DOCUMENT RESUME

ED 385 150 FL 023 148

AUTHOR Black, Cheryl A.
TITLE Laryngeal Licensing and Syllable Well-formedness in Quiegolani Zapotec.
PUB DATE 95
NOTE 23p.; In: Work Papers of the Summer Institute of Linguistics: University of North Dakota Session, Volume 39; see FL 023 147.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Foreign Countries; *Phonology; Suprasegmentals; *Syllables; Syntax; Uncommonly Taught Languages
IDENTIFIERS Mexico; *Zapotec

ABSTRACT

This paper analyzes linguistical features of Quiegolani Zapotec (QZ) via a combination of language-specific rules and universal constraints ordered within a constraint hierarchy that operates within a derivational phonology. A number of complex onset clusters in QZ do not follow the Sonority Sequencing Generalization discussed by J. Greenberg (1978) and E. O. Selkirk (1984), and the distribution of the laryngeal features likewise do not follow the Laryngeal Constraint of L. Lombardi (1991, 1995). QZ exhibits clusters that begin with voiceless fricatives and many reversed onset clusters consisting of sonorant or glide followed by an obstruent. Three privative laryngeal features are used in QZ: voice, spread glottis, and constricted glottis. Each of these features has special licensing constraints that, coupled with a ranking of the universal constraints on prosodic structure, serve to correctly limit the syllable shapes allowed in QZ. At the same time, these shapes also mark the reversed onset clusters as disfavored both language internally and universally. (Contains 39 references.) (NAV)

Laryngeal Licensing and Syllable Well-formedness in Quiegolani Zapotec*

Cheryl A. Black

A number of the complex onset clusters allowed in Quiegolani Zapotec do not follow the Sonority Sequencing Generalization (Greenberg 1978, Selkirk 1984, etc. The distribution of the laryngeal features likewise does not follow the Laryngeal Constraint (Lombardi 1991, 1995a). These recalcitrant facts are analyzed here via a combination of language-specific rules and universal constraints ordered within a constraint hierarchy, which operates within a derivational phonology.

1 Introduction

This paper analyzes the complex syllable structure and distribution of laryngeal features in Quiegolani Zapotec (henceforth QZ), one of the Southern group of Zapotecan languages spoken in Oaxaca, Mexico. The Otomanguean language family, to which QZ belongs, has been documented (Jaeger & Van Valin 1982, Marlett & Pickett 1987, Marlett & Ward 1990, Regnier 1993) as having consonant clusters which violate the normal sonority sequencing patterns given as universals by Greenberg (1978) and further discussed in Bell & Saka (1983), Selkirk (1984), etc. In addition to clusters beginning with voiceless fricatives, which are familiar from the behavior of *s* in English, QZ exhibits many reversed onset clusters consisting of a sonorant or glide followed by an obstruent, as shown in (1).[1]

*Thanks to Armin Mester, Junko Ito, Jaye Padgett, and Andrew Black for helpful comments on earlier versions of this paper.

[1]The data in the paper are mostly taken from Regnier (1993). In the examples, capitalization (other than *N*) indicates voicelessness, ˜ indicates a trill. V'V represents the laryngealized or interrupted vowels.

1995 Work Papers of the Summer Institute of Linguistics
University of North Dakota Session
Volume 39, 11-32.

(1) a. /y + se$^{?}$ed/ [Ise$^{?}$et^{h}] 'POTENTIAL-learn'
/y + ga$^{?}$az/ [iga$^{?}$as] 'POTENTIAL-turn.black'
/ydo$^{?}$o/ [ido$^{?}$o] 'church building'

b. /wkit/ [Ukit^{h}] 'game'
/w + git/ [ugit^{h}] 'COMPLETIVE-play'

c. /rsil/ [R̃sil] 'morning'
/r + to$^{?}$o/ [R̃to$^{?}$o] 'HABITUAL-sell'
/r + da$^{?}$a/ [r̃da$^{?}$a] 'HABITUAL-crawl'

The distribution of voicing in (1) and (2), native speaker intuition, and tone patterns all show that these clusters are tautosyllabic, so we must assume that while Sonority Sequencing plays a role in QZ, additional factors are also involved.

These reversed clusters are actually disfavored by the language itself as well as universally, as evidenced by the fact that phrasal resyllabification takes place whenever possible to move the initial sonorant into the coda of the preceding syllable. This is shown in (2), where the sonorant is voiceless when it is in the onset but voiced in (2c) since it is now syllabified as the coda.

(2) Phrase initially or in isolation:

a. /r + se$^{?}$ed/ [R̃se$^{?}$et^{h}] 'HABITUAL-learn'
b. /r + ki$^{?}$iN + t/ [R̃ki$^{?}$int^{h}] 'HABITUAL-serve-NEG'

Phrase internally dependent upon syllabification:

c. /Ne rse$^{?}$ed/ [ner.se$^{?}$et^{h}] 'that HABITUAL-learn'
d. /bat rki$^{?}$iNt/ [bat.R̃ki$^{?}$int^{h}] 'already HABITUAL-serve-NEG'

In the analysis presented here, the markedness of the reversed clusters is captured in two ways: (i) via onset filters which restrict which consonants may appear in clusters, and (ii) via a preference hierarchy of well-formedness constraints (as proposed by Prince & Smolensky 1993 and McCarthy & Prince 1993 for Optimality Theory) which assures that the reversed clusters will be tautosyllabic only when the sonorant cannot be resyllabified as a coda.

After giving the Segmental Inventory, section 2 discusses which laryngeal features are necessary to account for the fortis-lenis contrasts in QZ. Section 3 then details the well-formedness constraints on the QZ syllable structure, and section 4 shows how the constraint hierarchy accounts for the fact that the reversed clusters only occur word-initially, making an adjunction rule unnecessary. The well-formedness constraints alone do not account for the full distribution of the laryngeal features, however, and QZ does not obey the Laryngeal Constraint proposed by Lombardi (1991, 1995a) for a number of languages, so lexical and post-lexical (or word-level and phrase-level) phonological rules are posited in section 5. This analysis thus differs from the Optimality Theory model in viewing the hierarchy of well-formedness constraints as applying continuously throughout a derivational phonology (see also H.A.Black 1993).

