

Daniel Silverman

Dissertation Prospectus

UCLA

Laryngeal Phonology in Oto-Manguean

Despite recent advances in our understanding of the phonetic and phonological patterning of laryngeal phenomena (Kingston 1985, Lombardi 1991, Steriade 1992), there exists a sizeable list of unanswered questions. For instance, what is the phonetic inventory of linguistically significant laryngeal states? Within this inventory, which states may contrast, and which states may not? Under what circumstances, if any, may a single laryngeal feature possess distinct phonetic manifestations within a single system? What is the phonetic and phonological relationship between laryngeal states and supralaryngeal stricture? How many laryngeal states may be associated with a given supralaryngeal constriction?

The Oto-Manguean family of languages, native to State of Oaxaca, Mexico, and environs, possesses an unusually rich inventory of laryngeal phenomena. Among the relevant phenomena is the so-called ballistic accent, prevalent in Chinantec and Amuzgo (Merrifield 1963, Bauernschmidt 1965, Rensch and Rensch 1966, Robbins 1968, Mugele 1982), the existence of creaky-voiced and breathy-voiced vowels in Chinantec and Mazatec respectively (Rensch and Rensch 1966, Ladefoged, Maddieson, and Jackson 1988), the existence of so-called laryngeally

"interrupted" vowels in, for example, Proto-Chinantec, Otomi and Mazatec (Rensch 1976, Arroyo 1955), peculiar and varying co-occurrence restrictions between laryngeal states and particular supralaryngeal constrictions in, for example Trique and Chinantec versus Mazatec (Hollenbach 1977, Rensch and Rensch 1966, Pike and Pike 1947, Steriade 1992), constraints on the number of laryngeal gestures allowed to co-occur with a given supralaryngeal constriction (Steriade 1992), as well as co-occurrence constraints within the class of laryngeals themselves (Rensch and Rensch 1966, Robbins 1968) and the seeming free variation between vowel creaking and glottal checking in a particular sub-class of systems (Rensch and Rensch 1966, Williams and Pike 1968).

It would seem that Oto-Manguenan is replete with laryngeal phenomena that are calling out for phonetic and phonological analysis.

A thorough investigation may provide new insights into our understanding of both the mental and the physical relevance of the larynx in language. It is for these reasons that I plan to focus my dissertation on laryngeal phonology in Oto-Manguenan.

The organization of this prospectus loosely reflects my preliminary vision of the final dissertation:

(a) I investigate the various phonetic manifestations of laryngeal states vis-a-vis supralaryngeal states in Oto-Manguenan, and determine what generalizations can be made regarding their distribution both

within and across systems. This analysis should culminate in an inventory of contrastive laryngeal states for Oto-Manguean.

(b) I consider the extent to which laryngeal features may co-occur, herein discussing ballisticity in Chinantec. This discussion should be helpful in determining the phonological organization of laryngeal features.

(c) I consider how many distinct laryngeal states may co-occur with a given supralaryngeal configuration. Here I will present data from Mazatec, discussing the conclusions of Steriade (1992) in light of current hypotheses.

(d) I consider the hypothesis that a single laryngeal target obligatorily accompany any given supralaryngeal gesture. This presentation entails discussing the experimental phonetic findings of Löfqvist and associates, as well as a discussion of the findings in Maddieson (1984). I will consider data from Western Popoluca and Mazatec that would appear to counter-exemplify this claim. Assuming I find evidence in support of this hypothesis, I will investigate whether redundant laryngeal states possess linguistic significance, or are simply a phonetic enhancement phenomenon (Stevens and Keyser 1989, Keating 1990)? I will additionally consider laryngeal coarticulation phenomena, and what they may tell us about laryngeal underspecification.

(e) I envision preliminarily considering laryngeal processes outside Oto-Manguean, to see if the generalizations holding of Oto-Manguean hold elsewhere.

While it may be beyond the scope of this dissertation to provide a thoroughgoing investigation into all of these issues, I am hopeful that I will at least provide a theoretically relevant investigation into a rarely explored family of languages, and will help delineate the scope of future investigations in contribution to a universal theory of laryngeal phonology.

(a) I will preliminarily compare and contrast the inventory of phonetic manifestations of contrastive laryngeal phenomena in several languages. Here I present a few relevant observations.

