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Phonology and phonetics of laryngeal sounds in Chicontepec Nahuatl

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy

in

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by

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2020

The dissertation of Andrés Ehecatl Aguilar is approved, and it is acceptable in quality and form for publication on microfilm and electronically:

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DEDICATION

Nicmactilia ni tlahcuilolli pilaltepetzin tlen Nahua
huan nochi pilaltepetzitzin tlen macehualmeh pan ni tlaltipactli.
Notequiuh yohui ica noteqixmatcahuan, nomihtotiliz, nopilaltepeuh,
nohuahcapanhuan huan tlen yancuinih,
nouhquiya ica noDanteh.

Dedico esta tesis a la comunidad Nahua
y las comunidades indígenas de este continente.
Mi esfuerzo ha sido para mi familia, mi danza, mi comunidad,
mis antepasados y las futuras generaciones,
y sobre todo, para mi Dante.

This dissertation is dedicated to the Nahua community
and the indigenous communities of this continent.
My work is for my family, my *danza*, my community,
my ancestors and future generations,
and especially, for my Dante.

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LIST OF ABBREVIATIONS

1	first person
2	second person
3	third person
ABS	absolutive
ADJ	adjectival
ADP	adposition
ADV	adverbial
AUX	auxiliary
C	consonant
ChN	Chicontepec Nahuatl
CIRC	circumfix
COND	conditional
CONJ	conjunction
DEM	demonstrative
DIM	diminutive
DIR	directional
f0	fundamental frequency
FUT	future
G	glide
HOBJ	human object
IMP	imperative
IMPRF	imperfect
INAL	inalienable possession
INDEF	indefinite object
LOC	locative
N	nasal
NEG	negation
NOM	nominalizer
OBJ	definite object
PAUS	pausal
PERF	perfective
PL	plural
POS	possessive
PRET	preterit
PRO	pronoun
PROG	progressive
PRT	preterit stem allomorph
RED	reduplicant
REFL	reflexive
SUBJ	subject
SG	singular
V	vowel
VRB	verbalizing suffix

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This dissertation would not have been possible without the help of so many people. I am forever grateful to them for their generous contributions and support. I would like to begin by respectfully acknowledging that I live, work, and have completed much of this dissertation on the land of the Kumeyaay/Kumiai nation.

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taught me so much as teachers and linguists and have been an inspiration for how I approach my own research, writing, and teaching. Since my first summer at UCSD, Gaby has encouraged and fostered my dedication to fieldwork. She has been a role model for me through her inspiring work on Rarámuri and Kumiai, as well as her role as my supervisor in teaching. My courses with Marc forever expanded my research interests into the fascinating realm of phonetics, fomenting my interest in laryngeal sounds. Marc has equally been a role model for me through his inspiring research—I have learned so much about acoustic analysis and laboratory and experimental methods. Thank you, Gaby, thank you, Marc, for your patience, guidance, mentorship, encouragement and inspiration along this journey. Eric Baković has, since I first visited UCSD, always been enthusiastic, generous and supportive of my research and development. As has Sharon Rose, who along with her enthusiasm, generosity and support, also imparted many key insights on fieldwork. John Haviland has also shaped this dissertation with his invaluable perspective, reminding the anthropologist in me of the importance of sociolinguistic and interactional issues. I am grateful to you all for your extremely helpful input.

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ABSTRACT OF THE DISSERTATION

Phonology and phonetics of laryngeal sounds in Chicontepec Nahuatl

by

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Doctor of Philosophy in Linguistics

University of California San Diego, 2020

Professor Gabriela Caballero, Co-Chair
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One of the principle goals of linguistics is to understand the structure of language: what are the different domains of grammar, and how do they interface and interact? This dissertation addresses these questions through the lens of laryngeal sounds in Chicontepec Nahuatl (ChN), a Uto-Aztecan language. I show that laryngeal sounds arise in distinct domains of the grammar (i.e. lexical and postlexical phonology, and morphology) and that these laryngeal sounds can cooccur with one another. This dissertation documents and describes the multiple sources of laryngeal sounds in ChN through original field data and provides a detailed acoustic analysis of the phonetic implementation of these sounds.

ChN has a rich laryngeal landscape in which [h] is contrastive (/h/) but also derives from neutralizing lenition processes; [h] also features in templatic and realizational morphology and forms the single exponent of morphological constructions. There is also glottalization that is sensitive to morphological boundaries and larger prosodic domains. I argue that phrase-final glottalization is a suprasegment that moves inward from the phrasal edge to the nearest available anchor point when the expected phrase-final vowel is voiceless—a behavior documented for edge tones but not previously for laryngeal articulations.

The phonetic outcome of cooccurring laryngeal sounds, where both [h] and glottalization are specified to occur, sheds light on the interactions of grammatical domains and cost of reduction to morphological meaning. Findings suggest glottalization is sensitive to derivational lexical information: it is realized more strongly when co-occurring with an underived [h]. There is also an effect of cost of reduction: glottalization is less likely to occur when [h] reduction might carry a high cost. Finally, the distribution of laryngeals in ChN is situated within the larger language. This dissertation deepens our understanding of the phonology and phonetics of an under-described variety of Nahuatl, of the Nahuatl language and the Uto-Aztecan family more generally, and of indigenous languages of the Americas.

Chapter 1 Introduction

1.1 Topics and Scope

One of the principal goals of linguistics is to better understand the structure of language: what are the different modules of the grammar, and how do they interface and interact? In this dissertation I address these questions from the point of view of laryngeal sounds in Nahuatl—particularly in Chicontepec Nahuatl (ChN), a Uto-Aztecan Language spoken in Veracruz, Mexico, as well as in diaspora communities in Mexico and the United States. My overarching claim is that laryngeal articulations (in this language, as well as in other varieties of Nahuatl and more generally across languages) can arise at different levels of the grammar, i.e. from phonological, morphological and post-lexical prosodic domains. Moreover, because grammatical structure can have effects on phonetic implementation (Fougeron & Keating 1997, Xu & Xu 2005, Nespor & Vogel 2007, Lee-Kim et al. 2013, inter alia), I also show how different domains of grammatical structure influence the phonetic properties of laryngeal articulations.

The goals of this dissertation are the following: to document and describe the multiple sources of laryngeal sounds in ChN through original data collected in the field, and to provide a detailed acoustic analysis of the phonetic implementation of these sounds. As I show in this dissertation, laryngeal sounds arise in distinct domains of the grammar, and these sounds can cooccur. In the phonological analysis, processes of lenition and debuccalization, neutralization, and prosodic glottalization are described. In addition, these laryngeal sounds contribute differing degrees of unique morphological meaning. The relationship between the grammatical status of laryngeal sounds and their phonetic

realization is explored in contexts where these sounds cooccur. The third goal of this dissertation is to relate the laryngeal patterns found in ChN to similar phenomena documented across Nahuatl varieties. Finally, I document an acoustically under-described[1] contemporary variety of Nahuatl in order to contribute to our understanding of the phonology and phonetics of Nahuatl, Uto-Aztecan languages, and more broadly, indigenous languages of the Americas.

In this introductory chapter, the properties of laryngeal sounds, the language under study, and my teachers are introduced followed by the overall structure of this dissertation. In section 1.2, I discuss the unique properties of laryngeal sounds, providing a foundation for the questions addressed in the dissertation. In section 1.3, I introduce some details about Chicontepec Nahuatl, situating this variety within the Uto-Aztecan language family and Nahuatl varieties. In section 1.4, I introduce details of my *tlamachtianih*, my teachers, who graciously shared their time to teach me about their language and traditions. Finally, in section 1.5, the focus and topic of each of the chapters in this dissertation are described, previewing the empirical findings in each of the chapters.

[1] There have been many recent efforts to document, describe, and teach Huasteca Nahuatl by native speaker scholars, especially at the Instituto de docencia e investigación etnológica de Zacatecas (IDIEZ) associated with the Autonomous University of Zacatecas (UAZ). One such example is the monolingual Nahuatl Dictionary *Tlahtolxitlauhcayotl* (Sullivan et al. 2016).

1.2 Laryngeal sounds

Laryngeal sounds are peculiar for various reasons. While they can act as independent speech segments [h] and [ʔ], they can also comprise the secondary articulation of a segment, such as when a sound is aspirated or glottalized. This property is not unique to laryngeal sounds—non-oral sounds like nasals and pharyngeals frequently behave this way as well. Laryngeal articulations can also facilitate the production of a contrast. For example, low tones are often produced with creaky voice, presumably because the increased laryngeal constriction that occurs for creaky voice facilitates the production of a low pitch target (Garellek et al. 2013, Kuang 2013). They are also involved in the control of airflow of all speech sounds, such as vocal fold spreading to facilitate higher airflow for voiceless fricatives (Sawashima & Hirose 1983, Ladefoged & Johnson 2015, Löfqvist 1990, Gracco & Löfqvist 1994) or glottal stricture associated with the articulation of voiceless (especially unaspirated) stops (Löfqvist & Yoshioka 1981, Flege 1982, Harris 1999).

A major challenge with disambiguating the origin of laryngeal articulations in the grammatical system is that they have variable production and are often realized non-canonically (Pierrehumbert & Talkin 1992). In cases where laryngeal sounds do have segmental status, because they are not articulated orally (like nasality and pharyngealization), breathiness or glottalization can spread to adjacent sounds, or the sounds can be realized with variable phasing with respect to oral sounds (Borroff 2007). By using in-depth phonological analysis to determine the grammatical source of different laryngeal articulations in ChN, the complex functions of laryngeal sounds in a single phonological system is demonstrated.

In this dissertation, I investigate the laryngeal landscape of ChN specifically because Uto-Aztecan languages, like many languages of the Americas, are rich in laryngeal sounds. Across the language family, glottal stops, glottal fricatives, (pre-)glottalized and (pre-)aspirated consonants feature prominently in the phonological inventories of these languages (Saxton 1963, Hill & Hill 1968, Dedrick & Casad 1999, Elzinga 2003, Miller et al. 2005, Caballero 2011, Haugen 2014, inter alia).

The distribution of laryngeal sounds within a grammatical system is analogous to the more familiar case of tone and intonation. Much work has looked at the cross-linguistic interaction between lexical tone and intonation as well as between lexical tone and morphosyntactic tone. These investigations seek to understand possible accommodation strategies between different levels of the grammar in languages that use pitch to encode a contrast (Anderson 1983, Beckman & Pierrehumbert 1986, Hyman 1988, Hyman 1999, Gussenhoven 2004, Jenks & Rose 2011, Caballero & Carroll 2015, Palancar & Léonard 2016, inter alia). For example, in Choguita Rarámuri there is contrastive lexical tone: a three-way contrast between a high tone (H), a low tone (L) and a falling (HL) contour tone. In addition to lexical tone, there is morphosyntactic tone. For example, a tonal target is the single morphological exponent of the imperative construction (Caballero & Carroll 2015). There are also phrase-level boundary tones and prosodic rhythmic tones that interact with lexical and morphological tone in the utterance (Garellek et al. 2015). It is also known that when tonal specifications arising in different domains of the grammar cooccur, the outcome of that overlapping (or "stacked" context as I use in this dissertation) is determined by the grammar (e.g., downstep, upstep, contour tone, deletion, etc.). An example from Choguita Rarámuri is found in (1) below.

1) The “stacking” of lexical and morphosyntactic tone in Choguita Rarámuri

L (imp.) morphosyntactic tone

~~HL~~ lexical tone

/m a ˈt o/

‘carry it (on shoulders)!’

In the example presented in (1), the word *matô* ‘to carry on one’s shoulders’ has a HL lexical tone on the final syllable. However, a L tone is associated with the imperative construction. In this context, the possible logical outcomes include one of these two tones being over-written by the other, or both tones could be realized in a LHL contour tone, or a downstepped HL↓L. In, fact in Choguita Rarámuri, the outcome is that only the morphosyntactic tone surfaces. In this dissertation, a similar distribution of laryngeal sounds, arising from distinct domains of the grammar is demonstrated in ChN. Such a context of “laryngeal stacking” is shown below in (2). Then, the outcome of “laryngeal stacking”, contexts in which these laryngeal sounds cooccur, is addressed in an acoustic study.

2) The “stacking” of Laryngeal sounds in ChN

ʔ domain-final glottalization

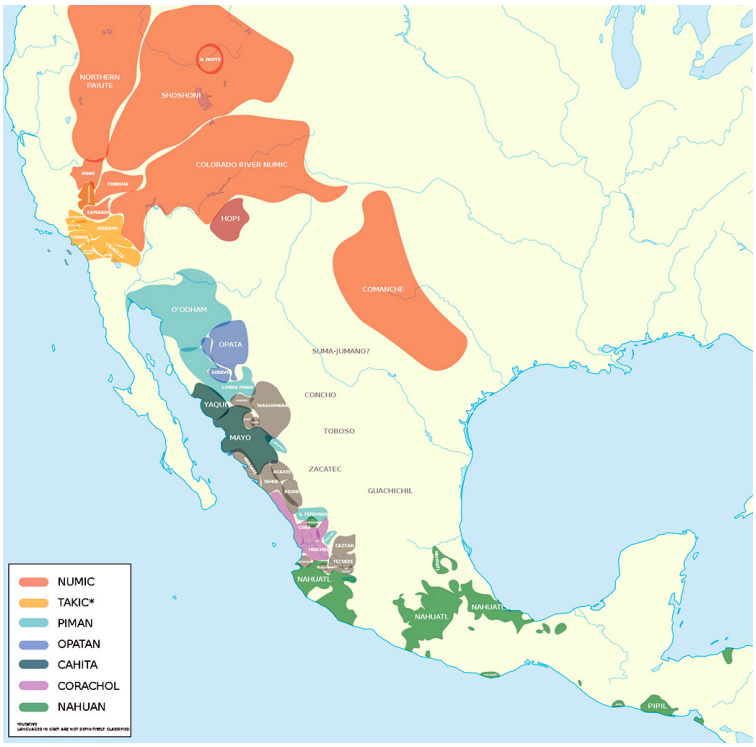
-h morphological glottal fricative

/ki-mama- /

‘they carry it (on their backs)’

1.3 Chicontepec Nahuatl

Chicontepec Nahuatl belongs to the southernmost branch (Aztecan/Nahuan) of the Uto-Aztecan language family. More than sixty varieties of Uto-Aztecan are still spoken in its vast territory that goes from the Great Basin area in North America to Central America. By number of languages, Uto-Aztecan is the largest language family of the Americas (Miller 1983, Campbell 1997, Mithun 1999). The Map in Figure 1 below shows the geographical distribution of Uto-Aztecan Languages.

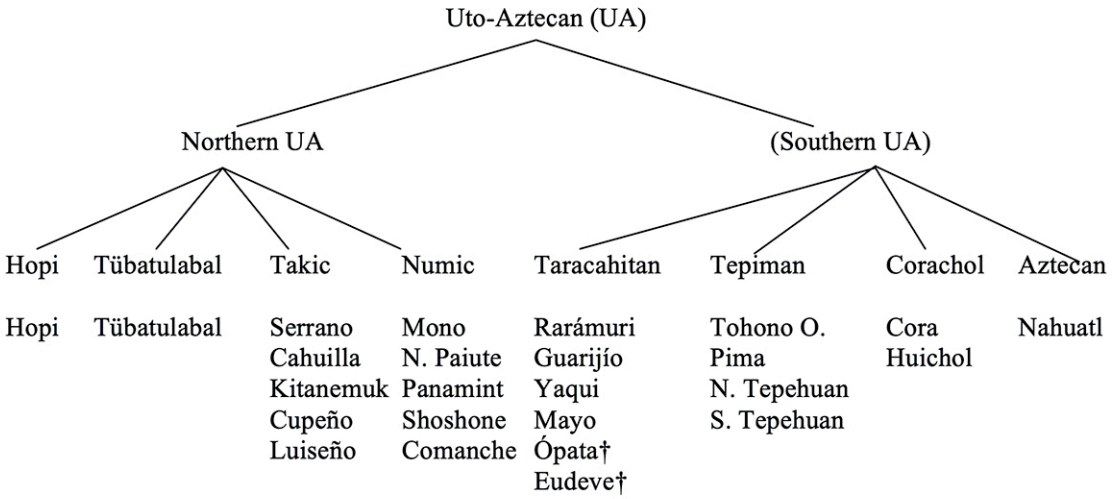


(From Wikimedia Commons, created by Noahedits, 7 January 2020, https://commons.wikimedia.org/wiki/File:Uto-Aztecan_map.svg)

Figure 1 Map of distribution of the Uto-Aztecan language family[2]

[2] Absent from this map are the communities of Hiaki (Yahqui) speakers in southern Arizona.

Uto-Aztecan is generally divided into two branches: northern and southern,[3] shown in Figure 2 below, which is reflected geographically in the map above in Figure 1.



(Adapted from Langacker 1977, Campbell 199l, Mithun 1999)

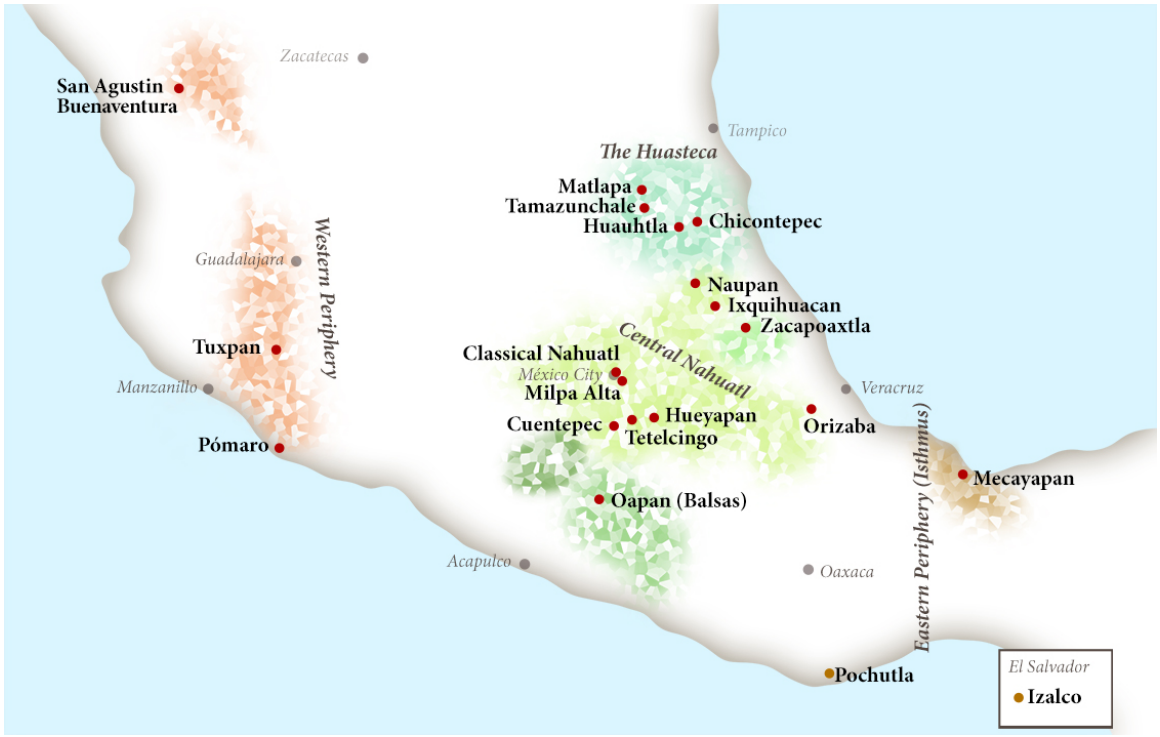
Figure 2 Uto-Aztecan language family

As seen in the map in Figure 1 (in green), the distribution of Nahuatl varieties is centered in the Mesoamerican cultural and linguistic area, where Nahuatl has been in contact with languages of other Mesoamerican language families. It shares certain Mesoamerican areal features such as relational nouns, body part noun-incorporation into verbs, body part nouns as locatives, and the morphological marking of inalienable possession (Campbell et al.

[3] Northern UA is widely recognized as a genetic unit, but status of the Southern branch is still debated (see Hill 2011 for discussion).

1986). Speakers of Chicontepec Nahuatl and Huastecan Nahuatl more generally have been in contact with Teenek (Huastec), Ñuhu (Otomí), and Tutunakú (Totonac), in addition to Spanish (Garcia 2014).

Chicontepec Nahuatl is a variety of Eastern Huasteca Nahuatl that, following Canger's (1988) analysis, is a dialect area on the northeastern edge of *central* Nahuatl. The most recent estimate is that it is spoken by about 40 thousand people in the municipality of Chicontepec Veracruz (INEGI 2005). However, it is also spoken in diaspora communities in Mexico (e.g., Zacatecas, Mexico) and the U.S. The map below shows the location of Chicontepec Veracruz (as well as Zacatecas, Mexico) in relation to the other varieties of Nahuatl.



(map based on Canger 1988, p. 46)

Figure 3 Map of Nahuatl varieties

1.4 My *Tlamachtianih*, my teachers

The data for this dissertation were collected over two field visits to Zacatecas, Mexico in the summers of 2014 and 2017. My teachers are native Nahuatl speakers who are also Nahuatl-Spanish bilinguals. All speakers grew up in neighboring Nahuatl-speaking communities in the municipality of Chicontepec, Veracruz. All speakers were between the ages of 25-45. This research project reflects collaboration with eleven speakers (six female and five male), the data included in the phonetic study come from six speakers, (four female and two male).

There is a community of Chicontepec Nahuatl speakers in the city of Zacatecas, Zacatecas, Mexico. This community consists of people who grew up in Nahuatl-speaking communities in the municipality of Chicontepec, Veracruz, who are native speakers of Nahuatl, but who have made their lives outside their ancestral community in Veracruz. Some of the speakers involved in this study are actively involved in language instruction and research. Several participants in this study are currently, or have previously, been involved with scholarship at the *Instituto de docencia e investigación etnológica de Zacatecas* (IDIEZ) associated with the Autonomous University of Zacatecas (UAZ). Others are friends and relatives of these participants, also from Chicontepec, and who also reside in Zacatecas City. These data reflect a specific speech community whose linguistic practices most likely mirror their peers living in Chicontepec, though there is the possibility that some differences may have developed in the Zacatecas context.

Data were collected via traditional elicitation techniques, through the collection of narrative texts and directed tasks for the phonetic study. During open elicitation, teachers were asked to provide example sentences for the lexical item/morphological construction

being discussed. These sentences provided much information about morphological structure as well as prosody. Elicitation was conducted in a mix of Spanish and Nahuatl, that is, elicitation was conducted in Nahuatl to the extent of my abilities as a language learner. Directed tasks using carrier sentences were also recorded to provide controlled data for inclusion in the phonetic study (Chapter 4). Examples of carrier sentences used are provided in section 4.4. Conversations in Nahuatl between speakers were also recorded and along with narrative texts, served as a point of comparison for some of the prosodic patterns described in this dissertation. Through examination of data obtained through this field research, I provide evidence for the phonological status of these laryngeal articulations, as well as preliminary evidence as to which level of the grammar these laryngeal articulations may be attributed to.

1.5 Structure of the dissertation

In this dissertation I make the claim that laryngeal spreading and constriction can arise at different levels of the grammar (i.e. from phonological, morphological and post-lexical prosodic components) in configurations analogous to the manipulation of pitch. The analysis of languages featuring these configurations must thus answer the following crucial questions: which laryngeal sounds are derived from which level of the grammar? And how do levels of grammatical structure interact to *constrain* or *determine* which laryngeals are realized when the position of two laryngeals (derived from different levels of the grammar) co-occur? In Chapter 2, I define the grammatical domains I appeal to in this dissertation and the criteria that will be referenced in the analysis of Chicontepec Nahuatl laryngeal sounds.

In Chapter 3, I provide a phonological analysis of larnygeal sounds in Chicontepec Nahuatl. In this chapter I begin with a description of the contrastive sounds in the language, and an analysis of syllable structure and stress. After providing some background information on the phonological system, I next describe the phonemic laryngeal /h/ and its distribution in the language, with an analysis of the templatic and realizational morphological processes in which it occurs. I then provide an analysis of debuccalization processes that result in glottal fricatives. I demonstrate that these lenition processes, which target coda labiovelar glides /w/, word-final nasals, and velar stops /k, k^w/, result in neutralization with /h/. I then turn to patterns of glottalization and demonstrate that there are two general types of prosodic glottalization: glottalization sensitive to morphological boundaries, and glottalization associated with pre-pausal contexts, both utterance-medially and utterance-finally. I show that glottalization is sensitive to morphological boundaries, which can be subdivided into two general environments (that partially overlap): glottalization at the prefix-stem boundary, and in stem-stem boundaries in hiatus contexts, which is essentially to the left of the rightmost stem in a polymorphemic word. There is no glottalization in the stem-suffix boundary. As to prepausal glottalization, I argue that this glottalization is distinct from other processes, such as phrase-final creak, which are associated phrase-boundaries. Instead, prepausal glottalization is best analyzed as a type of phrase-final glottalization which marks phrasal boundaries.

In Chapter 4 I look at the question of what happens when two seemingly opposing laryngeal sounds that arise in distinct domains of the grammar cooccur, through a phonetic analysis. I discuss two models of laryngeal abduction and adduction and the types of predictions that can be made for the outcome of a stacked laryngeal context. The results

from this study show that there is a difference between the realization of glottalization by underlying representation. I argue that glottalization is realized more strongly (i.e., more like [ʔ]) when co-occurring with an underived [h], than one derived in the lexical phonology. I also show that cost of reduction also plays a role in the phonetic outcome of stacked contexts: overt glottalization is less likely to occur when [h] has a high cost of reduction to meaning. In addition, I argue phrase-final glottalization is best characterized as a suprasegment [+constricted glottis] ([ˀ]) because it moves to the nearest available anchor point.

I then situate the findings on the laryngeal landscape of Chicontepec Nahuatl in the literature on other Nahuatl varieties in Chapter 5. I show that while the acoustic detail in the existing literature is limited, there is evidence that the phenomena documented in this dissertation may be found in other varieties. Evidence for "stacking" contexts and similar outcomes are explored. Finally, in Chapter 6, I conclude this dissertation, providing a summary of the preceding chapters and laying out future directions.

Chapter 2 Defining Grammatical Domains

2.1 Introduction

In this dissertation, my motivating claim is that laryngeal articulations can arise at different levels of the grammar, i.e. from phonological, morphological and post-lexical prosodic domains. Accordingly, it is essential to determine in a systematic manner the grammatical domains to which each pattern belongs. This requires that clear criteria be laid out to assign grammatical status.

In section 2.2, I begin with how the phonological component of the grammar is treated in this dissertation and how distinct phonological domains will be identified. Specifically, I assume there are distinct lexical and postlexical domains in the phonology, which has consequences for the types of possible outcomes for laryngeal interactions. Then, I turn to a discussion of the criteria I use to distinguish the phonological and morphological domains in section 2.3.

2.2 The Phonological Domain

Within the phonological domain of the grammar, one of the assumptions that will be made in this dissertation is that there are two distinct phonological domains, lexical and postlexical, as proposed in the theory of Lexical Phonology (Kiparsky 1973, Mascaró 1976, Halle 1978, Rubach 1981). As will be discussed in this section, this distinction is important in understanding the types of phonological patterns present in the language and their expected behaviors. These domains differ in scope: lexical phonological patterns are those whose domain is limited in scope to the word, and postlexical phonological patterns are those whose domain is larger than the word. Most relevant to this dissertation are the

interactions entailed with the morphological domain (with morphologically complex words at the lexical level) and higher prosodic domains (at the postlexical level), which will become relevant later in this discussion.

Lexical Phonology is a theory that proposes a modular organization to the phonological patterns attested in the world's languages. In its classical form, described in Rubach (2008), lexical phonology builds on the machinery of Sound Pattern of English (Chomsky & Halle 1968), specifically the notion of rules and ordering. Rules are organized into those that are restricted to the word (*lexical*) and those rules that apply after syntax (*post-lexical*) (Kiparsky 1982). This divides phonological processes into two grammatical domains: those that occur in the lexicon and those that occur post-syntactically.

In this framework, lexical rules are further subdivided into *cyclic* rules that apply during various stages in word formation (interacting with word formation processes), and *postcyclic* rules that apply after word formation is complete but prior to the syntax. The Strict Cyclicity Constraint, proposed by Mascaró (1976), is relevant in distinguishing between cyclic and postcyclic rules. This constraint prohibits the application of a cyclic lexical rule to the bare lexical item without derivation (no cyclic rules apply in the first cycle). This restriction accounts for derived environment effects, or patterns in which phonological rules only seem to apply to morphologically complex words. That is, bare stems do not undergo phonological rules that are associated with word-formation processes. So, if a rule does not apply to bare stems, the rule must be assumed to be cyclic. If a phonological rule applies to underived stems, then the rule must be postcyclic.

A key feature of the lexical (cyclic-postcyclic)/postlexical distinction is that strict ordering is built into the theory such that all cyclic lexical rules will occur before postcylcic

lexical rules which will in turn occur before postlexical rules. Ordering can also be construed in terms of the scope of application of the phonological rule. This is schematized in the figure below:

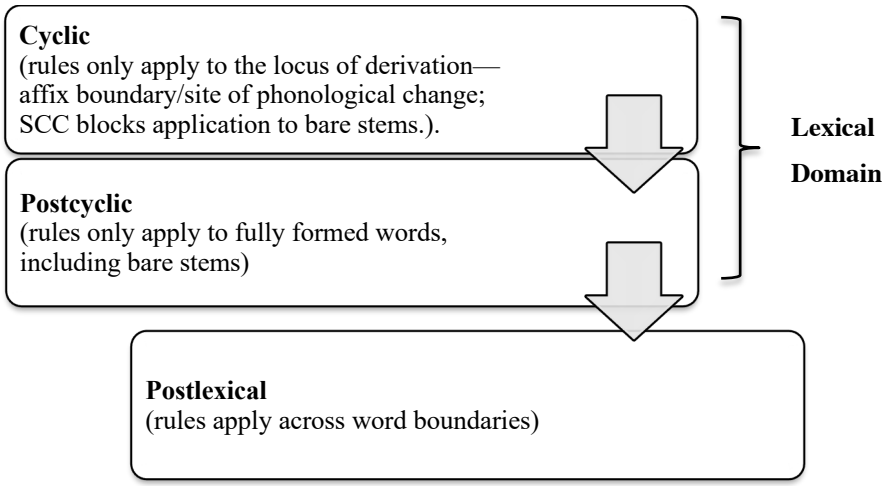


Figure 4 Rule ordering in lexical phonology model

For the purposes of this dissertation, the relevant distinctions are the larger grammatical domains. It is the interaction across domains that is of analytical interest here, rather than the internal structure of each domain. For this reason, I will only make a distinction between lexical and postlexical phenomena, combining the criteria for cyclic and postcyclic to describe phonological processes simply as *lexical*. Any reference to morphological conditioning or lexical information will qualify a process as lexical. Derived environment effects will also qualify a process as lexical. This is shown in the figure below:

Criteria	Cyclic	Postcyclic		Lexical
scope	word			word
word formation rules/cyclic	yes	no		yes
derived environment effects	yes	no	=	yes
reference to morphological/ lexical information	yes			yes

Figure 5 Criteria for lexical phonological processes

In the lexical phonology literature (Rubach 2008, Kaisse & Shaw 1985, Booij & Rubach 1987, inter alia) there is a consensus on the primary diagnostics for whether a rule can be classified as lexical or postlexical. The clearest criterion for a rule's status is based on the scope of its application: lexical rules are limited to the phonological word, while postlexical processes apply across word boundaries in domains larger than the word (e.g. phrase, utterance, etc.). Lexical rules are defined as applying during word-formation rules and immediately after word-formation, within the domain of the word. A rule that applies across word-boundaries must apply after processes belonging to other domains such as the syntax and cannot belong to the lexical domain of the grammar. If there is an absence of evidence that a rule can apply across word boundaries, then the process could be either lexical or postlexical. This cross-word boundary criterion can therefore only confirm postlexical status: if there is evidence that a phonological environment is created across word boundaries, a rule must be postlexical.

A clear example of a postlexical process is found in Russian. There is a process of vowel retraction that occurs across word boundaries shown in (3). Word-initial /i/ is realized as [ɨ] when it occurs in the environment of a back consonant (velarized consonants). In

these examples, the conditioning segment is the final consonant of the preceding word and accordingly, the process must be post-lexical.

3) Postlexical Russian Retraction: /i/ → [ɨ] / C ___
[+back]

a. [ivan] ‘Ivan’
b. [stɔlʸ ɨvana] ‘Ivan’s table’
c. [vagɔnʸ ɨvana] ‘Ivan’s carriage’
d. [bratʸ ɨvana] ‘Ivan’s brother’
e. [nɔsʸ ɨvana] ‘Ivan’s nose’
f. [dɔmʸ ɨvana] ‘Ivan’s house’

(Rubach 2008, pp. 457-458)

The second criterion for distinguishing between lexical and postlexical processes is reference to lexical information. The assumption is that if a rule is postlexical, it cannot make reference to information stored in the lexical entry which can be (i) lexical conditioning (membership to lexical class), (ii) morphological conditioning (specification of a morpheme for its grammatical features), and (iii) exceptions (e.g., morphemes/lexemes failing to undergo a general process) (Rubach 2008:459-460). Since postlexical rules cannot reference lexical information, they cannot exhibit any of these properties. If there is any reference to lexical information, then the rule must be lexical. However, a rule that makes no reference to lexical information may be lexical or postlexical.

While there is consensus on the criteria for making the distinction between lexical and postlexical processes, these criteria cannot be evaluated in every case, making

classification unclear in some cases. In ambiguous cases, evidence from other established processes that are clearly identifiable as belonging to either domain will provide evidence through their implicit ordering. For example, a hypothetical rule, *Rule A,* makes no reference to lexical information but also does not occur across word boundaries. It is therefore ambiguous in that it could be either lexical or postlexical. However, if *Rule A* is ambiguous but the data suggest that it must occur after *Rule B,* which has been shown to be postlexical, then Rule *A* must also be postlexical. Thus, rule interaction can help determine the rule's status as lexical or postlexical.

A third criterion for distinguishing lexical vs. postlexical processes invoked in the literature is *structure preservation*. Structure preservation is defined as "a restriction on underlying representation [that] holds throughout the lexical phonology" (Kiparsky 1985, p. 92), whereby phonological processes that belong to the lexical domain can only produce structures that are contrastive in the language—sounds in the phonemic inventory that can be part of an underlying representation in the lexicon. As a result, structure-preserving rules will necessarily involve neutralization. Postlexical rules may also be structure preserving, but any processes that are not structure preserving will be postlexical. So, in English, for example, nasal place assimilation is structure preserving because it results in only contrastive sounds [m, n, ŋ] and crucially not *[ɱ, ɲ, m̥, n̥, ŋ̊], which are not contrastive in English. It is likely a lexical process given that this process seems to make reference to word-formation in addition to being structure preserving. In contrast, a rule like English vowel nasalization creates nasalized vowels in the environment of a nasal consonant. Vowel-nasalization is not contrastive in English and should be assumed to be postlexical (Kaisse & Shaw 1985), since

it creates structures not possible in lexical representations. Given its postlexical status, it is predicted to occur across word boundaries.[4]

The criterion of structure preservation will only be used as a supplemental evidence for a rule's status as lexical or postlexical, since it has been shown to not necessarily be borne out empirically (Myers 1991). There are cases of phonological processes that do result in non-contrastive sounds and that make reference to morphological information and must therefore be lexical (see Mohanan & Mohanan 1984, Mohanan 1986, Hall 1989, Harris 1987, 1989, inter alia). For example, in Belfast English, there is a pattern in which alveolar consonants undergo dentalization when in the context of a tautosyllabic [ɹ] (shown in 4). However, this phonological pattern is sensitive to morphological information.

4) Belfast Dental Realization

Dental	Alveolar
a. matter	b. latter
c. ladder	d. louder
e. pillar	f. killer
g. spanner	h. runner

(From Harris 1989, p. 40)

As the data show, dentalization does not occur in morphologically complex words (the adjectives suffixed with the comparative *–er* suffix on the right-hand column): the [ɹ]

[4] For the researcher, a speaker of Chicano English from Southern California (n = 1), this prediction is born out. It remains unclear to me if this is true of other dialects of English.

must be tautomorphemic for dentalization to apply. Thus, we must conclude that this is a lexical rule since a postlexical rule would apply in all relevant environments without reference to morphological structure. This is problematic for structure preservation as a property of lexical rules since [d̪] and [n̪] are not (arguably) in the inventory of Belfast English. Consequently, structure preservation can be best treated as more of a tendency—that is, rules that create novel non-contrastive structures are likely, but not necessarily, postlexical. The criteria outlined thus far are summarized in the figure below.

Criteria	Lexical	Postlexical
scope	word	larger than the word
word formation rules/cyclic	yes	no
derived environment effects	yes	no
reference to morphological/ lexical information	yes	no
structure preservation	most likely	less likely

Figure 6 Criteria for lexical-postlexical distinction

In sum, the relevant distinction taken from lexical phonology is that between the lexical and the postlexical domains. A phonological process can be classified as postlexical if there is evidence that it applies after syntactic processes. Since lexical and postlexical phonological processes appeal to different grammatical domains and are predicted to show differences in behavior and distribution, this distinction is crucial to understanding how laryngeal articulations derived from different grammatical domains will interact.

Within the lexical domain of the phonology, there are also interactions between phonological processes and morphological domains. These interactions have only been mentioned in this section generally, if lexical phonological processes refer to morphological information (i.e. lexical conditioning, morphological conditioning, and exceptions to lexical phonology). In the next section, I explore how the phonological and morphological domains interact, and define the criteria that will be used to classify the processes responsible for allomorphic distributions as belonging to the phonological or morphological domains.

2.3 The Morphological Domain

In this dissertation, I make reference to both regular concatenative morphology as well as realizational morphology. In some constructions, multiple exponence results from the cooccurrence of both types of morphological exponents. Within the regular concatenative morphology there are alternations which have some bearing on their status relevant to this dissertation. I will begin by defining the general morphological alternations of interest here, and then define relevant non-concatenative realizational morphological processes.

Allomorphy, or alternations in the surface realization of morphological constructions, can be subdivided into two types of patterns: regular (non-suppletive) allomorphy and suppletive allomorphy. The distinction is based on assumptions about underlying representation and the role of the phonological component in determining the surface pattern. Regular allomorphy is assumed to be the result of regular phonological processes of a single underlying representation of a morpheme in the lexicon. In contrast, suppletive allomorphs are assumed to have multiple representations—that is, different allomorphs that are lexically listed. Crucially, suppletive alternations cannot be accounted for by general

phonological processes (Carstairs 1990, Kiparsky 1996, Paster 2006, Corbett 2007, inter alia).

The English past tense, shown in (5), provides a clear example of this distinction. The productive past tense construction involves two suffixal allomorphs, [-t] and [-d], exemplified in (2). The two allomorphs can be assumed to have a single underlying representation, /-d/, since their distribution can be accounted for through one phonological process, namely an assimilation rule (in this case, English devoicing).

5) Regular Allomorphy in English

Present tense construction	Past tense construction
a. [əˈgɹi]	b. [əˈgɹi**d**]
c. [kɑl]	d. [kɑl**d**]
e. [gɹɪn]	f. [gɹɪn**d**]
g. [pɪk]	h. [pɪk**t**]
i. [stɑp]	j. [stɑp**t**]
k. [flæʃ]	l. [flæʃ**t**]

A regular devoicing process can account for the pattern in which an underlying /-d/ is realized as [d] following a voiced sound (5b,d,f) and as [t] following a voiceless sound (e.g., 5h,j,l). The analysis of this construction is that only one morpheme is lexically listed, and general phonological processes are responsible for the surface allomorphy. We know the underlying morpheme is /-d/ rather than /-t/ because verbs that end in /t/ or /d/ have an epenthetic schwa: /wɑnt + d/ surfaces as [wɑntəd] and not *[wɑntt] or [wɑntət].

In contrast, the relationship between the present and past tense forms of *go* and *are* (exemplified in (6)) cannot be accounted for by any phonological rules of English. That is, the differences between the semantically related forms cannot be accounted for by a change in phonological features.

6) Suppletive Allomorphy in English

Present tense construction	Past tense construction
a. [goʊ]	b. [went]
c. [ɑɪ]	d. [wʌz]

Moreover, if we proposed a rule to account for this correspondence, it would have to be prevented from applying to phonologically-similar verbs like *flow, row, tow* (for rules accounting for *go*) and *bar, tar, mar,* etc. (for rules accounting for *are*) all of which take the regular /-d/ suffix. Thus, the surface alternation in form for *go* and *are* in the past tense is strictly morphological.

Although suppletive allomorphy is, by definition, not due to phonological processes, it may nevertheless exhibit a phonologically-conditioned distribution. This is exemplified in the third person singular suffix in Hungarian (Uralic). The data in (7) show that there are two allomorphs in the surface distribution, *-ja* and *-i*.

7) Third person singular construction in Hungarian (Uralic)

a.	ad-**ja**	'he gives'	b.	*kér-**i***	'he asks for'
c.	*ró-**ja***	'he carves'	d.	főz-**i** [5]	'he cooks'

(original data in Kenesei, Vago, & Fenyvesi 1997, p. 290-291 in Paster 2006, p. 34)

The allomorphs must be suppletive since there is no phonological process in Hungarian that can derive the two forms from a single underlying form, but their distribution is explained by the phonological environment of the base: the *-ja* allomorph occurs after bases containing a back vowel, while *-i* occurs after stems with front vowels like *é* and *ő* (Paster 2006, p. 34).

Kiparsky (1996) proposed four criteria for determining whether a particular morphological distribution should be considered regular allomorphy or suppletion when the distinction may be elusive. According to Paster (2006), two of these four criteria are relatively straightforward diagnostic tools for distinguishing regular allomorphy from suppletive allomorphy. I follow Paster and summarize these criteria in (8) below adapted from Paster (2006, p. 27) and refer interested readers to her dissertation for a full discussion.

8)	Regular Allomorphy[6]	Suppletive Allomorphy
a.	general (not item-specific) phonological patterns	item-specific phonological pattern
b.	involve a single segment	may involve more than one segment

[5] Hungarian ő = [øː], ó = [oː], a = [ɒ], é = [eː], i = [i].

[6] In Paster 2006, the headings are "Morphophonology" and "Allomorphy" which refer to the non-suppletive/-suppletive distinction.

Criterion (8a) holds that if a phonological rule can account for a number of allomorphic patterns within the same language, then the pattern can be described as regular non-suppletive allomorphy. Here, regular alternations that occur elsewhere in the phonological system account for the allomorphy. If a phonological rule is limited to one specific morpheme, then the allomorphy is most likely suppletive (Paster 2006, p. 28). This builds on the insight that while one might be able to posit a phonological rule that accounts for the alternation, it is most likely not a productive phonological process if the rule applies to a reduced pattern of allomorphy. The most parsimonious analysis is that the allomorphy is a lexicalized alternation.

Criterion (8b) takes the number of phonological changes required to account for the difference in surface forms as the determining factor: non-suppletive allomorphy tends to involve alternations of a single segment, while suppletive allomorphy tends to involve alternations in multiple segments. In the latter case, one must not be able to account for of the changes (alternation, deletion or insertion) with a single phonological rule. Recall the *go-went* example in (6). One would have to propose an underlying form like /ɡwoɛn-d/ and propose a number of item specific rules to derive [wɛnt] (and likewise [ɡoʊ]). This is not at all parsimonious, and so the example is better described as simple suppletion of lexically stored forms. Paster (2006) suggests a nuanced interpretation in which regular non-suppletive allomorphy can involve multiple changes (to multiple segments) if all of the rules that account for the allomorphy are fully general in the phonological system. But if numerous item-specific rules are required to account for the alternation, then there likely is suppletion (Paster 2006).

In addition to allomorphy patterns, there are other phenomena that require carefully assessing the role of phonology versus morphology in individual languages and cross-linguistically, and which motivate a distinction between *morphologically conditioned phonology* and *realizational morphology*. Morphologically conditioned phonology involves phonological patterns that are not fully general in the lexical phonology of the language but are instead associated with a specific morphological construction or a set of morphological constructions (Inkelas 2008). In these cases, there is something about the morphological exponent that imposes a unique phonological pattern. In contrast, realizational morphology is the case where a phonological pattern other than the concatenation of segmental exponents is the single exponent of a morphological construction (Inkelas 2008).

An example of morphologically conditioned phonology can be found in English, where suffixes are either stress-shifting or non-stress-shifting (Chomsky & Halle 1968, Siegal 1974, inter alia). The data in (9) demonstrate this pattern.

9) English Stress-Shifting and Non-Stress Shifting Suffixes

Base	a. Stress-shifting suffix	b. Non-Stress-shifting suffix
párent	parént-al	párent-ing
président	prèsidént-ial	présidenc-y
áctive	àctív-ity	áctiv-ist
démonstràte	demónstrative	démonstràtor

(Inkelas 2014, p. 11)

In these cases, the shift in stress does not involve a general phonological process, but rather a pattern imposed by the subset of stress-shifting suffixes (9a). That is, the surface pattern cannon be predicted based on a phonological environment. Instead, the distribution of stress-shift requires an arbitrary distinction among suffixes.

The relationship between morphology and phonology in morphologically conditioned phonology is such that the phonological pattern seems to accompany the addition of new morphological material (segments/affixes, reduplication, or compounding). This is distinct from *realizational morphology*, where a phonological process is the single exponent of a morphological construction (Inkelas 2008). In these cases, there is no affixation of morphemes made up of identifiable repeating strings of segments, but instead, realizational morphology involves non-concatenative or process morphology such as deletion/reduction, ablaut, stress-shift, and changes in tone. For example, in Tohono O'odham, the perfective construction is formed from the imperfective form by deleting the final segment (10). In this example, there is no morphological material added, only the rule itself that deletes the final segment.

10)

Imperative	Perfective	gloss	data source
síkon	síko	'hoe object'	Yu 2000
híwa	híw	'rub against object'	Yu 2000
hiːnk	hiːn	'bark'	Anderson 1992

(Inkelas 2008, p. 3)

In sum, morphologically conditioned phonology and realizational morphology both share that the phonological patterns involved are not part of the general lexical phonology. They are both limited to some subset of the lexicon. They differ however in the nature of the relationship between phonological patterns and morphological exponence. For morphologically conditioned phonology, the phonological pattern is triggered by the addition of morphological material (affixation, reduplication, compounding); for realizational morphology, the phonological pattern is itself the morphological exponent (non-concatenative morphology).

The question then is how to treat these two types of processes. Do they belong to morphological or phonological domains? Morphologically conditioned phonology may be treated as involving phonological processes, only differing from fully general phonological processes in being restricted morphologically or lexically; that is, it involves regular phonology across a subset of relevant morphological constructions. This is the assumption in cophonology theory (Anttila 2002, Inkelas & Zoll 2007), in which single morphological constructions or sets of morphological constructions are associated with different phonological subgrammars (operationalized as different constraint rankings in OT).

Realizational morphology, on the other hand, seems to straddle the phonological and morphological domains, and depending on the pattern in question, may be better classified as falling within the morphological domain in some cases and the phonological one in others. For example, in the Tohono O'odham final-segment deletion pattern in (10), the patterns of realizational morphology seem to comprise a phonological process that is general within this morphological construction, since all final segments delete.

As has been shown, morphologically conditioned phonology falls within the phonological domain. On the other hand, realizational morphology seems to straddle the phonological and morphological domains depending on the type of allomorphy and whether it can be best analyzed as suppletion (such as English ablaut). The types of morphophonological patterns that have been described in this section can be schematized in the two grammatical domains (phonological or morphological) as in (11).

11) Cline of Allomorphy Patterns

regular non-suppletive allomorphy	morphologically conditioned phonology	realizational morphology	suppletive allomorphy
Phonology		Morphology	
fully general pattern	morphological/lexical restrictions	lexically listed	

2.4 Prosodic Domains

In the both the phonological and phonetic analyses, I appeal to well established prosodic domains (Nespor & Vogel 1986/2007). These include the syllable, the phonological word, and the phrase and utterance. As is shown in the following chapter, syllable structure is a meaningful analytical tool for understanding phonological alternations in ChN. The domain of phonological word is a useful analytical tool to understand stress assignment as well as other phonological processes. Both of these domains are invoked in analyzing and determining the phonological and morphological status of a sound or process in ChN using the criteria described in the previous sections of this chapter.

The highest two prosodic domains that I make reference to in this dissertation are loosely defined. As it is outside the scope of this dissertation to provide a detailed

intonational analysis of ChN, I make reference to two larger intuitive units: the larger *utterance* and a *phrase*. Here, the *utterance*, may or may not correspond to a complete syntactic unit, such as a sentence. It is defined here as the phonetic string that is bounded by breaths (breath group). This larger utterance level can be made up of *phrases*, which may or may not correspond to the an intonational phrase or a syntactic unit but are bounded by perceptually salient pauses in the speech string. Prosodic boundaries have been shown to be marked by pause duration (Wightman et al. 1992, Männel et al. 2013). These two domains provide a springboard for the analysis presented here and lay the foundation for a more detailed intonational analysis of ChN in future work.

2.5 Summary

In this chapter I have laid out the criteria that will be used in this dissertation to analyze and describe the types of laryngeal sounds in ChN and the grammatical domain from which they arise. In summary, the processes discussed in this dissertation will be treated as belonging to the following grammatical domains: lexical phonology; postlexical phonology, which include processes targeting larger prosodic units like phrases and utterances; and morphological domains that cannot be accounted for through phonology: i.e., realizational morphology and suppletion. Regular non-suppletive allomorphy will be treated as belonging to the phonological domain. I will appeal to well the established prosodic domains of the syllable, phonological word, a larger phrase, and the utterance. I now turn to the phonology of ChN Laryngeals.

Chapter 3

Phonological Analysis of Laryngeals in Chicontepec Nahuatl

3.1 Introduction

In this chapter, I describe the types of laryngeal articulations found in Chicontepec Nahuatl (ChN). Using the criteria that have been described in the previous chapter, I provide evidence for the phonological, morphological and prosodic status of these laryngeal articulations, as well as evidence for which level of the grammar these laryngeal articulations may be attributed to.

Laryngeal articulations in Chicontepec Nahuatl involve segmental [h] and glottalization. As will be shown later in this dissertation, glottalization occurs in a number of contexts and can be realized segmentally and will be represented phonetically as [ʔ] in this chapter. Only /h/ is contrastive in the inventory; however [h] and glottalization often cooccur. Chicontepec Nahuatl does not have "laryngeal complexity" as defined by Silverman (1997), where vowels are specified for contrastive tone and phonation. However, as is shown in this chapter, there is laryngeal richness as glottal fricatives arise in a number of grammatical domains, resulting in much neutralization that then interacts with prosodic glottalization. Recall that I am interested in the how these sounds, which involve essentially opposite laryngeal settings in the vocal tract (gestures of spreading and constriction), overlap and interact in the grammatical system. In addition to being a contrastive phoneme /h/, glottal fricatives result from debuccalization processes that affect the labiovelar glide /w/, nasal stops /m, n/, and velar stops /k, k^w/. There is morphologically conditioned glottalization at morphological junctures as well as glottal fricatives that surface in specific

morphological constructions as morphological exponents and as part of templatic structures. There is also evidence of a post-lexical phrasal glottalization that surfaces adjacent to pauses.

In this chapter, I begin with a description of the inventory of sounds, syllable structure, and stress in ChN in section 3.2. Then in section 3.3, I provide a description of the distribution of the contrastive /h/ phoneme, with a discussion of its general restriction to syllable codas, its role in loanword adaptation, templatic and realizational morphology, touching on questions of exponence. In section 3.4 three debuccalization processes that result in glottal fricatives are described. The topics of lenition and neutralization are addressed. After describing the distribution of glottal fricatives, I turn to a discussion of two patterns of glottalization in section 3.6: glottalization sensitive to morphological structure with an affinity to hiatus contexts and prepausal glottalization.