2 Laryngeal Features on QZ Phonemes

QZ has six vowels as shown in (3).

(3)

	Front	Back Unrounded	Back Rounded
High	i		u
Mid	e		o
Low	æ	a	

Each vowel can also occur in a laryngealized or interrupted form [V$^{?}$V]. QZ does not have any long vowels or clusters.

The underlying segmental inventory for the QZ consonants is shown in (4).[2]

(4)

	Bilabial	Alveolar	Palato-Alveolar	Retroflexed	Velar	Palatal Velar	Labial Velar
Stops	p	t			k	k^y	k^w
		d			g	g^y	g^w
Affricates		c	č	č̣			
			ǰ				
Fricatives		s		ṣ̌			
		z		ẓ̌			
Nasals	m	n					
Laterals		l					
Approximants	ƀ		y	r			w

[2]The alveolar nasal is analyzed as /N/ which is unspecified for [Place]; it surfaces as homorganic with a following consonant, with a [coronal] default before vowels. /ƀ/ is pronounced phonetically as a bilabial fricative, but phonologically it patterns as a sonorant, in both its distribution in clusters and its devoicing behavior. (See Hayes (1984) for discussion of similar behavior of /v/ in Russian.) Some examples are given in (5a), (7), (22), (26e), and (30).

Though in QZ there is a clear voicing distinction, in Zapotecan languages in general the distinction between the following pairs of QZ segments is considered to be fortis/lenis rather than voiceless/voiced: t–d, s–z, ṣ̌–ẓ̌, č–ǰ, k–g, k^y–g^y, k^w–g^w. The phonetic quality of the segments varies considerably throughout the language family. The fortis obstruents are always voiceless, while the lenis obstruents vary in voicing. Fortis obstruents are of somewhat longer duration than their lenis counterparts.[3] Further, in a number of Zapotecan languages the fortis/lenis contrast extends to the nasals and liquids. In these cases, both fortis and lenis are voiced, with the fortis segments distinguished by length and intensity (Nellis & Hollenbach 1980). Jaeger & Van Valin (1982) claim that, because both fortis and lenis sonorants are voiced and lenis obstruents are often devoiced, the designation voiceless versus voiced is not appropriate in Zapotec.

Fortis and lenis are not features, however, so we must still seek a featural representation. Jaeger & Van Valin (1982) note that in Yatee Zapotec the consonant clusters tend to be homogeneous along a voiceless/voiced grouping, rather than on a strictly fortis/lenis grouping. Two obstruents in a cluster must be either both fortis (voiceless) or both lenis (voiced or partly voiced), but both fortis and lenis nasals and laterals (which are voiced) can follow lenis obstruents, since they are also voiced. This indicates that the feature [voice] is operative in Zapotec. Marlett & Pickett (1987) use [±voice] to distinguish the obstruents in Isthmus Zapotec and treat the fortis nasals and lateral as geminates, and Marlett & Ward (1990) mark the lenis obstruents in Quioquitani Zapotec with a privative [voice] feature.

A second laryngeal feature [spread glottis] is also involved and is sometimes used instead of [voice] to distinguish fortis obstruents from lenis ones (for example, Olney 1992 for Ngalakan). Butler (1988) notes that the fortis obstruents in Yatzachi Zapotec are aspirated. Marlett & Ward (1990) report that in Quioquitani Zapotec (which is closely related to QZ) fortis obstruents are aspirated word-finally, while lenis obstruents simply devoice in that position. Like QZ, Quioquitani Zapotec does not have a fortis/lenis distinction in nasals or laterals. Regnier (1993) describes the QZ contrast between the fortis and lenis obstruents as clearest in intervocalic position, where fortis obstruents are voiceless and somewhat longer and lenis obstruents are voiced and shorter. Utterance-finally the contrast is neutralized with both fortis and lenis members occurring unvoiced and with aspiration on stops and affricates. Utterance-initially there is a tendency for the lenis consonants to devoice, but this varies from speaker to speaker.

Both [voice] and [spread glottis] are thus operative in QZ consonants, and [constricted glottis] is used within the vowel system for the laryngealized or interrupted vowels. Each of these features can be used privatively, as strongly argued for in Mester & Itô (1989), Cho (1990), and Lombardi (1991, 1995b). Only lenis obstruents must be underlyingly specified with the feature [voice], with default voicing of sonorants occur-

[3]Bickford (1985) gives acoustic measurements of the length distinction between fortis and lenis consonants in Guichicovi Mixe, a Mixe-Zoquean language spoken in Oaxaca, Mexico.

ring post-lexically. While the fortis obstruents could be specified as [spread glottis] as well, this is not required; the utterance-final aspiration is accounted for by rule (34) in section 5. Alternatively specifying only the fortis obstruents as [spread glottis] without any [voice] specification for lenis obstruents is also possible. However, the account of the voicing agreement in the reversed clusters would not then follow from the Universal Tautosyllabic Voicing Constraint (Harms 1973) (see section 5). I therefore use [voice] as the distinctive feature.

3 Syllable Structure and Well-formedness Constraints

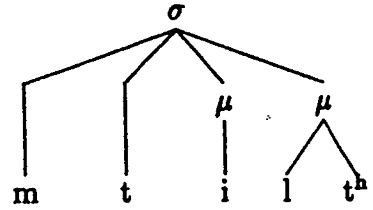
Syllables in QZ may maximally contain three segments in the onset, two positions in the nucleus, and two segments in the coda, though most syllables have only simple onsets and optional simple codas. (5) gives examples of longer monomorphemic words consisting of a single syllable.

(5) a. [ngbaˀan] 'thief'
b. [mtiltʰ] 'jicama' (a root vegetable)

The syllable template is: $[C_3\ C_2\ C_1\ V_1\ V_2\ C_4\ C_5]_\sigma$

Under the version of moraic theory adopted in Hayes (1989), (5b) would be represented as shown in (6).

(6)



The size of the syllable template is evidenced by epenthesis facts on both ends. For example, when the possessive prefix is added to a noun with a simple onset, a two-consonant onset is formed (7a). If the onset of the noun is already a cluster, however, an epenthetic vowel (either *a* or *e*, depending upon the speaker) is added (7b). (Triconsonantal onset clusters must begin with a homorganic nasal, as explained in section 3.1.)

