Patterns of (De)glottalization in Nivaĉle

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1. Introduction

The featural representation and phonemic status of the glottal stop, its surface realizations, and glottalization on vowels, have posed a long standing problem for the phonological analyses of languages of the Americas (Archangeli & Pulleyblank 1994, Silverman et al. 1995, Macaulay & Salmons 1995, Avelino 2004, Gerfen & Baker 2005, Stenzel 2007, Elías-Ulloa 2009, Chávez-Peón 2010, among many others).

Most of the challenges posed by the glottal stop arise from its ambiguous patterning. On the one hand, the glottal stop can pattern with either stops or sonorants. On the other hand, it can get realized as a full segment or as glottalization in the same language (Zoll 1998 [1996]). In that regard, what is commonly referred to in phonological inventories as 'glottal stop' has been variously analyzed as: i) a full independent segment (e.g., Yalálag Zapotec, cf. Avelino 2004); ii) a constricted glottis ([c.g.]) feature on vowels (e.g. Mixtec, cf. Gerfen 1999); iii) a floating constricted glottis feature (e.g., Mixtec, cf. Macaulay & Salmons 1995), and as a floating tone (Tukano, cf. Ramírez 1997 as cited in Stenzel 2007).

Further, unlike other features, which are posited to have a unique structural dominance affiliation within a given feature hierarchy model, the [c.g.] feature has been variously analyzed as directly dominated by a mora in Mixtec (Macaulay & Salmons 1995) and Wanano (Stenzel 2007), exclusively by a non-nuclear mora in Blackfoot (Peterson 2004), by a root node (Zoll 1998), or a laryngeal ([LAR]) node (Clements & Hume 1995).

The relationship between the glottal stop and vowels in Mataguayan languages (Chorote, Maká, Nivaĉle, and Wichí) has not been thoroughly studied. What seems to be consistent in the previous literature, though, is its treatment as a consonant rather than as a vocalic feature. Gerzenstein (1983, 1994) includes the glottal stop in the consonantal phonemic inventory of Chorote and Maká, and states that this consonant can occur in word initial, medial (between homorganic vowels), and final position. However, neither the featural representation of the glottal stop nor the nature of the relationship with the homorganic vowels that are interrupted by it is addressed. In turn, Nercesian (2014) claims that glottal stop in Wichí can serve as a word-initial and word-final onset and/or coda. In summary, then, glottal articulation has been analyzed as a consonant in Chorote, Maká and Wichí.

Nivaĉle is the only Mataguayan language where glottalization on vowels has been reported as a contrastive feature. Specifically, Stell (1989:97) postulates a phonemic distinction between plain vowels /i e a ɑ o u/ and 'glottalized' vowels /i e̊ a̰ ɑ̰ o̰ ṵ /. As well, she treats the glottal stop as an independent consonantal phoneme in the language /ʔ/. Yet, no formalization or justification for either of those proposals is presented. In contrast, in their article on internal reconstruction in Nivaĉle, Campbell and Grondona (2007:5) present the glottal stop as phonemic, but identify only six vowels /i e a ɑ o u/ in

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the Nivaĉle phonological inventory. The status and representation of Stell's proposed 'glottalized' vowels is not explicitly addressed.

This paper addresses the featural and prosodic representation of the alleged phonemic glottalized vowels (Stell 1989) and the glottal stop, and its patterns of deglottalization. Contra Stell (1989), I claim that there is no phonological opposition between modal vowels and glottalized vowels; Nivaĉle glottalized vowels are underlying sequences of /Vʔ/: a vowel plus a moraic glottal stop with different prosodic parsings. The mora is parsed to the Nucleus of the syllable, and depending on prosodic context, a *rearticulated/creaky* vowel or a *vowel-glottal* coda result. The moraic weight of /ʔ/ is consistently correlated with stress prominence. What will be shown is that Nivaĉle glottalized vowels deglottalize if a /Vʔ/ sequence is not parsed to the head syllable of a foot.

