MIXTEC PRENASALIZATION AS HYPERVOICING[1]

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1. Introduction. Most of the linguistic varieties grouped together under the rubric "Mixtec" have been analyzed as contrasting prenasalized voiced stops with plain voiceless ones, beginning with structuralist descriptive accounts and continuing up through the most recent contributions.[2] The thesis of this paper, however, is that while the voiced stops often are phonetically prenasalized in Chalcatongo Mixtec and a number of other dialects (especially Alta or Highlands varieties), their relevant phonological characterization is that of plain voiced stops, unspecified for the gesture of prenasalization.[3] Grounded in Mixtec-specific phonological behavior as

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[2] "Mixtec" is spoken by between 200,000 and 300,000 people throughout most of western Oaxaca in southern Mexico and includes around two dozen varieties which are not mutually intelligible but which are traditionally nonetheless called "dialects." Our data are taken from fieldwork by Salmons, primarily recorded in and around the village of Chalcatongo (officially known as Santa María Chalcatongo de Hidalgo, located south of Tlaxiaco), but including a number of shorter interviews in San Miguel el Grande, and with speakers of other Highlands dialects.

[3] We do not claim that all varieties of Mixtec should be analyzed as contrasting simple voiced and voiceless obstruents phonemically, but most varieties show a surface contrast between prenasalized and voiceless stops and exhibit, to a greater or lesser extent, the kind of behavior we describe here for Chalcatongo. Contributions to Bradley and Hollenbach's volumes (1988–92) posit prenasalized series across the major dialect groups, from the northeast corner of Mixtec-speaking territory (Coatzospan, "Northern Highlands"), to the far south (Jamiltepec, "Coastal"), to the Southern Lowlands dialect of Ayutla and the Guerrero dialect of Alacatlazala in the west, and in the Western Lowlands dialect of Silacayoapan, in addition to Western Highlands dialects most closely related to Chalcatongo. See Josserand (1983:188 and elsewhere) for similar analyses of other equally diverse dialects, including Acatlán, Atatlahuca, Peñoles, Jicaltepec, and Chayuco. Outside of Mixtec, Comaltepec Chinantec has /b d g/ which "are frequently prenasalized" (Anderson, Martínez, and Pace 1990:5). Varieties of Mixtec not possessing a full "prenasalized" series generally have at least /nd/, sometimes with velars and bilabials occurring marginally or in loanwords. Josserand (1983) reconstructs only a coronal prenasalized stop for the proto-language.

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well as in more general considerations of the patterning of speech sounds, this analysis finds considerable cross-linguistic support in the phenomenon of "hypervoicing" (Henton, Ladefoged, and Maddieson 1992) and results, we believe, in an appreciably more insightful description of the dialects at hand. From the traditional perspective, the representation of prenasalized stops as phonemically merely voiced is perhaps surprising, but it simplifies, and rationalizes, Mixtec segmental phonology on a number of counts. Indeed, recent theoretical work related to assimilatory spread of the feature [nasal] in some varieties of Mixtec (Piggott 1992, Gerfen 1996, as well as Cole 1987 and Trigo 1988) has also assumed some form of a simple voicing analysis of the prenasalized stops, an assumption for which we provide more specific phonemic support here, with typological underpinning from the general phonetics of "hypervoicing."[4]

Data. In Chalcatongo Mixtec, the surface forms [^{m}b, ^{n}d, ^{ŋ}g] (or [mb, nd, ŋg], if one prefers to treat these as clusters rather than complex segments) occur as exemplified in (1). Mixtec permits only open syllables, i.e., of the type CV, so that only two relevant environments exist: (couplet-) initial and medial.

