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ARTÍCULOS

Revisiting Karttunen and Lockhart's Nahuatl Nasals

Insights from the Phonology and Phonetics of Chicontepec Nahuatl

Volver a revisar los nasales en el náhuatl de Karttunen y Lockhart

Nuevas ideas basadas en la fonología y la fonética del náhuatl de Chicontepec

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Abstract

In a squib on Nahuatl nasals written in 1976, Karttunen and Lockhart address the erratic behavior of nasals in an 18th century Nahuatl text. This paper expands their discussion of Nahuatl nasals with insights from phonological and phonetic analyses of contemporary varieties of Nahuatl. Phenomena such as lenition and phonological neutralization, prosodic glottalization, and the relationship between nasal and laryngeal sounds are explored here as a novel explanation for the patterns they observe for intrusive and omitted nasals in the orthography in the colonial era text. In so doing, the complex arrangement of laryngeal and nasal articulations in Nahuatl phonology and how it relates to written representations is discussed. This paper draws on from fieldwork on Chicontepec Nahuatl, a variety of Eastern Huasteca Nahuatl, as well as published descriptions of other varieties of Nahuatl and contributes to the literature on historical varieties of Nahuatl and to our understanding of the relationship between written and spoken Nahuatl.

Keywords: Nahuatl nasals; Chicontepec Nahuatl; Huasteca Nahuatl; laryngeal sounds; glottals; rhinoglottophilia.

Resumen

En un artículo corto sobre los sonidos nasales en náhuatl escrito en 1976, Karttunen y Lockhart abordaron el comportamiento errático de los nasales en un texto náhuatl del siglo XVIII. Este artículo amplía su discusión sobre los nasales en el náhuatl con ideas procedentes de análisis fonológicos y fonéticos de variantes contemporáneas del náhuatl. Fenómenos como la lenición y la neutralización fonológica, la glotalización prosódica y la relación entre los sonidos nasales y laríngeos se exploran aquí como una explicación novedosa de los patrones que observaron para

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los nasales intrusivos y omitidos en la ortografía del texto de la época colonial. Al hacerlo, se discute la compleja disposición de las articulaciones laríngeas y nasales en la fonología del náhuatl y cómo se relaciona con la representación escrita. Este artículo se basa en trabajo de campo sobre el náhuatl de Chicontepec, una variante del náhuatl de la Huasteca oriental, así como en descripciones publicadas de otras variantes del náhuatl. Contribuye a la bibliografía sobre las variantes históricas del náhuatl y al conocimiento sobre la relación entre el náhuatl escrito y el hablado.

Palabras clave: *nasales en el náhuatl; náhuatl de Chicontepec; náhuatl de la Huasteca; sonidos laríngeos; glotales; rinoglotofilia*.

In a squib on Nahuatl nasals written in 1976, Karttunen and Lockhart (henceforth KL) noted a curious set of patterns in an 18th century Classical Nahuatl text. The presence or absence of the orthographic symbol "n" seems upon first view quite chaotic: underlying /n/s (as expected given Molina's 1571 dictionary) were regularly omitted from the manuscript. However, there was also a pattern of intrusive written nasals, where orthographic "n" frequently occurred where no underlying nasal had been analyzed as expected to occur. KL suggest two ways to account for these patterns: 1) that there was a pattern of reduction of final nasals; and 2) that two types of nasality were present in the Nahuatl of the colonial era author or *tlacuilo* (scribe): one from underlying nasal sounds, and a second type from a "constant suprasegmental feature of all vowels stemming from nondistinctive leakage of air through the velum" (KL 1976, 382). KL drew on comparative linguistics with modern Nahuatl varieties in order to show that patterns of reduction of underlying nasal sounds in specific contexts coupled with the proposed suprasegmental nasal airflow would create a situation in which Nahuatl speakers writing down their language would occasionally write them in when not expected because of the proposed noncontrastive suprasegmental nasalization in some cases, and leave them out when expected in other cases because of patterns of nasal reduction.

This paper seeks to expand the discussion on these fascinating patterns of nasal intrusion and omission in classical texts identified by KL, by providing insights from my own work on the phonetics and phonology of Chicontepec Nahuatl (henceforth ChN), a variety of Eastern Huasteca Nahuatl, and by drawing from developments in phonetics and phonology since 1976. I will show how 1) phonological processes that target nasals and other sonorants in the coda position, and 2) the constellation of laryngeal articulations (both glottal stops and fricatives) in ChN and other modern varieties can contribute to our understanding of these patterns in colonial

era texts. This also contributes to our understanding of some of the possible features of the historic phonologies that the manuscripts reflects.

Orthographies and their relationship to phonology and phonetics

Before diving into the patterns identified by KL, I will first expand upon an assumption in their analysis and proposal: typographical errors in a written text reflect something in the spoken language. This is a key assumption. Without this assumption, we would have to assume that all typographical errors had other performance or cognitive sources. Thus, the assumption that errors in writing reflect something specific about the language of the writer is key and is based on the seemingly systematic nature of the irregularities in spelling. The irregularities that KL identify seem to follow specific patterns suggesting that they are not accidental. Instead, they reflect the fact that literacy is not a trivial skill and that orthographies are not necessarily intuitive, even for native speakers of a language. There are conventions that people follow for writing when using an alphabet that in some cases reflect how a word sounds to a speaker and in other cases do not. The assumption made then is that orthographic errors indicate sounds that may be present or absent in the spoken form.

Literacy is not a trivial skill. It involves many different cognitive tasks such as pattern and symbol recognition for reading, mapping sounds or words to characters or strings of characters, and the motor skills involved in reproducing symbols in the case of handwriting. Crucially, it requires a fair amount of learning of spelling conventions that may or may not be entirely phonetically transparent. The less transparent the orthographic system, the more memorization of word shapes as whole symbols is required. Orthographies often stand in a tension between representing phonemic and therefore morphological information, and representing phonetic forms. Sounding out one's orthography can only get you so far if your orthography has been designed to represent phonemic and morphological information over phonetic information. Among languages using the Roman alphabet, English orthography is a well-known example of a relatively opaque or abstract orthographic system.

For example, we know that in many varieties of English, the productive plural marker /-z/ is voiced after voiced consonants and vowels, and is

voiceless [-s] through assimilation after voiceless consonants. Nonetheless we spell "cats" and "dogs" with a voiceless orthographic representation, rather than how the morpheme is realized for many speakers, such as something like "dogz". It is for this reason that people learning to read and write, must learn to ignore their understanding of the phonetic realization of their language and memorize the conventions of their orthographic system (Treiman 1985, 2004). In addition, orthographies can become fixed in time, and represent sounds no longer present in the spoken language. Consider the words "through", "tough", and "thought". The string of characters "ough" is realized as [uw], [ʌf], and [ɑ] respectively, at least in my Californian Chicano English dialect.

English orthography preserves historical information about sounds that are no longer part of the inventory of most varieties, (*i.e.* /x/ represented as "gh"). Speakers of the language must memorize the spelling convention that diverges from more regular sound-to-letter correspondences such as representing the word [θɑt] as "thought" rather than "thot". In many cases these opaque orthographies conserve morphological information. For example, in many dialects of English, the words "write", "right", and "rite" are all pronounced identically. Yet the orthography distinguishes morphological and semantic information. In addition, orthographies can conserve relationships between words that are no longer pronounced similarly. For example, the word "cupboard" in English, tends to be pronounced [kʌbɚd], phonetically obscuring the morphological relationship between [kʌp] "cup" and [bɔɹd] "board" for most speakers. Nonetheless the relationship is conserved through the orthography, which might be lost were the orthographic representation more phonetically transparent as would be in the hypothetical spelling "cubberd".

Nahuatl orthographies seem to be relatively phonetically transparent, thereby representing the phonetic form. An example of this in historical and contemporary orthographies is the relationship between /j/ and /ʃ/, often represented as "y/i" and "x" respectively in Nahuatl orthographies. In many varieties, there is a phonological process of neutralization such that both underlying /j/ and /ʃ/ surface as [ʃ] in the coda position (Aguilar 2020). It is perhaps because these sounds are contrastive in the phonemic inventory that in this case, the orthography represents the phonetic form. We know these sounds are contrastive because of minimal pairs such as those shown below in 1).

1)	IPA	*Gloss*	*Sources*
	[jama:nia:]	"to soften something"	("yamania" in Molina [1571] 1970, "YAMĀNIĀ" in Karttunen 1992)
	[ʃama:nia:]	"to crack, break someone's head or a gourd vessel"	("xamania" in Molina [1571] 1970; "XAMĀNIĀ" in Karttunen 1992)

Phonological neutralization occurs in the coda position so that the phonetic realization of /j/ is [ʃ], therefore neutralizing the contrast between /j/ and /ʃ/ shown in 2).