This paper is structured as follows. Section 2 presents an overview of the Nivaĉle language and phonology. Section 3 shows the different prosodic parsings of the glottal stop, and presents evidence for its contrastive value. Further it advances a proposal in which the glottal stop is specified for [c.g.], but not for PLACE. In Section 4, some of the acoustic properties of Nivaĉle glottalized vowels are discussed and a prosodic representation of Nivaĉle glottalized vowels is advanced. In Section 5, some patterns of deglottalization are analyzed. Section 6 concludes with the main findings of this paper.

2. Overview of the Nivaĉle language and phonology

Nivaĉle is a Mataguayan language spoken in the Argentinean and Paraguayan Chaco by approximately 16,350 speakers in Paraguay (DGEEC 2012) and 553 in Argentina (INDEC, 2004-2005). Besides Nivaĉle, the Mataguayan language family (Fabre 2005) comprises three other languages: Chorote, Maká, and Wichí.

The major source of data for this study comes from my own fieldwork with both female and male native speakers of Nivaĉle, belonging to the *shichaam lhavos* 'lowlanders' and *yita' lhavos* 'people of the scrub' varieties.

The phonemic inventory of consonants is presented in Table 1. Of special interest for this study are, the series of ejective stops and affricates and the presence of a glottal stop. Similar to other Mataguayan languages, Nivaĉle has a two-way laryngeal distinction in stops and affricates (plain vs. ejectives) and no voicing contrast (only voiceless) within this class.

Table 1. Nivaĉle consonants

		labial	dent-alv.	palato-alv.	palatal	velar	uvular	glottal
stop	plain	p	t			k	~ [q]	ʔ
	ejective	p'	t'			k'	~ [q']	
	laterally released					k͡l	~ [q͡l]	
affricate	plain		t͡s	t͡ʃ				
	ejective		t͡s'	t͡ʃ'				
fricative		f ~ [ɸ]	s	ɬ ʃ		x	~ [χ] ~	[h]
nasal		m	n					
approximants		w ~ [β]			j			

There are six vowels in Nivaĉle /i e a ɑ o u/. The vowel /a/ patterns with front vowels in processes of palatalization, while /ɑ/ systematically patterns with back vowels.

With regards to phonotactic constraints, the core syllable structure in Nivaĉle consists of the following: CV, CVC, CCV and CCVC. Contrary to Stell, I claim that there are no onsetless syllables in the language, neither word-initially, nor word-medially. That is, the constraint ONSET is undominated.

Onset clusters occur only in word-initial position; coda clusters are never attested. Here the notions of Onset and Coda are not considered as prime prosodic constituents, but rather as prosodic domain edges. I assume that the prime constituents within the syllable are the Nucleus, which functions as the prosodic Head of a syllable (Shaw 1992), and the mora (Hyman 1985). The mora, which serves as the "primitive subsyllabic constituent and as a measure of syllable weight" (Zec 1995:85), gets parsed to the Nucleus of a syllable and therefore plays a crucial role in the quantity-sensitive assignment of stress and, as is argued in this paper, in the realization of the postvocalic glottal stop.

3. Phonological status of glottal stop

In the literature on glottalized vowels in other languages, most of the arguments against treating the glottal stop as a phonemic segment rely on its defective distribution, e.g., the glottal stop may be the only coda in a language, e.g. in Mixe (Macaulay & Salmons 1995), and/or the glottal stop may not occur or be contrastive in initial position (e.g. in Quiaviní Zapotec; Chávez-Peón 2010). As will be shown in the following discussion, the Nivaĉle glottal does not fit this picture; /ʔ/ is the default epenthetic onset but it is also contrastive in onset position. Further, I will argue that, importantly, it can be parsed to either the Nucleus of the syllable or the coda.

Let us turn, then, to an investigation of the phonemic status and feature specification of glottal stop in Nivaĉle. One kind of evidence for the phonemic status of glottal stop in onset position is the contrast shown in the following minimal pair:

(1) a. kumʔá
'crowned eagle'
b. kumxá
'*aloja* (alcoholic drink)'

Further evidence can be found in the contrast between the second person object suffix /-ʔa/ (2a) and the third person object suffix /-a/ (2b):[1]

(2) a. k'-uʔ-éʃ-ʔa
1S-believe-INST-2O
'I believe in you'
b. k'-uʔ-éʃ-a pa = fi͡tsɑk'ɑjitʃ
1S-believe-INST-3O DET= God
'I believe in God'

Let us turn now to a consideration of contexts where glottal stop can be interpreted as serving as a word-final or word medial coda.