(7) a. /ṣ̌ + bič/ [ṣ̌bičʰ] 'POS-cat'
b. /ṣ̌ + bduˀu/ [ṣ̌ab.duˀu] 'POS-banana'

At the coda end, the negative suffix *-t* may be added to a verb which has a simple coda, forming a coda cluster, but when the suffix -it -r 'more' is also affixed, an epenthetic vowel is added to form two syllables, as shown in (8).[4]

(8)	a.	/r + ak + t/	[rakt^h]	'HABITUAL-be-NEG'
	b.	/w + zæl + t/	[wzælt^h]	'COMPLETIVE-be.found-NEG'
	c.	/n + an + t/	[nant^h]	'STATIVE-know-NEG'
	d.	/r + ak + t + r/	[rak.tre]	'HABITUAL-be-NEG-MORE'
	e.	/w + zæl + t + r/	[wzæl.tre]	'COMPLETIVE-be.found-NEG-MORE'
	f.	/n + an + t + r/	[nan.teR]	'STATIVE-know-NEG-MORE'

3.1 Onset and Coda Restrictions

Of the positions in the syllable template, only C_1 and V_1 are required, and only these positions are not restricted as to which segments may fill them. Normally, languages place restrictions on codas, while simple onsets are unrestricted. In QZ simple onsets and simple codas are unrestricted, but filters are needed to restrict the segments allowed in the complex onsets.

The C_3 position may only be filled by a nasal which is homorganic with the following consonant. This is expressed in the filter in (9), following the lead of Itô (1989) and assuming the Linking Constraint in Hayes (1986).

(9) $* \; [_{\sigma} \; \underset{\overset{|}{\text{[Place]}}}{\text{[+nasal]}} \; \text{[+cons]} \; \text{[+cons]}$

Two-consonant onset clusters consist of either a stop followed by any consonant higher on the sonority hierarchy, a voiceless (fortis) fricative followed by any other consonant (with obstruents in the C_1 position following a fortis (voiceless) fricative being devoiced), or a sonorant followed by any other consonant. The third option is the reversed cluster, which will resyllabify if possible. The first two possibilities are the same as those allowed in English (as noted in Selkirk 1982).

Conspicuously absent from the possible segments occupying the C_2 position are the affricates and voiced fricatives. The lack of affricates before another consonant can be explained by a process of deaffrication, which can be clearly seen in Quioquitani Zapotec. Marlett & Ward (1990) report that the Habitual aspect marker is /c/. Deaffrication occurs whenever /c/ is prefixed to any consonant-initial root yielding [s], as

[4]The reason for the syllabification of /r/ as a complex onset in some cases and as a coda in others is unknown. Capitalization indicates voicelessness.

shown in (10).

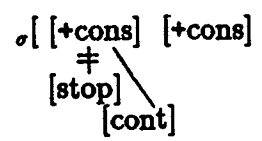
(10) a. /c + as/ [cas] 'HABITUAL-jump'
b. /c + to/ [sto] 'HABITUAL-sell'
c. /c + na/ [sna] 'HABITUAL-awaken'

QZ does not have any prefixes that are affricates, except for an allomorph of the Potential aspect prefix /c-/ which occurs before some /z/ and /ẓ̌/ initial verbs, as well as some vowel-initial verbs. The effect is somewhat hidden due to a coronal continuant merging process, but clearly both deaffrication and devoicing have occurred, as shown in (11).

(11) a. /c + zu/ [su] 'POTENTIAL-stand'
b. /c + ẓ̌obeʔe/ [ṣ̌obeʔe] 'POTENTIAL-fly'

We can thus write the rule of Deaffrication as shown in (12), which delinks the [stop] feature in the affricate (assuming the non-linear representation of affricates in Lombardi 1990), accounting for the fact that affricates never begin consonant clusters in syllable onsets.[5]

(12) Deaffrication

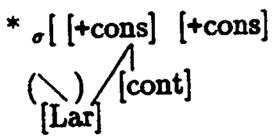


The fact that voiced fricatives may not begin consonant clusters is more curious and seems simply to be a language-specific restriction that QZ and English share. For instance, why can neither language have [zl] or [zn] clusters? Those clusters obey Sonority Sequencing and are allowed in other languages such as Yatee Zapotec, Italian, and Russian. The onset filter expressing the restriction that onset clusters may not begin with a voiced fricative is stated in (13), where both single and double linking of the laryngeal node is disallowed.

[5]An account that rules out affricates in consonant clusters on the basis that they fill two positions will not work for QZ, since deaffrication only occurs in initial position in onsets. Affricates may be the second member of an onset cluster (i) and may fill either position in a coda cluster (ii)–(iii).

(i)	/mǰin/	[mǰin]	'deer'
(ii)	/mlenč̣/	[mlenč̣^{h}]	'mosquito'
(iii)	/w + la + leʔej + t/	[wlaleʔejt^{h}]	'COMPLETIVE-call-liver-NEG' ='did not believe'

(13)

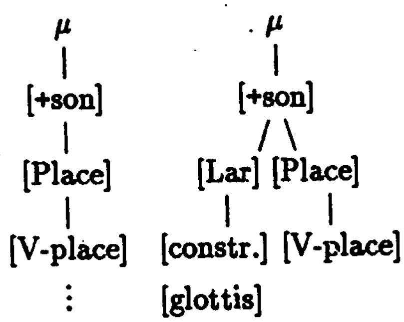


Though Sonority Sequencing is only minimally relevant in QZ onset clusters, it does play a role in the coda clusters. If we assume a simple sonority scale with stops $\prec$ affricates $\prec$ fricatives $\prec$ sonorants, then C_4 must be greater or equal to C_5 on the sonority scale, with equality possible only when both are stops.[6]

3.2 Constraints on the Syllable Nucleus

The QZ syllable nucleus is itself interesting with respect to laryngeal licensing. QZ does not have any long vowels or diphthongs. The laryngealized vowels are underlyingly contrastive and are realized as interrupted vowels with rearticulation after the short glottal stop. I propose the bimoraic underlying representation for laryngealized vowels given in (14), where I follow Clements (1991) and Odden (1991) in assuming the existence of a vowel-place node. The true vowel is fully specified with its [V-place] features, but the glottalized vowel has only an empty [V-place] node, with features to be filled in as discussed below.[7]

(14)



If the following coda consonant C_4 is a glide, its place features will be shared with V_2; otherwise, V_1 spreads its [V-Place] features to V_2. This is borne out by the data in (15)–(16). Normally, the vowel quality is identical before and after the glottal stop, as shown in (15).

