

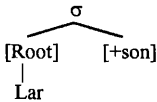
# THE DISTRIBUTION AND PHONETIC REALIZATIONS OF GLOTTALIZED SONORANTS

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## 1 Introduction

One of the most common phonological processes involving laryngeal features is laryngeal neutralization, whereby all laryngeal distinctions are lost in syllable-final position. Lombardi (1991) accounts for this type of restriction of laryngeal feature occurrence by way of a positive constraint which states that laryngeal features are licensed in the following configuration

(1)



This would predict that laryngeally-marked consonants tend to be restricted to syllable-initial position.<sup>1</sup> However, it was noted that in some languages laryngeally-marked sonorants such as glottalized sonorants are not subject to the same positional constraint as obstruents (Urbanczyk 1992). Unlike glottalized obstruents in general, which are always preserved in onset position, glottalized sonorants may be restricted to coda position, being absent in the onset in given languages. For example, in Tolowa (Bright 1964) and Kashaya (Buckley 1992), glottalized sonorants are allowed only in syllable-final position, while laryngeally-marked obstruents never occur there. It suggests that there may be some relation between the occurrence of laryngeal features and the phonetic properties of the context where they occur, including the kind of segment on which the laryngeal feature is realized. Unfortunately, however, there is a lack of both typological information and detailed phonetic data for the class of sonorants with an unusual phonation type.

In this paper, I examine the distributional properties and phonetic aspects of glottalized sonorants from a cross-linguistic perspective in the hope of providing a better explanation for their distributional patterns. The general findings observed in this survey are the following: 1. Word-initial glottalized sonorants are preglottalized and never postglottalized, 2. Syllable-finally, glottalized sonorants are more variably realized. On the basis of these findings, I suggest that the explanation for their distributional patterns can be found phonetically, both articulatorily and perceptually. More specifically, preglottalization, as opposed to postglottalization, in word or syllable-initial position is articulatorily easier. However, it can be perceptually less salient. If preglottalized sonorants are less salient in onset position, this might account for the fact that some languages neutralize the laryngeal contrast in that position.

## 2 Earlier views of phonetic constraints on laryngeally-marked segments

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<sup>1</sup> I assume that plain voiceless obstruents and voiced sonorants are laryngeally unmarked. Therefore, voiced/glottalized/aspirated obstruents and glottalized/voiceless sonorants belong to the class of laryngeally-marked segments.

Although glottalization is a feature used for distinctions among both sonorants and obstruents, it is reported by some linguists that the timing of the glottal closure relative to the edges of the oral constriction is frequently different for the two classes. Kingston (1985) notes that the glottal articulation is preferably timed to the onset of the oral closure in sonorants, and to its release in obstruents. In fact, the same observation about the oral-glottal timing difference was made earlier by Sapir (1938).

Kingston (1985), however, claims that glottal articulations bind more tightly to oral articulations in stops than in continuants<sup>2</sup>, the glottal articulation of a stop occurs close to the release of that stop, on the other hand, in continuants, the glottal articulation is more variable in its timing relative to the oral articulation. If Kingston is correct, we should expect glottalization to be freely realized anywhere in the production of a continuant segment. And since the cues for laryngeal contrast can be audibly present during the entire articulation of continuants, glottalized sonorants should be expected to occur freely regardless of syllable position. However, there are two commonly noted generalizations for glottalized sonorants that would suggest otherwise.

(2) Two commonly noted generalizations for glottalized sonorants

1. Sonorants tend to be preglottalized (Kingston 1985, Silverman 1995)
2. Glottalized sonorants are most frequently found in codas and less frequently in onsets (Kingston 1985)

Sternade (1996) tries to provide an explanation for the different distributional patterns of laryngeally-marked obstruents and sonorants, adopting Kingston's (1985) ideas discussed above. Also, her argument seems to be based on the generalizations in (2). She claims that the contexts of neutralization in obstruents and sonorants are different because of the difference in oral-glottal timing. That is, a glottalized sonorant which tends to be preglottalized depends on the left-hand context -- a preceding vowel or sonorant -- for optimal identification of its laryngeal category. On the other hand an aspirated or glottalized obstruent where the laryngeal gesture is timed to the release depends on the right-hand context, i.e., the following vowel or sonorant. Therefore, according to her claim, laryngeally-marked obstruents are likely to be neutralized when there is no vowel or sonorant following, while laryngeally-marked sonorants are likely to be neutralized when there is no preceding vowel or sonorant.

