The Dissertation Committee for Elizabeth Anne Wood
certifies that this is the approved version of the following dissertation:

Prosodic structure in spontaneous speech: Phrase-final marking, word-initial glottalization and vowel deletion in Chichicastenango K'iche'

Committee:

____
Scott P. Myers, Supervisor

____
Brandon O. Baird

____
Megan J. Crowhurst

____
Daniel Law

Prosodic structure in spontaneous speech: Phrase-final marking, word-initial glottalization and vowel deletion in Chichicastenango K'iche'

by

Elizabeth Anne Wood

Dissertation

Presented to the Faculty of the Graduate School of

The University of Texas at Austin

in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT AUSTIN

May, 2024

To Nora

Acknowledgments

This dissertation was made possible by the support of many people. First and foremost, I want to thank all of the K'iche' speakers in Chichicastenango and Nahualá who housed and fed me, taught me about their culture, and shared their beautiful language with me. Among them, I would especially like to acknowledge Miguel Ignacio, Juana Ventura, Sandra Ignacio, Sebastian Mateo Tiniguar, Gricelda Mateo Jerónimo, Magdalena Jerónimo, Teresa Jerónimo, Juana Tol, Manuel Chicoj, María Xirum, Mildred Mejía, Rafaela Sen, Sonia González, Manuel Tahay, Isabel Tzaj, and Nela Tahay. Sib'alaj maltyox chech alaq, sib'alaj maltyox chiwe!

This dissertation benefited immensely from conversations with many people. My thanks to Brandon Baird, Danny Law, Megan Crowhurst, Ryan Bennett, Robert Henderson, Telma Can, Perry Wong, Sergio Romero, James Tandy, and Justin Royer for sharing your insights. I also appreciate the thoughtful feedback provided on writing and presentations in the Phonetics and Phonology and Documentary and Descriptive Linguistics research groups at UT Austin. Thanks also to Emily Wood, Joanne Wood, and Paige Erin Wheeler for copy editing and catching many typos in earlier drafts of this document.

I also would like to acknowledge the emotional support and good humor of my cohort (from Year 1 Most Fun to the terrifying Year 7!), the West cubicles, and my family.

I am grateful for financial support from the University of Texas at Austin Graduate School and College of Liberal Arts, Foreign Language and Area Studies Summer Fellowship, Carlota Smith Fellowship, Sherzer Research Fellowship, Jacobs Research Funds, Tinker Field Research Grant, and National Science Foundation Graduate Research Fellowship Program. This material is based upon work supported by the National Science Foundation under Grant No. 000392968. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.

Finally, I owe an enormous debt of gratitude to four people. Paige Erin Wheeler and Mackenzie Walters kept me sane through a pandemic and writing a whole dissertation. Scott Myers advised me through nearly every aspect of the research, from planning and funding applications to data processing, analysis, and writing. Nora England made me into a Mayanist and sent me off to Chichicastenango to figure out what was going on with those funky vowels. Nora - I wish you could have been here to see the final product.

Prosodic structure in spontaneous speech: Phrase-final marking, word-initial glottalization and vowel deletion in Chichicastenango K'iche'

Publication No. ____________

Elizabeth Anne Wood, Ph.D.
The University of Texas at Austin, 2024

Supervisor: Scott P. Myers

Linguistic work, especially on understudied languages, is often primarily based on elicited data. This may reveal a different picture of the language than spontaneous speech, which can be highly variable and complex. This dissertation explores three aspects of the prosody of Chichicastenango K'iche' in a corpus of spontaneous narratives. An investigation of phrase-final/phrase-medial alternations in verbal suffixes and their correlation with clause boundaries and IP-final boundary tones shows that this alternation is sensitive to both intonational phrase position and word-level consonant cluster phonotactics. The complex relationship between syntactic and prosodic structure results in multiple optional surface forms in particular contexts. The exploration of vowel-initial words and voice quality uses both acoustic and (morpho)phonological evidence to show that glottal stops are epenthesized on words that otherwise begin with stressed vowels as well as on words that follow a pause or word ending in a vowel. Other apparently vowel-initial words are truly vowel-initial. Glottalized phonation also occurs at the beginnings of intonational phrases. Finally, the investigation of vowel deletion shows that in contrast to content words, deletion in function words is highly variable. The likelihood of deletion is affected by the quality of the vowel and its surrounding segmental/syllabic context, and the latter effect is mediated by phonological phrase position. These three studies contribute to understanding of the prosodic structure of K'iche' and show how optional patterns surface in spontaneous speech.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

This dissertation uses a corpus of spontaneous narrative speech to address three aspects of the prosody of Chichicastenango K'iche': phrase-final and phrase-medial suffixes, word-initial glottalization, and vowel deletion. The corpus consists of 2 hours and 40 minutes of recorded speech by native speakers from the Chichicastenango area, which were transcribed and translated by the author. The remainder of this chapter provides background information for the three studies. Section 1.1 introduces K'iche' and the Chichicastenango dialect in their historical and social context. Section 1.2 provides some basics of the phonology and prosody of K'iche'. Section 1.3 describes the corpus used for the three studies, including information on its origin and contents. Section 1.4 provides a roadmap to the remainder of the dissertation.

1.1 Language context

1.1.1 Classification and speakers

This dissertation is about K'iche', a Mayan language belonging to the Eastern branch of the family (Campbell 2017). As of the 2018 census, K'iche' was spoken by around 1 million people, located primarily in the northwestern highlands of Guatemala, in the departments of Quiché, Huehuetenango, Quetzaltenango, Retalhuleu, Sololá, Suchitepéquez, and Totonicapán (Instituto Nacional de Estadística 2019). This makes K'iche' one of the most widely spoken Mayan languages.

K'iche' is frequently classified into five broad dialect areas: West, East, Central, North and South (Par Sapón and Can Pixabaj 2000). However, even within each of these dialect areas there may be large differences between the varieties spoken in different towns, which are readily observed by speakers and linguists alike (Romero 2009); this high degree of regional variation is found across the Mayan family (Romero 2017). Linguists usually identify varieties of K'iche' by the town (*municipio*) in which they are spoken (Velleman 2014); e.g., Chichicastenango K'iche', Nahualá K'iche', Totonicapán K'iche', etc. Speakers usually also identify most closely with their town (Can Pixabaj 2017). The variety of K'iche' addressed in this dissertation is that spoken in the town and vicinity of Chichicastenango, which belongs to the Central dialect area. Some other towns included in this dialect area are Santa María Chiquimula, San Antonio Ilotenango and Santa Cruz del Quiché (Par Sapón and Can Pixabaj 2000). Chichicastenango also borders areas where the predominant language is Kaqchikel (Cojtí Ren 2019), a closely related Mayan language also in the K'ichean subgroup (Campbell 2017). Figure 1.1 shows the dialect areas of K'iche', with Chichicastenango represented in olive brown.

In my observation, K'iche' speakers refer to their language as *qach'ab'al* or *qatzij*, meaning 'our language'. Speakers do not usually use the name K'iche' to refer to the language; this term is more often used to refer to the ethnic group or their historic nation. The language and ethnic group are sometimes also spelled *Quiché*, as historically spelled in Spanish; however, this is increasingly avoided by linguists. The word Quiché may also refer to the El Quiché Department or its capital city Santa Cruz del Quiché.

1.1.2 Chichicastenango as a town

Chichicastenango as a *municipio* consists of a larger urban center surrounded by dozens of smaller rural communities referred to in Spanish as *cantones*. The population of the *municipio* of Chichicastenango is predominantly Maya. The town is well known for its large market as well as for Santo Tomás church, the site at which the *Popol Wuj*, a written narrative of history and mythology of the K'iche' people, was found. Like many other Maya communities, Chichicastenango is also known for religious syncretism, as both traditional Mayan spiritual practices and Christianity are widespread and elements of both traditions are combined. There are many traditional ceremonial sites around the town. All of these factors make Chichicastenango a popular tourist destination.

The archeological site of Chi Awär is located within Chichicastenango, in the *cantón*

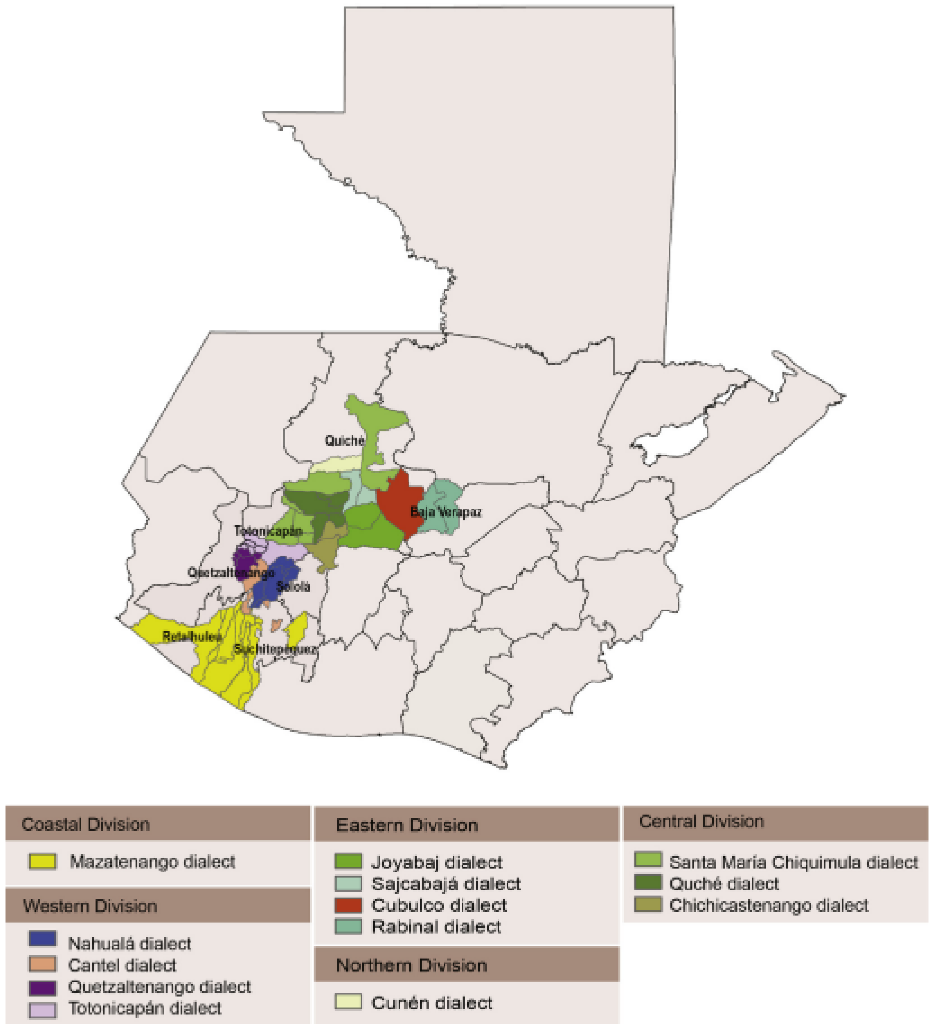
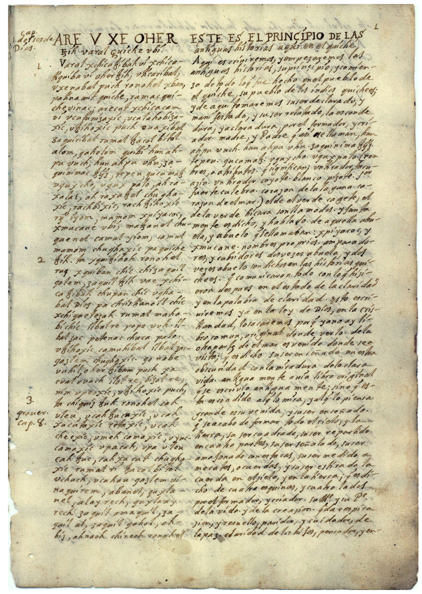


Figure 1.1: K'iche' dialect areas (Romero 2016)

of Chontalá. This site was originally a Kaqchikel settlement, given to the Kaqchikel as a reward for their military service supporting the K'iche' (Cojtí Ren 2019). Cojtí Ren (2019) argues that the Kaqchikel inhabitants of Chi Awär learned to speak K'iche' due to the dominance of the K'iche' in that area, where it was the official language, and that various features of the Chichicastenango dialect of K'iche' can be explained as due to transfer into K'iche' from their L1 Kaqchikel - most notably, the system of tense and lax vowels. Chi Awär was abandoned after a short period of around 70 years when the alliance between K'iche' and Kaqchikel came to an end (Cojtí Ren 2019).