2)	*Colonial orthography*	IPA	*Morphemes*	*Tense*	*Sources*
	a. meya	[me:ja]	/me:ja/ flow	present/ infinitival	("meya" in Molina [1571] 1970; "MĒY(A)" in Karttunen 1992)
	b. omex	[ome:ʃ]	/o-me:j/ PRET-flow. PRET	preterit	("omex" in Molina 1571; "MĒX" in Karttunen 1992)

The verb stem is /-mej(a)-/, which is vowel-final in certain constructions with /j/ as the onset of a syllable /ja/, while in other constructions, such as in the preterit (often referred to as the "preterit stem"), the stem loses the final vowel, and /j/ is stem-final. Thus, it is in a morphophonological context in which it is in the coda position in the syllable /mej/ —the coda status of underlying /j/ triggers the phonological process which results in an [ʃ] realization. This is supported by other words in colonial texts that contain the /-mej-/ alternant of this stem, but with another vowel from a suffix that follows. In such cases, the orthographic representation suggests that no alternation occurs such as *tōnamēyoā*, 'to shimmer, to shine in rays' (Karttunen 1992, 246), made up of the morphemes *tōna*, 'for the sun to shine' *mēy*, 'to flow', and the verbalizing suffix *-oā*. Here, the preterit stem alternant *mey* does not surface as *mex* because the underlying /j/ sound is not the coda of the syllable *mey*, but instead the onset of the syllable *yo*, and neutralization does not occur.

This type of alternation is found throughout colonial era Nahuatl examples such as words like *piya* and *pix*, 'to have/guard something'. In these cases, something about the phonological system and the resulting phonetic

form is being represented in the orthography. Phonological patterns in contemporary Nahuatl suggest that in other cases, it is possible that the phonetic form was not represented in the colonial orthography. Instead, the phonemic/morphological form, regardless of how it might have been pronounced, was represented.

Across Nahuatl varieties, there is a pattern of glottal fricatives [h] being associated with morphological geminates. For example, in some varieties in Guerrero, geminate [l]s that result from assimilation (sequences of /l-t͡ɬ/ surface as [l:]~[l]), are produced with an [h] preceding the lateral. Thus, /t͡ʃil-t͡ɬi/ surfaces as [t͡ʃihli]. This pattern can be analyzed as preaspiration of geminate consonants (Keer 1998, Stevens and Hajek 2004 *inter alia*), or as a pattern of degemination in which the first consonant in the l-l sequence debuccalizes to [h] following Aguilar (2020). In ChN, this is a robust pattern for sequences of velar stops: sequences of underlying /k-k/ surface as [hk], or undergo further lenition to [x] or [h]. Similarly, Sasaki (2014) notes that in Ixquihuacan Nahuatl, sequences of /kk/ reduce to [k] suggesting that it is likely processes targeting /kk/ sequences existed in at least some of the varieties of Nahuatl spoken in the colonial era. Yet, the orthographic conventions do not represent this pattern. The examples in 3) show forms in colonial era texts and related forms in contemporary ChN.

3)	*Colonial orthography*	*Morphemes*	*Gloss*	*Notes*
	a. micqui	mic-qui die-PRET	"dead person or animal, corpse"	("micqui" in Molina [1571] 1970, "MICQUI" in Karttunnen 1992)
	Phonetic form in ChN			
	b. [mihki]	/mik-ki/ die-PRET	"s/he/it died"	Related form in ChN is [mihkat͡sih] 'dead person' (Aguilar 2020)
	c. [kimiktia]	/ki-mik-tia/ 3OBJ-die-CAUS	"s/he/it killed it"	

In the ChN example, the preterit stem of [miki] /mik(i)/, 'to die', is /mik-/ rather than /mih-/ because it surfaces as [mik] in the causative form (3c) —there is no phonological alternation between /k/ and [h] when in a sequence of /k-t/. However, in the preterit form it is followed by the preterit marker /-ki/ triggering the debuccalization pattern such that

/mik-ki/ surfaces as [mihki], or is further lenited to [mixi]~[mihi]. If we presume that this pattern was present in the Nahuatl of at least some of the colonial era writers, then this would be an example of how the orthography would not reflect the phonetic form for those speakers in favor of the underlying phonemic/morphological form.

A final point on orthographies that is relevant here is that orthographies often reflect one particular variety of a language, and yet may be used by speakers of vastly different dialects of the same language. This is what hypothetically would have been at play in the previous discussion of morphological geminates in colonial Nahuatl where speakers of dialects with and without processes targeting /k-k/ all represent words with "cc~cq". A final example from English that illustrates this point is rhoticity in relation to orthography. The orthographic conventions of English match the phonologies of rhotic varieties of English much more than those from non-rhotic varieties. Intuitively, someone from my speech community is less likely to omit a final written "r" in a word like "runner" given that the final sound is rhotic in the spoken form [ɹʌnɚ], than someone who speaks a variety that does not have a rhotic sound in this context [ɹʌnə]. Similarly, there is a documented effect in which speakers of varieties with intrusive "r"s (*i.e.* pronouncing the word "idea" as [ɑɪdiɚ] rather than as [ɑɪdiə]) are more likely to insert an orthographic "r" in unexpected places given the mismatch between their phonology and the conventions of English writing (Treiman and Barry 2000). Were we to encounter a collection of orthographic errors in English such as "idear," and "Mariar," we could extrapolate that the writer most likely speaks a variety of English with intrusive "r"s. This is the logic employed by KL, which is taken up and extended here.

The conventions for writing Nahuatl that were developed in the colonial period and reflected in the works of Molina ([1571] 1970), subsequent grammars, and multitudes of colonial texts, were developed in a context of much linguistic variation across the Nahuatl linguistic landscape (Canger 2011). In addition, we cannot assume that all or most modern varieties descend from what we now call Classical Nahuatl, rather, it is more likely that at least some of the variation we find in contemporary Nahuatl was a feature of varieties in the colonial period (Canger 2011). At the time that the colonial-era written form was codified, it would have been used by speakers of the many existing varieties of Nahuatl outside the Valley of Mexico. Some of the differences found across dialects were regularly reflected in colonial written texts. For example, there is a split between

varieties that have /i/ versus /e/ in words such as *cintli~centli*, 'corn' (Canger and Dakin 1985). Moreover, this dialectal difference recorded in colonial era texts is present in contemporary varieties. This thus motivates the exploration of contemporary varieties of Nahuatl for insights into how to account for the systematic "errors" in colonial era texts. That is, we can ask: what features of modern Nahuatl varieties might have been present in the variety spoken by the *tlacuilo* of the texts analyzed by KL that can explain the unexpected orthographic forms that they identified?

As is argued here, the unpredictable representation of Nahuatl nasals suggests that the orthography employed by colonial writers favored underlying/morphological rather than the phonetic form. As a consequence, the noted orthographic errors by colonial-era *tlacuilos* must reflect them representing their own phonetic form rather than the conventionalized phonemic form that frames our expectations. We now turn to the seemingly chaotic nasals identified by Karttunen and Lockhart. I first discuss patterns of omitted nasals, and then address the intrusive nasals.

Omitted nasals

KL identify a number of contexts in which expected underlying nasals are omitted. These are repeated below in 4):

4) *Contexts for omitted nasals by KL*

a. when two nasals are adjacent *in nehuatl* '(article) + I' > *inehuatl*
b. phrase-finally
c. before nonnasal resonants *quinualuica* [kinwalwika] 'he brings them back' > *quiualuica*
d. with considerably less frequency before consonants in general. (p. 380)

KL provide a general explanation for why some of these omissions occur, which focus on processes of reduction of final nasal sounds. While I agree with their analysis, I will show that this pattern is part of a larger process in Nahuatl that targets codas and is connected to phonological distributions of laryngeal sounds. KL also note that the first observation 4a) deletion when two nasals are adjacent is, actually, accounted for by a different phenomenon. I will first discuss this pattern of omission. Then,

I will address 4b): omission of nasals phrase-finally. And then show how 4b) is related to 4c) and 4d), omission before other consonants. Finally, I will discuss the constellation nasal and laryngeal sounds that further add complexity to the picture.