While Kingston only notes the tendency for the sonorant to be preglottalized, Silverman (1995) tries to provide an explanation for the observation that sonorants tend to be preglottalized. According to him, the optimal site for the laryngeal gesture for nasals is the first portion of the nasal, so that the nasal place of articulation can be saliently encoded. His argument is based on the observation that the primary cues for nasal place articulation are encoded at the formant transitions between the nasal and a neighboring vowel (Recasens 1983). The main point of his argument is that glottalization, or voicelessness, in sonorants obscures the cues for their place of articulation, and therefore languages time the glottal articulation on the first part of the sonorant so that the formant transition from the sonorant into the vowel can be clearly preserved.

However, Silverman's argument holds only for prevocalic glottalized sonorants, he does not take into consideration the prevailing pattern of postvocalic glottalized sonorants. If his argument is to be

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<sup>2</sup> Kingston distinguishes continuants and noncontinuants due to the acoustically salient/nonsalient release of the oral closure.

extended to the laryngeally-marked sonorant occurring in coda position, it should be the case that such a sonorant tends to have its glottal articulation realized in the last portion of the sonorant so that the formant transition from the vowel into the sonorant may be preserved without being blurred by the glottal articulation<sup>3</sup> But this extension to postvocalic glottalized sonorants would seem to be at odds with the generalization that glottalized sonorants tend to be preglottalized, noted in (2)

The generalization that the coda is the preferred position for glottalized sonorants suggests that the coda is either articulatorily or perceptually an optimal place to realize the glottalization for sonorants, unlike the case for obstruents If this generalization is correct, we can conjecture that preglottalization will be consequently preferred because the preceding vowel also carries the cues for the distinction of glottalization

However, it is not clear that the generalizations in (2) are cross-linguistically verified In fact, Ladefoged and Maddieson (1996) mention various phonetic realizations of glottalized sonorants According to them, in some languages the laryngeal constriction gesture is centered at the same point in time as the oral closure, so that creaky voice characterizes the middle part of the sonorant, but in other languages the laryngeal constriction occurs at the beginning or the end of the sonorant

Since it is necessary to have more valid facts about glottalized sonorants in order to propose some phonetic explanation for their distributional pattern, I conducted a cross-linguistic survey In the next section, I examine the distributional properties and phonetic aspects of glottalized sonorants from a cross-linguistic perspective

### 3 The distribution and phonetic realizations of glottalized sonorants

Laryngeal articulations such as glottalization and aspiration are not commonly used in the production of sonorants It is reflected in the typological distribution of glottalized and voiceless sonorants Languages that are reported to have at least one glottalized sonorant (liquid, nasal, or semi-vowel) constitute 6.0% (19/317) of Maddieson's sample and 4.3% (30/693) of the larger sample of Ruhlen's (1976) 693 languages Languages that are reported to have at least one voiceless sonorant take up 5.0% (16/317) of Maddieson's sample Thus, glottalized and voiceless sonorants are very rare compared to their plain, namely voiced, counterparts For example, whereas plain voiced nasals occur in 96.8% (307/317) of Maddieson's (1984) sample of 317 languages, glottalized nasals occur in 4.7% (15/317) and voiceless nasals occur in only 3.5% (11/317)

#### (3) Distribution of plain, glottalized, and voiceless sonorants in UPSID languages

N	307/317 (96.8%)	N'	15/317 (4.7%)	ŋ	11/317 (3.5%)
L	304/317 (95.9%)	L'	9/317 (2.8%)	l̥	10/317 (3.2%)
G	287/317 (90.5%)	G'	15/317 (4.7%)	ç	12/317 (3.8%)

N nasals L liquids G glides  
' glottalized ˚ voiceless

Glottalized sonorants are found mostly in American indigenous languages However, they serve as phonemes also in some African, Mon-Khmer, Afro-Asiatic and Sino-Tibetan languages The

<sup>3</sup> Plauché (1998) notes that languages with distinctive glottalized sonorants show a tendency for these segments to surface as preglottalized in onset and postglottalized in coda position However, there are many counterexamples to this observation

following list of 17 languages shows the languages in Maddieson (1984) that are reported to have glottalized sonorants in their phonemic inventories

- (4) Gbeya, Sedang, Sui, Haida, Tolowa, Nez Perce, Klamath, Nootka, Kwakw'ala, Acoma, Wappo, 'Xu', Yuchi, Southern Nambiquara, Tiddim Chin, Lugbara, Hausa

In addition to these languages, the following languages are also reported to have glottalized sonorants in Ruhlen (1976) or are discussed in the literature (Urbanczyk 1992, etc.) as having glottalized sonorants

- (5) Navaho, Usarufa, Kashaya, Chitmachacha, Chontal (Hokan), Haisla, Coeur d'Alene, Montana Salish, Spokane, Kalispel, Shuswap, Wikchamni, Gitksan

The typological survey of the glottalized sonorant in this paper is based on the sample from Maddieson (1984) (languages in (4) above), and each of these individual languages are examined by referring to sources available in the literature. Unfortunately, however, the sources do not always provide sufficient information on their phonetic realizations. So I have tried to include as many languages as possible from the languages in (5) above when detailed information on the phonetic aspect of the glottalized sonorant is provided, maintaining the 17 languages in Maddieson (1984) as a basic sample for my typology.