ARE V XE OHER ESTE ES EL PRINCIPIO DE LAS

Figure 1.2: Santo Tomás church and a scan of the first page of the *Popol Wuj*

According to Gruhn (1969), Chichicastenango was founded by Spanish conquerors anxious to move the Quiché population away from their ceremonial centers and destroy their beliefs and customs. The name Chichicastenango comes from Nahuatl, meaning ‘place of the *chichicaste*’, a plant variously translated into English with terms such as ‘bramble bush’ (Bunzel 1952), ‘stinging nettle’ (Christenson n.d.), or ‘nettle sting’ (Cojtí Ren 2019). The K’iche’ name for Chichicastenango is *Chuwila* ‘above the *chichicaste*’, although local people more commonly refer to it as *Chja* ‘at the building’, referring to Santo Tomás Church which is located in the central plaza.

Figure 1.3: A picture of *chichicaste* (Orlandooliva33, CC BY-SA 4.0)

1.1.3 Language contact and shift

In recent years, there have been increased efforts to preserve Indigenous languages in Guatemala, after centuries of attempts to eradicate them. These include the creation of a language academy for each language. The K'iche' academy is located in the town of Santa Cruz del Quiché, relatively close to Chichicastenango.

However, despite these efforts, there is constant pressure for Indigenous people to speak Spanish, and influence of Spanish is readily observed in Indigenous areas. This is particularly notable in Chichicastenango as compared to some other areas as it is less isolated and heavily visited by tourists. Chichicastenango K'iche' is not yet truly endangered, but there is some language shift in process. Although many children in the area continue to learn and use K'iche', others prefer to use Spanish, and many parents choose to speak to their children in Spanish. Local schooling is in Spanish, and the few K'iche' classes teach a standardized version of the language which differs considerably from the local variant. Although there remain some functionally monolingual K'iche' speakers, in particular older women who never underwent formal education, the majority of the population is bilingual in K'iche' and Spanish, with some younger people being monolingual in Spanish or retaining only passive knowledge of K'iche'. In K'iche', many Spanish loanwords and frequent code-switching are observed in the daily speech of people of all ages, including those with limited Spanish proficiency. Some examples are shown in 1, with Spanish-origin words in bold. In these examples, and throughout the document, blue text indicates that the example can be listened to by clicking on the orthographic tier and the audio is included in the supplementary files to this dissertation.

(1) a. ***Farmasia*** *kïnchkün wï.*

faɾmasia	k-∅-ɪn-ʧ(ə)kʊn-∅	wɪ
pharmacy	INCPL-B:3SG-A:1SGL-work-SS:M	PP.TRACE

'I work in Pharmacy.' (talentos, 00:43)

b. *...**porke** ju ma xib'äl ju chköp.*

poɾke	χu	ma	ʃiɓəl	χu	ʧ(ɪ)kɔp
because	DET	AUG	big	DET	animal

'...because the animal was very big.' (kot, 01:23)

c. ***Dia mierkoles** ju **or orasion** käq-ij che.*

dia	mieɾkoles	χu	ʔoɾ	oɾasion	kə-∅-q(ə)-ɓiχ	ʧ-e
day	Wednesday	DET	hour	prayer	INCPL-B:3SG-A:1PL-say	PREP-REL.NOUN

'On Wednesday, a prayer hour we call it.' (church, 07:26)

d. ***Komo** k'ö ch **unos kinientos anyo** le' k'ölïk.*

komo	k'ɔ	ʧ(ɪ)	unos	kinientos	ʔaɲo	leʔ	k'ɔl-ɪk
like	EXIST	already	DET	five.hundred	year	DEM	EXIST-SS:F

'Like some five hundred years ago.' (mr, 01:32)

Some of these loanwords are adopted for new concepts introduced at or after contact with colonizers, such as days and months of the western calendar or terms specific to Christian religious practices. Others however are replacing available native resources, as in *porke* instead of *rmal* 'because', *or* instead of *rmaj* 'hour', or Spanish numbers instead of the fully productive K'iche' numeral system.

1.2 Some basics of K'iche' phonology

The following sections review some background on K'iche' phonology and prosody which will be helpful in understanding the studies presented in the later chapters.

1.2.1 Phoneme inventory

1.2.1.1 Consonants

The consonant inventory of K'iche' is shown in Table 1.1 (Can Pixabaj 2017). Where different from IPA, the orthographic symbol used for each sound is included in angle brackets.[1] In addition to these phonemes, some Spanish loanwords include Spanish sounds such as voiced stops.

	Bilabial	Alveolar	Postalveolar	Palatal	Velar	Uvular	Glottal
Plain stop	p	t			k	q	ʔ <’>
Ejective stop		t’			k’	q’	
Implosive	ɓ <b’>						
Plain affricate		ʦ <tz>	ʧ <ch>				
Ejective affricate		ʦ’ <tz’>	ʧ’ <ch’>				
Fricative		s	ʃ <x>			χ <j>	
Nasal	m	n					
Approximant	w	ɾ <r>		j <y>			
Lateral		l					

Table 1.1: Consonant inventory of K’iche’

1.2.1.2 Vowels

The vowel inventory of K’iche’ varies considerably by dialect. Most dialects have a contrast between long and short vowels, for a total of ten contrastive vowels: /i iː u uː e eː o oː a aː/. The dialects spoken in Cantel and parts of Totonicapán have lost the historic length contrast for all vowel pairs except for the central ones, which primarily contrast in quality; this results in an inventory of six vowels: /i u e o a ə/ (Baird 2018). The Chichicastenango dialect, the focus of this dissertation, replaced the length contrast with one of quality, resulting in a contrast between what have been called ‘tense’ and ‘lax’ vowels in the Mayan literature (Bennett 2016a; England and Baird 2017) The tense vowels /a e i o u/ are phonetically more peripheral than the lax vowels /ə ɛ ɪ ɔ ʊ/, which occur closer to the center of the vowel space (Wood 2020). The vowels of Chichicastenango K’iche’ are shown in Figure 1.4. The tense vowels, in blue, occupy the periphery of the vowel space, while the lax vowels, in red, fill the center.

[1] K’iche’ words throughout this document are written in the orthography standardized by the *Academia de Lenguas Mayas de Guatemala* (“Academy of Mayan Languages of Guatemala”) in 1987, by Decree 1046-87 (López Ixcoy 1997). The exception is that when a plain stop is immediately followed by a glottal stop, the glottal stop is indicated in the orthography with a hyphen rather than an apostrophe, in order to not be confused with an ejective stop, e.g. *käq-änö* [kəqʔənɔ] ‘we do it’.

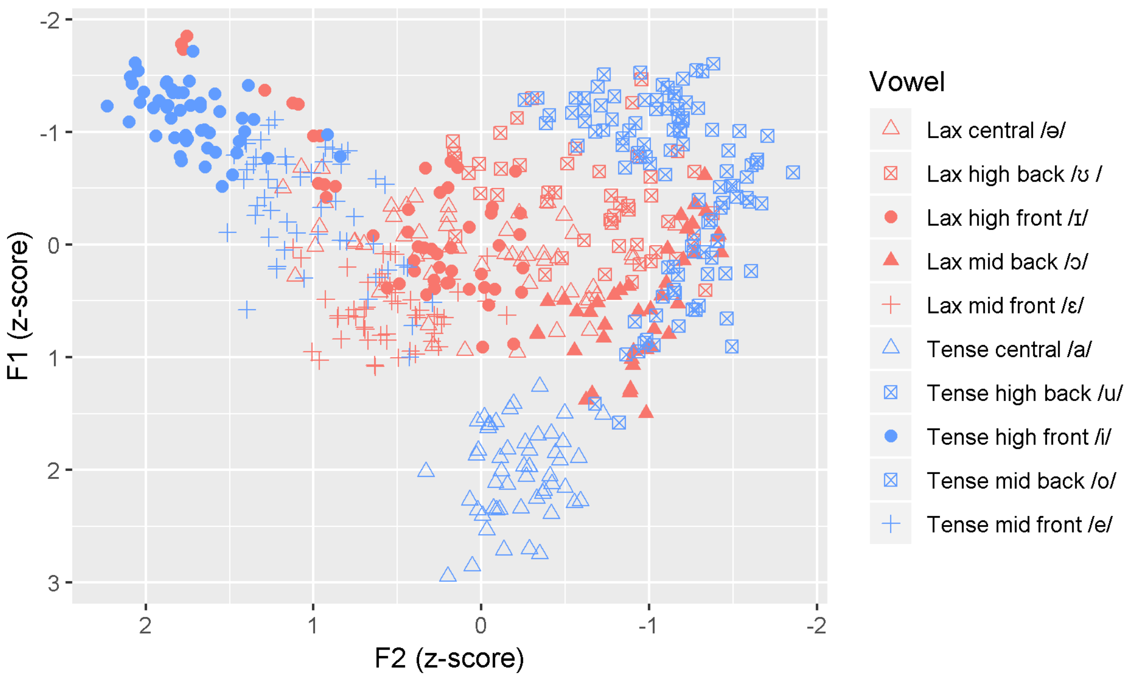


Figure 1.4: Chichicastenango K'iche' vowels

Examples of each of the vowel phonemes are shown in Table 1.2.

	Vowel	Orthography	IPA	Gloss	Data source
Tense	a	*chaj*	ʧaχ	'ashes'	healing, 08:52
	e	*lej*	leχ	'tortilla'	cooking, 03:28
	i	*tzij*	tsiχ	'language'	kot, 02:33
	o	*oj*	ʔoχ	'avocado'	healing, 11:04
	u	*tuj*	tuχ	'temascal'	tri, 01:04
Lax	ə	*chäj*	ʧəχ	'pine tree'	healing, 10:55
	ɛ	*q'ëq*	q'ɛq	'black'	3recipes, 00:50
	ɪ	*pïx*	pɪʃ	'tomato'	cooking, 03:01
	ɔ	*ch'ök*	ʧ'ɔk	'crow'	lxe, 06:34
	ʊ	*k'üch*	k'ʊʧ	'vulture'	tri 00:48

Table 1.2: Examples of the vowel phonemes of Chichicastenango K'iche'

Counter to previous descriptions (López Ixcoy 1994; López Ixcoy 1997; Par Sapón and Can Pixabaj 2000), tense and lax vowel pairs are contrastive in nearly all positions in Chichicastenango K'iche', not just word-final (stressed) syllables. However, the contrast is neutralized in unstressed, word-initial, onsetless syllables, where all vowels surface as tense. This is discussed further in Chapter 3. Examples of words with tense and lax vowels in non-final, unstressed syllables are shown in Table 1.3.

Quality	Orthography	IPA	Gloss	Data source
Tense	*kapraj*	kap.ˈɾaχ	'cloth'	planting, 13:02
	meb'il	me.ˈɓil	'livestock'	history, 01:39
	tikö'n	ti.ˈkɔʔn	'plant'	history, 01:41
	kotz'ï'j	ko.ˈts'ɪʔχ	'flower'	changes2, 02:22
	tukur	tu.ˈkuɾ	'owl'	owl, 00:33
Lax	*wächb'äl*	wətʃ.ˈɓəl	'image'	history, 02:55
	këb'rqän	kɛɓ.ˈɾqən	'earthquake'	earthquake 00:06
	tïnmït	tɪn.ˈmɪt	'town'	planting 00:05
	köjnel	kɔχ.ˈnel	'believer'	lifetjl 07:52
	kümb'äl	kʊn.ˈɓəl	'medicine'	talentos 01:40

Table 1.3: Tense and lax vowels in non-final, unstressed syllables in Chichicastenango K'iche'

1.2.2 Phonotactics

In Chichicastenango K'iche', clusters of up to four consonants are attested in word-initial and word-medial positions. These clusters are very frequent in the language, and there are no restrictions that I am aware of on the segments involved. Examples are shown in Table 1.4.

Orthography	IPA	Gloss	Data source
kkb'änö	**kkɓ**ənɔ	'they do it'	history, 01:55
ki'ktmal	ki**ʔktm**al	'happiness'	mushrooms, 08:35
njnab'	**nχn**aɓ	'my years'	mr, 08:28
k'äslmal	k'ə**slm**al	'life'	marriage, 10:36
chköp	**ʧk**ɔp	'animal'	kot, 00:25
tlül	**tl**ʊl	'sapote fruit'	mr, 14:54
xkämsxïk	ʃkə**msʃ**ɪk	'he was killed'	church, 04:52
wnäq	**wn**əq	'person'	history, 00:39
nk'laj	**nk'l**aχ	'my partner'	mr, 034:51
k-ix	**kʔ**iʃ	'it is said'	3recipes, 05:16
jattk'äl	ja**ttk'**əl	'go sit down!'	mr, 14:47
ub'äntjïk	uɓə**ntχ**ɪk	'its doing'	history, 10:41
kälk'wal	kə**lk'w**al	'their children'	marriage, 10:23
na'tsb'äl	na**ʔtsɓ**əl	'reminder'	church, 05:19

Table 1.4: Word-initial and word-medial consonant clusters in Chichicastenango K'iche'

In word-final position, however, consonant clusters are highly restricted. The only types of clusters that are found regularly across word classes are those composed of a glottal stop followed by another consonant. Examples include *pö't* [pɔʔt] 'blouse' (history, 10:20), *xtzë'n* [ʃtsɛʔn] 'he laughed' (fishing, 07:13) and *kotz'ï'j* [kots'ɪʔχ] 'flower' (changes2, 02:22). These types of clusters occur as an exceptional type of consonant cluster across the Mayan family, and it is debated whether they are best understood as containing a glottal stop consonant or rather a glottalization feature on the preceding vowel (Baird 2011; Bennett 2016b).