Adjacent nasals across word boundaries

KL note that a common context for the omission of orthographic "n" is when two nasals are adjacent. They also note that syllable-final nasals are not missing within a phonological phrase when the following syllable is vowel-initial. And in fact, this is a context in which they note that nasal intrusion also occurs in the written form (note, with monosyllabic words). The examples cited in KL are summarized below in 5):

5)	*Type of error*	*Expected form*	*Cited form*	*Gloss given*	
	a. omission	i**n n**ehuatl	i**n**ehuatl	'(article) + I'	(p. 380)
	b. intrusion	tle**n o**techtlaocoli	tle**nn**otechtlaocolli	'which he granted us'	(p. 380)
	c. intrusion	ça**n i**xquich	ça**nn**ixquich	'only'	(p. 381)

They attribute this pattern to resyllabification in which the final nasal is carried over to the syllable initial position. The implied argument is that because resyllabification happens across word boundaries, the *tlacuilo* could be unclear as to which syllable the nasal belonged to. That is, in the first case, the sequence of two nasals in *in nehuatl* would potentially sound like a single sound in connected speech, and therefore be represented with a single orthographic "n". By the same token, resyllabificaion of a word-final nasal to the onset of the following syllable would make it possible, in connected speech, to not be clear which syllable the final nasal belonged to. One can almost imagine the colonial-era *tlacuilo* saying "tlen" in isolation, and then the phrase "tle.no.tech.tla.o.co.li" (periods represent syllable boundaries). This could be the source of the intrusive "n" in words like *tlen**n**otechtlaocoli* in (5b-c) above. This parallels the synchronic word *cannot* in English. Here, *can* and *not* are represented together as a single word in the orthography, including both *n*s, but is typically syllabified [kæ.nɑt]~[kɛ.nɑt].

The phonological patterns observed in ChN, seem to support this conclusion. In ChN, resyllabification occurs both word-internally and across word boundaries following the *maximal onset principle* (Kahn 1976; Selkirk 1982; Clements and Keyser 1983). Cross-linguistically, there is a pattern of maximizing the number of consonants in the onset —that is of course to the degree allowed by the phonotactics of the particular language. In the case of ChN, like many varieties of Nahuatl, syllables can maximally have a single consonant in the onset and coda, with the possibility of off-glides. The data below in 6) show syllabification across morpheme boundaries word-internally.

6) *Syllabification in ChN*

a.	[a.ˈ**h**a.t͡ʃi]	b.	[a.la.ˈʃo.ʃa:t͡ɬ]
	/a*h*~at͡ʃi/		/alaʃoʃ-a:-t͡ɬ/
	RED~piece		orange-water-ABS
	'in small portions'		'orangeade'

(Aguilar 2020)

In example 6a) above, the [h] that forms part of the reduplicant template is syllabified as the onset of the vowel initial syllable of the stem. Similarly, in 6b) the final [ʃ] of the morpheme [alaʃoʃ], 'orange', forms the onset of the following syllable comprised of the morphemes making up the word [a:t͡ɬ], 'water', in this compound form such that the final syllable is [ʃa:t͡ɬ].

The maximal onset principle can also apply across word boundaries in ChN. However, prosody does condition when this occurs. Specifically, resyllabification can occur in connected speech, but will not occur at word boundaries that straddle a pause. This echoes Karttunen and Lockhart's assertion that this occurs within a phonological phrase —pauses occur at a phrasal boundary. In ChN, word-final nasals are realized as [h]. I will describe this pattern in much more detail in the following section, "Lenition of final nasal sounds in Nahuatl". For now, we can look at the syllabification of a phrase *naman ni tonatiuh* "today/ hoy día". The underlying form is /naman ni tonatiw/. In careful speech it is syllabified as in 7a), where the final nasal in /naman/ is realized as [h]. However, in normal to rapid speech the final nasal in *naman* is lost and the string of sounds is syllabified as in 7b).

7)	*Surface form*	*Underlying form*	*Morphemes*	*Gloss*
	a. [na.mah.ni.to.na.tih]	/naman ni tonatiw/	ADV DET day	'today'
	b. [na.ma.ni.to.na.tih]			

Word-internally, sequences of nasal stops across morpheme boundaries are reduced to the onset of a syllable during syllabification rather than as a long or geminate nasal. The examples in 8) show this pattern.

8)	*Surface form*	*Underlying form*	*Morphemes*	*Gloss*
	a. [si.na.ma.ka]	/sin-namaka/	corn-sell	'sell corn'
	b. [i.ne.t͡ʃi.tah]	/in-nech-ita-h/	2SUB.PL-1OBJ-see-PL	'you all see me'

This pattern in ChN, both word-internally and across word boundaries, accounts for the form cited in 5a) in the classical text. We can assume that such patterns were present in the Nahuatl spoken by the *tlacuilo* of the colonial manuscript. Patterns of resyllabification in ChN, can account for both omission and intrusion of orthographic "n" in these contexts. In the next section I will address the patterns in (1b-d) above and discuss the patterns for coda nasal sounds in ChN.

Lenition of final nasal sounds in Nahuatl

A wide range of diachronic and synchronic processes in which there is a weakening effect on a sound, such as debuccalization and devoicing have been described as *lenition* (Bauer 2008; O'Brien 2012; Kirchner 2013; Katz 2016; *inter alia*). Certain types of lenition results in the loss of contrasts in perceptually weak positions (Katz 2016). The omitted and intrusive nasals described by KL occur specifically at a perceptually weak position, the coda. By looking at modern Nahuatl, KL note that in some varieties, syllable-final nasals are weakened. They cite a process in which phrase-final nasals are devoiced in Veracruz Nahuatl (Wolgemuth 1969), Puebla Nahuatl (Robinson 1969) and Milpa Alta (Whorf 1946). They go on to report that coda nasals following a long vowel are realized as nasalization of the vowel rather than as a nasal consonant for the dialects spoken in Veracruz, in

which the vowel length distinction is maintained (KL 1976, 381). Finally, they describe that both nasalization and voiceless nasals often disappear in rapid speech. They conclude that the weakening of underlying nasals in the phrase-final position could lead to the omission of the letter *n* in the manuscript because it is so weakened in the spoken form.

Expanding on their survey shows that lenition processes targeting final nasals seem to be a common pattern across the Nahuatl dialectological landscape. Typically, descriptions make reference to the word-level domain rather than the phrase referenced by KL in 4b) above. These patterns can be grouped into four general types:

9) *Realization of final-nasals*

a. *Nasal absorption* [Ṽ]:	Matlapa (Croft 1951), Mecayapan (Wolgemuth 1969), Ixquihuacan (Sasaki 2014), Chicontepec (Aguilar 2020).
b. *Velar nasal* [ŋ] (possibly a placeless nasal [N]):	Zacapoaxtla (Key and Key 1953, Robinson 1969), Mecayapan (Wolgemuth 1969), Orizaba (Goller, Goller and Waterhouse 1974), Pipil (Campbell 2011).
c. *Devoicing* [n̥] (utterance-finally):	Naupan (Brockway 1963, 1979), Mecayapan (Wolgemuth 1969).
d. *Breathy debuccalization* [h]:	Possibly Tetelcingo (Pittman 1954), Chicontepec (Aguilar 2020).

Nasal absorption [Ṽ] (Trigo Ferre 1988, O'Brien 2012) 9a) is a form of debuccalization in which oral articulations are lost, and nasality is realized on the vowel. This has been documented some varieties of Nahuatl, including ChN (Aguilar 2020). Some varieties seem to have a *velar nasal* [ŋ]-realization of word-final nasals 9b). While in this case there is not a loss of oral articulation, this realization of final nasals can also be analyzed as the realization of a placeless nasal. Placeless nasals have been argued to surface as [ŋ] or an [ɴ]-like sound (Harris 1984; Trigo Ferre 1988; De Lacey 2002). The realization of velar nasals has been shown to overlap acoustically and visually with vowel nasalization (Ohala 1975; Johnson, DiCanio and MacKenzie 2007). This has been argued to account for excrescent nasal [ŋ] consonants developing from nasalized vowels such as in some varieties of Brazilian Portuguese where [ŋ] occurs where final nasalized vowels are

expected (Shosted 2011). Sound changes in either direction from [Ṽ]⇆[ŋ] can be attributed to shared acoustic properties and visual cues. This accounts for the types of sound correspondences [Ṽ] ⇆ [ŋ] in French varieties (Johnson, DiCanio and MacKenzie 2007), as well as the *nasal absorption* [Ṽ] and *velar nasals* [ŋ] correspondence in contemporary Nahuatl.

Devoicing 9c) is reported utterance-finally in Naupan and Mecayapan. This process seems to be related to the final pattern identified in this survey, voiceless *breathy debuccalization* (9d), which can be seen as a further lenited voiceless nasal in 9c), diachronically [n̥]⟶[h]. This pattern is found in ChN (and will be demonstrated more fully below), and can be extrapolated as at least a possible surface form from examples given by Pittman (1954) for Tetelcingo.

Word-final nasal lenition seems to be widespread in Nahuatl phonologies. For example, Boas and Beck ([1917] 2017), contrast Pochutec voiced word-final nasals and /l/with voiceless counterparts in Nahuatl varieties from the Valley of Mexico. The effect of these processes is evident when surveying contemporary placenames of Nahuatl origin. The variation in the presence or absence of final nasals, being loanwords into Spanish notwithstanding, suggest that word-final nasals were quite variable across varieties when the place names' orthographic representation were formalized in the colonial period. The locative suffixes "*-tlan*", "*-can*" and "*-pan*" occur without final "n" in contemporary place names throughout Mexico and Central America.