The languages examined are divided into the following groups based on the distributional patterns of glottalized sonorants

(6)

1 Languages in which the glottalized sonorant does not occur word-initially, but occurs word-finally, i.e. syllable-finally<sup>4</sup>. These are cases where glottalized sonorants are always postvocalic. Three out of the 17 languages belong to this group.

2 Languages in which the glottalized sonorant does not occur word or syllable-finally, but occurs word or syllable-initially. Twelve out of the 17 languages belong to this group. However, it should be noted that in many languages belonging to this group (10 among 12 languages), there exist other syllable structure conditions that restrict the occurrence of other consonants as well as glottalized sonorants, such as No Coda (3 among 10), Laryngeal Constraint (4 among 10), and other special coda conditions (3 among 10). Therefore, only 2 out of the 17 languages do not allow the glottalized sonorant word or syllable-finally for independent reasons.

3 Languages in which the glottalized sonorant occurs both word-initially and word-finally. Two out of the 17 languages belong to this group.

As for the phonetic characteristics of the glottalized sonorant in these languages, 11 languages have preglottalized sonorants, and 1 language has simultaneous or postglottalized sonorants. One interesting fact about glottalized sonorants is that in some languages they have different phonetic

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<sup>4</sup>One of the reasons that I refer to word position instead of syllable position is to distinguish the intervocalic position from the syllable-initial position that is not preceded by a vowel. Since, in most of the languages except Tolowa and Kashaya, glottalized sonorants occur in intervocalic position which is also syllable-initial, it is not very informative to refer to syllable-initial position. In addition, in most cases, if the glottalized sonorant is allowed in word-initial position, it is also allowed in word-medial syllable-initial position, and if it is allowed in word-final position, it is also allowed in word-medial syllable-final position.

realizations according to the context. The following table summarizes the distribution and phonetic realizations of the glottalized sonorant in the sample languages.

(7) Table 1 The distribution and phonetic realizations of glottalized sonorants in the sample languages (from Maddieson)

	#_ (word or syllable-initial position)	_# (word or syllable-final position)	phonetic realization
1 Nez Perce	*	√	variants
2 Wappo	*	√	?
3 Tolowa	*	√	simultaneous or post
4 Acoma	√	open	variants
5 Yuchi	√	open	pre
6 Lugbara	√	open	pre
7 Gbeya	√	*	pre
8 Hausa	√	*	pre
9 S Nambiquara	√	*	pre
10 Harda	√	*	pre
11 Suri	√	*	pre
12 Sedang	√	* y', y	pre
13 Kwakw'ala	√	*	pre or simultaneous
14 Nootka	√	*	pre
15 'Xu~	√	*	pre
16 Klamath	√	√	variants
17 Tiddim Chun	w' √	l' √	variants

√ occurrence                      \* non-occurrence  
 pre preglottalized                  post postglottalized  
 simultaneous simultaneous glottalization  
 variants positionally different realizations  
 open does not occur and all the syllables  
 are open

The following table is for the additional languages examined

(see Table 2 (next page))

As can be seen in the above summary, this survey does not support the generalization that the coda is the preferred position for glottalized sonorants. Although it is true that in some languages the glottalized sonorant is allowed only in coda and intervocalic position (3/17, 17.6%), a similar number of languages allow the glottalized sonorant only in onset position (2/17, 11.8%) or both in onset and coda position (2/17, 11.8%). Given that the coda is generally a restricted position and laryngeal features in general are restricted to onset position, it is interesting that sonorants violate the Laryngeal Constraint as

in (1) above, unlike obstruents. However, my survey shows that there is no basis for claiming that either the coda or the onset is preferred for the glottalized sonorant.

(8) Table 2 The distribution and phonetic realizations of glottalized sonorants in the additional languages

	#_ (word or syllable-initial position)	_# (word or syllable-final position)	phonetic realization
1 Usarufa	*	open	pre
2 Navaho	*	*	pre
3 Wikchamni	*	√	variants
4 Shuswap	*	√	variants
5 Kashaya	*	√	post
6 Chitmachacha	*	√	variants
7 Haisla	√	*	pre
8 Chontal (Hokan)	√	*	pre
9 Montana Salish	√	√	pre
10 Spokane	√	√	simultaneous
11 Gitksan	√	√	pre

As for the phonetic realization, although preglottalization occurs in the majority of glottalized sonorants (11/16, 68.8%), postglottalization and phonetic variants depending on the context are also noteworthy. In the following sections, I examine in detail the distribution of the glottalized sonorants and their phonetic realizations in individual languages.