[6]Two stops in the coda are only found when the negative suffix has been added to a verb ending in a stop. Even then, if the verb-final stop is a coronal, epenthesis results as an antigemination effect triggered by the Obligatory Contour Principle (McCarthy 1986):

/n + jiˀid + t/ [njiˀidetʰ] 'UNREAL-come-NEG'

[7]The presence of the [V-place] node on the second mora distinguishes it from a simple glottal stop, which is necessary since checked vowels [V?] and interrupted vowels [VˀV] contrast in other Zapotecan languages.

(15) a. /ƀaˀa/ [ƀaˀa] 'grave'
b. /ƀboˀo/ [ƀoˀo] 'coal'
c. /yuˀu/ [yuˀu] 'house'
d. /meˀeǰ/ [meˀeǰ] 'lion'

But when a laryngealized vowel is followed by a glide, the quality of the glide moves onto the vowel after the interruption, as shown in (16).

(16) a. /kƀaˀay/ [kƀaˀi] 'broom'
b. /gʸeˀey/ [gʸeˀi] 'mountain'
c. /meč̤uˀuy/ [meč̤uˀi] 'owl'
d. /mæˀæw/ [mæˀu] 'moon'
e. /doˀow/ [doˀu] 'corn bin'

Though underlyingly contrastive with simple vowels, the laryngealized vowels only occur in the stressed syllable. QZ only has one stress per word and it falls on the first syllable of the root if it is heavy (where both closed syllables and laryngealized syllables count as heavy), otherwise on the second syllable. The foot is therefore a quantity-sensitive iamb built on the root. In compounds, stress is on the final root, indicating that word prominence is rightmost. By looking at compound formation, we can see that the loss of laryngealization in unstressed syllables (leaving only a simple vowel) is an active process rather than simply a morpheme structure constraint. Some examples are given in (17).

(17) a. /leˀen + ziˀi/ [lenziˀi] 'insides-nose' or 'nostril'
b. /š̤naˀa + š̤naˀa/ [š̤naš̤naˀa] 'mother-mother' or 'grandmother'

Randy Regnier (p.c.) pointed out that this process is also sensitive to phrase-final stress, since the laryngealization is lost in the less prominent word in (18).

(18) /te mæˀæd ƀeˀe/ [te mæd ƀeˀe] 'one child male'

Other Zapotecan languages also bear out this link between the complex vowels and stress. For example, in Mitla Zapotec (Stubblefield & Hollenbach 1991) there are three types of complex vowels, each of which contains a laryngeal feature: vowels can be shortened by a glottal stop, laryngealized (pronounced with a creaky voice in this language), or aspirated. As in QZ, the stress falls only on the final root of a compound in Mitla Zapotec, so all of the three types of complex vowels are shortened to a simple vowel in the unstressed roots. In Juarez Zapotec (Nellis & Nellis 1983), both a checked vowel [V?] and an interrupted vowel [V$^{?}$V] may occur only in stressed syllables. However, Juarez Zapotec allows compounds to retain as many stresses as there are roots in the compound, so no reduction of the complex vowels is seen in Juarez compounds.[8]

We can see this restriction to stressed syllables as an instance of the Weight to Stress Principle (Prince 1990), which says if a syllable is heavy it must be stressed. When this principle is violated, the response is to delink the mora, making the syllable light. Following Mester (1994) we can assume that this occurs in closed syllables also, but the coda consonant(s) are able to relink to the first mora or directly to the syllable, retaining their prosodic licensing (Itô 1986, Goldsmith 1990, Itô & Mester 1991). The laryngeal feature [constricted glottis] may only be licensed by its own mora, as shown in (19), so when the mora is removed the laryngeal feature cannot be realized.

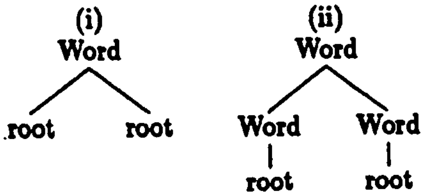
(19) Necessarily:

4 The Preference Hierarchy of Constraints

The observation that some well-formedness constraints seem to be violable rather than absolute led to the proposal by Prince & Smolensky (1993) and McCarthy & Prince (1993) that the constraints are hierarchically ranked. A lower ranked constraint may be violated if necessary to enforce a higher ranked constraint (but not vice versa), thus giving the optimal output. Using a preference hierarchy of constraints in QZ will allow us to account for the distribution of the reversed onset clusters without positing special adjunction rules.

At the top of the QZ preference hierarchy come the syllable template and the various

[8]This contrast between QZ and Mitla Zapotec on the one hand and Juarez Zapotec on the other can be analyzed as a difference in the structure of compounds. In QZ and Mitla, compounds consist of multiple roots in a single word (i), whereas in Juarez each part of the compound is itself a word and thus able to bear independent stress (ii).



restrictions on the onset and nucleus discussed in section 3. In addition to those, we need to add a licensing statement that says that nasals (and probably laterals) independently license [voice]. These segments do not participate in the devoicing that applies to the other sonorants in reversed clusters (see section 5). This is probably related to the fact that nasals and laterals, as opposed to the other sonorants, have a fortis/lenis distinction in other Zapotecan languages. I will call this group of constraints SYLLABLE & LARYNGEAL LICENSING.

After this come the two universal principles, the Weight to Stress Principle (WSP) and the Obligatory Contour Principle (OCP). These are not ordered with respect to one another because they apply to different domains. We can clearly see, however, that the WSP must be ranked above PARSE (i.e. do not delete) because a mora and subsequently the laryngeal feature [constricted glottis] and the vowel rearticulation are deleted in order to fulfill the WSP. Similarly, the OCP must dominate both PARSE and FILL (i.e. do not epenthesize), because some OCP violations are corrected by deleting or merging two like segments (as in the coronal-continuant merging shown in (11)), and some are corrected by epenthesis (as when two coronal stops come together due to the addition of the negative suffix shown in footnote 6).