10) *Placenames*

-tlan		*-(t)lan*	
Mazat**lan**	Papan**tla_**	Cuetza**lan**	Guatema**la_**
-can		*-pan*	
Michoa**can**	Tolu**ca_**	Papaloa**pan**	Xala**pa_**

These patterns for the realization of nasals across varieties provide insight into why the colonial *tlacuilos* might have omitted nasals in some contexts (e.g. *ipilhua* from expected *ipilhuan*, KL 1976, 380). An additional piece to this puzzle is the way in which nasal and laryngeal sounds are coextensive in ChN, providing further insights as to what might have been the source for the orthographic "n" in the colonial era texts. I will first

describe the distribution of nasals in ChN and then discuss interactions with laryngeal sounds in the section titled "Intrusive nasals" in order to discuss the intrusive patterns identified by KL.

Chicontepec Nasal Sounds

In ChN, there are two contrastive nasals in the prevocalic/onset, position: /m/ and /n/. In the coda position, there are three patterns associated with position in the word and stress. The examples below in 11) show this contrast with minimal pairs.

11)	*Surface*	*Underlying*	*Morphemes*	*Gloss*
	a. **m**omah	/mo-mah/	2SG.POS-hand	'your hand'
	b. **n**omah	/no-mah/	1SG.POS-hand	'my hand'
	c. t͡ɬa**m**i	/t͡ɬami/	finish	'to finish something'
	d. t͡ɬa**n**i	/t͡ɬani/	win/earn	'to win/earn something'

(Aguilar 2020)

Word-medial nasals undergo place assimilation to the following consonant in clusters as shown in 12).

12) *Place assimilation*

Surface	*Underlying*	*Morphemes*	*Gloss*
a. **kam**pot͡stik	/ka**N**-pot͡stik/	cheek-full	'for one's mouth to be full'
b. **kan**temi	/ka**N**-temi/	cheek-swell	'for one's cheeks to swell'
c. **kan̲**ʃima	/ka**N**-ʃima/	cheek-shave	'to shave one's face'

(Aguilar 2020)

In the word-final position, there are two realizations depending on stress. Since stress is predictably on the penultimate syllable, most word-final nasals follow this pattern: /n, m/ alternates with the glottal fricative [h]. The contrast with /h/ is neutralized. Thus, the stem cited in 12) above is [ika**h**] /i-ka**N**/ 'her/his/its cheek' in the possessed form. The following

data show that both contrastive nasals alternate with [h] in word-final contexts.

13) *Nasal debuccalization*

Surface	*Underlying*	*Morphemes*	*Gloss*
a. sin͡tɬi	/sin-t͡ɬi/	corn-ABS	'corn'
b. nosi**h**	/no-si**n**/	1POS-corn	'my corn'
c. ko**m**i͡tɬ	/ko**m**-i͡tɬ/	pitcher-ABS	'pitcher'
d. noko**h**	/no-ko**m**/	1POS- pitcher	'my pitcher'

(Aguilar 2020)

Unpossessed nouns with the absolutive suffix 13a) and 13c) provide evidence that there is an underlying nasal that is present in the possessed construction. In this construction, however, the nasal sound is word-final and realized as [h]. In sum, word-medially, coda nasals, which necessarily occur in consonant clusters undergo place assimilation. Word-finally placeless nasals are realized as [h] when unstressed.

There are three exceptions to this pattern. The first one is a sequence of /n-m/where the first nasal does not assimilate: [inmoitah], 'you all see each other.' Second, stressed word-final nasals surface as [n]~[Ṽ]. This seems to be free variation between *nasal absorption* and a default alveolar nasal (e.g., Harris 1984). Stressed final nasals occur in monosyllables 14) and loanwords.

14) *Nasal absorption*

a. [t͡ɬɛ̃] ~ [t͡ɬen] 'what/that'

b. [t͡ɬã] ~ [t͡ɬan] 'if'

c. [kã] ~ [kan] 'where'

d. [sã] ~ [san] 'only'

(Aguilar 2020)

Spanish loanwords in ChN also demonstrate the effect of stress on the realization of word-final nasals. Words like *asadón* and *violín* have variable

forms across speakers: [asˈaðoh]~[asaˈðon], [fiˈolih]~[βioˈlin], where the realization of the nasal is dependent on stress. The realization of nasals in ChN provides evidence for the pattern KL identified in 4b), phrase-final omission. It is likely that a phonological distribution of nasals similar to that of ChN was present in the Nahuatl spoken by the colonial *tlacuilo*. Nasal absorption ([Ṽ]) and breathy realization ([h]) with their loss of oral features, could certainly be a source of the omission of an orthographic "n". This is especially likely in the case of [h] given that many colonial texts did not represent glottal sounds with any regularity. This realization of final nasals as [h] will also be relevant to the discussion of intrusive nasals in the "Intrusive nasal" section.

Omission before consonants

KL identified patterns in which nasal sounds are omitted before consonants: before nonnasal sonorants 4) and less frequently before consonants generally 4d). Some insight can be gained from the patterns found in ChN for nasals before /j/ and /w/. The other sonorant in ChN is /l/ is rare morpheme-initially such that no examples of /n-l/ or /m-l/ sequences are found in the data. There is considerable variation in how the nasal is realized in these contexts, however in both, there are examples in which the nasal sound is deleted. The data in 15) below show examples of morphologically complex words in ChN in which the nasal stop /n/ precedes the labiovelar glide in the underlying form.

15) *Nasal-w sequences*

	Surface form	*Underlying form*	*Morphemes*	*Gloss*
a.	[aːt͡sintlah]	/aː-t͡sin-tla**n**/	water-base-LOC	'the bottom of a body of water'
b.	[aːt͡sintlawet͡si]	/ aː-t͡sin-tla**n**-wet͡si /	water-base-LOC-fall	'fall to the bottom of water'
c.	[t͡ɬaje:hkaːh]	/t͡ɬa-jek-ka**n**/	IS-clear-LOC	'a clear night sky'

d.	[t͡ɬajehãwia]	/t͡ɬa-jek-ka**n**-wia/	IS-clear-LOC-VBZ	‘for the night sky to clear’
e.	[se:ŋwet͡si]	/se:**m**-wet͡si/	one-fall	‘for it to rain constantly’
f.	[ikʃ͡ipaŋgʷia]	/ikʃ͡i-pa**n**-wia/	foot-LOC-VBZ	‘follow an animal’s footsteps’

The data in 15) show that /n/ in the context of /w/ has variable realization with a velar nasal, deletion, or nasal absorption as possible surface forms. In 15a) we see an n-final word with the glottal fricative realization. In 15b) the nasal sound is deleted in this same morpheme in the context of a /w/. In 15c) and 15d) we have a similar pair of morphologically related words, however in the context of a /w/ there is debuccalization with nasal absorption resulting in a nasalized vowel. In 15e)-15f), /m/ and /n/ surface as [ŋ]. The data in 15a)-15d) mirror the pattern in the colonial text suggesting that oral articulation of the /n/ was deleted for the colonial author as well. It would be easy to imagine the *tlacuilo* omitting an orthographic “n” if the oral articulation of the nasal sound were absent. ChN nasals in the context of /j/ exhibit similar variation: it surfaces as the palatal nasal [ɲ] or it is deleted. As was the case for sequences of /n-w/, there is variation across speakers in my field recordings. The two contexts represented in the data below are specifically the adverbial suffixes /-joh/, ‘covered in/full of’, and /-ja/, ‘already’. For some speakers, sequences of /n-j/ result in a surface form [ɲ]. The nasal takes on place features from the /j/ —16b) and 16f). For other speakers, the nasal sound is lost completely in this context —16c) and 16g). The diminutive form is provided in 16e) as a point of comparison. No examples of /m-j/ clusters are captured in my field recordings.

16) *Nasal-j Sequences*

	Surface form	*Underlying form*	*Morphemes*	*Gloss*
a.	[ilimoh]	/ilimon /	lime	‘lime’
b.	[ilimoɲoh]	/ilimon-joh/	lime-ADJ	‘limey’
c.	[ilimojoh]			

d.	[namah]	/naman/	adv	'now'
e.	[namant͡sih]	/naman-t͡sin/	ADV-DIM	'right now'
f.	[namaŋa]	/naman-ja/	ADV-ADV	'right now'
g.	[namaja]			

The patterns for the omission of orthographic nasals before non-nasal resonants 4c) in the colonial texts is not surprising given the variable realization of nasals in at least the context of /w/ and /j/ in modern varieties like ChN. A similar pattern has been documented in Mecayapan Nahuatl, where /n/ is reported to delete before /j/ and /w/ (Wolgemuth 1969).