### 3.1 Languages in which glottalized sonorants are always postvocalic

In 3 out of the 17 languages from Maddieson (1984), glottalized sonorants can occur only word-finally. Nez Perce, Wappo and Tolowa belong to this type. In these languages, glottalized sonorants occur only intervocalically or syllable-finally, suggesting that they are always postvocalic. In Tolowa the occurrence of glottalized sonorants is more restricted as mentioned earlier, they are allowed only in coda position, not being allowed intervocalically.

Glottalized sonorants in 6 among the additional 11 languages examined are also always postvocalic, Wikchamni, Shuswap, Kashaya, Chitmachacha, Navaho and Usarufa. In 2 of these languages, Navaho and Usarufa, glottalized sonorants are allowed neither word-initially nor word-finally, but only intervocalically. Although these 2 languages show a more restricted distributional pattern for the glottalized sonorant, I will include these languages in this group, since the glottalized sonorant is always postvocalic.

Among the 9 languages that belong to this group (3 from Maddieson, 6 from the additional data), in 2 languages, glottalized sonorants are preglottalized, and in 2 languages, they are postglottalized or simultaneously glottalized. In 4 languages, glottalized sonorants are realized differently depending on whether they occur intervocalically, or word-finally, or before another

consonant Information about the phonetic realization of the glottalized sonorant in the remaining language is not available

It is important to note that languages allowing glottalized sonorants only in intervocalic position have preglottalized sonorants And languages that allow glottalized sonorants only in coda position have postglottalization or simultaneous glottalization in sonorants I will discuss each language, grouping them according to the phonetic characteristics of their glottalized sonorants

### 3 1 1 Preglottalized sonorants

In Usarufa (East New Guinea Highland stock, Bee 1973) and Navaho (Sapir and Hoijer 1967), glottalized sonorants occur only intervocalically and are preglottalized

In Navaho, glottalized sonorants /m'/, /n'/ and /y'/ show a unique distributional pattern in that they may not begin a word, while all other consonants except /ʒ/ may occur word-initially Neither laryngeally-marked obstruents nor sonorants are allowed syllable-finally, indicating the Laryngeal Constraint applies both to obstruents and to sonorants In Navaho, obstruents and sonorants have distinct timing patterns for oral and laryngeal gestures In glottalized obstruents, glottalization is simultaneous or near simultaneous with the closure of the sound of which it is a part On the other hand, /m', n', y'/ are preceded, rather than followed by the glottal release (Sapir and Hoijer 1967) Therefore, /m'/ and /n'/ are phonetically [ʔm] and [ʔn], respectively

### 3 1 2 Postglottalized sonorants

In Tolowa and Kashaya, glottalized sonorants occur only in coda position and they either are postglottalized or have simultaneous glottalization In these languages, glottalized sonorants are different from glottalized obstruents in their distribution, laryngeally-marked sonorants are allowed in coda position, whereas laryngeally-marked obstruents are not

In Tolowa, /m'/ also occurs in two-consonant codas, of which the first consonant may be /ʔ/ or /m'/ and the second consonant may be /s, ʃ, ʒ/ According to Bright (1964), in most environments, /m'/ and /n'/ consist phonetically of the plain nasal followed by a glottal stop and a repetition of the plain nasal Thus they are realized as [mʔm] and [nʔn], respectively But when /m'/ occurs before a sibilant, it has the allophone [mʔ], i e , it is postglottalized

In Kashaya (Pomo, Buckley 1992), a glottalized sonorant loses its glottalization feature when it appears in the onset as a result of affixation and resyllabification, as can be seen in (9) and (10) (Buckley 1992)

- |                                  |                     |                  |              |
|----------------------------------|---------------------|------------------|--------------|
| (9) man' e'mu ---->              | mane'mu             | 'it's her'       |              |
| (man' 'her', e'mu 'verb suffix') |                     |                  |              |
| dolom' e'mu ---->                | dolome'mu           | 'it's a wildcat' |              |
| (10) balay=?-e'mu ---->          | (balay' e'mu) ----> | balay'e'mu       | 'it's blood' |
| (cf) še?et=?-e'mu ---->          | še?et'e'mu          | 'it's a basket'  |              |

In (10), y in balay merges with the following glottal stop from the assertive clitic ʔ to become a glottalized sonorant y' as in balay' But when the verb suffix e'mu beginning with a vowel follows, and

places the  $\underline{v}$  in onset position,  $\underline{v}$  loses its glottalization and becomes a plain sonorant. This suggests that the glottalized sonorant needs a tautosyllabic preceding vowel. Glottalized obstruents, on the other hand, do not deglottalize. As for the phonetic characteristics of the glottalized sonorant, Buckley observes that /n'/ is pronounced as [n̥ʔ], a nasal with normal voicing at the beginning and creaky voice toward the end, sometimes followed by a glottal stop.