3.2 Preliminaries

Before proceeding to discuss the distribution of laryngeal articulations in Chicontepec Nahuatl, I first describe some of ChN's basic phonological properties.

3.2.1 The inventory of sounds

The inventory of Chicontepec Nahuatl is comprised of the following consonants: /p, t, k, k^w, t͡s, t͡ʃ, t͡ɬ, s, ʃ, l, j, w, m, n, h/. In addition, /b, d, g, f, ɾ, r/ (represented in parentheses below in Table 1) are present to various degrees in loanwords from Spanish but are not found in native Chicontepec Nahuatl words (except [g], which is an alternant of /k/ tht will be discussed later in this dissertation).

Table 1 Inventory of Chicontepec Nahuatl consonants

p (b)		t (d)		k, k^w, (g)[7]	
m		n			
	(f)	s	ʃ		h
		t͡ɬ t͡s	t͡ʃ		
		l, (ɾ), (r)			
w			j		

The labialized velar stop only occurs in onsets. It is realized as [k] in the coda position. The approximants: /l/, /w/, and /j/ all surface devoiced to varying degrees after a voiceless consonant, especially [h] and [ɬ]. For some speakers, /j/ is realized somewhat like d͡ʒ utterance-initially. The postalveolar fricative /ʃ/ is realized as a retracted or retroflex [ʂ] in word-final position.

The native vowel inventory includes /i, e, a, o/, with contrastive length. As Beller & Beller (1979) note about Huasteca Nahuatl in general, vowel length distinctions are difficult to hear except in minimal pairs (they suggest that they are disappearing). A caveat here about the representation of length in the data: it is represented when known, though there are most likely many long vowels that go unmarked throughout in this dissertation. Short vowel /u/ occurs to varying degrees in loanwords from Spanish (e.g. [βoroh]~[βuroh] from Spanish [βuro] 'donkey' *burro*).

[7] [g] can also occurs as an alternant form of /k/ intervocalically in native Nahuatl words.

Table 2 Inventory of Chicontepec Nahuatl vowels

	Front	Back
High	i i:	(u)
	e e:	o o:
Low	a a:	

In addition, there is a coarticulatory effect on /o/ occurring in a syllable with a postalveolar/palatal consonant (j, ʃ, t͡ʃ) or before labiovelar glide (w)[8] in which the /o/ is fronted [o̟] (though perceptually [u]-like to my English-Spanish speaking ear). This tendency is strongest in a stressed position. Thus, words like /jowi/ 'he goes' can surface as [ˈjowi]~[ˈjo̟wi] and /ʃot͡ʃit͡ɬ/ 'flower' can surface as [ˈʃot͡ʃit͡ɬ]~[ˈʃo̟t͡ʃit͡ɬ].[9]

3.2.2 Syllable Structure

The phonological structure of words in ChN allows for only one consonant word-initially and word-finally—that is, there are no consonant clusters on the edges of prosodic words, and word-medially, there is a maximum of two consonants that can occur in an intervocalic heterosyllabic consonant cluster. The one exception to this generalization is that

[8] There seems to be a phonotactic constraint against homorganic glide-vowel sequences: *[wo] and *[ji]. This phonotactic restriction also appears to apply to secondary articulations: *[kʷo]. there is no restriction on the reverse order. Homorganic sequences such as [ow], [ij], and [okʷ] are well attested: [kipowa] 's/he counts', [kipija] 's/he has it', [kiahkokʷi] 's/he puts it away'.

[9] This pattern is distinct from varieties like Tetelcingo Nahuatl (Pittman 1954) where /u/ (similarly /ei/ with /e/) has replaced length contrasts with /o/ (*/oː/).

a palatal offglide is allowed to follow an onset consonant, which seems to result from the reduction of an underlying /i/ such as /tiankisko/ [tʲankisko] 'market, *mercado/tianguis*' (discussed in more detail below). A syllable can have both a long vowel nucleus and a coda. Stress assignment and glottalization (to be discussed later in this chapter) support an analysis where heterorganic vowels are syllabified separately (no diphthongs are allowed with the exception of some loan words). Therefore, the syllable structure can be analyzed as (C)(ʲ)V(ː)(C). In the following discussion, examples of each of the attested syllable structures are provided: (16c-d) show simple V syllables; (12 a-b, d), (13) and (16) show examples of CV(ː) syllables; (12c-d) and (16c-d) show examples of V(ː)C syllables; (12a), (13a) and (16d-e) show CV(ː)C syllables. These syllables shapes are attested in all contexts in the prosodic word.

The words in (12) demonstrate that consonant clusters at word edges that would arise through complex morphology are repaired. Here, I represent this as epenthesis (epenthetic [i]) for representational simplicity, though affix allomorphy or a process of deletion are all possible analyses.[10]

[10] A few alternations suggest suppletive allomorphy. In the forms presented in (12a-b), the 3rd person object marker has two surface forms [h] and [ki] and can be analyzed as underlyingly /-k/ that debuccalizes in coda position in a consonant cluster and undergoes epenthesis when the consononant cluster is word-initial. However, forms like [kiamati] /k-amati/ 'I like it' are crucially not *[kamati] as in other varieties. There is no phonotactic restriction on this surface form, yet the *possibly* epenthetic vowel occurs suggesting suppletive allomorphy here. An alternative analysis is prefix syncope: the underlying third person object prefix is /-ki/ and in forms like [nihkʷaː], the underlying representation is /ni-ki-kʷaː/ which goes to |nikkʷaː| which surfaces as [nihkʷaː].

12) a. nih.k^{w}aː
/ni-k-k^{w}aː/
1SUBJ-3OBJ-eat
'I eat it, *lo como*' (niccua)

b. ki.k^{w}aː, *kk^{w}a
/k-k^{w}aː/
3OBJ-eat
's/he eats it/*lo come*' (quicua)

c. aːt͡ɬ
/aː-t͡ɬ/
water-ABS
'water, *agua*' (atl)

d. at͡ʃ.t͡ɬi, *at͡ʃt͡ɬ
/at͡ʃ-t͡ɬ/
gourd.seed-ABS
'gourd seed, *semilla de guaje*' (achtli)

e. a.la.ʃo.ʃaːt͡ɬ
/alaʃoʃ-aː-t͡ɬ/
orange-water-ABS
'orangeade*, agua de naranja*' (alaxoxatl)

The examples in (12a-b) show that allomorphy of the object prefix ([h]~[ki]) prevents a word initial consonant cluster in (12b): either *[kk^{w}] or *[hk^{w}] (depending on the analysis of the underlying form of the 3rd person object marker). The [k]~[h] alternation will be treated in detail in section 3.4.3. The examples in (12c-d) show a similar pattern with the absolutive marker [-t͡ɬ]~[-t͡ɬi]: epenthesis prevents a word-final consonant cluster in (12d), which would involve the unattested word-final sequence *[t͡ʃt͡ɬ]. (12e) provides an example of a syllable with both a long vowel and a coda. Note that (12e) shows that syllabification does not need to align with morpheme boundaries.

In these examples, and in the data presented in this chapter, many patterns of allomorphy can be generally accounted for through a process of epenthesis.[11] For example,

[11] This is a claim about the synchronic pattern—diachronic analyses of Nahuatl allomorphy involve historical "reductions" (in the Nahuatl literature), or sound changes, in vowel quality a > e > i > Ø in "weak" positions.

the absolutive suffix can be posited as /-t͡ɬ/ with a number of surface forms: [-t͡ɬ, -t͡ɬi, -it͡ɬ, -i]. The distribution of these forms is as follows: [-t͡ɬ] occurs with a vowel-final stem; [t͡ɬi] occurs with a consonant-final stem (epenthesis), unless the final consonant is /m/ or /w/ in which epenthesis occurs to the right of the affix [-it͡ɬ] (after /m/ or /w/).[12] The final alternant [-i] is a result of an opaque process: /l/-final stems take the -*t͡ɬi* form; however, a lateral assimilation/reduction process results in an onset [l]. As such, an absolutive noun like [t͡ʃili] 'chile' would have the following derivation: /t͡ʃil-t͡ɬ/→⌈t͡ʃilt͡ɬi⌋→⌈t͡ʃilli⌋→[t͡ʃili]. This reflects a general constraint in the language against sequences of identical sounds. As is shown in this chapter, a number of sounds solve violations of this constraint through some form of lenition for both [+continuant sounds] and [–continuant sounds] as both degemination and debuccalization have been treated as forms of lenition (Honeybone 2008, Gurevich 2011, Katz 2016 and references therein).

Intervocalic consonant clusters impressionistically sound heterosyllabic. However, there is phonological evidence that consonant clusters are heterosyllabic. There is an alternation in sonorant sounds that is sensitive to syllable structure. Non-nasal sonorants are voiced only in onset position. In coda position, these sounds are devoiced. One sound

[12] This synchronic pattern of epenthesis may reflect a pressure to maintain the identity of the stem-final consonant. As will be discussed in detail later in this chapter, word-medial coda nasals assimilate to the place of the following onset. Epenthesis after /m/ before the absolutive marker prevents neutralization with /n/. In fact, this has been shown in other varieties: Classical Nahuatl *pam-* 'row/furrow, flag' has two surface forms in classical texts: *pamitl* and *pantli.* Similarly, coda /w/ surfaces as [h]. While lenition processes like this result in neutralization with contrastive /h/, epenthesis in this case prevents neutralizaton: such that a stem like /t͡ʃikiw/ surfaces as [t͡ʃikiwit͡ɬ] rather than *[t͡ʃikiht͡ɬi]. There are cases of pairs [kʷawit͡ɬl] 'tree/wood' and [kʷaht͡ɬi] 'eagle'. The stem of [kʷahtli] is analyzed as /kʷaw-/ in other varieties where the reported segment is [w] or [ʍ] in this stem (there is no debuccalization). However in ChN it is unclear if the sound is still analyzed as coda [w] by speakers, or if this and other similar stems have been reanalyzed as having /h/ instead.

undergoes debuccalization (/w/), and two of these alternations result in neutralization (/w/ and /j/). The data shown in Table 3 below demonstrate these alternations with morphologically related words:

Table 3 Alternation of voiced consonants in onset and coda positions

Sound	Onset	Coda
a. /w/	[w] [kʷa.**w**it͡ɬ] /kʷaw-t͡ɬ/ wood-ABS 'wood, *madera*' (cuahuitl)	[h] [no.kʷa**h**] /no-kʷaw / 1POS-wood 'my wood, *mi madera*' (nocuauh)
b. /j/	[j] [ki.pi.**j**a] /ki-pija/ 3OBJ-have 's/he has it, *lo tiene*' (quipija)	[ʃ] [ki.pi**ʃ**.ki] /ki-pij-ki/ 3OBJ-have$_{prt}$-PRET 's/he had it, *lo tuvo*' (quipixqui)
c. /l/	[l] [kʷa.**l**i] /kʷali/ good 'good, *bueno'* (cualli)	[ɬ] [kʷa**ɬ**.ti.tok] /kʷal-ti-tok/ good-caus-perf 'well done! *bien hecho*' (cualtitoc)

The data in (a) in Table 3 show the alternation between [w] and [h] by syllable position (this alternation is fully discussed in §3.4.2); (b) in Table 3 shows the alternation between [j] and [ʃ] by syllable position; and (c) in Table 3 show the alternation between [l] and [ɬ] also by syllable position. The argument for heterosyllabic consonant clusters is that

[w], [j] and [l] never occur as the first consonant in a consonant cluster which would be expected if the clusters were tautosyllabic, given that these sounds do occur as onsets intervocalically and word-initially. Moreover, these sounds never occur word-finally. Another argument in favor of a heterosyllabic analysis is that [ɬ] only occurs as the first consonant of clusters as well as in the word-final context and never word-initially. In sum, the distribution of these sounds is sensitive to syllabic structure, demonstrating that word-internal consonant structures are best analyzed as heterosyllabic.

The examples in (13) show how off-glides result from a pattern where [i] is reduced to an off-glide (no longer syllabic) between a consonant and another vowel (CiV→C^{j}V).

13) a. t^{j}aŋ.kis.ko
/tiankis-ko/
market-LOC
'the market, *el Mercado/tianguis*'
(tianquizco)

b. no.t^{j}o.nah
/no-tionan/
POS-godmother
'my godmother, *mi madrina*'
(notionan)

I have not found a similar pattern for sequences of CoV resulting in a labial offglide C^{w}V. However, both /w/ and /j/ can be realized as offglides in sequences with reduced homorganic vowels. The data in (14) show this pattern (CijV→C^{j}V and (CowV→C^{w}V).

14) a. p^{j}a.li
/pijali/
greeting
'hello, *hola*' (piyali)

b. sem.p^{w}a.li
/sem-powal-t͡ɬi/
one-count-ABS
'twenty, *veinte*' (cempohualli)

This process targets glides in this context, except in the final syllable, where deletion occurs. A glide that is the onset of the final syllable following a homorganic vowel can delete. That the vowel in this context would not reduce makes sense—a reduction of the homorganic vowel here would result in the loss of the stressed vowel (penultimate stress assignment will be discussed more fully in 3.2.3 below). Nonetheless some amount of reduction does target the stressed vowel, though this process does target all word-final vowel sequences: /V.V/→V̆.V/ __]$_{word}$. The stressed vowel is shortened. Glide reduction must occur prior to this vowel reduction process. The examples in (15a-d) show glide reduction after a tonic homorganic vowel, with a form without a homorganic vowel for comparison. (15e-f) show the reduction pattern in underlyingly VV sequences.

15) a. tɬa.kʷah.ˈkĭ.a
/t͡ɬa-kʷah-ki-ja/
INDEF-eat.PRT-PRET-ADV
's/he already ate, *ya comió'*
(tlacuahquiya)

b. tɬa.ˈkʷa.ja
/t͡ɬa-kʷa-ja/
INDEF-eat-ADV
's/he already eats, *ya come*'
(tlacuaya)

c. wa.lŏ.a
/wal-jow-ja/13
DIR-go-ADV
's/he already comes, *ya viene*'
(wallowa)

d. ki.ˈka.wa
/ki-kawa/
3OBJ-leave
's/he leaves it, *lo deja*'
(quicahua)

e. ki.t͡ɬa.t͡ʃi.ˈlĭ.a
/ki-t͡ɬat͡ʃilia/
3OBJ-leave
's/he watches over it, *lo cuida*'
(quitlachilia)

f. ki.paː.ˈt͡ʃŏ.a
/ki-paːt͡ʃoa/
3OBJ-mash
's/he mashes it, *lo aplasta*'
(quipachoa)

[13] This verb involves two examples of the palatal assimilation process discussed in more detail later in this chapter. Sequences of Cj→CC→C when the C is [+continuant] and Cj→CC→hC when the C is [-continuant].

Both off-gliding and glide reduction are optional and occur more often in casual and rapid speech. These processes are less robust in careful speech. The pattern of tonic vowel reduction in VV sequences is more obligatory and generally occurs in careful speech, that is, it is seemingly unaffected by the rate of speech.

Heterorganic vowels are syllabified separately. The evidence for this is that stress assignment will always land on the penultimate syllable (this will be discussed more fully in 3.2.3 below). As the data in (16) show, stress lands on the penultimate vowel, regardless of vowel length.

16) a. ˈkoːaːt͡ɬ
/koːaː- t͡ɬ/
snake-ABS
'snake, *vibora*' (coatl)

b. t͡ɬaˈoʃ.t͡ɬi
/t͡ɬaoj-t͡ɬi/
corn.kernel-ABS
'corn kernels, *grano de maíz*' (tlaoxtli)

c. aːˈo.niː
/aː-oniː/
water-drink
'to drown, *hundirse'* (aoni)

d. teˈi.pah
/teipan/
later
'later, *despues*' (teipan)

e. kʷaˈih.tik
/kʷa-ihti-k/
tree-stomach-PRET
'inside the forest, *en la selva'* (cuaihtic)

f. noˈik.nih
/no-ikni-w/
1POS-sibling-PSM
'my sibling, *mi hermana/o'* (noicniuh)

In the examples in (16), the VV sequences could in principle be syllabified as a single syllable. However, they are syllabified such that each vowel corresponds to a separate syllable. Moreover, in these examples, there is a clear prominence on the penultimate syllable. The vowel sequences in (16b-f) are particularly illustrative of the no diphthong

claim since these are common diphthongs cross-linguistically (Maddieson 1984): [ao~aw], [ai], [ei], and [oi]. Here, whether in monomorphemic words or if the VV sequences are at a morpheme boundary, vowels are treated as separate syllables.

3.2.3 Stress

Nahuatl varieties are described in the literature as having word-level stress. Stress has consistently been reported to be on the penultimate syllable in a word. Penultimate stress has been reported in Matlapa Nahuatl (Croft 1951), Tetelcingo Nahuatl (Pittman 1954), North Puebla Nahuatl (Brockway 1963), Milpa Alta Nahuatl (Whorf, Campbell & Karttunen 1993), Morelos Nahuatl (Velasquez-Patiño 2014) and Classical Nahuatl (Karttunen 1983, Lockhart 2001, Andrews 2003, inter alia). Rio Balsas Nahuatl varieties have been reported to have "hybrid" word-prosodic systems in which tone has developed and penultimate stress is retained (Guion et al. 2010). Descriptions of the stress systems of the different varieties do not provide many details of the phonological evidence for stress-accent, if any. One exception is the description of Matlapa Nahuatl stress, where penultimate stress is reported to be evidenced by a pattern in which /o/ surfaces impressionistically as [u] in stressed syllables (Croft 1951), though perhaps these are fronted as in ChN. The acoustic correlates of stress in some Nahuatl varieties have been described as involving manipulations of pitch (Croft 1951; Whorf, Campbell & Karttunen 1993), as well as intensity, where stressed syllables are impressionistically perceptually higher-pitched and louder than unstressed syllables (Croft 1951); however, these are not based on instrumental analysis. Additionally, Guion et al. (2010), found spectral acoustic correlates of stress: in San Miguel Nahuatl, a non-tonal variety of Balsas Nahuatl, stressed vowels had a flatter spectral slope (H1–H2 and

H1–A2) than unstressed vowels. Differences in duration and F0 depended on phrasal position (p. 19).

Impressionistically, there is a prominence on the penultimate syllable in ChN. In this dissertation, I follow Hyman's (2006) definition of a stress-accent system as a system with word-level metrical structure that satisfies two criteria: obligatoriness and culminativity. These criteria are defined in (17).

17) Defining criteria of Stress-Accent systems (Hyman 2006, p. 231)

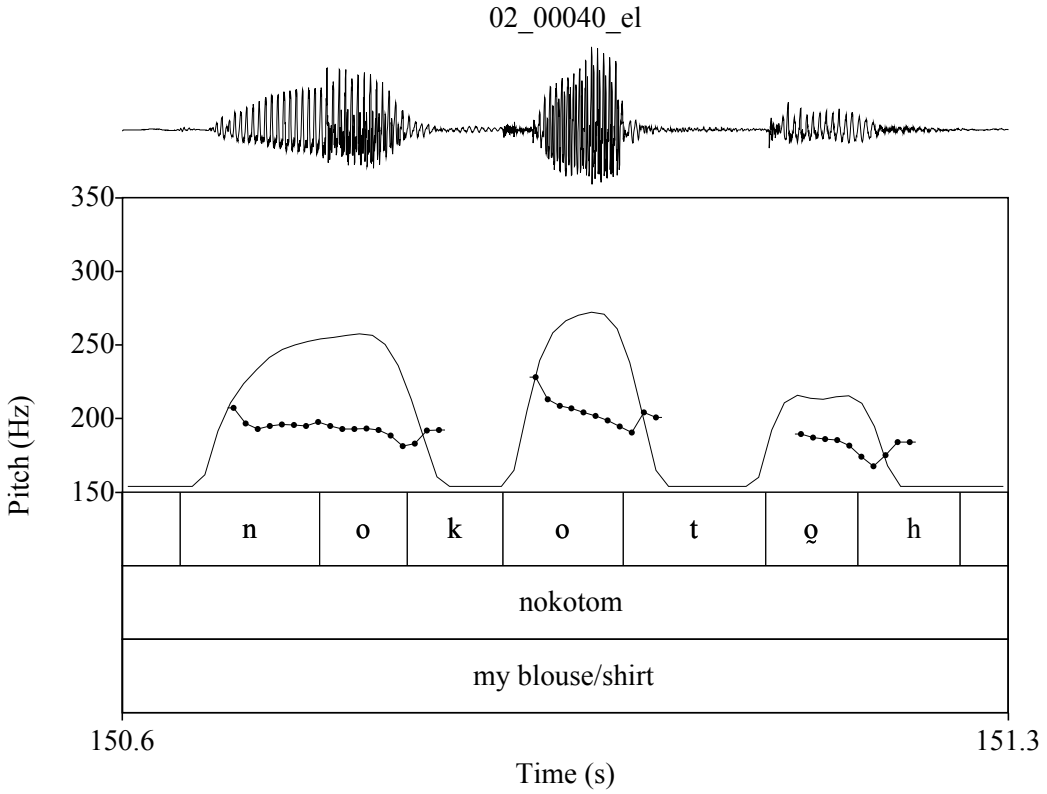
a. *obligatoriness*: every lexical word has at <u>least</u> one syllable marked for the highest degree of metrical prominence (primary stress);
b. *culminativity*: every lexical word has at most one syllable marked for the highest degree of metrical prominence.

The stress marks described in the examples in (18) are impressionistic. This perceived prominence, however, appears to meet Hyman's criteria: all words have at least one primary prominence (the penult), and each word has only one such prominence. The data in (18)[14] show a set of morphologically related words, where stress is regularly on the penultimate syllable as additional morphological material occurs on the right edge. Stress position is thus fixed.

[14] In compounds (see 18c), the preterit stem allomorph is used. This morphological alternation (between a vowel final and consonant final allomorph) is discussed in great detail in the next section of this chapter. CIRC refers to the diminutive circumfix /pil-X-t͡si͡tsi/ (18f).

18)	a.	ˈ**ko**t͡ʃi	/kot͡ʃi/	sleep	‘s/he sleeps, *duerme*’ (cochi)
	b.	kot͡ʃˈ**mi**ki	/kot͡ʃ-miki/	sleep.PRT-die	‘s/he is sleepy, *tiene sueño*’ (cochmiqui)
	c.	kot͡ʃmiˈ**ki**ja	/kot͡ʃ-miki-ja/	sleep.PRT-die-ADV	‘s/he is already sleepy, *ya tiene sueño*’ (cochmiquiya)
	d.	ˈ**mi**stoh	/miston/	cat	‘cat, *gato’* (miston)
	e.	misˈ**ton**meh	/miston-meh/	cat-PL	‘cats, *gatos*’ (mistonmeh)
	f.	piɬmistonˈ**t͡si**t͡si	/pil-miston-t͡sit͡si/	DIM-cat-CIRC.PL	‘little cats, *gatitos’* (pilmistontzitzi)

Pitch manipulations may be an acoustic correlate of penultimate stress in ChN. This is consistent with descriptions of other varieties of Nahuatl in which phonetic correlates of stress include a rise in pitch and intensity. The phonetic evidence I discuss here is purely impressionistic; nonetheless, it is still possible to describe a pattern in which peaks in f0 and intensity tend to occur on the penult. This suggests that f0/intensity targets are dependent on stress (i.e., they are “head”-marking) rather than aligning with word edges, as would be the case for targets associated with demarcative (“edge”-marking) functions (Jun 2014). In the example below, the pitch and intensity tracks over identical vowels (which avoid any confounding effects of vowel quality on intensity) demonstrate the characteristic pattern of words uttered in isolation: there is a H target aligning with the penult followed by a drop in both f0 and intensity in the final vowel.



*Pitch track (dotted line) and intensity track (solid line)

/no-kotom/
1POS-clothing
'my blouse/shirt, *mi blusa/camisa*' (nocoton) 02_00040_el.wav

Figure 7 Acoustic correlates of stress

As the example above shows, there is a high f0 target on the penult, suggesting a high pitch accent). The alignment of f0 targets in tokens Figure 7 like support an analysis of ChN as a stress-accent system since each word carries only one prominence and that prominence is obligatory. The important point here is that stress assignment is fixed and is thus assumed to be postlexical, occurring after morphological processes. Since these morphological processes include inflectional morphology, stress assignment is postlexical.

Monosyllabic words appear to have stress as well. In these cases, stress cannot land on the penult. Monosyllabic words are relatively scarce in the lexicon, but there is evidence from proclitics that monosyllabic words have stress. Proclitics appear to fall outside of the prosodic word and do not carry primary stress. Impressionistically, proclitics seem to have some sort of prominence, perhaps secondary stress. The data in (19) show that stress does not shift to the penultimate syllable, suggesting that proclitics are outside of the domain of stress assignment, outside of the prosodic word.

19) a. t͡ɬɛ̃
/t͡ɬen/
what/that
'what/that, *que/qué'* (tlen)

b. aʃ.ˈt͡ɬɛ̃
/aʃ = t͡ɬen/
NEG = what/that
'nothing/you're welcome, *nada/de nada*' (axtlen)

c. se
/se/
one
'one, *uno*' (ce)

d. jon.ˈse
/jon = se /
ADV = one
'zero, *zero*' (yonce)

Further evidence that proclitics seem to pattern differently in the phonology of the language is that the negation proclitic /aʃ-/ can surface as a syllabic [ʃ̩]. This is distinct from the syllable structure observed elsewhere in the language: there do not appear to be any syllabic consonants permitted, and as discussed earlier, no tautosyllabic consonant clusters like (including [ʃ͡t͡ɬ]) are allowed. This therefore supports the analysis that [aʃ.ˈt͡ɬɛ̃] 'nothing' consists of two prosodic units.

I now return to the inventory of sounds in Chicontepec Nahuatl. In the next section, the distribution of /h/ in ChN is described. This serves as a starting point for section 3.4, where the laryngeal sounds that result from lenition processes are discussed.

3.3 Contrastive laryngeal sound: [h]

3.3.1 Laryngeals in the Inventory

The glottal fricative is the only phonologically contrastive laryngeal sound in the inventory of ChN, and it has a restricted distribution: while all other consonants in the inventory are contrastive pre-vocalically in onsets, /h/ generally occurs post-vocalically in codas (exceptional cases will be described below). The examples in (20-21) demonstrate that [h] is a contrastive segment in ChN.[15]

20)	a.	noajo**h**	/no-ajoh/	1POS-squash	'my squash, *mi calabaza*' (noayoh)
	b.	noa:jo	/no-a:jo/	1POS-turtle	'my turtle, *mi tortuga*' (noayo)
	c.	ajo**h**t͡ɬi	/ajoh-t͡ɬi/	squash-ABS	'squash*, calabaza*' (ayohtli)
	d.	a:jot͡ɬ	/a:jo-t͡ɬ/	turtle-ABS	'turtle, *tortuga*' (ayotl)

[15] Note that many speakers use a possessum suffix [-h] for vowel-final possessed nouns and thus 'my turtle' [noa:joh] and 'my squash' [noajoh] are *nearly* homophonous, the contrast is maintained by vowel length and context.

As the examples in (20) show, [h] is contrastive word-finally (compare (20a) ‘my turtle’ with (20b) ‘my squash’). The absolutive form of these noun stems show that [h] is contrastive word-medially before a consonant (compare (20c) ‘squash’ with (20d) ‘turtle’). Here, [h] can be analyzed as a surface form of a contrastive segment /h/; that is, there is no evidence that these laryngeal articulations are the surface form of another contrastive sound nor that they are part of a morphological template as is the case for other articulations discussed in this chapter. The examples in (21) show a few minimal and near-minimal pairs that further show that /h/ is a contrastive segment. These forms all share parallel phonological environments. The consonants not shown here (such a /j/ or /w/) are not possible codas because of various phonological processes and restrictions which will be addressed throughout this chapter.

21) a. ˈo͡hn̥t͡ɬi ‘road, *camino*’ (ohtli)

b. ˈt͡so͡nn̥t͡ɬi ‘bundle of grass, *manojo de hierbas*’ (tzontli)

c. ˈpo͡kn̥t͡ɬi ‘smoke, *humo*’ (poctli)

d. ˈo͡tsn̥t͡ɬi ‘farm animal, *ganado*’ (otztli)

e. ˈko͡tʃn̥t͡ɬi ‘gulp of liguid, *un trago de agua*’ (cochtli)

f. ˈko͡sn̥t͡ɬi ‘necklace, *collar*’ (coztli)

g. aˈmo͡ʃn̥t͡ɬi ‘book, *libro*’ (amoxtli)

h. teˈt͡so͡pn̥t͡ɬi ‘something of stone/cement e.g. a patch, *algo de cemento y piedra, como un parche*’ (tetzoptli)

Pre-consonantal, or coda, [h] can occur before any other consonant in the inventory. The data in (22) show [h] occurring in consonant clusters with all consonants in the

inventory. There is no difference in the realization of [h] in stressed and unstressed syllables.[16]

22)	a.	_[p]	nomah**p**iɬ	'my finger, *mi dedo*' (nomahpil)
	b.	_[t]	itɬah**t**oɬ	'her/his words, *sus palabras*' (itlahtol)
	c.	_[k]	t͡ɬah**k**o	'half, *medio'* (tlahco)
	d.	_[k^{w}]	ah**k^{w}**eʃoa	'to sneeze, *estornudar*' (ahcuexoa)
	e.	_[t͡s]	kaht͡**s**ot͡ɬ	'jicama, *jicama*' (kahtzotl)
	f.	_[t͡ʃ]	t͡ʃaht͡**ʃ**a	'to spit, *escupir'* (chahcha)
	g.	_[t͡ɬ]	paht͡**ɬ**i	'medicine, *medicina/abono* (pahtli)
	h.	_[s]	ah**s**i	'to arrive, *llegar*' (ahci)
	i.	_[ʃ]	ah**ʃ**ilia	'to catch up, *alcanzar*' (ahxilia)
	j.	_[m]	ah**m**o	'no, *no*' (ahmo)
	k.	_[n]	nah**n**awa	'to hug someone, *abrazar*' (nahnahua)
	l.	_[l]	ih**l**ia[17]	'to say, *decir'* (iuhlia/ilhuia)
	m.	_[w]	ah**w**a	'to scold someone, regañar' (ahhua)
	n.	_[j]	akah**j**a	'someone, *alguien*' (acahya)

This distribution supports an analysis in which these tokens of [h] are associated with a segment /h/ rather than preaspiration, given that preaspiration is cross-linguistically mostly

[16] Note that the consonants that are found in Spanish loan words (/b, d, g, f, r, ɾ/) will not occur after [h] because of the phonotactic restrictions in Spanish: [x] does not occur in consonant clusters.

[17] I analyze this as /ihlia/ though the form in ChN seems to reflect a historical metathesis: /ilwia/ in other varieties can be analyzed as having been /iwlia/, where the labiovelar glide undergoes debuccalization as discussed later in this chapter. This may be the synchronic status, though it is represented here as reanalyzed and underlyingly /h/.

restricted to stops and affricates (Silverman 2003; Clayton 2010, though Roos 1998, reports preaspirated fricatives in Western Yugur and preaspirated /l/ is reported in Urarina by Elias-Ulloa & Aramburú 2019).

The distribution of /h/ in ChN is such that it mostly occurs as a coda. This is an interesting distribution since it has been shown that /h/ is more perceptually salient in the onset position and is not expected to have such a distribution (Silverman 1995/1997).[18] There are only three exceptions to this generalization in which /h/ occurs as an onset. In the following sections, these cases are discussed.

3.3.2 Loanwords

Loanwords from Spanish provide one of three sources of intervocalic [h], where Spanish intervocalic [x] is realized as [h] in ChN loanwords.[19] In addition, vowel-final Spanish loans occur with a final [h].[20] This pattern of final [h] insertion has been described

[18] Nonetheless, there are other languages such as Chamicuro (Parker 1994) with similar distributions of laryngeal sounds.

[19] Interestingly, some word-initial Spanish [x] were borrowed as [k], presumably early borrowings, such as [ˈkoseh] 'Joseph' from Spanish [xoˈse] *José*—this suggests that the velar feature was prominent in perceiving the Spanish name, which is perhaps connected to the relationship between [x] and [k], described later in this chapter.

[20] Final [h] seems to be a Mesoamerican areal feature of loanword adaptation reported in unrelated languages such as Yucatec Maya (Frazier 2009) and Sierra Popoluca (de Jong Boudreault 2009) and may stem from Nahuatl's status as a lingua franca and early Spanish borrowings via Nahuatl (Bright 1992). The [h]-final pattern is reminiscent of loanword adaptation in Wappo, where the added segments is [ʔ] rather than [h] (Sawyer 1981). Some loans end in [ʃ] rather than [h] such as [wakaʃ] 'cow' from Spanish [βaka], [mankaʃ] 'sleeves' from [maŋgas], [patoʃ] 'duck' from [pato], [alaʃoʃ] 'orange' from [naranxa]. This pattern of Spanish [s] to loanword [ʃ] is also reported for Kaqchikel (Adell 2014), Lachixío Zapotec (Sicoli 1999), Filomeno Mata Totonac (McFarland 2009), as well as

occurring in loanwords in other varieties as well (e.g., Key & Key 1954, Croft 1958, Goller et al. 1974,). The data in (23) show examples of Spanish loanwords.

23)	a.	ˈhaimeh	from [Jaime] *Jaime*	'James' (Haime)
	b.	maneharoa	from [maneˈxaɾ] + [oa] *manejar*	'to drive' (maneharoa)
	c.	tiˈheras	from [tiˈxeras] *tijeras*	'scissors' (tiheras)
	d.	alfeˈhores	from [alfaˈxoɾes] *alfajores*	'a dessert' (alfehores)
	e.	parehoˈmana[21]	from [paˈɾexo] + [mana] *parejo*	'to make even in height' (parejomana)
	f.	koˈlantoh	possibly from [kuˈlantɾo] *culantro* or [siˈlantɾo] *cilantro*	'cilantro/coriander' (colantoh)
	g.	ˈfolsah	from [ˈβolsa] *bolsa*	'bag' (folsah)

3.3.3 Compounding and noun-incorporation

Another source of intervocalic [h] is compounding and noun-incorporation. A morphological juncture where the left morpheme is [h]-final and the right morpheme is vowel-initial results in an intervocalic/onset [h]. For example, [pahoni] /pah-oni/ medicine-

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in a few other American languages by Kiddle (1952). It is possible that these forms were borrowed (and *mankaʃ* make sense) from the plural forms in Spanish, which are [s]-final. Why Spanish /s/ would be borrowed as [ʃ] is unclear. Perhaps these were early borrowings and the Spanish /s/ encountered were apical [s̪] (a noisier "s") as in many Iberian varieties rather than the laminal [s̻] of Mexican Spanishes and Nahuatl, or as has been proposed by others, early colonial "s" was retracted (Sicoli 1999) and presumably also noisier and [ʃ]-like.

[21] [parehomana] does not end in an [h] because it is a compound of the Spanish word *parejo* and the Nahuatl word *mana* 'to place something', and as a native Nahuatl verb, it can be inflected without the productive [-oa] verbalizing suffix used in adapting Spanish verbs such as [maneharoa] from [manexaɾ] 'to drive'.

drink ‘take medicine’ shows that noun-incorporation of an [h]-final stem (like [pah] ‘medicine’) with a vowel-initial stem (like [oni] ‘drink’) can be a source of novel intervocalic [h].

3.3.4 Reduplication

Reduplication provides the third source of intervocalic/onset [h]. This is a morphologically conditioned distribution of [h]. The principal reduplication pattern in ChN can be analyzed as prefixing reduplication that involves copying the leftmost CV of the verb root (with a loss of vowel length) and the insertion of a glottal fricative, (C)V + h, where the glottal fricative may be analyzed as a fixed segment of the reduplicative construction.[22] Reduplication has a number of functions/meanings in ChN including intensifying, distributive, or iterative. The data in (24) below show examples of reduplication in ChN. Here, the morphologically conditioned [h] is italicized in the underlying representation to differentiate it from other sources of [h].

[22] There appears to be a second reduplication pattern that adds the meaning of “after all” that involves copying the leftmost CV and lengthening the vowel. The reduplicant structure is thus /(C)V*ː*~/ rather than the /(C)V*h*~/ pattern described above: /maka/ ‘to give something to someone’, /mah~maka/ ‘to distribute things’, /maː~maka/ ‘to give something to someone after all’.

24)	a.	kipa:ka	/ki-pa:ka/	3OBJ-wash	‘s/he washes it, *lo lava*’ (quipaca)
	b.	kipahpa:ka	/ki-pa*h*~pa:ka/	3OBJ-RED~wash	‘s/he washes many things, *lava muchas cosas*’ (quipahpaca)
	c.	nemi	/nemi/	walk	‘s/he walks, *camina*’ (nemi)
	d.	nehnemi	/ne*h*~nemi/	RED~walk	‘s/he walks around, *camina*’ (nehnemi)

The data above exemplify reduplication with consonant-initial stems: the initial CV of the stem is copied with the addition of the glottal fricative. The data in (25) show reduplication in vowel-initial stems.

25)	a.	a͡tʃi	/a͡tʃi/	piece	‘a piece of something, *un pedazo*’ (achi)
	b.	aha͡tʃi	/a*h*~a͡tʃi/	RED~piece	‘in small portions, *en pedacitos*’ (ahachi)
	c.	kiʔita	/ki-ita/	3OBJ-see	‘s/he sees it, *lo ve*’ (quiitta)
	d.	kiʔihita	/ki-i*h*~ita/	3OBJ-RED~see	‘s/he goes over something, *lo revisa*’ (quiihitta)

Vowel-initial stem reduplication results in intervocalic [h] since the first vowel is the only element copied and occurs with the [h] as a fixed segment. I analyze the glottal fricative as part of the reduplicant template because it occurs in every case of this type of reduplication, whether or not there is a glottal fricative in the stem (such as (25b) and (25d)). It is clear that this glottal fricative is not derived by a phonological process such as

devoicing of the second vowel in the nucleus because not all cases of reduplication copy a base with a long vowel (e.g., (24b) vs. (24d)). Moreover, as will be clear from the discussion below, this glottal fricative does not arise from one of the phonological alternations discussed in this chapter, given that this [h] can occur pre-vocalically rather than only pre-consonantally or word-finally. As in the case of intervocalic [h] in Spanish loan words (at least impressionistically), [h] forms the onset of the syllable. There is evidence that there is a preference for CV syllable shapes in VCV sequences such that syllabification of such a string is V.CV rather than *VC.V. This evidence is also relevant in the distribution of non-nasal sonorants. A VCV sequence in which the C is /l/ will always be the voiced lateral approximant [l]. Coda /l/ always surfaces as [ɬ], which is not the surface form of the intervocalic /l/: for example /alaʃoʃ/ ‘orange (fruit)’ is syllabified [a.la.ʃo̱ʃ] rather than *[aɬ.aʃ.oʃ].

3.3.5 Preterit Stems

In this and the next section (3.3.6), I describe two additional morphological constructions that result in glottal fricatives. I begin with the preterit construction where morphologically-conditioned glottal fricatives surface in two classes of verbs. There are classes of verbs that alternate between stem forms in various constructions. In the Nahuatl literature, the alternant form is often called the *preterit stem* because the preterit construction is the diagnostic for whether or not there is an alternation—the shape of the alternant stem allows for grouping verbs into classes in many varieties of Nahuatl (Pittman 1954, Kimball 1990, Lockhart 2001, Andrews 2003, inter alia). However, the stem allomorph is used in other constructions such as the progressive and in compounding (recall (18b) [kot͡ʃmiki]

's/he is sleepy', where the verb [kot͡ʃi] takes the preterit form [kot͡ʃ-] in compounds). The two patterns are demonstrated in (26) below:

26) Class 1 verbs without preterit stem allomorphy (single exponent)

a.	nitemo	/ni-temo/	1SUBJ-descend	'I descend, *bajo'* (nitemo)
b.	nitemok	/ni-temo-k/	1SUBJ-descend-PRET	'I descended, *bajé'* (nitemoc)
c.	nit͡ʃoka	/ni-t͡ʃoka /	1SUBJ-cry	'I cry, *lloro'* (nichoca)
d.	nit͡ʃokak	/ni-t͡ʃoka-k/	1SUBJ-cry-PRET	'I cried, lloré' (nichocac)

Class 2 verbs with preterit stem allomorphy (multiple exponence)

e.	nikot͡ʃi	/ni-kot͡ʃi/	1SUBJ-sleep	'I sleep, *duermo*' (nicochi)
f.	nikot͡ʃki	/ni-kot͡ʃ-ki/	1SUBJ-sleep.PRT-PRET	'I slept, dormí' (nicochqui)
g.	nikisa	/ni-kisa/	1SUBJ-leave	'I leave, *salgo'* (niquiza)
h.	nikiski	/ni-kis-ki/	1SUBJ-leave.PRT-PRET	'I left, *salí'* (niquizqui)

For all verbs in ChN, such as in (26a, c, e, g), the verb root in the present tense is vowel-final. In the preterit construction there is an alternation for one class of verbs that is characterized by a consonant-final alternant (26f, h) (compare with (26b, d)). This can be analyzed as realizational morphology like that described in related Tohono O'odham in (10): final vowels are deleted in these morphological constructions. In sum, for Class 1 verbs, the preterit construction is marked by a suffix [-k]. For the remaining verb classes, the preterit construction is marked by both stem allomorphy and a suffix [-ki]—multiple exponence.

For a subset of these alternating verbs, Class 3 and 4, preterit stems are [h]-final. For Class 3 verbs only, the preterit suffix is optional in the preterit construction (a class of verbs ending in [-oa] or [-ia][23] when uninflected, e.g. (27a, e)). Note that unlike (26f, h), where the pattern appears to be an alternation derived by deleting the final vowel, for these verbs, the alternation is derived by an alternation of the final vowel with [h] (possibly analyzed as a realizational morphological process of devoicing), but only in the preterit construction.[24]

27)	a.	t͡ɬaʃkaˈloa	/t͡ɬaʃkaloa/	make.tortilla	‘s/he makes tortillas, *hace tortillas/tortear*’ (tlaxcaloa)
	b.	t͡ɬaʃkaˈlo**h**ki	/t͡ɬaʃkaloh-ki/	make.tortilla.PRT-PRET	‘s/he made tortillas, *hizo tortillas*’ (tlaxcalohqui)
	c.	t͡ɬaʃˈkalo**h**	/t͡ɬaʃkaloh/	make.tortilla.PRT	‘s/he made tortillas, *hizo tortillas*’ (tlaxcaloh)
	d.	t͡ɬaʃkaˈɬki	/t͡ɬaʃkal-ki/	make.tortilla.PRT-PRET	‘s/he made tortillas, *hizo tortillas*’ (tlaxcalqui)
	e.	maɬˈtia	/maltia/	bathe.oneself	‘s/he bathes, *se baña’* (maltia)
	f.	maɬˈti**h**ki	/maltih-ki/	bathe.oneself.PRT-PRET	‘s/he bathed, *se bañó’* (maltihqui)
	g.	ˈmaɬti**h**	/maltih/	bathe.oneself.PRT	‘s/he bathed, *se bañó’* (maltih)

[23] It is unclear if the final vowel on this verbal ending is a long vowel, though it has been analyzed as such in other varieties ([oaː] and [iaː]). Verbs that end in [ia] are often causative and applicative constructions ([-tia] and [-lia].

[24] An alternative analysis is that there are two preterit markers /-h/ and /-k/ which can cooccur as multiple exponence in Class 3 and 4. Class 3 and Class 4 would then be distinguished by the application or non-application of the final-vowel-deleting realizational process responsible for the Class 2 alternations described above: Class 3 t͡ɬaʃkaˈloa > t͡ɬaʃkaˈlo > t͡ɬaʃkaˈlo-h > t͡ɬaʃkaˈlo-h-ki ‘s/he made tortillas’, and Class 4 kikʷaː > kikʷaː-h > kikʷaː-h-ki ‘s/he ate it’.

Given that there are two options for this construction, one in which there is both the glottal fricative and the past tense marker (27b) and (27f), and one in which the glottal fricative is the only marker of preterit (27c) and (27g), there is a difference in the morphological role of the glottal fricative in these pairs of alternate forms (note that (27d) included for completeness, shows a pattern specific to Class 3 verbs ending in [loa] or [lia] where there is further truncation in the preterit stem). In one form, the glottal fricative marks the preterit form in conjunction with the preterit marker /-k(i)/ that occurs across all verb classes. In the second form, the glottal fricative is the single exponent of the preterit construction. Thus, in the first case, we have multiple exponence. We can tell that this [h] is specifically associated with the preterit tense because it does not occur in other constructions for these verbs as shown in (28) for [t͡ɬaʃkaloa] 'to make tortillas'.

28)	a.	t͡ɬaʃˈkalos	/t͡ɬaʃkalo-s/	make.tortilla-FUT	's/he will make tortillas, *hará tortillas*' (tlaxcaloz)
	b.	t͡ɬaʃkaloˈjaja	/t͡ɬaʃkalo-jaja/	make.tortilla.IMP	's/he used to make tortillas, *torteaba'* (tlaxcaloyaya)
	c.	t͡ɬaʃˈkalosˈkia	/t͡ɬaʃkalo-skia/	make.tortilla-COND	's/he would make tortillas, *haría tortillas*' (tlaxcalozquia)

As the data in (28) demonstrate, the inflected stem is [t͡ɬaʃkalo-], suggesting that the [a] in Class 3 verbs is some sort of verbal or present tense marker specific to this class of verbs (e.g. [t͡ɬaʃkalo-a]). This class of verbs patterns differently than the other verb classes which have one stem such (26a-b) [temo-] 'descend' or two stem allomorphs such as (26e-f)

[kot͡ʃi-] and [kot͡ʃ-] in that it has three verb stem allomorphs: present [t͡ɬaʃkaloa-], preterit/perfect [t͡ɬaʃkaloh-] and remaining tense constructions [t͡ɬaʃkalo-]. The future, imperfect and conditional forms for /temo/ 'descend' (class 1) and /kot͡ʃi/ 'sleep' (class 2) are provided below in (29) for comparison with (27) and (28).

29)	a.	nitemos	/ni-temo-s/	1SUBJ-descend-FUT	'I will descend, *bajaré'* (nitemoz)
	b.	nitemojaja	/ni-temo-jaja/	1SUBJ-descend-IMPRF	'I used to descend, *bajaba*' (nitemoyaya)
	c.	nitemoskia	/ni-temo-skia/	1SUBJ-descend-COND	'I would descend, bajaría' (nitemozquia)
	d.	nikot͡ʃis	/ni-kot͡ʃi-s/	1SUBJ-sleep-FUT	'I will sleep, *dormiré'* (nicochiz)
	e.	nikot͡ʃijaja	/ni-kot͡ʃi-jaja/	1SUBJ-sleep -IMPRF	'I used to sleep, *dormía*' (nicochiyaya)
	f.	nikot͡ʃiskia	/ni-kot͡ʃi-skia/	1SUBJ-sleep-COND	'I would sleep, *dormiría*' (nicochizquia)

This discussion of preterit stems accomplishes two goals. First, I establish that there are glottal fricatives that arise in the templatic stem allomorphy for two classes of verbs in ChN. Second, it introduces the types of realizational morphology (final-vowel deletion), that is used to demonstrate phonological alternations in subsequent sections of this chapter. The distribution of preterit stem constructions is summarized in the table below.

Table 4 Summary of Preterit Stem alternations

	Class 1	**Class 2**	**Class 3**	**Class 4**
Present Tense	**No change** t͡sah t͡si cry 's/he cries, *llora*' (tzahtzi)	**No change** kot͡ʃi sleep 's/he sleeps, *duerme*' (cochi)	**Final [-a]** ki-t͡ɬat͡ʃili-a 3OBJ-watch-VRB 's/he watches over someone, *la/o cuida'* (quitlachilia)	**No change** ki-kʷaː 3OBJ-eat 's/he eats, *come'* (quicua)
Future Tense	**No change** t͡sah t͡si-s cry-FUT 's/he will cry, *llorará'* (tzahtziz)	**No change** kot͡ʃi-s sleep-FUT 's/he will sleep, *dormirá'* (cochiz)	**No change** ki-t͡ɬat͡ʃili-s 3OBJ-watch-FUT 's/he will watch over someone, *la/o cuidará'* (quitlachiliz)	**No change** ki-kʷaː-s 3OBJ-eat-FUT 's/he will eat, *comerá'* (quicuaz)
Preterit Tense	**No change** t͡sah t͡si-k cry-PRET 's/he cried, *lloró'* (tzahtzic)	**Delete final vowel** kot͡ʃ-ki sleep.PRT-PRET 's/he sleept, *durmió'* (cochqui)	**Final [h]** ki-t͡ɬat͡ʃilih 3OBJ-flee.PRT 's/he watched over someone, *la/o cuidó'* (quitlachilih) but also: [kit͡ɬat͡ʃilihki] & [kit͡ɬat͡ʃiɬki] (quitlachilih, quitlachilihqui, quitlachilqui)	**Final [h]** ki-kʷaːh-ki 3OBJ-eat.PRT-PRET 's/he ate, *comió'* (quicuahqui)

3.3.6 Plural Marking

Plural marking in verbs also provides a case where the glottal fricative is the single exponent of a morphological construction. The data in (86) contain contrasting pairs in the

present tense construction where the glottal fricative is the morphological exponent of plurality (the *-h* plural suffix).

30)	a.	tiahki	ti-ahki	2SUBJ-swim	'you swim, *nadas*' (tiahqui)
	b.	tiahki**h**	ti-ahki-h	1SUBJ-swim-PL	'we swim, *nadamos*' (tiahquih)
	c.	ahki	ahki	swim	's/he swims, *nada'* (ahqui)
	d.	ahki**h**	ahki-h	swim-PL	'they swim, *nadan*' (ahquih)

In these pairs, the glottal fricative is not only a contrastive segment, but is the single exponent of an inflectional morpheme. The first-person plural and second-person singular prefixes share the same phonological form but are distinguished by the presence or absence of the plural marker (86a-b). In (86c-d) the data show that the third person takes no person prefix and could be analyzed as /Ø-ahki-Ø/, zero marked for person and number. The bare verb is third person singular while the plural suffix marks the form as third person plural. These examples in (86) are different from those in (20a-c), the near-minimal pair [ajoht͡ɬi] 'squash' and [a:jot͡ɬ] 'turtle' which is governed by the lexical phonology, because the [h] is consistently in the same construction, with the same meaning (plurality) across all words.[25]

[25] After the future or preterit suffixes, the plural [h] surfaces as [eh] and could be analyzed as an allomorphic plural marker [-eh], or alternatively, the [e] could be analyzed as an epenthetic vowel: [ahkiseh] 'they will swim' (cf. [ahkis] 's/he will swim') and [ahkikeh] 'they swam' (cf. [ahkik] 's/he swam'.

In this section I have shown that /h/ is a phoneme in ChN and in addition to building lexical entries, is involved in a number of morphological constructions such as templatic structures and as realizational morphology resulting in stem alternation. These are glottal fricatives [h] that can only be analyzed as underlyingly /h/. However, the constellation of laryngeal articulations in ChN is more complex. In the next section, I describe [h] resulting from lenition processes targeting nasal stops, the labiovelar glide, and velar stops.