ChN, however, does not shed light on 4d), omission before consonants in general —in ChN, nasal sounds undergo place assimilation in consonant clusters. I turn to Karttunen and Lockhart's account which points to Nahuatl varieties such as Mecayapan Nahuatl, where Wolgemuth (1969) describes coda nasals, which word medially necessarily occur in consonant clusters in Nahuatl (maximal onset principle), as reducing to nasalization on the vowel without oral articulation after long vowels (nasal absorption).

In 17) below, I summarize the insights from ChN and other Nahuatl varieties that can help account for patterns of nasal omission identified by KL (in 4) above).

17)	*Observation by KL*	*Insights from ChN or other Nahuatl varieties*
a.	two adjacent nasal	Onset maximization and resyllabification
b.	phrase-finally	Lenition patterns that target word-final coda nasals resulting in perceptually weaker realizations of nasal sounds: [Ṽ]~[Vh]~[Vŋ]~[Vn̥]
c.	before nonnasal resonants	Deletion of nasal sounds before /w/ and /j/ in ChN and Mecayapan.
d.	with considerably less frequency before consonants in general.	Patterns of word-medial nasal absorption: Mecayapan.

Intrusive nasals

Having discussed omitted nasals, let us now turn to the patterns for nasal intrusion. Here I argue that many of the patterns for omission reflect the relationship between the acoustic properties of nasality and laryngeal sounds, and the ways in which these types of sounds are arranged in the phonologies of contemporary Nahuatl varieties. KL observed a series of contexts for intrusive nasals in the colonial text, summarized in 18) below.

18) *Contexts for intrusive nasals by KL*

a. when an adjacent syllable contains a nasal quimatican, 'let them know' > quimatincan palpan tlaca, 'Palpan people' > palpan tlanca

b. metathesized from another syllable ypan, 'on it' > ynpa Teohuacan (name) > Teohuanca

c. in the segmental position of underlying glottal stop quitos [kiʔtos], 'he will say' > quintos cate [kateʔ], 'they are' > caten

d. before nonnasal resonants mayor (Spanish), 'greater' > manyor chicuepohualli [cikwepowalli] '60' > chicueponhualli onpohualli, '40' > onpohuanlli

e. finally niquitohua, 'I say' > niquitohuan

f. with somewhat lesser frequency before nonnasal consonants in general ytoca, 'his name' > yntonca sitio (Spanish), 'site' > sintiyon (p. 381)

I will begin by addressing the pattern observed in 18c): "in the segmental position of underlying glottal stop". The two examples given are [kiʔtos], 'he will say', being written as *quintos* rather than the expected *quitos*; and [kateʔ], 'they are', being written as *caten* rather than the expected *cate*. In the colonial era, glottal segments —*i.e.* the *saltillo*— were not systematically represented in all variants of the orthography —however, nasal stops were. Recall from section "Lenition of final nasal sounds in Nahuatl" that final nasals have variable realizations across varieties of Nahuatl, which ranges from [n̥], [ŋ]/[N], [Ṽ], and [h]. I will focus on the [h] realization found in ChN and other varieties ("breathy debuccalization"). In these varieties, there is phonological neutralization such that any [h] segment in the phonetic implementation of the lexicon will have two possible underlying forms. That is, in principle, as speakers of ChN hear a word such as [nikah], 'here', there is the possibility that the underlying form is /nikan/

or /nikah/ as both contrastive sounds /n/ and /h/ are produced as [h] in the word-final context.

The intrusive nasals in contexts of expected glottal stops, can be argued to instead correspond to expected glottal fricatives. The expected forms in varieties with phonologies like ChN would not be [kiʔtos], but rather [kihtos] ([kiʔihtos] in ChN). If the colonial *tlacuilo* were a speaker of a variety of Nahuatl where 1) glottal fricatives rather than glottal stops were part of the inventory, and 2) there was a phonological alternation between the glottal fricative [h] and nasal stop [n], then these intrusive nasals would not be surprising —no different from today's English speakers who write *could of* rather than *could've* because of the phonetic overlap of *f* and *v* in English orthography. For the *tlacuilo*, there would be words when an [h] in the spoken form corresponded to an orthographic *n* and others when [h] corresponded to no standard representation in the orthography.

Spanish loanwords provide further evidence that the relationship between nasals and laryngeals in Nahuatl can accounts for intrusive nasals. In 18f), the expected form of the Spanish loan is *sitio*, 'site', but instead the reported form is *sintiyon*. This immediately suggests a pattern in many Nahuatl varieties in which vowel-final words borrowed from Spanish take on a final [h] (Key and Key 1954, Croft 1951, Goller, Goller and Waterhouse 1974, Sasaki 2014, Aguilar 2020). In ChN, for example, Spanish *toro*, 'bull', occurs as [ˈtoɾoh]. In addition, ChN n-final words borrowed from Spanish occur with [h]: [iˈlimoh], 'lime' (*limón*) and [ˈlistoh], 'ribbon' (*listón*). This dynamic in ChN create the conditions for reanalysis. One example of reanalysis is 'coffee' which varies between [kafeh]~[kafen]. In compounds, the final segment of the stem is [n]: [kafen͡tsih], 'coffee-DIM', [kafentik], 'brown'. As the Spanish word *café* does not contain an nasal, it must have first been borrowed following the pattern for vowel-final words with a final [h], and subsequently reanalzyed as being n-final.[1] We can account for at least the second intrusive nasal in (18f) *sintiyo**n*** by proposing that then, as in many varieties now, the loan word written, and expected, *sitio*, was pronounced [sitʲoh] and overlapping realization of nasals and laryngeals resulted in the intrusive nasal. In a similar development, Flores Farfán (2003, 340) documents *kichiiwaa-**n***, 'they make it', in Xalitla Nahuatl rather than

[1] The placename *Chiapas* is a possible parallel reanalysis case. Nahuatl *Chiapan*, 'place of chia', may have been pronounced [t͡ʃiapah] to be reanalyzed as s-final by speakers of "aspirating" dialects of Spanish where [s] alternates with [h] (e.g., *las cosas* as [lah kosah]).

the expected *kichiiwaa-**h*** as in nearby Oapan Nahuatl (also ChN [kit͡ʃiwah]). While, Flores Farfán analyses this as convergence with Spanish plural verb paradigms, it is interesting that again we find this connection between [h] and [n]. I will return to possible accounts for cases like the first *n* in *si**n**tiyon* shortly. But first, we turn to additional breathy sounds which further help account for the patterns for intrusive nasals identified by KL.

Additional sources of breathy sounds

So far, I have established that /h/ and /n, m/ are contrastive sounds in ChN, but undergo neutralization to [h] in the word-final position, e.g., [nosih] /no-sin/ 'my corn, *mi maíz*'. There is an additional neutralization pattern in ChN relevant here: /w/ is also realized as [h] in the word-final position. This is in fact part of a larger pattern in ChN where all non-nasal sonorants in undergo lenition in the coda position, summarized in 19).

19)

Sound	*Onset*	*Coda*
/w/	[w]	[h]
/j/	[j]	[ʃ]
/l/	[l]	[ɬ]

(Aguilar 2020)

In ChN, all non-nasal sonorants are voiceless and spirantized (and therefore breathier) in the coda position. /w/ is fully debuccalized. Discussed previously in the "Omitted nasals" section, the [j]~[ʃ] alternation in 19) is a long-standing feature of Nahuatl and is reflected in the orthographic conventions of colonial era texts. With respect to the other sonorants in colonial Nahuatl, the orthography does not tell us if there were the types of alternations seen in ChN. The graphemes "l" and "uh"/"u"/"hu" are not as revealing in colonial orthographies as the alternation between "y/i" and "x". Alternations between voiced [l] and voiceless and/or spirantized [l̥]~[ɬ] have been documented in Hauhtla (Beller and Beller 1979), Ixquihuacan (Sasaki 2014), Matlapa (Croft 1951), Mecayapan (Wolgemuth 1969), Orizaba (Goller, Goller and Waterhouse 1974), and Sierra Puebla (Robinson 1969). Similarly, alternations between voiced [w] and voiceless

and/or debuccalized [ʍ̥]/[h] have been documented in Ixquihuacan (Sasaki 2014), Mecayapan (Wolgemuth 1969), Naupan (Brockway 1963), Pomaro (Sischo 1979), Sierra Nahuat (Key and Key 1953), Sierra Puebla (Robinson 1969), and Tuxpan (Cuauhtli 2022). It is possible that patterns of lenition targeting coda /l/ and /w/ were also present in the colonial era, but were not represented in the orthography. The example in 20) shows this alternation for the labiovelar glide in ChN for the verb 'to buy'.