Quiotepec Chinantec possesses so-called "interrupted" syllables (Robbins 1968), in which a nucleus (either simplex or complex) is interrupted by glottalization. This syllable type is also present in Western Popoloca, where it is contrastive with glottally checked syllables (Williams and Pike 1968, Steriade 1992). Relatedly, Rensch and Rensch (1968) report that in Lalana Chinantec, post-vocalic /?/ is in free variation with creaked vowels: "...the wave of laryngealization is actualized over the entire syllable nucleus" (p. 457), and thus patterns parallel to Lalana's post-vocalic /h/, which

is Rensch and Rensch's transcription of the ballistic phenomenon.

There are obviously several distinct possibilities for the realization of laryngealization vis-a-vis vocalic material: it may "interrupt" the vowel, it may continually creak the vowel (certainly outside Oto-Manguean, though I have yet to encounter this description within Oto-Manguean), it may vary freely between a check and creakiness.

Obviously, when a language possesses a contrast between interruption and glottal checking, as in Western Popoloca, free variation between these forms will not be present. However, when a language does not possess this contrast, as in Lalana, we may witness their free variation.

I will investigate the hypothesis that all these manifestations of glottalization may be reducible to the single feature, [cg], manifesting itself distinctly, though never contrastively, in a variety of fashions.

That is, a [cg] specification, either associated with a given supralaryngeal constriction or not, may be phonetically manifested in a variety of ways across and between languages. Nonetheless, we will never observe contrastive realizations of this feature vis-a-vis a single supralaryngeal state. Thus, a language may phonetically implement a [cg] specification associated with a vowel as creakiness, or as interruption, or possibly as both. However, vowel creakiness and vowel interruption will be predicted never to contrast in a language.

I will investigate this hypothesis with respect to various supralaryngeal stricture specifications vis-a-vis [cg].

Similar phenomena are found upon investigating the distribution of breathiness: breathiness may be realized as a full breathy vowel, an "interruption" of aspiration (as in Popolocan (Rensch 1976)), or, I hypothesize, as ballisticity.

The picture I envision emerging from this investigation is one in which all laryngeal phenomena may be reducible to three distinct laryngeal features: [sg], [cg], and [vc] (cf. Lombardi 1991), which may have distinct phonetic realizations depending on supralaryngeal stricture as well as language-specific conventions.

(b) Now consider the following question: what, if any, contrastive laryngeal states may co-occur? Assuming I provide supporting evidence for the hypothesis that there are only three contrastive laryngeal features in Oto-Manguean, the question then arises how these states are phonologically organized. Are they three binary features, three privative features, a single ternary-valued feature, or something else? Investigating what, if any, combinatory possibilities exist for these three states may help answer this question. I will explore laryngeal behavior in Oto-Manguean voiced and voiceless sounds, including the distinct classes of obstruents, sonorant consonants, and vocoids, in order to determine whether there is phonetic and phonological evidence that laryngeal features may co-occur. If, as I suspect, it emerges that [cg] and [vc], as well as [sg] and [vc] may co-occur, then positing a ternary-valued single laryngeal feature becomes implausible, as a single feature cannot simultaneously

possess two values. The rarity of [vc] occurring simultaneously with [cg] or [sg] may have both phonetic and phonological explanations. In phonetic terms, a spread glottis and voicing, though placing conflicting demands on the glottis, are nonetheless not incompatible: the vocal cords may be simultaneously abducted to create an acoustic "breathy" quality, while still being adducted sufficiently for voicing. Similarly, the vocal cords may be sufficiently adducted to initiate creakiness while being simultaneously abducted to allow the vibration necessary for voicing. Thus the co-occurrence of laryngeal features results in a compromise of sorts: conflicting, though not incompatible, demands are placed on the glottis.¹

The phonetic facts translate quite readily into a theory of phonological markedness. I assume that certain markedness relations fall out from featural complexity. That is, the more featurally complex a segment, the more marked that segment is. If we assume [vc] to be a feature distinct from both [cg] and [sg], we have a phonological explanation for the rarity laryngeal feature co-occurrence: the presence of two laryngeal features is a more complex representation than the presence of a single laryngeal feature.

¹Note, however, that this co-occurrence is still stricture-dependent: it seems that only in vowels may two laryngeal features co-occur phonetically. Aspirated sonorant consonants are typically voiceless (as in, e.g., English post-plosive liquids), while constricted sonorant consonants reportedly linearize their laryngeal specifications, sometimes culminating in surface preglottalization (Hollenbach 1977, Steriade 1992). Certainly, supralaryngeal stricture constraints on laryngeal feature co-occurrence is a phenomenon requiring an explanation.