Clusters of a glide followed by another consonant are also attested in word-final position, but only in a small number of verb stems, such as *xik'iyr* [ʃik'ijɾ] 'they grew' (history, 03:23) or *xöjkown* [ʃɔχkown] 'we were able to' (church, 01:39). Finally, word-final consonant clusters are found in some recent Spanish loanwords, such as *b'elt* [ɓelt] (3recipes, 08:01) from Spanish *vuelta* [buelta] 'time, round' or *entons* [entons] (mxm4, 04:50) from Spanish *entonces* [entonses] 'then'. These same words are often produced with deletion of the first consonant in the cluster, as in *b'et* [ɓet] (history, 06:09) and *tos* [tos] (church, 01:26).

1.2.3 Prosody

1.2.3.1 Stress

In Chichicastenango K'iche' there is a distinction between stressed and unstressed syllables which has consequences for the phonology. Vowels are not deleted in stressed syllables, and word-initial unstressed vowels always surface as tense. The difference between stressed and unstressed syllables has yet to be studied acoustically, but based on my observation stressed syllables are typically longer and often occur with higher pitch than unstressed syllables.[2]

In non-verb word classes, stress occurs on the final syllable of the word (Wood 2020). Examples are shown in Table 1.5.

Orthography	IPA	Gloss	Data source
chanim	ʧa.ˈnim	'now'	kot, 00:02
wächb'äl	wəʧ.ˈɓəl	'image'	history, 02:55
meb'il	me.ˈɓil	'livestock'	history, 01:39
wakäx	wa.ˈkəʃ	'cow'	cooking, 03:06

Table 1.5: Stress in non-verbs in Chichicastenango K'iche'

In verbs, stress is weight-sensitive and does not always fall on the final syllable. The stress domain excludes inflectional morphemes: person, aspect, and incorporated movement prefixes as well as intransitive and plain transitive status suffixes (see Chapter 2 for information on status suffixes). Stress occurs on the leftmost syllable of the heaviest type available within the verb, or on the rightmost syllable when there are no heavy syllables (Wood 2020). Syllables with tense vowels and those that are closed are heavy, with tense vowels in open syllables being heavier than lax vowels in closed syllables. This results in a four-level hierarchy, shown as follows, where the stress domain is indicated in square brackets. Stress will fall:[3]

[2]The only phonetic study of stress in K'iche' shows that stressed syllables occur with significantly higher F0 in the Nahualá, Zunil, and Cantel dialects of the language, as well as longer duration in the Cantel dialect (Baird 2014a).

[3]In examples throughout this document, vowels that are deleted in the surface form but present underlyingly are marked in parentheses.

- On the left-most tense vowel in a closed syllable, if available (as in 2):[4]

(2) a. *Käqmub'a'.*
kə.q(ə).[mu.ˈɓaʔ]
kə-∅-qə-mu-ɓaʔ
INCPL-B:3SG-A:1PL-soak-CAUS.POS
'We soak it.' (3recipes, 05:32)

b. *Kwa'ktïk.*
k[ˈwaʔ.k(ə).t]ɪk
k-∅-waʔkət-ɪk
INCPL-B:3SG-wander-SS:F
'He wanders around.' (mr, 12:28)

c. *Xuchpa'.*
ʃu.[ʧ(ə).ˈpaʔ]
ʃ-∅-u-ʧəp-aʔ
CPL-B:3SG-A:3SG-catch-SS:F
'He caught it.' (mr, 14:30)

- Otherwise, on the left-most tense vowel in an open syllable, if available (as in 3):

(3) a. *Kasipäj.*
ka.[ˈsi.pəχ]
k-∅-a-sip-ə-χ
INCPL-B:3SG-A:2SG-gift-TV-ACT
'You gift it.' (fishing, 09:02)

[4] Very few verbs contain multiple tense vowels within the stress domain. I have only found this one example. Due to a lack of suitable data, it is also not possible to tell whether the stress domain is bounded or unbounded, as verbs of more than a few syllables are rare.

b. *Chawesäj.*
ʧa.w[ˈe.səχ]
ʧ-∅-aw-e-sə-χ
IMP-B:3SG-A:2SG-leave-CAUS-ACT
'Remove it!' (marriage, 08:45)

c. *Xchomrïk.*
ʃ[ˈʧo.m(ə).ɾ]ɪk
ʃ-∅-ʧom-əɾ-ɪk
CPL-B:3SG-fat-VER-SS:F
'He became fat.' (tjl2, 02:11)

d. *Ktäkmayïk.*
k[tək.ˈma.j]ɪk
k-∅-tək-maj-ɪk
INCPL-B:3SG-walk-AFF-SS:F
'He limps.' (mcx3, 36:18)

- Otherwise, on the left-most lax vowel in a closed syllable, if available (as in 4):

(4) a. *Käqpq'öwsäj.*
kə.q(ə).[p(ɔ).ˈq'ɔw.səχ]
kə-∅-qə-pɔq'ɔw-sə-χ
INCPL-B:3SG-A:1PL-boil-CAUS-ACT
'We boil it.' (3recipes, 03:49)

b. *Ktzäktïk.*
k[ˈʦək.t(ə).(χ)]ɪk
k-∅-ʦək-təχ-ɪk
INCPL-B:3SG-cook-PASS.C-SS:F
'It is fully cooked.' (3recipes, 07:07)

c. *Kach'äjb'ëj.*
ka.[ˈʧəχ.ɓɛχ]
k-∅-a-ʧəχ-ɓɛ-χ
INCPL-B:3SG-A:2SG-wash-INSTR-ACT
'You use it to wash.' (healing, 00:46)

d. *Xkämsxïk.*
ʃ[ˈkəm.s(ə).ʃ]ɪk
ʃ-∅-kəm-sə-ʃ-ɪk
CPL-B:3SG-die-CAUS-PASS-SS:F
'He was killed.' (church, 04:52)

- Otherwise, on the final syllable (as in 5):

(5) a. *Kïnchkünïk.*
kɪn.[ʧ(ə).ˈkʊ.n]ɪk
k-ɪn-ʧək-ʊ-n-ɪk
INCPL-B:1SG-work-TV-ANT-SS:F
'I work.' (talentos, 01:01)

b. *Xchq'ïjïk.*
ʃ[ʧ(ə).ˈq'ɪ.χ]ɪk
ʃ-∅-ʧəq'ɪχ-ɪk
CPL-B:3SG-cook-SS:F
'It cooked.' (3recipes, 03:53)

1.2.3.2 Intonation

There is no previous work on intonation in Chichicastenango K'iche', and little work on K'iche' or other Mayan languages more broadly. However, from what I have observed from looking at many examples and pitch tracks while working on the three studies described in this dissertation, I see evidence for two types of pitch movements: small pitch movements on stressed syllables and larger pitch movements at the edges of larger phrases.

Small pitch rises are found on most stressed syllables in the corpus. I identify these as pitch accents associating with the stressed syllables. Because stress is not always word-final in verbs, it is possible to see that these follow the position of stress rather than occurring necessarily on the word-final syllable. An example of a pitch rise associated with a non-final stressed syllable can be seen in the verb *xutz'lib'säj* 'he/she made dirty' in 6 and Figure 1.5.

(6) *Laj ak'al* ***xutz'lib'säj*** *rib' chï xq'ö'l.*

ˈlaχ	a.ˈk'al	ʃu.[ts'(ɪ).ˈliɓ.səχ]	ˈɾiɓ	ʧɪ	ˈʃq'ɔʔl
laχ	ak'al	ʃ-∅-u-ts'ɪl-iɓ-sə-χ	ɾ-iɓ	ʧɪ	ʃq'ɔʔl
little	child	CPL-B:3SG-A:3SG-dirty-VER-CAUS-ACT	A:3SG-REFL	PREP	mud

'The little child got him/herself dirty in the mud.' (mcx2, 20:10)

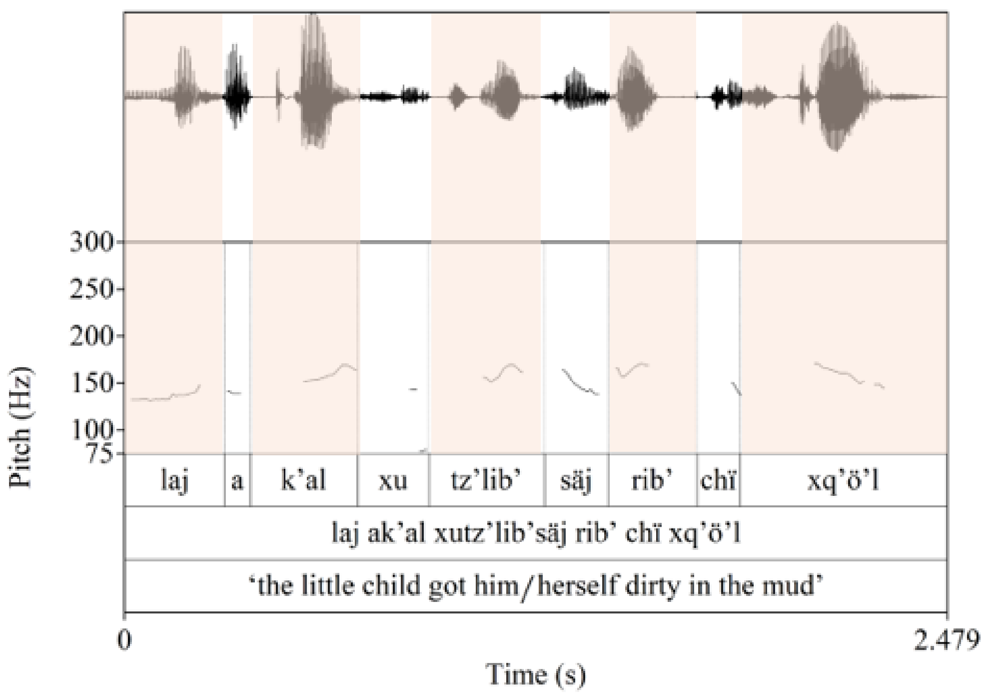


Figure 1.5: A sentence showing a pitch rise associated with the non-final stressed syllable *tz'lib'* in the verb *xutz'lib'säj*

Each of the stressed syllables, highlighted in orange, shows a small rise in pitch, including the stressed but non-final syllable *tz'lib'*.

Additionally, the pitch track of a text can be divided into chunks ending in a larger pitch movement, which is usually high/rising pitch in the corpus of narrative speech, likely reflecting continuing intonation. When the speaker does not intend to continue speaking (e.g. at the end of a text or before a turn change) there is often a lowering of the pitch instead. These large pitch movements tend to occur at the ends of clauses as well as topicalized phrases. In line with previous literature, I identify these pitch movements as boundary tones which mark the ends of intonational phrases (IP) (Nielsen 2005, Henderson 2012, Velleman 2014, Burdin et al. 2015); the exact connection between IP boundaries and boundary tones will be discussed in more detail in Chapter 2. Figure 1.6 shows an example of several boundary tones from the beginning of a text (audio, owl, 00:02).

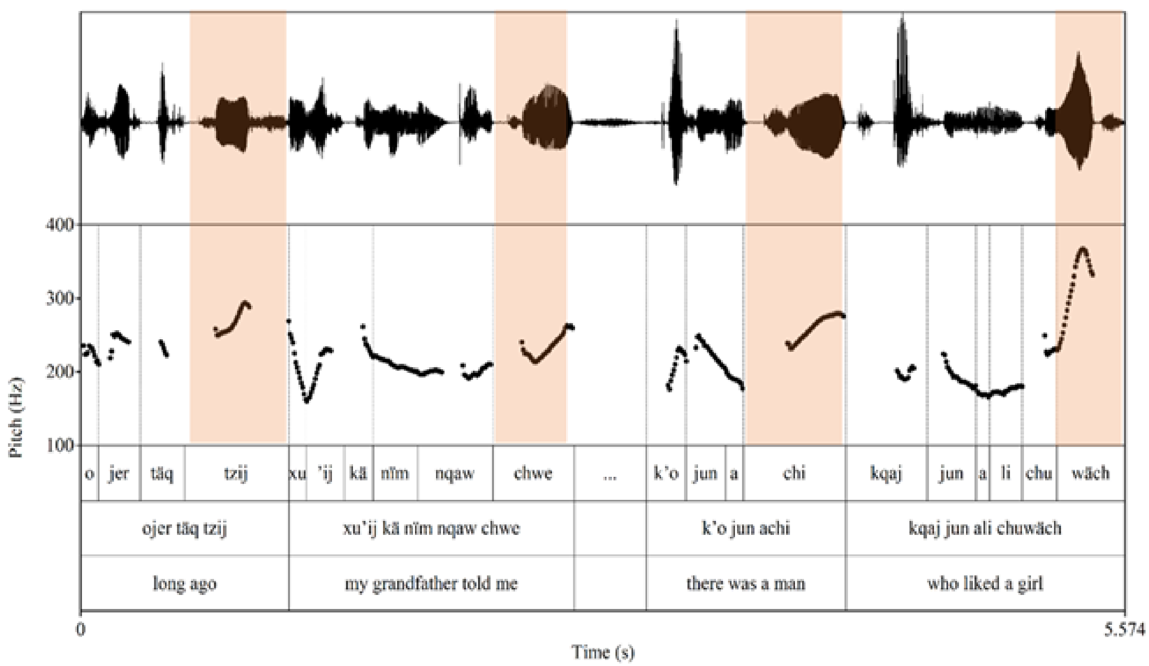


Figure 1.6: A fragment of speech consisting of several intonational phrases marked with highlighted boundary tones

In this fragment of speech, there are many different pitch movements. The pitch rises slightly on many of the stressed syllables, such as *jer* in *ojer* ‘long ago’ and *li* in *ali* ‘girl’. There are also local pitch variations caused by the effects of adjacent consonants, such as the dip in the middle of *xu'ij* ‘he said’ due to the presence of a glottal stop between the vowels. However, the pitch excursions which reach the highest pitch in the context, considerably higher than on any other syllable, are those that occur on the final syllable of each of the four phrases, highlighted in orange: *tzij*, *chwe*, *chi* and *wäch*. The use of a high boundary tone on each of these phrases likely reflects the fact that the speaker intends to continue speaking.