CVC is an attested (and frequent) syllable type in the language. Further, Nivaĉle presents an interesting case study in that a CVC syllable can stand alone as a word (Gutiérrez 2015). In contrast, a CV syllable never stands alone as a word. Nor does a CV syllable function as a foot in the stress system, whereas a CVC syllable can. Because there is no prosodic evidence for coda consonants in Nivaĉle being moraic, a CVC word does not satisfy either the bimoraic constraint FT-BIN-μ, or the bisyllabic constraint FT-BIN-σ. Therefore, the smallest word in Nivaĉle does not conform transparently to the Binarity generalization of the prosodically-defined notion of a "Minimal Word". It is proposed nonetheless that CVC in Nivaĉle, despite being monomoraic and monosyllabic, constitutes a Minimal

[1] Abbreviations used in this paper include the following: 1=first person, 2=second person, 3=third person, COL=collective, DET=determiner, INST=instrumental, IPFV=imperfective, LOC=locative, O=object, PL=plural, POSS=possessive, PUNC=punctual, S=subject, VBLZ=verbalizer.

Word and functions also as a minimal well-formed foot, as illustrated in (3). Note that primary stress is represented with an acute accent.

(3) a. (p'ók)
'arrow'
b. (x-én) pa = Jesus
1S-love DET=Jesus
'I love Jesus'

Given the fact that an open [CV] syllable does not constitute a well-formed independent word in Nivaĉle, it is argued that the glottal final in (4) is parsed to coda position and satisfies word minimality.

(4) a. méʔ
'otter'
b. x-úʔ
1S-throw
'I throw'

Instances of glottal stop in word-medial coda can also be found. Examples in (5) show that a coda containing a /ʔ/ can precede both obstruents and sonorants. However, it cannot precede another glottal stop or an ejective, providing evidence of a constraint against adjacent segments specified for [c.g.].

(5) a. ji-páʔ.kɑt
1POSS-hand
'my hand'

b. xi.βéʔ.k͡la
'moon'

c. táʔ.ɬɑs
'vase'

d. náʔ.ni
'girl'

e. xa-péʔ.j-a
1S-her-PUNC
'I hear'

As will be discussed in Section 4, a post-vocalic glottal stop (6a) can be parsed to the Nucleus of the syllable if a following consonant fills the coda position, as the related form in (6b) shows.

(6) a. ɬ-áʔ
3POSS-fruit
'its fruit (of the tree)'

b. t-a̱-j
3S-fruit-VBLZ
'it has fruit'

In (6b) a stative verb 'to have X' is created by suffixation of the verbalizer /-j/ to a ʔ-final nominal root. Given that complex codas are illicit in Nivaĉle the glottal stop (Section 2), in order to optimize I-O faithfulness to both the /ʔ/ and /-j/, the glottal stop is parsed into the nucleus of the syllable and the verbalizer is parsed into the coda.

A further distributional constraint is that that glottal stop can be parsed to coda, whereas ejective obstruents cannot; /p' t' k' t͡s' t͡ʃ'/ only occur before a vowel. Congruent with proposals that maintain that both place and laryngeal features are often restricted in coda position (Itô 1986, Mester & Itô 1989, Itô & Mester 1994; Lombardi 1991, 1995), I claim that whereas both ejectives and glottal stop in Nivaĉle are specified with a [c.g.] feature, only ejectives are specified for place – LABIAL, CORONAL, and DORSAL. Glottal stop is not: it is literally place-less.[2]

[2] For a more detailed argumentation of the placeless specification of Nivaĉle glottal stop see Gutiérrez (2015).