(1) Surface pattern of prenasalized obstruents in Chalcatongo Mixtec[5]

Initial		**Couplet-medial**
[$^{(m)}$bà?à]	'good'	
[$^{(m)}$bá?ù]	'coyote'	[Prenasalized form nonoccurring]
[$^{(m)}$bí?ža]	'nopal'	

[4] In this paper, we leave aside the position of Marlett (1992) that nasalization, throughout all of Mixtec, is a morpheme-level feature spreading leftward from the right edge of couplets. He argues (1) that prenasalized stops like [mb] actually consist of clusters of nasal plus voiceless stop, /mp/; (2) that /nd/ is actually /n^{d}/, i.e., /n/ with an oral release in nonnasalized morphemes; and (3) that [m] and [β] are allophones in nasal and oral couplets respectively. Some key objections should be mentioned in passing: Gerfen (1996) provides phonetic (nasal airflow) data and phonological arguments indicating that at least in Coatzospan nasality does not spread leftward. In addition, positing initial clusters like /mp/ and /nč/ violates the sonority sequencing generalization, a serious concern in languages which often show absolutely no consonant clusters, even medially. Furthermore, Chalcatongo Mixtec shows a couple of words like *ndi̱ki̱* 'seed', where both vowels are nasalized and yet the "oral" variant of Marlett's initial /n/ appears (data from Macaulay 1996), which would be impossible under Marlett's analysis. While Marlett's arguments may be of diachronic interest, the facts just noted show that they cannot reflect synchronic processes.

[5] We follow the usual Mixtecanist orthographic conventions for tone here, whereby ´ indicates high tone, ` indicates low tone, and unmarked vowels carry mid tone. We have further adapted the transcription of San Miguel forms, from Dyk and Stoudt (1973) as well as from Salmons's field notes, for easier comparison to the Chalcatongo data.

[ⁿda?a]	'hand'	[čindɨtɨ]	'to gore'
[ⁿdɨžɨ]	'dead person'	[andɨ́ú]	'sky'
[ⁿdákɨ]	'stiff, stale'	[onde]	'up to'
		[čɨŋgɨ ~ čɨŋgi]	'to curl'
[Velars nonoccurring]		[tilíŋgɨ́]	'skinny'
		[kʷaŋgo]	'to twist'

The variation of these forms with plain voiced stops and other manifestations is complex and asymmetric: The alveolar always appears with prenasalization, but the bilabial is prenasalized only sometimes in couplet-initial position and does not occur medially at all in this form; voiced velar stops do not occur initially in any form and appear medially only in a few words, where they are prenasalized and contrast with the plain voiceless velar stop.[6] Positing a basic form for these stops is thus not straightforward and has led to analyses with highly skewed distributions, like the most recent and exhaustive description of a Mixtec dialect, Macaulay (1996), which analyzes the bilabial as simply voiced but the coronal and velar as voiced and prenasalized. Phonologically, however, nothing justifies positing more than two obstruent series: a plain voiceless one and a marked one traditionally called "prenasalized." We turn now to the question of how best to represent that contrast.

3. The phonology of Mixtec obstruent contrasts: language-specific arguments for representation with the feature [voiced].

3.1. The first and most basic set of arguments for an underlying voicing representation for Chalcatongo Mixtec stops (rather than voicing in tandem with prenasalization) relates to the frequency and distribution of the bilabial and velar members of the series, the characterization of which as underlyingly prenasalized is ill-equipped to accommodate the distributional facts described below.

Chalcatongo /b/ shows realizations as [mb] or [ᵐb] and [b] in root-initial position. The traditional analysis cannot easily account for such variability in this most prominent prosodic position, where it is expected that a segment would show its fullest form. That is, other things being equal, initial position is the site of maximal phonetic realization, so that if these stops were indeed underlyingly prenasalized, the surface form of initials presumably should more consistently be [mb]. The analysis suggested here, by contrast, is based on prenasalization serving only as the phonetic implementation of an underlying voicing feature (see below), hence certain variability is

[6] A voiced velar fricative [γ] occurs in Spanish loanwords for some speakers.

natural or expected. Furthermore, as this bilabial segment usually derives from Proto-Mixtec /w/ (cf., e.g., Josserand 1983), a phonemic prenasalization account must posit a more complicated evolution, namely, from glide [w] to voiced stop [b]—still attested in some nearby dialects—to prenasalized stop [mb], which then sporadically varies with or reduces to a simple voiced [b]. Under the present view, this development is merely a historical "hardening" of /w/ → /b/, with variable phonetic implementation of prenasalization across the relevant dialects. Mixtec dialects such as Alacatlazala and Ayutla, which are analyzed with the lone fricative /β/ in some treatments, then fall into place as well: Rather than positing a single-member fricative series and a prenasalized series with a labial gap, we suggest simply that the bilabial member of an underlying voiced series appears here without prenasalization, usually as a fricative.