In sum, a preliminary prosodic description of Chichicastenango K'iche' includes the identification of stressed syllables, to which pitch accents are often associated, as well as phrases - referred to in this document as intonational phrases (IP) - which correspond roughly to the level of the clause and end in a high or low boundary tone.

These observations fit into what previous research exists on the intonation of other dialects of K'iche', which has been mostly focused on specific information structural contexts (focus and contrastive topic). Large boundary tones are found to occur at the ends of intonational phrases (Nielsen 2005; Yasavul 2013; Burdin et al. 2015). Nielsen (2005) and Burdin et al. (2015) also note the existence of rising pitch movements at the ends of some lower phrases (accentual phrases and intermediate phrases) in the Cantel dialect and Joyabaj dialect, respectively, though this is difficult to disambiguate from pitch accents on stressed syllables since stress is word-final in these dialects. Yasavul (2013) notes the existence of high pitch accents on stressed syllables in Joyabaj K'iche'.

1.3 A corpus of Chichicastenango K'iche'

The series of studies described in this dissertation use a corpus of spontaneous speech of K'iche' speakers from the Chichicastenango area. This corpus includes recordings of monolingual narrations on a variety of topics, including traditional stories, personal anecdotes, recipes, instructions, local geography, history and mythology, etc. Two male speakers and 10 female speakers are represented, ranging in age from young adults to elders and originating from the city center or nearby rural communities. Basic demographic information about the speakers is shown in Table 1.6.

Initials	Gender	Age	Location
JT	Female	Middle aged	Rural community
LRI	Female	Young adult	Rural community
LXE	Female	Middle aged	City center
MACM	Female	Middle aged	Rural community
MCX	Male	Young adult	City center
MJL	Female	Elder	Rural community
MRT	Male	Elder	Rural communit y
MXM	Female	Middle aged	Rural community
RSI	Female	Young adult	Rural community
SAGB	Female	Young adult	City center
TJL	Female	Middle aged	Rural community
TRI	Female	Young adult	Rural community

Table 1.6: Basic demographic information for the speakers represented in the corpus

The audio recordings were made by the author in 2018 and 2019 using a Zoom Hn4 digital recorder at a sampling rate of 44.1 kHz, using either the internal microphone or (in most cases) connected to a Shure SM10A headset microphone. In total the corpus consists of about two hours and 40 minutes (estimated at roughly 20,000 - 25,000 words).

The audio recordings were transcribed and translated by the author using the program ELAN (Max Planck Institute for Psycholinguistics 2023) with some help from native speakers. The transcription was done in the practical K'iche' orthography, representing tense vowels as plain vowels and lax vowels with diereses. Deleted vowels and word-initial glottal stops are not typically written. Nothing in the corpus was assumed to be an error unless the speaker self-corrected; all non-corrected utterances were taken as grammatical speech. However, there are parts of the corpus where I am unsure of the transcription and there are likely some transcription errors. Therefore, portions of the corpus where I am uncertain of the transcription in a way relevant to the research questions were excluded from the studies, and I feel confident in the reliability of the transcriptions for the purposes of this dissertation.

All of the audio files, transcriptions and translations of this corpus are archived and publicly available in the Archive of the Indigenous Languages of Latin America (AILLA, https://www.ailla.utexas.org/) in the K'iche' Collection of Elizabeth Wood, with the exception of those where the speaker did not grant permission for archiving. Examples throughout this document appear with a code that shows where they can be found in the corpus.

Table 1.7 gives information about the recordings included in the dissertation corpus.

Speaker	Code	Duration	Topic	PID ailla
JT	3recipes	05:36	Recipes	271541
MJL	cooking	04:22	Traditions	271543
	chilmol	01:42	Recipe	271539
	church	09:08	History	271549
	changes1	03:43	History	271536
	changes2	03:34	History	271536
MCX	history	11:06	History	271547
	kot	03:15	Traditional story	271553
	planting	13:55	Traditions	271561
	mushrooms	10:59	Traditions	271559
	fishing	10:43	Personal life	271530
MXM	marriage	10:56	Traditions	271555
	earthquake	02:37	History	271528
MACM	healing	14:44	Traditions	271557
RSI	caldores	01:20	Recipe	271534
	owl	02:09	Traditional story	271526
SAGB	sewing	02:13	Traditions	271563
TJL	semanasanta	02:58	Traditions	271551
	talentos	06:20	Personal life	271545
	atolblanco	02:58	Recipe	271532
TRI	tri	02:46	Traditional story	Unarchived
LRI	dailyactivities	03:00	Personal life	Unarchived
	magicegg	02:15	Traditional story	Unarchived
LXE	lxe	06:00	Traditions and traditional stories	Unarchived
MRT	mr	22:10	History and traditional stories	Unarchived

Table 1.7: Codes and information about each of the recordings that make up the corpus

The dissertation corpus makes up a subset of the full documentary corpus of Chichicastenango K'iche' that has resulted from my fieldwork and collaborations with local speakers since 2018. The full documentary corpus has continued to grow since I began the research presented in this dissertation and now includes an additional 34 texts (4 hours and 10 minutes of audio) by 23 additional speakers. These newer recordings were not included as data in the studies presented in this dissertation, but most of them will be available in the AILLA archival collection and are ready to be used for future projects.

I attempted to provide examples from the dissertation corpus whenever possible in this document. Occasionally, examples are included from the larger documentary corpus or elicitation materials for illustrative purposes. The other recordings referenced in this dissertation are summarized in Table 1.8.

Speaker	Code	Details
DMB	naturalmed	Monologue: traditional natural medicines
EJL	lifeejl	Monologue: the speaker's life and work
MCX	mcx2 mcx3	Elicitation: on words with complex glottal stop codas Elicitation: on verbs
MXM	mxm2 mxm4	Elicitation: on verbs Elicitation: on words with complex glottal stop codas
TJL	tjl2 lifetjl	Elicitation: on polysyllabic words Monologue: the speaker's life and work
TMT	pedida lifetmt	Monologue: traditional marriage proposals Monologue: the speaker's life and work

Table 1.8: Codes and information about each of the additional recordings referenced that are not part of the corpus

Throughout this document, clicking on blue text will play the example. All audio files embedded in this document are also included in the dissertation supplemental files.

1.4 Roadmap

The remainder of this document is organized as follows.

Chapter 2 addresses the distribution of status suffixes, a class of verbal suffixes whose appearance is conditioned by phrasal context. This chapter explores whether the relevant phrasal context which conditions the alternation is syntactic or prosodic as well as the effect of word-final consonant clusters on this alternation. The results show that neither clause-final position nor co-occurrence with a boundary tone are perfectly correlated with the appearance of a phrase-final suffix. A prosodic analysis is proposed in which phrase-final suffixes appear at all intonational phrase boundaries, but boundary tones only at the ends of the highest intonational phrase level in a recursive structure. Overt phrase-final suffixes also appear on verbs in a medial position in order to avoid word-final consonant clusters with the exception of those formed with a glottal stop or glide followed by another consonant.

Chapter 3 explores word-initial glottalization using acoustic and (morpho)phonological data. The acoustic study measures indicators of glottalized phonation in each third of all vowel-initial words in the corpus as well as word-initial full glottal closures. Results show that higher rates of glottalization are found in the first third of the vowel when preceded by a word ending in a vowel or a pause, as well as for words with initial stress, mirroring the results for words preceded by a word ending in a glottalized consonant. These results are consistent with an initial glottal stop segment in these cases. Higher rates of glottalization were also found throughout the whole vowel for words that are in the initial position of an intonational phrase (follow a word with a boundary tone), indicative of an IP-initial boundary marker. The (morpho)phonological data supports the results of the acoustic study, showing that the distinction between words which begin in a stressed vowel (have an initial glottal stop) and those which begin with an unstressed vowel (no initial glottal stop) affects the realization of underlying lax vowels as well as the shortening of certain proclitics. Finally, the distribution of preconsonantal and prevocalic possessive prefixes demonstrates that these initial glottal stops, where present, are epenthetic rather than phonemic.

Chapter 4 addresses vowel deletion, with a focus on function words. In these words, vowel deletion is more likely for lax vowels and those that are in a non-final and non-initial syllable of a syntactic phrase. Deletion is also affected by surrounding segmental and syllabic context, with the highest rates of deletion adjacent to a vowel and the lowest adjacent to a consonant cluster. The effect of segmental context is mediated by phrase position, with the effects being blocked or weakened across phrase boundaries. Each of these factors represent a statistical tendency rather than a fully predictive rule, in contrast to how deletion appears to operate in content words.

Chapter 5 concludes the dissertation, highlighting some of the challenges and benefits of using spontaneous speech as linguistic data and summarizing how the results of the three studies illuminate aspects of the prosodic structure of K'iche'.

Finally, Appendix A lists the abbreviations used in examples throughout this document and Appendix B includes results of the statistical analysis of word-initial voice quality not included in Chapter 3.

Chapter 2

Status suffixes and phrase boundary marking

2.1 Introduction

A variety of phonetic strategies are used cross-linguistically to mark the ends of phrases, including final lengthening (Shattuck-Hufnagel and Turk 1996; Jun 2005; Davidson 2021), pauses (Shattuck-Hufnagel and Turk 1996), tones (Shattuck-Hufnagel and Turk 1996; Jun 2005), pitch reset (Garellek 2013) and creaky phonation (Garellek 2013; Davidson 2021). A number of Mayan languages, especially those in the K'ichean and Q'anjob'alan branches, have a different strategy: a distinction between so-called 'phrase-final' and 'phrase-medial' morphemes (Polian 2017). This contrast is particularly prevalent in the grammar of K'iche', where it includes a large number of different morphemes. The basic contrast between phrase-final and phrase-medial forms is exemplified for a set of verbal suffixes called status suffixes in 7. Here, and throughout this chapter, clause boundaries are marked within [ ]$_{CP}$.

(7) a. ***Kawïl*** *rï pö't.*

[	k-∅-aw-ɪl-∅	ɾɪ	pɔ́ʔt	]$_{CP}$
	INCPL-B:3SG-A:2SG-see-SS:M	DET	blouse	

'You see the blouses.' (kot, 02:23)

b. ***Kawïlö*** *su r kuya r ja'.*

[	k-∅-aw-ɪl-ɔ́
	INCPL-B:3SG-A:2SG-see-SS:F

[	su	ɾ(ɪ)	k-∅-u-ja-∅	ɾ(ɪ)	χáʔ	]$_{CP}$	]$_{CP}$
	what	DET	INCPL-B:3SG-A:3SG-give-SS:M	DET	water		

'You see what the water gives.' (fishing 10:32)

c. ***Kawilö.***

[k-∅-aw-ɪl-ɔ́ $]_{CP}$

INCPL-B:3SG-A:2SG-see-SS:F

‘You see it.’ (planting, 08:21)

The verb in 7a is followed by the object *rï pö’t* ‘the blouses’ within the clause and has a phrase-medial suffix (glossed SS:M). The same verb appears with the phrase-final suffix -ɔ <-*ö*> in 7b where it precedes an embedded clause and in 7c where it is utterance-final (glossed SS:F). The phrase-final suffixes in these examples also correlate with the positions of large high pitch movements (marked with an acute accent), analyzed as boundary tones which fall on the final syllable of an intonational phrase. The verb in 7a does not bear a boundary tone and has a phrase-medial suffix, whereas the verbs in 7b and 7c bear boundary tones on the phrase-final suffix which is their final syllable.