4. Nivaĉle glottalized vowels

One of the central claims in this paper is the close relationship between the variable parsing of glottal stop, rooted in a set of prosodic constraints, and the realization of glottalized vowels in Nivaĉle. On the basis of my fieldwork, I observed two basic categories of realization of Nivaĉle 'glottalized' vowels: the first, I call a *rearticulated/creaky* vowel, represented variably as [Vʔᵛ] (careful speech) ~ [V̰], and, the second I refer to as a *vowel-glottal coda*, represented as [Vʔ]. It has been noted that the implementation of 'glottalized' vowels is subject to variation within and between speakers across languages (Gordon & Ladefoged 2001, Avelino 2004, Gerfen & Baker 2005, Picanço 2005, Munro, Lillehaugen & Lopez 2008).[3] The Nivaĉle glottalized vowels follow this pattern. What I refer to as rearticulated/creaky vowels tend to consist of a modal vowel portion followed by either: (i) a glottal closure released into a short voiceless or creaky vowel [Vʔᵛ] ~ [Vʔᵛ] or (ii) a period of glottalization or creak [VV̰], respectively. The alternation between (i) [Vʔᵛ] ~ [Vʔᵛ] and (ii) [V̰], is, according to my fieldwork research, mostly due to speech style factors, (formal vs. casual speech). Yet overall, despite the variability in the production of Nivaĉle glottalized vowels, these vowels involve a sequencing of modal phonation and laryngealization, similar to Coatzospan Mixtec laryngealized vowels (Gerfen & Baker 2005).

There are two important observations about the distribution of the Nivaĉle glottalized vowels. First, they never occur in an unstressed context. Secondly, in the case of rearticulated vowels, stress is consistently realized on the first, not the second (or "rearticulated") portion of these sequences. Based on this observation, I claim that the "rearticulated" portion does not constitute a second, separate syllable. Rather, these "rearticulated" vowels constitute a single complex bimoraic syllable nucleus. Figures 1 and 2 illustrate the alternative realization of rearticulated and creaky vowels, respectively. Note that both the rearticulated [Vʔᵛ] and the creaky variant [V̰] have approximately identical duration: 200 ms.