(c) Positing the co-occurrence of [sg] and [cg] will be shown to be both phonetically and phonologically implausible, requiring distinct, incompatible laryngeal gestures. In phonetic terms, [sg] and [cg] place opposite demands on the glottis: [sg] targets a maximally abducted glottal state, while [cg] targets an adducted glottal state. As for the phonological implausibility of these features' co-occurrence, I will further investigate the patterning of laryngeals in Oto-Manguan vis-a-vis particular supralaryngeal constrictions.

Steriade (1992) offers a thorough investigation of possible onset clusters in the Huautla de Jimenez dialect of Mazatec (hereafter Mazatec), based on Pike and Pike's (1947) presentation. Steriade argues that despite the apparent richness and diversity of these clusters (among them pre- and post- aspirated and glottalized plosives, as well as their prenasalized counterparts) the Mazatec phonotactic system possesses a rather rigid constraint: onsets in Mazatec are superficially monosegmental. That is, despite an array of combinatory possibilities involving stricture, nasality, and laryngeal specifications, all onsets maximally possess a single place node, as well as a single laryngeal specification. Possessing two Aperture-positions (Steriade 1991), the attested array of plosives is richer than that of continuants, but still not in violation of superficial monosegmentality (see Steriade 1991 for a full discussion of the determinants of monosegmentality).

For our purposes, the most relevant observation made by Steriade is that a single supralaryngeal constriction may maximally possess a single laryngeal gesture thus being compatible with the monosegmentality constraint. While a given onset in Mazatec may consist of [vc], [sg], [cg], or [vc] and [sg] or [vc] and [cg] laryngeal states, there are no instances of monosegmental onsets which contain both [sg] and [cg] specifications². This fact, in conjunction with the monosegmentality hypothesis, lends preliminary support to the claim that [sg] and [cg] do not co-occur either phonologically or superficially.

Other Oto-Manguean languages possess similar, though far less rich, constraints on onset complexity (Trique (Hollenbach 1977), Chinantec, Western Popoloca).

In addition to onsets, I will investigate whether a similar constraint on laryngeal specifications may apply to both nuclei and codas in Oto-Manguean.

One phenomenon germane to my investigation of laryngeal co-occurrence restrictions beyond onsets occurs in Chinantec. A certain phenomenon traditionally regarded as prosodic in origin in this and at least one other Oto-Manguean language (Amuzgo (Bauernschmidt 1963)) will be reanalyzed as deriving from lexical laryngeal specifications. These laryngeal specifications will be

²Certain superficial exceptions involving pre-aspirated - post-glottalized sequences are accounted for by Steriade, although the presence of contrastively aspirated fricatives would still appear problematic for the theory to be investigated below

shown to pattern in a manner consistent with the claim that [sg] and [cg] may not co-occur. Chinantec possesses a phonemic contrast between regular syllables and "ballistic" syllables (Merrifield, 1963, Rensch and Rensch 1966, Rensch 1976, 1978, 1989, Mugele 1982). Ballistic syllables are characterized primarily by their increased "intensity", which may very well be a cover term for increased rapidity of air expulsion from the lungs. Spectrographic analyses of these syllables have shown them to possess enhanced high frequency energy (Mugele 1982). They have been described as being shorter in duration than normal syllables (Mugele 1982, Robbins 1968), with aspirated onsets (when present), devoiced (nasal) codas (when present) (Rensch and Rensch 1966), as well as breathiness of vowel quality (Rensch 1976, Gardner and Merrifield 1990), and post-vocalic aspiration. Mugele argues that ballistic syllables are phonologically characterized by increased subglottal pressure, and lexically marked "ballistic syllable" (hereafter [+bs]), a phonological feature elsewhere unattested.

I would like to investigate an alternative characterization of the ballistic syllable, one involving the well-attested feature [spread glottis] (one of three privative laryngeal features to be argued for, the others being [voice] and [constricted glottis]), with increased internal intercostal activity co-occurring as a phonetic enhancement (Stevens and Keyser 1989).