Finally we come to the four constraints which are crucial to the correct syllabification of the reversed clusters. In this group, the preference to PARSE all segments comes first, followed by the ONSET requirement, since ordering ONSET above PARSE would cause deletion of initial onsetless syllables.[9] The SONORITY statement in (20) that sonorants prefer moraic positions, along with the other Sonority Sequencing restrictions for QZ, is next, and FILL is the final constraint. (The ranking of FILL in this position correctly restricts epenthesis to nucleus epenthesis only within words.)

(20) SONORITY: Avoid $\begin{array}{c}\sigma\\ |\\ [+son]\end{array}$ i.e. Prefer $\begin{array}{c}\mu\\ |\\ [+son]\end{array}$

The SONORITY constraint in (20) accounts for the fact that, while a sonorant may form a complex onset word initially, it will resyllabify as a coda to a final open syllable in the preceding word if possible. Whenever an onset is available, the sonorant will resyllabify to avoid a violation of SONORITY. This is shown in (21). Note that in (21a,b,&d) the sonorant is voiceless, as we will see in section 5 is required before a voiceless obstruent in the syllable onset, whereas it is voiced in (21c) since it is now syllabified as the coda.

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[9] I assume here that the ONSET constraint is a strict requirement and that the ordering of the constraint within the hierarchy accounts for the word-initial or phrase-initial exceptions. This means that a condition on the constraint, such as 'except phrase-initially' used in Prince & Smolensky (1993), is unnecessary.

(21) Phrase initially or in isolation:

a. /r + se$^{?}$ed/ [R̃se$^{?}$et^{h}] 'HABITUAL-learn'

b. /r + ki$^{?}$iN + t/ [R̃ki$^{?}$int^{h}] 'HABITUAL-serve-NEG'

Phrase internally dependent upon syllabification:

c. /Ne rse$^{?}$ed/ [ner.se$^{?}$et^{h}] 'that HABITUAL-learn'

d. /ƀat rki$^{?}$iNt/ [ƀat.R̃ki$^{?}$int^{h}] 'already HABITUAL-serve-NEG'

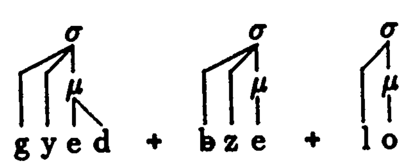
Derivations for these forms are given at the end of section 5 to illustrate the interaction between voicing and syllabification.

The reversed clusters are only tolerated word-initially. Word-medially the sonorant can syllabify as a coda to a preceding open syllable. In cases where the preceding syllable is closed, epenthesis occurs, as verified in (22).

(22) /g^{y}ed + ƀze + lo/ [g^{y}e.deƀ.ze.lo] 'eyelid'
skin eye face

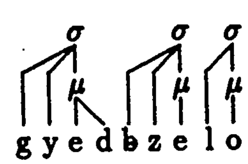
Such facts normally require positing an onset adjunction rule which can apply only word-initially. The ordering of the constraints in the hierarchy will account for the correct distribution, however, eliminating the need for the special adjunction rules, as shown in (23). Word-internally, the desire for sonorants to be in coda position can be met since the coda of the preceding syllable provides a possible onset. The SONORITY constraint is higher than FILL, so epenthesis applies to create optimal syllables. In the word-initial case, a syllable consisting of an epenthetic vowel and the sonorant coda would not have an onset. The fact that syllables require onsets overrides the desire for sonorants to be in coda position, so the reversed cluster is tolerated pending possible compounding or phrase-level resyllabification.

(23) Initial syllabification

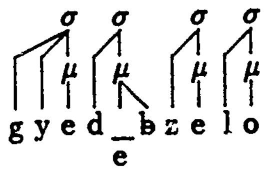


After compounding

SONORITY violation



Resyllabification
and
Epenthesis



The overall ranking of constraints we have discussed for QZ is thus:

SYLLABLE & LARYNGEAL LICENSING ≻ { WSP, OCP } ≻ PARSE ≻ ONSET ≻ SONORITY ≻ FILL

5 The Full Distribution of Laryngeal Features

Lombardi (1991, 1995a) accounts for the distribution of laryngeal features in a number of languages, such as Dutch, Catalan, Polish, and German, using the Laryngeal Constraint, which licenses laryngeal features only in the position immediately preceding a sonorant, and a separate spreading rule for some of the languages. This accounts for syllable final devoicing and cluster spreading. The Laryngeal Constraint and spreading rule is not operative in QZ since it has neither syllable final devoicing[10] nor cluster spreading across syllable boundaries, as shown in the compounds in (24).

(24)	a.	/ƀdoẓ̌ + ṣ̌til/	[ƀdoẓ̌.ṣ̌til]	'bird of prey'
	b.	/g^{y}ed + k^{w}es/	[g^{y}ed.k^{w}es]	'cheek'
	c.	/ẓ̌iz + ki^{ʔ}in/	[ẓ̌iz.ki^{ʔ}in]	'heart of a liver'

We can distinguish three processes occurring in QZ which account for the full distribution of the laryngeal features [voice] and [spread glottis]. The two processes involving [voice] conspire to fulfill the Universal Tautosyllabic Voicing Constraint (UTVC) (Harms 1973, Greenberg 1978), which says that a voiced consonant may not appear outside of a voiceless obstruent within a single syllable. (The UTVC can itself be seen to follow from Sonority Sequencing.)

First, there is a lexical process which devoices an obstruent following a fortis coronal continuant, thus neutralizing the voicing distinction as shown in (25).[11]

[10] QZ does have word-final devoicing with aspiration, however, as discussed at the end of this section.