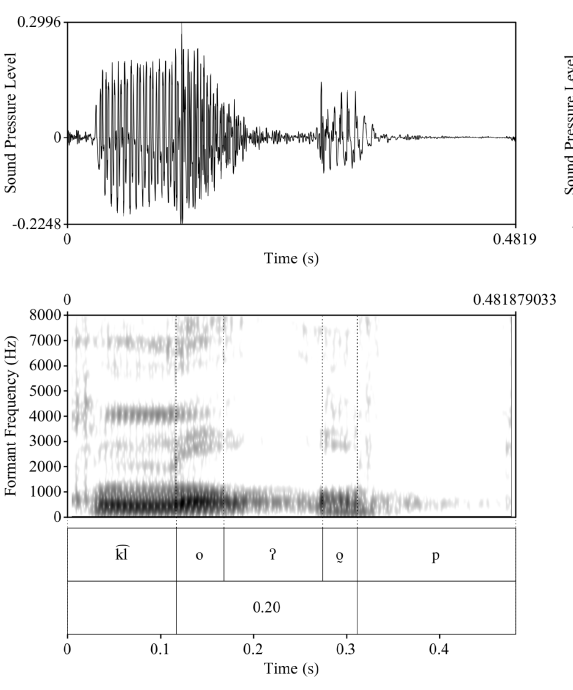

Figure 1. Waveform and spectrogram of [k͡lóʔᵒp] 'winter' by male speaker MV

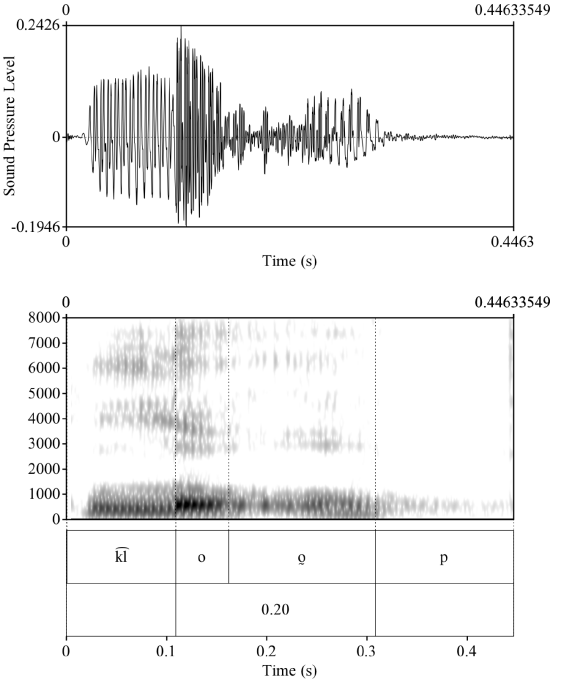

Figure 2. Waveform and spectrogram of [k͡lo̰p] 'winter' by male speaker MV.

[3] For instance, gender has been noted as a factor in the realization of phonation types. Gordon and Ladefoged (2001:10), and Munro, Lillehaugen and López (2008:35) report that creaky vowels produced by Quiaviní Zapotec men sound creakier than those produced by women. Speech rate has also been correlated to variation in the implementation of phonation types (Esposito 2003, Picanço 2005:37).

In Figure 1, three different phases can be clearly observed: modal phonation followed by a glottal closure, followed by aperiodicity in the glottal pulses, which translates into a creaky (and lower amplitude) vowel. Figure 2 shows an initial period of modal phonation followed by aperiodicity.

Let us turn to an acoustic consideration of what are referred to as the Nivaĉle "vowel-glottal coda" cases. These are represented as [V?], and occur when there is no (other) coda consonant in the syllable (cf. (4), (5), and (6a)).

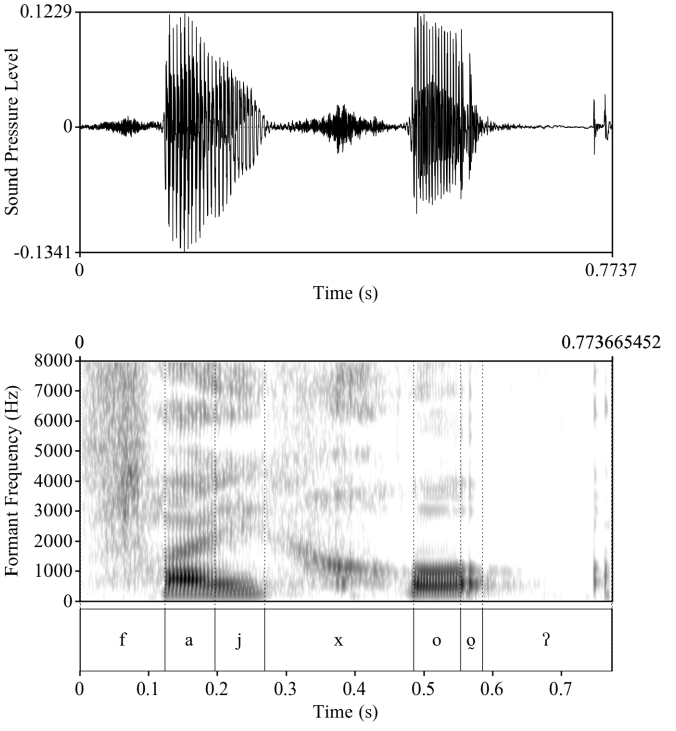

Figure 3. Waveform and spectrogram of [fajxóʔ] 'charcoal' by female speaker CS.

As seen in Figure 3, a vowel-glottal coda consists of a modal vowel portion followed by a full glottal closure. The last part of the vowel can be creaky due to the adjacency with the glottal stop.

What crucially differentiates the variant realizations in Figures 1 and 2 from the consistent [Vʔ] realization in Figure 3 is the prosodic context: if an immediately following consonant is parsed to coda position – e.g, [p] in Figures 1 and 2 – then the [c.g.] feature will be realized as a rearticulated vowel or as 'creak' in the adjacent vowel. If there is no following consonant, the [c.g] will be parsed as a coda. There are two important consequences of this analysis. First, contra Stell (1989), glottalized vowels are not phonemically contrastive. Secondly, the patterning of coda glottal stop is systematically related. Specifically, all 3 phonetic variants - rearticulated [Vʔ$^{\text{v}}$], creaky [V̰], and [ʔ] coda - are underlyingly non-distinctive, their variant surface realization being dependent on prosodic parsing into the syllable.