Let us first consider the aerodynamic effects of increased internal intercostal activity, and compare them to those of increased

glottal aperture. In fact, both these articulatory actions result in an increase of oral airflow. If ballistic syllables were phonologically characterized as [+bs] with an increase in sub-glottal pressure, there would be no explanation for their concomitant aspiration: a spread glottis decreases subglottal pressure by allowing a more rapid decrease in the subglottal - supraglottal pressure differential. However, if ballistic syllables are characterized as [sg], increased subglottal pressure indeed may act as a phonetic enhancer, as heightened subglottal pressure results in an increase in trans-glottal airflow, thus increasing perceived "breathiness".

If a spread glottis co-occurs with increased internal intercostal activity, we might expect a particularly forceful expulsion of air, resulting in a rapid exhaustion of air from the lungs, hence a shorter temporal duration than usual of an otherwise equivalent prosodic domain. This is in fact exactly what we find with ballistic syllables: they are of shorter duration than normal syllables.

Acoustically, breathy-voiced vowels have been shown to possess an enhanced fundamental relative to F_1 , as well as enhanced high frequency noise (Ladefoged, Maddieson, and Jackson 1988); qualities not inconsistent with those associated with ballisticity.

Note that no system which possesses ballistic syllables also possesses breathy voice. (Breathy voice, recall, is well-attested in Oto-Manguean. It is present, for example, in Jalapa Mazatec (Ladefoged and Maddieson 1988), and manifested as interruption in Popoloca (Rensch 1976).) This is predicted if the two phenomena

are phonologically identical. If the phenomena were phonologically distinct, as Mugele implicitly assumes, we might encounter both features within the same system, as these features may be manipulated independently of one another.

A phonetic analysis of ballistic syllables would indicate whether both increased subglottal muscular activity and increased glottal aperture are present. Might an interaction between the two result in additional, unpredicted (i.e., emergent) acoustic consequences?

A preliminary study might shed light in this area: how does breathy voice interact with emphatic stress? An experiment along these lines may be performed at UCLA. Measuring supraglottal and subglottal pressure in a fashion akin to that outlined in Ladefoged (1993) -- inserting tubes nasally into the pharynx and esophagus, connected to a pressure transducer -- may provide the necessary information to infer the state of the glottis, i.e., whether it is spread or constricted. If sub-glottal pressure slowly approaches supraglottal pressure, the glottis is presumably not spread; if subglottal pressure quickly approaches supraglottal pressure, the glottis is presumably spread. Airflow measurements provide additional information concerning the state of the glottis. This technique may be employed to determine the articulatory characteristics of ballistics, assuming a willing subject is found.

The analysis to be investigated is consistent with historic origins of ballistic syllables. Rensch (1976) reconstructs

proto-Oto-Manguean syllables as possessing solely /h/,/?/ codas (possibly breathy voice and creaky voice, respectively), as well as nasals. In the modern Lalana and Quiotepec dialects of Chinantec, ballistic syllables never co-occur with glottally checked ones (Rensch and Rensch 1966, Robbins 1968). If /h/ codas have evolved into the ballistic syllable of Chinantec, then the co-occurrence restriction between checked and ballistic syllables within Lalana and Quiotepec would be explained, as would be the fact that no system contains both breathy voice and ballistic syllables. Additionally, this would further motivate representing ballistic syllables with a [sg] specification that has diachronically spread across the domain of its syllable (with concomitant phonetic enhancement).

Robbins (1968) reports the following root paradigms in Quiotepec:
 short freeshort checked long free long checked

1		1		1		1
2	'2	2		2		2
	'3	3			'3	3
	'12				'12	
					'13	13
				212		212
				21		21

(where 1,2,3 = H,M,L tones respectively, ' = ballistic syllable)

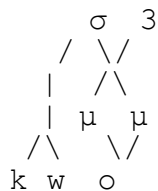
Roots may be short or long, free or glottally checked, and also interrupted or non-interrupted. Observe that ballistic roots never co-occur with glottal checking (or, presumably, with glottal interruption) (but see Gardner and

Merrifield 1990 for a slightly different analysis). Robbins additionally reports that inflected roots often possess "extensions", that is, additional segmental and tonal material, which may possess ballisticsity if unchecked. Inflection in Chinantec takes the form of stem modification, including tone, length, ballisticsity, , some of which is exemplified below.

kwoh3	I give (something)
kwoh212	I gave (something)
kwo?h21	thou givest (something)
kwo?h31	thou gavest (something)
kwo?h2	I give (something to someone)
kwo?h3	I gave (something to someone) etc.