In medial position, the voiced bilabial fricative has generally been lost in the recent history of Chalcatongo Mixtec. The chart in (2) presents a comparison between Chalcatongo Mixtec and the more conservative neighboring dialect to the west, San Miguel el Grande.[7]

(2) Medial loss of bilabial obstruents in Chalcatongo Mixtec

San Miguel	**Chalcatongo**	**Gloss**
Cɨvɨ → Cɨu		
ndɨvɨ	*ndɨù*	'egg'
kɨvɨ	*kɨù*	'day'
andɨ́vɨ́	*andɨ́ú*	'sky'
Cɨʔvɨ → Cɨʔu		
sɨ́ʔvɨ́	*sɨ́ʔu*	'name'
tɨʔvɨ	*tɨʔu*	'to suck'
lɨʔvɨ́	*lɨʔú*	'slick'

Synchronically, medial /b/ occurs in verbs with derivational prefixes, such as *ndúbà* 'to be excited, to cause commotion', which derives transparently from *ndu-* 'inchoative' plus a previously /b/-initial root meaning 'noisy' (cf. San Miguel *baà* 'tumultous, noisy' [Macaulay 1996]).[8] In such cases, the phonetic realization is neither prenasalized nor occluded, but rather is the voiced fricative [β], as in Alacatlazala and Ayutla generally. On the assumption of an underlying prenasalized stop, it would be necessary to posit an otherwise

[7] Parallel to the weakening and vocalization of [β] to [u] discussed here, there is also variability between [ž] and [y] under similar circumstances, without, however, the final step of loss of the segment as we find with the bilabial.

[8] A few other exceptional lexical items in Chalcatongo Mixtec retain a medial bilabial fricative. The form *laba* 'lima (bean)' is probably a Spanish loan based on *haba*. And in a couple of remnant forms, like *kaba* 'to braid or twist', the bilabial is also still realized as a continuant, [β]. Additionally, Macaulay cites one loanword with a medial [w], *snawa* 'skirt', from Spanish *enaguas*.

unmotivated loss of the prenasalization along with further fricativization; starting from a voiced stop, however, all that is required is the common conversion of an intervocalic voiced stop to a fricative. To sum up thus far, then, the bilabial stop displays a distribution which is much more consistent with a simple voicing analysis than with underlying prenasalization.

We turn now to the velar stop in this series. Unlike the bilabial and coronal, this segment is sufficiently rare to have questionable phonemic status, although Macaulay does list one segmental minimal pair: *čt̨ŋgt̨* 'curly' vs. *čt̨kt̨* 'seed'. This near-gap in Chalcatongo—an apparently complete gap in some neighboring dialects (see below)—accords well with analysis of the velar as simply voiced: Greater physiological effort is required in order to maintain voicing at the velar point of articulation than at points farther forward, a property which is reflected typologically in the tendency of gaps in a simple voiced stop series to occur at the velar place of articulation (cf. Gamkrelidze 1975 and Maddieson 1984). An underlyingly prenasalized velar stop would be less likely to show this restricted distribution, since its nasal quality facilitates rather than inhibits the maintenance of voicing during closure. The question remains open, of course, but we know of no languages with phonemically unequivocal (voiced) prenasalization which display a gap in the prenasalized series at the velar place of articulation.