3.4 Lenition and Debuccalization

In this section, phonological processes of lenition that result in glottal fricatives are discussed. In the literature, debuccalization processes are generally treated as a subset of lenition (Lavoie 1996, Kirchner 2001, Gurevich 2004, Bauer 2008, Gess 2009, O'Brien 2012, Katz 2016, inter alia). The term lenition has been used to describe a wide range of diachronic and synchronic processes. Katz (2016) makes the case for two subsets of lenition: *loss lenition* and *continuity lenition.* These are defined in (31) below:

31) Loss Lenition and Continuity Lenition

a. **loss lenition** "is meant to suggest the loss of length, features or gestures; it also often entails the loss of one or more contrasts. It generally targets consonants or contrasts in perceptually weak positions, such as the ends of prosodic domains. Debuccalisation (e.g. [k'] → [ʔ]) is an example of loss lenition." (p.43)

b. **continuity lenition** "often targets consonants in perceptually strong positions, for example between vowels. Unlike loss lenition, it rarely neutralises contrasts that are present elsewhere in a language; instead it is generally accompanied by domain-initial fortition. Spirantisation (e.g. [k] → [x]) is an example of continuity lenition" (p. 44)

The lenition processes in ChN presented here mostly fall under the category of loss lenition: lenition processes described here target nasals stops, the labio-velar glide, and velar stops. In these cases, there is a loss of features or gestures (i.e. debuccalization) and neutralization with a contrastive sound in the inventory [h]. All of these processes target codas, which is a perceptually and phonologically weak or dispreferred position (i.e. the *maximal onset principle* (Kahn 1976) and the *coda condition* (Itô 1986)). Two cases of continuity lenitions are described here targeting velar stops, one of which seems to be triggered by loss lenition. In these cases of continuity lenition there is no neutralization with native ChN consonants, and the targeted sound is in a phonologically and prosodically strong position. The distinction between stop lenition and continuity lenition is a useful analytical tool. However, as the discussion of lenition processes targeting velar stops will show, the boundaries between these two types of lenition can be somewhat blurred. Nonetheless, many of the processes described here can be clearly argued to be examples of loss lenition as they are examples of debuccalization processes in ChN. Here, I begin with the definition of debuccalization given in O'Brien (2012, p. 3) below in (32):

32) **Debuccalization** is any sound change or synchronic alternation that turns an oral consonant into a laryngeal consonant ([h], [ɦ], or [ʔ]).

In this definition, only glottal segments are included as possible outputs. However, as I show in the next section, I expand this definition to include a placeless nasal following Trigo (1988) (though O'Brien does treat nasal absorption, discussed below, as a form of debuccalization).

In this chapter, I describe debuccalization processes targeting nasals, the labiovelar glide, and velar stops. The first two are typologically rare. In the survey presented O'Brien (2012), no cases of nasal debuccalization resulted in glottal fricatives. Only two languages, Yoruba (Akinlabi 1992) and Pipil (Campbell 1985), are reported to have [h] resulting from /w/. This pattern in Pipil is not surprising, since it is closely related to ChN. And the pattern described in Yoruba is quite distinct, occurring only before nasalized homorganic vowels. Velar stops debuccalizing to [h] is attested in the world's languages, however /k/ debuccalization to [ʔ] is more widely attested in the survey: roughly four cases of /k/→[h] versus roughly seven k→[ʔ], not counting /k'/→[ʔ] or stops→[ʔ][26] in O'Brien (2012) which increases the number of examples.

3.4.1 Word-final Nasal Debuccalization

A source of laryngeal articulations is a process of debuccalization of word-final nasals. In this section, the alternation between nasal stops and [h] in ChN is shown. In prevocalic contexts, there are two contrastive nasals, /m/ and /n/, as evidenced in the minimal pair in (33).

33)	a.	**m**omah	/mo-mah/	2SG.POS-hand	'your hand, *tu mano*' (momah)
	b.	**n**omah	/no-mah/	1SG.POS-hand	'my hand, *mi mano*' (nomah)

[26] Including these, assuming velars stops are in the "stops" inventory, would result in ~9 [h] vs. ~15 [ʔ].

In the word-internal coda contexts, nasals undergo place assimilation to the following consonant in the cluster, as shown in (34).

34)	a.	**kam**pot͡stik	/ka**N**-pot͡stik/	cheek-full	'for one's mouth to be full of food, *tiene la boca llena*' (campotztic)
	b.	**kan**temi	/ka**N**-temi/	cheek-swell	'for one's cheeks to swell, *tener los cachetes hinchados*' (cantemi)
	c.	**kan̲**ʃima	/ka**N**-ʃima/	cheek-shave	'to shave one's face, *rasurase la cara*' (canxima)

In (34) the stem /kaN/ 'cheek' demonstrates the distribution of nasals in ChN in different phonological environments. Because of nasal place assimilation, it is not clear which nasal stop is in the underlying representation, so I represent it with an archiphoneme /N/. The data in (35) show an underlying /m/ surface as [ŋ] in the context of a velar and [n] in the context of an alveolar sound.

35)	a.	nehnemi	/nehnemi/	walk	's/he/it walks, *camina*' (nehnemi)
	b.	nehneŋki	/nehnem-ki/	walk.PRT-PRET	's/he/it walked*, caminó'* (nehnenki)
	c.	nehnentika	/nehnem-tika	walk.PRT-PROG	's/he/it is walking, *caminando'* (nehnentica)

Nasal stops exhibit alternations with a glottal fricative [h], in morphologically related words. I describe this process as *word-final nasal debuccalization* (WFND), though it also

involves loss of voicing as well as nasality, e.g., the possessed form of the stem ‘cheek’ shown in (34) is [ika**h**] /i-ka**N**/ ‘her/his cheek’.[27] The process is described in (36).

36) Word-final Nasal Debuccalization

/ + nasal/→[h]/___]$_{WORD}$

The data in (37) show that both nasal stops (/m/ and /n/) alternate with [h] in word-final contexts.[28]

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[27] It should be mentioned that this is an empirical question and remains to be tested with airflow measurements to see if there is any residual nasality. There might be nasal airflow given that nasality is not lost in monosyllabic words and the rare words with final stress: /ˈVN/→[ˈṼ]/__]$_{WORD}$

[28] Lenition processes targeting word-final nasals are widespread across Nahuatl varieties. So much so, that Boas (2017/1917), when describing Pochutec, noted that word-final nasals and /l/ were voiced in Pochutec in contrast with Valley of Mexico Nahuatl varieties where all consonants (including nasals and *l*) were voiceless word finally. This is likely a long-standing process in Nahuatl varieties evident in the varying realization of the locative suffixes “*-tlan”, “-can”* and *“-pan”* in contemporary place names throughout Mexico since Nahuatl place names were established throughout “New Spain” during the colonial period (e.g. Analco in Santa Fe, NM). Below are examples of contemporary place names with and without final nasals.

-tlan		*-(t)lan*		*-can*		*-pan*	
Tepos**tlan**	Papan**tla**	Cuetza**lan**	Guatema**la**	Michoa**can**	Amecame**ca**	Urua**pan**	Xala**pa**
Maza**tlan**	Cuau**tla**	Ocui**lan**	Tequi**la**	Singuilu**can**	Tolu**ca**	Acto**pan**	Tegucigal**pa**

The pronunciation of these names in Mexican Spanish is interesting because, with the exception of *-pan* and *Singuilucan*, they reflect the stress patterns of Spanish such that the native Nahuatl penultimate stress is allowed in the forms that reflect debuccalization ([paˈpantla]), while the stress shifts to the ultima in names with orthographic final *n*s ([teposˈtlan], except *Tonalá* which has the n-final stress pattern with no final *n*. The state name of *Chiapas* is derived from Nahuatl Chiapan [t͡ʃia-pan] ‘place of chia’. This form again points to nasal debuccalization to [h] in other varieties of Nahuatl (and rhinoglottophilia). Perhaps the final “s” in the name was a reanalysis of final [h] by local Spanish speakers since many local varieties are “aspirating” dialects of Spanish where /s/ alternates with [h].

37)	a.	sin͡tɬi	/sin-t͡ɬi/	corn-ABS	'corn, *maíz'* (cintli)
	b.	nosi**h**	/no-si**n**/	1POS-corn	'my corn, *mi maíz*' (nocin)
	c.	t͡ʃan͡tɬi	/t͡ʃan-t͡ɬi/	home-ABS	'home, *hogar'* (chantli)
	d.	no t͡ʃa**h**	/no-t͡ʃa**n**/	1POS-home	'my home, *mi hogar*' (nochan)
	e.	komit͡ɬ	/kom-it͡ɬ/	pitcher-ABS	'pitcher, *cántaro'* (comitl)
	f.	noko**h**	/no-ko**m**/	1POS- pitcher	'my pitcher, *mi cántaro*' (nocon)
	g.	kotomit͡ɬ	/koto**m**-it͡ɬ/	cloth-ABS	'cloth/article of clothing, *tela/ropa*' (cotomitl)
	h.	nokoto**h**	/no-koto**m**/	1POS-cloth	'my cloth/article of clothing, *mi tela/ropa*' (nocoton)
	i.	nama**h**	/nama**n**/	now	'now, *hora'* (naman)
	j.	naman͡tsih	/nama**n**-t͡sih/	now-DIM	'right now, *ahorita'* (namantzin)

In the possessive construction in ChN, many stems are word-final without affixation.[29] The forms with absolutive suffixation in (37) provide evidence that there is an underlying nasal. The [-it͡ɬ] allomorph, which attaches to labial-final stems (shown in (37)), provides an intervocalic context that shows the place of articulation of the nasal. The bilabial nasals in (37f, h) are stem-final and therefore word-final in the possessive construction,

[29] A number of stems take a possessive marker /-w/ which has two surface forms: [-h] and [-wi]). This alternation is discussed in more detail below.

surfacing as a [h]. These types of alternations provide the only evidence for the surface form of underlying /m/ in the word-final context.

As these data have shown, the debuccalization process seems to be limited to the word-final context. The distribution of nasals in the word can be accounted for if we treat debuccalization as a total loss of oral place specifications (Harris 1984, Trigo 1988, De Lacy 2002). In this analysis we can propose a rule in which coda nasals are debuccalized across the board rather than limiting this process to the word-final context. Word-medially, coda nasals occur in consonant clusters and undergo place assimilation, which falls out from treating debuccalization as resulting in orally placeless nasal segments. Word-medial coda nasals then get place features from adjacent sounds. In the word-final context without an adjacent sound, it is realized as [h] when unstressed, losing voice and nasality in this context. The revised debuccalization analysis can be summarized as in (38) below.

38) Coda-Nasal Debuccalization

$/+\text{nasal}/ \rightarrow [-\text{place}] / \_\_\_]_{\text{CODA}}$

In the word final context, we must specify two surface patterns: for unstressed word-final nasal and stressed final nasals. The debuccalization pattern shown in the data in (37) is for unstressed final nasals, which surface as [h]. The majority of nasal-final words are of this type since stress is with a few exceptions described in (§3.2.3), on the penultimate syllable. In stressed contexts, there is variation among speakers: nasal absorption (Trigo 1988, O'Brien 2012) resulting in nasalization of the vowel, or the assignment of a default alveolar nasal, similar to Harris's proposal for standard and non-standard Spanish varieties (1984). In

the discussion of stress, in (8) repeated here with more data in (39) below), monosyllabic words were argued to have stress. There is a limited number of nasal-final monosyllables (outside of loanwords), though they are high-frequency functional words. For most of these I have found that they vary freely between nasalization Ṽ and [n]. Only (39g-h) seem to have only occurred as alveolar stops in my recordings.[30]

39) a. [t͡ɬɛ̃] ~ [t͡ɬen] 'what/that, *que/qué'*
b. [aʃˈt͡ɬɛ̃] ~ [aʃˈt͡ɬen] 'nothing/you're welcome, *nada/de nada*' (axtlen)
c. [t͡ɬã] ~ [t͡ɬan] 'if, *si'* (tlan)
d. [kã] ~ [kan] 'where, *dónde*' (can)
e. [kɛ̃] ~ [ken] 'how, *cómo*' (quen)
f. [sã] ~ [san] 'only, *sólo*' (zan)
g. [pan] 'in/on/at, *en*' (pan)
h. [wan] 'and/with, *con'* (huan)

This suggests that in stressed contexts, debuccalized nasals can revert to a default alveolar nasal (following Harris 1984), unlike in other languages where the default nasal is argued to be a placeless nasal (surfacing as [ŋ] or an [ɴ]-like sound) or a nasal aspirated offglide [h̃] (Harris 1984, Trigo 1988, de Lacey 2002). In sum, under this analysis, the phonetic implementation of debuccalized/placeless nasals in the word-final context is sensitive to stress. The derivation for the nasal surface patterns would work as follows:

[30] There is a possibility that a default [n] realization is less common among monolingual speakers, since Spanish has word-final [n]. This could be explored in Chicontepec, Veracruz.

40) Coda-Nasal Debuccalization Derivation

	/nehnem/ + /-tika/	/sin/ + /-t͡ɬi/	/no-/ + /sin/	/t͡ɬen/
Affixation	nehnem-tika	sin-t͡ɬi	no-sin	t͡ɬen
Coda-Nasal Debuc.	neh.neN.ti.ka	siN.t͡ɬi	no.siN	t͡ɬeN
Nasal Place Assim.	nehnentika	sint͡ɬi	—	—
Stress Assignment	nehnenˈtika	ˈsint͡ɬi	ˈnosiN	ˈt͡ɬeN
Surface Form	nehnenˈtika	ˈsint͡ɬi	ˈnosih	ˈt͡ɬɛ̃
	‘s/he walks, *camina’* (nehnentica)	‘corn, *maíz*’ (cintli)	‘my corn, *mi maíz*’ (nocin)	‘what, *qué’* (tlen)

There is further evidence that supports a debuccalized nasal analysis rather than some other type of alternation. There is a process of palatal assimilation in which sequences of underlying consonants and palatal glides /C-j/ surface following three distinct patterns: if the C is [+ continuant], it surfaces as [C] (attested assimilating sequences: /l-j/→[l], /ʃ-j/→[ʃ], /s-j/→[s]). An example of this pattern is discussed in more detail below in (50). On the other hand, [–continuant] sounds result in an [hC] surface form (attested assimilating sequences: /k-j/ →[hk], /t͡ʃ-j/→[ht͡ʃ], /t͡s-j/→[ht͡s]). This will be discussed further below in (66). In both of these cases, I describe the process as palatal glide assimilation because the analysis is that sequences of /C-j/→|CC|→[C]/[hC]. The distribution of palatal glide assimilation is accounted for by phonotactic constraints against sequences of identical sounds, which play out differently for [–continuant] and [+ continuant sounds]. These are summarized below:

41) Palatal Glide Assimilation

a. $\overset{C}{[+\text{continuant}]}$ /C-j/→|CC|→[C]

b. $\overset{C}{[-\text{continuant}]}$ /C-j/→|CC|→[hC]

c. $\overset{C}{[-\text{place}]}$ /C-j/→[Cj]

The CC sequence reduces to C when the CC are [+continuant] sounds (seen here in palatal assimilation and previously in lateral assimilation in the absolutive suffix), while the first C debuccalizes when the CC are [–continuant] sounds. The motivation for treating the [hC] sequences as debuccalized CC sequences will be discussed in detail in section 3.4.3, but there is evidence that sequences of velar stops /kk/ surface as [hk]. Both processes, degemination and debuccalization, can be treated as forms of lenition (Gurevich 2011). The third pattern is specific to nasals and [h]. The pattern for these sounds is that they do not participate in assimilation and surface fully faithfully. The data in (42) show this pattern in an adjectival construction in which the affix is /j/-initial.

42) **V-final, h-final, N-final**

a.	sokit͡ɬ	/soki-t͡ɬ/	mud-ABS	'mud, *lodo/zoquete'* (zoquitl)
b.	soki**j**oh	/soki-joh/	mud-ADJ	'muddy, *embarrado'* (zoquiyoh)
c.	paht͡ɬi	/pah-t͡ɬ/	fertilizer-ABS	'medicine/fertilizer/herbicide, *medicina/abono*' (pahtli)
d.	pah**j**oh	/pah-joh/	fertilizer-ADJ	'a field with a lot of fertilizer/ herbicide, *lleno de abono*' (pahyoh)
e.	ilimoh	/ilimon/	lime	'lime (citrus), *limón'* (ilimon)

f.	ilimon**j**oh[31]	/ilimon-joh/	lime-ADJ	'limey, *con mucho limón'* (ilimonyoh)
[+continuant]				
g.	t͡ɬaʃkali	/t͡ɬaʃkal-i/	tortilla-ABS	'tortilla, *tortilla*' (tlaxcalli)
h.	t͡ɬaʃkaloh	/t͡ɬaʃkal-joh/	tortilla-ADJ	'full of tortillas' (tlaxcalloh)
i.	tiʃt͡ɬi	/tiʃ-t͡ɬi/	dough-ABS	'dough, *masa*' (tixtli)
j.	tiʃoh	/tiʃ-joh/	dough-ADJ	'doughy, *lleno de masa*' (tixxoh)
k.	kʷaest͡ɬi	/kʷa-es-t͡ɬi/	wood-blood-ABS	'sap, *savia*' (cuaeztli)
l.	kʷaesoh	/kʷa-es-joh/	wood-blood-ADJ	'sappy, *lleno de savia*' (cuaezzoh)
[–continuant][32]				
m.	wit͡st͡ɬi	/wit͡s-t͡ɬi/	thorn-ABS	'thorn, *espina'* (huitztli)
n.	wiht͡soh	/wit͡s-joh/	thorn-ADJ	'thorny, *espinoso'* (huitztzoh)
o.	ahwet͡ʃt͡ɬi	/awet͡ʃ-t͡ɬ/	dew-ABS	'dew, *rocio*'(ahhuechtli)
p.	ahweht͡ʃoh	/awet͡ʃ-joh/	dew-ADJ	'dewy, *rociado*' (ahhuechchoh)

In (42a-f), stems ending in a vowel, [h], or [n] surface fully faithfully to the underlying representation. In the context the [h] sound, which is a continuant sound, are

[31] It should be noted that there is variation across speakers of ChN. Some produce this word with nasal place assimilation [ilimoŋjoh]. While other speakers delete the final nasal altogether prior to affixation. For these speakers /ilimon + joh/ surfaces as [ilimojoh]. This also could be analyzed as some sort of nasal absorption, another debuccalization process where vowel nasality is ultimately lost word-medially in these specific contexts, requiring a cyclic derivation.

[32] For the /-joh/ morpheme, /k/-final stems, while [–continuant], do not participate in palatal assimilation e.g., [potekt͡ɬi] /potek-t͡ɬi/ dust-ABS 'dust' and [potekjoh] /potek-joh/ dust-ADJ 'dusty.' However, /k/-final stems do participate in palatal assimilation in other constructions: [temok] /temo-k/ descend-PRET 's/he descended' and [temohka] /temo-k-ja/ descend-PRET-ADV 's/he already descended'. This difference suggests two forms of this process reflecting the division between lexical/postlexical phonology and/or derivational/inflectional morphology since the adjectival suffix /-joh/ is a derivational affix and /-ja/ is an adverbial suffix, possibly an enclitic.

expected to pattern like /l/, /s/, and /ʃ/ shown in (42g-l) i.e. *[pahoh], while [n], which is typically treated as a [–continuant] sound is expected to pattern like (42m-p) i.e. *[ilimohnoh]. The sounds /n/ and /h/ can be unified if [h] is treated as underspecified for place (Steriade 1987, McCarthy 1988, Keating 1988, Schluter et al. 2016, inter alia). Under this analysis, [h] and coda nasals are both placeless in ChN and so it follows that they would not participate in palatal glide assimilation. The examples in (42m-p) show the pattern for [–continuant] sounds for completeness.

While it may seem odd for there to be an alternation between a nasal stop and glottal fricative, I posit that this pattern perhaps began as nasalization of the final vowel as is the case in stressed/monosyllabic words in ChN. At some point in ChN, there could have been breathiness overlapping with nasality as has been reported in other varieties of Nahuatl: Sasaki (2014) describes a degree of phonetic similarity between unstressed word-final nasals which are realized as nasalized vowels and word-final Vh sequences in Ixquihuacan Nahuatl. while laryngeal and nasal articulations are articulatorily quite distinct, breathiness and nasality may overlap in their acoustic cues (Garellek et al. 2016).[33] In addition, this

[33] Karttunen and Lockhart (1976) discuss the inconsistent omission of expected nasals in the orthography in coda position in Classical Nahuatl texts, especially phrase-finally and before consonants. In addition, they identify cases of "nasal intrusion" in a number of contexts. Most interesting here is nasal intrusion in contexts where the laryngeal is expected, shown below.

	Intrusion form	**Expected orthographic form**	**Reconstructed Pronunciation**	**Gloss**
a.	quintos	quitos	[kiʔtos]	'he will say'
b.	katen	cate	[kateʔ]	'they are'

(Karttunen and Lockhart 1976, p. 381)

These forms point to a possible neutralization between nasals /N/ and the Saltillo (/ʔ/) in classical varities. While the saltillo in classical Nahuatl it is assumed to have been a glottal, speakers of many

alternation between nasals and [h] seems to parallel the alternations in the coda position found for the other sonorants in ChN that are described in Table 3 and addressed in the next section (3.4.2). Trigo (1988) proposes [h̃] as the placeless nasal—is it is not a big leap to make from [h̃] to [h]. In sum, it is not implausible, and in fact phonetically motivated, that an alternation between nasal stops and the glottal fricative could be phonologized. This pattern fits into the collection of phenomena termed rhinoglottophilia (Matisoff 1975, Ohala & Ohala 1975, Ahland 2005, Igartua 2015 inter alia), where nasality and laryngeal articulations are linked in a number of diachronic correspondences as well as synchronic patterns in the world's languages.[34]

Having made the case for coda nasal debuccalization, which on the surface looks like word-final nasal debuccalization, I now turn to the status of these patterns. Given the criteria described in Chapter 1, we can conclude that this pattern is a lexical process. The evidence

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varieties were using the same orthography at the time and it is possible that intrusive nasals reflect speakers of varieties with [h] "saltillos" rather than [ʔ], in which case there could have been confusion/reanalysis between nasality and breathiness. The authors also note that in the intrusion contexts (there are more than the ontext above) there are also attested "intrusions" of *l* and *uh* (w), constexts in which in many varieties, including ChN, are spirantized (/l/→[ɬ]) or debuccalized (/w/→[h]). It is possible that breathiness, either as preaspiration or debuccalization is the source of intrusive nasals in Classical Nahuatl given that the perception cues for nasality overlap with those of breathiness (Garellek et al. 2016)

[34] The pattern described in this dissertation in ChN seems to be the culmination of two related pressures on nasals across the languages: to debuccalize and to devoice. In addition to nasal place assimilation processes targeting word-final nasals have been widely reported:

- ***Nasal absorption* [Ṽ]:** Matlapa, San Luis Potosí (Croft 1951), Ixquihuacan, Puebla (Sasaki 2014).
- ***Velar nasal* [ŋ] (possibly a placeless nasal [N]):** Zacapoaxtla, (Sierra) Puebla (Key & Key 1953, Robinson 1969), Orizaba, Veracruz (Goller, Goller & Waterhouse 1974), Pipil (Campbell 2011), Mecayapan, (Isthmus) Veracruz (Wolgemuth 1969, 2007).
- ***Devoicing* [ŋ̥]**: Naupan, North Puebla (Brockway 1963, 1979)
- ***Breathy debuccalization* [h]:** Possibly Tetelcingo, Morelos (Pittman 1954)

in favor of this conclusion is that the process is limited to the word. Nasal place assimilation occurs with debuccalized nasals within the word only. At the right edge, no place features come from adjacent words. For example, if we look at the word /naman/ 'now' shown in (37i-j), on the surface it will always be produced [namah], in isolation and in an Utterance medial context. A string such as /naman ki-ita/ 's/he sees it now' will never surface as *[namaŋ kiʔitaʔ]. This will always surface as [namah kiʔitaʔ]~[nama kiʔitaʔ]. If this were a postlexical process, we would expect debuccalization and subsequent place assimilation to occur across word boundaries in the way it does word-internally.

3.4.2 Labiovelar Glide Debuccalization

There is a pattern of alternation between [w] and [h] in morphologically related words (shown previously in Table 3). The labiovelar glide [w] only occurs in prevocalic contexts as an onset. As noted previously, all consonants are contrastive as onsets except /h/, which only marginally occurs in onsets (except in loanwords (23), reduplicative forms (25), and in compounds). As the data in (43) show, an underlying /w/ debuccalizes to [h] in the same context in which /h/ can surface.[35] The data in (43) show the alternation with pairs of alternate stem forms that are used in present and preterit constructions.

[35] A similar alternation is documented in other Nahuatl varieties, though the alternation is between onset [w] and coda [ʍ] in North Puebla Nahuatl (Brockway 1963) and only in the Utterance-final context in Sierra Nahuat (Key & Key 1953).

43)	a.	ki.ko:.**w**a	/ki-ko:wa/	3OBJ-buy	's/he/it buys it, *lo compra*' (quicohua)
	b.	ki.ko:**h**.ki	/ki-ko:w-ki/	3OBJ-buy.PRT-PRET	's/he/it bought it, *lo compró'* (quicouhqui)
	c.	ki.t͡ʃi.**w**a	/ki-t͡ʃiwa/	3OBJ-make	's/he makes it, *lo hace'* (quichihua)
	d.	ki.t͡ʃi**h**.ki	/ki-t͡ʃiw-ki	3OBJ-make.PRT-PRET	's/he made it, *lo hizo*' (quichiuhqui)

The verbs in (43a-d) are in a class in which the verb root is vowel-final in present tense constructions (e.g. /ko:wa/ in (43a)) and consonant-final in preterit and other constructions (e.g. /ko:w/ in (43b)). These alternations were described in section 3.3.5. In the present tense (43a,c), /w/ is prevocalic and surfaces as a glide. In contrast, in the preterit (43b, d), the underlying /w/ is pre-consonantal and surfaces as a glottal fricative [h].

The possessum marker in the possessive construction also provides evidence of this alternation. There are two markers of possession[36] in ChN: prefixes that mark for possessor, and a suffix that marks that the noun is possessed—possessum marker /-w(i)/. The occurrence of this suffix is lexically specified—not all noun stems take a possessum (e.g. no possessum suffix in /N/-final stems in (37) above), and there seems to be some variation among those that do. Similarly in the examples in (44), the /w/-final stems do not take a possessive suffix. Crucially, the absolutive suffix (/-(i)t͡ɬ(i)/, which marks the noun as unpossessed, does not co-occur with possessive prefixes and the /w/ occurs as a coda. The form of the absolutive marker selected for by labial-final stems (/w/ or /m/) is [-it͡ɬ] (recall the /m/-final stems in (37e-f) komit͡ɬ 'jug-ABS'

[36] There is a third possessive suffix, the inalienable possession market /-jo/ that marks nouns as inalienably possessed: [alaʃoʃ ikakawajo] /alaʃoʃ i-kakawa-jo/ orange POS-rind-INAL 'the orange rind'

vs. nokoh ‘my jug’ and (37g-h) kotomi͡tɬ ‘cloth-ABS’ vs. nokotoh ‘my cloth/clothing’). The data in (44) show the alternation of /w/ as [w] and [h] based on its position as onset or coda.

44)	a.	kʷa.**w**i͡tɬ	/kʷaw-i͡tɬ/	tree-ABS	‘tree/wood, *arbol/ madera*’ (cuahuitl)
	b.	no.kʷa**h**	/no-kʷaw/	1POS-tree	‘my tree/wood, *mi arbol/madera*’ (nocuauh)
	c.	t͡ʃi.ki.**w**i͡tɬ	/t͡ʃikiw-i͡tɬ/	basket-ABS	‘basket, *canasta/ chiquihuite*’ (chiquihuitl)
	d.	no.t͡ʃi.ki**h**	/no-t͡ʃikiw/	1POS-basket	‘my basket *mi canasta/ chiquihuite*’ (nochiquiuh)
	e.	t͡ʃi.ki**h**.na.ma.ka.ke͡tɬ	/t͡ʃikiw-namaka-ke-t͡ɬ/	basket-sell-NOM-ABS	‘basket seller, *vendedor de canastas*’ (chiquiuhnamacaquetl)

In the examples in (44), the possessive form goes unmarked, taking no possessum suffix. Other stems are lexically specified to take a possessum suffix that has two alternant forms, [-h] and [-wi] shown in (45-46) respectively.

45)	a.	no.a.ma**h**	/no-ama-w/	1POS-paper-PSM	‘my paper, *mi papel’* (noamauh)
	b.	a.ma͡tɬ	/ama-t͡ɬ/	tree-ABS	‘paper, *papel’* (amatl)
	c.	no.aɬ.te.pe**h**	/no-altepe-w/	1POS-town-PSM	‘my town/city, *mi pueblo/ciudad’* (noaltepeuh)
	d.	aɬ.te.pe͡tɬ	/altepe-t͡ɬ/	basket-ABS	‘town/city, *pueblo/ciudad*’ (altepetl)

46)	a.	no.nek.**w**i	/no-nek-wi/	1POS-honey-PSM	'my honey, *mi miel'* (noneuchui)
	b.	nek͡tɬi	/nek-t͡ɬ/	honey-ABS	'honey, *miel'* (neuctli)
	c.	no.ʃi.nat͡ʃ.**w**i	/no-ʃinat͡ʃ-wi/	1POS-corn.seed-PSM	'my corn kernel, *mi grano de maíz'* (noxinachhui)
	d.	ʃinat͡ʃt͡ɬi	/ʃinat͡ʃ-t͡ɬ/	corn.seed-ABS	'corn kernel, *grano de maíz'* (xinachtli)

The analysis put forth here is that the [-h] possessum marker form is underlyingly /-w/. The alternation between [-wi] and [h] follows a pattern also observed with other suffixes we have seen thus far. There is a -C/-CV morphological alternation where a -CV alternant is selected by C-final stems and the -C alternant is selected by V-final stems. In the data discussed thus far, we have seen this type of alternation with the absolutive suffixes [-t͡ɬ] and [-t͡ɬi] and the preterit suffixes [-k] and [-ki]. Epenthesis[37] avoids illicit word-final

[37] It is outside the scope of this dissertation to resolve the question of whether or not these patterns are in fact an example of epenthesis. In the philological literature, the historical account is that there have been a series of reductions in vowels in the development of Nahuatl varieties in which chains of vowel shifts in weak positions (i.e. post-stress) have led to changes down this chain: a > e > i > Ø. All three vowels are found in ChN affix allomorphy. An alternative synchronic analysis to epenthesis using ghost segments (Szpyra 1992, Zoll 1996, Yang 2004), could describe the alternation patterns in affixes in ChN while also not requiring the positing of multiple epenthetic vowel qualities. This analytical tool proposes the following: there are "segments that only surface in certain contexts' (Yang, 2004, 71). These are weakly active segments that surface only when needed to prevent a violation of a phonotactic constraints. In ChN, there are the affixes that have appeared thus far in this dissertation where the epenthesis pattern is -C- when syllable structure allows, and -Ci- or -iC- when affixation would create an illicit consonant cluster. However, there are other affixes that exhibit the same pattern, with different vowels. For example, the plural marker is [-h] except when a consonant cluster would result from affixation, in which case it is [-eh]. If stems and affixes were analyzed as

consonant clusters. For example, the word-final [i] in forms like [kiko:hki] ‘s/he bought it’ (43) prevents a tautosyllabic cluster [*kiko:hk]. Similarly, the final [i] in [ajoht͡ɬi] ‘squash’ (20) prevents a tautosyllabic cluster [*ajoht͡ɬ]. The data in (45-46) show two sets of words that take the possessum suffix. Note that the absolutive suffix and the possessum suffix share the presence or absence of the [i] which is dependent on the shape of the stem. The possessum suffix is /-w(i)/ and the surface realization that contains an [h] (45) or a labiovelar glide (46) is dependent on position in the syllable. Thus, syllable structure is a source of laryngeals in that it generates the context for the application of the debuccalization of labiovelar glides. In this analysis, the [-h]/[-wi] alternation, is not suppletion, but regular non-suppletive allomorphy.

Labiovelar glide debuccalization is an instance of positional neutralization: /h/ occurs in the coda position (with the exception of reduplication and loanwords) and coda /w/ surfaces as [h]. The derivation in (47) demonstrates positional neutralization:

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containing ghost segments, the complex epenthesis pattern is simplified through a purely representation-phonological account where segments only emerge if necessary because of phonotactic constraints. Thus, the absolutive suffix would be /t͡ɬ*i*/ where the [i] only appears if necessary. In this analysis /m/ and /w/ final stems would actually be vowel final with ghost final [i]s which would account for the exceptional epenthesis pattern. [komit͡ɬ] ‘jug’, which I have previously analyzed as underlyingly /kom + it͡ɬ/ which requires a third allomorph for the absolutive marker -it͡ɬ, would be /kom*i* + t͡ɬ*i*/ in this analysis. In contrast [ʃamit͡ɬ] ‘fresh corn tamale’ would be underlyingly /ʃami + t͡ɬ*i*/. The observed possessed surface forms for these two words fall out with the ghost segment analysis: [nokoh] /no + kom*i*/ 1POS + jug ‘my jug’ and [noʃamih] /no + ʃami + w/ 1POS + corn.tamale + POSS ‘my corn tamale’.

47) Positional Neutralization of /w/ and /h/: ‘my squash’ and ‘my basket’

	/ajoh/	/t͡ʃikiw/	/aːjo/
Affixation	no + ajoh[38]	no + t͡ʃikiw	no + aːjo + w
Labiovelar Glide Debuccalization	_	not͡ʃikih	noaːjoh
Surface Form	[noajoh]	[not͡ʃikih]	[noaːjoh]
	‘my squash, *mi calabaza*’ (noayoh)	‘my basket, *mi canasta*’ (nochiquiuh)	‘my turtle, *mi tortuga*’ (noayouh)

The process of labiovelar debuccalization fits within a larger pattern of sonorant devoicing and spirantization in the coda context in ChN. Sonorants are devoiced and spirantized in the coda position, both word-medially and word-finally, with nasals, which undergo place assimilation, only undergoing this process in the word-final context. The distribution of voiced consonants is summarized in (48).

48)

Sound	Onset	Word-medial Coda	Word-final Coda
/w/	[w]	[h]	[h]
/j/	[j]	[ʃ]	[ʃ]
/l/	[l]	[ɬ]	[ɬ]
/n/	[n]	[m], [n], [ɲ], [ŋ]	[h] ([˜]/[n])[39]
/m/	[m]	[m], [n], [ɲ], [ŋ]	[h] ([˜]/[n])

[38] There is some variation as some speakers also use [noajohwi] with the possessum mrker.

[39] [˜]/[n] in stressed syllables

Though the distribution of these sounds seems intuitively to result from the same rule/constraint, interactions with morphological processes suggest that there is a distinction between the pattern specifically for /w/ and /l/.[40] I return to the /-joh/ adjectival morphological construction and the process of palatal glide assimilation described previously for evidence of the lexical status of coda-w debuccalization. The affix /-joh/ derives an adjective from a noun stem. For stems that end in a vowel, /h/, or nasal sound /N/, the affix attaches unchanged and cooccurs with place assimilation. The data in (49) (repeated from 42) show this pattern.

49)	a.	soki͡tɬ	/soki-t͡ɬ/	mud-ABS	'mud, *lodo/zoquete'* (zoquitl)
	b.	soki**j**oh	/soki-joh/	mud-ADJ	'muddy, *embarrado'* (zoquiyoh)
	c.	paht͡ɬi	/pah-t͡ɬ/	fertilizer-ABS	'medicine/fertilizer/herbicide, *medicina/abono*' (pahtli)
	d.	pah**j**oh	/pah-joh/	fertilizer-ADJ	'a field with a lot offertilizer/ herbicide, *lleno de abono*' (pahyoh)
	e.	ilimoh	/ilimon/	lime	'lime (citrus), *limón'* (ilimon)
	f.	ilimon**j**oh	/ilimon-joh/	lime-ADJ	'limey, *con mucho limón'* (ilimonyoh)

[40] I have not found any /j/ final stems to test comparable morphological structures.

When the palatal glide follows a consonant other than /N/ or /h/, it assimilates to the preceding consonant (or alternatively, deletes). That is, /C-j/ sequences surface as [C]. The data in (50) demonstrate this pattern.

50)	a.	t͡ʃi:li	/t͡ʃi:l-t͡ɬi/	chile-ABS	'chile pepper, *chile*' (chilli)
	b.	t͡ʃi:l̲oh	/t͡ʃi:l-joh/	chile-ADJ	'something with a lot of chile, *con mucho chile*' (chiloh)
	c.	tiʃt͡ɬi	/tiʃ-t͡ɬi/	dough-ABS	'dough, *masa*' (tixtli)
	d.	tiʃoh	/tiʃ-joh/	dough-ADJ	'doughy, *lleno de masa*' (tixxoh)
	e.	kʷaest͡ɬi	/kʷa-es-t͡ɬi/	wood-blood-ABS	'sap, *savia*' (cuaeztli)
	f.	kʷaesoh	/kʷa-es-joh/	wood-blood-ADJ	'sappy, *lleno de savia*' (cuaezzoh)

A crucial point in (50) is that the processes targeting coda consonants shown in (48), must occur after word formation and the application of the palatal assimilation process for /l/-final stems (50a-b). However, the process targeting /w/ is distinct from /l/ (and possibly /j/) because of the surface form of /w/-final stems in this same construction.

The data in (51) show the [w]-[h] alternation in two morphologically related words: verb (a) and nominalized form in (b). (51c) show this stem in the adjectival construction.

51)	a.	t͡ʃijawa	/t͡ʃijawa/	be.fatty	'for meat to be fatty, *el tener mucha grasa (carne)'* (chiyahua)
	b.	t͡ʃijahtɬi[41]	/ t͡ʃijaw-tɬ/	meat.fat-ABS	'meat fat, *grasa*' (chiyahtli)
	c.	t͡ʃijahjoh	/ t͡ʃijaw-joh/	ADJ-meat.fat	'fatty, *grasoso'* (chiyahjoh)

As these data show, in contrast to the surface forms of /l/-final stems, the lenition process must occur prior to affixation, otherwise the expected surface form would be *[t͡ʃijawoh].[42] A derivation comparing the two lenition patterns for /l/ and /w/ are shown in (52).

[41] Interestingly, there is an alternant form of this word [t͡ʃijant͡ɬi] suggesting a reanalysis of the debuccalized /w/ as a debuccalized /n/ that surfaces in the nominal form. This variation in forms points to rhinoglottophilia (Matisoff 1975) and the issue of "nasal intrusion" in Classical Nahuatl texts. Karttunen and Lockhart (1976) document a number of nasals that occur in classical texts in unexpected contexts. The stem in the adjectival construction ([t͡ʃijahjoh]) must be underlyingly /t͡ʃijaw/ and not /t͡ʃijan/ otherwise we would expect the derived form to be [t͡ʃijanjoh] since /h/ and /n/ do not participate in palatal assimilation.

[42] There is one form that suggests that historically, coda-/l/ spirantization and coda-/w/ debuccalization patterned together. The verb *jowi* 'to go' and *walah* 'to come' are irregular suggesting that they make up lexicalized paradigms, a distribution that is rare in ChN. [walah] seems to be composed of the verb *jowi,* which alternates with *jah* (/*jaw*/) in the paradigm, with the directional prefix *wal-* 'there to here'. /wal/ + /jaw/→|walaw| with palatal glide assimilation and surfaces as [walah] with coda-/w/ debuccalization. With the adjverbial suffix /-ja/ 'already', [*walah]* surfaces as [*walowa]* suggesting a historical derivation of *wal+ jow+ ja.* This must be a lexicalized exception, because the synchronic pattern predicts **walahja.*

52) Coda-w Debuccalization/Spirantization

	/t͡ʃijaw/ + /-joh/	/t͡ʃi:l/ + /-joh/	/pil- -t͡sin/ + /sin/
Coda-w Debuc.	t͡ʃijah	—	—
Affixation	t͡ʃijaw + joh	t͡ʃi:l + joh	pil + sin + t͡sin
Palatal Assimilation	—	t͡ʃi:loh	—
Coda-l Spirantization	—	—	piɬsint͡sin
Coda-Nasal Debuc.	—	—	piɬsint͡sih
Surface Form	[t͡ʃijahjoh]	[t͡ʃi:loh]	[piɬsint͡sih]
	'fatty, *grasoso*' (chiyahyoh)	'covered in chile, *lleno de chile*' (chilloh)	'corn (dim.), *elotito*' (pilcintzin)

As is demonstrated here, coda-l spirantization must occur after affixation and palatal assimilation. Otherwise, if palatal assimilation occurred after coda-l spirantization, the expected surface form would be *[t͡ʃi:ɬoh].[43] That is, the assimilating sound would be [ɬ] rather than [l]. While the process that targets coda /l/ may be lexical or postlexical (though it is not structure preserving), given the criteria laid out in the previous chapter, labio-velar glide debuccalization must be a lexical process since it interacts with word formation.

A final note on the related patterns targeting coda sonorants summarized in (48). The three approximants have quite distinct patterns: /w/ debucallizes, /j/ alternates with [ʃ], and /l/ alternates with [ɬ]. As the previous derivation suggests, coda labiovelar glide debuccalization is a lexical process. An additional argumement in favor of such a

[43] Intervocalic [ɬ] is attested in lateral assimilation in /l + t͡ɬ/→[ɬ] sequences on the left edge of the stem (on the right edge, /l + t͡ɬ/→[l]). Assimilation on the right edge is a distinct process. This is exemplified in /t͡ʃil-t͡ɬakʷal-t͡ɬi/ chile-food-ABS 'food with chili', which surfaces as [t͡ʃiɬːakʷali].

designation is that it is structure preserving. That is, /w/→[h] is a contrastive sound. if /w/ were to undergo devoicing and spirantizing as in the case of /l/, this would result in a non-contrastive sound [ʍ]. While found in other varieties of Nahuatl, this sound is absent in ChN. Similarly the /j/→[ʃ] pattern is structure preserving. Devoicing and spirantizing a palatal sound results in [ç] and the acoustically nearest structure preserving sound is the postalveolar fricative [ʃ]. Devoiced /j/, [j̥], does occur in ChN, but not in the coda context, but rather as the second consonant in a consonant cluster after voiceless sounds. Taken together, this distribution of sounds suggests that the larger pattern of coda-sonorant lenition is mostly a lexical process, with the exception of the lateral approximant, which is post lexical.

Having shown that glottal fricatives can arise in ChN through lenition processes targeting nasals and labiovelar glides, I now turn to the final source of glottal fricatives, lenition processes that target velar stops.

3.4.3 Lenition Processes Targeting Velar Stops

In Chicontepec Nahuatl, there is a constellation of patterns that affect underlying velar stops (/k/ and /k^{w}/). Here, as will be shown, the data require modifying the definitions posited above. Velar stops undergo various degrees of lenition resulting in surface realizations that range from voicing ([g]), to spirantization ([x]), to complete debuccalization ([h]). These patterns are relevant to this dissertation because there are glottal fricatives that arise through debuccalization processes that target velar stops, creating further contexts for neutralization. Debuccalization is generally thought of as a loss of oral features or articulations (O'Brian 2012) adopted above in (32). However, as will be shown, there is

variation such that debuccalization can be framed as gradient. Because debuccalization is treated like a type of lenition, the [x] alternant can, to a certain extent, be treated as a type of debuccalization—that is spirantization is a weakening of oral stricture that is in a sense an incomplete debuccalization. This is not unprecedented: Gildea (1995) treats consonant alternations in Cariban languages as debuccalization with surface forms ranging from [x]~[h]~[ʔ]. Similarly, lenition of /k/ in Ghomara Berber is reported to have similar degrees of lenition as in ChN: /k/→[k] →[x] →[h]—spirantization with possible debuccalization (El Hannouche 2008, pp. 34-35).[44] This approach raises an issue for the distinction between *loss lenition* and *continuity lenition* described in (31). A single phonological process results in what falls under the definition of continuity lenition, but also in what would fall under the definition of continuity lenition.

In ChN, debuccalized velars are found in four environments: (i) a sequence of two velar segments across morpheme boundaries, where the first segment undergoes debuccalization, which can trigger further lenition of the second velar (*narrow velar lenition*); (ii) a broader pattern of lenition in which velar stops spirantize or debuccalize before any consonant (broad velar lenition); and (iii) a pattern of allomorphy in which the third person object marker is realized as a reduced [h]. These three patterns are schematized in (53).

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[44] I treat velar stop spirantization and debuccalization as part of the same larger process in ChN. Cross-linguistically, these do not necessarily cooccur as they do in the Cariban and Berber examples. For example, there are cases such as Bolivian Quechua where /k/ and /q/ are spirantized in codas, but no debuccalization is cited (Gurevich 2004 citing Bills et al. 1969:xix). Similarly, other cases of debuccalization do not involve spirantization. In fact, debuccalization results in glottal stricture [ʔ] rather than [h]. An example is debuccalization in Toba Battak where /p, t, k/→[ʔ]/ _C (Gurevich 2011 citing Hayes 1986: 341).

53) Contexts of velar lenition

a. Narrow Velar Lenition
/k(ʷ)-k(ʷ)/→[hk(ʷ)]~[xk(ʷ)]~[x(ʷ)]~[h]

b. Broad Velar Lenition
/k/→[g]~[x]~[ɣ]~[h]/___C

c. Velar Prefix Allomorphy
/-k-/→[h]~[Ø]/___C

In the patterns described in (53), there is a relationship between (53a) and (53b): the broad velar lenition pattern (b) overlaps with the narrow velar lenition pattern (a), only the broad pattern is an optional process that may involve factors such as prosody, speech rate, or sociolinguistic register. In contrast, in the narrow word-internal velar-velar context, some form of lenition always occurs. Thus, these patterns can also be distinguished by the obligatoriness of their application in addition to the further lenition processes that can result in intervocalic [x] and [h]. The third pattern, Velar Prefix Allomorphy, is distinct from the other two (Narrow and Broad Velar Lenition) in that it is a case of morphologically conditioned phonology. In this section I begin with the narrow pattern (53a), then describe the broader pattern (53b). Finally, I describe the pattern of morphologically conditioned phonology that targets the prefix-stem boundary context (53c). It should be noted that there is a fourth pattern that I mention for completeness but is not relevant to a discussion of laryngeals. This additional pattern falls neatly under the definition of continuity lenition, targeting intervocalic velar stops. It is somewhat infrequent and is more common among some speakers than others. The surface pattern can be described as in (54):

54) Intervocalic velar lenition

/k/→[ɣ]~[g]/ V__V

This pattern will not be discussed in detail because it does not result in a glottal fricative. However, it does share commonalities with the other velar lenition patterns in (53).

3.4.4 Narrow Velar Lenition

Sequences of velar stops are only attested arising in morphologically-complex words or across word boundaries. There is no evidence of monomorphemic sequences of velar stops.[45] Moreover, the only sequences of identical stops that I have documented in ChN thus far are sequences of velar stops, either /k/ or /k^{w}/.[46] In the introduction to this section, the pattern is described as: /k$^{(w)}$-k$^{(w)}$/→ [hk$^{(w)}$]~[xk$^{(w)}$]~[x$^{(w)}$]~[h] . The assumption made here is that there are degrees of lenition that ranges from spirantization of one or both segments to complete debuccalization. This departs from a distinction between half-spirantization and half-debuccalization argued for by Kirchner (2000). A second assumption is that this is a two-step process that involves levels of lenition. In the first step, /k$^{(w)}$-k$^{(w)}$/→|xk$^{(w)}$| the first

[45] There are stem-internal sequences of [hk] such as [wahka] ‘far’ and [nohkia] ‘also’ 02_0028_el. In these cases, I assume that the underlying representation is /hk/, but in principle it is possible that the UR is /k$^{(w)}$k/.

[46] I have found two forms that can be analyzed as underlyingly sequences of /-t-t/. However, they have completely different surface forms suggesting that they are lexicalized morphological alternations. I do not have any evidence that either of these forms reflect synchronic processes: [ita] ‘to see’ that when in the progressive, surfaces as [i͡tstika] presumably from an underlying /it-tika/ (compare with [nehnemi] ‘to walk’ and [nehnentika] ‘s/he is walking’), /-tika/ bing the progressive suffix. On the other hand, ‘to teach’ which consists of the verb [mati] ‘to know’ and the causative /-tia/ surfaces as [ma͡ʃtia], presumably /mat-tia/ (compare with [miki] ‘to die’ and [miktia] ‘to kill').

segment spirantizes and can further debuccalize to |hk$^{(w)}$|. In either case, labial gestures of the lenited segment are lost. The second step is a process that targets all sequences of *hk$^{(w)}$*-, whether underlyingly /k$^{(w)}$-k$^{(w)}$/, /h-k(^{w})/, or /w-k(^{w})/. All of these underlying representations can surface as [hk$^{(w)}$], but also as [xk$^{(w)}$], or reduce to [x$^{(w)}$] or [h]. The only exceptions to this generalization are the cases where C_2 is /k^{w}/, in which case it will not completely debuccalize to [h]: /k$^{(w)}$-k^{w}/→[hk^{w}]~[xk^{w}]~[x^{w}] but not *[h] or *[h^{w}]. This process parallels the spirantization pattern described for Tigrinya, where heteromorphemic velar stop sequences /k-k/ surface as [xk] (Schein 1981, Kenstowicz 1982) as well as patterns of preaspiration (which will be addressed below).

Katz's (2016) definitions are helpful in developing a typology of lenition. Interestingly narrow velar lenition seems to straddle the boundaries between loss lenition and continuity lenition since minimally, the coda velar can lenite and debuccalize (loss lenition) but the effect can extend to the onset velar as well (continuity lenition) with gradient outputs. Debuccalization is gradient in the four possible outcomes ([hk$^{(w)}$]~[xk$^{(w)}$]~[x$^{(w)}$]~[h]) like the Ghomara Berber case.

It should be noted that there seems to be a degree of circularity due to coarticulation effects. While I argue that lenition results in a chain of k→x→h, one could also argue that since /h-k/ and /w-k/ can surface as [xk] the process is actually k→h→x, debuccalization followed by coarticulation before a velar stop. In any case, all of these can surface as intervocalic [x] or completely debuccalize to [h].[47]

[47] The fact that the labial features of /k^{w}/ are lost if the first consonant C_1 in a velar stop sequence does not bear on the question of whether there is stepwise lenition or simply debuccalization with

Let us first look at examples that demonstrate the obligatory component of the lenition process. All sequences of velar stops will minimally surface as a fricative-stop sequence. This can be demonstrated with the adverbial proclitic /ajok-/ which surfaces as [ajok-] before vowel initial stems (55a) and non-velar consonant-initial stems (55b-c), but as [ajoh-] ~[ajox-] before velar-initial verbs, whether plain (56a-b) or labialized (56c).

55)	a.	ajo**k**ahki	/ajok-ahki/	ADV-swim	's/he no is longer swimming, *ya no nada*' (ayocahqui)
	b.	ajo**k**nehnemi	/ajok-neh~nemi/	ADV-RED~walk	's/he no is longer walking around, *ya no camina*' (ayocnehnemi)
	c.	ajo**k**tekiti	/ajok-tekiti/	ADV-work	's/he no is longer working, *ya no trabaja*' (ayoctequiti)
56)	a.	ajo**h**kanah	/ajok-kanah/	ADV-AUX	'no longer, *ya no*' (ayoccanah)
	b.	ajo**h**kikʷaː	/ajok-ki-kʷaː/	ADV-3OBJ-eat	's/he is no longer eating, *ya no come*' (ayocquicua)
	c.	ajo**h**kʷalaŋki	/ajok-kʷalan-k/	ADV-angry.PRT-PRET	's/he was no longer angry, *ya no está enojada/o'* (ayoccualanqui)

coarticulation because there is a general constraint against [w] or [ʷ] in the coda position: /w/→[h] and /ʷ/ →Ø, regardless of whether there is a velar following the labial sound.

Sequences of /k(w)-k/ which surface as [hk]~[xk] are also found in the preterit construction: the preterit marker is /-k(i)/ and an alternation between a vowel-final stem and consonant-final stem create the environment for a velar stop sequence in the latter context with this class of verbs (described in section 3.3.5). The data in (57) show an example of this stem alternation.