The fact that glottalized sonorants are postglottalized or have simultaneous glottalization indicates that glottalized sonorants do not depend on preceding context for their glottal feature to be realized. As mentioned above, glottalized obstruents are not allowed in syllable-final position in these languages, which suggests that they need a following vowel or sonorant to realize the glottalization. However, in the case of the sonorant, the open vocal tract allows simultaneous manifestation of the glottal gesture with the oral gesture.

One important question arises, then: Why are there languages like Tolowa and Kashaya where glottalized sonorants do not occur in syllable-initial position? The answer can be found in both articulatory and perceptual causes. Syllable-initial postglottalization involves more articulatory complexity than preglottalization. In a syllable-initial <sup>2</sup>RV sequence (<sup>2</sup>R stands for a preglottalized sonorant), the glottal constriction occurs at the beginning and the state of vocal folds changes to that of the modal voicing for the sonorant and remains the same for the production of the vowel. In addition, syllable-initial glottal constriction seems to be physiologically a natural tendency, considering that in many languages words beginning with a vowel are pronounced with an initial glottal stop. On the other hand, in a R<sup>2</sup>V sequence (R<sup>2</sup> stands for a postglottalized sonorant), the state of the vocal folds needs to change from that of the modal voicing for the sonorant onset to that of constriction, and again to that of the modal voicing for the vowel, unless the following vowel is affected throughout. Therefore, it is evident that the latter sequence is articulatorily more complicated. With respect to perception, Silverman's (1995) work may provide a perceptual motivation. He argues that postglottalization in onset position attenuates the formant transition from the nasal to the following vowel, and so is auditorily sub-optimal. The same argument would hold for simultaneous glottalization in onset position.

Neither Kashaya nor Tolowa change the timing pattern of oral and laryngeal gestures to that of preglottalization in onset position. Rather, they drop the glottalization feature in onset position, thereby neutralizing the laryngeal distinction of sonorants. The explanation may be found once again in a perceptual point of view. Preglottalization in onset position does not seem to be perceptually salient. Silverman's (1995) argument for the preference of preglottalization in onset position noted above relates only to information about the sonorant itself, namely information about the place and manner of articulation. But it is not clear that preglottalization in onset position is perceptually salient for the distinction of the glottalization feature in sonorants.

### 3.1.3 Phonetic variants depending on the context

In Nez Perce (Northern Penutian, Aoki 1970a), Wikhamni (Yokuts, Newman 1944), Shuswap (Interior Salish, Kuipers 1974) and Chitimacha (spoken in Southern Louisiana, Swadesh 1934), glottalized sonorants are always postvocalic and the phonetic realization of glottalized sonorants differs according to the context. In languages like Shuswap, phonological rules such as the deglottalization rule work to avoid the violation of the positional constraint that glottalized sonorants should occur only after vowels. Thus, the glottalization of the glottalized sonorant is quite mobile. Let us take the following examples:



- (11) a q'ey' 'write'  
 b q'yem' 'write, intransitive'
- (12) a -fi'əp 'foundation'  
 b séy'-ləp 'soft foundation of boughs'  
 (sey- 'make such a foundation')

The glottalization of the sonorant *y'* in (11a) is moved from the root to the suffix in (11b), since it is located after a consonant. In (12), if a suffix beginning in -V'R'V occurs in a root-stressed form, it loses its initial vowel and R' cannot remain glottalized after the final consonant of the preceding syllable. Consequently, the glottalized sonorant of the suffix yields its glottalization to the final sonorant of the root CVR.

As for the phonetic realization, in general, glottalized sonorants are mostly preglottalized or simultaneously glottalized in intervocalic position, whereas they are preglottalized or postglottalized in syllable-final position. This pattern of phonetic variation of glottalized sonorants is consistent with the phonetic aspects of glottalized sonorants in the other languages that belong to this group: intervocalic preglottalized sonorants of Usarufa and Navaho, and postglottalized sonorants of Kashaya that occur only in coda position. Although there is no strong tendency for the preference of any specific laryngeal timing in any particular position in a syllable, it is significant that no occurrence of postglottalization in intervocalic position is found.

The following table summarizes the positional phonetic variants of the glottalized sonorants.

(13) Table 3 The positional phonetic variants of glottalized sonorants

	V_V	_# (or _C)
Nez Perce	simultaneous [RʔR]	pre [ʔR]
Wikchamni	pre or simultaneous [ʔN] ~ [NʔN], [ʔY] ~ creaky	pre [ʔR] ~ [ʔ]
Shuswap	pre or simultaneous (glottal closure falls at the implosion)	post (glottal closure falls at the end)
Chitimacha	N' [NʔN] simultaneous Y' [YʔY] simultaneous	N' [NʔN] simultaneous Y' [Yʔ] post

R sonorants N nasals  
 Y glides

In all the languages discussed in this section the glottalized sonorant needs a preceding vowel. That is, the glottalized sonorant in these languages is always postvocalic, whether intervocalically or before a consonant or word boundary. As for the phonetic aspects, intervocalic glottalized sonorants are preglottalized or simultaneously glottalized with no occurrences of postglottalization. On the other hand, syllable-final glottalized sonorants realize their glottal gesture more freely in the sonorant structure, preglottalization, postglottalization, and simultaneous glottalization are all observed in syllable-final position.