The alternation between phrase-final and phrase-medial forms in other word types is shown in 8 and 9. 8 shows phrase-medial and phrase-final forms of a positional predicate, a word class characteristic of Mayan languages which expresses states, shapes, and physical positions (López Ixcoy 1997; Can Pixabaj 2017). 9 shows the contrast for a directional, a type of particle which indicates the direction of the action expressed by the verb (Zavala Maldonado 1993; López Ixcoy 1997; Can Pixabaj 2017).

(8) a. ***Jë’lik.***

[χɛʔl-ík $]_{CP}$

delicious-SS:F

‘It is delicious.’ (mushrooms, 08:45)

b. ***Jë’l** rï kär rï’.*

[χɛʔl	ɾɪ	kəɾ	ɾíʔ	$]_{CP}$
delicious	DET	fish	DEM	

‘That fish is delicious.’ (fishing, 08:58)

(9) a. *Kkk'äm **löq**.*

[k-∅-k(ɪ)-k'əm-∅	lɔ́-q	]$_{CP}$	
INCPL-B.3SG-A.3PL-take-SS:M	DIR-SS:F		

'They bring it.' (mushrooms, 01:04)

b. *Kkk'äm **lö** r kk'ay.*

[k-∅-k(ɪ)-k'əm-∅	lɔ-∅	ɾ	k(ɪ)-k'áj	]$_{CP}$
INCPL-B.3SG-A.3PL-take-SS:M	DIR-SS:M	DET	A.3PL-merchandise	

'They bring their merchandise.' (history, 00:50)

The positional predicate *jë'lïk* 'delicious' in 8a has the final suffix *-ïk* and is the final element in the phrase, while the corresponding word *jë'l* in 8b has the null medial suffix and is followed by the subject *r kär rï'* 'that fish'. Similarly, the directional particle *löq* 'from there to here' in 9a has the final suffix *-öq* and is the final element, while the corresponding particle *lö* in 9b is followed by the object of the verb and appears with the null medial suffix.

Although the contrast between final and medial morphemes is found in a number of languages across the Mayan family, the literature on most languages notes the existence of phrase-final forms but provides no comment on what phrasal domain conditions the alternation or any apparent exceptions (e.g. Mó Isém 2007, Tuyuc Sucuc 2001, Can Pixabaj 2007). Previous descriptions of K'iche' (Nahualá, Santa Lucía Utatlán and Santa Cruz del Quiché dialects) and Chuj, however, propose two types of analyses: syntactic and prosodic. Earlier studies say that phrase-final morphemes appear preceding clause boundaries (see Mondloch 1981, Larsen 1988, Can Pixabaj and Sis Iboy 2004, Barrett 2007 on K'iche'; Hopkins 2012 on Chuj). Some more recent studies argue that they appear when final in the intonational phrase and coincide with the positions of boundary tones (Henderson 2012 on K'iche'; Royer 2022 on K'iche' and Chuj) or that they appear on the last full prosodic word in an intonational phrase (Tyers and Henderson 2021 on K'iche'). The prosodic proposals further differ in their views on the syntax-prosody interface: Henderson (2012) argues for the existence of certain mismatches between the edges of syntactic and prosodic phrases, where the phrase-final forms align with the prosodic boundaries rather than the syntactic ones, whereas Royer (2022) argues that prosodic and syntactic boundaries are aligned in all of these cases.

Due to the close relationship between syntactic and prosodic boundaries, each of these accounts explains the occurrence of a majority of phrase-final forms. Most verbs either are clause-medial, don't bear a boundary tone, and have a phrase-medial status suffix, or are clause-final, bear a boundary tone, and have a phrase-final status suffix. However, none of the previous accounts accurately explains the full range of contexts in which final forms occur in spontaneous speech in Chichicastenango K'iche'. In addition to the contexts shown previously, phrase-final forms are also attested in a number of other utterance-medial contexts, some of which are shown in 10.

(10) a. *Sabado **köjchkünik** rï'.*

[sabado	k-ɔχ-ʧ(ə)kʊn-ɪk	ɾíʔ	]$_{CP}$
Saturday	INCPL-B:2PL-work-SS:F	DEM	

'On Saturday we work.' (talentos, 06:00)

b. ***Ki'etz'nik** r ak'lab'.*

[k-i-ets'(ə)n-ɪk	ɾ(ɪ)	ak'(ə)l-áɓ	]$_{CP}$
INCPL-B:3PL-play-SS:F	DET	child-PL	

'The children play.' (changes1, 02:36)

c. *Këb'rqän **xu'unö** quk' ojer.*

[kɛɓɾqən	ʃ-∅-u-ɓən-ɔ	q-uk'	oχeɾ	]$_{CP}$
earthquake	CPL-B:3SG-A:3SG-do-SS:F	A:1PL-with	long.ago	

'An earthquake that happened to us long ago.' (earthquake, 00:15)

Phrase-final status suffixes are frequently, but not always, found on verbs preceding demonstrative pronouns (as in 10a), which would be expected to be within the clause, as well as on clearly clause-medial verbs with stem-final consonant clusters (as in 10b). Phrase-final forms are also sometimes attested in apparently fully medial environments where no obvious generalization presents itself as to the cause for the presence of the final form, as in 10c. In each of these examples the verb does not occur with a boundary tone. It is not clear whether these types of examples exist in the dialects of K'iche' previously described in the literature on status suffixes but were not identified in these works, or whether these are constructions specific to the Chichicastenango dialect.

The study described in this chapter is motivated by the observation that phrase-final status suffixes are attested in Chichicastenango K'iche' spontaneous speech in some contexts that do not precede a clause boundary and do not bear a boundary tone. The goal of the study was to describe the full range of contexts in which phrase-final suffixes occur in spontaneous speech, without being tied to specific constructions that I had happened to notice or that had been addressed in previous literature. Special attention is given to two questions. First, whether the occurrence of phrase-final forms better correlates with clause boundaries, as described in many early works on Mayan languages, or intonational phrase boundaries (and specifically boundary tones), as has been argued in more recent works. And second, how word-final consonant clusters of various types affect the status suffix alternation.

The remainder of the chapter is organized as follows. Section 2.2 describes the methods used in the corpus study and Section 2.3 the results. Section 2.3.1 addresses the effect of consonant clusters, showing that only certain types of consonant clusters trigger the use of phrase-final suffixes in medial environments and that underlying consonants not produced in the surface form are active in this process. Section 2.3.2 addresses the effect of clause position, reviewing the syntactic environments where phrase-final and phrase-medial forms occur in the corpus and showing that a subset of the data cannot be explained by this variable. Section 2.3.3 addresses the effect of prosodic position, showing that phrase-final status suffixes frequently occur on verbs without boundary tones when in hierarchical syntactic structures, such as preceding embedded clauses and discourse particles. Section 2.4 discusses the results of the study, arguing that a variable prosodic parsing of the same syntactic structures can account for the variability observed in the data in the positions of status suffixes and boundary tones: phrase-final suffixes appear before all IP boundaries, but boundary tones only appear at the end of the highest IP in a potentially recursive structure. Finally, Section 2.5 summarizes this study's main contributions and concludes the chapter.

2.2 Methods

This study explores the locations of phrase-final and phrase-medial verbal status suffixes in a corpus of spontaneous narratives of the Chichicastenango dialect of K'iche'. The following sections describe the methods used in the study.

2.2.1 Data

The data for this study comes from the corpus of spontaneous narratives described in Section 1.3.

The contrast between phrase-final and phrase-medial forms is found on verbs, positional adjectives, and many function words. This study does not include all instances of positional allomorphy in the corpus, but rather focuses on verbal status suffixes, which are a closed, easily defined class and are very frequent. Status suffixes appear on all verbs except for derived transitive verbs (where a transitive stem is formed through derivational suffixes) and mark the transitivity and mood of the verb stem in addition to its phrase position (Can Pixabaj 2017). There is one irregular intransitive verb, the quotative *cha*, which does not have status suffixes.

All verbs of the classes that have phrase-final and phrase-medial forms were included in the study, with the exception of instances whose correct classification according to any of the experimental groups described below was uncertain. These included verbs whose correct transcription was uncertain, verbs produced with significant hesitations (such as between syllables), verbs which the speaker started to utter but were unfinished, and verbs which were produced immediately before the speaker corrected by restarting the sentence with another verb (a total of 239 exclusions). This left a total of 2772 verbs from the corpus included in the study.

2.2.2 Categorization

Each verb token in the study was classified according to the type of status suffix (phrase-medial or phrase-final). Additionally, each token was coded according to the following factors: final consonant clusters, prosodic position, syntactic position, and speaker.

These categories are explained further as follows.

2.2.2.1 Dependent variable: type of status suffix

Each verb was categorized as having a phrase-final or phrase-medial status suffix, as the primary goal of the study was to observe what environments condition this contrast. In the Chichicastenango dialect of K'iche', the phrase-final status suffixes are -*ïk*, -*öq*, -*ö/ü*, -*a'/o'/u'*. The phrase-medial status suffixes are -*a/o/u* and the null form.[1] These suffixes are shown in Table 2.1.[2]

		Phrase-medial	Phrase-final
Intransitive	Plain	∅	-ɪk <-*ïk*>
	Dependent	∅	-ɔq <-*öq*>
Root transitive	Plain	∅	-ɔ/ʊ <-*ö/ü*>
	Dependent	-o/u/a <-*o/u/a*>	-oʔ/uʔ/aʔ <-*o'/u'/a'*>

Table 2.1: Status suffixes in Chichicastenango K'iche'

As the table shows, so-called 'plain' and 'dependent' verb classes have different status suffixes. The 'dependent' class includes imperative verbs and those with incorporated movement prefixes and the 'plain' class includes all other verbs (Can Pixabaj 2017).[3] This contrast is illustrated in the following two pairs of examples. 11a shows the transitive verb *ch'äj* 'wash' in the plain form, where its status suffix is null. 11b shows the same verb in the imperative, where it has the dependent status suffix -V. These are both phrase-medial verbs.

[1]Following previous work on status suffixes in Mayan languages (Henderson 2012; Royer 2022), I assume that there is a null suffix for phrase-medial intransitives and dependent root transitives, rather than these verbs being unsuffixed and alternating with a suffixed form in phrase-final position. However, nothing in the analysis hinges on this assumption, as the goal is to see what conditions the alternation between the two distinct forms.

[2]The suffix -a found in some other K'iche' dialects on phrase-medial dependent intransitives (Larsen 1988) is absent in Chichicastenango K'iche'.

[3]The term 'dependent' to refer to this class of verbs is not particularly informative, but is standard usage among Mayanists, going back to early work by Terrence Kaufman (e.g. Kaufman 1990).

(11) a. ***Kach'äj*** *alaq.*

[k-∅-a-ʧ'əχ-∅ a-láq]CP

INCPL-B:3SG-A:2SG-wash-SS:M A:2SG-dish

'You wash your dishes.' (cooking, 01:53)

b. ***Chach'ja*** *bien r upam r kär rï'.*

[ʧ-∅-a-ʧ'(ə)χ-a bien ɾ(ɪ) u-pam ɾ(ɪ) kəɾ ɾíʔ

IMP-B:3SG-A:2SG-wash-SS:M well DET A:3SG-stomach DET fish DEM

]CP

'Wash the inside of that fish well!' (fishing, 08:55)

Similarly, 12a shows the transitive verb *ïl* 'see' in the plain form, and the status suffix is *-ö*. The same verb is shown in a construction with the incorporated movement prefix *i-* 'go' in 12b, where it has the status suffix *-a'*. These are both phrase-final verbs.

(12) a. ***Kkïlö***.

[k-∅-k-ɪl-ɔ́]CP

INCPL-B:3SG-A:3PL-see-SS:F

'They see it.' (mushrooms, 10:03)

b. ***Kikla'***.

[k-∅-i-k-(ɪ)l-áʔ]CP

INCPL-B:3SG-INC.MOV-A:3PL-see-SS:F

'They go to see it.' (history, 06:08)

For plain root transitive verbs, the phrase-final suffix is -ʊ for verbs with high back vowels in the root and -ɔ for all other verbs; e.g. *kqpüq'ü* /kqpʊq'ʊ/ 'we knead it' (3recipes, 05:01) with the root /pʊq'/ vs. *kqtïjö* /kqtɪχɔ/ 'we eat it' (mushrooms, 09:48) with the root /tɪχ/. Similarly, the status suffixes for dependent root transitive verbs are phrase-medial -u and phrase-final -uʔ for verbs with high back vowels in root, phrase-medial -o and phrase-final -oʔ for verbs with mid back vowels and phrase-medial -a and phrase-final -aʔ for verbs with any other root vowel, e.g. *kuk'tu* /kuk'(ʊ)tu/ 'he goes to show it' (history, 09:47) with the root /k'ʊt/ vs. *kurqa* /kuɾ(ɪ)qa/ 'he goes to find it' (marriage, 05:37) with the root /ɾɪq/.

2.2.2.2 Independent variables: stem-final consonant clusters, syntactic position, prosodic position, speaker

In addition to the dependent variable of type of status suffix, each verb was categorized according the the following independent variables, each of which might have an effect on the distribution of the phrase-final and phrase-medial forms.