[11] The situation is more complex for the coronal fricatives due to an antigemination restriction which causes merging of coronal continuants, but devoicing is still operative in these cases:

(25)	a.	/ṣ̌ + pit/	[ṣ̌pitʰ]	'POS-nose'
	b.	/s + toˀo/	[stoˀo]	'FUTURE-sell'
		/ṣ̌ + tis/	[ṣ̌tis]	'POS-officials'
	c.	/s + deˀe/	[steˀe]	'FUTURE-give'
		/ṣ̌ + deN/	[ṣ̌ten]	'POS-ranch'
	d.	/s + kaˀa/	[skaˀa]	'FUTURE-stay'
	e.	/s + kʸe/	[skʸe]	'FUTURE-roast'
	f.	/ṣ̌ + kʷart/	[ṣ̌kʷartʰ]	'POS-room'
	g.	/s + gob/	[skoΦ]	'FUTURE-tighten'
		/ṣ̌ + goz/	[ṣ̌kos]	'POS-tail'
	h.	/ṣ̌ + gʸag/	[ṣ̌kʸakʰ]	'POS-water gourd'
	i.	/ṣ̌ + gʷay/	[ṣ̌kʷaY]	'POS-horse'

No devoicing occurs when these prefixes are added to roots beginning with sonorants, however.

(26)	a.	/ṣ̌ + maˀa/	[ṣ̌maˀa]	'POS-animal'
	b.	/s + Nu/	[snu]	'FUTURE-speak'
		/ṣ̌ + Niz/	[ṣ̌nis]	'POS-corn'
	c.	/s + laˀa/	[sla?a]	'FUTURE-do'
		/ṣ̌ + loˀo/	[ṣ̌loˀo]	'POS-corral'
	d.	/s + ruˀu/	[sr̃uˀu]	'FUTURE-leave'
	e.	/s + baˀaN/	[sbaˀan]	'FUTURE-rob'
		/ṣ̌ + bay/	[ṣ̌baY]	'POS-shawl'

(i)	/s + sac/	[sacʰ]	'FUTURE-cover'
	/ṣ̌ + sæˀæ/	[ṣ̌sæˀæ]	'POS-dinner'
(ii)	/s + zeˀeb/	[seˀeΦ]	'FUTURE-owe'
	/ṣ̌ + zaa/	[ṣ̌saˀa]	'POS-corn'

f. /s + wiˀi/ [swiˀi] 'FUTURE-see'
/ṣ̌ + wak/ [ṣ̌wakʰ] 'POS-cockroach'

g. /s + ya/ [sya] 'FUTURE-dance'
/ṣ̌ + yuˀu/ [ṣ̌yuˀu] 'POS-house'

This process could easily be expressed as a rule spreading [−voice] or [spread glottis] if the voiceless coronal continuants (or all fortis obstruents) were so marked. We can maintain the claims of both privative feature theory and underspecification theory, however, by formulating this process as simply a lexical rule in which a consonant assimilates to the voicing of a preceding obstruent within the syllable onset. As noted in Mester & Itô (1989), the classical Praguean conception of assimilation conceives of all assimilation processes as contingent upon prior neutralization (Davidsen-Nielsen 1978, Kiparsky 1985:98). With this understanding, the rule in (27) achieves both (a) neutralization of all Laryngeal specifications (only [voice] is specified) on a consonant following an obstruent within the syllable onset and (b) spreading of any laryngeal specification on the obstruent to the consonant.[12]

(27) Fortis Assimilation

```
a.  σ[ [-son]  [+cons]             b.  σ[ [-son]  [+cons]
                  ≠                         |_ _ _ /
                [Lar]                     [Lar]
```

There are only four possible outcomes from this rule, as shown in (28), all of which obey the UTVC.[13]

```
(28) a. [-son] [-son]  or  [-son] [-son]  ==>  [-son] [-son]    e.g. [sk] or
                                     |                           [ṣ̌d] → [ṣ̌t]
                                   [Lar]

     b. [-son] [-son]  or  [-son] [-son]  ==>  [-son] [-son]    e.g. [gʷz] or
          |      |           |                      \  /          [gs] → [gz]
        [Lar]  [Lar]       [Lar]                   [Lar]

     c. [-son] [+son]                     ==>  [-son] [+son]    e.g. [sr]
```

[12] I follow Lombardi (1991) in assuming that voiceless, unaspirated, unglottalized segments do not have any Laryngeal specification (or node) at all, since this accounts best for the neutralization facts cross-linguistically.

[13] The [Lar] for sonorants is specified by default later, so it is not shown in (28). Though there is no prefixation operation to show this as an overt process, the reflection of [gs]⟶[gz] in (28b) is meant to show that rule (27) also accounts for the lack of [gs]-type clusters in QZ.

d. [-son] [+son] ⟹ [-son] [+son] e.g. [gr]
[Lar] [Lar]

Second, in the phrase level phonology, after resyllabification to optimize syllables and after default specification of [voice] for sonorants, onset voicing agreement applies regressively (rule (31)), as shown in (29)–(30). (Capital letters indicate voicelessness.)

(29)
a. /y + seˀed/ [Iseˀetʰ] 'POTENTIAL-learn'
/y + gaˀaz/ [igaˀas] 'POTENTIAL-turn.black'
/ydoˀo/ [idoˀo] 'church building'

b. /wkit/ [Ukitʰ] 'game'
/w + git/ [ugitʰ] 'COMPLETIVE-play'

c. /rsil/ [R̃sil] 'morning'
/r + toˀo/ [R̃toˀo] 'HABITUAL-sell'
/r + daˀa/ [r̃daˀa] 'HABITUAL-crawl'

(30) shows that this regressive voicing agreement is crucially dependent upon syllabification. Since the /ƀ/ syllabifies as the coda of the first syllable in (30b), no devoicing occurs.

(30)
a. /ƀc̦uˀuș/ [Φc̦uˀuș] 'tomato'
b. /ș + ƀc̦uˀuș/ [șaƀ.c̦uˀuș] 'POS-tomato'

The purpose of rule (31) is to assure (a) neutralization of the [voice] specification on the sonorant and (b) agreement with the voicing of the following obstruent in the reversed onset clusters.

(31) Reversed Onset Voicing

a. $_\sigma$[[+son] [-son]
ǂ
[Lar]

b. $_\sigma$[[+son] [-son]
[Lar]

The two possible outcomes from this rule, shown in (32), both obey the UTVC.

(32) a. [+son] [-son] ⟹ [-son] [+son] e.g. [rd]
[Lar] [Lar] [Lar]

b. [+son] [−son] ⟹ [−son] [+son] e.g. [Rk]
   |
   [Lar]

Rule (31a) can be seen as following naturally from the UTVC under Cho's (1990) formulation of the UTVC as a rule of Universal Devoicing, as given in (33).