### 3 2 Languages where the glottalized sonorant occurs word/syllable-initially, but not syllable-finally

In 12 out of the 17 languages taken from Maddieson's sample, the glottalized sonorant does not occur in syllable-final position, although it occurs in word-initial or syllable-initial position. In 10 of the languages, the non-occurrence of the glottalized sonorant in syllable-final position is not peculiar to this class of segments, but is due to other kinds of syllable constraints such as No Coda or the Laryngeal Constraint which holds for both sonorants and obstruents. The remaining 2 languages, Kwakw'ala (Sapir 1938) and Nootka (1938) are cases in which the glottalized sonorant is always prevocalic for independent reasons. Kwakw'ala and Nootka are both Wakashan, so the restriction of glottalized sonorants to initial position seems to be in fact quite rare.

One interesting finding is that the glottalized sonorant is realized as preglottalized in all but two languages that belong to this group. The two exceptions are Kwakw'ala, where it has simultaneous glottalization or creaky voice, and Acoma which has positional variants. In Acoma (Keres, Miller 1965), however, glottalized sonorants are also mostly preglottalized, especially in word-initial position. Therefore, in general, syllable-initial (other than intervocalic, i.e., word-initial and postconsonantal) glottalized sonorants are preglottalized.

#### 3 2 1 Cases where other syllable-final restrictions are required

##### 3 2 1 1 Languages with No Coda

In Acoma, Lugbara (Central Sudanic, Barr 1965) and Yuchi (Siouan, Crawford 1973), not only the glottalized sonorant but any consonant is absent from syllable-final position. That is, the basic syllable well-formedness condition NoCoda (McCarthy and Prince 1993) is active in these languages. Since there is no closed syllable in these languages, it is not significant that glottalized sonorants do not occur in syllable-final or word-final position.

In Acoma, glottalization is medial for lengthened glottalized sonorants, and initial elsewhere. That is to say, glottalization is medial when the glottalized sonorant occurs after an accented vowel, while a word-initial glottalized sonorant is preglottalized. According to Miller (1965), glottalization is especially light in initial position, and it is difficult to distinguish glottalized sonorants from plain sonorants in this position.

##### 3 2 1 2 Languages with the Laryngeal Constraint

In Gbeya, Haida, and Sui, not only the glottalized sonorant but all other laryngeally-marked consonants do not occur in syllable-final position. That is, the Laryngeal Constraint applies to both sonorants and obstruents.

Samarin (1966) mentions that in Gbeya (African) preglottalized nasals differ from plain ones only by the glottal closure which immediately precedes the articulation of the nasal continuant.

Glottalized nasals are not frequent in Haida (Sapir 1921-23). On the other hand, /w', y', l'/ are exceedingly common sounds, appearing in some of the most important stems in the language. According to Sapir, in the glottalized stops and affricates the closing of the glottis lasts during the whole oral articulation of the consonant and beyond, in the glottalized nasals, semivowels, and laterals, however, the glottis is closed simultaneously with the oral contact of the articulator but released instantly thereafter, the voiced continuant thereupon becoming fully audible. That is, they are preglottalized.

In both Sui (Afro-Tai, Li 1948) and Sedang (Mon-Khmer, Smith 1968), glottalized sonorants are preglottalized and allowed only in syllable-initial position<sup>5</sup>

### 3 2 1 3 Languages with other language-specific coda conditions

Hausa (Afro-Asiatic, Kraft and Kraft 1973), Southern Nambiquara (Southern Amerindian, Price 1976) and 'Xu~ (Khoisan, Traill 1981) allow some limited set of consonants in syllable-final position, which has no particular relation to the occurrence of the laryngeal feature. For example, in 'Xu~ only /m/ and /n/ (as well as /ŋ/, dialectally) occur in final position

### 3 2 2 Cases where the glottalized sonorant is prevocalic

In Kwakw'ala and Nootka (Wakashan, Sapir 1938), the glottalized sonorant occurs at the beginning of words and syllables such that it is only immediately before a vowel. However, the glottalized obstruent is allowed in syllable-final position. Similarly, in Haisla (Lincoln and Rath 1986) as well, which is also a Wakashan language, consonantal /m', n', l', y', w'/ are generally pronounced [ʔm, ʔn, ʔl, ʔy, ʔw] and can occur word-initially. Like their plain counterparts, /m', n', l', y', w'/ are separated phonetically from a following obstruent by an anaptyctic vowel and do not occur word-finally<sup>6</sup>. Though rarely, glottalized obstruents occur word-finally. The need for a following vowel, however, applies not only to glottalized sonorants but also to plain sonorants and other obstruents in medial position.