A simple voicing analysis is by extension also consistent with the nonoccurrence of the velar in initial position, since the phonetic production of initial voiced stops presents a more complex challenge than does the production of intervocalic—here, root-medial—voiced stops (cf. Kohler 1984), a point to which we will return in the next section. In short, the prenasalization account cannot predict any of the properties of the velar member of this series, while both its low overall frequency and its failure to occur in root-initial position fall out from the present proposal in typologically expected ways.[9]

The only strong case for the prenasalization analysis lies with the coronal member of this series, since its surface form is always [nd]/[ⁿd].[10] The

[9] Referring again to the survey of phonemic inventories by Josserand (1983:188), we note that plain voiced velars are rare at best, occurring only marginally in one of the sixteen inventories given. This corresponds neatly to the asymmetry expected between velars and labials in hypervoicing: labials, with the entire oral cavity behind them, allow for sufficient passive expansion to support obstruent voicing without leakage past the velic valve, whereas velars, with only the smaller volume of the oral pharynx available to accommodate translaryngeal airflow, represent the greatest articulatory challenge to ordinary voicing; indeed, we have not found nonprenasalized voiced velar stops in any variety of Mixtec.

[10] Macaulay (1996) reports that some borrowings from Spanish retain a voiceless oral component for only a few speakers, such as [kwenta ~ kwentu] 'on account of'. Such forms support the voicing-only position, since if prenasalization were the phonologically relevant element, this cluster would be expected to be interpreted as /nd/ by speakers. Instead, at least those bilingual in Mixtec and Spanish maintain the otherwise-impermissible consonant cluster here.

other two members of the series do not evince this invariability, however, and we shall pursue the idea below that all three of them—more or less, depending on place of articulation, but to a degree which is predictable—reflect superficial prenasalization as a property of phonetic implementation rather than as a fundamental phonemic feature.

It should be noted that many cursory descriptions of Mixtec varieties are available, but few of these give sufficient phonetic and phonological detail to be of comparative use here. Nonetheless, evidence suggests that the pattern described in this section holds more broadly across the Highlands group of Mixtec dialects. For San Miguel el Grande Mixtec, prenasalization is explicitly regarded as facultative by Dyk and Stoudt (1973:118): "A veces las consonantes ch, d, g tienen una calidad nasal, y entonces se escribe una 'n' antes de la consonante" [Sometimes the consonants ch, d, g have a nasal quality, and therefore an 'n' is written before the consonant]. Like in Chalcatongo, the bilabial generally surfaces without prenasalization, a pattern found in Jamiltepec Mixtec as well (Pensinger 1974).[11] These dialects and various others likewise have no initial voiced or prenasalized velar stops, and San Juan Colorado Mixtec appears to lack the velar altogether (Stark Campbell et al. 1986). Finally, Pike and Ibach (1978:293) describe a somewhat different but also interesting pattern of prenasalization in Mixtepec Mixtec: prenasalized stops occur only in root-initial position, and plain voiced stops occur only root-medially; in line with the suggestion above that the maximal phonetic realization should be found in the most prosodically salient position, we infer that Mixtepec restricts the implementation of prenasalization to root-initial position because stop voicing in medial position presents less of an articulatory challenge (see also below).

3.2. A second kind of evidence comes from outside the stop system itself. Fricatives contrast on the surface in Mixtec by voice rather than prenasalization, so that the proposed analysis of the stops as phonemically just voiced adds considerable symmetry to the consonant system. Under a traditional analysis, the phonemic inventory of Chalcatongo Mixtec requires positing a voiceless–voiced distinction among the fricatives, based on contrasts like those in (3*a*), but a distinction of voiceless-prenasalized voiced among the stops to describe the pairs in (3*b*):

(3) Series contrasts among Chalcatongo Mixtec obstruents

(3*a*)	[š]:	*šoò*	'comal'	*šɨkɨ*	'fist'		
	[ž]:	*žoò*	'moon, month'	*žɨkɨ*	'bone'		
(3*b*)	[t]:	*tóo*	'drop' (noun)	*túú*	'sting, bite'	*táʔa*	'suffer'
	[nd]:	*ndóo*	'stay'	*ndúú*	'day'	*ndaʔa*	'hand'

[11] As noted already by Pike (1944:115), the San Miguel initial bilabial can surface as a stop [b] or a fricative [β], like in Chalcatongo.