2.2.2.2.1 Stem-final consonant clusters

Over the course of my work on Chichicastenango K'iche', I noticed that verbs with a stem ending in a consonant cluster often occurred with phrase-final status suffixes in medial environments rather than the expected phrase-medial status suffixes. However, this only happened on verbs with null phrase-medial status suffixes, which would cause a stem-final cluster to be word-final.

In Chichicastenango K'iche', only intransitive verbs have the potential to both be of a verb class that has a null phrase-medial suffix and also have a stem-final consonant cluster. This is because plain root transitive verbs never end in consonant clusters (they all have the shape (C)V(C), as in /tɪχ/ 'eat', /ɪl/ 'see', or /ja/ 'give'), and dependent root transitives have no null status suffixes (see Table 2.1). Therefore, individual verbs were categorized as having a final consonant cluster if they were intransitive and had a stem-final cluster in the surface form produced by the speaker. Examples are shown in 13.

(13) a. ***Kesxik*** *kwere.*

[k-∅-e-s(ə)-ʃ-ɪk	k(ɪ)-weré	]$_{CP}$
INCPL-B:3SG-go.out-CAUS-PASS-SS:F	A:3P-tooth	

'Their teeth were removed' (talentos, 05:26)

b. ***Kek'ma*** *b'ï l ali.*

[k-∅-e-k(ɪ)-k'(ə)m-a	ɓɪ	l(e)	alí	]$_{CP}$
INCPL-B:3SG-INC.MOV-A:3PL-take-SS:M	DIR	DET	girl	

'They go to take the girl.' (marriage, 05:59)

The verb *kesxïk* in 13a was included as a verb with a final consonant cluster, because the stem ends in the surface cluster /sχ/ and this is a plain intransitive verb which would be expected to appear with the null phrase-medial status suffix. The verb *kek'ma* in 13b was not included as a verb with a final consonant cluster, because although the stem ends in the surface cluster /k'm/, this is a dependent root transitive verbs where the phrase-medial status suffix is -a, and therefore this consonant cluster can never be word-final no matter which status suffix appears on the verb.

It was expected that verbs with final consonant clusters would appear with phrase-final status suffixes in all cases rather than alternating based on phrase position.

2.2.2.2.2 Syntactic position: clause-final or clause-medial

In order to assess whether the phrase-final/phrase-medial alternation correlates with clause position (Mondloch 1981; Larsen 1988, Can Pixabaj and Sis Iboy 2004; Barrett 2007), verbs were categorized as clause-final or clause-medial. Clause-final verbs are those that occur preceding a clause boundary, and clause-medial verbs those that are followed by additional overt material before the next clause boundary. Each clause contains a finite verb or a non-verbal predicate along with all of its dependent arguments and modifiers, such as subjects, objects, and locative and temporal adjuncts (Can Pixabaj 2015). An example is shown in 14.

(14) *Kuando ya* ***käpq'öwïk, käqya*** *q-aseite.*

[[kuando ja kə-∅-p(ɔ)q'ɔw-ík]CP
when already INCPL-B:3SG-boil-SS:F

kə-∅-q(ə)-ja-∅ q(ə)-aséite]CP
INCPL-B:3SG-A:1PL-give-SS:M A:1PL-oil

'When it is boiling, we add our oil.' (3recipes, 05:49)

This sentence contains two clauses. The embedded clause *kuando ya kpq'öwïk* includes the verb *käpq'öwïk* 'it boils' along with the complementizer *kuando* that introduces it and the temporal/aspectual particle *ya*. The matrix clause includes the verb *käqya* 'we give it' along with its direct object *q-aseite* 'our oil' and the full embedded clause. Here the verb *käpq'öwïk* is clause-final because it occurs immediately before a clause-boundary, while the verb *käqya* is clause-medial because it is not immediately followed by a clause boundary.

Although the majority of the verbs in the data were clearly clause-medial or clause-final, there were a small number of cases where the boundaries of the clause were uncertain, all of which are infrequent constructions in the data. These include verbs preceding vocatives, quotatives, ideophones, and embedded clauses introduced by relational nouns. Each of these are briefly outlined as follows.

Only one verb in the data occurs immediately preceding an ideophone. The ideophone was considered to be a non-verbal predicate, and therefore this verb was classified as clause final. This sentence is shown in 15.

(15) ***X'ek*** *tas tas tas.*

[ʃ-∅-ɓe-k]CP [tas]CP [tas]CP [tas]CP
CPL-B:3SG-go-SS:F IDEO IDEO IDEO

'He went off, *tas, tas, tas.*' (mr, 12:49)

Similarly, only one verb in the data occurs immediately preceding a vocative expression. This was considered to be part of the same clause as the verb (Henderson 2012) and therefore the verb was classified as phrase-medial. This sentence is shown in 16.

(16) ***Chatja*** *ombr.*

[ʧ-∅-a-t(ɪ)χ-a ómbɾ]CP

IMP-B:3SG-A:2SG-eat-SS:M man

'Eat it, man!' (mr, 17:41)

Two verbs in the data precede embedded clauses introduced by relational nouns. The verbs in these constructions were classified as clause-final following Can Pixabaj (2015) (c.f. Henderson (2012)). An example is shown in 17 with the relational noun *rech*.

(17) *Bien* ***käpq'öwïk*** *rech k'ok' ku'un la qärkil.*

[bien kə-∅-p(ɔ)q'ɔw-ɪ́k [ɾ-eʧ

well INCPL-B:3SG-boil-SS:F A:3SG-REL.NOUN

k'ok' k-∅-u-ɓən-∅ la qə-ɾ(ɪ)kɪ́l]CP]CP

tasty INCPL-B:3SS-A:3SG-do-SS:M DET A:1PL-meal

'It boils well so that our meal will be tasty.' (caldores, 01:01)

Finally, the quotative *cha* has two distinct uses. When used as a predicate, it occurs with aspect and person marking and may license an indirect object argument (as in 18a). When used as a particle, it is not inflected (as in 18b). Verbs preceding the predicate use of *cha* were considered to be clause-final, and those preceding the particle use clause-medial.

(18) a. *"Su ki'inö?"* ***kcha*** *chqe.*

[[su k-∅-i-ɓən-ɔ́]CP

what INCPL-B:3SG-A:2PL-do-SS:F

k-∅-ʧa ʧ-q-é]CP

INCPL-B:3SG-say PREP-A:1PL-REL.NOUN

'"What are you doing?" he said to us.' (fishing, 05:10)

b. *Xi'e* ***cha*** *rech r kkej.*

[ʃ-i-ɓe ʧa ɾ-eʧ ɾ(ɪ) k(ɪ)-kéχ]CP

CPL-B:2PL-go-SS:M QUOT A:3SG-REL.NOUN DET A:3PL-horse

'They went - it is said - on their horses.' (magicegg, 01:29)

It was expected that verbs that are clause-final would appear with phrase-final status suffixes and verbs that are clause-medial would appear with phrase-medial status suffixes.

2.2.2.2.3 Prosodic position: with final rise or not

Each verb was categorized as occurring in the final or medial position of an intonational phrase based on the locations of boundary tones. Intonational phrase (IP) in this context refers to a hypothesized prosodic constituent smaller than the utterance and larger than the phonological phrase in a hierarchically layered prosodic structure which tends to align with the illocutionary clause in the syntax (Selkirk 1984, 2011). The locations of tones were chosen as the metric for intonational phrase boundaries because they appear regularly at the ends of approximately clause-sized phrases in Chichicastenango K'iche' (see Section 1.2.3.2). Boundary tones are also described as occurring at the ends of all intonational phrases in K'iche' in a number of works (Nielsen 2005, Henderson 2012, Velleman 2014, Burdin et al. 2015).

Boundary tones were identified in this study as a rise in F0 on the final syllable of a word that reached the greatest relative height in the surrounding context. These word-final higher rises relative to other pitch excursions in the context occur frequently in the data at the ends of topicalized phrases (preverbal, where the basic word order is verb-initial) as well as at the ends of clauses. However, there were also some word-final rises in other environments. The syntactic context was not considered when judging whether a given final rise was identified as a boundary tone, and therefore these verbs were also classified as IP-final.

Many words in the data which bear boundary tones are also followed by pauses, and pauses are frequently appealed to as indicators of prosodic structure. However, pauses were not considered in this study. This is because pauses also occur frequently within phrases, and even within words between the aspect and person prefixes and the verb root or between the possessive prefixes and the noun, indicating that they do not reliably correlate with syntactic or prosodic constituent structure in the naturalistic speech that forms the corpus. An example is shown in 19.

(19) *Kägya ch b'ï u... rchaj.*

[kə-∅-q(ə)-ja-∅	ʧ(ɪ)	ɓɪ	u	ɾ-(ɪ)ʧáχ	]$_{CP}$
INCPL-B:3SG-A:1PL-add-SS:M	again	DIR	A:3SG	A:3SG-vegetable	

'Again we add its... its vegetables.' (caldores, 00:42)

Furthermore, pauses and final rises often do not coincide. As discussed in Chapter 3, among vowel-initial words in the corpus where the preceding word bears a boundary tone, only 49% are separated by a pause from this preceding word. Conversely, among vowel-initial words immediately preceded by a pause, 68% follow a word bearing a boundary tone. Similarly, among the function words investigated in Chapter 4, only about half of words bearing a boundary tone are followed by a pause, and among words followed by a pause, about a third do not bear a boundary tone. Therefore, although there is some degree of correlation between the positions of boundary tones and those of pauses, there are also a large proportion of pauses that do not correlate with boundary tones. Due to these observations, pauses were not considered as an indicator of intonational phrase structure in this study.[4]

2.2.2.2.4 Speaker

The corpus includes data from 12 different speakers (for more information, see Section 1.3). Which speaker produced each verb was tracked in order to see if there are individual differences in where phrase-final and phrase-medial status suffixes were used.

2.3 Results

The following sections present the results of the study. Section 2.3.1 shows the results of the consonant cluster variable, Section 2.3.2 the results of the syntactic position variable and Section 2.3.3 the results of the prosodic position variable.

[4] Royer's 2022 work on status suffixes in Chuj and K'iche', however, uses both pauses and boundary tones as evidence for the locations of intonational phrase boundaries.

2.3.1 Status suffixes and word-final consonant clusters

This section addresses the results of the consonant cluster variable. Table 2.2 shows the overall results. The table includes the full dataset and is divided according to word-final consonant clusters and type of status suffix. The data is additionally separated into two broad phrase position categories in order to disambiguate the effect of consonant clusters from that of phrase position. In this chart, final position includes verbs that are either clause- or IP-final (with boundary tone) and medial position all other verbs.

Category	Position	Phrase-medial status suffix	Phrase-final status suffix	Total
No final cluster	Clause- and IP-medial	2068 (94.6%)	117 (5.4%)	2627
	Clause- or IP-final	28 (6.3%)	414 (93.7%)	
Final cluster	Clause- and IP-medial	24 (21.6%)	87 (78.4%)	145
	Clause- or IP-final	0 (0%)	34 (100%)	

Table 2.2: Phrase-final and phrase-medial status suffixes according to word-final consonant clusters

As this table shows, there is a much larger number of verbs that occur with no final consonant clusters than with final clusters. Verbs with no final cluster have mostly phrase-medial status suffixes in medial contexts and mostly phrase-final status suffixes in final contexts. Verbs with final clusters, in contrast, have phrase-final status suffixes in most cases no matter whether the phrase position is final or medial. The same overall pattern was found across individual speakers.

Although many verb stems ending in consonant clusters occurred with an overt suffix in place of the expected null suffix, this did not occur for all. Table 2.3 shows all of the surface stem-final consonant clusters attested on verbs in fully medial environments in the data (clause-medial and not occurring with a boundary tone; verbs preceding demonstrative/discourse particles are also excluded as they usually appear with phrase-final status suffixes as will be shown in the following section). Clusters with three consonants are categorized according to the **last** two; e.g. the cluster /ntχ/ is categorized as C1 stop and C2 fricative. Cells with clusters that appear on verbs with phrase-final status suffixes are highlighted in gray and those with clusters that appear on verbs with phrase-medial status suffixes are left white. The number of tokens with each cluster is shown in parentheses.

C2 / C1	Stop/affricate	Fricative	Nasal	Liquid	Glide
Stop/affricate	pt (2), kt (4), qt (13), q’t (2), ɓt (2), tt (1), ʔkt (2), ʔtɓ (1)	ɓχ (2), ɓʃ (1), ntχ (1)	ts’n (4), q’n (1)		
Fricative	χt (4), ʃt (2)	χʃ (1), sʃ (1)			
Nasal	nt (9)	nχ (2)			
Liquid		ʔlχ (1)	ln (3)		
Glide	jt (1)	wʃ (9)	wn (7)	jɾ (2)	
Glottal stop	ʔt (14)		ʔn (1)	ʔl (1)	ʔj (2)

Table 2.3: Stem-final consonant clusters attested with phrase-final (gray) and phrase-medial (white) status suffixes in medial environments

There are no identical stem-final clusters attested both on verbs with phrase-final status suffixes and on verbs with (null) phrase-medial status suffixes in phrase-medial position. However, the motivation for the distinction is not clear based on this table. The clusters that occur with null medial suffixes and are therefore word-final all have a nasal, glide, or glottal stop as the first consonant. However, there are also clusters with these same consonants that occur with (overt) phrase-final status suffixes in phrase-medial position. For example, final clusters of a glottal stop followed by a nasal or glide occur with phrase-medial suffixes while those followed by a stop or liquid occur with phrase-final suffixes. Examples are shown in 20.