57)	a.	kimati	/ki-mati/	3OBJ-know	's/he knows it, *lo sabe*' (quimati)
	b.	kimatki	/ki-mat-k/	3OBJ-know.PRT-PRET	's/he knew it, *lo supo*' (quimatqui)
	c.	tikʷalani	/ti-kʷalani/	1SUBJ-angry	's/he is angry, *está enojada/o'* (ticualani)
	d.	tikʷalaŋki	/ti-kʷalan-k/	1SUBJ-angry.PRT-PRET	's/he was angry*, estuvo enojado*' (ticualanqui)

In (57a, c), the present tense is marked by the bare stem, which is vowel-final; in (57b, d), on the other hand, the preterit is marked both by the attachment of the preterit [-ki] suffix and the use of the consonant-final preterit stem alternant. The examples in (58) show this alternation with the verb /t͡ʃoka/ 'cry,' which is velar-final in the preterit stem.[48] The data show two morphological constructions that take the consonant-final "preterit" stem: the preterit form in (58b) [t͡ʃohki] 'cried' and the causative construction (58c) [t͡ʃoktia] 's/he made someone cry'.

[48] The verb [t͡ʃoka] 'to cry' is exceptional in that it can both act like a class 1 and class 2 verb. That is, it can have both [t͡ʃokak] (no stem alternation, see (26d)) and [t͡ʃohki] (with stem alternation) as preterit forms.

58)	a.	nit͡ʃo:**k**a	/ni-t͡ʃo:ka/	1SBJ-cry	‘I cry, *lloro*’ (nichoka)
	b.	nit͡ʃo:**h**ki	/ni-t͡ʃo:k-ki/	1SBJ-cry.PRT-PRET	‘I cried, *lloré’* (nichocqui)
	c.	nikt͡ʃo:**k**tia	/ni-k-t͡ʃo:k-tia/	1SBJ-3OBJ-cry.PRT-CAUS	‘I make someone cry, *lo hago llorar*’ (nicchoctia)

As shown in (58), in the preterit construction, the underlying /k-k/ surfaces as [hk]. The causative form of the verb (as do other constructions) shown in (58c) provide evidence that the consonant-final stem alternant contains an underlying velar segment rather than an /h/; the two stem alternants are then -*t͡ʃoka*- and -*t͡ʃok*-. The velar-final alternant participates in the lenition process when in the context of the velar affix, which does not occur in the causative construction, which takes an alveolar-initial suffix.

The data in (59) show [h] in velar stop sequences that include the labialized velar stop. Here, the verb [a:t͡ɬa**k**^{w}i] ‘to fetch water’ is shown in the preterit construction (with the consonant-final stem alternant followed by the *-ki* suffix), except the stem is /k^{w}/-final and the underlying string is /k^{w}-k/. Here the glottal fricative surfaces in the preterit form and labialization is lost, showing that this debuccalization process applies to both labialized and plain velar stops. Moreover, the labial feature does not dock on to the following velar segment.

59)	a.	a:t͡ɬa**k**^{w}i	/a:t͡ɬak^{w}i/	3SBJ-fetch.water	‘s/he fetches water, *acarrea agua*’ (atlacui)
	b.	a:t͡ɬa**h**ki	/a:t͡ɬak^{w}-ki/	3SBJ-fetch.water.PRT-PRET	‘s/he/it fetched water, *acarreó agua*’ (atlaucqui)

Compound noun forms demonstrate this pattern for /k-k^{w}/ sequences as well. The data in (60) show this pattern in a compound noun form (60b) [toh^{l}k^{w}awit͡ɬ] ‘corn stalk’. In these cases, the labialized velar stop is the second consonant in the velar stop sequence /k-k^{w}/ and labialization is not lost in the surface form.

60)	a.	tok͡ɬi	/tok-͡ɬi/	corn.plant-ABS	‘corn plant, *mata de maíz*’ (toctli)
	b.	toh^{l}k^{w}awi͡ɬ	/tok-k^{w}aw-i͡ɬ/	corn.plant-tree-ABS	‘cornstalk, *tallo de maíz’* (toccuahuitl)

In all of these data, I have represented the first segment of an underlying velar stop sequence as surfacing as [h]. However, the first velar stop can also surface as [x]. Recall that the analysis is that there is stepwise lenition where coda /k$^{(w)}$/ can surface as x or completely debuccalized as [h] before a velar stop.

There is an alternative analysis in which the [h] is not the result of debuccalization, but rather preaspiration of the resulting velar stop sequence stop, a fake geminate /k$^{(w)}$-k$^{(w)}$/→[^{h}k$^{(w)}$ː]. Preaspiration as a perceptual cue for geminates has been shown for Sienese Italian (Stevens 2010, Hajek & Stevens 2011). In addition, geminate consonants have been analyzed as the historical source of preaspirated consonants in Numic, Uto-Aztecan (Miller et al. 2005). As an analytical question, the difference between these two analyses is the segmental status of the aspiration articulation. If there is debuccalization, the [h] has a one-to-one correspondence with one of the underlying velar stops—it is a segment. In the second analysis, the surface form is a velar stop sequence, and preaspiration is part of the phonetic implementation of the contrast in length—a subsegmental articulation. The debuccalization

account is favored when considering the optional broad lenition pattern (/$k^{(w)}$/→[h]/__C) that will be discussed in more detail below. In these cases, preaspiration would need to be posited for consonant clusters rather than long false geminates, but this does not occur in other consonant clusters.[49]

Velar stop sequences also surface as intervocalic fricatives. Here we see the same range in articulatory constriction that is attested for C_1: [x]~[h]. Impressionistically, this surface form is at least equally if not more common than the [hk]~[xk] form. There is intra-speaker variation between the [h] and [x], e.g., [aːˈt͡ɬahki] 's/he fetched water' in (59b) varies freely with [aːˈt͡ɬaxi] and [aːˈt͡ɬahi] for all speakers. This stepwise gradient lenition process can be schematized as in (61).

61) $/k^{(w)}\text{-}k^{(w)}/ \begin{cases} xk^{(w)} \rightarrow x^{(w)} \\ hk^{(w)} \rightarrow h \end{cases}$

The distribution of [x] and [h] does not seem to be associated with the presence of the high front vowel, which might be expected since there is constriction associated with the gestures that produce the high front vowel. Words like [wahka] 'far' vary freely with [waxa]

[49] If we assume that there is not a constraint against coda-labial articulations (and coda-/w/ debuccalization is an unrelated phenomenon), then the data for the distribution of [k^w] alternations with [h], provide further evidence in favor of debuccalization. A debuccalization analysis is consistent with the pattern observed for the labialized velar in (59b): in /k^w-k/ sequences, debuccalization results in an [hkː^w] ([aːˈt͡ɬahki], *[aːˈt͡ɬahk^{w}i]) surface form, as one would predict to surface in the preaspiration account: that is, a sequence of k^wk would surface as a preaspirated long k^w. The length would preserve the underlying two velar stops, and labialization would differentiate the sound from underlyingly sequences of /k-k/.

and [waha]. The data in (62) show lenition to fricatives for different underlying representations.

62)	a.	no**h**ia	/no**hk**ia/	also	‘also, *también*’ (nocquia)	02_0052_el
	b.	nika**h**ok^{w}i	/ni-k-a**hk**ok^{w}i/	1SUBJ-3OBJ-put.away	‘I put it away, *lo guardé’* (nicahocui)	02_0035_el
	c.	nika**x**ok^{w}i	/ni-k-a**hk**ok^{w}i/	1SUBJ-3OBJ-put.away	‘I put it away, *lo guardé’* (nicahocui)	02_0035_el
	d.	nitemi**x**i	/ni-temi**k-k**i/	1SUBJ-dream.PRT-PRET	‘I dreamt, soñé’ (nitemicqui)	02_0040_el
	e.	ajo**x**anah	/ajo**k-k**anah/	ADV-AUX	‘no longer, *ya no*’ (ayoccanah)	02_0035_el

The forms in (62a-c) show stem internal /hk/ sequences realized as both [h] ([nika**h**ok^{w}i] ‘I put it away’ (62b)) and [x] ([nika**x**ok^{w}i] ‘I put it away’ (62c)). The forms in (62d-e) show underlying velar stop sequences /k-k/ at morphological junctures also surfacing in reduced forms ([nitemi**x**i] ‘I dreamt’ (62d)). The data in (63) show that this process also occurs when the [h] in an expected [hk] sequence is underlyingly a debuccalized labiovelar glide /w/.

63)	a.	kiko:**h**ki~ kiko:**x**i	/ki-ko:w-ki/	3OBJ-buy.PRT-PRET	‘s/he/it bought it, *lo compró’* (quicouhqui)
	b.	ki$\widehat{\text{tʃ}}$i**h**ki~ ki$\widehat{\text{tʃ}}$i**h**i	/ki-$\widehat{\text{tʃ}}$iw-ki	3OBJ-make.PRT-PRET	‘s/he made something, *lo hizo*’ (quichiuhqui)

So far we have seen that velar stop sequences undergo various levels of lenition that can result in [h]~[x]. This pattern also applies to sequences of underlying /w-k/ and /h-k/ which can result in intervocalic [x] or [h]. There is a fourth underlying representation that follows this lenition pattern. Underlying /k-j/ sequences will also surface as [hk]~[xk]~[x]~[h]. Recall the palatal assimilation pattern described in (42). The analysis is that underlying sequences of /C-j/, where the C is [–continuant], will surface as [hC] (attested assimilating sequences: /k-j/ →[hk], /t͡ʃ-j/→[ht͡ʃ], /t͡s-j/→[ht͡s]). The assimilation pattern is shown below in (64), which repeats relevant data from (42) above.

64)	a.	soki**t͡ɬ**	/soki-t͡ɬ/	mud-ABS	'mud, *lodo/zoquete'* (zoquitl)
	b.	soki**j**oh	/soki-joh/	mud-ADJ	'muddy, *embarrado'* (zoquiyoh)
	c.	wi**t͡st͡ɬ**i	/wi**t͡s**-t͡ɬi/	thorn-ABS	'thorn, *espina'* (huitztli)
	d.	wih**t͡s**oh	/wi**t͡s**-joh/	thorn-ADJ	'thorny, *espinoso'* (huitztzoh)
	e.	ahwe**t͡ʃt͡ɬ**i	/ahwe**t͡ʃ**-t͡ɬ/	dew-ABS	'dew, *rocio*'(ahhuechtli)
	f.	ahweh**t͡ʃ**oh	/awe**t͡ʃ**-joh/	dew-ADJ	'dewy, *rociado*' (ahhuechchoh)

The same pattern arises in the velar context with the adverbial suffix /-ja/ 'already'.[50] The data in (65) show the surface forms of the adverbial suffix /-ja/ 'already' when attached to a vowel-final stem.

[50] /-ja/ is likely an enclitic corresponding to the unbound adverb [je] in other varieties of Nahuatl, however unlike proclitics, /-ja/ does participate in stress assignment.

65)	a.	kiˈʔita	/ki-ita/	3OBJ-see	‘s/he sees it, *lo ve*’ (quiitta)
	b.	kiʔiˈtaja	/ki-ita-ja/	3OBJ-see-ADV	‘s/he now sees it, *ya lo ve*’ (quiittaya)
	c.	kaˈlahki	/kalak-ki/	enter-PRET	‘s/he entered, *entró’* (calacqui)
	d.	kalahˈkija	/kalak-ki-ja/	enter-PRET-ADV	‘s/he already entered, *ya entró’* (calacquiya)

The data in (66) show this suffix attached to velar-final stems. Here the surface form looks like the velar stop sequences shown earlier in this discussion. Note that in this case the relevant verbs are from the class of verbs that do not have preterit stem allomorphs (Class 1). Thus, the preterit marker is simply [-k] creating the /k-j/ context.

66)	a.	kiˈʔitak	/ki-ita-k/	3OBJ-see-PRET	‘s/he saw it, *lo vió’* (quiittac)
	b.	kiʔiˈtahka	/ki-ita-k-ja/	3OBJ-see-PRET-ADV	‘s/he already saw it, *ya lo vió’* (quiittacca)
	c.	moˈpat͡ɬak	/mo-pat͡ɬa-k/	REFL-change-PRET	‘s/he changed’ (clothes), *se cambió (ropa)’* (mopatlac)
	d.	mopaˈt͡ɬahka	/mo-pat͡ɬa-k-ja/	REFL-change-PRET-ADV	‘s/he already changed, *ya se cambió (ropa)’* (mopatlacca)’

As the data in (66) show, where one would predict a [kj] sequence, the attested surface form is [hk] which varies freely for all speakers with [xk]~[x]~[h], the pattern we saw for sequences of velar stops. This provides the evidence for the analysis in which the

derivation is /k-j/→|kk|→[hk]: the palatal glide assimilates to the preceding velar stop creating the environment for the narrow velar lenition process described above. It should be noted that references to "free" variation in this dissertation do not assume that there are no other factors influencing realization such as speech rate, intonational structure, sociolinguistic register, or discourse structure. Such analyses merit inquiry but are outside the scope of this dissertation.

The environment that triggers narrow velar lenition also occurs across word boundaries. The data in (67) show that **two** adjacent velar stops across word boundaries[51] show the same pattern of lenition.

67)	a.	onka mia**h k**ali	/onka miak kal-i/	AUX many house-ABS	'there are many houses, *hay muchas casas'* (onca miac calli)	02_0053_el
	b.	mia**k**	/miak/	many	'many, much, *mucho'* (miac)	02_0025_el
	c.	namano**h k**omo	/naman-ok komo/	now-ADV like	'just now, like, *hace poco, como'* (namanoc como)	02_0052_el
	d.	namano**k**	/naman-ok/	now-ADV	'just now, *hace poco* (namanoc)	02_0052_el

[51] The *como* in [namano**h k**omo] is a code-switch context, though, this word and other functional words have been borrowed such as *de* and *para*.

In (68), the data show that the more lenited surface form of narrow velar lenition is triggered across word boundaries. Here, the adjacent velar stops surface as a velar fricative (represented below as the onset of the second word).

68)	a.	ki?i͡tsto**x**ena	/ki-i͡ts-tok kena/	3OBJ-see-PERF	's/he has seen it, yes *lo ha visto, sí'* (quiitztoc, quena)	02_0051_el
	b.	**k**ena	/kena/	Yes	'yes, *sí'* (quena)	02_0035_el

The example in (68a) contains a velar fricative [x] where a [k] is expected—compare with the response in (68b). Parallel realizations of /k-k/ sequences with [h] instead are also attested as the result of velar stop lenition across word boundaries. Given the criteria adopted here, it can be concluded that narrow velar lenition is a postlexical phonological process because it occurs across word boundaries.

In this discussion, I have shown that velar stops undergo gradient lenition in consonant clusters. Sequences of velar stops trigger lenition of the first velar stop which can in turn result in lenition of the second velar stop in the cluster. The degrees of lenition range in spirantization (incomplete debuccalization, [x]) and debuccalization ([h]). I then showed a related pattern in which any sequence of [hk], regardless of its underlying representation, can trigger lenition of the velar stop. I now turn to a broader velar lenition pattern that is not limited restricted to the /$k^{(w)}$-$k^{(w)}$/ context.

3.4.5 Broad Velar Lenition

In this section, a parallel but broader optional lenition process is described. Broad velar lenition, is described in (53b) as /k$^{(w)}$/→[g]~[x]~[ɣ]~[h]/___C. Note that the phonotactic restriction on coda labialization is also at play here (for example *x^{w}C and *k^{w}C, only xC and kC surface). This process is optional, and lenition can include debuccalization to a glottal fricative [h]. Velar stops in this context have a range of possible realizations, which like narrow velar lenition are analyzed here as degrees of lenition: /k$^{(w)}$/→g~x~ɣ→h/___C. This pattern is similar to narrow velar lenition but differs in a number of crucial ways. It can be thought of as a broadening of the phonological contexts that trigger narrow velar lenition: a lenition process that targets a velar in any consonant cluster. Also, the process is optional. Narrow velar lenition always applies to some degree in sequences of velar stops. In the broader pattern, application is optional and may involve factors such as prosody, speech rate, or sociolinguistic register. For example, it cannot be overlooked that the researcher is not a native Nahuatl speaker, nor part of the community and thus may have impacted the data collected. The speech recorded was either directed at or uttered in the presence of a nonnative speaker, leaving the possibility that the data reflect a specific register or foreigner-directed speech.

The data in (69) show the optionality of the lenition process. These forms are from the same speaker. Each pair was recorded in the same elicitation session, in sequential order. Teachers were asked to repeat tokens 2-3 times in response to questions such as "Queniuhqui moihlia ___" '*como se dice* ___, how do you say___'.

69)	a.	pi**k**tok pi**x**tok	/pik-tok/	wrap-PERF	'it's wrapped up/ covered up, *envuelto*' (pictoc)	02_0053_el
	b.	temi**k**t͡ɬi temi**x**t͡ɬi	/temik-t͡ɬi/	dream-ABS	'a dream, *un sueño*' (temictli)	02_0040_el
	c.	noi**k**niwah noi**x**niwah	/no-ikni-wah/	1POS-sibling-PSM.PL	'my siblings, *mis hermanas/os*' (noicnihuan)	02_0051_el

As the data in (69) show, this process is optional, in that speakers vary freely in as much as can be analyzed in these responses taken in isolation. Velar lenition is attested in velar stops occurring before a wide range of consonants in the inventory. In a controlled task during elicitation sessions, speakers were asked to produce tokens from two wordlists written in Nahuatl orthography: one that contained noun-noun compounds in which there was a /k.C/ cluster at the morphological juncture, and one in which noun incorporation (noun-verb) provided a /k.C/ cluster at the morphological juncture. They were asked to repeat each token three times. The lists were compiled in collaboration with two of my teachers. The noun-noun compounds were words such as /to**k-p**ah-t͡ɬi/ corn.plant-medicine-ABS 'fertilizer/insecticide' or /wa**k-t͡ʃ**il-i/ something.dried-chile-ABS 'dried chile'. Segments were categorized using spectrograms in Praat (Boersma & Weenink 2019) in combination with the researcher's perception judgements. Segments counted as [k] if there was canonical closure in the spectrogram; [x] if there was a fricative with less lower frequency noise (as compared to [h]) and evidence of velar pinch in formant structure; [ɣ] if frication had evidence of voicing throughout the duration of the sound; [g] if there was closure with prevoicing; and [h] is there was

broad-band noise in the spectrogram. The data for the realization of the velar stop in these contexts for one speaker (speaker 11) is summarized in (70).

70) Speaker 11: Noun-Noun Compounds

realization	context /_C	count	% of total tokens
k	p, t, t͡ʃ, t͡s, t͡ɬ, s, ʃ, l, w	32	53.33%
x	p, t, k, k^w, t͡ɬ, m, n, s, l, w, j	25	41.67%
ɣ	j	1	1.67%
h	k, k^w	2	3.33%
	Total Tokens	60	

As the table in (70) shows, fully faithful and lenited instances of underlying velars are roughly evenly split. Given the small sample size, it is not clear if there are differences between phonological contexts. For example, the nasals only seem to co-occur with [x] in this task for this speaker, but it is possible (and as we will see in the next data set) that this is due to the sample size, and with more tokens of this type for this speaker, tokens with faithful stop realization would likely occur. Note that there were only two instances of debuccalized [h] forms of the sixty tokens recorded. These do occur in a context that overlaps with the context for narrow velar lenition.

The data for noun incorporation show a similar distribution, only no debuccalized tokens were recorded, likely due to the small sample size. Incorporated noun stems included /tok/ ‘corn plant’ such as: /to**k-t**eki/ corn.plant-cut ‘to cut down the cornstalk’. The data in (71) below summarize the distribution of velar stop realization for speaker 11.

71) Speaker 11: Noun-Verb Compounds (Noun Incorporation)

realization	context /_C	count	% of total tokens
k	p, t͡ʃ, t͡s, t͡ɬ, m, s, ʃ, l, w, j	25	55.56%
x	t, k, k^w, t͡ɬ, ʃ, r, w	19	42.22%
ɣ	w	1	2.22%
	Total Tokens	45	

These summaries show that the distribution of broad velar lenition is distinct from that of narrow velar lenition and support the analysis of these as distinct processes.[52] As for the phonological status of this process, there is clear evidence that velar stop lenition is postlexical since it occurs across word boundaries. This is exemplified in (72), where word-final velar stops surface as [x] in the environment of a following word-initial consonant.

[52] This does not preclude, velar lenition targeting |x| to result in [h] preceding a C, surface forms like [hC] are expected with the proposed rules.

72) a. kanikajo**x** **t**ihniki 02_0052_el
/kanika-jok ti-k-neki/
approx.where-ADV 2SUBJ-3OBJ-want
'until approximately where [do you want me to move?,
hasta donde quieres [que vaya]' (canicayoc ticnequi)

b. kanikajok 02_0052_el
/kanika-jok/
approx.where-ADV
'until where approximately, *hasta donde* (canicayoc)

c. ti?isto**x** **n**i 02_0028_el
/ti-i͡stok ni/
2SUBJ-AUX DEM
'[how] are you, on... [this day]' (tiitztoc ni)

d. ni?i͡stok 02_0028_el
/ni-i͡stok/
1SUBJ-be
'I am [good]' (niitztoc)

In another controlled elicitation task, speakers were asked to say a carrier sentence with new lexical items following the word-final velar stop [jałwaja nikitak ___] 'yesterday I saw ____'. My teachers read from a list of words in Nahuatl orthography. Minimally, two words were elicited per sound in the inventory, including loan words with marginal phonemes. The data for speaker 11 is summarized in (73).

73) Speaker 11: [jałwaja nikitak ___] *Yalhuaya niquitac* _____

realization	context /_C	count	% of total tokens
k	p, k, k^w, b, s, l, w, j	38	30.89%
g	b, l	3	2.44%
x	p, t, k, b, ɣ, t͡ɬ, t͡ʃ, f, s, h, m, n	52	42.28%
ɣ	b, ɣ, f, r, m, n	23	18.70%
h	t͡ɬ, f, s	7	5.69%
	Total tokens	123	

As shown in the distribution of tokens, while this process is optional, lenition seems to be the predominating pattern across word boundaries. A fully faithful realization of the velar stop is only produced in 30.89% of tokens. The cases of counted as deletion here were cases where there was no evidence of frication in the spectrogram. While the broad lenition pattern seems to be variable, one tendency that does emerge is that voiced realizations precede voiced consonants, which is expected through coarticulation. However, the instances of [ɣ] that precede [f] are unexpected. The cases of /k#k/ to [hk] across word boundaries shown can be equally attributed to narrow and broad velar lenition.

3.4.6 Velar Prefix Allomorphy

There is a pattern of velar stop lenition that is clearly a lexical phonological process. While similar to the postlexical velar lenition pattern described above (broad velar lenition), this process is distinct because of its obligatoriness and the phonetic realization, as described below. This pattern applies in the context of the affixation of the third person singular object

prefix /k-/ to a verbal stem.[53] This prefix exhibits a pattern of phonologically conditioned allomorphy that parallels velar lenition. However, the surface forms are less gradient: the prefix surfaces as [k] before vowel-initial verb stems (74), but as an [h] before consonant initial verb stems (75).

74)	a.	ni'**k**ahsi	/ni-k-ahsi/	1SUBJ-3OBJ-touch	'I reach out and touch it, *lo alcanzo y toco*' (nicahci)
	b.	ni'**k**amati	/ni-k-amati/	1SUBJ-3OBJ-like	'I like it, *me gusta*' (nicamati)
	c.	ni'**k**oni	/ni-k-oni/	1SUBJ-3OBJ-drink	'I drink it, *lo bebo*' (niconi)
	d.	ni**k**ih'ɬia	/ni-k-ihlia/	1SUBJ-3OBJ-say	'I say it, *lo digo*' (niquiuhlia)

75)	a.	nih'notsa	/ni-k-notsa/	1SUBJ-3OBJ-call	'I call her/him/it, *lo llamo'* (nicnotza)
	b.	ni**h**'tema	/ni-k-tema/	1SUBJ-3OBJ-pour	'I pour/dump it (like seeds), *lo vacío (como semillas)'* (nictema)
	c.	ni**h**'t͡ʃiwa	/ni-k-t͡ʃiwa/	1SUBJ-3OBJ-make	'I make it, *lo hago'* (nicchihua)
	d.	ni**h**'pija	/ni-k-pija/	1SUBJ-3OBJ-have	'I have it, *lo tengo*' (nicpiya)
	e.	ni**h**'kowa	/ni-k-kowa/	1SUBJ-3OBJ-buy	'I buy it, *lo compro*' (niccohua)
	f.	ni**h**'wat͡sa	/ni-k-wat͡sa/	1SUBJ-3OBJ-dry	'I dry it, *lo seco*' (nichuatza)

[53] The third person object marker, attaches to the verb in at the same place (in principle) as incorporated nouns: [na nia:toloni] /na ni-**a:tol**-oni/ I 1SUBJ-atole-drink 'I drink atole' vs. [na nikoni a:toli] /na ni-**k**-oni atol-t͡ɬi/ I 1SUBJ-3SUBJ-drink atole-ABS 'I drink atole'.

In these examples, forms like (74a), [ni'**k**ahsi] ‘I touch it’, contrast with forms like (75a) [ni**h**'notsa] ‘I call her/him’, where pre-consonantal object /k-/ prefix surfaces as [h].[54] This distribution is similar to the velar stop lenition process (53b) that results in variation such as [pi**x**tok]~[pi**k**tok] ‘it’s wrapped up/covered up’ (69a). However, the alternation of the 3rd person object prefix differs from this pattern in the following ways: 1) it is obligatory (i.e., [k] never surfaces before a consonant); 2) the surface form is always [h] and never [x] (except through coarticulation when the verb is velar-initial) and can reduce to breathy phonation or be deleted altogether[55]. This does not occur in the other lenition processes such as labiovelar glide debuccalization or narrow velar lenition.[56]

In a controlled task, speakers were asked to produce transitive verbs in first person singular and plural constructions, such as /ni-k-t͡ʃiwa/ 1SUB-3OBJ-make ‘I make it’ and /ti-k-t͡ʃiwa-h/ 1SUB.PL-3OBJ-make-PL ‘we make it’. The table in (76) contains counts for each type of realization for speaker 11.

[54] The data in (74) show the surface forms of verbs inflected for first person singular subject. In 3rd person constructions, there is no overt subject marker and the object marker surfaces as [ki] in all phonological environments.

[55] Deletion here does not necessarily result in ambiguity, however, an intransitive read is a logical possibility since intransitive verbs do not take the object marker

[56] This may be due to the object marker being a high frequency morpheme that only marks a verb as transitive. Deletion does not necessarily result in a loss of information given that there are other clues such as arguments, and in the case of intransitives, valency is increased through applicative and causative suffixes.

76) Speaker 11: Third Person Object Marking

realization	context /_C	count	% of total tokens
h	p, t, k, k^w, t͡ʃ, t͡ɬ, j	26	30.04%
V̥~V̤	p, t, k, t͡s, t͡ɬ, m, n, f, ɣ, l, w, j	50	29.24%
Ø	p, t͡ʃ, t͡s, t͡ɬ, m, n, f, ɣ, s, ʃ, l, w, j	69	40.35%
	Total Tokens	171	

There is a difference between the surface realization of the [h] allomorph in this construction and the debuccalized velars in the two previous lenition processes. As is shown in (76), the allomorph was only produced as an [h] in 30% of the tokens while reduced to breathy phonation or deleted altogether in the remaining tokens. No other patterns of velar lenition result in breathy voice or this rate of deletion. This is specific to this morphological construction. For example, tokens such as [ninohnot͡sa] rather than the expected [nihnohnot͡sa] /ni-k-noh~not͡sa/ 1SUB-3OBJ-RED~call 'I call her/him' were recorded. The expected [-h] allomorph does not surface; however, the /h/ that forms part of the reduplication template, the Vh sequence later in the verb, does not delete or surface as breathy voice. Neither of these tokens of [h] are in stressed syllables, so the difference cannot be attributed to prominence, and, if this were purely a speech rate issue, one would expect both kinds of [h] to be reduced. From the many tokens recorded we can thus conclude that this is not a process that occurs with any sequence of /Vh/, but rather, is something specific to this morphological construction.

This alternation should be classified as morphologically-conditioned phonology given the definition adopted in this dissertation: phonological patterns that are not fully general in the lexical phonology of the language but are instead associated with a specific

morphological construction or a set of morphological constructions (Inkelas 2008). Here, there is regular (phonological) allomorphy (an alternation), not suppletion. The analysis is that this is an obligatory lexical counterpart to the optional postlexical broad velar stop lenition process (53b) that is associated with this morphological construction. It is a regular phonological process that must be lexical given that it makes reference to morphological information i.e., it is limited in application to this morphological construction.

3.5 Summary of Glottal Fricatives

When first beginning to learn about Chicontepec Nahuatl, it was clear to me that there were a great many glottal fricatives present in the language, though to my English-Spanish speaker ear, many were at first easily missed. And in fact, as I hope I have shown in this chapter, there are many sources of glottal fricatives in ChN. In addition to being a phoneme in the language, glottal fricatives form part of morphological templates (i.e. reduplication and preterit stem allomorphs) and constructions. Still other glottal fricatives arise through lenition processes targeting nasal sounds, /w/, /k/ and /k^w/ resulting in a fair amount of neutralization. What makes these patterns so interesting is that despite the neutralization that results from these processes, and the fact that [h] is less perceptually salient postvocalically, glottal fricatives often carry a fair amount of morphological information. I return to this question of morphological information in the next chapter (§4.3.7). A summary of the glottal fricatives discussed here is provided in Table 5 with a description of the impact of the [h] on morphological information.

Table 5 Summary glottal fricatives in ChN by grammatical domain

Grammatical Domain		Source of Laryngeal Articulation	Morphological information
Lexical Domain	Contrastive [h] in inventory (3.3.1)	Lexicon	Forms minimal pairs with other sounds (presence and absence is lexically contrastive).
	Reduplication (3.3.4) *Templatic reduplicant structure*	*CVh~*	[h] contrast with a less-productive CV~ reduplicant template.
	Preterit Stems (3.3.5) *lexically specified templatic allomorph*	Verb-final [oa] and [ia] alternate with [oh] and [ih] respectively in the preterit construction.	Single exponent of preterit construction unless combined with past tense marker [-ki].
	Plural Marking (3.3.6) *morphological exponent*	[-h] suffix	Single exponent of plurality and person in second person singular vs. first person plural, and third person singular vs. plural.
	Word-final Nasal Debuccalization (3.4.1) *general phonological pattern*	/m, n/ → [–place]/___]$_{CODA}$ Surface as [h] in unstressed word-final contexts.	Neutralizes contrast between coda /h/ and word-final nasals.
	Coda Labiovelar Glide Debuccalization (3.4.2 *general phonological pattern*	/w/→[h]/___]$_{CODA}$ Neutralizes contras between word-final nasal and final /h/ and /w/	Neutralizes contrast between coda /h/ and coda /w/.
	Velar Prefix Allomorphy (3.4.6) *morphologically conditioned phonology*	/-k-/→[h]~[Ø]/___C	Deletion results in a loss in overt marking of transitivity.
Postlexical Domain	Narrow Velar Lenition (3.4.4)	/k$^{(w)}$-k$^{(w)}$/→ [hk$^{(w)}$]~[xk$^{(w)}$]~[x$^{(w)}$]~[h]	Neutralization of contrast of /k$^{(w)}$-k$^{(w)}$/ with /hk$^{(w)}$/ and /wk$^{(w)}$/ sequences.
	Broad Velar Lenition (3.4.5)	/k/→ [g]~[x]~[ɣ]~[h]/___C	Contrast is mostly maintained, except [h] surface form, which neutralizes contrast with /h/ and /w/.

Having described the sources of glottal fricatives in ChN, I now turn to glottalization. As will be discussed in this next section, glottalization aligns with larger prosodic domains and can thus cooccur with the glottal fricatives that have been described in the section. Taken together, the distribution of glottal fricatives and glottalization set the stage for Chapter 4, in which the phonetic outcome of stacked contexts is addressed.

3.6 Glottalization in ChN

Absent in the overview of the inventory of ChN was glottal stop. While there is no evidence that [ʔ] is a contrastive sound, glottalization occurs in a number of predicable contexts. In this section, the various contexts for glottalization in ChN are described. Glottalization will be transcribed using [ʔ] for convenience. As is expected with laryngeal articulations, it can have realizations that range from creaky phonation to a segmental glottal stop, and when reference is made to a glottal stop, it is solely a reference to its segment-like realization rather than a claim about its segmental status.

In ChN, glottalization occurs at the prefix-stem boundary, stem-stem boundaries, hiatus contexts and in prepausal contexts. Glottal stop epenthesis in hiatus contexts and in stressed vowel-initial word environments is common cross-linguistically (Kohler 1994, Dilley et al. 1996, Davidson & Erker 2014, Garellek 2014, Edwards 2017 to name a few). In addition, glottal stops have been shown to coocur with morphological boundaries in numerous languages: including Cahuilla (UtoAztecan, Seiler 1965), Top End languages (Gunwinjguan, Harvey 1991), Agutaynen (Austronesian, Quakenbush 1991), German (Germanic, Kohler 1994), Shipibo (Panoan, Valenzuela et al. 2001), Amarasi (Austronesian, Edwards 2017), Nivaĉle (Mataguayan, Gutiérrez 2016) among others. Glottalization has also been shown to be associated with larger

phrasal domains (Dilley et al. 1996, Rodgers 1999, Redi & Shattuck-Hufnagel 2001, Garellek 2014, 2015, Garellek & Seyfarth 2016, among others).

As is shown in this chapter, glottalization in ChN is a prosodic articulation that aligns with phrasal boundaries. Using the criteria set out in the previous section, these articulations must be analyzed as a postlexical phenomenon given that they result in a non-contrastive sound, and in the case of pausal glottalization, correspond to units larger than the prosodic word.

3.6.1 Glottalization Sensitive to Morphological Structure

There is a regular pattern of glottal stops occurring at the prefix-stem boundary. No glottalization in the stem-suffix, nor in the prefix-prefix boundaries is attested. This process appears to be optional, as exemplified in (77) (optional glottal stops are highlighted in boldface and underlined) and occurs before vowel-initial stems.[57]

77) a. tine͡tʃˈ**ʔ̲**ita
/ti-ne͡tʃ-ita/
2SUBJ-1OBJ.SG-see
'you see me, *tu me ves*'
(tinechitta)

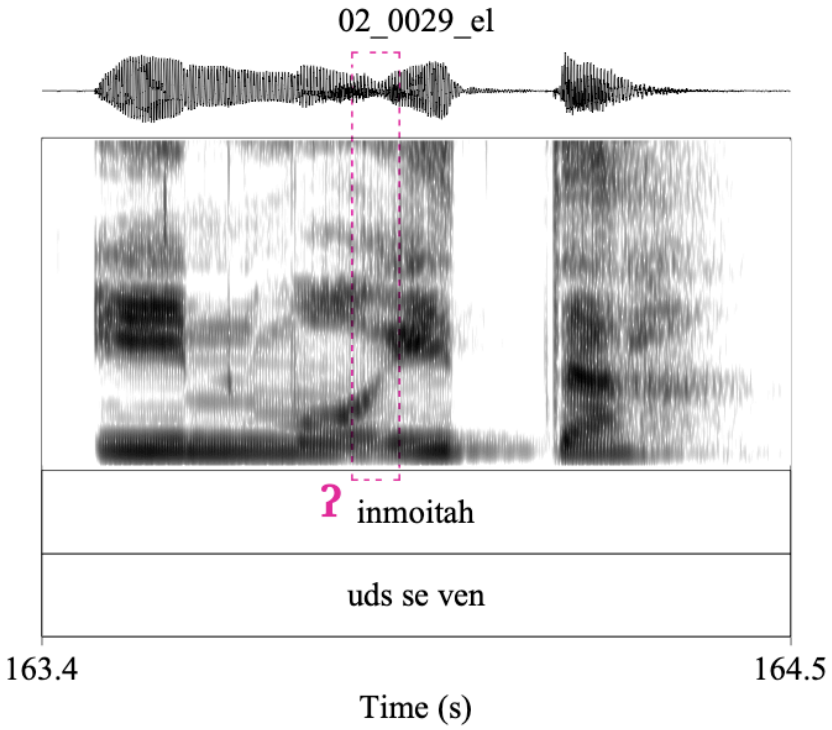
b. tineˈt͡ʃita
/ti-ne͡tʃ-ita/
2SUBJ-1OBJ.SG-see
'you see me, *tu me ves*'
(tinechitta)

c. nimi͡t**s̲ʔ̲**aːˈmati
/ni-mi͡ts-aːmati/
1SUBJ-2OBJ.SG-like
'I like you, *me gustas*'
(nimitzamati)

d. nimi͡tsaːˈmati
/ni-mi͡ts-aːmati/
1SUBJ-2OBJ.SG-like
'I like you, *me gustas*'
(nimitzamati)

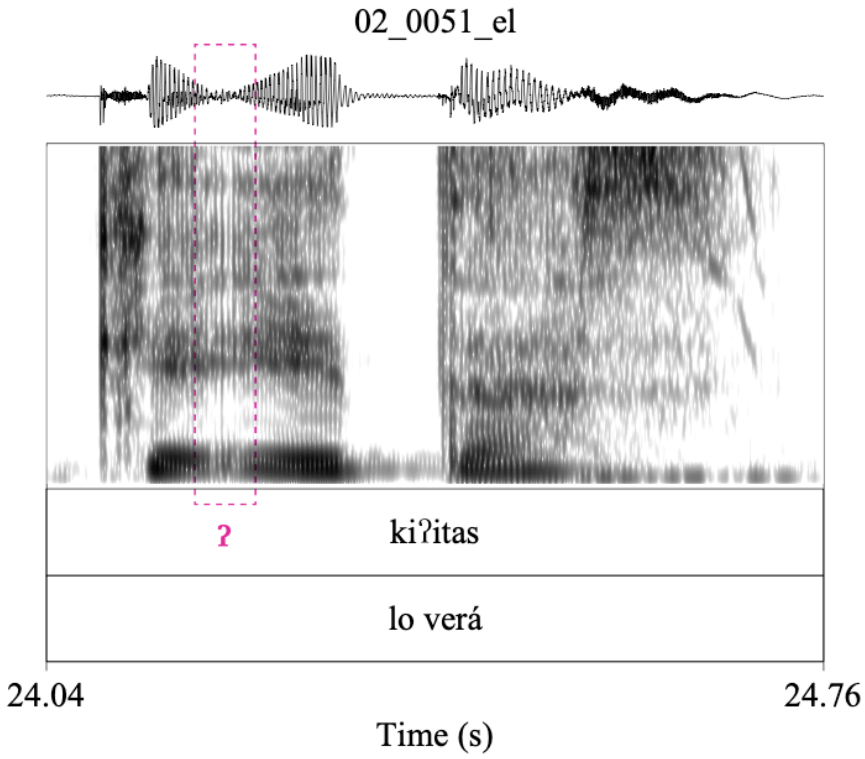
[57] Since glottalization can occur on sonorants in other contexts, it is expected that glottalization can occur at this juncture for sonorant initial verbs, though I have not yet found any such cases in my data.

The presence of glottal stop was determined by the presence of at least one of the following criteria from Dilley et al. (1996) and Garellek (2013): irregular pulsing in the waveform/spectrogram, a dip in f0/attenuation of signal, or complete closure (canonical glottal stop). The range in glottalization is demonstrated in Figure 8-Figure 10, which show the range in glottalization with weak creaky voice in Figure 8 [inmoʔitah] 'you all see youselves', strong creak in Figure 9 [kiʔitas] 's/he will se it', and a canonical glottal stop in Figure 10 [timoʔitah] 'you all see youselves'.



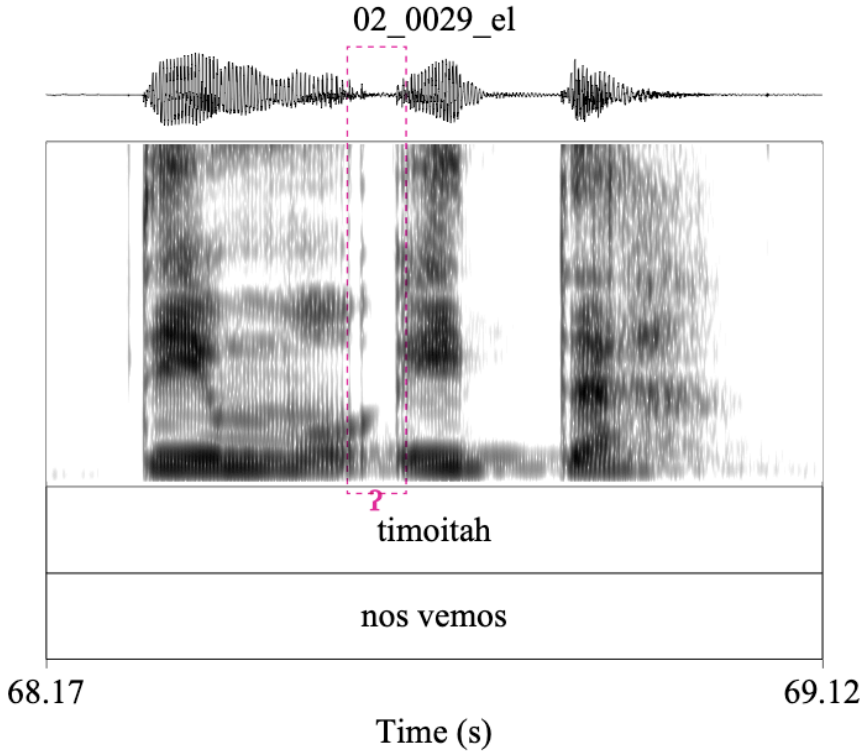
[inmoʔitah]
/in-mo-ita-h/
2SUBJ.PL-REFL-see-PL
'you all see youselves, *ustedes se ven'* (inmoittah)

Figure 8 Glottalization with weak creaky voice



[kiʔitas]
/ki-ita-s/
3OBJ-see-FUT
's/he will se it, *lo verá'* (quiittaz)

Figure 9 Glottalization with weak creaky voice



[timoʔitah]
/ti-mo-ita-h/
1SUBJ.PL-REFL-see-PL
'you all see youselves, *ustedes se ven*' (timoittah)

Figure 10 Glottalization with canonical glottal stop

The data in (77) showed that the prefix-stem boundary is the locus of glottalization, and that the prefix does not need to be vowel-final. The examples in Figure 8-Figure 10 demonstrate that in addition to occurring at the prefix-stem boundary, glottalization also occurs in a hiatus context. Hiatus-resolving glottal stops occur most often between two homorganic vowels as in Figure 8 above, but can occur between heterorganic vowels as well (Figure 9-Figure 10). There is no evidence of root-internal sequences of identical vowels, though vowel length is contrastive, and they only occur across morpheme boundaries. As we

saw in (16a-b) reproduced here in (78a-b), sequences of morpheme-internal heterorganic vowels do not necessarily trigger glottalization. Similarly, heterorganic vowels across morpheme boundaries do not tend to trigger glottalization (78c-d). However, glottalization is attested in this context in careful speech.

78)	a.	ko͡ːa͡ːt͡ɬ	/koːaː-t͡ɬ/	snake-ABS	'snake, *vibora'* (coatl)
	b.	t͡ɬao͡ʃt͡ɬi	/t͡ɬaoj-t͡ɬi/	corn.kernel-ABS	'corn kernels, *granos de maíz'* (tlaoxtli)
	c.	t͡ɬai͡ːʃpaːh	/t͡ɬa-iʃ-paːn/	NS.OBJ-eye-LOC	'altar, *altar*' (tlaixpan)
	d.	kʷae͡st͡ɬi	/kʷa-es-t͡ɬi/	tree-blood-ABS	'tree sap, *savia de un arbol*' (cuaeztli)

In (79), glottal stop inserts between homorganic vowels at morpheme boundaries in morphologically complex words.

79)	a.	kʷaʔ̲ahalaˈʃoa	/kʷa-ah~alaʃoa/	head-RED~rub	'caress (some)one's head, *acariciarle la cabeza'* (cuaahaxaloa)
	b.	t͡ɬaʔ̲aːˈmeja	/t͡ɬa-aː-meja/	NS.OBJ-water-flow	'water flows from the ground, *mana mucha agua*' (tlaameya)
	c.	t͡ɬahkoˈʔ̲oht͡ɬi	/t͡ɬahko-oh-t͡ɬi/	half-road-ABS	'the middle of the road, *en medio del camino*' (tlahcoohtli)

The data in (80), further support the analysis that glottalization is postlexical, since glottal stops are also inserted resolving hiatus across word boundaries.

80)	a.	kiːhˈɬihki ʔiˈnana	/ki-ihlih-ki# i-nana/	3OBJ-say.PRT-PRET# 3POS-mother	's/he told his/her mother, *le dijo a su mama*' (quiuhlihqui inana)
	b.	ˈmost͡ɬa ʔaʃtiˈwelis	/most͡ɬa# aʃ-ti-weli-s/		'you can't tomorrow, *mañana no podrás*' (moztla axtihueliz)
	c.	noˈtata ʔiˈmilah[58]	/no-tata# i-milah/	1POS-father 3POS-field	'my father's field, *la milpa de mi papá'* (notata)

Hiatus-resolving glottalization, while widely attested, seems to be optional, allowing for variation in the occurrence of hiatus resolution through glottal stop epenthesis. The examples in (81) do not contain a glottal stop where one is expected given the pattern observed above in (80).

81)	a.	ne eːˈlot͡sih	/ne # eːlot͡sin/	DEM corn-DIM	'that corn (reverential), *ese elotito*' (ne elotzin)
	b.	ˈmost͡ɬa aʃtiˈwelis	/most͡ɬa # aʃ-ti-weli-s/	tomorrow # NEG-2SUBJ-can-FUT	'you can't tomorrow, *mañana no podrás*' (moztla axtihueliz)

The absence of glottal stop suggests that glottal epenthesis is an optional process that may be influenced by rate of speech, register (e.g. teacher speech), or intonational context.

[58] The word for father is often [notatah], though [notata] is also attested.

This has been shows to be the case in German where the rates of word-initial glottalization decrease as speech rate increases (Pompino-Marschall & Żygis 2010). It may also be the case that glottal stop epenthesis in these contexts is driven by intonational phrase structure. However, an intonational model for Chicontepec Nahuatl is left outside of the scope of this dissertation, and so for now I assume that this postlexical pattern of glottal stop insertion is simply optional.

The hiatus environment for glottal epenthesis can co-occur with another environment, the prefix-stem context discussed earlier and shown in (77). This occurs in vowel-initial verbs when the prefix is vowel-final (shown in (82) below). Both of these conditioning environments for glottal epenthesis appear to be optional. However, when the stem-prefix juncture co-occurs with the penultimate vowel in a word, the locus of the hypothesized prominence/stress, glottal epenthesis occurs more frequently as the onset of the stressed syllable.

82)	a.	kiˈʔ̲ita	/ki-ita/	3OBJ-see	‘s/he sees it, *lo ve*’ (quiitta)	02_00026_el
	b.	kiˈʔ̲itas	/ki-ita-s/	3OBJ-see-FUT	‘s/he will see it, *lo verá’* (quiittaz)	02_00051_el
	c.	kiˈʔ̲itak	/ki-ita-k/	3OBJ-see-PRET	‘s/he saw it, *lo vió’* (quiittac)	02_00051_el
	d.	moˈʔ̲ita	/mo-ita/	REFL-see	‘sees him/herself, *se ve’* (moitta)	02_00029_el
	e.	teˈʔ̲ita	/te-ita/	3OBJ-see	‘s/he sees someone, *ve a alguien’* (teitta)	02_00026_el

In a random sample of tokens in which the penultimate vowel co-occurs with the prefix-stem boundary and is stem-initial (twenty-seven tokens total) for one female speaker

(speaker 02), every token with a stressed hiatus context underwent glottal stop epenthesis. The examples in (82) demonstrate this type of distribution. Crucially in this comparison, the prefixes are vowel-final so that both the hiatus triggering and the stem-prefix juncture co-occur.

In contrast, there is variation in glottal epenthesis when the same hiatus context and stem-prefix juncture does not coincide with the stressed penultimate syllable. Of the thirty-nine tokens sampled for the same speaker, only thirteen were produced with glottal epenthesis in these contexts. Two thirds of the tokens were produced without glottal stops like the examples in (83). This distribution suggests that while glottal epenthesis in forms such as [kiʔiˈtaseh] (compare with (83d) is optional, it is more likely to occur (or may even be obligatory) in the context of stress (which has been found for English: Davidson & Erker 2014, and Garellek 2014).

83)	a.	kiiˈtaja	/ki-ita-ja/	3OBJ-see-ADV	's/he already sees it, *ya lo ve*' (quiittaya)	02_00051_el
	b.	kiiˈtasa	/ki-ita-s-ja/	3OBJ-see-FUT -ADV	's/he will see it now, *ya lo verá'* (quiitazza)	02_00051_el
	c.	kiiˈtahka	/ki-ita-k-ja/	3OBJ-see-PRET-ADV	's/he already saw it, *ya lo vió'* (quiitacca)	02_00051_el
	d.	kiiˈtaseh	/ki-ita-seh/	3OBJ-see-FUT.PL	'they will see it, *lo verán*' (quiitazeh)	02_00051_el
	e.	kiitaˈsehja	/ki-ita-seh-ja/	3OBJ-see-FUT.PL-ADV	'they will see it now, *ya lo verán'* (quiitazehja)	02_00051_el
	f.	moihˈlia	/mo-ihlia/	REFL-say	'it is said, *se dice*' (moiuhlia)	02_00026_el

In this section I have shown that glottalization is sensitive to morphological boundaries to the left of the stem. This raises an issue for the criteria established in Chapter 2—if glottalization, as I argue here, is a postlexical phonological phenomenon, then it should not be able to see word structure. The standard assumption is that postlexical processes are blind to internal word structure. However, as the data in this section have shown, as well as the results from the acoustic study in Chapter 4 will show, postlexical phenomena may in fact be sensitive to lexical information.

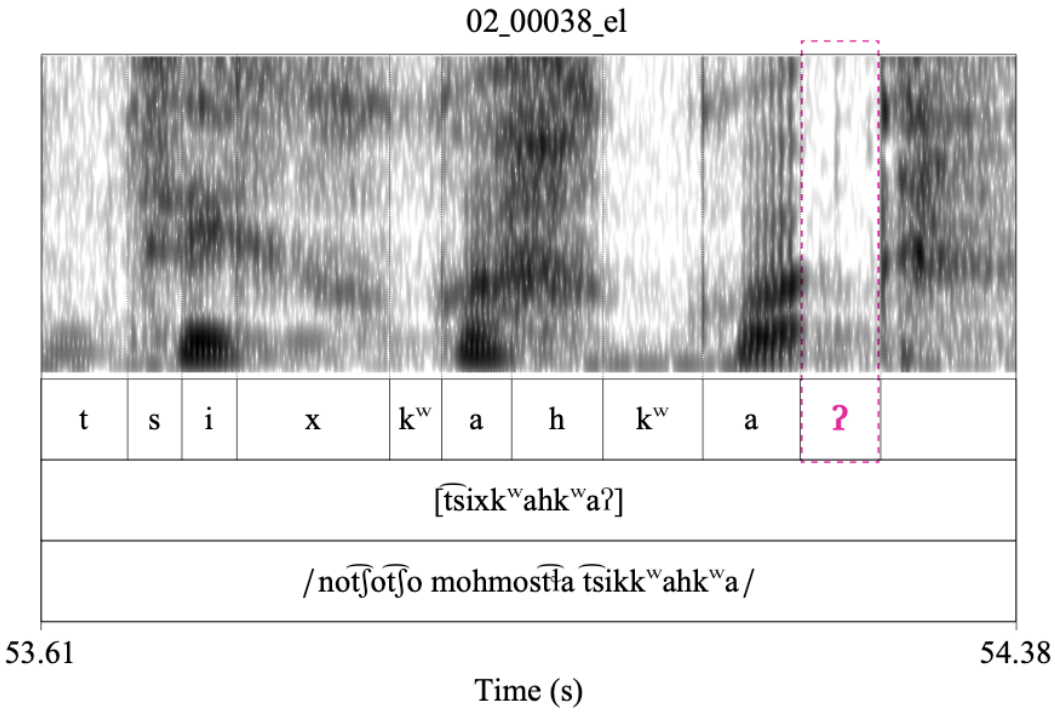
3.6.2 Pausal Glottalization

Another pattern of glottalization aligns with pausal contexts. The intuition that there is intonational or syntactic structure associated with these glottal stops is largely simplified for the purposes of this dissertation. A detailed intonational model for, or syntactic analysis of CN, is outside the scope of this dissertation. Thus, I assume that any pause will trigger glottal stop epenthesis, including the Utterance-final context. Here, a pause is defined as a period of silence, a perceptible and physical break in the speech stream, that may or may not align with other prosodic boundaries. A glottal stop generally surfaces with Utterance-medial pauses and Utterance-finally.