20)	a. [ki.ko:.**w**a]	/ki-ko:wa/	3OBJ-buy	's/he/it buys it'
	b. [ki.ko:**h**.ki]	/ki-ko:w-ki/	3OBJ-buy.PRT-PRET	's/he/it bought it'

(Aguilar 2020)

These spirantized alternants found in ChN and other varieties are of interest here because of the laryngeal component. Both [ɬ] and [h] realizations of /l/ and /w/ involve a higher air turbulence than their voiced counterparts, and perceptually overlap with other sounds with distinct underlying forms. A ChN speaker who hears an [h] in the speech stream might map the surface form to underlying /h/, /n, m/, or /w/. The spirantized lateral [ɬ] also introduces its own ambiguity. Onset sonorants tend to devoice after an [h] in ChN: a sequence such as /hl/ is realized as [hl̥]~[hɬ] such as [ihɬia] /ihlia/ 'to say'. In addition, sequences of /l͡tɬ/ are realized as [ɬ:] e.g., [t͡ʃil̥:akʷat͡sih] /t͡ʃil-t͡ɬakʷa-t͡sin/, 'food with a lot of chile'. Both patterns result in a voiceless lateral onset. It is not difficult to imagine possible reanalysis of any of these /l/ realizations encountered in the speech stream as corresponding to an /hl/ phonological representation. In fact, I have seen contemporary speakers write "hl" in informal writing (*i.e.* on social media) for an "l" in a coda position.

KL reference the generalized pattern of syllable-final sonorants weakening in Nahuatl, but contend that only the glottal stop provides the phonological motivation for hypercorrection with a nasal. However, it seems laryngeals broadly correspond to intrusive nasals. The patterns for coda sounds directly relate to the process for nasal intrusion as KL note that "intrusion of *l* and *uh*" (KL 1976, 382) also occurs in the contexts for nasal intrusion. It seems clear then that it is the relationship between breathiness and the phonological alternations with nasal sounds, /l/, and /w/ that are the source for a number for the intrusive nasals. The fact that "uh/hu" and 'l' intrusion occurs in the same contexts as nasal intrusion in KL's analysis

points to phonological distributions like that of ChN where [h] from /n,m,w/ and [ɬ] from /l/ all share being breathy sounds. Let us now turn to a final piece to this complex laryngeal landscape is glottalization.

Prosodic glottalization in ChN

In many varieties of Nahuatl, there is typically one contrastive laryngeal sound. In the central varieties like Milpa Alta (Whorf, Campbell, and Karttunen 1993), Nauhpan (Brockway 1963 and 1979) and reconstructed for *classical* Nahuatl, it is glottal stop /ʔ/. In a great number of varieties —ChN, Río Balsas (Guion *et al*. 2010), Huauhtla (Kimball 1990), Hueyapan (Campbell 1976), Ixquihuacan (Sasaki 2014), Matlapa (Croft 1951), Orizaba (Goller, Goller and Waterhouse 1974; Campbell 2011), Pómaro, Michoacán (Sischo 1979), San Agustín Buenaventura (Canger 2000), Tetelcingo (Pittman 1954, Tuggy 1979), Tuxpan (Valiñas 2013), Zacapoaxtla (Key and Key 1953, Robinson 1969), among others—, this sound corresponds to the glottal fricative /h/ such that there are correspondences across varieties between words like [paʔt͡ɬi] ~[paht͡ɬi], 'medicine'. There are at least two varieties reported to have contrastive /h/ and /ʔ/ including Cuentepec (Velázquez Patiño 2014) and Mecayapan (Wolgemuth 1969, 2007). Even in varieties where there is no evidence that [ʔ] is a contrastive sound, there are a number of predictable prosodic contexts in which glottalization occurs. In ChN, glottal stop is not a contrastive segment. Nonetheless glottalization occurs at the prefix-stem boundary, stem-stem boundaries, hiatus contexts and in pre-pausal contexts (Aguilar 2020). This laryngeal articulation can range from realization as a canonical glottal stop to a period of aperiodicity (irregular pulsing) during phonation. This is expected given that glottalization has variable realization cross-linguistically (Pierrehumbert and Talkin 1992; Garellek, Ritchart and Kuang 2021; Garellek 2022). For clarity, glottalization is transcribed here using [ʔ].

In ChN, prosodic glottalization occurs with variable frequency within the word. Pre-pausal glottalization is a more obligatory pattern. I will briefly demonstrate these distinct types of glottalization, beginning with glottalization sensitive to morphological structure. Glottalization at morphological junctures in ChN occurs at the prefix-stem boundary. It never occurs at the stem-suffix boundary —e.g., 21) below.

21) nimit͡s̲ʔa:mati
/ni-mi͡t͡s-a:mati/
1SUBJ-2OBJ.SG-like
'I like you'

(Aguilar 2020)

Similarly, glottalization occurs in hiatus contexts at morphological junctures 22). Note that glottalization occurs most frequently with homorganic vowels, but also occurs regularly in other hiatus contexts.

22) a. t͡ɬaʔa:meja
/t͡ɬa-a:-meja/
NS.OBJ-water-flow
'water flows from the ground'

b. moˈʔita
/mo-ita/
REFL-see
'sees him/herself'

(Aguilar 2020)

Glottalization also occurs in hiatus contexts across word boundaries 23).

23) ki:hɬihki ʔinana
/ki-ihlih-ki# i-nana/
3OBJ-say.PRT-PRET# 3POS-mother
's/he told his/her mother'

(Aguilar 2020)

As 21)-23) show, within a single utterance in ChN, there will be many possible laryngeal articulations, both contrastive (*i.e.* [h]) and prosodic (glottalization).

In ChN, glottalization also occurs at pauses in natural speech —pauses may align with prosodic boundaries. Utterance-medially, glottalization is typically realized as a canonical glottal stop. Utterance-finally, this prepausal glottalization is realized as a canonical glottal stop after vowel-final words with an audible release. The examples in 24) show that glottalization is not a lexical sound associated with the word [t͡sikt͡ɬi], 'gum', or [kʷa:], 'chew', but rather an articulation associated with the end of the utterance.

24) ‘My younger sibling chews gum daily’ with and without noun-incorporation

a. not͡ʃot͡ʃo mohmost͡ɬa kikʷa: t͡sikt͡ɬi?
/no-t͡ʃot͡ʃo moh~most͡ɬa ki-kʷa: t͡sik-t͡ɬi/
1POS-younger.sibling RED~tomorrow 3OBJ-chew gum-ABS

b. not͡ʃot͡ʃo mohmost͡ɬa t͡sihkʷahkʷa:ʔ
/no-t͡ʃot͡ʃo moh~most͡ɬa t͡sik-kʷah~kʷa:/
1POS-younger.sibling RED~tomorrow gum-RED~chew

(Aguilar 2020)

When the utterance-final word is consonant-final, glottalization is realized as aperiodicity during phonation on the final vowel(s) —the context determines the realization as aperiodicity (consonant-final) or glottal stop (vowel-final). Vowel-final utterance-final context glottalization seems to be obligatory, while variable in its overt realization in the consonant-final utterance-final context (Aguilar 2023). Huauhtla (Kimball 1990), Hueyapan (Campbell 1976), Ixquihuacan (Sasaki 2014), Orizaba (Goller, Goller and Waterhouse 1974), Sierra Nahuat (Key and Key 1953), Sierra Puebla (Robinson 1969), Tuxpan (Cuauhtli 2022), and Matlapa (Croft 1951) are all described as having both a contrastive [h] and some form of phrase/word-final glottalization. Descriptions generally focus on the vowel-final context which makes sense since glottalization is most salient there.

There are two other issues to note here regarding utterance-final glottalization in ChN. First, this glottalization seems to behave like a suprasegmental feature, moving leftward to the penultimate and even antepenultimate syllable in cases where the final syllable(s) is devoiced (Aguilar 2020, 2023). Thus, glottalization, can occur in multiple places in an utterance-final word —glottalization at prosodic boundaries as well as from pre-pausal glottalization on the ultimate, penultimate and antepenultimate syllables.

A key context is the utterance-final position where both pre-pausal glottalization and glottal fricatives can be specified to cooccur. In ChN, an utterance like /ki-ita-h/, ‘they see it’ (quiittah), is produced as [kiʔitaʱh], [kiʔita:], [kiʔitaˀ], or [kiʔitah (versus /ki-ita/, ‘s/he/it sees it’ [kiʔita**a**ʔ] with a canonical glottal stop). In addition, ChN data show that the hiatus resolving glottalization described above in 23) can also overwrite glottal fricatives

utterance medially: [noˈtata ʔiˈmilah] /no-tatah# i-milah/ 1POS-father# 3POS-field 'my father's field'. The expected form [notatah] is produced as [notata] in the context of the glottalization. It is likely that some of the omitted nasals observed by KL reflect the interaction between lexical glottal fricatives and prosodic glottalization.