Some languages are reported to have lost glottalization of sonorants in onset position, which indicates the vulnerability of glottalized sonorants in this position. Kingston (1985) reports that glottalized sonorants have disappeared in some Wakashan languages such as Nitinat and Makah, which are closely related to Nootka. According to him, the glottalized sonorants in Nitinat and Makah have disappeared without a trace from the beginning of words as seen in (14), and medially they also lose their glottalization with the preceding short vowel compensatorily lengthened as seen in (15). The following examples are cited from Kingston (1985)

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<sup>5</sup> In Sedang, the following consonants are reported to occur as syllable-final consonants /m, n, ŋ, p, t, k, w, h, ʔ, (l, r), yʔ, yh/. According to Smith (1968), yʔ and yh are interpreted as complex unit phonemes rather than a sequence of semivowel plus ʔ or h, because word-final position is otherwise filled only by single consonants. Apparently Sedang seems to be a very unusual case where the Laryngeal Constraint applies with an exception to only the segment /y/. However, in this language, plain /y/ also is not allowed in syllable-initial position except in some loanwords. In addition, glottalized or voiceless /y/ does not occur in syllable-initial position. Therefore, it seems that /y/ is a defective phoneme in this language, its non-occurrence in certain positions being fortuitous. In addition, in Mon-Khmer languages the issue of laryngeal features becomes more complicated due to register issues, which are beyond the scope of this study.

<sup>6</sup> In most cases, an obstruent is separated phonetically from a following one by an anaptyctic vowel. Word-final obstruents are never pronounced with any following phonetic vowel. Word-final aspirated plosives /c, ʔ, k, k<sup>w</sup>, q, q<sup>w</sup>/ are pronounced as their respective homorganic fricatives, that is, /s, ʃ, x, x<sup>w</sup>, ʃ, ʃ<sup>w</sup>/

(14)		Nootka	Makah
*w'	'cedar bark apron'	w'anus	wadis
*y'	'younger sibling'	y'uk <sup>w</sup> i qsu	yuk <sup>w</sup> i qs(u)
*m'	'raining'	m'itf	bitf -
*n'	'to sew'	n'iq-	diq-
(15)		Nootka	Makah
*w'	'steel-head salmon'	qiw'ah	qiway
*y'	'picking berries'	cay'ax	ca yax
*m'	'wild rhubarb'	hum'a q	hu baq
*n'	'smelt'	man'u	ba daw

It is also reported that glottalization has vanished from glottalized sonorants which immediately followed another consonant in medial cluster. Kingston claims that the loss of glottalization from sonorants in Makah and Nitinat results from their reanalysis as ?R clusters. That is, since no clusters occur in onset position, the glottal stop is lost in onset position. The reason for the loss of glottalization may also be found in a perceptual aspect, preglottalization in onset position is not particularly perceptually salient.

In most languages that allow glottalized sonorants in word-initial syllable-initial position, they are realized as preglottalized sonorants. As mentioned in Section 3.1.2, preglottalization in onset position is articulatorily easier than postglottalization or simultaneous glottalization. Also, Silverman's (1995) argument may provide a perceptual motivation for initial preglottalized sonorants, preglottalization allows the cues for sonorant place and manner to be encoded saliently. Therefore, preglottalization may be favorable in onset position in both articulatory and perceptual respects.

However, glottalization itself does not seem to be perceptually salient in word-initial or postconsonantal syllable-initial position, there being a lack of contextual cues, namely a preceding vowel or sonorant. This perceptual defect may have caused the loss of glottalization in onset position in languages such as Nitinat and Makah. To summarize, initial glottalized sonorants are disfavored due to perceptual reasons and yet when it occurs, preglottalization is favored.

### 3.3 Languages in which the glottalized sonorants occur both syllable-initially and syllable-finally

In Klamath (Barker 1964), Montana Salish (Flemming, Ladefoged and Thomason 1994) and Spokane (Interior Salish, Carlson 1972), glottalized sonorants occur both syllable-initially and syllable-finally. The glottalized sonorant of Spokane is simultaneously glottalized or creaky voiced and that of Montana Salish is preglottalized in all positions. Klamath has phonetic variants depending on the context. They are mostly preglottalized or simultaneously glottalized and there is no postglottalized realization.