(20) a. ***Xtzë’n*** *chwij.*

[ʃ-∅-tsɛʔn-∅ ʧ-w-íχ]CP

INCPL-B:3SG-laugh-SS:M PREP-A:1SG-REL.NOUN

‘He laughed at me.’ (fishing, 07:13)

b. ***Köjwa'lïk*** *b'ik.*

[k-ɔχ-waʔl(χ)-ɪk ɓ-ɪ́k]$_{CP}$

INCPL-B:1PL-get.up-SS:F DIR:F

'We get up.' (dailyactivities, 00:46)

The verb *xtze'n* in 20a ends in the cluster /ʔn/ and has a null medial status suffix, while the verb *köjwa'lïk* in 20b ends in the cluster /ʔl/ but has the phrase-final status suffix *-ïk*.

The results shown above categorize the data based on the surface form produced by the speaker. However, a closer look at the data reveals that many of the clusters that result in the appearance of the phrase-final suffix belong to verbs with two alternating surface forms, and sometimes have an additional consonant as part of the cluster. Many of these are verbs with the completive passive suffix, which can be produced either as [t] or as [tχ]. Other examples include the verbs *wa'l(j)* [waʔl(χ)] 'get up' and *wa'(k)t* [waʔk(t)] 'walk around', where the surface forms may appear with or without the parenthesized consonants. In fact, the clusters in the data formed by a glottal stop followed by another consonant where there is no deletion of a third underlying consonant all occur with phrase-medial status suffixes. Thus the stem /tseʔn/, with an underlying and surface coda of /ʔn/ can occur with the null phrase-medial suffix in 20a whereas the stem /waʔl(χ)/, with surface cluster [ʔl] but underlying cluster /ʔlχ/, requires the use of the overt phrase-final suffix *-ïk* in 20b.

Table 2.4 shows the results of the consonant cluster variable re-categorized according to underlying consonant clusters. Here, a consonant present in some but not all surface forms of the morpheme is posited to exist underlyingly in all instances of that morpheme. The table again marks clusters found on verbs with phrase-medial status suffixes in white and those with phrase-final status suffixes in gray. Clusters with three consonants are again categorized according to the **last** two, and the number of tokens with each underlying cluster is shown in parentheses.

C2 / C1	Stop/affricate	Fricative	Nasal	Liquid	Glide
Stop/affricate	ʔkt (3) ʔtɓ (1)	ɓχ (2), ɓʃ (1), ɓtχ (2), χtχ (4), qtχ (13), q'tχ (2), ʔtχ (13), ktχ (4), ntχ (10), ptχ (2), ʃtχ (2), ttχ (1), jtχ (1)	ʦ'n (4), q'n (1),		
Fricative		χʃ (1), sʃ (1)	lχn (3)		
Nasal		nχ (2)			
Liquid		ʔlχ (2)			
Glide		wʃ (9)	wn (7)	jɾ (2)	
Glottal stop			ʔn (1)		ʔj (2)

Table 2.4: Stem-final underlying consonant clusters attested with phrase-final (gray) and phrase-medial (white) status suffixes in medial environments

Looking at underlying clusters, a clearer picture emerges: null phrase-medial suffixes occur when the verb would end in a cluster composed of a glide or glottal stop followed by another consonant, but not with other types of consonant cluster. The only exception is /nχ/, which occurs in the data only on the two instances of the stem *kanj* /kanχ/ 'stay' produced by the same speaker in two identical sentences, one of which is shown in 21.

(21) ***Xöjkanj*** *kä chï r uwäch ulew.*

[	ʃ-ɔχ-kan(ə)χ-∅	kə	ʧɪ	ɾ(ɪ)	u-wəʧ	uléw	$]_{CP}$
	CPL-B:1PL-stay-SS:M	DIR	PREP	DET	A:3SG-REL.NOUN	land	

'We stayed on the Earth.' (church, 05:24)

In sum, the results of the consonant cluster variable show that verbs with otherwise word-final consonant clusters appear with overt phrase-final status suffixes in all phrase positions rather than the expected null phrase-medial status suffixes in medial positions. The only stem-final clusters that occur with null phrase-medial suffixes are those composed of a glottal stop or glide followed by another consonant, as well as two examples with a nasal-fricative cluster. This factor overrides the factor of phrase position. The next two sections therefore set aside the cases with final consonant clusters in order to zoom in on this phrase position alternation.

2.3.2 Status suffixes and clause position

This section addresses the results of the syntactic position variable: that is, whether the verb is clause-final or not. The overall pattern found in the data, as expected from the previous literature, is that phrase-medial status suffixes occur on verbs that are clause-medial and phrase-final status suffixes on verbs that are clause-final. Furthermore, this overall pattern is consistent across speakers. However, the correlation is not perfect, as evidenced by the results summarized in Table 2.5. In order to focus on the question of the variation in status suffix use that is due to positional constraints, the data discussed in this section excludes all instances of verbs with final consonant clusters (145 tokens), which appear with phrase-final status suffixes irrespective of position.

Clause position	Total	Phrase-medial status suffix	Phrase-final status suffix
Medial	2226	2088 (93.8%)	138 (6.2%)
Final	401	7 (1.7%)	394 (98.3%)

Table 2.5: Phrase-final and phrase-medial status suffixes by clause position (excluding final consonant cluster data)

Verbs occur more frequently in medial position than in final position, with 2226 clause-medial verbs and 401 clause-final verbs; this is not surprising as the basic word order of the language is verb-initial. Most clause-medial verbs have phrase-medial suffixes and most clause-final verbs have phrase-final suffixes, but 1.7% of the clause-final verbs have phrase-medial suffixes and 6.2% of the clause-medial verbs have phrase-final suffixes.

Examples of clause-final verbs with phrase-final status suffixes are shown in 22.

(22) a. *Tzätz* ***ku'unö****. N ch'ür ja' täj ka'an che.*

[tsəts k-∅-u-ɓən-ɔ́]CP [[n(ə) ʧ'ʊɾ χaʔ təχ]CP

thick INCPL-B:3SG-A:3SG-do-SS:F NEG runny water IRR

k-∅-a-ɓən-∅ ʧ-é]CP

INCPL-B:3SG-A:2SG-do-SS:M PREP-REL.NOUN

'It becomes thick. You do not make it runny.' (3recipes, 06:04)

b. ***Knumïk*** *pero n kraj t uwa.*

[k-∅-num-ík]$_{CP}$

INCPL-B:3SG-A:3SG-hunger-SS:F

[peɾo n(ə) k-∅-ɾ-aχ t(ə) u-wá]$_{CP}$

but NEG INCPL-B:3SG-A:3SG-want IRR A:3SG-food

'He/she is hungry but he/she doesn't want to eat.' (healing 14:14)

c. ***Käwïlö*** *su r kuya r ja'.*

[k-∅-aw-ɪl-ɔ́

INCPL-B:3SG-A:2SG-see-SS:F

[su ɾ(ɪ) k-∅-u-ja-∅ ɾ(ɪ) χáʔ]$_{CP}$]$_{CP}$

what DET INCPL-B:3SG-A:3SG-give-SS:M DET water

'You see what the water gives.' (fishing 10:32)

22a precedes an independent clause, 22b a coordinated clause, and 22c an embedded clause. Each of these verbs have a phrase-final status suffix.

Although most clause-final verbs have phrase-final status suffixes and most clause-medial verbs have phrase-medial status suffixes, there is a small subset of the data where the correlation does not hold. The occurrence of some phrase-final status suffixes in clause-medial position and clause-medial status suffixes in clause-final position is unexpected if the conditioning environment for the alternation is the clause. Each of these unexpected uses of status suffixes is explored in the following sections.

2.3.2.1 Clause-final verbs with phrase-medial status suffixes

Among the 401 clause-final verbs, seven tokens (1.7%) appear with phrase-medial status suffixes.

Of these seven verbs, one is *kuya* 'it gives it', which occurs with some glottalization (a brief dip in amplitude in the middle of the final vowel and an increase in aperiodicity). This may indicate that this is a reduced form of *kuya'ö* with phrase-final status suffix -*ö*, where the final vowel has merged in quality with the preceding /a/ and the intervening glottal stop is highly reduced. Glottal stops are frequently reduced in spontaneous speech in K'iche' (see Chapter 3 on word-initial glottal stop reduction).

Another of these seven verbs is immediately followed by a speech filler and a pause and may therefore represent a speech error: the speaker did not realize that the following material would constitute a full clause rather than a noun phrase at the time it was produced.

The remaining five tokens precede embedded clauses. Examples are shown in 23.

(23) a. *Je tä r **ki'in** chër kichäpö.*

[χe tə ɾ(ɪ) k-∅-i-ɓən-∅
like IRR DET INCPL-B:3SG-A:2PL-do-SS:M

[ʧɛɾ k-∅-i-ʧəp-ɔ́]CP]CP
COMP INCPL-B:3SG-A:2PL-catch-SS:M

'It's not like that what you do to catch them.' (fishing, 05:23)

b. ***Kqïl** k'ö r kär keq'axïk.*

[k-∅-q-ɪl-∅
INCPL-B:3SG-A:1PL-see-SS:M

[k'ɔ ɾ(ɪ) kə́ɾ [k-e-q'aʃ-ɪ́k]CP]CP]CP
EXIST DET fish INCPL-B:3PL-pass-SS:F

'We see there are fish passing by.' (fishing, 03:38)

c. ***Kana** w xaq are ku'un rtz'am rï'.*

[k-∅-a-na-∅
INCPL-B:3SG-A:2SG-taste-SS:M

[w(e) ʃaq are k-∅-u-ɓən-∅ ɾ-(ə)ts'am ɾíʔ]CP]CP
if just FOC INCPL-B:3SG-A:3SG-do-SS:M A:3SG-salt DEM

'You taste if the salt is just right.' (3recipes, 05:07)

The verb *ki'in* 'you do it' in 23a precedes an embedded purpose clause but appears with the (null) phrase-medial suffix. The verbs *kqïl* 'we see' and *kana* 'you taste' in 23b and 23c each precede an embedded clause acting as their object, and have (null) phrase-medial status suffixes. The occurrence of a phrase-medial suffix on verbs like these cannot be accounted for under a syntactic analysis of the alternation, as they are clearly clause-final. Thus, while some of the seven occurrences of phrase-medial status suffixes on clause-final verbs may be explained, five tokens find no justification from a syntactic perspective, all of which are verbs preceding embedded clauses.

2.3.2.2 Clause-medial verbs with phrase-final status suffixes

Conversely, among the clause-medial verbs 138 (6.2%) have phrase-final status suffixes.

Of these, six precede the demonstrative pronoun *le'* 'that one (in sight)' and 66 the demonstrative pronoun *rï'* 'that one (out of sight or previously mentioned)'. An example is shown in 24.

(24) *Je rï'* ***ku'unö*** *rï'.*

[	χe	ɾɪʔ	k-∅-u-ɓən-ɔ	ɾíʔ	]$_{CP}$
	like	DEM	INCPL-B:3SG-A:3SG-do-SS:F	DEM	

'Like that it does it.' (planting, 09:28)

Although the demonstratives that appear in these sentences in phrase-final position after the verb are identical in form to when they are used as typical demonstrative pronouns, they do not refer to any particular entity, and their analysis is uncertain. López Ixcoy (1997; 1999) and Sam Colop (1990) give similar examples of sentence-final or post-verbal demonstratives in other K'iche' dialects with a range of meanings related to speaker attitudes, including certainty, possibility, hope, and response to a request, which suggests that they function as discourse particles. From a discussion of examples of this type with several speakers from Chichicastenango I concluded that the distal demonstrative *rï'* can be used to indicate a greater degree of uncertainty, lack of importance, or temporal distance when compared to identical examples with the proximal demonstrative *wa'* (which does not follow any of the verbs included in this corpus study). A minimal set of examples is shown in 25.

(25) a. *Kmik kpi jäb' **wa'**.*

kmik	k-∅-pi-∅	χəɓ	**waʔ**
today	INCPL-B:3SG-come-SS:M	rain	DEM

'It will rain today.' (guess, hope or likelihood; relatively certain) (unrecorded elicited example)

b. *Kmik kpi jäb' **rï'**.*

kmik	k-∅-pi-∅	χəɓ	**ɾɪʔ**
today	INCPL-B:3SG-come-SS:M	rain	DEM

'It will rain today.' (guess, hope or likelihood; relatively uncertain) (unrecorded elicited example)

The speaker feels relatively more confident in the likelihood of rain when using the proximal demonstrative *wa'* than its distal counterpart *rï'*.