Laryngeals in ChN are complex and present an interesting piece to the puzzle of intrusive nasals. It seems likely that most varieties of Nahuatl exhibit some amount of laryngeal complexity beyond the presence of a contrastive laryngeal sound. Let us look at one example, Milpa Alta Nahuatl, which gives insight to the relationship between glottal stops and nasality. Whorf describes 1930s Milpa Alta Nahuatl of Mexico City as having only one laryngeal, transcribed as *'h,* which mostly occurs in the coda position (Whorf, Campbell and Karttunen 1993). Whorf describes a strong or aspirated release. He also describes the glottal sound as preaspirating the following consonant; *i.e.* [notaʔhtsi̥n] 'my father' (p. 175). In a recent paper, Hejná (2023) showed that the fortis contrast in Welsh English was not only marked with preaspiration, but also preglottalization in some cases, as well as with both in other cases demonstrating that glottalization and aspiration are not necessarily exclusive. Perhaps what Whorf observed in Milpa Alta was inverse to Welsh English where the specification for a laryngeal sound could be realized as glottalization as well as glottalization with a period of aspiration, and perhaps solely aspiration (*i.e.* [h]) as in other varieties of Nahuatl. In both the Nahuatl and Welsh English cases, the contrast is maintained by something laryngeal. Whorf contrasts the *'h* articulation with what seems like preglottalization of geminates; *i.e.* [iʔta] or [iˀtːa], 'to see' (p. 176) (*cf.* ChN [ita]). This point of comparison in Whorf's description suggests that varieties with the phonemic /ʔ/ (rather than /h/ like ChN) most likely also have additional laryngeal articulations associated with prosody or the phonetic implementation of other contrasts such as the geminates above. Thus, forms like 18f), *yntonca*, where the first intrusive nasal corresponds to the site of prosodic glottalization found in ChN (at morpheme boundaries), might have been produced with a breathy release as described for Milpa Alta and be the source of the intrusive nasal.

ChN and other contemporary varieties of Nahuatl feature both glottalization and aspiration in some form or another. Let us now explore the relationship between laryngeal sounds and intrusive nasals.

Laryngeals and nasals: rhinoglottophilia

In the first part of this section, I demonstrated how the phonological alternations between a glottal fricative and nasal stops in ChN gives insight into one of the types of nasal intrusions. Here, I explore KL's observations and discuss the relationship between laryngeal sounds and nasal sounds.

KL hypothesize that there were two types of nasality in Nahuatl: one corresponing to the contrastive sounds in the language, and the other a "constant suprasegmental feature of all vowels stemming from nondistinctive leakage of air through the velum" (KL 1976, 382) —in other words, KL hypothesized that vowels were generally nasalized in Nahuatl. In their explanation, the fact that there were weakened syllable-final nasals, combined with a general nasal quality to segments not specified to be nasal lead to instability of nasals in Nahuatl, creating the context for the colonial *tlacuilo* to be unsure when to include an *n* in the written form. While this is a possibility, it alone cannot account for the fact that intrusive nasals, in their own description, seem systematic. Were this the only factor responsible for intrusive nasals, then one would expect to find them anywhere and everywhere there was a somewhat nasalized vowel. Their list of contexts for nasal intrusion is long, but still constrained. Instead of a suprasegmental velar leakage, I argue that the relationship between laryngeal sounds and nasality cross-linguistically, is a more likely explanation for intrusive nasals.

I begin with the phonologized pattern in ChN in which the phonetic [h] has multiple phonological representations (/h,n,m,w/) with an additional source of breathiness from [ɬ]. These patterns specifically point to the relationship between nasality and breathiness in the acoustic signal. The diachronic and synchronic relationship between nasality and breathiness has been called "rhinoglottophilia" (Matisoff 1975; Blevins and Garrett 1993; Igartua 2008; *inter alia*), applied to cases in which nasal segments developed from aspirated ones, or conversely, where glottal fricative segments developed from nasal segments. Oft cited examples include British English [hɑ̃ːvəd] 'Harvard' as a synchronic example, where nasalization is associated with the breathiness of [h]; and Hindi [sə̃p] 'snake' from Sanskrit *sarpa* as a diachronic example where nasality is associated with the breathiness of [s] (Ohala, 1980). With respect to nasality and breathiness, their acoustic correlates are quite similar, despite arising from distinct articulations. Both, for example, have been shown to have a weaker first

formant (lower amplitude) and therefore increased spectral tilt (H1*-H2*) relative to oral vowels/modal voicing: from of velopharyngeal coupling in the case of nasality (Chen 1997; Maeda 1993; Stevens 2000; Simpson 2012), and a larger open quotient of vocal fold vibrations in breathy phonation (Bickley 1982; Klatt and Klatt 1990; Garellek and Keating 2011; *inter alia*). In addition, both nasal and breathy vowels share an increased first formant bandwidth and a stronger first harmonic (Chen 1997; Simpson 2012; Styler 2015), and are characterized by an increase in amplitude of lower frequency energy (Stevens 2000; Gordon and Ladefoged 2001; Garellek and Keating 2011). Moreover, breathiness has been shown to be able to function as an enhancement strategy for nasality in both nasal vowels and consonants (Garellek, Ritchart, and Kuang 2016) —that is, breathy phonation during a nasal vowel or consonant can heighten the perception of nasality for the listener. Warekena (Maipuran) provides an interesting example of how nasality and breathiness cooccur. Utterance-medial and final pauses are marked with a final-h segment along with a nasalized copy vowel: /-hṼ/. Following Garellek, Ritchart, and Kuang (2016), we can posit that the nasalization on the copy vowel enhances the breathiness of the [h] marking the pause in the utterance.

The relationship between nasality and glottalization is less straightforward. Breathiness and glottalization have been modeled as being on opposite ends of Ladefoged's Continuum model of glottal states (Gordon and Ladefoged 2001). Evidence such spectral tilt (H1*-H2*) seem to support this difference between glottalization and breathiness. Breathiness has been shown to have a higher spectral tilt (H1*-H2*) and glottalization lower as compared to modal phonation (Garellek 2015). Also, glottalization is associated with aperiodicity in f0, while breathiness is not. Nonetheless, there are cases in which there seems to be a relationship between nasality and laryngeal stricture. For example, in Thai, vowels have been shown to nasalize without a nasal antecedent after glottal fricatives and to a lesser degree after glottal stops (Matisoff 1975, Johnson *et al*. 2019). Similarly, Ulrich (1993, 439) notes that glottal stops have an affinity for nasalized vowels in Chickasaw, occurring "disproportionately" after nasalized vowels. As a Nahuatl-specific phenomenon, glottalization and breathiness are connected. In ChN, utterance-final glottalization is realized as a canonical glottal stop, followed by a breathy release. In the acoustic signal, an utterance-final phrase like [ne t͡ʃit͡ʃi] 'that dog', could be narrowly transcribed as [ne t͡ʃit͡ʃiʔh]. This parallels Whorf's description of Milpa Alta Nahuatl /ʔ/ which is tran-

scribed as *'h* to express the aspirated portion after the glottal stricture (Whorf, Campbell, and Karttunen 1993). Whorf includes glottal stop as part of the class of sounds along with /p, t, k/, which are strongly aspirated. In ChN, /p, t, k/ are also aspirated consonants and would be narrowly transcribed as [pʰ, tʰ, kʰ] —this especially salient in the word-final position. Interestingly, in Milpa Alta, Whorf describes expected /ʔ/ in the word-final position to be weakened or surface as *h* or ʰ (which perhaps indicates a weak [h]) that attaches itself to the following vowel-initial word (onset maximalization), suggesting that in Milpa Alta, at least, glottalization and breathiness can occupy the same place. Perhaps specification is not for glottal adduction nor abduction, but rather, broadly laryngeality that is generally realized as [ʔh] but sometimes [ʔ], [h], or weaker forms of either, along the lines of the Welsh English pre-glottalization/aspiration example (Hejná 2023).

We have already seen a context noted by KL, 18c), where nasal intrusion corresponds to an expected laryngeal sound. The relationship between breathiness, glottalization, and nasality in Nahuatl suggests that the presence of prosodic glottalization as well as various sources of aspiration (e.g., neutralization/ debuccalization of consonants, spirantization of sonorants, and complex glottal consonants [ʔh] such as in Milpa Alta Nahuatl, and aspirated voiceless stops), may together help account for the multitude of nasal intrusion contexts. Let us now return to the unaddressed contexts for nasal intrusion observed by KL summarized in 18) above.

One possibility is that the increased number aspirated/laryngealized articulations in a single word might have compounding effect on the acoustic properties of breathiness such that the *tlacuilo* perceived nasality and thus included an orthographic *n*. For example, 18a) the expected form *quimatican*, 'let them know', is instead *quimatincan*. In phonology like ChN, a narrow transcription would be [kʰimatʰikʰah]. It is possible that nasal intrusion occurs here in a context sandwiched between an aspirated consonant and a very breathy syllable. The overall effect of this sequence of aspirated articulations could work together to misguide the perception of nasality.