### 3.4 Other patterns

In Tiddim Chin (spoken in the Northern Chin Hills in Burma, Henderson 1965), there are two glottalized sonorants, /w'/ and /l', which occur in different positions and have different phonetic realizations. Henderson (1965) describes /w'/ as a preglottalized continuant and /l' as a postglottalized continuant. No other glottalized consonants or ejectives exist in the inventory. It is not common that

the glottalization feature is used only for sonorants, while not for obstruents Fordyce (1980) reports that Tiddim Chin is the only exception to the generalization that glottalized sonorants imply glottalic or glottalized obstruents The following consonants are found at the beginning of stressed syllables /p, t, k, b, d, g, p<sup>h</sup>, t<sup>h</sup>, s, x, h, c, v, z, l, w', m, n, ŋ/ Consonants found at the end of stressed syllables are the following /m, n, ŋ, l, p, t, k, ʔ, l'/ It is apparent that preglottalized /w'/ is restricted to syllable-initial position, while postglottalized /l'/ is restricted to syllable-final position The phonetic realizations of these glottalized sonorants are consistent with the phonetic tendency found in other languages preglottalization in onset position and postglottalization in coda position

The following table shows the positional variants of the glottalized sonorant in languages that belong to groups 2, 3 and 4

(16) Table 4 The positional phonetic variants of glottalized sonorants in Acoma, Klamath and Tiddim Chin

	V_V	_# (or _C)	#_
Acoma	simultaneous	N/A	pre
Klamath	pre	pre (*_N'#) V_C simultaneous	pre simultaneous
Tiddim Chin		l' post	w' pre

#### 4 Summary and discussion

Thus far I have examined the phonetic characteristics and the distribution of glottalized sonorants from a cross-linguistic point of view As predicted by Kingston's binding principle, the laryngeal articulation does not seem to be bound to the oral articulation in the case of sonorants Nonetheless only a limited number of patterns are attested Glottalized sonorants are largely preglottalized, rather than postglottalized or simultaneously glottalized, and in some languages they are realized phonetically differently according to context The general tendencies of the relationship between the distribution and phonetic realizations of glottalized sonorants found in this survey are as follows

##### (17) General constraints on glottalized sonorants

- 1 Syllable-initially glottalized sonorants are mostly preglottalized, and never postglottalized
- 2 Syllable-finally glottalization is variably realized on any part of the sonorant

Let us compare these findings with those previously noted by others (same as (2) of this paper)

##### (18) Two commonly noted generalizations for glottalized sonorants

- 1 Sonorants tend to be preglottalized (Kingston 1985, Silverman 1995)
- 2 Glottalized sonorants are most frequently found in codas and less frequently in onsets (Kingston 1985)

Although it is true that glottalized sonorants are restricted to coda position in languages such as Tolowa and Kashaya, my survey does not show that there is a strong tendency for a syllable-position preference The generalizations in (18), taken together, may lead to two incorrect reasonings Firstly,

glottalized sonorants, which are frequent in coda position, are preglottalized because preglottalization is perceptually salient in postvocalic position, where the sonorants have not only inherent but also contextual cues, namely a preceding vowel or sonorant. Secondly, glottalized sonorants, which tend to be preglottalized, are frequently found in coda position because postvocalic position is perceptually an optimal position, where contextual cues are available.

The two new generalizations in (17) resulting from my cross-linguistic survey of the distribution and phonetic realizations of glottalized sonorants lead to somewhat different reasonings or explanations. First, there are two reasons glottalized sonorants show a tendency for preglottalization depending on their context. In onset position, preglottalization in sonorants involves less articulatory complexity or effort. In coda position, i.e., postvocalic position, preglottalization is more perceptually salient for the distinction of the glottalization feature of sonorants. On the other hand, postglottalization is also as frequently found as preglottalization in postvocalic position, since it does not involve as much articulatory complexity as it does in onset position.

As for the different neutralization patterns in obstruents and sonorants, sonorants tend not to be neutralized in positions where obstruents become neutralized, i.e., in syllable-final position, since sonorants are not so dependent on context as obstruents are, carrying the glottalization feature themselves. Theoretically then, sonorants would be predicted to occur without restriction, which is not true. In some languages, glottalized sonorants, like laryngeally-marked obstruents, are not found in postvocalic position. For example, in Navaho, Gbeya, and Haida, the Laryngeal Constraint applies both to obstruents and to sonorants.

Laryngeal neutralization can be viewed as a universal tendency toward economy. It is not impossible to express laryngeal contrasts saliently in syllable-final position. This is especially true for ejectives, which can be perceptually salient even syllable-finally with a distinct glottal release. Nonetheless, some languages choose to neutralize the ejectives to plain obstruents for articulatory simplicity. The same argument holds for the glottalized sonorant. If there is no compelling need to preserve distinctiveness -- in this case, a syllable-final laryngeal contrast --, languages choose to minimize articulatory effort, i.e., neutralize the contrast.

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