Under the present proposal, these two series would be phonologically parallel, both based on a voicing distinction, with the proviso that the phonetic implementation of the stops involves prenasalization, as described above. This derives from the fact, to which we now turn, that maintenance of voicing presents a considerable articulatory challenge for stops, but not for fricatives (for which it is therefore unnecessary or counterfunctional).[12]

4. Cross-linguistic support: hypervoicing. As is now well established, stops are inherently hostile to voicing. This circumstance results from the difficulty during oral closure of maintaining transglottal pressure drop sufficient to sustain voicing. Regarding stop nasalization, in particular, Lisker and Abramson (1971:775) observe as follows: "Of course, in the absence of either active or passive adjustment of the pharyngeal volume, [glottal] pulsing may be maintained during articulatory closure if the velopharyngeal seal is not tight." In other words, voicing can be maintained in stops if air is allowed to leak out through the nasal cavity. A profound articulatory connection thus already exists between nasality and the physical gestures necessary to create or maintain voicing during stop production. It is also well established, moreover, that languages make use of secondary phonetic features to enhance the saliency of segmental realizations while the underlying phonological distinctions rely on a minimal feature set. As Henton, Ladefoged, and Maddieson (1992:96) have recently remarked, "some contrasts, most notably those for phonation, use a large number of cues for each distinctive feature."

Several reactions are invoked across the world's languages in order to maintain otherwise vulnerable stop voicing contrasts, and these involve various additional cues to enhance saliency. Most notably, there exists a tendency in widely scattered languages—including Vietnamese, Zulu, and Maidu—to realize phonologically voiced stops with implosion (Ladefoged 1993). Thus, while the marked stop series of Vietnamese can best be analyzed as underlyingly simply voiced, the phonetic realization is more complex: "The voiced stops *b*, *đ* are preglottalized and often implosive . . ." (Nguyên 1987:784). In Vietnamese, it is implosion or preglottalization that is employed to lend additional saliency in support of the otherwise precarious voicing distinction. We maintain that prenasalization represents another type of hypervoicing in Chalcatongo Mixtec and other languages of the world, a suggestion which

[12] A sound change very close to completion in this area has in fact changed a prenasalized affricate into a simple voiced fricative. The old and rapidly disappearing [ndž] apparently developed from **nd-* preceding /e/, before a lowering of that vowel to /a/ (cf. Josserand 1983:262). Most reflexes of such shapes have become [ž], but a few speakers retain a handful of words containing [ndž], and these speakers occasionally produce [nž]. We attribute such forms to the mistiming of the release, supporting the generalization that (underlying) affricates can surface as prenasalized while fricatives are merely voiced.

has also recently been made in the general phonetics literature: "Prenasalization appears most often with voiced stops, and, in the many languages where no plain voiced stops contrast with the prenasalized series, may be thought of as a way to facilitate the maintenance of voicing on stops" (Henton, Ladefoged, and Maddieson 1992:71).[13]

The hypervoicing analysis also helps explain the distribution of prenasalized and plain voiced realizations in Mixtec. The velar gap in root-initial position and the rarity medially of the voiced velar derive from the universal tendency of voiced stops to avoid back points of articulation. The small supralaryngeal chamber available for expansion to maintain voicing in velar stops, following the work of Lisker and Abramson (1971), is insufficient in the phonology of many languages. That is, the space between the velum and the vocal folds does not expand enough to allow the vocal folds automatically to continue vibrating during production of [g], and so some languages, like Arabic and Dutch, lack voiced velar stops altogether. Voicing is easiest at the bilabial point of articulation, however, because there the potential expansion chamber is greatest, hence prenasalization is dispensable as a phonetic implementation of voicing in the bilabial stop. The sound [d] obviously lies between these two extremes, and there Mixtec regularly exploits the possibility of prenasalization to reinforce the underlying voicing.

In fact, Ohala and Ohala (1991:213) suggest that voiced stops accompanied by nasalization are still perceived as ordinarily voiced, which they explain as follows:

> Why should voiced stops tolerate velic leakage during the first part of their closure and still be perceived as voiced stops? The reason may be that among the auditory cues for a voiced stop there must be a spectral and amplitude discontinuity with respect to neighboring sonorants (if any), low amplitude voicing during its closure, and termination in a burst; these requirements are still met even with velic leakage during the first part of the stop as long as the velic valve is closed just before the release and pressure is allowed to build up behind the closure. However, voiceless stops have less tolerance for such because any nasal sound—voiced or voiceless—would undercut either their stop or their voiceless character.