(33) Universal Devoicing

C ǂ [voice]   C [−son]

——→ syllable nucleus

Note that this formulation does not limit the delinking to obstruents, so the QZ syllabification rules would allow the appropriate sonorants to be devoiced. The spreading of [voice] in the direction outward from the nucleus after neutralization is also seen to be a universal process by Cho (1990), thus reducing (31) to the setting of two parameters, [cluster-devoicing] and [+spreading] under that view. Rule (27) does not follow from Universal Devoicing, however, since the neutralization and spreading in onset obstruent clusters works in the opposite direction, with the leftmost obstruent determining the voicing for the cluster. (Note that English also needs a rule such as (27), proposed as a Morpheme Structure Constraint in Halle (1962), to account for the fact that only voiceless obstruents may follow *s*.)

Finally, before pause all stops and affricates are voiceless and aspirated, and all continuants and approximants are voiceless.[14] This can be analyzed as the insertion of the feature [spread glottis] on the final segment before pause (analyzed as the Intonational Phrase level), as shown in (34), where I again assume that neutralization of any existing Laryngeal specification occurs first.

(34) [spread glottis] Insertion

[+cons]]*IntonationalPhrase*
|
[Lar]
|
[spread glottis]

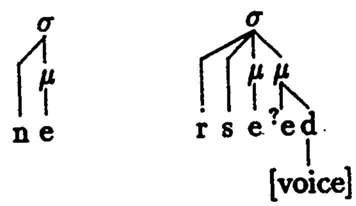
[14]QZ thus seems close to being a language that has word-final (or phrase-final) devoicing but not syllable-final devoicing, which Lombardi (1991, 1995a:69) predicts does not exist. I noted earlier that the Laryngeal Constraint Lombardi proposes is not operative in QZ. Due to the presence of aspiration on phrase-final obstruents, I analyze the QZ process as insertion of [spread glottis] rather than as neutralization of [voice].

The phonological rules of Fortis Assimilation (27), Reversed Onset Voicing (31), and [spread glottis] Insertion (34) apply subject to the constraint hierarchy; for example, the rule of [spread glottis] Insertion will not apply to nasals, since they separately license [voice].

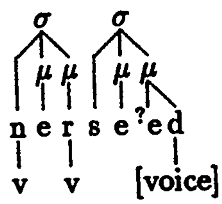
Derivations of the forms cited earlier in (21c–d) will be given here to illustrate how voicing and syllabification interact. (35) gives the derivation of (21c) where phrasal resyllabification occurs.[15]

(35) /Ne rse^{ʔ}ed/ [ner.se^{ʔ}et^{h}] 'that HABITUAL-learn'

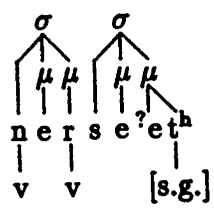
Initial syllabification through lexical phonology



Phrase level resyllabification and default voicing



[spread glottis] insertion

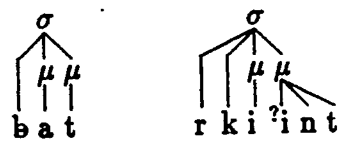


This contrasts with the derivation for (21d), given in (36), where resyllabification is not possible; therefore, the reversed cluster remains tautosyllabic, and onset voicing agreement (rule (31)) applies.

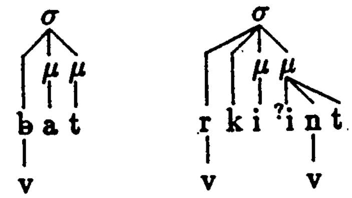
(36) /ɓat rki^{ʔ}iNt/ [ɓat.R̃ki^{ʔ}int^{h}] 'already HABITUAL-serve-NEG'

[15] Default specification of [voice] for sonorants is shown as 'v' in derivations (35) and (36). The [constricted glottis] feature of the interrupted vowels is not relevant, so it is not shown. In derivation (35), neither Fortis Assimilation nor Reversed Onset Voicing are applicable. Likewise, Fortis Assimilation is not applicable in derivation (36).

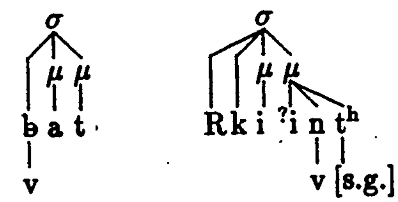
Initial syllabification through lexical phonology



No phrase level resyllabification
Default voicing



Universal devoicing
[spread glottis] insertion



Considering the fact that Fortis Assimilation and Reversed Onset Voicing conspire to force compliance with the UTVC, it may be possible to reformulate these rules to fit into the constraint hierarchy as well, though the exact formulation is not clear. The insertion of [spread glottis] could be reformulated as a licensing constraint rather than an insertion rule; then a violation of FILL would allow the Laryngeal node with the feature [spread glottis] to be added where required by the licensing. If these moves were made, all the 'rules' operable in QZ could be part of the constraint hierarchy as proposed in Optimality Theory (Prince & Smolensky 1993 and McCarthy & Prince 1993).

Optimality Theory assumes a non-derivational view, with the hierarchy of constraints determining the optimal surface form (and prosodic structure) from a set of candidates. Due to the resyllabification and constraints which apply to higher levels of prosodic structure, this non-derivational view of QZ phonology would require the candidates to be parsed into Intonational Phrase units, rather than considering single words, causing the size of each candidate to be considered as well as the size of the candidate set itself to be greatly multiplied. For this reason, as well as the reluctance to throw away the results established in derivational models of phonology, I prefer to view the hierarchy of constraints as applying throughout a derivational phonology. Such a theory is formalized as Constraint-Ranked Derivation by H.A.Black (1993).

6 Conclusion

The three privative laryngeal features, [voice], [spread glottis], and [constricted glottis], are thus utilized in QZ, with special licensing constraints on each one. These constraints, coupled with a ranking of the universal constraints on prosodic structure, serve to correctly limit the syllable shapes allowed in QZ. At the same time, they mark the reversed onset clusters as disfavored both language internally and universally.