(where [h] = length)

The prosodic representation of, for example *kwoh3* would be the following:



Extensions occur only in inflected forms, and are considered by Robbins to be tautosyllabic with the root. Like roots, extensions may be short or long, free or checked, but only free extensions may be ballistic.

extended free 'kuh2-1 thy money

domain of the syllable, culminating in an aspirated onset and a breathy vowel. In fact, his notation makes clear his belief that the domain of aspiration is the syllable. He indicates breathy syllables via a diacritic external to the syllable, indicating its affiliation is not segmental, but syllabic.

^hbuj - realize ^hpi - each

Of course, unlike in Chinantec, the diachronic origins of syllabic aspiration in Oriya are presumably from the onset position (cf. the prevalence of aspirated onsets in related Indo-Aryan languages).

Moreover, Ladefoged (1958, 1968) reports that English words beginning with /h/ are preceded by "striking increases in the [intercostal -- D.S.] muscular activity".

Given that both prosodically determined featural affiliation as well as increased intercostal activity are elsewhere attested in representations involving [sg], it becomes well within the realm of possibility that both phenomena be present in the same system.

Keating (1990), drawing from Ladefoged and Lindau (1986) and Stevens and Keyser (1989), believes that languages may indeed employ articulatorily distinct gestures that nonetheless have an enhancing effect on the contrasting acoustic component of a sound: "...a single feature may have more than one parameter value...languages may differ in how they realize a given value. Such a difference would be related to saliency: the more parameters that are use for a given feature,

the more robust and salient that feature's value will be" (p.332).

My approach to ballisticity in Chinantec is similar, though not so abstract as Keating's theory seemingly permits: [sg] is present both phonologically *and phonetically*, with concomitant phonetic enhancement and syllabic affiliation, resulting in a particularly salient phonetic manifestation of [sg].

The fact that ballistic syllables, possibly reanalyzed as [sg] syllables, do not co-occur with interrupted or creaky/checked vowel syllables in Quiotepec or Lalana lends support to the claim that [sg] and [cg] are phonologically incompatible feature specifications, and that only a single laryngeal state is possible for any given supralaryngeal constriction.

(d,e) If this further support is uncovered, we might want to investigate the possibility that a single laryngeal state is *minimally* associated with a given supralaryngeal constriction. That is, we might hypothesize that laryngeal targets are obligatory for any given supralaryngeal constriction.

The phonetic studies of Löfqvist et.al. (Löfqvist 1980, Löfqvist and Yoshioka 1980, Yoshioka, Löfqvist, and Hirose 1981, and Yoshioka, Löfqvist, and Hirose 1982) appears to support this hypothesis.

These investigators studied laryngeal states across sequences of voiceless obstruents in a variety of languages, finding distinct laryngeal gestures temporally coordinated with each supralaryngeal

constriction. They observed three potentially distinct phenomena in the various laryngeal gestures:

- 1) Timing (and duration) of glottal abduction and adduction.
- 2) Velocity of glottal movement.
- 3) Degree of glottal aperture

Not surprisingly, Löfqvist and Yoshioka (1980) tentatively conclude that since these three articulatorily distinct phenomena tend to positively correlate, that only one of them possesses linguistic significance, namely, the timing of the laryngeal gesture vis a vis the supralaryngeal constriction (see in particular Löfqvist (1980), also Flege (1982)).

Across domains of voiceless consonant clusters, the authors find discrete, though variable, realizations of laryngeal abduction associated with every supralaryngeal gesture:

- 1) Voiceless fricatives: vocal cords are quickly and maximally abducted for more or less the duration of the supralaryngeal constriction, no doubt in order to allow maximal airflow for downstream excitation.

- 2) Aspirated stops: a marked degree of glottal opening just post-release.

- 3) Unaspirated stop production appears to be associated with a minimal degree of glottal abduction, attributed by Yoshioka et.al. (1979) to an adjacent aspirated stop or fricative. However, this hypothesis is implicitly rejected by Löfqvist (1980), who concludes that "... the vocal cords seem to be constantly moving" (p.484),

"laryngeal articulations appear to be a continuous gesture" (p.485), and most importantly, that "the laryngeal gesture would...seem to be an inherent feature in the production of voiceless stops and fricatives and perhaps clusters of voiceless obstruents" (p.488).