Based on the observation that glottalized vowels are consistently stressed in Nivaĉle, I further propose that the glottal stop is moraic. However, no other coda consonants are moraic. In Nivaĉle, moraic segments (viz. vowels and glottal stop) can only be parsed to the Nucleus. Unifying these several properties, my proposal is that Nivaĉle glottalized vowels are bimoraic. Because this syllable type is therefore heavy, and the Nivaĉle stress system is quantity-sensitive, it functions as the head syllable of an iambic foot.

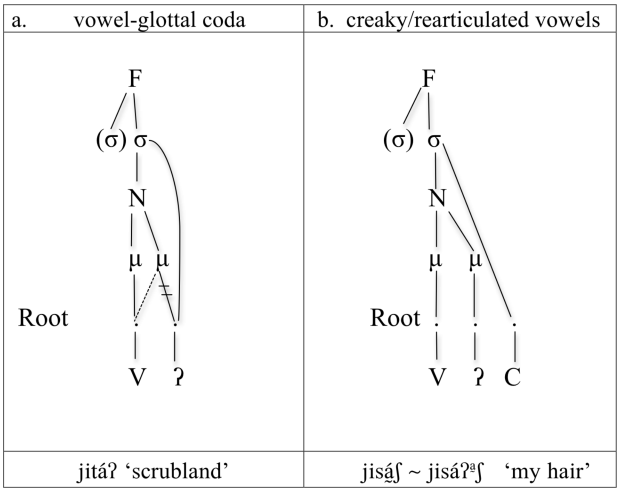

Figure 4. Prosodic representation of /Vʔ/

The proposed analysis offers a principled explanation of two prosodic properties related to the distribution and characteristics of Nivaĉle glottalized vowels. First, duration is a statistically significant acoustic property that differentiates modal from rearticulated vowels in Nivaĉle; the non-modal vowels are (almost) twice as long as their modal counterparts. Five repetitions of each of the following minimal words/near-minimal words were recorded with six Nivaĉle speakers.

(7)	a.	[ʔ]ís	'nice'	b. ʔi̱s	'write!'
(8)	a.	jitéx	'carob tree'	b. jite̱x	'grass'
(9)	a.	ɬ-sáʃ	'mucus'	b. ɬ-sa̱ʃ	'his wool'
(10)	a.	k͡lúp	'fast'	b. k͡lu̱p	'to be seated on the lap'
(11)	a.	k͡lóp	'white/larva'	b. k͡lo̱p	'winter'
(12)	a.	ji-f.xúx	'my toe'	b. ji-f.xu̱x	'my stick'

The words were recorded in isolation and measurements were done in Praat for Mac (version 5.3.08; Boersma & Weenink 2014). Results were compiled and statistics were run in R for Mac (R Core Team 2013). Figure 5 presents the durational differences for the modal and rearticulated/creaky vowels as produced by male speakers FR, FAR, GR, and female speakers CS, TS, and RF.