Let us first look at Utterance-final stops. The Utterance here is preliminarily defined as a breath group. In this context, glottalization is generally released with some degree of breathy noise and detectable in acoustic analysis, as exemplified in the spectrograms in Figure 11 and

Figure 12. Note the breathy release of the glottal stop, which is characteristic of the type of canonical glottal stop that occurs in the Utterance-final context. These spectrograms

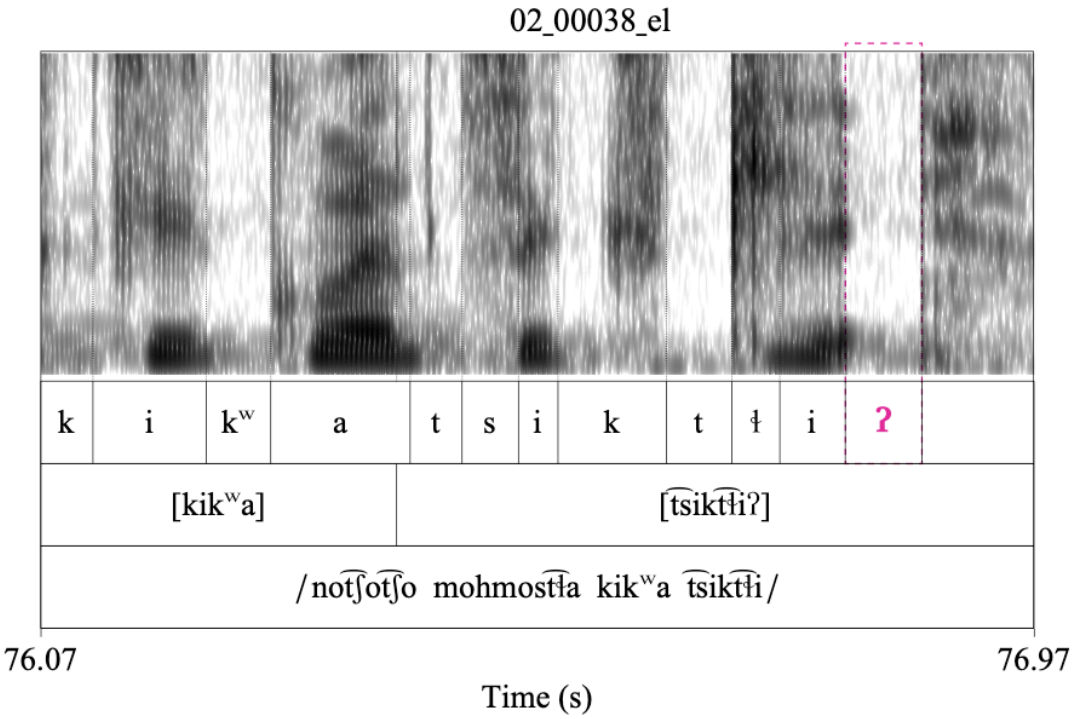
show two equivalent sentences with different word order, with different words Utterance-finally, the environment for glottalization. [59] This shows that glottalization is not associated with the lexical level, but with the Utterance level instead.



[not͡ʃot͡ʃo mohmost͡ɬa t͡sihkʷahkʷaːʔ]
/no-t͡ʃot͡ʃo moh~most͡ɬa t͡sik-kʷah~kʷaː/
1POS-younger.sibling RED~tomorrow gum-RED~chew
'my younger sibling chews gum daily, *mi hermano menor come chicle todos los días*'
(nochocho mohmoztla tziccuahcua) [02_00038_el]

Figure 11 Utterance-final glottalization on verb with incorporated noun

[59] Note that Figure 11 and Figure 12 are different in that the verb /kwaː/ is reduplicated in the incorporated form.



[not͡ʃot͡ʃo moh~most͡ɬa ki-kʷaː t͡sikt͡ɬiʔ]
/no-t͡ʃot͡ʃo moh~most͡ɬa ki-kʷaː t͡sik-t͡ɬi/
1POS-younger.sibling RED~tomorrow 3OBJ-chew gum-ABS
'my younger sibling chews gum daily, *mi hermano menor come chicle todos los días*'
(nochocho mohmoztla quicua tzictli) [02_00038_el]

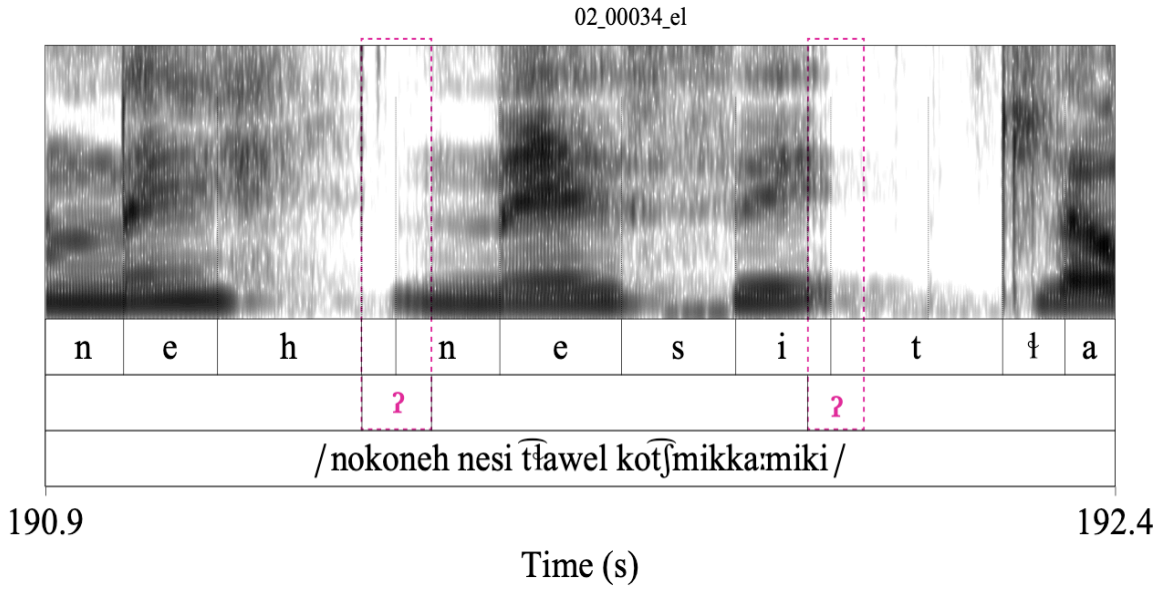
Figure 12 Utterance-final glottalization on unincoprorated noun

Morphosyntactically, the difference between these sentences is that the predicate in Figure 11 has an incorporated noun, /t͡sik-/ 'gum', while in Figure 12, the object noun is a separate word.[60] The verb /kʷaː/ 'to chew' occurs Utterance-finally in Figure 11 and is produced with a final glottal stop. In contrast, in Figure 12 the noun is not incorporated and

[60] This particular token exemplifies reduplication-specific [h] ([mohmost͡ɬa] and [t͡sihkʷahkʷaː]) and velar lenition [t͡sihkʷahkʷaː] /t͡sik-kʷ*ah*~kʷaː/ gum-RED~chew 'chew gum' in addition to the prepausal glottal stop.

follows the verb. Here, the predicate /kʷaː/ is not Utterance-final and is produced without glottalization, while the unincorporated noun [t͡sikt͡ɬi] ‘gum’ is Utterance-final and surfaces with a final glottal stop. This suggests that there is a glottal stop that is associated with the end of an Utterance, rather than one associated with a particular lexical item.

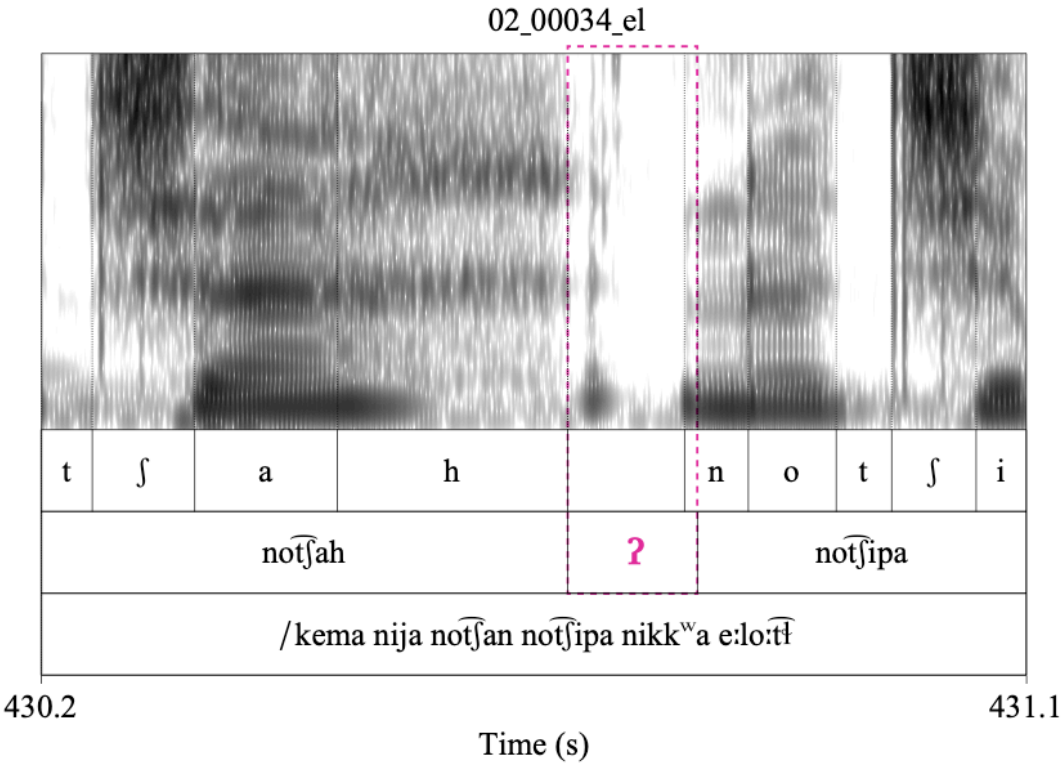
This Utterance-final glottalization seems to have an Utterance-medial counterpart also associated with pauses. The Utterance in Figure 13 has postlexical glottal stops, associated with Utterance-medial pauses after the words [nokoneh] ‘my child’ and [nesi] ‘awaken’. This token was uttered while the speaker was thinking of an example sentence, allowing for pauses at these syntactically unexpected places. Thus, it can be concluded, that while glottal stops may often align with relevant syntactic constituents (as is shown later), it is the pause itself that triggers glottalization. This evidence supports the conclusion that these glottal stops are prosodic, since each of these words are produced at prosodic breaks in the phrase. It should be noted here that although the pauses in Figure 13 are syntactically unexpected, each of these fragments separated by a pause can stand as a complete phrase if uttered in isolation: [nokoneh] ‘it is my child’; [nesi] ‘s/he/it awakens’, [t͡ɬawe͡ɬ koʊ̯t͡ʃmihkaːˈmiki] ‘s/he/it is very sleepy’.



[noˈkone-hʔ ˈnesiʔ ˈt͡ɬawel kot͡ʃmihkaːˈmikiʔ]
/no-kone-w nesi t͡ɬawel kot͡ʃ-mik-kaː-miki/
1POS-child-PSM awaken very sleep-die.PRT-AUX-die
'My child…awakens…very sleepy, *mi hija/o…amanece…con mucho sueño'*
(noconeuh nesi tlawel cochmiccamiqui) [02_00034_el]

Figure 13 Utterance-medial glottalization

Utterance-medial glottalization is not always realized as a canonical glottal stop articulated with sustained glottal closure. In Figure 13, for example, the glottal stop following [nokoneh] 'my child' is realized as closure with glottalization that continues onto the initial part of the nasal stop in [nesi] 'awaken'. The pausal glottalization that follows [nesi] overlaps with the last part of the [i] vowel followed by a long closure of the [t]. These two different realizations of a glottal stop in the same Utterance demonstrate the property characteristic of laryngeal sounds—it is possible for laryngeal articulation to overlap with adjacent sounds articulated with oral gestures. The Utterance in Figure 14 provides another example of Utterance-medial glottalization co-occurring with a pause.



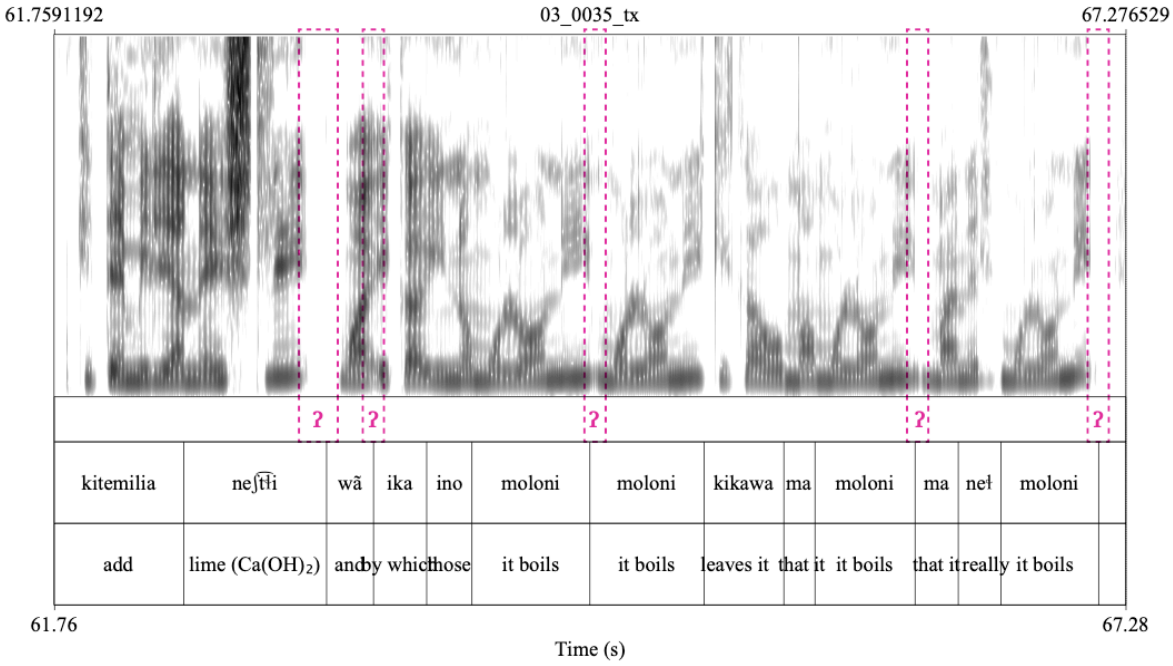
[kemah nijah notʃahʔ notʃipa nihkʷaʔ eːloːtɬ]
/keman ni-jah no-tʃan notʃipa ni-k-kʷa eːloː-tɬ
when I-go my-house always 1SUBJ-3OBJ-eat corn.cob-ABS
'when I go to my house, I always eat corn (on the cob), *cuando voy a mi casa, siempre como elote'* (quemman niyauh nochan nochipa niccua elotl) [02_00034_el]

Figure 14 Utterance-medial glottalization

In this example (Figure 14), glottalization occurs in a similar context to the previous example in Figure 13: between an [h] and [n]. Here, there is a pause in the Utterance after the Wh-cleft [kema nija notʃah] 'when I go to my house'; the noun stem [notʃah] ends in a glottal fricative and is followed by a glottal stop that is coextensive with the pause and continues into the onset of the following nasal, as evidenced by the irregular voicing at the start of the nasal. The result is a complex sequence of laryngeal abduction and adduction in

rapid succession showing one of the logical possibilities for how overlapping laryngeals from distinct levels of the grammar interact. Here there is an underlying nasal that is debuccalized word-finally, which occurs before an Utterance-medial pause. The derived [h] aligns with a context for a postlexical pausal [ʔ]. In this token, the overlapping laryngeal sounds are both realized and articulated sequentially. The spectrogram in Figure 13 shows the same sequential realization, [hʔ], for a debuccalized /w/ in a prepausal context ([nokoneh] /no-kone-w/ 1POS-child-PSM 'my child').

Setting Utterance-final glottalization aside for the moment, at least Utterance-medially, there is the possibility that glottalization is simply a non-segmental strategy used to initiate voicing after a pause. Glottal stops have been argued to be a strategy used to initiate voicing (Garellek 2014). It is thought that initiating vocal fold vibration when the vocal folds are brought together is easier than beginning with a more spread glottis. However, as the Utterance in Figure 15 shows, Utterance-medial glottal stops may not have much of a pause at all, co-occurring with loosely defined prosodic phrases. This example comes from a text describing how to prepare tortillas from dried corn kernels. In this text, the nixtamalization process is being described at a normal speaking rate. The first two glottal stops do cooccur with a longer pause. However, the second two Utterance-medial glottal stops (underlined) occur with much shorter pauses but align with relevant syntactic positions. This further points to the fact that there is much at work in the Utterance-medial context that needs to be understood in future work. Also, in this example there is an Utterance-final glottal stop, which is produced canonically.



[kitemilia neʃt͡ɬi? wã? ika ino moloni? moloni kikawa ma moloni? ma neɬ moloni?]
/ki-temilia neʃ-t͡ɬi wan ika inon moloni moloni ki-kawa ma moloni ma nel moloni/
OBJ-add lime-ABS CONJ ADP DEM boil boil 3OBJ-leave IMP boil IMP very boil
'[she] adds lime (Ca(OH)2) so that it boils, and boils with it, and leaves to boil, so that it is well boiled, *le agrega cal y lo deja hervir, hierve, hierve para que se hierva bien'* (quitemilia nextli huan ica inon moloni quicahua ma nel moloni) [03_00034_tx]

Figure 15 Utterance-medial glottalization in narrative text

An outstanding question concerns how unrestricted pausal glottalization is. Utterance-medially, a number of tokens demonstrate that glottal stops may not always occur. This pausal glottalization may be syntactically or intonationally constrained. However, the Utterance-final glottal stop seems to be unrestricted and is attested with a number of final segments. The data in (84) was collected using carrier sentences to control for intonational and syntactic context. Except for (84a), all tokens contain possessed objects. This was done to glottal fricatives derived from distinct underlying representations in the same context since the stem-final segment will occur at the end of the word (no suffixes). Vowel-final

noun stems take a possessed marker /-w/ which surfaces as [h] (recall Labiovelar Glide Debuccalization 3.4.2). For this reason (84a) is not possessed since it is one of a handful of native Nahuatl words that are vowel-final and do not take an absolutive marker.[61]

84) a. jałwaja nikitak chachaʔ
/jalwaja ni-k-ita-k chacha/
ADV 1SUBJ-3OBJ-see-PRT pitaya
'I saw a pitaya yesterday, *ayer ví la pitaya*'
(yalhuaya niquittac chacha) [11_0004_el]

b. jałwaja nikitak noaːjo̱**h**
/jalwaja ni-k-ita-k no-ajo-**w**/
ADV 1SUBJ-3OBJ-see-PRT 1POS-turtle-PSM
'I saw my turtle yesterday, *ayer ví mi tortuga*
(yalhuaya niquittac noayouh) [11_0012_el]

c. jałwaja nikitak noajo̱**h**
/jalwaja ni-k-ita-k no-ajo**h**/
ADV 1SUBJ-3OBJ-see-PRT 1POS-squash
'I saw my squash yesterday, *ayer ví mi calabaza*'
(yalhuaya niquittac noayoh) [11_0012_el]

d. jałwaja nikitak notekạ̱k
/jalwaja ni-k-ita-k no-tekak/
ADV 1SUBJ-3OBJ-see-PRT 1POS-shoe
'I saw my shoes yesterday *ayer mis zapatos*'
(yalhuaya niquittac notecac) [11_0012_el]

e. jałwaja nikitak nok^{w}ạ̱**h**
/jalwaja ni-k-ita-k no-k^{w}a**w**/
ADV 1SUBJ-3OBJ-see-PRT 1POS-wood
'I saw my lumber yesterday, *ayer ví mi leña'*
(yalhuaya niquittac nocuauh) [11_0012_el]

[61] Recall that vowel-final Spanish words are produced with a final [h].

f. jałwaja nikitak notepo̰s
/jalwaja ni-k-ita-k no-tepos/
ADV 1SUBJ-3OBJ-see-PRT 1POS-metal
'I saw my metal yesterday, *ayer ví mi metal'*
(yalhuaya niquittac notepoz) [11_0012_el]

g. jałwaja nikitak notʲona̰**h**
/jalwaja ni-k-ita-k no-tiona**n**/
ADV 1SUBJ-3OBJ-see-PRT POS-godmother
'I saw my godmother yesterday, *ayer ví a mi madrina'*
(yalhuaya niquittac notionan) [11_0012_el]

h. jałwaja nikitak noamo̰tʃ
/jalwaja ni-k-ita-k no-amo͡tʃ/
ADV 1SUBJ-3OBJ-see-PRT 1POS-book
'I saw my book yesterday, *ayer ví mi libro*'
(yalhuaya niquittac noamox) [11_0012_el]

i. jałwaja nikitak noko̰**h**
/jalwaja ni-k-ita-k no-ko**m**/
ADV 1SUBJ-3OBJ-see-PRT 1POS-jug
'I saw my jug yesterday, *ayer ví mi jarro'*
(yalhuaya niquittac nokon) [11_0012_el]

j. jałwaja nikitak noneʃtama̰ł
/jalwaja ni-k-ita-k no-neʃtamal/
ADV 1SUBJ-3OBJ-see-PRT 1POS-nixtamal
'I saw my nixtamal/hominy yesterday, *ayer ví mi niztamal'*
(yalhuaya niquittac nonextamal) [11_0012_el]

For all words tested, glottalization was found to co-occur with the consonant-final, Utterance-final, word. This suggests that the final glottal stop is a regular prosodic laryngeal target, at least in declarative sentences tested in these (and other) controlled environments. As a counter example, there were also numerous cases in which no overt glottalization was found. The example in (85) below demonstrates such forms.

85) ne naxat͡ɬ t͡ʃene t͡ʃijahjoh
/ne naka-t͡ɬ t͡ʃene t͡ʃijaw-joh/
DEM meat-ABS ADV meat.fat-ADJ
'that meat is very fatty, *esa carne es muy grasosa*'
(ne nacatl chene chiyahyoh) [10_0022_el.WAV]

The particulars of the realization of glottalization are discussed in detail in Chapter 4 when looking at the realization of phrase-final glottalization in [h]-final utterances.

3.7 Summary

In section 3.6, distinct loci of prosodic glottalization were described: the prefix-stem juncture and hiatus in stem-stem/word-word junctures (left of the stem), Utterance-medial and Utterance-final pauses. These patterns of glottalization complete the phonological description of the laryngeal landscape in Chicontepenc Nahuatl. Taken in conjunction with the numerous lenition processes that result in a [h], the phonemic /h/ and the multiple constructions in which a glottal fricative is the single exponent of a morphological construction, it is clear that Chicontepec Nahuatl is laryngeally rich. The following table expands on Table 5 adding Glottalization to the summary of laryngeal articulations in Chicontepec Nahuatl.

Table 6 Summary glottal fricatives in ChN by grammatical domain

Grammatical Domain		Source of Laryngeal Articulation	Morphological information
Lexical Domain	Contrastive [h] in inventory (3.3.1)	Lexicon	Forms minimal pairs with other sounds (presence and absence is lexically contrastive).
	Reduplication (3.3.4) *Templatic reduplicant structure*	*CVh~*	[h] contrast with a less-productive CV~ reduplicant template.
	Preterit Stems (3.3.5) *lexically specified realizational morphology*	Verb-final [oa] and [ia] alternate with [oh] and [ih] respectively in the preterit construction.	Single exponent of preterit construction unless combined with past tense marker [-ki].
	Plural Marking (3.3.6) *morphological exponent*	[-h] suffix	Single exponent of plurality and person in second person singular vs. first person plural, and third person singular vs. plural.
	Word-final Nasal Debuccalization (3.4.1) *general phonological pattern*	/m, n/ → [–place]/___]$_{CODA}$ Surface as [h] in unstressed word-final contexts.	Neutralizes contrast between coda /h/ and word-final nasals.
	Coda Labiovelar Glide Debuccalization (3.4.2 *general phonological pattern*	/w/→ [h]/___]$_{CODA}$ Neutralizes contras between word-final nasal and final /h/ and /w/	Neutralizes contrast between coda /h/ and coda /w/.
	Velar Prefix Allomorphy (3.4.6) *morphologically conditioned phonology*	/-k-/→[h]~[Ø]/___C	Deletion results in a loss in overt marking of transitivity.

Table 6 Summary glottal fricatives in ChN by grammatical domain (continued)

Grammatical Domain		Source of Laryngeal Articulation	Morphological information
Postlexical Domain	Narrow Velar Lenition (3.4.4)	/$k^{(w)}$-$k^{(w)}$/ → [$hk^{(w)}$]~[$xk^{(w)}$]~[$x^{(w)}$]~[h]	Neutralization of contrast of /$k^{(w)}$-$k^{(w)}$/ with /$hk^{(w)}$/ and /$wk^{(w)}$/ sequences.
	Broad Velar Lenition (3.4.5)	/k/ → [g]~[x]~[ɣ]~[h]/___C	Contrast is mostly maintained, except [h] surface form, which neutralizes contrast with /h/ and /w/.
	Glottal Stop Epenthesis at Morphological Junctures (3.6.1)	Glottal stop epenthesis at the prefix-stem boundary.	Morpheme boundary
	Hiatus Resolution (3.6.1)	Ø→[ʔ]/[V_α___V_α]	Hiatus/morpheme boundary
	Pausal Glottal Stops (3.6.2)	Glottal stop epenthesis at pauses.	Marking larger prosodic structure.

In the introduction, one of the questions laid out in this dissertation was how laryngeal articulations arising in distinct domains of the grammar interact when they cooccur. There were previews of some of the possible phonetic outcomes of cooccurring laryngeals in the description of prepausal glottal stops in section 3.6.2. This question is explored more deeply in Chapter 4.

Chapter 4

The Phonetic Implementation of Laryngeal Sounds

4.1 Introduction

In this chapter I explore the phonetic implementation of laryngeal sounds in Chicontepec Nahuatl. Specifically, I examine the interactions between glottal fricative [h] of different phonological and morphological statuses in the contexts in which they cooccur with glottalization. In Chapter 3, I showed that there are a number of sources of glottal fricatives in ChN. The [h] is not only a contrastive sound in the inventory but can also surface as a result of lenition processes that target nasal stops in word final contexts, the labiovelar glide in the coda position, and velar stops in consonant clusters. In addition, I demonstrated that not all instances of surface [h] have the same grammatical status in terms of their contribution to morphological exponence. Some cases of [h] can be the single exponent of a morphological construction, while others form part of a larger, multi-segment morpheme. In addition, I showed that there are cases of glottalization that arise at specific phonological, morphological, and prosodic contexts: hiatus environments, prefix-stem junctures, and prepausal/Utterance-final contexts.

In this chapter, I examine configurations arising when Utterance-final glottalization cooccurs with an [h] that is underlyingly /h/, /n/, /m/, or /w/. This is a key context in which to explore the question of how grammatical domains interact to constrain or determine how laryngeals are realized. In such a position where [h] and glottalization (referred to as [ʔ] for convenience) cooccur, the two laryngeals can be said to be in a "stacked" configuration. That is, they belong to two distinct grammatical domains: there is the word-level [h]

cooccurring with prepausal (Utterance-final) glottalization. The outcome of stacking contexts will shed light on the nature of this phrasal glottalization. In Chapter 3, I presented the pattern in Chicontepec Nahuatl in neutral terms, without analyzing its status. As I show in this chapter, the outcome of [h]-[ʔ] co-occurrence has implications for the grammatical status of [ʔ]. Moreover, the sources of the word-level [h] reflects distinct grammatical domains: [h] resulting from word-final nasal debuccalization and labiovelar glide debuccalization are likely lexical processes, while instances of [h] that are underlyingly /h/ are underived. In addition, an [h] in a word-final position can provide differing levels of morphological information. In some cases, a final [h] is part of the root or stem, or a multi-segment suffix, while in other cases, final [h] is the single exponent of a morphological construction. Potential reductions in these two contexts have different implications for loss of morphological information.

Glottal fricatives will form part of the phonological word, as either the edge of a lexical root without suffixes, or as part of a complex morphological construction. Glottalization obligatorily occurs in prepausal contexts, meaning at the edges of larger phrasal domains. While other instances of prosodic glottalization can occur at morphological junctures and in hiatus contexts, those will not be considered in this chapter. Hiatus glottalization cannot occur if there is a glottal fricative; that is to say that a string /VhV/ would not be a triggering environment for glottalization (*[VhʔV] or something similar). And, while it is possible to have a glottal fricative in the stem-prefix juncture, it is only the [h] alternant third person/object marker (alternant of [-k-] and [ki-]), and it does not occur before a vowel. In sum, the context of interest in this chapter is the Utterance-final context because (1) this is a context in which both [h]-final words and vowel-final words can

cooccur with Utterance-final glottalization; (2) Utterance-final glottalization across tokens can be assumed to belong to the same prosodic domain, while Utterance-medial glottalization may correspond do differing prosodic domains; (3) glottal fricatives from distinct grammatical statuses can be compared in the same context.

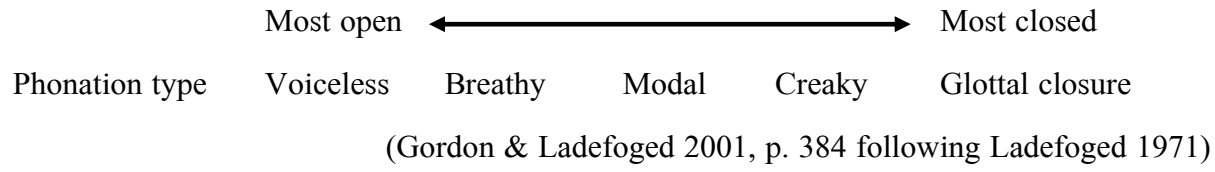
This Chapter is structured as follows: in 4.2 there is a discussion of [h] and glottalization as gesturally opposite and how these are conceived of in two models of laryngeal articulation. In 4.3, "stacking" contexts are defined and the logical outcomes of these stacked laryngeal contexts are discussed, with reference to how the two models make slightly different predictions. Then, there is a discussion of grammatical domains and unique meaning (disambiguation) as possible factors on the outcome of stacking contexts in 4.3.6 and 4.3.7. In 4.4 the methodology for this phonetic study is described, including a brief description of a portable sound booth solution for recording high quality sound in a field setting. In 4.5 the results are presented, first by looking at any effects by the domain of grammar, followed by effects of unique meaning. Then in 4.6, there is a discussion of the patterns that emerge in the data, making a case for treating Utterance-final glottalization as a suprasegment.

4.2 [h] and [ʔ] as Gesturally Opposite

The articulation of [h] and glottalization can be accounted for by two commonly-used models of laryngeal sounds: the Continuum model and the Valves model. These two different approaches make distinct predictions on the relationship between glottal stops and glottal fricatives within a linguistic system.

4.2.1 Continuum Model

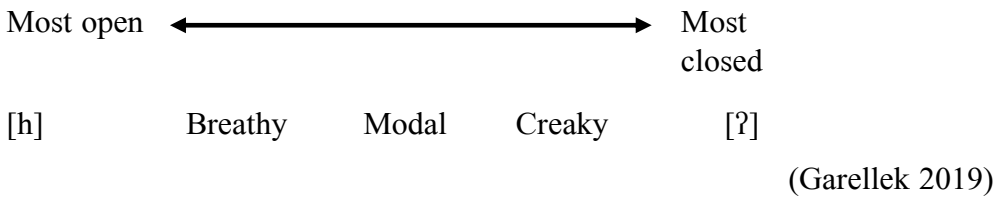
Ladefoged's Continuum model of glottal states (Ladefoged 1971, Gordon & Ladefoged 2001) schematizes the gestural relationship between modal phonation and non-modal phonation types as a continuum of glottal aperture. In this model, there is a continuum of glottal articulations that depend on the width between the arytenoid cartilages. The continuum ranges from most open to most closed: glottal closure forms one end of the continuum, modal phonation is a midpoint, and voicelessness results from the glottis being most open (and the opposite to glottal closure). This model of phonation is presented below in Figure 16.



(Gordon & Ladefoged 2001, p. 384 following Ladefoged 1971)

Figure 16. Ladefoged's continuum of phonation types

The Continuum model is concerned with phonation and the laryngeal articulations associated with the voiced-voiceless contrast. This continuum can be mapped onto a larger three-way contrast that includes [h] (which can also be represented as a voiceless vowel [V̥]), modal voicing [V] in the middle, and [ʔ], as described by Garellek (2019) and restated in Figure 2.



(Garellek 2019)

Figure 17. Ladefoged's continuum of phonation types restated

While Gordon & Ladefoged (2001) note that this schematization might be an oversimplification, many of the contrasts documented in linguistic systems are nonetheless captured here. In this continuum, glottal stops [ʔ] and glottal fricatives [h] are articulatorily opposite—glottal (or inter-arytenoid) adduction on one end, and abduction on the other. What follows from this model is that glottal stops and glottal fricatives are articulatorily opposite, such that constricting articulatory gestures cannot overlap temporally with spreading articulatory gestures.

4.2.2 Valves Model

A more expanded approach to laryngeal articulations is a "whole-larynx" approach to laryngeal articulations. The whole-larynx approach attempts to describe full range of gestures involved in articulating all phonation types (creak vs. modal vs. breathy), as well as other voice qualities (such as whispered voice, harsh voice, and falsetto, among others) and vowel qualities (Laver 1968, Edmondson et al. 2003, Edmondson & Esling 2006, Moisik & Esling 2011). In this view, there are multiple "valves" of the vocal tract in which voice quality can be changed.

In the valves model proposed by Edmondson & Esling (2006), there are six valves at which laryngeal articulations can occur. The description of these valves is reproduced in Table 7 below.

Table 7 Valves of the throat and their functioning

Valve	**Description of the functioning of the valve**
Valve 1	glottal vocal fold adduction and abduction
Valve 2	partial covering and damping of the adducted glottal vocal fold vibration by the ventricular folds (hereafter called ventricular incursion)
Valve 3	sphincteric compression of the arytenoids and aryepiglottic folds forwards and upwards by means of the thyroarytenoid muscle complex
Valve 4	retraction of the tongue and epiglottis moving backwards and downwards, culminating in extreme cases in full closure onto the pharyngeal wall, by means of the hyoglossus muscles (hereafter called epiglotto-pharyngeal constriction)
Valve 5	laryngeal raising by the suprahyoid muscle group, i.e. the anterior and posterior digastric, stylohyoid, geniohyoid and hyoglossus (and, conversely, lowering by the suprahyoid muscle group)
Valve 6	inward constriction of the pharynx walls due to the sphincteric action of the superior/middle/inferior pharyngeal constrictors (hereafter called pharyngeal narrowing)

(Edmondson & Esling 2006, p. 159)

Under this approach, multiple valves can be manipulated and as a consequence, seemingly opposite articulations in the continuum model can be realized simultaneously. The glottal fricative [h] generally corresponds to Edmondson and Esling's valve 1 (2006). In contrast, glottal stricture for a glottal stop may involve valves 1-3, that is, the glottis (V1), ventricular incursion (V2), and sphincteric compression of the arytenoids and aryepiglottic folds forwards and upwards by means of the thyroarytenoid muscle complex (V3).

What follows from the Valves model is that cooccurring laryngeal sounds with different features could, in principle, be produced simultaneously. That is to say, a glottal fricative may overlap with the realization of a glottal stop since there can be stricture or spreading in any of the valves. If glottal fricatives involve abduction of valve 1, and if glottal constriction does not necessarily involve valve 1, in principle a glottal stop could be realized during a glottal fricative. With a more complex treatment of laryngeal articulations, glottal stop and glottal fricatives are not necessarily articulatorily opposite. That is, because glottal stop can involve multiple adductory gestures,[62] realizations of glottal stop are theoretically possible through stricture higher in the epilarynx while maintaining the glottis is open.

4.3 Stacking Contexts

Following the strict layering hypothesis of prosodic domains (Selkirk 1984, Nespor & Vogel 1986/2007), we can say that [h] and glottalization are specified to occur in the same phrasal location when they align with the end of the Utterance. I posit that there are minimally two prosodic domains that align at the Utterance-final boundary: the word and the major intonational phrase. Because glottalization occurs prepausally in both Utterance-final and Utterance-medial positions, I consider the relevant larger prosodic domain to be a major intonational phrase, which is marked by a pause. Following the strict layering hypothesis, the boundary of the phrasal level, prosodic word, and the syntactic boundary will align, allowing for co-occurrence. This can context is schematized below.

[62] This is not making claims about representation, that is a glottal stop realized with additional constriction does not necessitate representation as /ʔ/

[ʔ]$_{phrase}$
[jałwaja nikitak [notjonah]$_{prosodic\ word}$
/jalwaja ni-k-ita-k no-tionan/$_{(phonemic\ transcription)}$
yesterday 1SUBJ-3OBJ-see-PRT 1POS-godmother
'I saw my godmother yesterday, *ayer ví a mi madrina*
(yalhuaya niquittac no tionan)

Figure 18 Laryngeal "stacking" in Chicontepec Nahuatl

The question then is: how will these two opposing articulatory targets be implemented in this context? Glottalization is generally characterized by the adduction of the glottis (phonologically [+constricted glottis]), whereas [h] is generally characterized by the abduction of the glottis (phonologically [–constricted glottis]). Considering that [ʔ] is produced by glottal constriction while [h] is produced via glottal spreading, we can consider a number of logical possibilities of the articulatory outcome of their co-occurrence:

(i) ***h-ʔ sequential realization***: the phrasal glottalization occurs after the glottal fricative, [hʔ] or or [V̤ʔ];

(ii) ***ʔ-h sequential realization***: the glottalization occurs before the word-final glottal fricative, [Vʔh] or [V̰h];

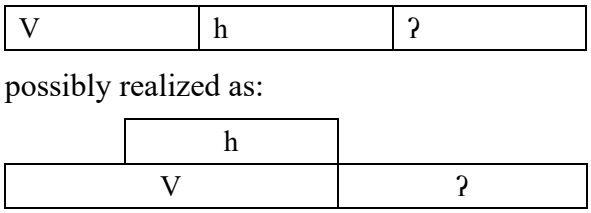
(iii) ***cancellation***: where the opposing nature of the articulatory gestures involved in producing these sounds results in a laryngeally neutral production (Ø);

(iv) ***simultaneous realization***: where glottalization is realized during the realization of [h]; and

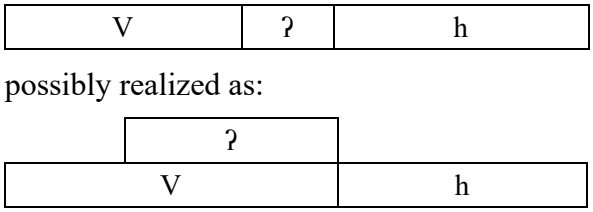
(v) ***overwriting***: where one of the two sounds will surface, either [ʔ] or [h] and the competing gesture is deleted.

These logically possible realizations of coocurring laryngeal sounds are represented graphically in the following figure.

(i) ***h-ʔ sequential realization***:

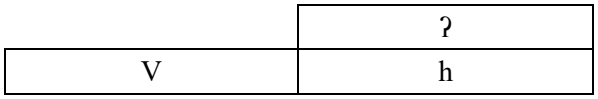


(ii) ***ʔ-h sequential realization***:



(iii) ***cancellation***:

(iv) ***simultaneous realization***:



(v) ***overwriting***:

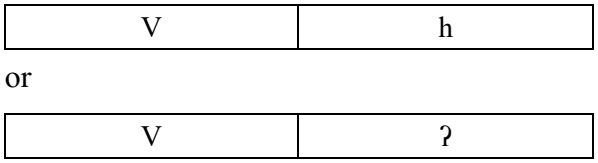


Figure 19 Logically possible realizations of cooccurring laryngeal segments

The outcome of co-occurrence can tell us about the interaction between these two prosodic domains.

4.3.1 (i) h-ʔ sequential realization

In the first possible outcome, (i) h-ʔ sequential realization, the relative order can show us if there is a primacy on the integrity of the prosodic word—that glottalization is realized after the prosodic word and the phonetic implementation of a laryngeal target associated with the phrasal boundary occurs after the prosodic word. This would help illuminate the relationship between levels in the prosodic hierarchy, when the linguistic feature associated with higher levels of the prosodic hierarchy involve something other than pitch.[63] One outcome of this realization would be a possibly difficult signal to perceive given that [h] is already perceptually weak in the coda position. Perceiving a glottal stop after [h] would seem disadvantageous.

4.3.2 (ii) ʔ-h sequential realization

In the second possible outcome, (ii) ʔ-h sequential realization ([Vʔh]), specifically if glottal stricture is realized on the final vowel as glottalization ([V̰h]), this would show that the pausal glottalization is patterning like, and can thus be analyzed as analogous to, more well-established intonational manipulations of pitch. F0 manipulations are only possible during phonation. Since voiceless sounds by definition have no f0, intonational pitch targets are usually realized only on voiced sounds, where they most salient perceptually. When

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[63] Aikenvald's (1998) proposes a pausal morpheme in Warekena (Northern Maipuran). A segmental morpheme that consists of a laryngeal and nasalized copy vowel (/-hṼ/) is posited to mark pauses utterance-medially and finally. It is not clear that it carries meaning in the standard way morphemes are conceived of:

eni-**hĩ** diutsu anetua-li eni-**hĩ** walamat͡ʃia-**hã**
this-PAUS god good-REL this-PAUS save-PAUS
'This very God is good, it is he who saves' (Aikhenvald 1998, p. 412-413)

comparing the possible realization of [ʔ] in a sequential order with [h], is seems likely that ʔ-h would be perceptually more salient than h-ʔ. If the preceding vowel were glottalized or a canonical glottal stop interrupted the vowel and [h], it would make sense that cues of glottalization like irregular glottal pulsing would only be perceptible following a voiced segment (i.e. a vowel) rather than following a voiceless sound ([h]). The other cue associated with glottalizations, a period of silence, are not predicted to be as strongly perceptible following an [h], though a perception study is needed.

4.3.3 (iii) cancellation

The Continuum model (Ladefoged 1971, Gordon & Ladefoged 2001) treats glottal stop and the glottal fricative as opposite ends of a continuum. It then follows that the gestures involved in the production of these sounds are opposite: general adductory versus abductory gestures are involved in the articulations of these sounds in the glottis. Thus, the Continuum model predicts that if these two sounds are specified in the same location, the two sounds will cancel each other out resulting in neither laryngeal segment being realized. That is to say, the result of a midpoint between these two voiceless segments is the voiceless counterpart of modal phonation. Not surprisingly, then, the expected surface form of a [Vh] word in phrase-final position before glottalization would be [V].

4.3.4 (iv) simultaneous realization

The Valves model (Edmondson & Esling 2006, Moisik & Esling 2011) suggest that simultaneous realization of a glottal stop and a glottal fricative is a possible outcome: this must assume that the "glottal" stop is not in fact glottal; instead, it would involve

epilaryngeal constriction, but where the glottis can still be spread enough to allow for the production of [h]. This result would suggest that a whole-larynx approach better captures surface realization of stacked, seemingly opposite, "glottal" sounds.

4.3.5 (v) overwriting

An overwriting result would suggest that for stacked contexts, the continuum model sufficiently captures the relation between glottal stop and glottal fricative in ChN. Since only one of the two sounds will surface, either the glottal stop or the glottal fricative, we can conclude that their phonological features are implemented phonetically as gesturally opposite. Unlike cancellation, which is also a logical possibility given the Continuum model, if one articulation supersedes the other, this would provide insight into the grammatical domains question: is the prosodic word more prominent than the higher phrasal level? Which laryngeal persists and overwrites the competing gesturally opposite laryngeal sound? The prediction is that if there is that the glottal fricative of the word will be more likely to overwrite the pausal glottalization because it carries morphological information. A loss of information from the word in favor of phrasal glottalization could result in ambiguity.

4.3.6 Grammatical domains

As described in Chapter 1, this dissertation employs a modular approach to describe phonological patterns as belonging to lexical and postlexical domains. This is key to understanding the surface interactions between phrasal and word-level domains. Surface glottal fricatives [h] in ChN can be derived from lexical and postlexical phonological processes or be underlyingly /h/. As I established in Chapter 3, the source of [h] from

debuccalized underlying nasal sounds and labiovelar glides are lexical phonological processes. Assuming that different grammatical domains are hierarchically structured, we can predict that the pattern for how an [h] is realized on the surface reflects in some way the grammatical status of that sound. The prediction made here is there is a possibility that [h] may pattern differently, depending on the domain of its derivation: no derivation /h/, lexical /N/ and /w/. Glottalization is a postlexical process and the outcome of stacking can tell us about the relationship between these domains.

If there is an interaction between grammatical domains and the post-lexical pausal glottalization, then this raises a problem for the standard assumptions made about postlexical phonological processes laid out in Chapter 2. Should the outcomes of stacked laryngeals be sensitive to lexical information, this would suggest that postlexical phonology can have access to some amount of lexical information.

4.3.7 Unique Meaning

Another dimension to consider is that not all laryngeals in ChN carry the same morphological or informational load. That is, some laryngeals provide disambiguating information while others do not necessarily do so. This suggests that a segment that carries much or all of the morphological load will be less likely to reduce than a segment that carries less of the morphological load. As shown in the previous chapter, instances of word-final [h] provide varying degrees of meaning. In some cases they are the single exponent of a morphological construction, while in other cases, they form part of a multi-segment morpheme: a plural verbal suffix /-h/, or possessive suffix /-w/ realized as [-h] caries more of a meaning load than the [h] in the plural nominal suffix [-meh], or a monomorphemic

word such as [alampreh] ‘wire’. Phrasal glottalization, has a role in the signal marking a phrasal boundary. Since glottalization and glottal fricatives can occur in stacked contexts, with potentially antagonistic articulations, there is motivation beyond general patterns of lenition to expect that a reduction of one or both of the laryngeals in stacked contexts might reduce or delete.

Variationist studies have shown that in morphological context can have a direct effect on rates of reduction in natural speech. For example, in English /t/ and /d/ reduce more often in monomorphemic words such as “pact” and “mist” as compared to morphologically complex consonant clusters such as “packed” and “missed” (Fasold 1972, Guy 1980, Guy & Boyd 1990, Guy 1991, Tagliamonte 2011). In addition, informativity has been shown to correlate with the reduction of sounds in specific environments (Cohen Priva 2008/2015, Seyfarth 2014). Sounds that are more informative (Cohen Priva 2008/2015) or predictable in context (Seyfarth 2014) tend to undergo reduction processes at lower rates than their less informative or less predictable counterparts. In these studies, informativity is calculated with statistical analyses of natural text corpora. For this study the dimension of unique meaning will be explored with a more course-grained metric: the relative cost of reduction, which parallels the t/d reduction studies in English. The relative cost of a glottal fricative is captured by looking at the relative ambiguity that would result from its deletion, or the possible ambiguity that would result from a high degree of reduction. Unique meaning in this dissertation is divided into three levels: (1) *high cost of reduction* ,where [h] is the single exponent of a morphological construction and reduction would result in ambiguity; (2) *moderate cost of reduction*, where the reduction of [h] would result in ambiguity, but a prefix or another word in the utterance mitigates the ambiguity that would result from the

reduction of [h]; and (3) *low cost of reduction,* where [h] is part of a large multi-segment morpheme and its loss or reduction does not result in the loss or partial loss of the morphological information. The prediction here is that [h] with a lower cost of reduction will be more likely to delete or reduce, given that its reduction would not result in ambiguity.

The following data show final [h] with high cost of reduction. In (86), the suffix /-h/ is the single exponent of plurality.

86)	a.	tiahki	/ti-ahki/	2SUBJ-swim	'you swim, *tu nadas*' (tiahqui)
	b.	tiahki**h**	/ti-ahki-h/	1subj-swim-pl	'we swim, *nadamos'* (tiahquih)

In Nahuatl verb paradigms in the present tense, the difference between second person singular and third person plural is the plural suffix /-h/. Both constructions take a homophonous /-ti/ prefix. Similarly, in (87), the plural /-h/ suffix is the single exponent of plurality for the third person. The third person is unmarked for person (no prefix).

87)	a.	ahki	/ahki/	swim	's/he swims, *ella/el nada*' (ahqui)
	b.	ahki**h**	/ahki-h/	swim-PL	'they swim, *nadan*' (ahquih)

In cases such as these, deletion of the /-h/ would result in an ambiguity. In these cases a pronoun such as [ja] or [jahwa:] 's/he' or [inihwa:ntih] 'they' would resolve the ambiguity in much the same way that a prefix might (as will be shown shortly) and would be an example of moderate cost of reduction. However, Nahuatl has been described as a pro-

drop language (MacSwan 1998, Andrews 2003, Hansen 2010) and Chicontepec Nahuatl also fits this characterization. Person-marking prefixes (or the absence of any in the case of the third person) provide person information and so utterances in which there is no pronoun are common. The ChN data analyzed in this study is both controlled data as well as some naturalistic data mostly gathered in elicitation though a small portion of the data were taken from texts. Data analyzed included forms with and without pronouns. The data in (88) were gathered in a controlled task exploring the meaning of [wan] "with" and [mo-] the reflexive pronoun.

The data in (88) show that any ambiguity resulting from the deletion of the final [h], can be mitigated by a pronoun.

88) a. namah ahki
naman Ø-ahki-Ø
now 3SUBJ-swim-SG
's/he swims now, *ahora nada*'
(naman ahqui)

b. namah hwan ahki
naman hwan Ø-ahki-Ø
now Juan 3SUBJ-swim-SG
'Juan swims now, *Juan nada ahora*'
(naman Juan ahqui)

c. namah ahki**h**
naman Ø-ahki-h
now 3SUBJ-swim-PL
'they swim now, *ahora nadan*'
(naman ahquih)

d. namah inihwa:ntih ahki**h**
naman inihwa:ntin Ø-ahki-h
now they 3SUBJ-swim-PL
'they swim now, *ellos nadan ahora*'
(naman inihhuantin ahquih)

e. namah hwan wan mariah ahki**h**
naman hwan wan mariah Ø-ahki-h
now Juan and Maria 3SUBJ-swim-PL
'Juan and Maria swim now, *Juan y María nadan ahora'*
(naman Juan huan Maria ahquih)

The mitigated cost of reduction in a sense results from a sort of multiple exponence, that is, the potential ambiguity that could result from deletion is mitigated by the presence of another affix or word that provides the same morphological information. For example in (86), the morphological information provided by the presence or absence of the plural marker /-h/ in combination with the morpheme /ti-/ (a homophonous prefix for the second person singular and the first person plural) could also be provided by the additional [ta] or [tahwaː] ‘you’ and [tohwaːntih] ‘we’.

The presence or absence of the plural marker /-h/ also provides the number information for first person singular and second person plural constructions in the paradigm. However, the deletion of the plural marker in the second person plural does not result in ambiguity. The paradigm below shows the cells with minimal pairs in which deletion of the plural marker would result in ambiguity. The unshaded cells show mitigated forms with a moderate cost of reduction—the plural marker or its absence is meaningful, however, the prefixes [ni-] and [in-] are unique and resolve any ambiguity.