For additional evidence concerning the obligatoriness of laryngeal gestures, I will consider phonation contrasts within and across language systems. It will emerge that positing a "plain" laryngeal series as distinct from all the features [vc], [sg], and [cg] makes incorrect predictions in terms of number of laryngeal contrasts within a given system. That is, if phonologically "plain" segments possess no laryngeal specifications, it is predicted that some systems will minimally contrast this series with three additional series, each specified for a single laryngeal feature, i.e., it is predicted that some system will possess a plain series, as well as [vc], [sg], and [cg] series, minimally contrasting.

However, if laryngeal states are obligatory, and if there exist only three distinctive laryngeal features, then we predict that no system will minimally contrast more than three laryngeal states.

Consider first laryngeal contrasts within the class of fricatives. It is predicted that no fricative system will minimally contrast more than three laryngeal states. Therefore, no system will possess greater than three contrastive fricative phonation types, as any greater number would exceed the possible number of laryngeal states:

[vc] [sg] [cg]

Maddieson reports only one language, Kabardian, exploits all three possible phonation types in its fricative series: plain (redundantly [sg]), voiced (contrastively [vc]), and ejective (contrastively [cg]). Assuming that fricatives are redundantly [sg] in the unmarked case, no system is predicted to have a contrastive [sg] series.

Again, a theory which allows segments to lack any laryngeal specification would predict that some fricative series would possess a four-way contrast (where [] = phonologically "plain").

[] [sg] [cg] [vc]

In fact, no system presented by Maddieson possesses four series of fricatives. This result is predicted if laryngeal states are obligatory for any given supralaryngeal constriction.³

Consider next sonorant contrasts. Surely, it is not under dispute that a "plain" sonorant series never contrasts with a voiced one.

A maximum of three sonorant series is thus predicted for any one system if laryngeal states are obligatory: [vc] (plain), [sg], and [cg]. Indeed, no system is known to exploit more than these three series.

³Apparent exceptions in Mazatec, and also in certain Burmo-Tibetan languages, will require an analysis.

Finally, consider plosives. Assuming the bipositionality of plosives (Steriade 1991), no system is predicted to possess greater than three contrastive laryngeal states for any one root node. Given that plosives are presumed to bear two root nodes, we predict more contrasts within the series of plosives than within the series of sonorants or fricatives.

In Maddieson (1984), 4-stop series include the following (where [] = phonologically "plain"):

- | | | | | |
|----|-----|------|---------------|--------------|
| 1. | [] | [vc] | [vc]
[cg] | [cg] |
| 2. | [] | [sg] | [vc] | [vc]
[cg] |
| 3. | [] | [vc] | [vc]
[nas] | [vc]
[cg] |
| 4. | [] | [vc] | [vc]
[nas] | [vc]
[cg] |

In each system, it is possible for a single redundant feature to be associated with the plain voiceless series without any risk of neutralizing a contrast.⁴ So, for example, series (2) above may be lexically specified as follows:

onset plosives

⁴We might preliminarily hypothesize that so-called "plain" series possess a [sg] target in onset position, and a [cg] target in coda position, although this surely requires investigation.

series		closure		release
plain		[sg]		(projected)
aspirated	[sg]		[sg]	
voiced		[vc]		(projected)
implosive		[vc]		(projected)
			[cg]	

Another way of stating these lexical contrasts might be to claim that aspirate series are in fact underlying clusters which pattern phonotactically as single segments (cf. Steriade 1992).

I would like to investigate the relevant languages in Maddieson to determine if such a hypothesis is viable.

An additional system is exemplified by Kiowa (Watkins 1984):

[] [vc] [sg] [cg]

Plain stops here may again be non-contrastively specified [sg] (or perhaps [cg], as Watkins reports that the plain series is tense) in onset closures, and thus the contrastive [sg]/[cg] series, manifested as aspirates and ejectives respectively, possesses their laryngeal feature lexically associated with release. In coda position, obligatory neutralization results in only the "plain" series' being allowed, /p,t/ (as well as /m,n,l,y/), which possibly possess [cg] targets.

Two closely related Otomanguean languages, Otomi and Mazahua, are claimed by Maddieson to possess five series of stops (on the surface) including three VOT categories, and two glottalic series:

[] [vc] [sg] [cg] [vc]
 [cg]

Again, we may assume the contrastively aspirated series to possess [sg] lexically associated with release, while the plain series possesses aspiration on the closure.

Preliminary Reading List

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