This view also motivates the use of PRE- rather than POST-nasalization as a manifestation of hypervoicing, since pressure release is central to perceiving the segments in question as stops—postnasalization would effectively eliminate the needed salient burst and, thus, mask their stop quality.

Prenasalization in Chalcatongo Mixtec, we conclude, is an instantiation of this kind of hypervoicing: a low-level phonetic phenomenon serving to help maintain a distinction that is otherwise difficult to produce. In fact, it is relatively common for languages with just two stops series to have one be

[13] For another, very different kind of "overshooting" of phonetic targets in production, see Johnson, Flemming, and Wright (1993).

the unmarked voiceless type and the other realized phonetically as both voiced and prenasalized. Thus Maddieson (1984:67) observes that several languages (e.g., Hakka, Apinaye, Siriono) ". . . lack a plain voiced plosive series: In a sense the prenasalized stops take its place" or that "there are languages which have both a series of P[rimary] N[asal] C[onsonants] and a prenasalized stop series in place of a simple voiced series." Other typological correlations may also emerge from the general connection made in this article. Specifically, languages which contrast surface prenasalized stops just with voiceless stops are by and large languages in which the voiceless series is unaspirated, i.e., with short lag in voice onset time (VOT). In a two-way system with phonemically unaspirated stops, hypervoicing of the phonemically voiced series would of course maximize the VOT difference between voiced and voiceless (as per Lisker and Abramson 1971).

It seems that voicing distinctions in general tend to be reinforced by secondary phonetic characteristics, such as aspiration of voiceless stops, in order to heighten their saliency, especially when in initial position (Keating 1984 and Kohler 1984). Kohler, in particular, posits a parallel between aspiration in voiceless stops and "special articulatory maneuvers" in voiced stops, dubbing them "feature accentuation mechanisms." These can be "performed to create the favorable aerodynamic conditions for active voicing during word-initial stop closures. Languages with two-way obstruent oppositions do not seem to make use of both feature accentuation mechanisms jointly: if the lenis feature is manifested in active closure voicing, the fortis feature does not include aspiration; if the fortis feature is accentuated by aspiration, the lenis feature does not require active voicing" (Kohler 1984:154–55). From this point of view, hypervoicing is a particularly salient form of closure voicing, one found predominantly in languages, like Mixtec, that do not exploit aspiration in voiceless stops.

We distinguish, then, two levels at which prenasalization functions: first, as a low-level phonetic phenomenon, i.e., hypervoicing, and, second, as a phonological feature distinct from voicing. In the latter role, however, it appears to occur mostly in languages with four-way manner contrasts that include glottalics. The former situation, i.e., voiceless stops in contrast with superficially voiced prenasalized stops, is found in Mixtec and various other American languages, numerous Bantu languages, and so forth. The latter, a four-way system of distinctions, is attested in, for instance, Gbeya, Yulu, and Sara. Languages in which a plain voiced series contrasts with an underlyingly prenasalized series often also include a series marked by implosion.

5. Conclusion and summary. Analyzing the manner contrast between the two Mixtec obstruent series to consist underlyingly of just voicing provides a number of distinct advantages. First, it accounts substantially better for the surface distribution of two of the three members of the voiced stop

series (labials and velars) than an analysis which posits phonological prenasalization. Second, it makes for parallel distinctions among stops and fricatives, rather than have the difference in stops marked redundantly by both voicing and prenasalization while fricatives are distinguished in terms of voicing alone. This property of the analysis is rooted physically and physiologically in the relative difficulty of maintaining voicing in stops vis-à-vis fricatives. Third, in view of the superficial hypervoicing phenomenon and the cross-linguistically restricted distribution of phonemic prenasalization to stop systems with at least three manner contrasts, the analysis of Mixtec voiced stops proffered here accords with the finding that prenasalization in two-way systems is added in certain contexts as part of phonetic implementation.

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