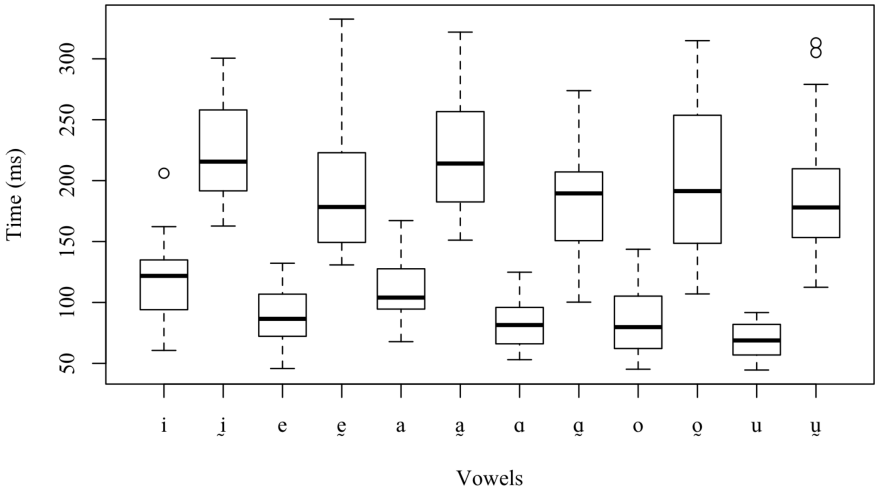

Figure 5. Duration results for creaky vs. modal vowel pairs across six Nivaĉle speakers: FAR, FR, GR (male) and CS, RF, TS (female)

A repeated measures ANOVA was conducted with duration as the dependent variable and vowel quality as a within-speaker variable with six levels /i e a ɑ o u/ and glottalization as another within-speaker variable with two levels (plain vs. glottalized). The analysis yields significant main effects of vowel quality ($F(5, 25) = 7.99$, $p < 0.001$) and glottalization ($F(1, 5) = 119.5$, $p < 0.001$). The analysis did not show a significant interaction of vowel quality and glottalization ($F(5, 25) = 0.552$, $p = 0.73$).

The second prosodic property of glottalized vowels that is congruent with the representation advanced in Figure 6 is the phenomenon of deglottalization; glottalized vowels consistently deglottalize (and thus shorten) in unstressed/non-head position. In the following section, I turn to the discussion of this phenomenon in Nivaĉle.

5. Patterns of deglottalization in Nivaĉle

In Gutiérrez (2015), it is proposed that a superficially complex stress system in Nivaĉle reduces to systematic regularities of three types. First, it is shown that stress is quantity-sensitive, with a consistent correlation between bimoraic weight (tautosyllabic /VʔV/) and stress prominence. Secondly, primary/secondary stress patterns reflect competing Left- and Right edge-alignment constraints where prosodic foot domains align with internal morphological category (MCat) edges: Root, MStem1, MStem2, and MWd. edges. Thirdly, it is argued that a (CVC) syllable, which constitutes the Minimal Prosodic Word in Nivaĉle, can function as a degenerate foot. The generalization that it only ever surfaces with secondary stress is shown to be an emergent consequence of independently motivated constraint rankings. Importantly, CVC foot minimality provides an argument for the glottal stop functioning as a coda if there is no other segment parsed into that position.

With these proposals in mind, let us examine how stress is assigned in two MCat domains: the Root and the MStem1. The MStem1 consists of the root + derivational suffixes. I posit two alignment constraints associated with these two MCats:

(13) ALIGN-R (Root, Ft): Align the right edge of the Root with the right edge of a Foot.
(14) ALIGN-R (MSt1, Ft): Align the right edge of the MSt1 with the right edge of a Foot.

The following pairs of related forms provide evidence for an iambic foot being aligned with the right edge of the Root (15a), but with the right edge of the MSt1 (15b), respectively. The presence of a derivational suffix 'shifts' stress to the last syllable. That is, stress falls on the rightmost syllable of the MSt1, rather than on the rightmost syllable of the internal root (15c). The generalization is that ALIGN-R (MSt1, Ft) is higher ranked than ALIGN-R (Root, Foot); the form in (15c) is not optimal.

(15) a. $[(si.sé)]_{Rt}$
'cane'

b. $[[si.(sɪ]_{Rt}\text{-}\widehat{tʃát})]_{MSt1}$
cane-COL
'cane field'

c. $*[[(si.sé)]_{Rt}\text{-}\widehat{tʃat}]_{MSt1}$

Compare now (15) with the following examples:

