chah-nulth glottalization is one of the cases where linguistic modules interact with each other.

However, there is still an open issue. In spite of general lack of glottalization in fricatives and resonants, a fricative or a resonant in some lexical items is glottalized. Whether these exceptions are due to phonological or morphological (or lexical) factors will be revealed by further research.

Appendix

Fig. 1

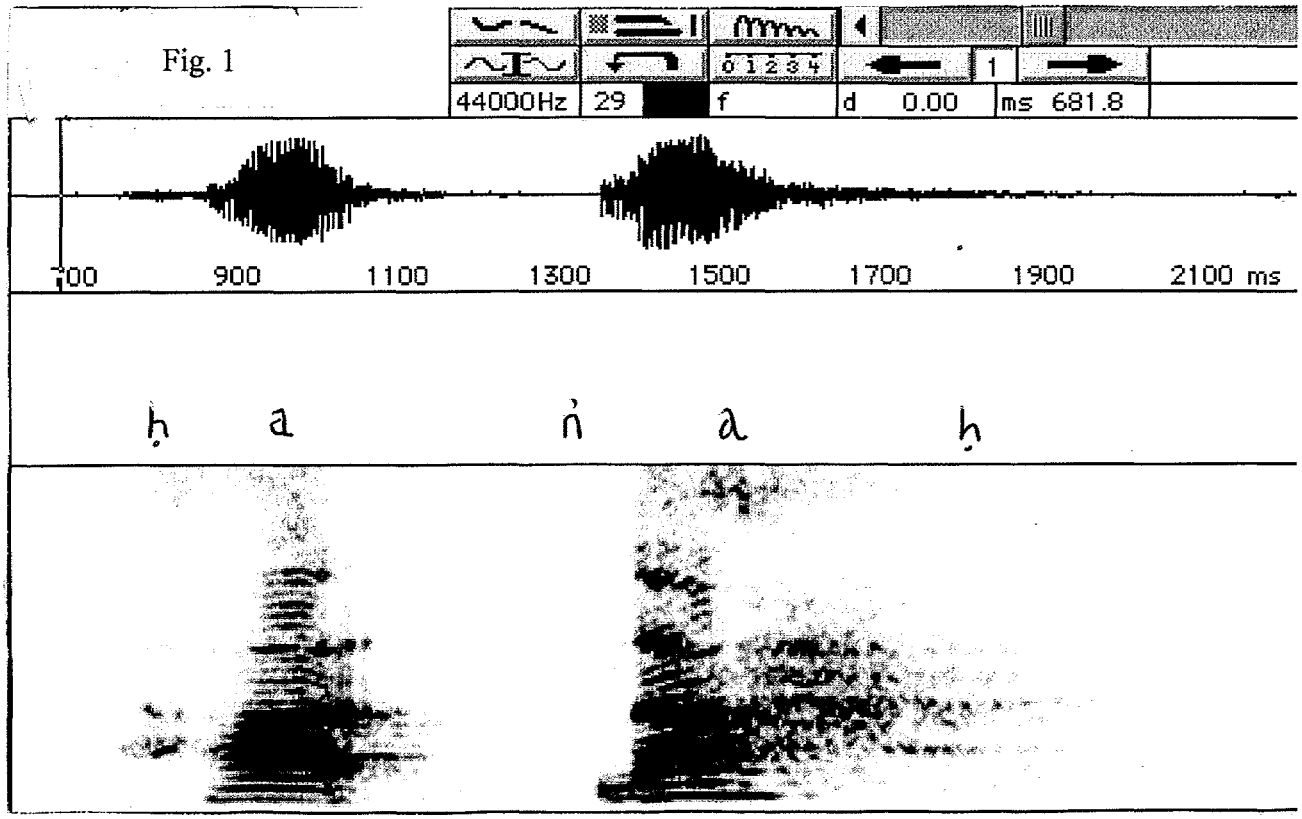
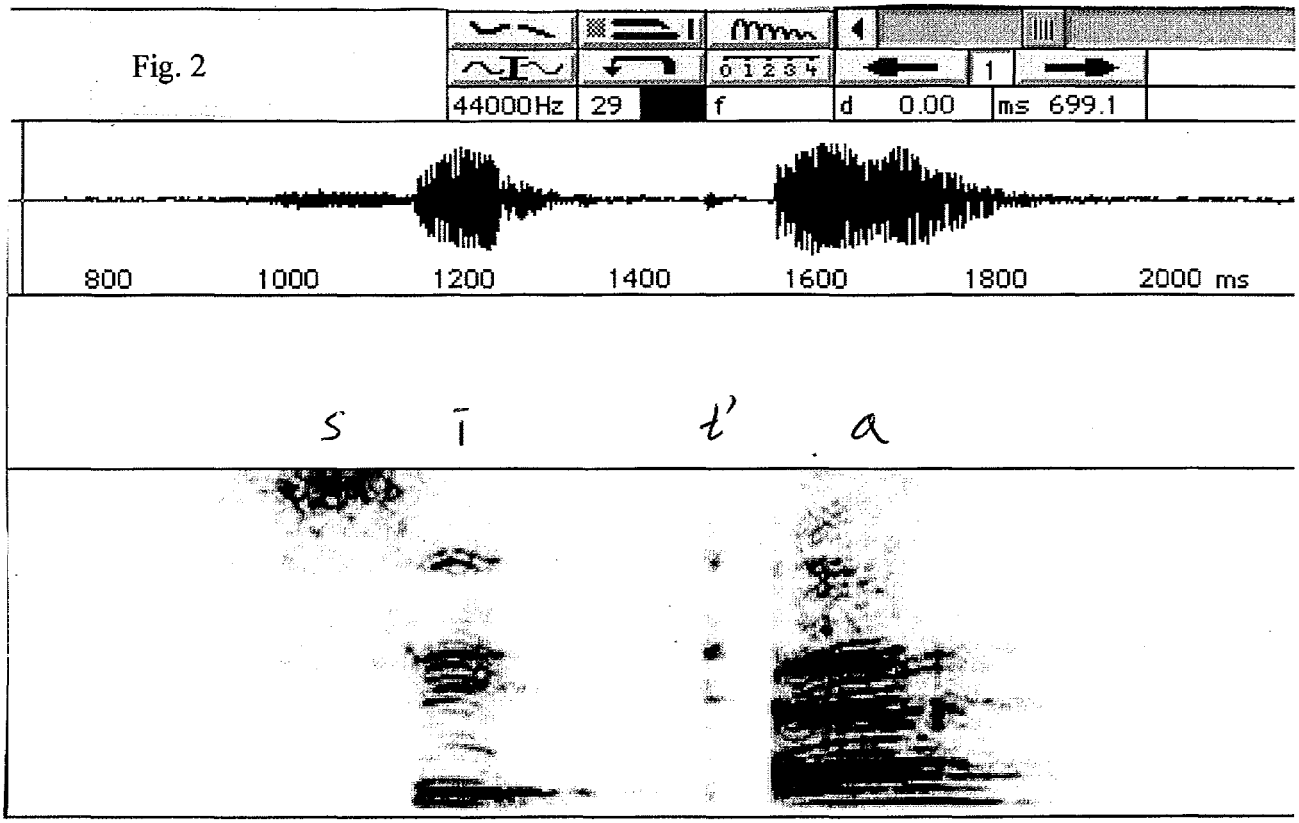


Fig. 2



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