	Singular	Plural
1	ni-___-Ø	ti-___-h
2	ti-___-Ø	in-___-h
3	Ø-___-Ø	Ø-___-h

Figure 20 ChN present tense paradigm

Another example of moderate cost of reduction is between the two suffixes /-joh/, an adjectival suffix meaning 'full of/covered in', and /-jo/, inalienable possessor. Both attach to noun stems and in principle, the deletion of the [h] in the adjectival suffix could result in ambiguity. However, this, too, is a case of more moderate cost of reduction. The [h] of the /-joh/ suffix is not as informative as the plural markers in (86) and (87) because the inalienable possessor /-jo/ must co-occur with a possessive prefix. Any ambiguity that would result from deletion of the final [h] is mitigated by the prefix. Possible ambiguity is mitigated by prefixes in isolation, though in a larger utterance, syntactic relations further mitigate ambiguity: /-joh/ is a derivational suffix that results in an adjective while /-jo/ is an inflectional suffix. The examples in (89) demonstrate related forms in isolation, and in a larger utterance in (90) .

89)	a.	kʷatehjoh	/kʷateh-joh/	dust-ADJ	'having a lot of dust, *lleno de basuritas*' (cuateuhyoh)
	b.	ikʷatehjo	/i-kʷateh-jo/	3POS-dust-INAL	'its dustiness, *su basurita*' (icuateuhyo)

90) a. ne aːt͡ɬ kʷatehjoh
/ne aː-t͡ɬ kʷateh-joh/
DEM water-ABS dust-ADJ
'that water is dusty, *el agua esta lleno de basuritas*'
(ne atl cuateuhyoh)

b. ne aːt͡ɬ ikʷatehjo
/ne aː-t͡ɬ i-kʷateh-jo/
DEM water-ABS 3POS-dust-INAL
'it's the water's dust, *la basurita del agua*
(icuateuhyo)

In contrast to the examples shown thus far, [h] segments with low cost of reduction involve multi-segment morphemes where deletion of final [h] does not result in a loss of the entire morpheme and therefore in ambiguity. In these cases, deletion or reduction of the final [h] does not result in another word. The examples in (91) demonstrate words from a number of different categories in which the final [h] has a low cost of reduction.

91)	a.	namah	/naman/	now	'now, ahora' (naman)
	b.	walah	/walaw/[64]	come	's/he comes, *viene*' (huallauh)
	c.	siwameh	/siwa-meh/	woman-PL	'women, *mujeres'* (cihuameh)
	d.	ahkiseh	/ahki-s-eh/	swim-FUT-PL	'they will swim, *nadarán*' (ahquizeh)
	e.	tit͡ɬaʃkaloh	/ti-t͡ɬaʃkaloh/	2SUBJ-tortilla.make.PRT	'you made tortillas, *hiciste tortillas*' (titlaxcaloh)

For example, in (91a) there is no other word [nama] in ChN. The deletion of the final [h] would not necessarily result in an ambiguity. The same holds for (91b). For (91c-d), the final [h] is part of an affix, but the affixes have multiple segments that can carry the morphological information. Deletion or reduction of final [h] will not result in ambiguity.

[64] Here the word [walah] 'to come' is represented as underlyingly /walaw/. This is because this is a high frequency word and likely lexicalized as such. Recall that it can be analyzed as a derived from the directional prefix /wal-/ 'there to here' and the verb /jowi/~/jaw/~/jow/ 'to go'. The verb 'to go', and by extension 'to come', is the only verb in ChN to have multiple forms of the stem in any given TAM paradigm. Palatal assimilation/deletion and coda-w debuccalization, described in the previous chapter, results in /wal + jaw/ surfacing as [walah]. Similarly, the stem that takes the /-ja/ adverbial suffix is /wal + jow + ja/, which as a result of the same palatal assimilation process surfaces as [walowa] 's/he already comes'.

For example [siwame] (compare with (91c)), is not ambiguous with another word in ChN, and the presence of [me] after the root still makes the contrast with the singular form [siwat͡ɬ]. The preterit stems for Class 3 verbs (end in [oa] and [ia]) can optionally take the preterit suffix /-ki/: [t͡ɬaʃkalohki] 'you made tortillas'. This is an example of multiple exponence—both the preterit form of the verb and suffix mark past tense. In (91e), there is no suffix, and the [h] is the single exponent of the preterit construction and distinguishes this form from third person singular in other tenses: [t͡ɬaʃkaloa] present, [t͡ɬaʃkalos] future, [t͡ɬaʃkalojaja] imperfect, and [t͡ɬaʃkaloskia] conditional, among others. While the final [h] in (91e) is the single exponent of the preterit construction, its deletion or reduction does not result in ambiguity.[65] This [h] is not very informative in its unique meaning, and therefore is predicted to be more likely to delete or reduce. The expected likelihood of reductions is expected to be as follows:

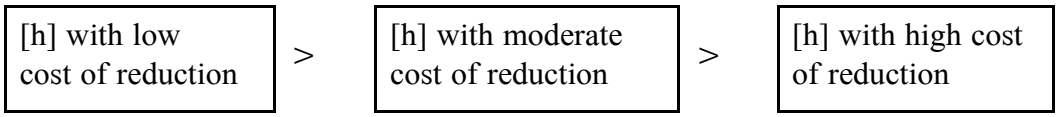


Figure 21 Expected likelihood of reduction

4.3.8 Summary of Predictions

In this section various possibilities were laid out for the realization of laryngeal articulations in stacking contexts. Word final [h] cooccurring with phrase-final glottalization

[65] [tit͡ɬaʃkaloh] /ti-t͡ɬaʃkaloh/ 'you made tortillas' 2nd person plural is not ambiguous with 1st person plural in this case because, the plural forms must take the preterit marker: [titlaʃkalohkeh] /ti-t͡ɬaʃkaloh-k-eh/. [t͡ɬaʃkaloh] 's/he made tortillas' is ambiguous with [t͡ɬaʃkaloh] /t͡ɬaʃkal-joh/ 'full of tortillas' (as in [ne t͡ɬakʷali t͡ɬaʃkaloh] 'that food is full of tortillas') however the ambiguity does not result from a reduction of the final [h], and is likely resolved by syntax in context.

could potentially have the following outcomes: (i) ***h-ʔ sequential realization***: the phrasal glottal stricture occurs after the glottal fricative, [hʔ] or or [V̤ʔ]; (ii) ***ʔ-h sequential realization***: the glottal stricture occurs before the word-final glottal fricative, [Vʔh] or [V̤h]; (iii) ***cancellation***: where the opposing nature of the articulatory gestures involved in producing these sounds results in a laryngeally neutral production (Ø); (iv) ***simultaneous realization***: where glottalization is realized during the realization of [h]; and (v) ***overwriting***: where one of the two sounds will surface, either [ʔ] or [h] and the competing gesture is deleted.

The articulatory outcomes are predicted to be influenced by grammatical domain and informational cost of reduction. There are two phonological domains from which [h] can originate: from underived underlying /h/; and from the lexical phonology from debuccalized underlying /n/ and /m/ (/N/) and /w/. One possible outcome is that all types of [h] and glottalization pattern the same way. It is also possible that a different pattern may be found for underived [h] from /h/ versus [h] derived from /N/ and /w/. Yet another possibility is that all three sounds have distinct patterns. This is a logical possibility given that, while both /N/ and /w/ debuccalization were argued to be lexical processes, the two sounds participate in palatal-glide assimilation differently and thus their status within the lexical phonology may be distinct. Another dimension predicted to have an effect on the articulatory outcome of stacked contexts is the relative cost of reduction. The prediction is that the likelihood of reduction of [h] in the context of [ʔ] is lowest for [h] with a high cost of reduction and highest for [h] with a low cost of reduction.

4.4 Methods

4.4.1 Data

For this study, data consist of utterances for which the final segment is a glottal fricative, a vowel, alveolar fricative, or velar stop. The data were then organized on two distinct dimensions: underlying representation and morphological criteria. In the first round of comparisons, utterances with glottal fricatives were compared based on the underlying representation of the surface [h] (i.e. /h, n, m, w/). In the second round of comparisons, data with final-glottal fricatives were separated into three groups based on the relative level of unique meaning of the glottal fricative.

4.4.2 Data Elicitation

The data for this study were collected over two field visits to Zacatecas, Mexico in the summers of 2014 and 2017. Data analyzed in this study were collected via open ended elicitation (52%) and directed tasks (47%) with a small portion of data from texts (1%). During open elicitation teachers were asked to provide example sentences for the lexical item/morphological construction being discussed. Elicitation was conducted in a mix of Spanish and Nahuatl; that is, elicitation was conducted in Nahuatl to the extent to which the researcher could, using phrases such as [tɬɛ̃ kiʔihtos neki __] 'what does ___ mean' *¿qué quiere decir __'* (tlen quiihtoz nequi __) to begin discussing a lexical item, or [kenihki moihlia __] 'how do you say __' *¿cómo se dice __'* (queniuhqui moihlia __), in which case, Spanish was given. When a new word or construction was discussed, the speaker was prompted to provide an example sentence in Nahuatl: [welis motekiwia] 'can you use it? *¿lo*

puedes utilizer?' (hueliz motequihuia), and then was asked to repeat it one to two additional times to help get a more naturalistic rhythm to the example sentences.

These elicited example sentences provide a large part of the data used in this study. The examples in (92) demonstrate the range of sentences offered by my Nahuatl teachers.

92) Example sentences given in response to *hueliz motequihuia* 'can you use it?'

a. jowatsinko nihmehlahki notʲotah
/jowa-tsin-ko ni-k-mehlaw-ki no-tiotah/
dark-DIM-LOC 1SUBJ-3OBJ-greet.encounter.PRT-PRET 1POS-godfather
'I ran into my godfather in the morning, *en la mañana me encontre con mi padrino'* (yohuatzinco nicmelauhqui notiotah)

b. ne t͡ʃit͡ʃi kit͡ɬapaŋki nokoh
/ne t͡ʃit͡ʃi ki-t͡ɬapan-ki no-kom/
DEM dog 3OBJ-shatter.PRT-PRET 1POS-jug
'That dog broke my pot, *el perro quebro mi jarro'*
(ne chichi quitlapanqui nocon)

c. tohwantih tikaxoxeh jaɬwaja
/tohwantin ti-k-ahkokʷ-keh jalwaja /
We 1SUBJ-3OBJ-put.away.PRT-PRET.PL yesterday
'We put it away yesterday, *lo guardamos ayer'*
(tohhuantin ticahcoucqueh yalhuaya)

d. pan t͡ɬaɬtepakt͡ɬi it͡stokeh miak masewaɬmeh wan tekʷanimeh
/pan t͡ɬaltepakt͡ɬi it͡sto-keh miak masewal-meh wan te-kʷa-ni-meh/
LOC earth-ABS AUX-PRET.PL many people-PL and HOBJ-eat-NOM-PL
'there are many people and wild animals on the earth, *hay mucha gente y muchos animales en el mundo*'
(pan tlaltepactli itztoqueh miac macehualmeh huan tecuanimeh)

e. t͡ʃiht͡ʃikʷeji tohwantih tijowih tiopah
/t͡ʃih~t͡ʃikʷeji tohwantin tijowih tiopan/
RED~eight PRO 1SUBJ.PL-go-PL god-LOC
'We go to church once a week, *vamos a misa cada ocho dias'*
(chihchicueyi tohwantin tiyohuih tiopan)

This elicitation data is complemented by targeted elicitation tasks, during which speakers were trained to use carrier sentences and prompted to fill in designated words from a list in Nahuatl orthography that provided the Utterance-final stacking context of interest. They were asked to repeat these tokens three times each, pausing between each token to avoid list intonation so that each token could be treated as a single Utterance. My Nahuatl teachers collaborated in the design of carrier sentences and wordlists. The list in (93) shows the type of sentence structure used in one elicitation task. For this task, the carrier sentence was filled in with words with vowel and final [h]s that are underlyingly /h, n, m/. Word with final [h] that is underlyingly /w/ do not occur in this context nor do velar stops.

93) /jalwaja nikitak __X__ / 'I saw __X__ yesterday, *ayer ví* __X__ ' (yalhuaya niquittac)

a. jałwaja nikitak t͡ʃat͡ʃa
/jalwaja ni-k-ita-k t͡ʃat͡ʃa/
yesterday 1SUBJ-3OBJ-see-PRET pitaya
'I saw the pitaya yesterday, *ayer ví la pitaya*' (yalhuaya niquittac chacha)

b. jałwaja nikitak t͡ʃakah
/jalwaja ni-k-ita-k t͡ʃakah/
yesterday 1SUBJ-3OBJ-see-PRET chakah
'I saw the chacah (tree) yesterday, *ayer ví el chacah (arbol)*'
(yalhuaya niquittac chacah)

c. jalwaja nikitak listoh
/jalwaja ni-k-ita-k liston/
yesterday 1SUBJ-3OBJ-see-PRET ribbon
'I saw the ribbon yesterday, *ayer ví el listón*' (yalhuaya niquittac liston)

d. jalwaja nikitak roskas
/jalwaja ni-k-ita-k roskas/
yesterday 1SUBJ-3OBJ-see-PRET rosca.bread
'I saw the sweet bread yesterday, *ayer ví la rosca*' (yalhuaya niquittac roscas)

The examples in (94) (repeated from (84)) show a second elicitation task in which the possessed construction was used. In this construction, final [h] of all underlying representations (/h, n, m, w/) as well as /s/ and /k/ for comparison, could be recorded.

94) /jalwaja nikitak no-__X__/ 'I saw my __X__ yesterday, *ayer ví mi __X__* '
(yalhuaya niquittac no-)

a. jałwaja nikitak noajoh
/jalwaja ni-k-ita-k no-ajoh/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-squash
'I saw my squash yesterday, *ayer ví mi calabaza*' (yalhuaya niquittac noayoh)

b. jałwaja nikitak noa:joh
/jalwaja ni-k-ita-k no-a:jo-w/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-turtle-PSM
'I saw my turtle yesterday, *ayer ví mi tortuga'* (yalhuaya niquittac noayouh)

c. jałwaja nikitak nok^{w}ah
/jalwaja ni-k-ita-k no-k^{w}aw/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-lumber
'I saw my lumber yesterday, *ayer ví mi leña'* (yalhuaya niquittac nocuauh)

d. jałwaja nikitak not^{j}onah
/jalwaja ni-k-ita-k no-tionan/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-godmother
'I saw my godmother yesterday, *ayer ví a mi madrina'* (yalhuaya niquittac notionan)

e. jałwaja nikitak nokoh
/jalwaja ni-k-ita-k no-kom/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-jug
'I saw my jug yesterday, *ayer ví mi jarro'* (yalhuaya niquittac nocon)

f. jałwaja nikitak notepos
/jalwaja ni-k-ita-k no-tepos/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-metal
'I saw my metal yesterday, *ayer ví mi metal'* (yalhuaya niquittac notepoz)'

g. jałwaja nikitak notekak
/jalwaja ni-k-ita-k no-tekak/
yesterday 1SUBJ-3OBJ-see-PRET 1POS-shoe
'I saw my shoes yesterday, *ayer ví mis zapatos'* (yalhuaya niquittac notecac)

The examples in (95) show a third elicitation task used in gathering data in the final context. These were designed to elicit the proclitic /ajok=/ in a number of contexts for the debuccalization process in the /kC/ context discussed in the previous chapter, while providing data for final laryngeals.

95) *ajok=_X_* 's/he/it no longer _X_, *ya no_X_*' (ayoc-)

a. ajokto꞉ka
/ajok=to꞉ka/
ADV=plant.corn
's/he no longer plants corn, *ya no siembra maíz*' (ayoctoca)

b. ajoksokijoh
/ajok=soki-joh/
ADV=mud-ADJ
's/he/it is no longer muddy, *ya no está embarrado*' (ayoczoquiyoh)

c. ajokwalah
/ajok=walaw/
ADV=come
's/he/it no longer comes, *ya no viene'* (ayochuallauh)

d. ajok͡tsaktok
/ajok=͡tsak^{w}-tok/
ADV=trap/close-PERF
's/he is no longer enclosed, *ya no está encerrado'* (ayoctzactoc)

4.4.3 "Soundbooth" Recording in the Field

Recording in the field poses a number of challenges to phonetic inquiry. The primary challenge is creating an environment that will result in clear recordings without the benefits of a sound booth. Most of the recording locations were rooms with concrete (or wood in one case) floors, concrete/cinderblock walls, concrete or corrugated ceilings, which create conditions for noisy recordings with much echo. In order to capture clean recordings which

were high quality enough to be analyzed with software like Praat (Boersma & Weenink 2019) and VoiceSauce (Shue et al. 2011), a portable sound booth was improvised in the field. This sound booth was made from upholstery foam shaped into a U-shape standing on end, with a roof and floor of foam to create a 5-sided structure inside which a shotgun microphone could be placed. An additional piece of foam was added to help block echo from the floor in the second iteration. Speakers sat in front of the structure, which was placed on a table. Language teachers were able to sit naturally in front of the structure to engage in fieldwork. Figure 22 shows a schematic of the portable sound booth design and Figure 23 shows the actual sound booths used in the field. Data were recorded in mono with a Marantz PMD660 portable solid-state recorder (shown in Figure 22) and an Audio-technica AT897 shotgun microphone.

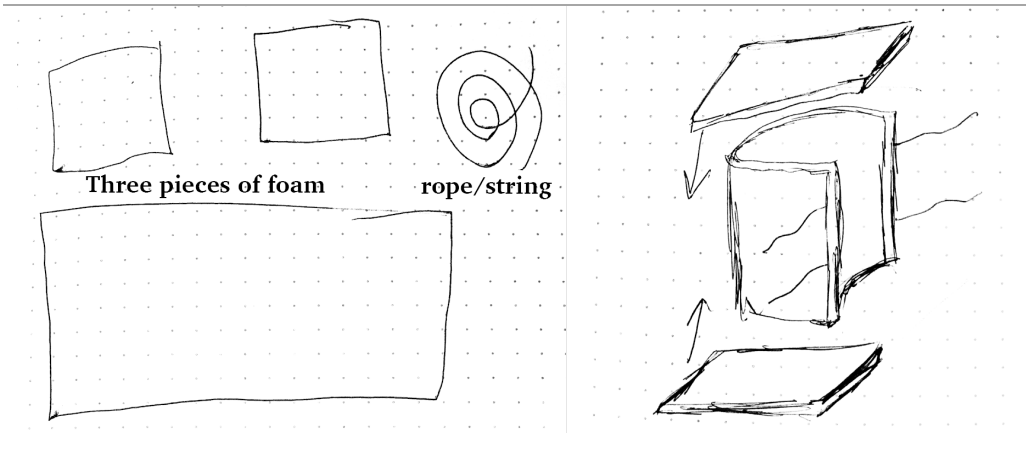


Figure 22 Design for simple portable foam sound booth

2014 portable sound booth, only smooth foam was available so additional foam circles were hand sewn.

2017 sound booth, egg crate foam was available in the local upholstery shop. Ribbon was used instead of rope.

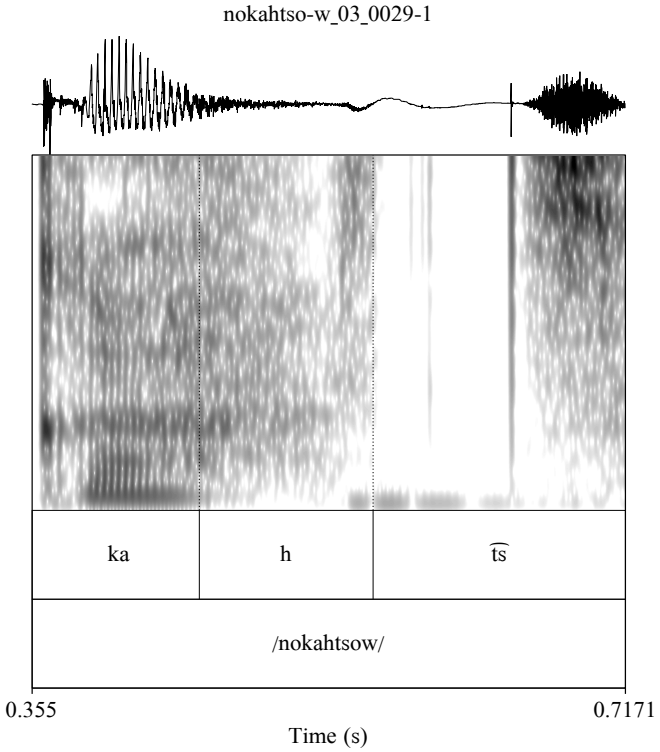
The portable sound booth is easily rolled up for transport.

Figure 23 Portable sound booths used in this fieldwork

4.4.4 Coding and Segmentation

4.4.4.1 The realization of the glottal fricative [h] in ChN

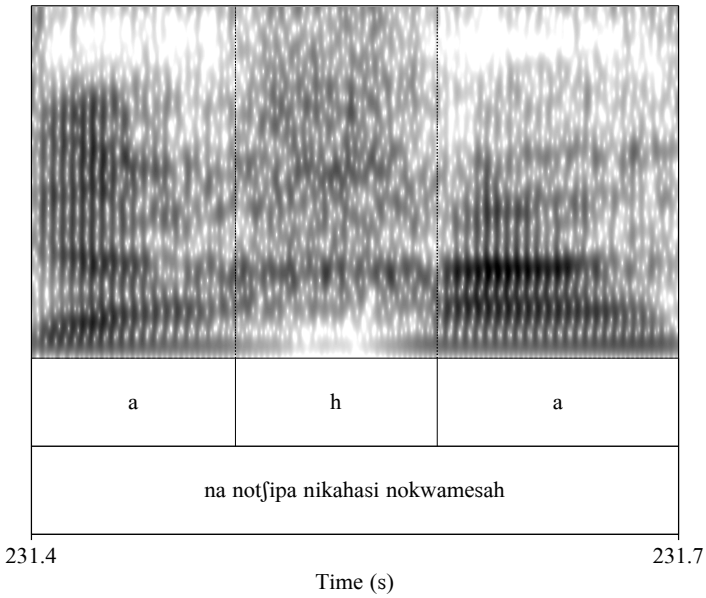
The segment [h], typically classified as a glottal fricative, is characterized by aspiration noise rather than frication noise produced in the supralaryngeal vocal tract. The spectrogram in Figure 24 shows a canonical [h].



[no**kaht͡s**oh]
/no-kaht͡so-w/
1POS-jicama-PSM
'my jicama, *mi jícama'* (nocahtzouh) 03_0021.wav

Figure 24 Spectrogram of canonical [h]

There is broadband energy, with more energy around the adjacent vowel's formant frequencies, and absence of voicing. Coupled with the fact that [h] is generally restricted to coda position (more on this shortly), perceiving [h] in the field on the part of the researcher was initially difficult. When it does occur in onset position, [h] is typically higher in energy, as expected: see Figure 25, [h] occurs in an onset position through reduplication on a vowel-initial root.



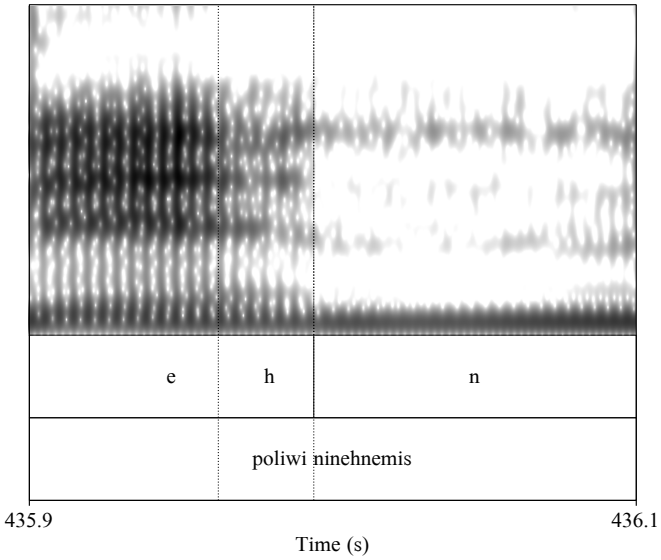
[nikahahsi]
/ni-k-ahahsi/
1SUBJ-3OBJ-TOU
'I reachout and touch, *alcanzo a tocar'* (nicahahci) 03_0021.wav

Figure 25 Spectrogram of [h] showing voicing ([ɦ])

The [h] in Figure 25 demonstrates a common pattern in ChN in which the transition from vowel to voiceless [h], and vice versa, is gradual. There is increased breathiness leading into period of reduced voicing, that is, in Figure 25 some amount of voicing carries on throughout the /h/ which can be better described as [ɦ] rather than [h].

As has been widely noted in the literature, laryngeals sounds can have variable realizations (Pierrehumbert & Talkin 1992, Ladefoged & Maddieson 1996). In ChN, before a voiced consonant, an /h/ or /w/ can be realized as a breathy vowel [V̤]. The spectrogram in Figure 26 shows this breathy voice realization of [h] in ChN. In Figure 26, breathy phonation is visible as attenuation of energy—formants are weaker during the final portion of the vowel. A decrease in both overall intensity (and therefore formant energy) and high-

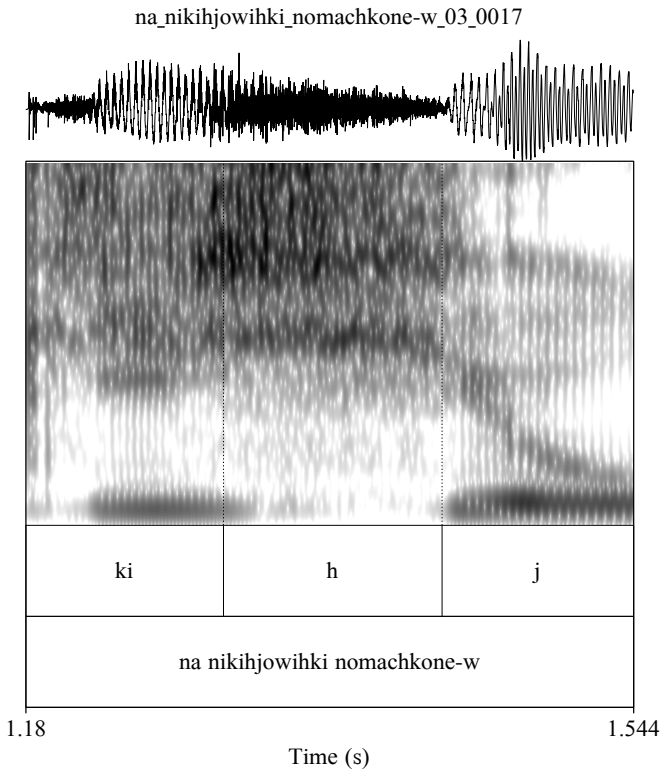
frequency energy is associated with breathy voice (Garellek & Keating 2011, Gordon & Ladefoged 2001).



[nin**ehn**emis]
/ni-neh-nemi-s/
1SUB-RED~walk-FUT
'I will walk, *caminaré'* (ninehnemiz) 03_0022.wav

Figure 26 Realization of [h] as breathy phonation

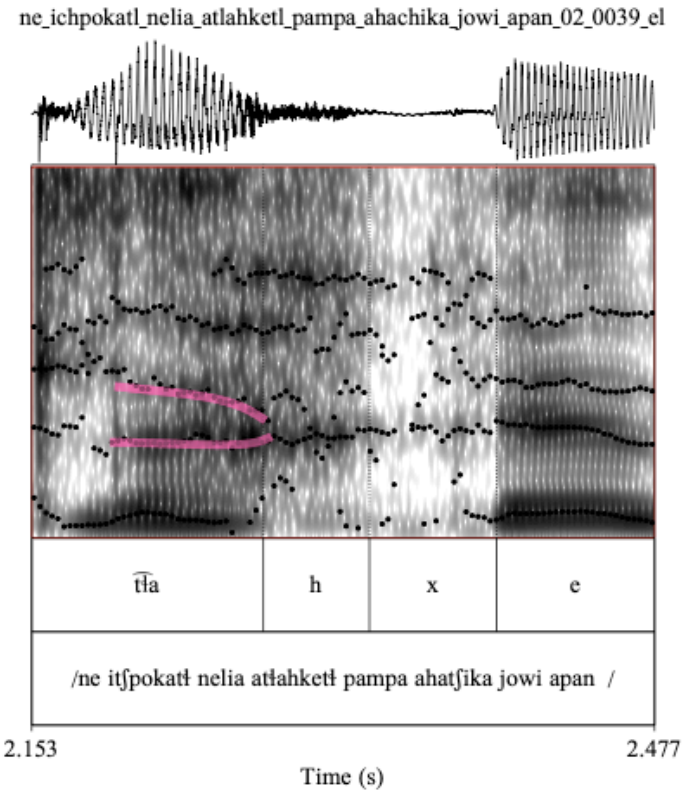
In the intervocalic context (Figure 25), voicing can carry through the glottal fricative to varying degrees. Other variable realizations of [h] in ChN involve secondary frication through coarticulation with adjacent sounds. For example, the glottal fricative can be palatalized when preceding [ʃ], [t͡ʃ], [j], and [i]. The following spectrogram shows palatalization of [h] between [i] and [j]. The energy is concentrated in the higher frequencies, appearing more [ç~ʃ]-like.



[ni**kihj**owihki]
/ni-k-ihjowih-ki/
1SUBJ-3OBJ
'resist sleepiness, *aguantar el sueño'* (niquihyohuihqui) 003_0017.wav

Figure 27 Palatalization of [h]

The glottal fricative can be velarized when preceding [w], [k], and [k^w]. The spectrogram in Figure 28 shows the characteristic velar pinch in the second and third formants of the vowel [a] leading into the [h], demonstrating that the [h] is being produced with some amount of velar stricture ([x̟]~[h^Y]). Also note that this is the context for lenition of /k/, which in this spectrogram is realized as a fricated k (~[x̟]).



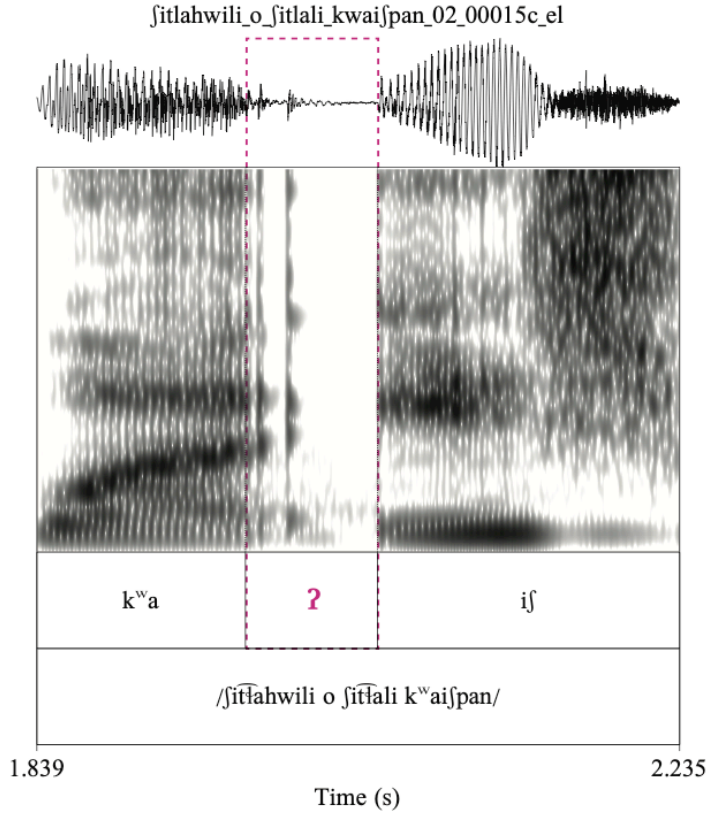
[a:t͡ɬahketl]
/a:-t͡ɬak^{w}-ke-t͡ɬ
water-bring-NOM-ABS
'person who brings water, *persona que acarrea agua'* (atlaucquetl) 02_0039.wav

Figure 28 Velarization of [h]

4.4.4.2 Phonetic realizations of glottalization

Glottal stops have been shown to have variable realization within and across languages (Pierrehumbert & Talkin 1992). As expected, the phonetic realization of glottalization in ChN ranges from canonical glottal stops to varying degrees of creaky phonation on adjacent voiced sounds. The spectrogram in Figure 29 shows a canonical glottal stop that consists of a clear period of silence following the regular phonation of the

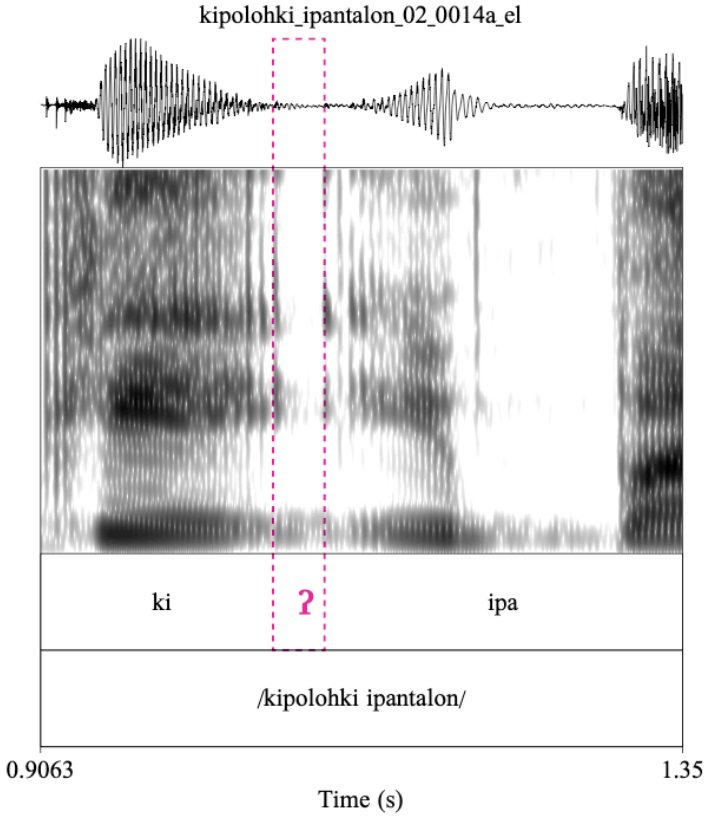
previous vowel. In the transition from the vowel to the glottal stop, there are the characteristic irregular pulses leading into the glottal closure. Another common feature of glottalization in ChN is that it can precede, anticipatorily, as well as carry on after the glottalization target. In Figure 29, irregular pulses continue through the [i]. The glottal stop in Figure 29 is occurring at a morpheme boundary within the word /kwa-iʃ-pan/ wood-eye-ADP 'on the wood/tree's surface'.



[kʷaʔiʃpah]
/kʷa-iʃ-pan/
tree-eye-LOC
'on top of the tree, *en cima del arbol'* (cuaixpan) 002_00015c_el.wav

Figure 29 Canonical glottal stop in ChN

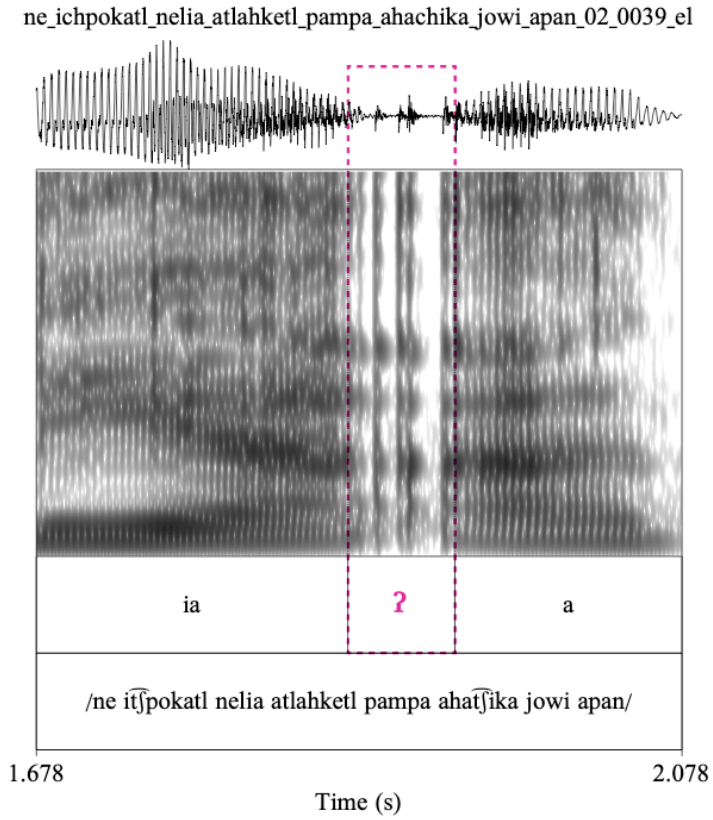
In many cases, there is some amount of residual noise or weak voicng that carries on through the period of glottal closure. The spectrogram in Figure 30 demonstrates this type of realization. Similar to the properties of [h], the formant structure of the noise during the articulation of the glottal obstruent matches the flanking vowels. In Figure 30, the glottalization is resolving hiatus at a word boundary.



[kipo:loh**ki ʔ ipa**ntaloh]
/ki-po:loh-ki i-pantalon/
3OBJ-dirty.PRT-PRET 1POS-pants
's/he dirtied her/his pants, *se embarró sus pantalones'* (quipolohqui ipantalon)
02_0014a_el.wav

Figure 30 Near canonical glottal stop in ChN

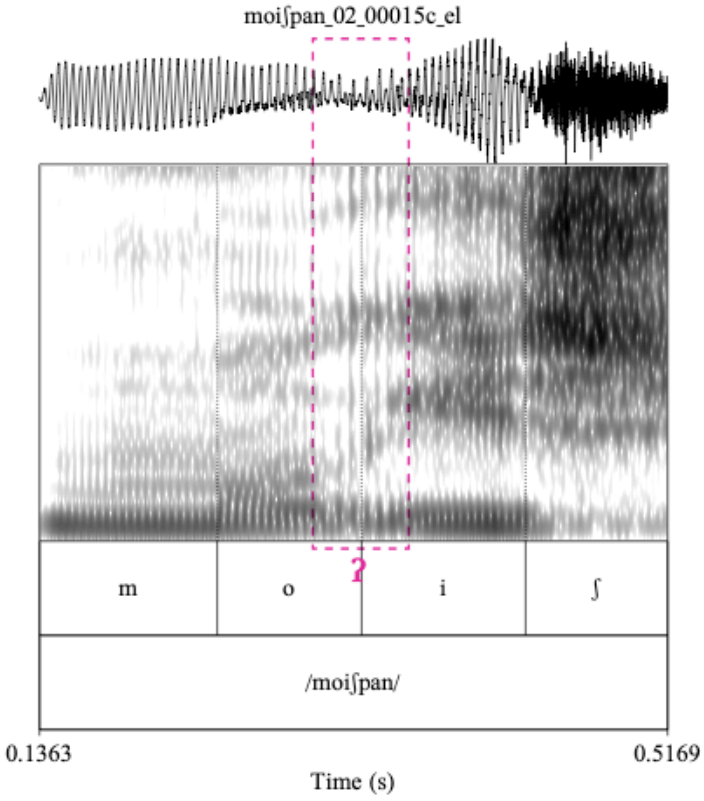
In ChN, glottalization can also be realized as incomplete closure but with strong glottalization such that there is a period of irregular glottal pulsing during phonation. The spectrogram in Figure 31 show this type of realization. Here the glottalization is resolving hiatus between two homorganic vowels at a word boundary ([nelia ʔ at͡ɬahket͡ɬ] ‘a good water-bringer’).



[nelia ʔ at͡ɬahket͡ɬ]
/nelija aː-t͡ɬakʷ-ke-t͡ɬ/
truly water-bring.PRT-NOM-ABS
‘a very good water transporter, *un buen acarreador de agua’* (nelliya atlaucquetl)
02_0039_el.wav

Figure 31 Glottalization realized as irregular pulsing in ChN

The degree of glottalization can be reduced so that the glottal stricture is realized as a period of weaker creaky phonation [V̰]. The spectrogram in Figure 32 demonstrates this type of realization word-internally at a morpheme boundary /mo-iʃ-pan/ 2POS-eye-LOC ‘in front of you’. 02_00015c_el.wav

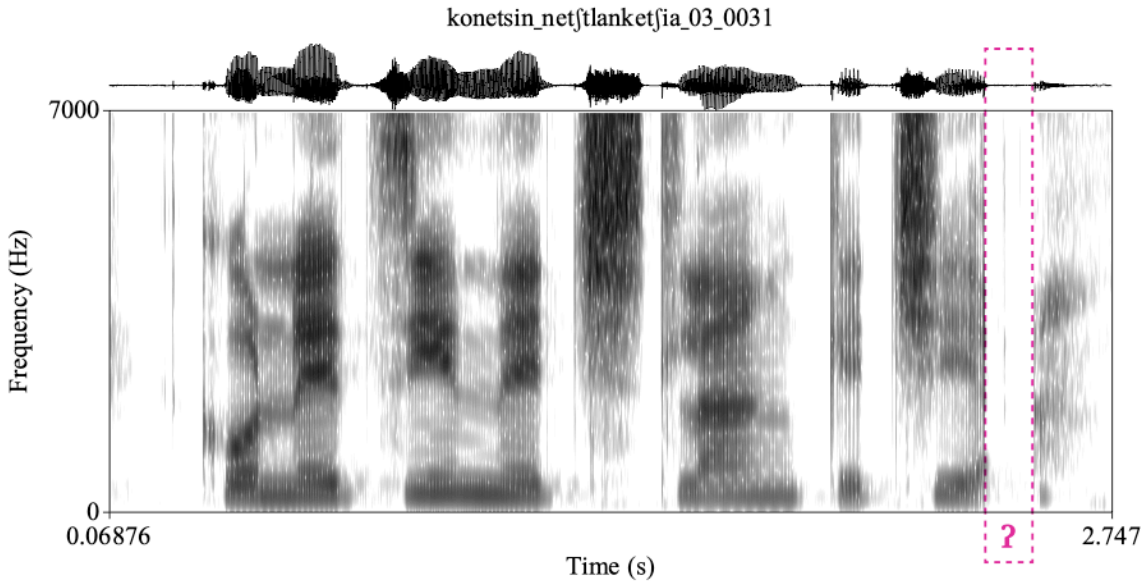


[moʔiʃpah]
/mo-iʃ-pan/
2POS-eye-LOC
‘before you, *en tu presencia’* (moixpan) 02_00015c_el.wav

Figure 32 Glottalization realized weak irregular glottal pulsing in ChN

In Chapter 3, where the case is made for the presence of a Utterance-final prosodic glottalization, the evidence is drawn from Utterances that are vowel-final. The phrase-final laryngeal target in ChN is almost without exception realized as a canonical glottal stop.

Despite the variable realization in other prosodic contexts demonstrated above and the cross-linguistic tendency for variable realization of segmental and non-segmental glottal stops (Pierrehumbert & Talkin 1992), utterance-final glottalization is reliably realized as canonical glottal stops in the context of a final vowel. The spectrogram in Figure 33 demonstrates the canonical glottal stop realization of utterance-final glottalization in ChN.

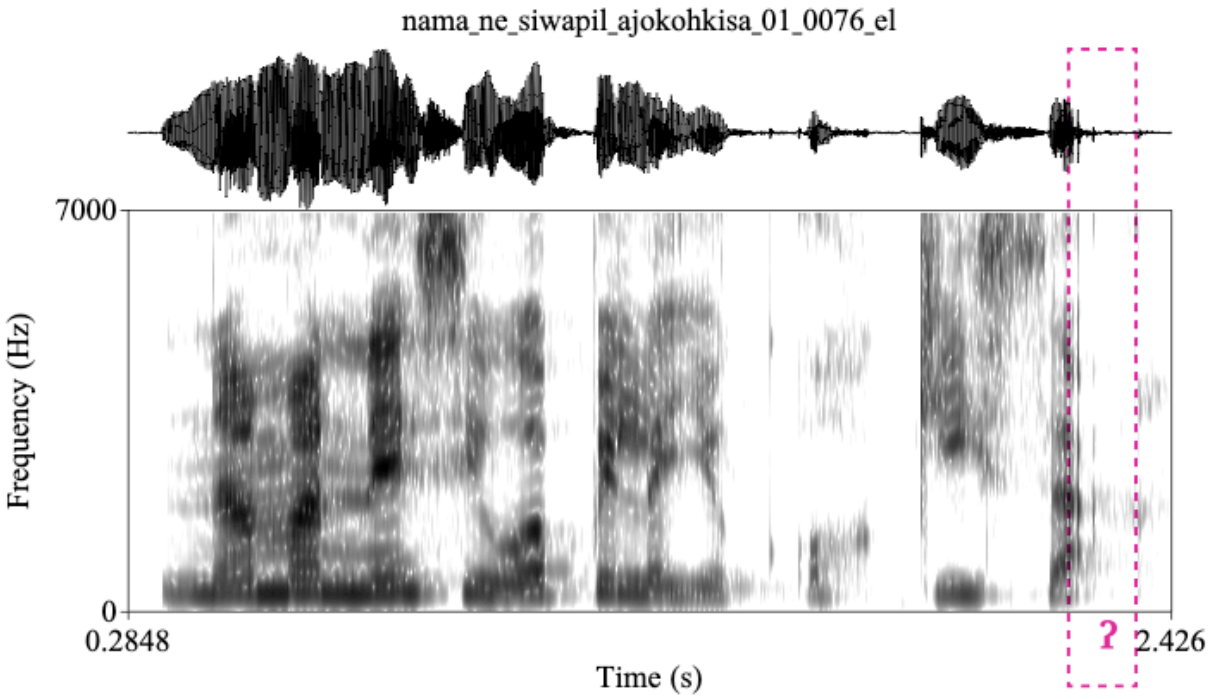


[konet͡si net͡ʃt͡ɬanket͡ʃia]
/kone-t͡sin net͡ʃ-t͡ɬanket͡ʃia/
child-DIM 1OBJ-bite
'The child bites me, *na/el niña/o me muerde'*
(conetzin nechtlanquechia)(03_0031.wav)

Figure 33: Canonical glottal stop realization of utterance-final glottalization

As can be seen in Figure 33, there is a clear period of silence following the regular phonation of the final vowel, that is similar in duration to other stops in the utterances. This period of silence is accompanied by one or two characteristic irregular pulses leading into

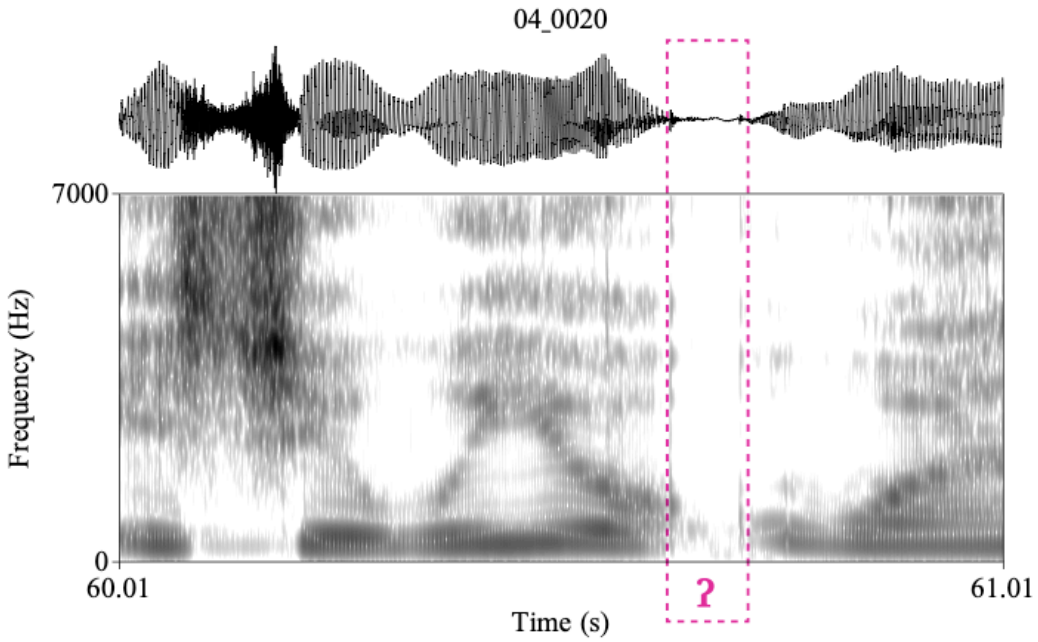
the glottal closure as well as more in the release. Some speakers, such as speaker 01, tend to have glottalization occur during much of the final vowel, in addition to the canonical glottal stop. This is shown in Figure 34.



[namah ne siwapił ajokohkisaʔ]
/naman ne siwa-pil ajok=oh-kisa/
now DEM woman-DIM ADV=road-stray
'now that girl no longer strays from the road' (01_0076.wav)

Figure 34 Glottalization leading into canonical glottal stop

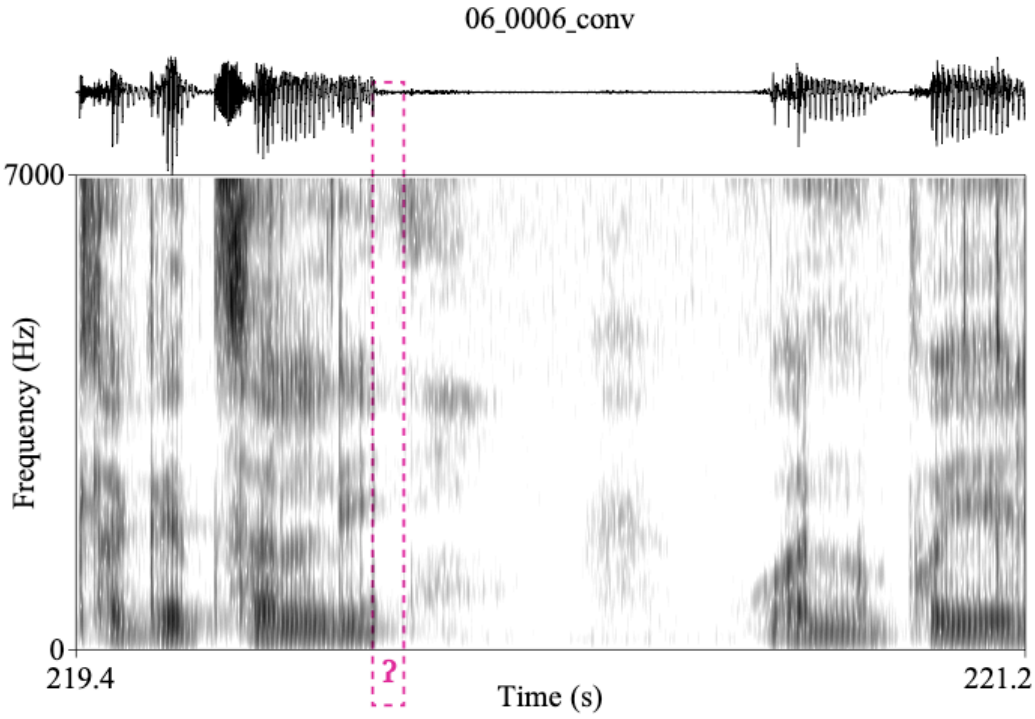
These examples are of Utterances in isolation. However, canonical glottal stops are characteristic of this syntagmatic target in connected speech in larger texts as well. The spectrogram below shows a canonical glottal stop between sentences in a story text—taken from a traditional story about the ants' role in nature.



[iʃiwijoʔ wan]
/i-ʃiwi-jo wan/
3POS-leaf-INAL CONJ
'[They cut the flower's] leaves. And [the ants…],
[de la flor le cortan] sus ojas. Y, [las hormigas…]'
(…ixiwiyo wan…) 04_0020.wav

Figure 35 Canonical glottal stop realization in narrative text

The spectrogram in Figure 36 shows an example of the canonical glottal stop in natural conversation (speaker 08 speaking with speaker 04). This spectrogram is taken from a conversation about how traditional homes were built in their community prior to the easy availability of concrete.