References

Bell, Alan and Mohamad M. Saka. 1983. Reversed sonority in Pashto initial clusters. *Journal of Phonetics*. London: Academic Press, Inc. 11.259–275.

Bickford, J. Albert. 1985. Fortis/lenis consonants in Guichicovi Mixe: a preliminary acoustic study. *Work Papers of the Summer Institute of Linguistics, University of North Dakota Session*. 29.195–207.

Black, H. Andrew. 1993. *Constraint-Ranked Derivation: A Serial Approach to Optimization*. Santa Cruz, CA: University of California, Santa Cruz dissertation.

Butler H., Inez M. 1988. *Gramatica Zapoteca; Zapoteco de Yatzachi el Bajo. Serie gramatica de lenguas indigenas de Mexico 4*. Mexico: Instituto Lingüístico de Verano.

Cho, Young-mee Yu. 1990. A typology of voicing assimilation. *WCCFL* 9.

Clements, G.N. 1991. Place of articulation in consonants and vowels: a unified theory. In B. Laks and A. Rialland, eds. *L'Architecture et la Gomtrie des Representations Phonologiques*. Paris: Editions du C.N.R.S.

Davidsen-Nielsen Niels. 1978. *Neutralization and archiphoneme: Two phonological concepts and their history*. Copenhagen: Academisk Forlag.

Goldsmith, John A. 1990. *Autosegmental and Metrical Phonology*. Cambridge, MA: Basil Blackwell, Inc.

Greenberg, Joseph. 1978. Some generalizations concerning initial and final consonant clusters. In J. Greenberg, ed. *Universals of Human Language*. Stanford, CA: Stanford University Press. 2.243–279.

Halle, Morris. 1962. Phonology in generative grammar. *Word*. 18:54–72.

Harms, R. 1973. Some non-rules in English. Indiana University Linguistics Club.

Hayes, Bruce. 1984. The phonetics and phonology of Russian voicing assimilation. In A. Aronoff and R.T. Oehrle, eds. *Language Sound Structure*. Cambridge, MA: MIT Press. 318–328.

Hayes, Bruce. 1986. Inalterability in CV Phonology. *Language*. 62.321–351.

Hayes, Bruce. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry*. 20.253–306.

Itô, Junko. 1986. *Syllable Theory in Prosodic Phonology*. Amherst, MA: University of Massachusetts, Amherst dissertation. Published in 1988 by Garland Publishers, New York.

Itô, Junko. 1989. A prosodic theory of epenthesis. *Natural Language and Linguistic Theory* 7.215–259.

Itô, Junko and R. Armin Mester. 1991. *The Prosodic Phonology of Japanese*. Class Reader LINS 224, 1991 Linguistics Institute. University of California, Santa Cruz.

Jaeger, Jeri J. and Robert D. Van Valin, Jr. 1982. Initial consonant clusters in Yatee Zapotec. *International Journal of American Linguistics* 48.125–138.

Kiparsky, Paul. 1985. Some consequences of lexical phonology. *Phonology Yearbook* 2:82–138.

Lombardi, Linda. 1990. The Nonlinear Organization of Affricates. *Natural Language and Linguistic Theory* 8:375–425.

Lombardi, Linda. 1991. *Laryngeal Features and Laryngeal Neutralization*. Amherst, MA: University of Massachusetts, Amherst dissertation.

Lombardi, Linda. 1995a. Laryngeal Neutralization and Syllable Wellformedness' *Natural Language and Linguistic Theory* 13.39–74.

Lombardi, Linda. 1995b. Dahl's Law and Privative [VOICE]. *Linguistic Inquiry* 26.365–372.

Marlett, Stephen A. and Velma B. Pickett. 1987. The syllable structure and aspect morphology of Isthmus Zapotec. *International Journal of American Linguistics* 53.398–422.

Marlett, Stephen A. and Michael Ward. 1990. The phonology and morphology of Quioquitani Zapotec. Summer Institute of Linguistics, Mexico Branch, ms.

McCarthy, John J. 1986. OCP effects: gemination and antigemination. *Linguistic Inquiry* 17:207–263.

McCarthy, John J. and Alan S. Prince. 1993. Prosodic Morphology I: constraint interaction and satisfaction. University of Massachusetts, Amherst and Rutgers University, ms.

Mester, R. Armin. 1994. The quantitative trochee in Latin. *Natural Language and Linguistic Theory* 12.1–61.

Mester, R. Armin and Junko Ito. 1989. Palatal prosody in Japanese mimetics. *Language*. 65.259–93.

Nellis, D.G. and B.E. Hollenbach. 1980. Fortis versus lenis in Cajones Zapotec phonology. *International Journal of American Linguistics* 46:92–105.

Nellis, Neil and Jane Goodner de Nellis. 1983. *Diccionario Zapoteco de Juarez: Vocabularios Indigenas 27*. Mexico: The Summer Institute of Linguistics, Inc.

Odden, David. 1991. Vowel geometry. *Phonology* 8.261–289.

Olney, Tobias. 1992. On fortis-lenis stop contrast in Ngalakan. Paper presented at Linguistics Mini Conference, University of California, Santa Cruz.

Prince, Alan. 1990. Quantitative consequences of rhythmic organization. *Proceedings of the 26th Annual Meeting of the Chicago Linguistics Society.*

Prince, Alan and Paul Smolensky. 1993. *Optimality Theory*. Piscataway, New Jersey: Rutgers University Center for Cognitive Science Technical Report No. 2.

Regnier, Sue. 1993. Quiegolani Zapotec phonology. *Work Papers of the Summer Institute of Linguistics, University of North Dakota Session* 37:37–63.

Selkirk, Elizabeth O. 1982. The syllable. In H. Van der Hulst and N. Smith, eds. *The Structure of Phonological Representations* 2:337–384.

Selkirk, Elizabeth O. 1984. On the major class features and syllable theory. In M. Aronoff and R. Oehrle, eds. *Language Sound Structure*. Cambridge, MA: MIT Press. 107–136.

Stubblefield, Morris and Elena E. de Hollenbach. 1991. 'Gramática Zapoteca de Mitla, Oaxaca'. Summer Institute of Linguistics, Mexico Branch, ms.

Cheryl A. Black
PO Box 8987 CRB
Tucson, AZ 85738

Andy.Black@sil.org