An alternative account is that intrusive nasals in the orthographic representation do not necessarily reflect a mistaken nasality but rather, simply the perception of breathiness. Since [h] in a variety like ChN often corresponds to two orthographic representations in colonial orthographies: *n* in the case of underlying nasals and zero graphemic representation in the case of underlying /h/. In this account we can imagine the *tlacuilo*, inter-

preting the aspiration/breathiness in the speech stream and having to decide if it should be represented orthographically with an *n* (or even *l* or *uh*) or not represented at all.

We have already addressed the final intrusive *n* in *sintiyon,* 'site' 18f), as possibly coming from the common pattern of adding an [h] to vowel-final loanwords. The first intrusive *n* here seems to occur in a similar context as the [sãp] Hindi example. Here the aspiration of the [s] combined with the overall breathiness of rest of the word [sitʰʲoh] might have also resulted in minimally the perception of breathiness if not the perception of nasality, either of which to be represented by an orthographic *n*. *Ytoca*, 'his name', occurring as *yntonca*, also in 18f), provides a similar context. In ChN, this word is [itʰokʰah]. The final [h] in ChN [itʰokʰah], 'her/his name', like other words such as [imah], 'her/his hand', correspond to forms in Classical Nahuatl with an *i* such as *tocaitl*, 'name,' and *maitl*, 'hand'. While not represented in the orthography, it is likely that the form in classical Nahuatl also had a final laryngeal sound, moreover, vowel-initial words are candidates for prosodic glottalization in ChN. Again here, the multiple sources of laryngeal sounds could have been the source of the intrusive nasals in the written form: [ʔitʰokʰah] represented as *yntonca*. The fuller phrasal context of the tokens described by KL would be useful here.

The second example in 18a) *palpan tlanca* from the expected *palpan tlaca*, 'Palpan people', also likely had a glottal fricative that was not systematically represented in the orthography. In some varieties, the plural of *t͡ɬakat͡ɬ* man/person is *t͡ɬakah.* Here, we may have an example of metathesis as identified in 18b), only in this case metathesis of a glottal fricative, represented as an *n.* Were this historical token pronounced in the ChN phonology, it would be [pʰałpʰah t͡ɬakʰah] (*cf.* ChN [t͡ɬakameh]). In this case not only are there a number of aspirated consonants in the word, there is also a final glottal fricative that the *tlacuilo* would have had to decide whether to represent it in some way or another. Following this theme of metathesis, KL suggest that the forms *ynpa* from *ypan*, 'on it', and *Teohuanca* from *Teohuacan* (place name) reflect methathesis of a nasal segment from an adjacent syllable. Metathesis here may also have been motivated aspiration on stops combined with some of the nasal realizations described above: [n̥]~[h]~[Ṽ]. All would potentially have the perceptual effect of leftward movement of the acoustic properties associated with an *n* in the orthography. The combined breathiness of the aspirated release of the stop combined with either [n̥]~[h] (e.g., [ipʰan̥]~[ipʰah], [tʰeowakʰan̥]~[tʰeowakʰah])

could have either inspired the *tlacuilo* to represent the breathiness with an *n* earlier in the word, or alternitively have resulted in the percepts of nasality earlier in the word to be represented by an *n*. Similarly, the loss of a final segment through nasal absorption would have moved the nasal articulation closer to the stop (e.g., [ipã], [tʰeowakʰã].

Two additional examples in 18d) seem to be the result of a different process than what I have described above. KL described intrusion as occurring before "nonnasal resonants". The unexpected nasal in *manyor* may reflect nasality spreading across the syllable from the initial *m*. On the other hand, *onpohuanlli* from *onpohualli*, '40', seems to be accounted for by the pattern of preaspiration found in some dialects such that /l͡tɬ/ sequences surface as [hlː]. In these cases, the preaspiration might have been interpreted as a sound to represent with the letter *n* or created the percept of nasality. In the case of *chicueponhualli* from *chicuepohualli*, '160', there is no straightforward account. Perhaps in the context of both preaspiration of the *ll* sequence and the aspirated release of the /p/, the percepts of nasality were created, or at least the precepts of breathiness. For these examples, a possible variable is vowel height. In Thai, spontaneous nasalization following both glottal fricatives and glottal stops occurs more often with mid and low vowels, and may be the result of lower resting position of the velum in the production of these vowel qualities (Johnson *et al*. 2019).

In addition, glottalization emerging from phrasal structure might also have contributed to some of the intrusive nasals, especially since some glottal stops (*i.e*. those of Milpa Alta) are described as being accompanied by aspiration. Taken with the pattern observed in ChN, where glottalization can move leftward to the nearest voiced syllable, it is possible that some of the harder to explain cases reflect prosodic glottalization and something about the phrase structure, especially in the cases described as occurring less frequently. However, without knowing the phrase structure in which the examples given by KL were in, it is impossible to know if this had an effect. One example suggests that this nonetheless could have been a factor in some of the intrusive nasals. In 18e) KL note that a common site of nasal intrusion is "finally." The example given is *niquitohuan* from the expected *niquitohua*, 'I say'. I suspect that the intrusive nasal here corresponds to a laryngeal articulation associated with the pre-pausal context. For example, in the *Testaments of Culhuacan* (Cline and León-Portilla 1984), both forms, *niquitohua* (293 instances) and *niquitohuan* (36 instances), 'I say', are found. In most cases they occur in the same context: at the beginning

of a declaration with the formulaic phrase *Ihuan niquitohua(n)*, 'and I declare', followed most often by a subordinate clause introduced with *yn*. It is plausible that in the phrasal structure of the text analyzed by KL, that a pause in the spoken form could align and be accompanied by some form of glottalization as in ChN —perhaps realized like the Milpa Alta [ʔh]. In the example below, the unexpected *n* at the end of *niquitohua* in the sentence below from the *Testaments of Culhuacan* might align with pre-pausal glottalization that the *tlacuilo* perceived as a segment to be represented with *n:* "–yhuan niquitohuan yn nocaltzi yn onpa ycac yn tiyanquiztenco tonatiuh yquiçayanpa ytzticac monamacaz. 'And I declare that there is a house of mine in Tianquiztenco which faces east'" (Cline and Portilla 1984, 23).

Finally, a possibility is that some of the intrusive nasals reflect local variants not widely attested in other documents or varieties. One such example is the observation of *nehuantl,* 'I' (KL p. 380), from the expected *nehuatl*. While most attestations of the first-person singular pronoun do not feature an additional nasal, there is at least one that does. From a 1598 document from Temascalapan (Rojas Rabiela, Rea López and Medina Lima 1999), the form "*nehuantli notoca don Francisco Ximenes*" is given, very similar in form to *nehuantl*. Similarly, Melton-Villanueva (2016) notes that *Nehuatli* was the preferred form used in the valley of Toluca. Here we can posit the presence of a laryngeal consonant as the *-tli* absolutive is used but no consonant is represented in the consonant cluster (similar to cases like *patli* [pahtl͡i]~[paʔtl͡i]). In these two variants, *nehuantli* and *nehuatli*, KL's observed intrusive nasal in *nehuantl* corresponds to either a laryngeal or nasal sound. Interestingly in ChN, one of the forms of the first-person singular pronoun, [nahwa], also contains a laryngeal sound.

In 25) below, I summarize the insights from ChN and other Nahuatl varieties that can help account for patterns of nasal intrusion identified by KL (in 18) above).

25)	*Contexts for intrusion*	*Insights from ChN or other Nahuatl varieties*
	a. Word-initially after *n*	Resyllabification
	b. expected [ʔ] 18c)	Likely [h] —either overlap in representation of [h] with *n* or the percept of nasality.
	c. Finally in loans 18f)	Reanalysis from final [h].

d. Before consonants 18d) and 18f)	Spirantization of coda sonorants reanalysis as [h] for nasals, but also *l* and *uh*.
e. Morpheme boundaries 18f)	Prosodic glottalization
f. In a breathy context 18a) and 18d)	Compounding breathiness from adjacent sounds.
g. Finally 18e)	Prosodic structure and glottalization [ʔh]
h. Nehuantl (p. 380)	Less common variants.

Concluding remarks

In this paper I have expanded the discussion of Nahuatl nasals initiated by KL's 1976 squib. Their methodology was a point of departure to expand the comparative survey of modern Nahuatl varieties, with particular focus on my work on the phonetics and phonology of ChN. The relationship between nasal and laryngeal sounds, both in Nahuatl and cross-linguistically, can account for the seemingly erratic occurrence of nasals in the colonial text analyzed by KL and contributes to our understanding of the phonologies of varieties behind colonial era texts and their orthographies. While none of the explanations argued for here can be definitive, especially given the few examples provided by KL, it is my hope that this discussion demonstrates the relevance that detailed phonetic and phonological research on contemporary varieties has on our interpretation of colonial texts and to our understanding of the landscape of grammatical possibilities within the Nahuatl language across time and space.

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