[t͡ɬaket͡sali ʔ wan]
/t͡ɬaket͡sal-t͡ɬi wan/
beam-ABS CONJ
'[…a large] beam. And [then it's built, a house…], *…un poste [grande]. Y [luego está construida, la casa…]'* (tlaquetzalli huan) 06_0006_conv.wav

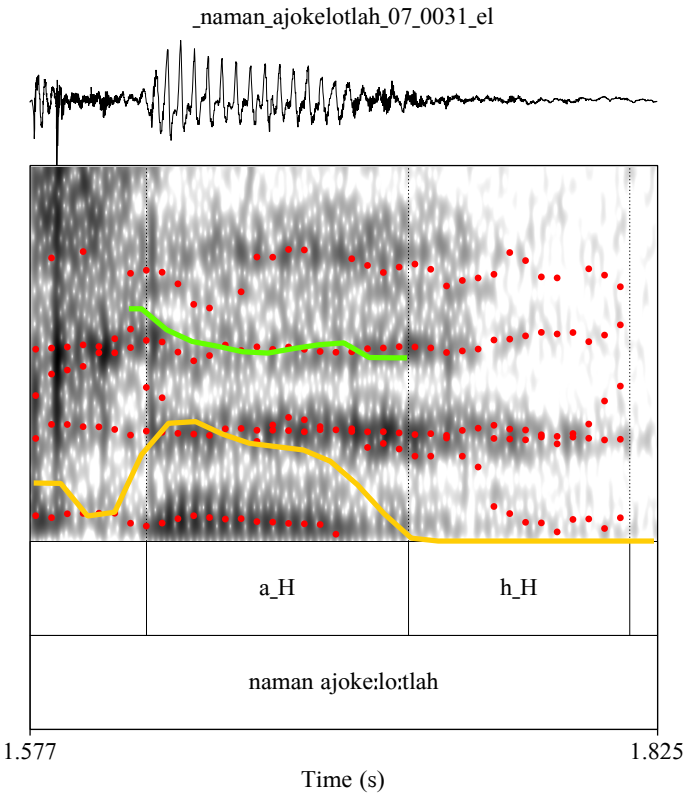
Figure 36 Canonical glottal stop realization in conversation

As these figures demonstrate, pausal glottalization is not a byproduct of a specific methodology or context, but rather, a wide-spread pattern in the language, marking phrasal boundaries across different genres of speech.

4.4.4.3 Segmentation Protocol

Data were coded and segmented in Praat (Boersma & Weenink 2019). First, vowel portion of each phrase-final syllable was segmented in order to be analyzed for acoustic

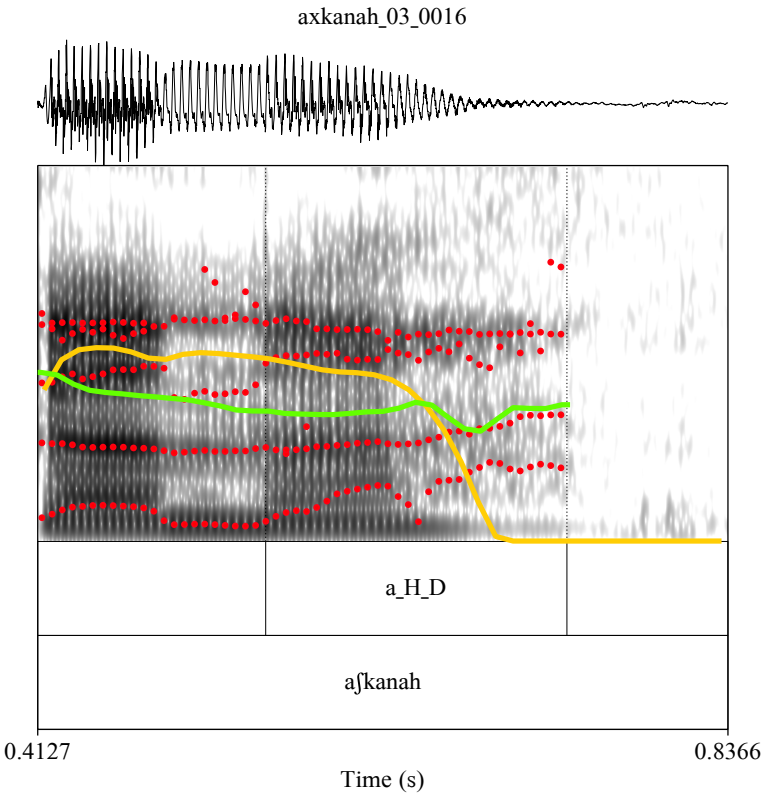
measures. Vowels were tagged for vowel quality, presence or absence of glottalization, and in the case of [h]-final phrases, the presence or absence of [h] and the underlying representation of [h]. In the case of expected final [h], the presence or absence of [h] was coded for. An [h] was coded as present when there was evidence of a voiceless breathy portion of the final speech segment. That is, the f0 track/glottal pulses could no longer be tracked, but there was energy in the higher frequency with characteristic formant structure, and boundary between the final vowel and [h] segment could be identified. By "glottal pulses" I refer to contact between the vocal folds that corresponds to the impulses of energy during oscillations seen in the audio signal. What results from this is that any voiced portion in the gradient transition from vowel to glottal fricative is counted as part of the vowel. Thus, in cases where the token was tagged as having a deleted [h], the glottal fricative may still have been realized as breathy voice on the vowel. The spectrogram in Figure 37 shows segmentation following these criteria: the vowel is segmented from the final [h], where voicing (corresponding to glottal pulses/f0) ends. The green line shows f0 and the yellow line shows intensity. The [h] is determined as ending where broadband energy weakens to the point where formants can no longer be tracked (red dots).



[naman ajoke:lo:t͡ɬah]
/naman ajok = e:lo:tlan/
now ADV = fresh.corn.season
'it's no longer fresh corn season, *ya no es temporada de elote'*
(naman ayocelotlah) 07_0031_el.wav

Figure 37 Segmentation of vowel from [h]

The spectrogram in Figure 38 shows a token coded as [h] being "deleted". The diminution of broadband energy aligns with cessation of formant and f0 tracking. Note that, in such cases, the preceding vowel is nonetheless breathy.



[aʃkanah]
/aʃ=kanah/
NEG-AUX
'no, *no*' (axcanah) 03_0016.wav

Figure 38 Segmentation of vowel when [h] is deleted

The presence or absence of an overt glottalization was identified and coded as "surfacing" if there was overt evidence of glottal stricture in the spectrogram and wave form such as irregular pulsing of f0 (also not able to be tracked in Praat) or canonical glottal closure. Glottal stops were not segmented separately from the vowel or [h] portion of the spectrogram. This is demonstrated in Figure 39 where irregular glottal pulsing results in an error in pitch tracking (pitch halving) throughout the vowel.

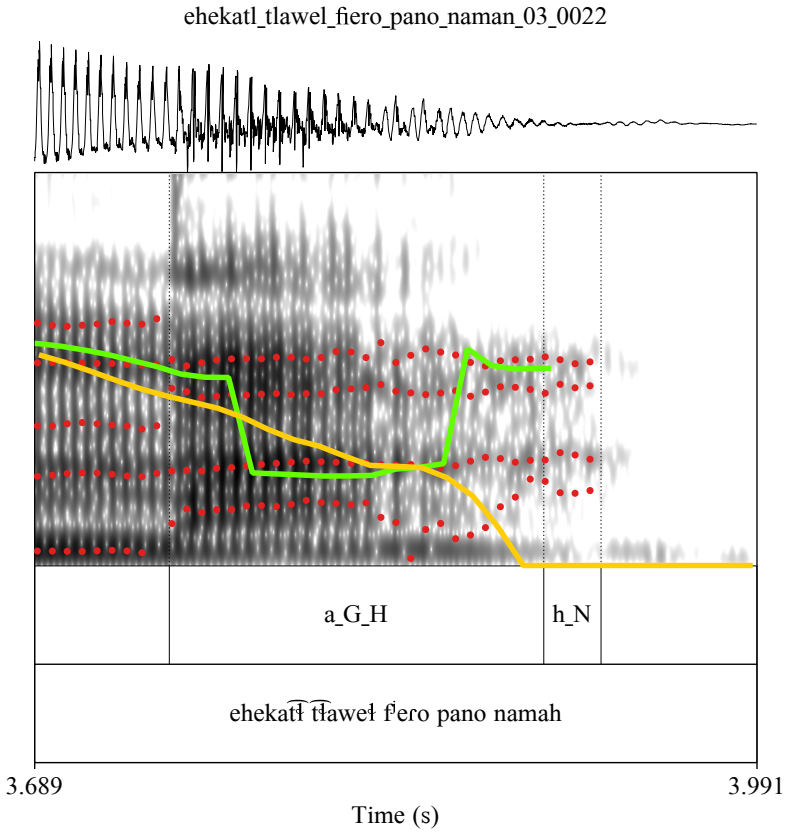


Figure 39 Segmentation of vowel when overt glottal stop occurs.

Note in both Figure 38 and Figure 39, under a different set of criteria could be counted has having an [h], given that there is breathy phonation in the second portion of the vowel. In order to be consistent, I chose to count these as deleted because the absence of a strongly and voicelessly articulated [h] suggested a high degree of reduction, distinct from cases with overt [h] segments.

4.5 Results

4.5.1 Distribution of [ʔ] and [h] realizations by U.R.

The distribution of realizations for overt glottalization and glottal fricatives by underlying representation all follow the same trends. Glottalization is more often deleted than realized overtly: the overwhelming pattern, occurring with %57 of /h/ tokens, %73 of /N/ tokens, %73 of /w/ tokens, is that glottalization is deleted and only [h] is produced (i.e., there is overwriting in favor of *h*). If glottalization is realized, the most likely realization is for it to occur sequentially in a [ʔ]-[h] order. The distribution of glottalization and glottal fricative realization is summarized in Table 8 in both counts and proportions:

Table 8 Distribution of [h] and overt [ʔ] realization by UR

	/h/	/N/	/w/
Sequential Realization [ʔ]-[h]	58 [.20]*	27 [.15]	17 [.19]
Sequential Realization [h]-[ʔ]	0	0	0
Cancellation	45 [.16]	15 [.09]	3 [.03]
Simultaneous Realization	0	0	0
Overwriting in favor of [ʔ](/h/→Ø)	20 [.07]	6 [.03]	3 [.03]
Overwriting in favor of [h](/ʔ/→Ø)	165 [.57]	128 [.73]	66 [.73]
Total	288	176	90

*Proportion of total tokens in brackets.

As is summarized in Table 13, there were no cases of glottalization occurring after the glottal fricative. There was also no evidence of simultaneous realization. While it is in principle possible for glottalization to be realized as epiglottal constriction during the [h], it

seems that this is not the case in ChN, for a number of reasons: 1) when glottalization is realized as an overt glottal stop, it occurs on the vowel (as discussed below, perhaps timed for optimal perception) and 2) phrasal glottalization seems to avoid anchoring on to a voiceless vowel (essentially an [h]) and instead anchors onto the final voiced vowel in the Utterance. This too will be discussed shortly.

If glottalization is realized, the most likely realization is for it to occur *sequentially* in a [ʔ]-[h] order. In these cases, glottalization is realized on the vowel as shown in the examples in Figure 39-Figure 42.

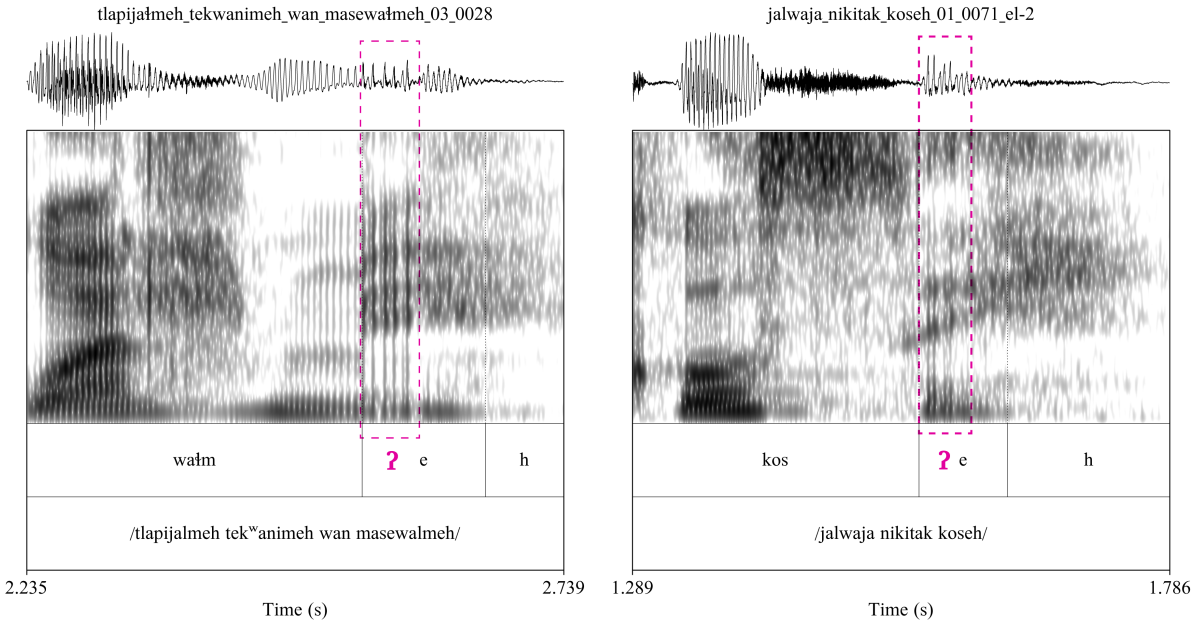


Figure 40 Glottalization realized on first half of vowel before /h/

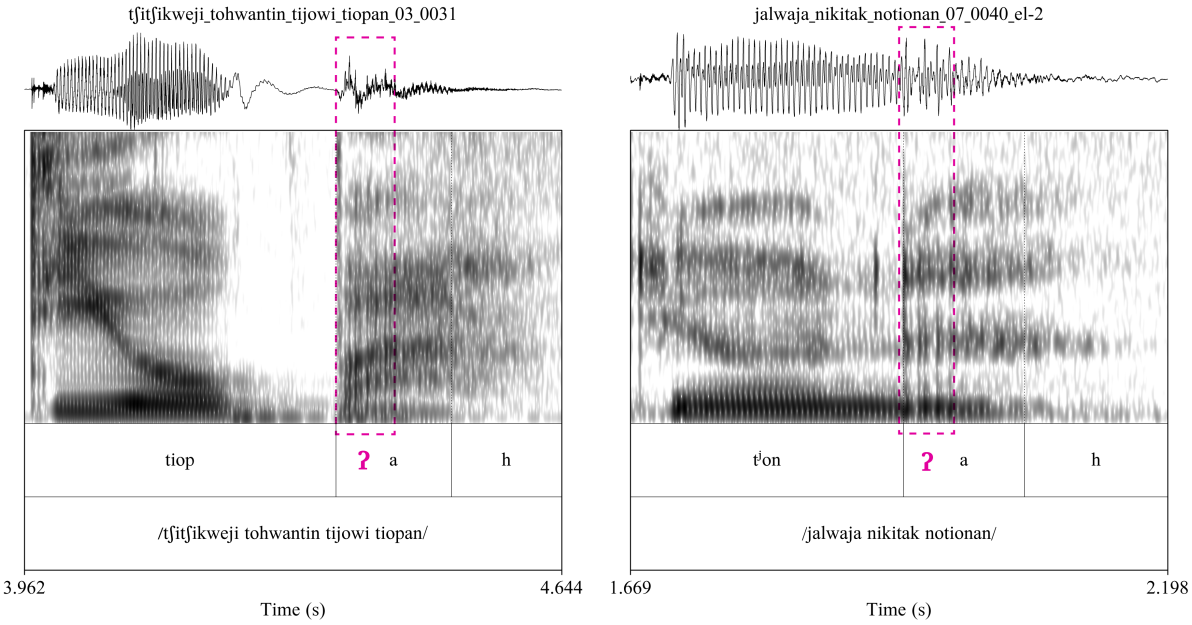


Figure 41 Glottalization realized on first half of vowel before /N/

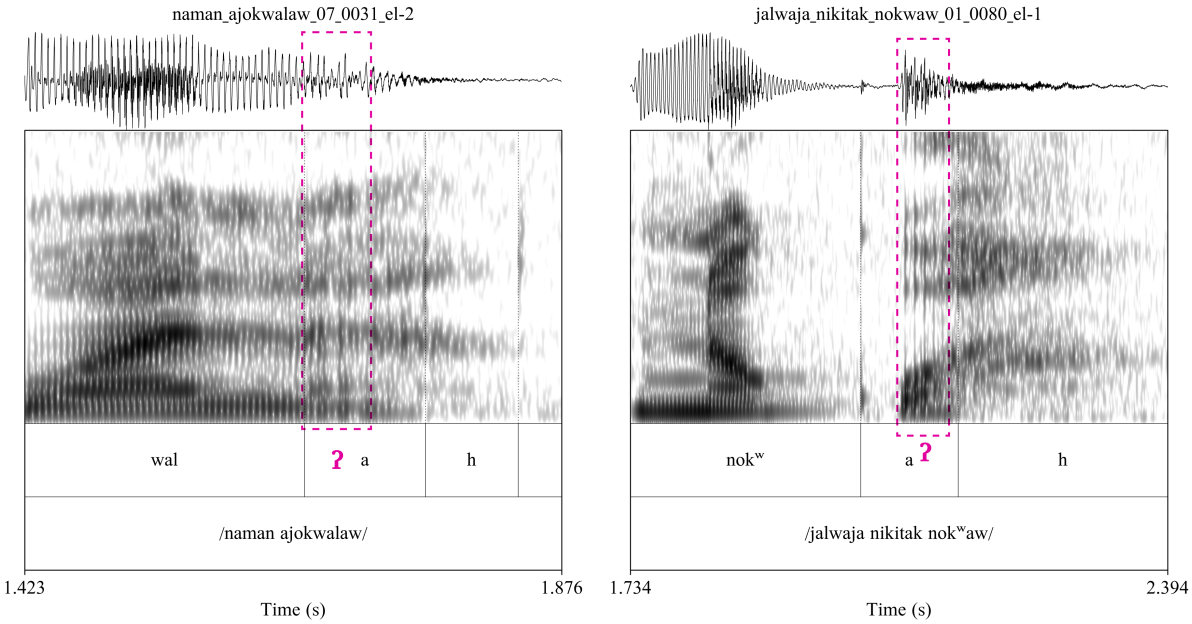


Figure 42 Glottalization realized on first half of vowel before /w/

This position for the realization of phrasal glottalization is attested in tokens ending with a consonant other than [h]. The spectrograms in Figure 43 show that, in Utterances that end in [s], glottalization can occur on the final vowel, just as with [h]-final Utterances.

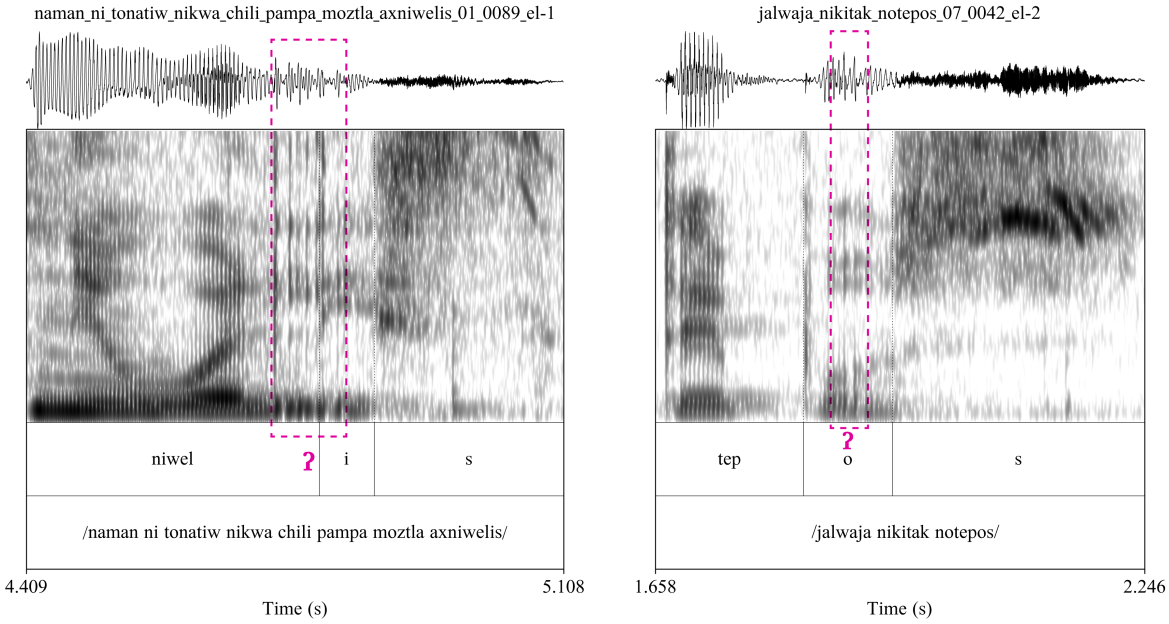


Figure 43 Examples of /s/-final tokens with overt glottalization

The generalization that emerges is that the Utterance-final glottalization, when realized, is realized on the final vowel, regardless of whether the word ends in an open or closed syllable.

There is, however, one environment in which glottalization is realized on the penultimate syllable. Two speakers (01 & 11, who are also siblings) frequently produced voiceless vowels Utterance-finally[66], even when these vowels were followed by consonants ([h], [ɬ], [ʃ], [s], [t͡ɬ],

[66] All speakers devoiced final syllables occasionally, though not as frequently as these two speakers.

[t͡ʃ], [k]). In the case of [h]-final Utterances, the vowel is devoiced, such that the vowel and [h] are indistinguishable, resulting in a syllabic [h] (e.g. /ita-h/ produced as [itḁ]).

In these contexts, glottalization, when overtly realized, anchors onto the penultimate syllable instead of the ultima, skipping voiceless vowels. Recall that this is the tonic syllable in ChN. Only fifteen [h]-final tokens produced with voiceless final vowels were attested in this data set, of which eight were produced with strong glottalization on the penultimate syllable. The remaining seven had no overt glottalization. While this is a small number in the total tokens included in this study, a cursory search found many more tokens like this in my data not included in this study. This suggests that this pattern is more common than is represented in these data, including tokens ending in other consonants. The spectrograms in Figure 44 show this realization.

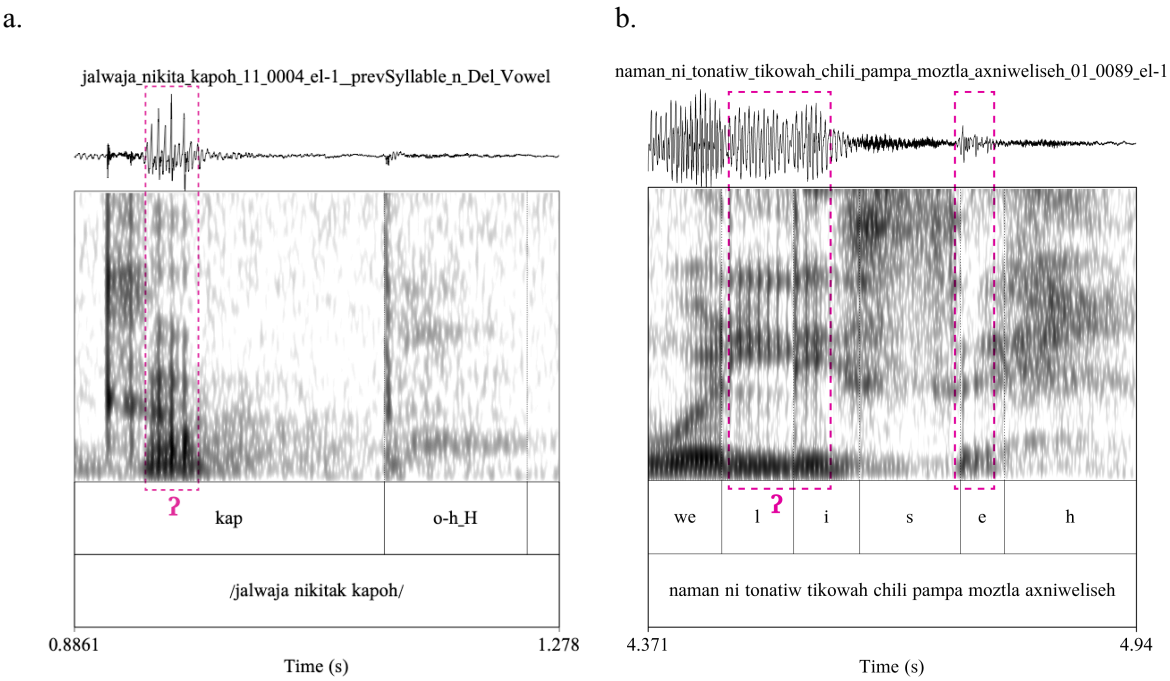


Figure 44 Voiceless final vowel and glottalization on penultimate syllable

In Figure 44(a), the [a] in [kapoh] ‘barrow” is glottalized and the final vowel is completely devoiced. In Figure 44(b), the glottalization is strongly realized both on the penultimate syllable, as well as briefly on the ultima.

The next likeliest realization of glottalization in the context of segmental [h] is *overwriting* of the [h]—that is, the glottalization is realized on the final vowel, but no [h] is produced. An example of this type of realization is shown in Figure 45.

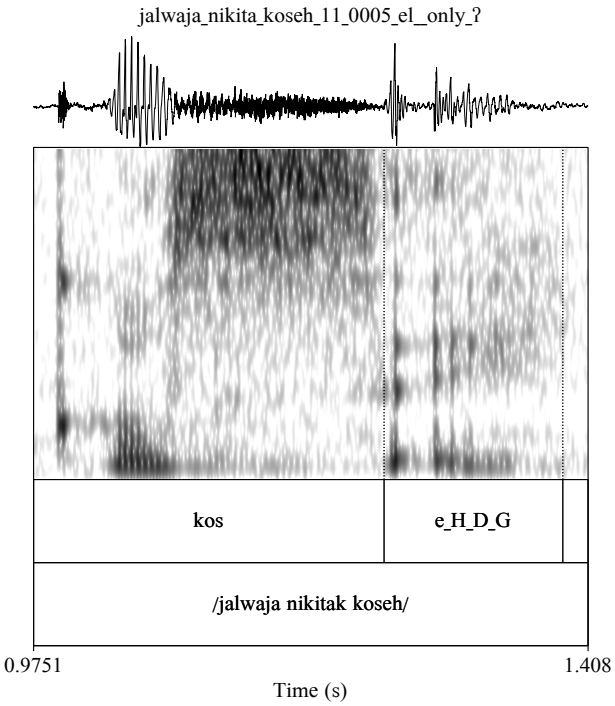


Figure 45 Overwriting of [h]

As is demonstrated by Figure 45, glottalization begins at the start of the vowel and carries on through the remainder of the vowel. While there is some breathy portion at the very end of the vowel, f0 and glottal pulses are tracked through the end of the utterance.

Under a different set of criteria, this could be counted as a sequence of [ʔ] + [h], where the [h] is not voiceless, but is breathy phonation/[ɦ]. The overwhelming pattern is that [h] is realized to some extent and never fully deleted. As it is being treated here, overwriting describes a very high degree of reduction.

The least likely outcome of the stacked context found in this data is "cancellation," where neither glottalization nor the glottal fricative is produced. Perceptually, tokens with cancellation are quite distinct from vowel-final tokens where, without exception, vowel-final tokens occur with final glottal stops. A comparison of such tokens is shown in Figure 46.

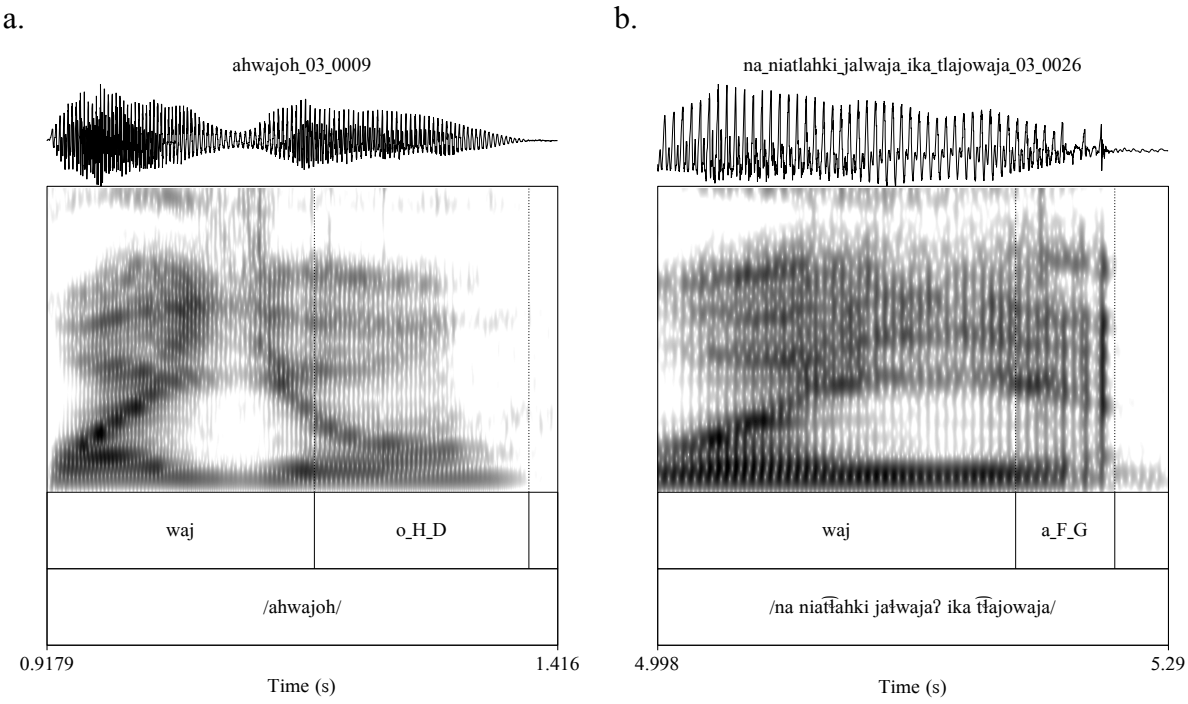


Figure 46 Cancellation vs vowel-final tokens

The phrase-final vowels in Figure 46, are quite distinct. On the left (a), where there is cancellation, there is no overt glottalization or [h]; on the right (b), where the token is vowel final, there is clear glottalization. Also note that the realization of glottalization on a vowel-

final utterance is distinct from an [h]-final utterance. The spectrogram in Figure 45 shows that glottalization is realized early in the vowel. This is distinct from Figure 46(b), where glottalization anchors towards the end of the vowel. In comparing the spectrograms in Figure 46, neither final vowel is underlyingly long, however the vowel on the left (a) is considerably longer than the vowel on the right (b) in comparison to the [waj] portion of the spectrogram. This may be compensatory lengthening in the cancelled forms. In addition, vowels that precede [h] (whether realized, cancelled, or overwritten) tend to include a breathy portion in the latter portion of the vowel, such that while described as "cancelled", [h] is not really deleted or overwritten but rather only highly reduced, realized with some degree of breathy phonation.

Now we turn to whether the UR influences how [h] surfaces when glottalization is present or absent. In Table 9, counts for each of the underlying representations are presented. Chi-squared tests were used to assess whether there is a significant relationship between presence vs. absence of glottalization and whether [h] is realized or deleted. Results indicate that, regardless of UR, there is no evidence for a significant relationship between presence vs. absence of glottalization and whether [h] is realized or deleted.

Table 9 Contingency tables by UR of surface [h]

/h/	[h]	no [h]	Total
[ʔ]	58	20	78
no [ʔ]	165	45	210
Total	223	65	288
X-squared = 0.36161, df = 1, p-value = 0.5476			

/N/	[h]	no [h]	Total
[ʔ]	27	6	33
no [ʔ]	128	15	143
Total	155	21	176
X-squared = 0.86652, df = 1, p-value = 0.3519			

/w/	[h]	no [h]	Total
[ʔ]	17	3	20
no [ʔ]	66	4	70
Total	83	7	90
X-squared = 0.79942, df = 1, p-value = 0.3713			

4.5.2 Distribution of [ʔ] and [h] by cost of reduction to [h]

The relative cost of reduction is another dimension predicted to have an effect on the rates of reduction of [h] and on the realization of [ʔ]. Recall the predictions made in 4.3.7: tokens of [h] which have a lower cost of reduction with regard to morphological information are predicted to be reduced more so than those with moderate cost of reduction. In turn, tokens of [h] with moderate cost of reduction were predicted to be subject to reduction more so than token of [h] with a high cost of reduction. This is schematized in Figure 21 repeated here as Figure 47.

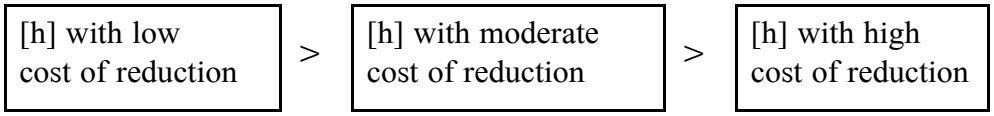


Figure 47 Expected likelihood of reduction

This prediction could also be framed (given the Continuum model) as: glottalization is predicted to be realized more strongly when there is a low cost of reduction of [h], and be most weakly realized in the context of [h] with a high cost of reduction.

Analyzed on this dimension, cost of reduction seems to have an effect on the rates of reduction of [h] and realization of [ʔ] in this data set. The data gathered in the field were skewed toward tokens with low cost of reduction. This is partially owing to the fact that only some of the data was collected using methodology designed to answer this question and much data came from conversations, texts, and elicitation. This suggests that speakers avoid forms with higher risk of ambiguity through reduction in naturalistic speech (or at least in speech aimed at a non-native listener i.e. me). Of the data with a final morpheme with a high

cost of reduction, the majority had a mitigating morpheme such as a noun, pronoun, or prefix. One reason for this was that in tasks where speakers were prompted to give tokens with high cost of reduction, mitigating morphemes such as pronouns (in the case of number) or adverbs (in the case of tense) were produced spontaneously. These tokens were included but categorized as *moderate cost of reduction* because of the mitigating morpheme. This most likely occurred in order to avoid ambiguity on the part of my teachers. It is not clear if this is a generalized communicative strategy or a byproduct of the teaching context of elicitation. The contingency table below (Table 10) show the rates of deletion and realization of [h] by relative cost of reduction.

Table 10 Contingency table for the realization [h] by relative cost of reduction

	low cost of reduction of *[h]*	**Moderate Cost of Reduction of *[h]***	**High Cost of Reduction of *[h]***	**Total**
[h]	415	77	31	523
no [h]	73	12	2	87
Total	488	89	33	610

X-squared = 2.0533, df = 2, p-value = 0.3582

A Chi-squared test indicates that the relationship between [h] realization and the cost of reduction is not significant. While the prediction was that reduction of [h] would follow the trend of low > moderate > high, this was only partially borne out: low ≈ moderate > high. The rates of overt realization of [h] in forms with low cost of reduction of [h] and moderate cost of reduction were roughly the same. Both of these occurred at a lower rate than in tokens with a high cost of reduction. There is also a relationship between the cost of

reduction of [h] and the rates of overt realization for phrasal glottalization. This is shown in the contingency table below where "[ʔ]" stands for glottalization.

Table 11 Contingency table for the realization [ʔ] by relative cost of reduction

	Low Cost of Reduction of *[h]*	**Moderate Cost of Reduction of *[h]***	**High Cost of Reduction of *[h]***	**Total**
[ʔ]	101	12	0	113
no [ʔ]	387	77	33	497
Total	488	89	33	610

X-squared = 10.527, df = 2, p-value = 0.005176

A Chi-squared test indicates a significant relationship between overt glottalization realization and the cost of reduction as the p-value is below 5% chance. The results of the overt realization are as predicted where glottalization is realized most often when there is a low cost of reduction of [h] and realized least often when [h] has a high cost of reduction (low > moderate > high).

These two contingency tables can be summarized together in the table below, where the rates of realization of [h] and glottalization are represented in percentages in relation to the n of each category.

Table 12 Summary of [h] and [ʔ] realization by relative cost of reduction of [h]

	Low Cost of Reduction			Moderate Cost of Reduction			High Cost of Reduction		
	[h]	**No [h]**	**Total**	**[h]**	**No [h]**	**Total**	**[h]**	**No [h]**	**Total**
[ʔ]	18%	2%	20%	11.2%	2.3%	13.5%	0%	0%	0%
No [ʔ]	67%	13%	80%	75.3%	11.2%	86.5%	94%	6%	100%
Total	85%	15%	100%	86.5%	13.5%	100%	94%	6%	100%
	n=488			n=89			n=33		

Presented in percentages, the trends are more easily visible given the differing number of tokens per group. Shown in Table 11, Glottalization is realized in 20% of low cost tokens, 13.5% in the moderate cost tokens, while never being overtly realized in the high cost of reduction dataset. In both low and moderate categories *cancellation* occurs over twice as many times as in the high cost tokens.

4.6 Discussion

The contingency tables in Table 9 show that the distributions for each underlying representation and for the data as a whole are not statistically significant. However, looking at Table 8 it is clear that there are overall trends (repeated here in Table 13 for convenience).

Table 13 Distribution of [h] and overt [ʔ] realization by UR

	/h/	/N/	/w/
Sequential Realization [ʔ]-[h]	58 [.20]*	27 [.15]	17 [.19]
Sequential Realization [h]-[ʔ]	0	0	0
Cancellation	45 [.16]	15 [.09]	3 [.03]
Simultaneous Realization	0	0	0
Overwriting in favor of [ʔ](/h/→Ø)	20 [.07]	6 [.03]	3 [.03]
Overwriting in favor of [h](/ʔ/→Ø)	165 [.57]	128 [.73]	66 [.73]
Total	288	176	90

*Proportion of total tokens in brackets.

Looking at overt glottalization only, there appears to be a difference between the realization of glottalization by underlying representation. It can be argued that [ʔ] is realized more strongly when co-occurring with /h/, than with /N/ and /w/: overwriting in favor of [ʔ] occurs twice as often for tokens with underlying /h/ than for /N/ and /w/; and, overwriting in favor of [h] occurs more often for /N/ and /w/ than for /h/. Cancellation also occurs at a higher rate for /h/ than for /N/ and /w/. Taken together, the distribution of [ʔ] and [h] realization suggest that [h] that is underlyingly /h/ is more likely to be reduced than [h] that is underlyingly /N/ or /w/. This could be restated as [h] that is underlyingly /N/ or /w/ is more strongly produced than /h/, that is, they are more persistent. The persistence of [h] that is derived from an underlying /N/ (/n/ and /m/) and /w/ in light of a pressure to reduce in the context of [ʔ], in effect ensures that the derivational phonological information is not lost. When considered through the lens of grammatical domains, here the lexical phonology persists through the potentially cancelling effects of the postlexical phonology. This result,

taken in conjunction with glottalization sensitive to morphological boundaries suggests then that the criteria adopted in Chapter 2 should be revised such that postlexical phonological patterns, specifically prosody, can be sensitive to lexical information.

The distribution of [h] and glottalization in ChN also suggests that the *continuum model* or Valve 1 in the *valves model* is sufficiently descriptive. There is no evidence of simultaneous realization, a realization that would support appealing to more than one valve in the valves model. The timing of glottalization and the glottal fricative in ChN suggests that modelling these sounds in ChN as articulatory gestures that lie on opposite ends of a continuum from most open to most closed is sufficient: glottalization and glottal fricatives must occur in a sequential order otherwise, one or both of these articulations will be cancelled out. If the timing is such that glottal stricture does not occur during the vowel, one of three realizations occurs: overwriting in favor of [h]; overwriting in favor of [ʔ]; or cancellation such that neither [h] nor [ʔ] is realized. Any breathy phonation in the "overwriting in favor of [ʔ]" and "cancellation" cases can be interpreted as coarticulation or anticipatory breathiness on the vowel leading into the [h] that is either cancelled or overwritten by the gestures involved in articulating a glottal stop.

Generally, glottalization is deleted more often than realized as an overt glottal stop, and [h] is almost always realized to some degree. Tokens which were counted as being examples of cancellation and overwriting in favor of [ʔ] still contain some degree of breathy phonation, and thus likely represent a very high degree of reduction of the [h]. If glottalization is in fact realized, the most likely realization is for it to be realized sequentially with the glottal fricative a [ʔ]-[h] order. I hypothesize that the sequential ordering in the [ʔ]-[h] order in ChN maximizes the perception of both articulations, even though glottalization

is marking the larger prosodic unit. If glottalization were realized after [h], it would be less perceptible than on a vowel because the previous sound is voiceless and already weak. The perception of glottalization involves the perception of changes in voice quality (Hillenbrand & Houde 1996) in addition to the silence resulting from glottal closure. There is generally no phonation during [h], meaning that the main cue to the glottal stop after [h] would be silence. Yet this silence for glottal closure coincides with the end of an utterance, and thus wouldn't be perceptually distinct from a pause. Moreover, [h] are very low energy in ChN (likely because it is a coda), and especially low energy in the utterance-final position since subglottal pressure declines as the utterance progresses (Westbury & Keating 1986). As such, the difference between an [h] and the silence resulting from glottal closure would be reduced in an [h]-[ʔ] order. This hypothesis would need to be tested with perception experiments in future work. I turn now to the effects of cost of reduction.

The results from this analysis show that [h] is realized more often when it has a high cost of reduction compared with tokens in which it has a low or moderate cost of reduction. This suggests that the persistence of [h] is influenced by morphological context—by the [h]s contribution to meaning as the single exponent in a morphological context. The glottal fricative is more likely to reduce if that same morphological information is carried by other parts of the string, either other segments in the morpheme or additional disambiguating morphemes. In addition, [ʔ] is realized more often in tokens with a low or moderate cost of reduction and not realized at all in the tokens with a high cost of reduction. The realization of [h] and [ʔ] are in an inverse relationship: glottalization is reduced in favor of [h] if that [h] has a high cost of reduction. The glottal fricative is reduced and glottalization is realized more often if [h] has a low or moderate cost of reduction.

Most striking is that glottalization is not realized in tokens where [h] has a high cost of reduction suggesting that there is something about the articulation of glottalization that interferes with the persistence of [h]. Perhaps the articulatory gestures associated with the production of [ʔ] are such that they interfere with the production of a stronger realized [h] and are forgone in order to avoid reducing [h]. Or perhaps the perceptual cues associated with [ʔ] cloud the perception of [h] and are thus avoided. Perception experiments in future work could help shed light on this effect.

While there is a difference by cost of reduction, the effect is not as strong as originally expected. One possible reason for this is that even when there is a high degree of reduction of utterance-final [h], the contrast with vowel-final tokens is maintained. Recall the results presented in 4.5.1 there was a difference between [h]-final tokens with cancellation and vowel-final tokens. The same held for overwritten forms. This maintenance of contrast despite different degrees of reduction, or perhaps better framed as different forms of phrasal glottalization realization are summarized in Table 14 below.

Table 14 Maintenance of contrast in different [ʔ] and [h] realizations

	/ki-ita-h/ 'they see it, *Io ven*' (quiittah)	/ki-ita/ 's/he/it sees it, *Io ve*' (quiitta)
cancellation	[kiʔita:]$_{\text{UTTERANCE}}$	[kiʔita̲ʔ̲]$_{\text{utterance}}$
overwriting	[kiʔita̲]$_{\text{utterance}}$	[kiʔita̲ʔ̲]$_{\text{utterance}}$
sequential ordering	[kiʔita̲h]$_{\text{UTTERANCE}}$	[kiʔita̲ʔ̲]$_{\text{utterance}}$

As is shown in Table 14, despite different forms of reduction and realization of glottalization, a contrast is still maintained in this context such that it is most likely the case

that reduction does not necessarily result in an ambiguity. Perhaps the effect shown in the distribution of [h] and [ʔ] by cost of reduction summarized in Table 10 is a trend that reflects the pressure to maximize contrast. It is possible that the effect would be stronger in a noisier environment where reducing [ʔ] in favor of a strongly articulated [h] is preferable.

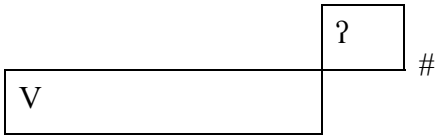
Taken together, the effect by underlying representation coupled with the effects from cost of reduction to unique meaning suggest a more fine-grained study with a larger corpus is merited. It is highly likely that disentangling the different types of "high cost" [h]s by their grammatical domain (i.e. lexical vs postlexical, derived vs. underived) could show stronger effects and merits further investigation.

4.6.1 Phrasal glottalization as suprasegment

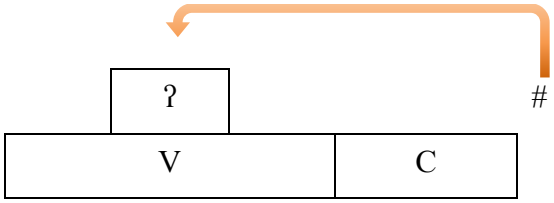
Devoicing of final vowels, attested for two speakers, may be partially driven by coarticulation with voiceless consonants, declination, and/or perhaps the anticipation of the open-glottis gesture associated with inspiration after the completion of the utterance (Ohala 1983, Klatt & Klatt 1990, Slifka 2006). In any case, devoicing reveals an interesting behavior for this segmental phrase-final glottalization.

Until now the pausal/phrasal glottalization has not been treated overtly as a floating [+constricted glottal] feature specified to occur at the end of a phrase, specifically at the end of an utterance. However, what is interesting here is that a segment that marks the *end* of a phrase can be realized before the end of the segmental string suggesting that this laryngeal target moves to the nearest possible anchor point. Figure 48 schematizes the movement of glottalization anchor points.

(i) V-final



(ii) C-final



(iii) Voiceless V-final

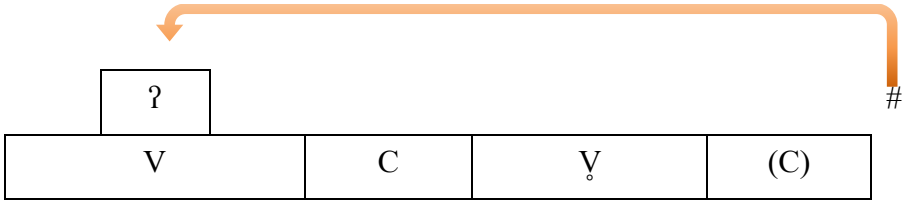


Figure 48 Anchoring points for suprasegmental phrasal glottalization

In Figure 48 (i), glottalization is realized as expected, after the vowel at the end of the segmental string. But in Figure 48 (ii), the glottalization moves leftward, anchoring onto the final vowel. Finally, if the vowel is voiceless, as in Figure 48 (iii), glottalization is realized on the penultimate syllable. Thus, it may be more appropriate to characterize the phrasal glottalization as a suprasegment [+constricted glottis] ([ˀ]) that can move in from the edge depending on the context given that: (1) the glottal stop often precedes the [h], but rarely follows it in (arguably only in cases of cancellation); (2) the glottal stop often

precedes other utterance-final consonants; and (3) the glottal stop can move onto penult when the final vowel devoices.

Devoicing has been shown to cause pitch-accent to shift in Japanese (Vance 1987, Maekawa 1990). Similarly, edge or boundary tones, which mark the ends of the prosodic phrases, have been shown to move and appear before the phrase edge or move to an epenthesized vowel when no voiced nucleus is available in Tashlhiyt Berber (Grice et al. 2011, Gordon & Nafi 2012). The similarity in position and behavior between intonational tones and ChN utterance-final glottalization suggests that the latter *might* best be described as a [+constricted glottis] boundary target analogous to pitch, but involves laryngeal constriction rather than laryngeal raising. More conservatively, phrase-final glottalization can be described as a floating [+constricted glottis] feature associated with utterance or loosely-defined phrasal boundaries.

Laryngeal articulations associated with utterance boundaries, and presumably phrase boundaries, are not unprecedented. For example in Choguita Rarámuri (Uto-Aztecan), utterance-final vowels with falling tones are rearticulated—that is they are closed with a glottal stop and copy vowel (/V̂/→[V́ʔV̀]/_]$_{\text{Utterance}}$) such that a word like /na^{h}pô/ 'prickly pear' surfaces as [na^{h}póʔò][67] (Garellek et al. 2015). In Cahuilla (Uto-Aztecan) words with "moveable" glottal stops are reported to occur most reliably in specific phrasal contexts such as phrase-finally and in isolation—which may also be phrase-final as it is in Nahuatl (Seiler 1965). In Dagbani (Niger-Congo), glottal stops are reported to mark phrasal boundaries

[67] Choguita Rarámuri /na^{h}pô/ is probably cognate to Nahuatl forms for the prickly pear cactus *nopalli and nehpalli.*

utterance-medially (pauses) and utterance finally (Hyman 1988). Similarly in Lahu (Tibeto-Burman), a phrase-final glottal stop is associated with imperative constructions (Matisoff 1973). In a parallel case involving laryngal abduction, a laryngeal morpheme /-hṼ/ is reported to attach to pre-pausal and utterance-final vowels such that a word like /walamat͡ʃia/ utterance finally is realized as [walamat͡ʃiahã] (Aikenvald 1998). However, this pattern could be analyzed as a phrasal [+spread glottis] counterpart to the rearticulation pattern in Choguita Rarámuri, where the nucleus of rearticulation is [h] rather than [ʔ].[68] Glottal effects at prosodic boundaries has been of interest in the literature (i.e. prosodic strengthening, phrase-initial glottal stops, phrase-final creak, phrase-final boundary tone truncation by devoicing etc.). And while examples of phrasal glottalization like that found in ChN are few, I expect that this type of phrasal laryngeal to be found in many more languages. This leads to the question of how representative is this pattern across Nahuatl varieties. In Chapter 5, I review the Nahuatl literature in order to situate the laryngeal landscape of ChN within the larger Nahuatl context.

A final note on the rates of glottalization in these data. As mentioned previously, these data were gathered in the elicitation context in Zacatecas. My teachers are bilingual with Spanish (which has not been reported to have glottalization at phrasal boundaries), and elicitation was conducted in mostly Spanish with my best attempts to elicit data in Nahuatl. It is unclear what effect code-switching in a Spanish-speaking context may have had on these results, especially since this type of glottalization is not present in standard Mexican

[68] The nasalization of the copy vowel could be the result of phonologizing a reanalysis of breathy phonation carried over from the intervening [h] as nasalization since the cues of breathy phonation and nasalization have been shown to overlap.

Spanish. The rates of phrase-final glottalization in these data reflect the linguistic context of Chicontepec Nahuatl speakers in Zacatecas and the elicitation setting. It is possible that in a more monolingual environment (i.e. in Chicontepec, Veracruz), capturing naturalistic data (which presents its own set of analytical challenges) with less codeswitching than in the elicitation setting, the rates of overt realization of phrase-final glottalization would increase. Like most original languages of the Americas, speech communities are bilingual/multilingual and, to the extent that there are still monolingual speakers, this is an interesting question to ask.

4.7 Summary

In this chapter, I presented a study on the phonetic implementation outcome in a context in which larygneals arising in distinct domains of the grammar cooccur. I discussed two models of laryngeal articulations of abduction and adduction and the types of predictions that can be made for the outcome of a lexically, phonologically or morphologically derived [h] cooccurs with postlexical glottalization. I also looked at this question through the lens of unique meaning: the cost of reduction of the [h] in the context of an arguably opposing articulation of glottal stricture.