(16) a. $[(ta.\widehat{kl̩ǫ́k})]_{Rt}$
'weed'

b. $[[ta(\widehat{klok}]_{Rt}\text{-}\widehat{tʃát})]_{MSt1}$
weed-COL
'scrub'

c. $*[[(ta\widehat{kl̩ǫ́k})]_{Rt}\text{-}\widehat{tʃat}]]_{MSt1}$

d. $*(ta.\widehat{klòk})\text{-}(\widehat{tʃát})$

(17) a. $[(ji.jéʔ)]_{Rt}$
'*caraguata*'

b. [ji(je]$_{Rt}$-t͡ʃát)]$_{MSt1}$ c. *[[(jijéʔ)]$_{Rt}$-t͡ʃat]$_{MSt1}$ d. *(jijèʔ)-(t͡ʃát)
caraguata-COL
'a place where the *caraguata* plant lives'

Examples (16b) and (17b) provide further evidence for ALIGN-R (MSt1, Ft) being higher ranked than ALIGN-R (Root, Ft). Neither in (16b) nor in (17b) do the creaky vowel and the glottal coda get realized; Nivaĉle glottalized vowels deglottalize when /ʔ/ and its associated mora do not get parsed to the head syllable of the foot. Examples (16d) and (17d) show that the glottalized vowels cannot be preserved in the form of secondary stress because there cannot be two adjacent stressed syllables in Nivaĉle; *CLASH is an undominated constraint.

Finally, let us investigate the next higher domain for stress assignment in Nivaĉle, namely the MSt2, which is associated with the presence of prefixes. Possessive prefixes mark the left edge of nominal roots. What the following data based on bare (unprefixed) vs. possessed (prefixed) alienable roots show is that primary stress is aligned with the *left* edge of these derived MSt2 forms. The edge alignment of disyllabic forms is ambiguous, as either R-edge alignment (with Root/MSt1) or L-edge alignment with the MSt2 edge is consistent with the output. However, trisyllabic forms present crucial evidence for L-edge alignment:

(18) a. [(k͡le.sá)]$_{Rt}$
'knife'
b. [(ji-[k͡lé).sa]Rt]$_{MSt2}$ c. *ji(k͡le.sá)
1POSS-knife
'my knife'

(19) a. [(ʃin.βóʔ)]$_{Rt}$
'honey'
b. [(ji-[ʃín)βo]Rt]$_{MSt2}$ c. *ji-(ʃin.βóʔ)
1POSS-honey
'my honey'

The pair of forms in (18) and (19) shows stress "shifting" from the final to the penultimate syllable; stress assignment is made with reference to the left edge of the MSt2, the morphological domain marked by the possessive prefixes. Because the syllable with the final glottal coda does not get parsed to the head of the foot (19b), the glottal does not surface.

6. Conclusions

Relating the syllable and phonotactic restrictions in the Nivaĉle language, this paper has established the featural and prosodic representations of the glottal stop and the so-called 'glottalized' vowels in Nivaĉle (Stell 1989). It has been proposed that the glottal stop is unspecified for place features, but specified for [c.g.]. Glottalized vowels are underlying vowel-glottal sequences: /Vʔ/. As such, they consist of a vowel followed by glottal stop, which is moraic. The /ʔ/ can attach (i) to the nucleus of the syllable and form part of a complex nucleus – phonetically realized as a 'rearticulated/creaky' vowel – or (ii) to the syllable node as coda and thus get realized as a glottal stop. Phonetic evidence for the alternation and relationship between rearticulated and vowel-glottal coda has been provided in the effect of affixation processes on syllabic parsing. Congruent with the proposed prosodic representation of glottalized vowels, two related generalizations emerge: First, glottalized vowels only surface under stress. Second, glottalized vowels consistently deglottalize in unstressed/non-head position.

The complexities of both the phonetic implementation of glottalization and its phonological implications are of considerable theoretical interest. To account for the robust correlation between glottalization and stress prominence, I propose that the "weight" of the glottal stop in Nivaĉle is

appropriately represented by its being linked to the *mora*, as a consistent unit of weight in Nivaĉle. Given that glottalized vowels only surface under stress, and adopting the notion of the Nucleus as head of the syllable, I propose that in Nivaĉle, the Nucleus functions as the prosodic unit that hosts all and only the moraic units of the language. There is no evidence that segments other than vowels and glottal stops are moraic.

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