The results from this study showed that there is a difference between the realization of glottalization by underlying representation. I argued that [ʔ] is realized more strongly when co-occurring with an [h] that corresponds to an underived /h/, than one derived in the lexical phonology from /N/ and /w/. Glottal fricatives derived from underlyingly /N/ or /w/ are more persistent in the context of glottalization, effectively ensuring that the derivational phonological information is not reduced through the articulatory and acoustic properties of

glottalization. By the same token, this outcome can be interpreted as the domain of postlexical phonology having sensitivity to lexical derivational information.

I also showed that cost of reduction also plays a role in the phonetic outcome of stacked contexts: Overt glottalization was less likely to occur in tokens where [h] has a high cost of reduction suggesting that there is something about the articulation of glottalization that interferes with the persistence of [h]. I suggest that the motivation for avoiding glottalization in this context may be that the articulatory gestures associated with the production of [ʔ] interfere with the production of a more strongly realized [h], or that the perceptual cues associated with [ʔ] cloud the perception of [h]. In either case, the loss of morphological information is avoided.

Also demonstrated in this chapter is that the *continuum model* or Valve 1 in the *valves model* sufficiently describe the distribution of [h] and glottalization in ChN. There is no evidence of simultaneous realization of [h] and glottalization that would support appealing to more than one valve in the valves model. Modelling ChN [h] and glottalization as articulatory gestures that lie on opposite ends of a continuum from most open to most closed is sufficient. In addition, I argue that the sequential order suggests it is more appropriate to characterize the phrase-final glottalization as a suprasegment [+constricted glottis] ([ˀ]) because it moves to the nearest available anchor point, persisting when the host is no longer available. If final vowels are devoiced, then glottalization is realized on the penult, including on intervening sonorants.

Chapter 5 Laryngeals across Nahuatl varieties

5.1 Introduction

The role of laryngeal articulations and their diachronic changes have been an area of interest in Uto-Aztecan languages (Seiler 1965, Whorf et al. 1993, Haugen 2014, among others). As has been shown in the previous chapters, laryngeal articulations have multiple sources in the grammar of Chicontepec Nahuatl: [h] patterns like a segment, while glottal stop patterns like a suprasegment (as a form of phrasal glottalization); moreover, [h] and glottal stop can interact in "stacked" contexts in which two laryngeal articulations originating in different domains of the grammar are specified to co-occur, such as phrase-final glottalization with word-final [h] in a phrase-final word. This raises the question: is there evidence of this type of patterning in other varieties of Nahuatl, or across Uto-Aztecan more broadly?

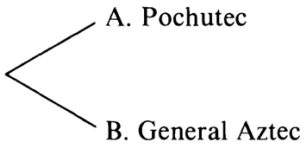
This data necessary to answer to this question is limited by the fact that much of contemporary Nahuatl varieties are generally not well documented phonetically, and detailed analysis of the phonetics (e.g. from the acoustic signal) is needed to investigate the interactions between the two sounds. Nonetheless, I will show here that existing descriptions and more recent acoustic studies do suggest that laryngeal patterns and phenomena like those described in this dissertation for ChN are more widespread across Nahuatl language varieties and merit further exploration. In this chapter, I situate Chicontepec Nahuatl within the Uto-Aztecan language family more broadly and then

within the Azteca/Nahuan languages[69] more specifically, comparing descriptions of laryngeals in other varieties of Nahuatl and Pochutec to ChN. I begin with background information on the Nahuatl language and the dialectal variation (section 5.2). This is followed by a brief discussion on the diversity of available sources surveyed in this chapter (section 5.3). Then, existing descriptions of contemporary Nahuatl varieties are surveyed in order to understand how the patterns found in ChN fit within the larger Nahuatl grammatical landscape beginning with the phonological status of laryngeal sounds in contemporary Nahuatl varieties (section 5.4), and concluding with evidence of laryngeal interactions in stacked contexts in other varieties (section 5.5).

5.2 Background

5.2.1 Nahuatl Varieties

Within the Aztecan or Nahuan branch of Uto Aztecan (recall Figure 2), there is a division between more distantly related Pochutec and Nahuatl ("Aztec," including Pipil and Classical Nahuatl) shown below in Figure 49.



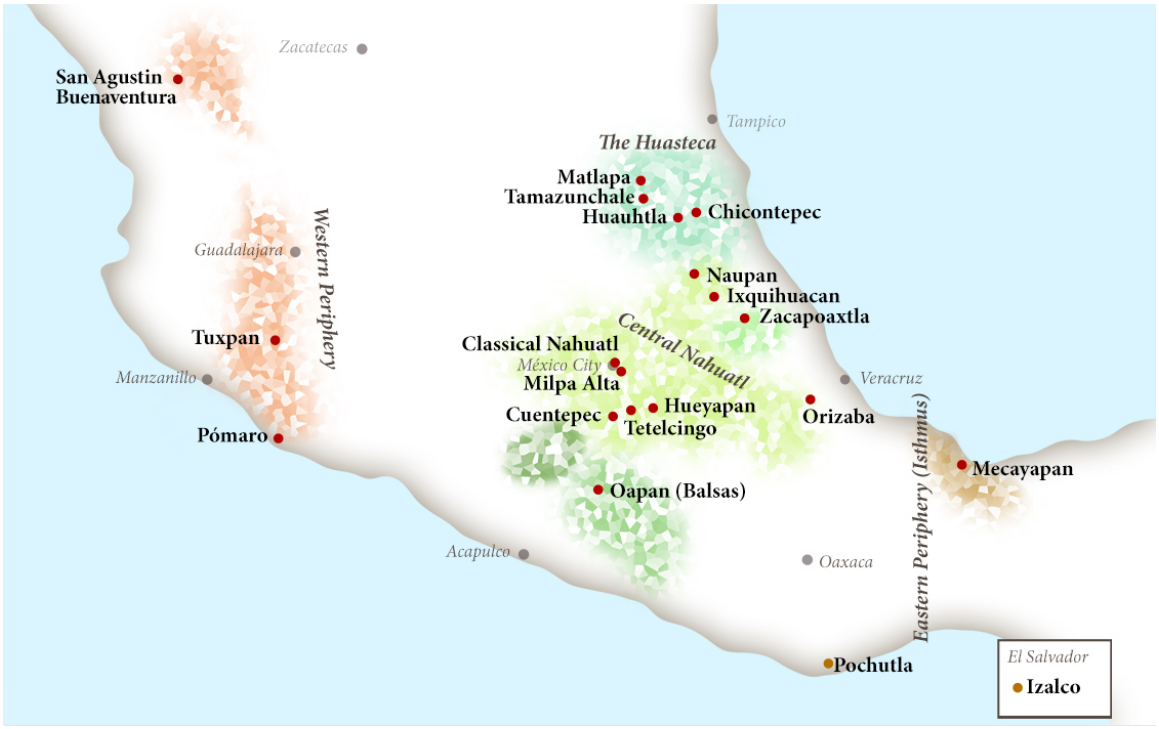
(Canger, 1988 p.47)

Figure 49 Aztecan/Nahuan languages

[69] Nahuan here refers to the subgrouping that includes the Nahuatl language and Pochutec, as well as Pipil in sources where it is treated as separate from Nahuatl.

There is much variation across varieties of Nahuatl; some features reflect an east-to-west dialect continuum (resulting from migration patterns; see Figure 1 for the distribution of Nahuatl in relation to the rest of the Southern Uto-Aztecan language communities), while others reflect a center-out influence of central highland urban varieties in the late pre-contact and early colonial era (Canger 1988).

As described in the introduction, Chicontepec Nahuatl is a variety of Eastern Huasteca Nahuatl that is a dialect area on the northeastern edge of *central* Nahuatl (Canger 1988). Eastern and Western Huasteca Nahuatl roughly correspond to varieties on either side of a line between Platón Sánchez, Veracruz, Mexico and Tianguistengo, Hidalgo, Mexico (Beller & Beller 1979), though some sources make references to a third central Huasteca Nahuatl area. The map in Figure 3 repeated below in Figure 50 for convenience shows the varieties surveyed here in this chapter in relation to Chicontepec, mapped onto Canger's (1988) proposed dialect groupings of Western Periphery-Central-Eastern Periphery varieties. The varieties discussed here represent varieties from each of these groups.



(map based on Canger 1988, p. 46)

Figure 50 Map of Nahuatl varieties

Laryngeal sounds play important phonological, morphological and phonetic roles in ChN. As will be shown in this chapter, laryngeal sounds do so to different degrees in other varieties on Nahuatl. From the earliest documentation of Nahuatl, the status of laryngeal sounds has been a topic of interest. The missionaries[70] who, with their Nahua students first began documenting Nahuatl, were speakers of 16th century Iberian languages and educated in ecclesiastical Latin and classical Greek. While certain orthographic conventions in Classical

[70] The Fray Andrés de Olmos wrote the first Nahuatl grammar *Arte para aprender la lengua mexicana* in 1547, only 26 years after the fall of Mexihco Tenochtitlan to the Spanish and Tlaxcallan forces in 1521. Fray Alonso de Molina wrote the first Nahuatl-Spanish/Spanish-Nahuatl dictionary *Vocabvlario en Lengva Castellana y Mexicana.* Fray Bernardino de Sahagún led the creation of the *Florentine Codex* between 1545-1590. All during an era of brutal violence, social/cultural/political upheaval, and repeated devastating epidemics.

Nahuatl drew from their linguistic experience (i.e. the use of *x* for /ʃ/ from Portuguese and Galician), there was debate on how to represent laryngeal sounds in Nahuatl. I turn to a discussion of the *saltillo* of Classical Nahuatl because this body of literature has been a touchstone for much of the literature on contemporary Nahuatl varieties.

5.2.2 Classical Nahutal and *saltillo*

The literature on the Nahuatl language goes back to Spanish colonization as missionaries created grammars for what is now referred to as "Classical" Nahuatl (Olmos, León-Portilla & León-Portilla 1547/2002, Molina 1571/1992, Carochi 1645/1845, Simeon 1885, Garibay K. 1970, Andrews 1975/2003, Sullivan & León-Portilla 1976, Launey 1980, Kartunnen 1992, Lockhar 2001, inter alia). This variety of Nahuatl spoken in the 16th-18th centuries in Central Mexico reflects a standard variety that emerged from the central varieties of Nahuatl spoken in the Valley of Mexico and is recorded in a rich corpus of texts reflecting the colonial experience of communities as far north as Santa Fe, New Mexico and as far south as Nicaragua and El Salvador. In early dictionaries and grammars, one laryngeal sound is reported in the language: the *saltillo* or 'little skip'. There is a consensus among Nahuatlists that the *saltillo* of Classical Nahuatl refers to a glottal stop; however, it has also been argued that the sound varied between glottal stop and glottal fricatives (Ramer 1995). In addition, there is evidence that prosodic laryngeal articulations were a feature of Classical Nahuatl: Whorf, Campbell, and Karttunen (1993) cite Horacio Carochi's 1759[71] description of the need to mark a word-final glottal stop differently from utterance-final glottal stops:

[71] Originally published in 1645.

> De quatro accentos usaremos en este Arte, para distinguir quatro generos de tonos, con q[ue] se pronuncia la vocal de cada syllaba, y son estos, á, ā, à, â. El accento (´) es nota, y señal de syllaba breve como tétl [te-tl], piedra: tlétl [tle-tl], fuego. La (¯) es accento de syllaba larga, como ātl [a·-tl], agua: teōtl [teo·-tl], Dios. La (`) es señal de la pronunciacion, q[ue] suelen llamar saltillo; porque la vocal sobre que cae este accento se pronuncia como con salto, ò singulto, ò reparo, y suspension: ver.gr. tàtli [ta'-tli], padre: pàtli [pa'-tli], medicina: mōtòtli [mo·-to'-tli], ardilla. Del accento (ˆ) usaremos solamente en las ultimas vocales de todos los plurales de verbos, y nombres, q[ue] acabaren en vocal quando no se pronunciare immediatamente otra diccion." Whorf, Campbell, and Karttunen (1993, p.168)

> "We will use four accent marks in this work, to distinguish four types of tones, with which the vowel of each syllable is pronounced, and they are, á, ā, à, â The accent (´) notates a short syllable like tétl [te-tl], stone: tlétl [tle-tl], fire. The (¯) is the accent for a long syllable like ātl [a·-tl], water: teōtl [teo·-tl], God. The (`) is the sign for the type of pronunciation that is typically called saltillo; because the vowel on which this accent is placed is pronounced like with a jump, or hiccup, or pause, and suspension: see tàtli [ta'-tli], father: pàtli [pa'-tli], medicine: mōtòtli [mo·-to'-tli], squirrel. We will use the accent (ˆ) only on the last vowels of all the plural verbs, and names, that end in a vowel when another sentence is not immediately pronounced." (*My translation*)

Why might the noting of multiple accents suggest a phrasal laryngeal? Recall that, in ChN, A phrase such as [ki?itah] 'they see it' in utterance-final position, would have the plural marker [-h] in a stacked context, because the [h] would coincide with phrasal glottalizarion. In Classical Nahuatl, the phrase would have been pronounced as [kita-ʔ]. It is possible then that, in Utterance-final position, the glottal stop was realized differently, leading Carochi to mark an utterance-final glottal stop differently in the orthography than the utterance medial glottal stops.[72]

[72] For a discussion of the *Saltillo* and its realization in classical Nahuatl as well as in Milpa Alta Nahuatl see Whorf, Campbell, and Karttunen (1993).

A final note on Classical Nahuatl and the *saltillo*: it is not assumed here that the modern varieties of Nahuatl descend from classical Nahuatl (except perhaps for Milpa Alta Nahuatl). As Canger (2011) argues, Classical Nahuatl is better thought of as a highly innovative "urban" variety (*Urban* Nahuatl) that became standardized during the colonial period. In this survey, I make reference to the *saltillo* as many of the sources surveyed here have also done. However, in doing so, I make reference to a cognate sound in the inventory, rather than a proto sound with modern reflexes. That is, the *saltillo* of Classical or Urban Nahuatl is a cognate sound in sister nodes of related dialects. When the *saltillo* is referenced, it is a point of comparison for the expected laryngeal sound found in many Nahuan varieties.

5.3 Survey Methods for Contemporary Varieties

Much literature on the Nahuatl language has been produced, from many research traditions. Whereas the focus of much research has been on Classical/Urban Nahuatl texts and grammar, the literature on contemporary varieties of Nahuatl provides varying amounts of phonetic or phonological detail. For this survey, I focus on key works that represent the variation across Nahuatl that also have some degree of description of the sound system, allowing for the assessment of question on the status of laryngeal sounds.

In most of the sources surveyed here, researchers focused on specific varieties of Nahuatl, while a few focused on larger dialect regions. For example, Beller and Beller (1979) describe "Huasteca" Nahuatl generally, pointing out differences between Western Nahuatl from Tamazunchale, San Luis Potosí and Eastern Huasteca Nahuatl from Huautla, but otherwise treating the different dialect groups as sufficiently similar.

Each source consulted for this survey presents a number of challenges in terms of discovering the necessary phonological, phonetic, and prosodic detail for this survey. In many cases the information presented required some interpretation on my part, which will be referenced in the discussion. This is partially due to the diversity in aims and audience for which these sources were written. While a number of grammars were consulted, several sources were written with more specific goals; e.g. Guion et al. (2010) who describe tonogenesis in Balsas Nahuatl and Patiño (2014) who presents an intonational analysis of Cuentepec, Morelos Nahuatl. In some cases, the description is limited to a listing of the phonemic sounds, while in others there are fuller discussions of laryngeal sounds, alternations and data from which analyses of laryngeal distribution can be made. In many cases, there is reference to the *saltillo*. If the description refers to a glottal stop as a "phoneme," but then describes what sounds like predictable prosodic glottalization, then the variety was categorized (for this survey) as having prosodic glottalization, sometimes in addition to a laryngeal phoneme like /h/. In the process of surveying and presenting examples, original transcriptions of data have been transliterated into IPA.

5.4 Phonemic Laryngeals and Prosodic Glottalization

In this section, the distribution of laryngeal articulations in Nahuatl varieties is discussed. In the synchronic landscape of Nahuatl, some varieties are reported to have a glottal fricative /h/, a glottal stop /ʔ/, or both in their phonemic inventory. The table below summarizes the distribution of Nahuatl varieties by phonemic laryngeals surveyed here.

Table 15 Nahuatl varieties by laryngeal articulation in the inventory

	Variety of Nahuatl
Phonemic /ʔ/ (unpredictable [ʔ])	• Classical/Urban Nahuatl • Milpa Alta, México (Whorf, Campbell & Karttunen 1993) • Naupan, North Puebla (Brockway 1963, 1979)
Phonemic /h/ (unpredictable [h])	• Balsas Guerrero Nahuatl (Guion et al. 2010) • Chicontepec Nahuatl (this dissertation) • "Huasteca" Nahuatl (Beller & Beller 1979) • Huautla, Hidalgo (Kimball 1990) • Hueyapan, Morelos (Campbell 1976) • Ixquihuacan, Puebla (Sasaki 2014) • Matlapa, San Luis Potosí (Croft 1951) • Orizaba, Veracruz (Goller, Goller & Waterhouse 1974) • Pipil (Campbell 2011) • Pómaro, Michoacán (Sischo 1979) • San Agustín Buenaventura, Durango (Canger 2000) • Tetelcingo, Morelos (Pittman 1954, Tuggy 1979) • Tuxpan, Jalisco (Valiñas 2013) • Zacapoaxtla, (Sierra) Puebla (Key & Key 1953, Robinson 1969)
Phonemic /h/ and /ʔ/ (unpredictable [h] & [ʔ])	• Cuentepec, Morelos (Patiño 2014) • Mecayapan[73], (Isthmus) Veracruz (Wolgemuth 1969, 2007) • Pochutla, Oaxaca [74] (Boas 1917/2017)

[73] Also Tatahuicapan township.

[74] Boas (2017) in his 1917 description says that the glottal stop of Classical Nahuatl is missing from Pochutla Mexicano, however, later in the monograph, glottal stop in Pochutec is reported to correspond to a number of vowels in Classical Nahuatl.

From the descriptions of modern Nahuatl surveyed here, most varieties seem to have glottal fricative as the phonemic laryngeal in their inventory, which is a cognate with the *saltillo*. As will be discussed in this chapter, many of these "h-varieties" have patterns of phrase-final glottalization similar to that of Chicontepec Nahuatl. In this section, the discussion of the Nahuatl laryngeal landscape will be organized as follows: 1) varieties with phonemic /ʔ/; 2) varieties with phonemic /h/; 3) varieties with phonemic /h/ and phrase-final glottalization; and 4) varieties reported to have two contrastive laryngeal sounds /h/ and /ʔ/.

5.4.1 Varieties with Phonemic /ʔ/ (unpredictable [ʔ])

In this survey, there are only two varieties in which only a glottal stop /ʔ/ is reported: these are North Puebla Nahuatl and Milpa Alta. Brockway (1963, 1979) includes glottal stop in the phonemic inventory; however, no phonetic detail is provided. Whorf describes 1930s Milpa Alta Nahuatl of Mexico City as having only one laryngeal, which mostly occurs in coda position and is transcribed as *'h*. (Whorf, Campbell & Karttunen 1993). This transcription refers to an aspirated (or strongly released) glottal stop[75] described as being part of a class of sounds (including /t/ and /k/) that are aspirated word-finally , and is also described as pre-aspirating the following consonant; i.e. [notaʔhtsi̥n] 'my father' (p. 175). Whorf contrasts this articulation with what can be interpreted as preglottalization of long

[75] There appears an alternation with [h] in word-initial contexts, however perhaps this is really only the strongly released ʔh: kiteikilla ha'hseite blanko 'le echa aceite blanco/one pours for her white oil', and also reports this form: *haseite* (Whorf et al. 1993, p. 175).

consonants; i.e. [iʔta] or [iˀtːa] ‘to see’ (p176).[76] This point of comparison in Whorf’s description suggests, as in Carochi’s description of Classical Nahuatl, that varieties with phonemic /ʔ/ most likely have other laryngeal sounds associated with prosody or the phonetic implementation of other contrasts (i.e. geminates).

5.4.2 Varieties with Phonemic /h/ (unpredictable [h])

For three varieties of Nahuatl, only the glottal fricative /h/ is reported: Tetelcingo, Balsas, and Durango Nahuatl. In Tetelcingo, Morelos Nahuatl, only /h/ is listed as a contrastive sound (Pittman 1954, Tuggy 1979). In both of these grammars, there is limited information on the details of laryngeal sounds beyond the phonemic inventory. Balsas Guerrero Nahuatl is reported to have [h] or its voiced counterpart [ɦ] in the four varieties described: San Miguel, Ameyaltepec, Ahuelican, and Oapan (Guion et al. 2010). Similarly, the data reported for San Agustín Buenaventura, Durango Nahuatl (Canger 2000) contains only [h] in the transcriptions. While only the glottal fricative is reported in these varieties, this does not preclude these varieties from having prosodic glottalization. In fact, given the distribution of laryngeals in the varieties surveyed here, one would expect glottalization in the form of creaky voice or a full glottal stop to occur at morphological junctures or in hiatus contexts, and possibly phrase-finally, as is found in ChN.

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[76] “Long” or geminate consonants have been reported in some dialects (especially with regard to lateral assimilation: /l-t͡ɬ/→[lː]. Long consonants are not found in ChN with the exception of lateral assimilation left of the stem where long [ɬː] surfaces: [t͡ʃili] /t͡ʃil-t͡ɬi/ chile-abs ‘chile’ vs. [t͡ʃiɬːakʷali] /t͡ʃil-t͡ɬakʷal-t͡ɬi/ chile-food-abs ‘food with chile’. Recall that to the right of the stem, lateral assimilation results in [l] e.g. [t͡ʃili].

5.4.3 Varieties with Phonemic /h/ and Phrase-final Glottalization

In the materials surveyed, there was a variety of ways that laryngeals were reported. In all of these cases, /h/ was reported as a phoneme, and either a phonemic /ʔ/ or non-phonemic [ʔ] was described. I interpret these glottal stops, including the "phonemic" glottal stops as in fact being a type of phrase-final glottalization, because they were predictable from prosody.

Some descriptions are somewhat ambiguous. For example, in Huauhtla, Hidalgo Nahuatl (Eastern Huasteca Nahuatl like ChN) Kimball (1990) reports that, in addition to phonemic /h/, glottal stop is contrastive in a few words such as personal pronouns. The examples given all seem to be hiatus contexts. An example is [naʔa] 'I' (p. 197) which could potentially contrast with a string like [naː] or [naha] in Huauhtla Nahuatl. Given that this variety is Eastern Huasteca Nahuatl like ChN, a sequence of two vowels is exactly where one would expect a hiatus- resolving glottal stop. A morpheme like /naa/ in Huauhtla might reflect a loss of an intervening consonant: compare with [na] and [nahwaː] 'I', [nahaja] 'I alone' in ChN and [newaːt͡ɬ] 'I' in Classical Nahuatl). Perhaps these marginal word-internal glottal stops correspond to morphological junctures, given that Kimball reports glottal stops occurring between vowels across word-boundaries. If [ʔ] is a phoneme then, it is a marginal one. The most common context for glottal stop is after all word-final vowels. Kimball suggests that it is a "signal that a word ends in a vowel rather than h" (p. 197). However, it is not clear if these glottal stops occur after word-final vowels without exception, or if these data reflect words uttered in isolation and reflect instead a form of phrase-final glottalization.

Another ambiguous case occurs in Hueyapan, Morelos Nahuatl, in which glottal stop is reported to be contrastive; however, I posit that the reported glottal stop is likely to

correspond to phrase-final glottalization. Campbell's (1976) analysis of Hueyapan, Morelos Nahuatl is not a grammar; however, the data presented suggests that there is a glottal stop after vowel-final words. The data in (96) shows the glottalization after final vowels.

96) a. ni-g-ihk^{w}iloaʔ 'I write it'
b. o-ni-g-ihk^{w}iloh 'I wrote it'
c. ni-k-toloaʔ 'I bend it down'
d. o-ni-k-toloh 'I bent it down'

(Campbell 1976, pp. 46-49)

Here Campbell treats glottal stop as a contrastive sound that is deleted in the past tense: "final vowel and glottal stop are deleted in the past and an [h] is added" (p. 49). However, this looks like the same pattern as in ChN, suggesting that perhaps it is not a contrastive [ʔ], but rather phrase-final glottalization. In utterance-final position, the comparable forms to (96a-b) in ChN would are: [nikihk^{w}iloa]^{ʔ} 'I write it' and [nikihk^{w}iloh]^{ʔ}~[nikihk^{w}ilohki]^{ʔ}. I analyze Campbell's description to be an instance of the type of pattern observed in ChN, where phrase-final vowel-final words are strongly glottalized, with a segment-like glottal stop; and where glottalization is realized to varying degrees when the phrase-final word is consonant-final. Thus we can propose that the forms given in (96a) and (96c) are instead [nigihk^{w}iloa]^{ʔ} and [niktoloa]^{ʔ}. The verbs Campbell uses to demonstrate this pattern are Class III (verbs ending in -oa or -ia), which tend to have stem alternation in present and preterit/perfect constructions across Nahuatl varieties: [oa] and [ia] in the present construction is [oh] and [ih] in preterit constructions. Thus, Hueyapan Nahuatl is included here as a potential variety with both phonemic /h/ and phrase-final glottalization.

Many of the varieties of Nahuatl surveyed here describe some pattern of phrase-final glottalization, whether at utterance/larger phrase level or at the word level. It is possible that these two types of descriptions are describing the same phenomenon, given that many words in isolation comprise entire phrases given the agglutinative tendency of Nahuatl, and meaning associated with zero-marking in verb paradigms.[77] For example, Sasaki (2014) reports that a "non-phonemic" glottal stop is inserted after word-final short vowels in San Francisco Ixquihuacan, Puebla Nahuatl (p. 242). I treat the reported non-phonemic glottal stop as a restricted form (limited to short vowels) of the phrase-final glottalization pattern of ChN, only the prosodic domain is ambiguous.

The remaining cases have similar descriptions of a contrastive [h] and a phrase-final glottalization: Orizaba, Veracruz Nahuatl; Zacapoaxtla (Sierra), Puebla Nahuatl; Tuxpan, Jalisco Nahuatl; and Matlapa, San Luis Potosí, Nahuatl. For example, Goller, Goller and Waterhouse (1974) treat glottal stops as "feature of the utterance final-vowel" (p.126) in Orizaba Nahuatl. The same is reported for Zacapoaxtla (Sierra), Puebla Nahuatl (Key & Key 1953, Robinson 1969).

In all of these sources, descriptions of word-final or phrase-final glottal stops describe it in a vowel-final context; which in ChN is the context with the most salient realization of phrase-final glottalization. However, there are no descriptions that suggest that phrase-final glottalization is realized on consonant-final words in a phrase-final context, as has been shown in ChN in Chapter 4.

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[77] Some examples of single word phrases: [kit͡ʃiwa] 's/he makes it', [komalt͡ʃiwa] 'she makes a griddle', [komali] 'a griddle' (noun) but also 'it is a griddle' (phrase).

5.4.4 Phonemic /h/ and /ʔ/ (unpredictable [h] and [ʔ])

Two varieties have been reported to have both laryngeals as phonemic sounds /h/ and /ʔ/: Cuentepec, Morelos Nahuatl and Mecayapan, Veracruz (Isthmus) Nahuatl. In Patiño's (2014) paper on Cuentepec, Morelos Nahuatl intonation patterns, both glottal stops and glottal fricatives are reported as neutralizing in coda position with "a shortening of the vowel's modal portion followed by a glottalization, which is produced as creaky voice or voicelessness." (p.1). There is not more detail provided, however given that the two segments are reported to occur in coda position, it can be assumed that this glottal stop is not like what I have analyzed as prosodic glottalization in the other varieties which, do not occur in coda position except in utterance-final position. Since it is not entirely clear what the status of the two laryngeal sounds is in Cuentepec Nahuatl, this variety is tentatively included here are having both phonemic /h/ and /ʔ/.

Mecayapan, Veracruz, also known as Isthmus Nahuatl, is reported to have both /h/ and /ʔ/. Wolgemuth's descriptions (1969, 2007) present a complex set of laryngeal articulations. There are both phonemic segmental /h/ and /ʔ/ as well as a pattern of glottalization that parallels phrase-final glottalization in ChN. In Mecayapan Nahuatl, [h] corresponds to the *saltillo* of Classical Nahuatl (Wolgemuth 1969). According to Wolgemuth (2007), the glottal stop segment has resulted from debuccalized coda /t/ and /k/. In the data presented in (21) below show the contrast between /h/ and /ʔ/ in Mecayapan Nahuatl.

97) a. nemi nasih ‘we are arriving

b. nemi kiːsah ‘they are emerging’

c. nemi nasi ‘I am arriving’

d. nemi kiːsa ‘he is emerging’

e. jegin nasiʔ[78] ‘he arrived a while ago’

f. jegin kiːsaʔ ‘he emerged a while ago’

(Wolgemuth 2007, p. 15)

In the examples in (21) above, [-ʔ] is a past tense marker in Mecayapan, corresponding to /-k(i)/ in ChN. As is shown in (21), the plural marking /-h/ is shared with ChN, corresponding to the saltillo, making the phonemic /ʔ/ an innovation of this variety not shared by any of the varieties surveyed here except tentatively Cuentepec, Morelos Nahuatl. In Wolgemuth’s (2007) description, vowel-final words undergo some amount of glottalization utterance-finally, but where the glottalization is distinct from glottal stop:

> “The pronunciation of h at the end of a word cited by itself is easy to miss because in that position the aspiration is heard just like the pronunciation of an open syllable in English. However, words that end with this aspiration contrast with the words that end in a simple vowel, because when a simple vowel appears at the end of an utterance, it is always pronounced with a brief closure of the throat (less abrupt than the one produced by the glottal stop). (p. 14-15)

[78] “ásiʔya *he has already arrived*” is given by Wolgemuth (2007, p. 14). The adverbial affix “-ya” given here is cognate to the /-ja/ described in this dissertation ChN, Though in Mecayapan, this affix seems to be more clitic-like in that it does not participate in stress assignment as it does in ChN. The ChN counterpart [ahsiˈkoja] (ChN requires the use of purposive /-ko/ for the “arrived” meaning. /ki-ahsi-k-ja/ [kiahˈsihka] 3OBJ-find-PRET-ADV ‘s/he already touched/found someone’.

In this excerpt, Wolgemuth describes two patterns that parallel the one seen in ChN. First, there is utterance- or phrase-final glottalization on final vowels. Second, there is support for phrasal interactions between [h] and phrasal glottalization. Utterance-finally, word-final [h] is realized less forcefully, such that it can be imperceptible to a non-native hearer. If we propose phrase-final glottalization as in ChN, then an utterance-final [h]-final word is in a stacking context in Mecayapan Nahuatl and the reported outcome is some amount of *cancellation*. I return to this stacking question in Mecayapan Nahuatl in section 5.5.

This phrasal glottalization is also described as occurring before vowel-initial syllables and following vowels before silence (Wolgemuth 1969), making the distribution of prosodic glottalization very similar to that in ChN. In my analysis of ChN, I distinguish phrase-initial glottalization from the hiatus-resolving glottalization word-internally and distinguish these two from prepausal or phrase-final glottalization. What I am interpreting as prepausal or phrase-final prosodic glottalization in Mecayapan is described by Wolgemuth (1969) as "glottal closure" that is a "junctural feature" that is phonetically similar to /ʔ/ but shorter in duration.[79] Two sets of contrastive forms are given to demonstrate the distinction between phonemic /ʔ/ and phrase-final glottalization ("junctural glottal closure"):

[79] Wolgemuth (1969) also describes the two glottal stops as *fortis* and *lenis* (p.3)

98) a. kiˈpʲaʔ b. ‘he has it’

c. kiˈpʲaʔ d. ‘he had it’

e. iˈkoneːʔ f. ‘his child’

g. ˈkoneːʔ[80] h. ‘a child’

(Wolgemuth (1969, p.3)

Phrase-final glottalization is reported to have variable realization between three general types having 1) non-fricative 2) fricative, and 3) voiced releases. These are described as ranging from a slight release after glottalization (1), a more strongly articulated glottal fricative release (2), and what Wolgemuth (1969) described as “nasalized rearticulation” (pp. 2-3)[81]. My interpretation of Wogelmuth’s (1969, 2007) descriptions of the phrasal realization of /h/, /ʔ/, and the phrasal glottalization /*ʔ/ in Mecayapan Nahuatl are summarized below:

[80] Both the phonemic /ʔ/ and junctural glottal closure are described as further reducing after long vowels in Mecayapan Nahuatl (Wolgemuth 1969, p.3).

[81] The realization of phrase-final glottalization as nasalized rearticulation, or VʔṼ, may perhaps reflect breathy phonation of the rearticulation vowel since it has been shown that the cues for nasality overlap with the cues for breathiness. However, this is strikingly similar to the pausal marker proposed in Warekena, a northern Maipuran language spoken in Brazil. In this language, a /-hṼ/ marks phrasal boundaries (Aikhenvald 1998) before a pause as well as at the end of an utterance:

eni-**hĩ** diutsu anetua-li eni-**hĩ** walamat͡ʃia-**hã**
this-PAUS god good-REL this-PAUS save-PAUS
'This very God is good, it is he who saves' (pp. 412)

Table 16 Realization of /h/, /ʔ/, /*ʔ/ in Mecayapan Nahuatl[82]

	/h/	/ʔ/	Phrasal glottalization
Phrase-initially	?	?	ʔ[V] (word-initial vowels)
Phrase-medially	[h]	[ʔ]	?
Phrase-finally	[V^{h}]	[Vʔ]	[V]^{ʔh}, [V]^{ʔ}h, [V]^{ʔ}Ṽ (word-final vowels)

While Wolgemuth does not describe what I interpret as phrase-final glottalization as behaving as a suprasegment, it is possible that with a detailed acoustic study, glottalization may be found behaving like a suprasegment, realized on the ultimate or penultimate vowel of a consonant-final word.[83]

[82] Wolgemuth (1969) suggests that there is neutralization of the difference in articulation of /ʔ/ and /*ʔ/ after word-final long vowels.

[83] There is a description of the phonemic /ʔ/ and /h/ patterning like suprasegments such that a segmental analysis would violate Mecayapan syllable structure, which like many varieties of Nahuatl does not have onset or coda consonant clusters. There is an optional phonological process in which the final vowel can be deleted in words that end in a sequence of VRV(ʔ/h)→VR(ʔ/h), where R is a sonorant (resonant). If the word ends in a glottal stop or a glottal fricative, the laryngeal is realized on the sonorant: VRVh→V$\underset{\circ}{R}$ and VRVʔ→VR^{ʔ}, Wolgemuth analyzes these are "portmanteau syllabic consonants" (p.6) because of two facts: (1) if there is no laryngeal present, then the final consonant remains voiced (VRV→VR) which is unexpected since coda sonorants are voiceless (as in ChN); and (2) nasals retain their place of articulation, which is unexpected since /m/ and /n/ neutralize (as in ChN) in coda position to a nasalization on the vowel. The voiceless or glottalized realization of final sonorants can be analyzed as the final laryngeal glottal feature docking onto the voiced consonant.

5.4.5 Summary of Phrase-final Glottalization

The following table (Table 17) provides a summary of the varieties reported or analyzed here as having glottalization associated with phrasal boundaries, organized by their shared phonemic laryngeal sounds.

Table 17 Nahuatl varieties with prosodic glottal stop

Phonemic Laryngeal	Variety analyzed as having Phrase-Final Glottalization
Phonemic /ʔ/ (unpredictable [ʔ])	*Possibly* Classical/Urban Nahuatl
Phonemic /h/ (unpredictable [h])	Huauhtla, Hidalgo Nahuatl Hueyapan, Morelos Nahuatl Ixquihuacan, Puebla Nahuatl Matlapa, San Luis Potosí, Nahuatl Orizaba, Veracruz Nahuatl Tuxpan, Jalisco Nahuatl Zacapoaxtla (Sierra), Puebla Nahuatl
Phonemic /h/ and /ʔ/ (unpredictable [h] & [ʔ])	Mecayapan, Veracruz Nahuatl

5.5 Evidence of interaction between /h/ and phrase-final glottalization

In Chapter 3, I showed that [h] and glottalization interact in "stacking" environments in Chicontepec Nahuatl. With the number of varieties surveyed here reported to have some form of phrase-final glottalization, one would expect the ChN-type of pattern to be found across other varieties of Nahuatl. In fact, Canger (1990) makes this generalization about

Nahuatl varieties in which the *saltillo* of Classical Nahuatl corresponds synchroncially to a glottal fricative in sister varieties:

> In most modern dialects, what corresponds to the "saltillo" in the sixteenth century is pronounced as [h], both medially and word-finally. What is also characteristic of the dialects that have this [h] is an utterance-final non-phonemic automatic glottal stop, which has confused a good many field workers, particularly since the phonemic final *h* is only barely perceptible. We thus find:
>
> Zitlala
> [nemiʔ] /nemi/ 'he goes'
> [nemi^{h}] /nemih/ 'they go'
>
> (Canger 1990, p. 115)

This observation by Canger suggests that stacking contexts and such reduction of word-final [h] in the context of phrase-final glottalization is common (represented here as [^{h}]). In this section I will discuss evidence of interaction of phrase-final glottalization with the realization of final /h/ in the descriptions surveyed in this chapter.

Orizaba Nahuatl is reported to have a similar pattern to Canger's description of Zitlala Nahuatl: "Laryngeal h is aspiration except in word final position where it indicates an open glottis" (Goller et al. 1975, p. 127). Goller et al. (1975) also treat [ʔ] as a "feature of utterance-final vowels" which I interpret as analogous to the phrase-final glottalization in ChN. I interpret this description as lining up with the *cancellation* outcome of a stacking context in Orizaba Nahuatl: vowel-final words occur with a glottalization, while h-final words occur as an unglotalized vowel. The data below demonstrate this pattern in Orizaba Nahuatl:

99) a. [tʰi.tlah.kʷi.ɬo.waʔ]
titlahkʷiɬowa
'you are writing'

b. [tʰi.tlah.kʷi.lo.wah]
titlahkʷiɬowah
'we are writing'

(Goller et al. 1975, p. 127)

Presumably in this data, the [h] transcribed in (99b) by Goller et al. is highly reduced given their description.

I now turn to a description of "Huasteca" Nahuatl, though it mostly makes reference to Huauhtla Nahuatl and will be referred to as such. This is a variety of Eastern Huasteca Nahuatl and is expected to be quite similar to ChN. The authors describe glottal stop as a phoneme, but describe a distribution similar to Chicontepec Nahuatl: before all vowel initial-words, between two vowels at a morphological boundary, and final in a phonological phrase (p. 204). In my interpretation, analyzing the description and data through the lens of my analysis of ChN, this glottal stop is not a phoneme, but rather three types of predictable prosodic glottalization.

While there is no explicit discussion of stacking interactions between final [h] and phrase-final glottalization, the transcription of data provides clues that the types of reduction of [h] found in ChN are also found in Huauhtla Nahuatl (*cancellation*). Surface [h] tokens that are underlyingly /h/, /w/, or /N/ in ChN are not regularly transcribed in Beller and Beller (1979). The data in (100) show examples from their grammar of Huauhtla Nahuatl with comparable forms from ChN. The forms given from Chicontepec do not reflect phrase-final glottalization effects.

100)	Huauhtla Nahuatl (Beller & Beller 1979)	Chicontepec Nahuatl
	a. i͡ts-tok-eh miak tosa-meh ipan no-mila ‘there are many moles in my field.’ p. 215	b. [nomilah]
	c. a͡tʃi tomi ‘little money’ p. 250	d. [tomih]
	e. ni-motlaloh-ki asta mo-t͡ʃa ‘I ran to your house.’ p. 243	f. [mo͡tʃah]
	g. ma wala ‘have him come’ p. 224	h. [walah]
	i. no-ma ‘my hand’ p. 243	j. [nomah]
	k. no-pah-wi ‘my medicine’ p. 241	l. [nopahwi]

The forms in (100a) show word-final /h/ (e.g. [i͡stokeh] ‘there are’ and [tosameh] ‘moles’) except in phrase-final contexts. In (100c) and (100e) the expected [h] of a word-final nasal sound is also omitted. Similarly (100g) and (100i) are transcribed without the expected [h] from a coda /w/. As (100k) shows the possessed marker /-w(i)/ occurs after a C-final root /pah/ ‘medicine’ in Huauhtla Nahuatl. However, is not transcribed in (100i), where the final /-w/ is expected, at least based on the forms in Chicontepec Nahuatl. Other transcriptions from Beller and Beller (1979) show that final [h] in forms such as these are indeed present, and so it is not the case that they simply do not occur in Huauhtla Nahuatl:

101) Huauhtla Nahuatl (Beller & Beller 1979)	Chicontepec Nahuatl
a. ma ti-ja-kah 'let's go.' p. 224	b. [ma tijakah]
c. ki-pija miak tomin 'He has a lot of money' p. 274	d. [tomih]

As the forms in (101) suggest, it is likely that the realization of [h] in phrase-final position is variable in Huauhtla Nahuatl because of interactions with phrase-final glottalization. The transcriptions in (100), could then be posited to reflect *cancellation* as I analyzed for Orizaba Nahuatl above.

The data transcribed for Class III verbs suggest an *overwriting* outcome is also possible in Huauhtla Nahuatl. Recall that in ChN, class III verbs, those ending in [oa] or [ia] have two to three possible preterit forms involving stem alternation and the past tense suffix [-ki]. For example a verb like [t͡ʃoloa] 'it flees' can be realized as [t͡ʃolohki]~[t͡ʃoloh]~[t͡ʃołki] 'it fled'. In the description of Huauhtla Nahuatl, Beller and Beller (1979) discuss an alternation that looks like *overwriting* in favor of glottalization: in forms in which no preterit suffix is used, there is a final glottal stop.[84] If the preterit marker is used, then the expected [h] surfaces. The data in (102) show this distribution with comparable forms in ChN.

[84] In fact I interpret a phonological rule described on p. 205 in which final "w and y" surface as glottal stops word-finally (Beller & Beller 1979) as describing overwriting in this morphological context. These are Class 3 verbs that end in [oa] and [ia] in ChN, analyzed in Huautla as [ija] and [owa], which in ChN, at least, alternate with [h]-final allomorphs. The sole example of this process is ki-ilwija 'he says it' and ki-ilwiʔ 'he said it'—compare with the ChN forms: [kiʔihɬia] [kiʔihlih(ki)]

102) Huauhtla Nahuatl (Beller & Beller 1979, pp. 276-277)	Chicontepec Nahuatl
a. ki-mik-tija’ ‘He kills it.’	b. [kimiktia]
c. ki-mik-ti’ ‘He killed it.’	d. [kimiktih]
e. ki-mik-tih-ki ‘He killed it.’	f. [kimiktihki]
g. ki-ihtowa’ ‘He said it.’	h. [kiʔihtoa]
i. ki-ihto’ ‘He said it.’	j. [kiʔihtoh]
k. ki-ihtoh-ki ‘He said it.’	l. [kiʔihtohki]

As the examples in (102) show, the expected [h] that is part of the stem alternant associated with the preterit construction is absent, or realized as a [ʔ], unless co-occurring with the preterit suffix. If this is thought of as reflecting *overwriting* in a stacking context, the forms in (102c) and (102i) reflect the glottalization overwriting the final glottal fricative of the Class III preterit stem alternant. The forms in (102e) and (102k) represent the final glottal fricative of the Class III preterit stem surfacing because it is not subject to phrase-final glottalization since it is in a sense “protected” from a stacked context by the preterit suffix. Taken together, the data in (100)-(102) suggest that either there are multiple possible

(The form in ChN seems to reflect metathesis: /ilwia/ in other varieties can be analyzed as /iwlia/ and surfaces as [ihlia]~[ihɬia]).

outcomes for a stacking outcome, as was shown for ChN, or perhaps overwriting and cancellation are domain specific: overwriting in Huauhtla targets final [h] involved in suppletive allomorphy.

This may not be the only case of *overwriting*. Valiñas (2013) says that there is only one case of word-final [h] in Tuxpan Nahuatl, but that it appears to be a glottal stop.[85] It is possible that the distribution Valiñas describes is overwriting of the final /h/ with phrase-final glottalization. It should be noted that there is no mention of anything else that would suggest a phrase-final glottal stop in Tuxpan Nahuatl.

The stacking outcomes of final [h] and phrase-final glottalization discussed here are summarized in Table 18. These patterns were also observed in ChN; however, the most robust pattern, *sequential realization,* is absent from these descriptions.

Table 18 Analysis of phrase-final effects

	Original analysis	Proposed Stacking Interaction
Cancellation Orizaba, Huauhtla	Vh]→V] V] →V?]	Vh]$^{?}$→[V] V]$^{?}$→[V?]
Near Cancellation Zitlala	Vh]→V^{h}] V] →V?]	Vh]$^{?}$→[V^{h}] V]$^{?}$→[V?]
Overwriting Huauhtla, Tuxpan	Vh]→V?]	Vh]$^{?}$→[V?]

[85] "La fricativa glotal h sólo aparece en posición media formando grupos consonánticos. Ejemplo, mocihcal `tu saliva'. Hay un único caso de h final, pero parece ser un saltillo." (p.47)

5.6 Summary

In ChN, there is a phonemic contrastive /h/ and some degree of prosodic glottalization. This is also the most widespread pattern for laryngeals among varieties surveyed here. The majority of varieties surveyed here have one phonemic laryngeal, a cognate of the *saltillo* of Classical/Urban Nahuatl. Where there is evidence of phrasal-final glottalization, all descriptions describe a vowel-final context, which in ChN is where we find the most salient realization of phrase-final glottalization. Unlike what was found in Ch. 3 for ChN, there are no descriptions that suggest that phrase-final glottalization is realized on consonant-final words, except for the contrastive /h/ (and /N/ and /w/ in Huauhtla) interacting with phrase-final glottalization interactions described abovei.e., Zitlala, Orizaba and Tuxpan Nahuatls. When there is evidence that there is a stacking interaction, the data and descriptions suggest the possibility of *cancellation* or *overwriting* outcomes. There is also no evidence that phrase-final glottalization is realized sequentially as glottalization of the final vowel or antipenultimate vowel, as was found in Ch. 3. However, given the widespread reports of a phrase-final glottal stop and the fact that, in at least one variety both /h/ and /ʔ/ neutralize to creaky voice in coda position (Cuentepec Nahuatl, Patiño 2014), it highly likely that suprasegment-like behavior or phrase-final glottalization is present in other varieties. It is also possible however that other phonological patterns may be at play in these varieties. Future work on other varieties looking at these possible loci of laryngeal interaction is merited.

Chapter 6 Conclusion

In this dissertation I use original data collected through fieldwork to demonstrate that laryngeal articulations arise from distinct domains of the grammar of Chicontepec Nahuatl. I am reminded of a comment made by Sawyer (1981) on the grammatical complexities that result from the use of [ʔ] and [h] in Wappo, an indigenous language of California: "Wappo…uses the glottal stop and voiceless h to an extent that is surprisingly beyond the level of usage that one would expect of sounds that are generally low in amplitude" (p. 146). It is surprising that laryngeals would have so many functions with complex interactions in a system like Chicontepec Nahuatl, especially given that [h] is mostly limited to the coda position, a perceptually weak position (Silverman 1995/1997). This is even more surprising, given that several lenition processes were shown to neutralize contrasts to this sound in this perceptually weak position. It is hoped that the data and analyses presented in this dissertation contribute to our understanding of how a constellation of laryngeal articulations and contrast neutraliztion can function within a larger system.

In Chapter 3, I provided a phonological analysis of laryngeal sounds in Chicontepec Nahuatl. I began the chapter with a general phonological sketch with a description of the contrastive sounds in the language and an analysis of syllable structure and stress. I then provided a description of phonemic /h/ and its distribution in the language, with an analysis of the templatic and realizational morphological processes in which it occurs. I then discussed three processes of lenition that result in debuccalization. These debuccalization processes result in glottal fricatives that neutralize the contrast between /h/ and /n/, /m/, /w/, /k/, and /k^w/. I then demonstrated three patterns of glottalization. Glottalization sensitive to

morphological boundaries that occurs at the left edge can be subdivided into two general environments that partially overlap: glottalization at the prefix-stem boundary, and in stem-stem boundaries in hiatus contexts. No glottalization in the stem-suffix, nor in the prefix-prefix boundaries is attested. A second type of glottalization shown is associated with pre-pausal contexts, both utterance-medially and utterance-finally. I argued that this glottalization is distinct from processes such as phrase-final creak and is better analyzed as phrase-final glottalization which marks phrase-final boundaries.

This phrasal glottalization was then used to address the question of grammatical domain interaction as phrase-final glottalization can align with word-final glottal fricatives that belong to different domains of the grammar. In Chapter 4 I investigated these "stacking" contexts in a phonetic study looking at the outcomes of cooccurring specifications for laryngeal abduction and adduction. While findings from these studies were not as categorical as expected, there were still effects by underlying representation and by cost of reduction. Findings from this study showed that there is a difference between the realization of glottalization by underlying representation: [ʔ] is realized more strongly when co-occurring with an underived [h], than one derived in the lexical phonology. Findings also show that there is also an effect by cost of reduction to unique meaning: overt glottalization is less likely to occur when [h] has a high cost of reduction to unique meaning.

I discuss two models of laryngeal abduction and adduction and the types of predictions that can be made for the outcome of a stacked laryngeal context. I argue that the distribution of [h] and glottalization and their timing in stacked contexts in ChN are such that one sole laryngeal dimension of glottal spreading-constriction, as in Ladefoged's (1971) *continuum model,* or just Valve 1 in Edmondon & Esling's (2005) *valves model,* is

sufficiently descriptive. There is no evidence of simultaneous realization, a realization that would support appealing to more than one dimension (cf. Garellek 2014). Finally, I argue that phrase-final glottalization is best characterized as a [+constricted glottis] suprasegment ([ˀ]), because it moves inward from the phrasal edge to the nearest available anchor point when the expected phrase-final vowel is voiceless—a behavior documented for edge tones but not previously for laryngeal articulations.

In Chapter 5 I situate the findings on laryngeal articulations in Chicontepec Nahuatl with a survey of the literature on other Nahuatl varieties. I show that, despite limited acoustic detail in the existing descriptions, the patterns presented for ChN are similar to phenomena found in some these other varieties. Moreover, it is likely that laryngeal stacking is present in many of the other varieties of Nahuatl.

This dissertation has demonstrated that laryngeal articulations of abduction and adduction can be analyzed analogously to manipulations of pitch (a different type of laryngeal articulation), which is relevant to other languages of the Americas, as many are laryngeally rich (Avelino et al. 2016). I established the presence of a constricted-glottis suprasegment in ChN that merits further analysis, especially as it relates to intonational phrasal structure and other lower prosodic units, such as phonological phrases. For the outcomes of stacking contexts, electroglottographic studies complemented by ultrasound studies might illuminate overlapping presence of glottal spreading and constriction, as well as (for ultrasound) supraglottal activation not evident in the acoustic signal. In addition, finding that glottalization is sensitive to lexical information (both derivational phonology and morphological boundaries) contribute to the larger linguistic program of understanding how different grammatical domains interact, suggesting that postlexical domain can have access

to lexical information. These findings, coupled with the effects from cost of reduction to unique meaning, suggest a more fine-grained study with a larger corpus is merited for disentangling the different types of “high cost” [h] by their grammatical domains.

Finally, as I have described, this variety of Nahuatl is in a close contact situation with Spanish. It has been shown that, in other contact situations, Spanish has been "laryngeally influenced” by the local indigenous language: Yucatan Mexican Spanish (Michnowicz & Kagan 2016) and in Asuncion Paraguayan Spanish (Trawick & Michnowicz 2019). Looking at the Spanish spoken in Chicontepec, Veracruz where there is significant bilingualism could be a worthwhile investigation given the constellation of laryngeal articulations described here and further our understanding of language contact phenomena.

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