Although there is much more to be studied about this use of demonstratives, following Bliss & Wiltschko's (2020) analysis of similar discourse uses of demonstratives in Blackfoot I propose that these discourse meanings arise because the demonstratives are located outside of the main clause and scope over the full proposition. This means that the preceding verb is in fact clause-final in these cases, as shown in the structure in 26, and the appearance of the phrase-final status suffix is to be expected under a clause-sensitive analysis.

(26) *Je rï' **ku'unö** rï'.*

[	[	χe	ɾɪʔ	k-∅-u-ɓən-**ɔ**	]$_{CP}$	ɾɪ́ʔ	]$_{CP}$
		like	DEM	INCPL-B:3SG-A:3SG-do-SS:F		DEM	

'Like that it does it.' (planting, 09:28)

Phrase-final status suffixes are also found frequently on verbs preceding several discourse particles borrowed from Spanish: two precede *pues* 'then, so' and five *tambien* 'also'. Like demonstratives with discourse functions, these particles may be located outside of the clause; if so, then the appearance of phrase-final status suffixes on these verbs is expected under a syntactic analysis. An example is shown in 27.

(27) *Kuando ya **kqïlö** pues.*

[	[	kuando	ja	k-∅-q-ɪl-ɔ	]$_{CP}$	pués	]$_{CP}$
		when	already	INCPL-B:3SG-A:1PL-see-SS:F		then	

'When we see it, then...' (3recipes, 03:31)

Another group of clause-medial verbs with phrase-final status suffixes are 9 cases followed by a pause or speech filler, indicating that the following clause-internal material may have been added as an afterthought and the speaker intended the verb to be clause-final when it was produced.[5] An example is shown in 28 and Figure 2.1.

(28) ***Xïnchkünïk**... ruk' rï n... rï nqaw.*

[	ʃ-ɪn-ʧ(ə)kʊn-ík	ɾ-uk'	ɾɪ	n	ɾɪ	n-qáw	]$_{CP}$
	CPL-B:1SG-work-SS:F	A:3SG-with	DET	A:1SG	DET	A:1SG-father	

'I worked ... with my... my father.' (mr, 08:33)

Here the verb *xinchkünïk* 'I worked' has a phrase-final status suffix and occurs with a boundary tone. As shown in Figure 2.1, a pause separates the verb from the following clause-internal modifier *ruk' r nqaw* 'with my father', indicating that the speaker may have intended to finish the sentence at the verb before deciding to add the following modifier as an afterthought.

Finally, there remain 50 other clause-medial verb tokens with phrase-final status suffixes. These precede arguments and modifiers of many different types. There is no obvious reason why the phrase-final status suffix should occur on these verbs under a syntactic analysis of the status suffix alternation; it would merely have to be stipulated that this following material is outside of the clause in these cases. An example is shown in 29.

(29) *Su **ku'unö** jun [...]?*

[	su	k-∅-u-ɓən-ɔ	χún	]$_{CP}$
	what	INCPL-B:3SG-A:3PL-do-SS:F	one	

'What does one do [who believes]?' (church, 08:09)

[5] Note that these cases were not excluded from the data as hesitations because the hesitation occurs *after* the full verb is uttered, not *within* it.

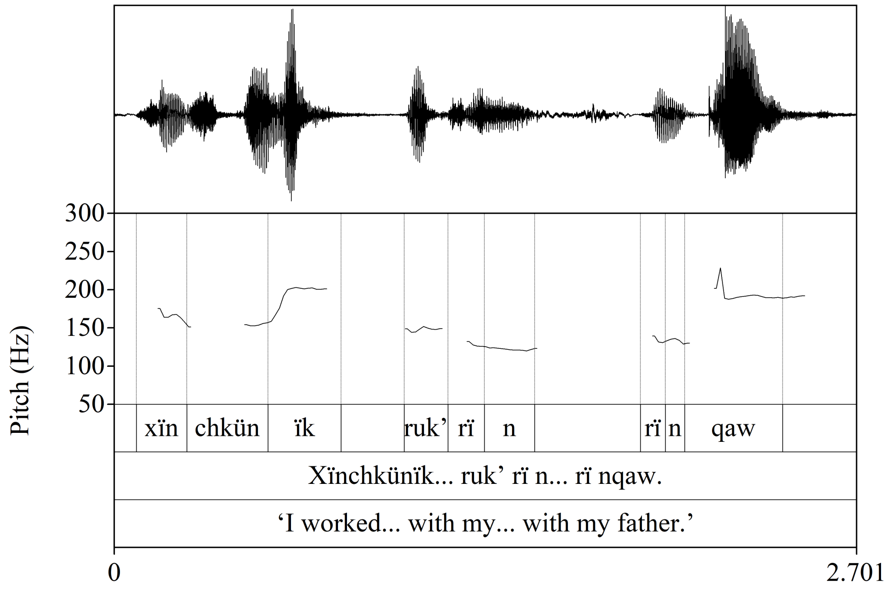


Figure 2.1: Waveform and pitch track of *Xïnchkünïk ruk' rï nqaw* 'I worked with my father', where the clause-medial verb *xïnchkünïk* has a phrase-final status suffix and precedes a pause

Here the verb precedes the subject and yet has a phrase-final status suffix.

In sum, from a syntactic perspective the majority of the data conform to the expected pattern, but some of the cases that don't conform to the pattern cannot be explained (55/2627, or about 2% of the data). In particular, there are a number of cases where there is clearly a clause boundary but the verb appears with a phrase-medial status suffix. In the following section I explore whether prosodic position can better account for this data.

2.3.3 Status suffixes and boundary tones

This section explores the data from the perspective of a prosodic analysis: whether the verb occurs with a final rise indicative of a boundary tone (prosodically final) or not (prosodically medial). The overall pattern is that phrase-final forms occur on verbs with final rises and phrase-medial forms on verbs without final rises, and this is found for all speakers. However, as occurred with clause boundaries, the correlation is not perfect. These results are summarized in Table 2.6. As in the previous section, data with final consonant clusters are excluded in order to focus on the question of variation in status suffix form conditioned by phrase position.

With boundary tone	Total	Phrase-medial status suffix	Phrase-final status suffix
No	2281	2075 (91.0%)	206 (9.0%)
Yes	346	20 (5.8%)	326 (94.2%)

Table 2.6: Phrase-final and phrase-medial status suffixes by occurrence with a boundary tone (excluding final consonant cluster data)

2281 verbs occur without a boundary tone, while only 346 occur with a boundary tone. The majority of instances of phrase-final status suffixes have boundary tones and the majority of phrase-medial suffixes do not. However, 5.8% of verbs with boundary tones have phrase-medial suffixes and 9.0% of verbs without boundary tones have phrase-final suffixes.

Examples of verbs with phrase-final status suffixes and boundary tones are shown in 30, repeated from 22 above.

(30) a. *Tzätz **ku'unö**. N ch'ür ja' täj ka'an che.*

[tsəts k-∅-u-ɓən-ɔ́ $]_{CP}$ [[n(ə) ʧ'ʊɾ χaʔ təχ $]_{CP}$
thick INCPL-B:3SG-A:3SG-do-SS:F NEG runny water IRR

k-∅-a-ɓən-∅ ʧ-é $]_{CP}$
INCPL-B:3SG-A:2SG-do-SS:M PREP-REL.NOUN

'It becomes thick. You do not make it runny.' (3recipes, 06:04)

b. ***Knumïk** pero n kraj t uwa.*

[k-∅-num-ɨ́k $]_{CP}$
INCPL-B:3SG-A:3SG-hunger-SS:F

[pero n(ə) k-∅-ɾ-aχ t(ə) u-wá $]_{CP}$
but NEG INCPL-B:3SG-A:3SG-want IRR A:3SG-food

'He/she is hungry but he/she doesn't want to eat.' (healing 14:14)

c. ***Käwïlö*** *su r kuya r ja’.*

[k-∅-aw-ɪl-ɔ́

INCPL-B:3SG-A:2SG-see-SS:F

[su r(ɪ) k-∅-u-ja-∅ r(ɪ) χáʔ]CP]CP

what DET INCPL-B:3SG-A:3SG-give-SS:M DET water

‘You see what the water gives.’ (fishing 10:32)

Each of the bolded verbs have a boundary tone and a phrase-final status suffix. The pitch track of 30c is shown in Figure 2.2.

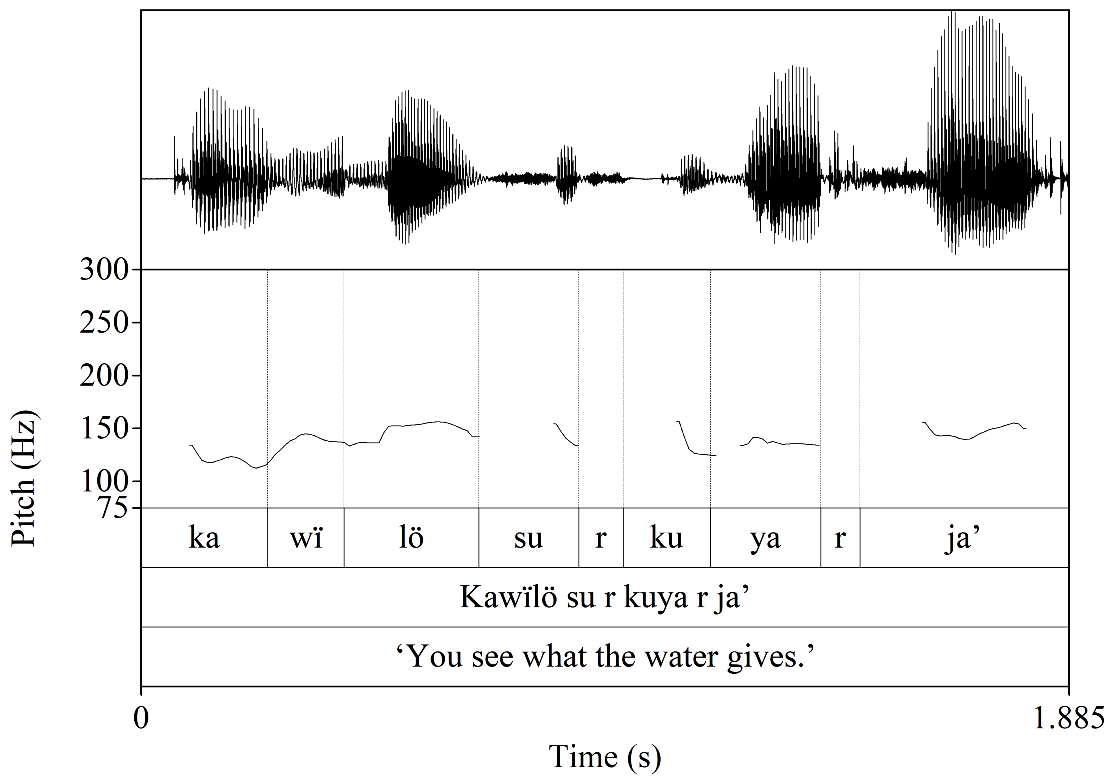


Figure 2.2: Waveform and pitch track of *Kawïlö su r kuya r ja’*, where the verb *kawïlö* ‘you see it’ precedes an embedded clause and has a boundary tone

Although most verbs with boundary tones have phrase-final status suffixes and most verbs without boundary tones have phrase-medial status suffixes, there is a minority of the data where the correlation is not met. The following sections dig deeper into the unexpected instances of status suffixes from the perspective of a prosodic analysis.

2.3.3.1 Verbs with boundary tones and phrase-medial status suffixes

Of the 346 verbs that occur with a large final rise identified as a boundary tone, 20 (5.8%) have phrase-medial status suffixes.

One is the verb *köj'e* 'we go' which precedes the verb *ki'eqla'* 'we go to see them', and the final -*k* which marks the phrase-final status suffix for this verb may have merged with the initial *k* of the following verb. This example is shown in 31.

(31) ***Köj'e*** *ki'eqla'.*

[k-ɔχ-ʔé-∅	[k-i-e-q-(ɪ)l-áʔ	]$_{CP}$	]$_{CP}$
INCPL-B:1PL-go-SS:M	INCPL-B:3PL-INC.MOV-A:1PL-see-SS:F		

'We go to see them.' (history, 05:46)

The remaining 19 verbs are plain transitives and intransitives and are all clause-medial, and an apparent boundary tone falls on their last syllable, which is the verb root. An example is shown in 32 and Figure 2.3.

(32) ***Xïnchäp*** *ju laj amlo.*

[ʃ-∅-ɪn-ʧə́p-∅	χu	laχ	am(ɔ)ló	]$_{CP}$
CPL-B:3SG-A:1SG-catch-SS:M	a	little	fly	

'I caught a little fly.' (fishing, 06:40)

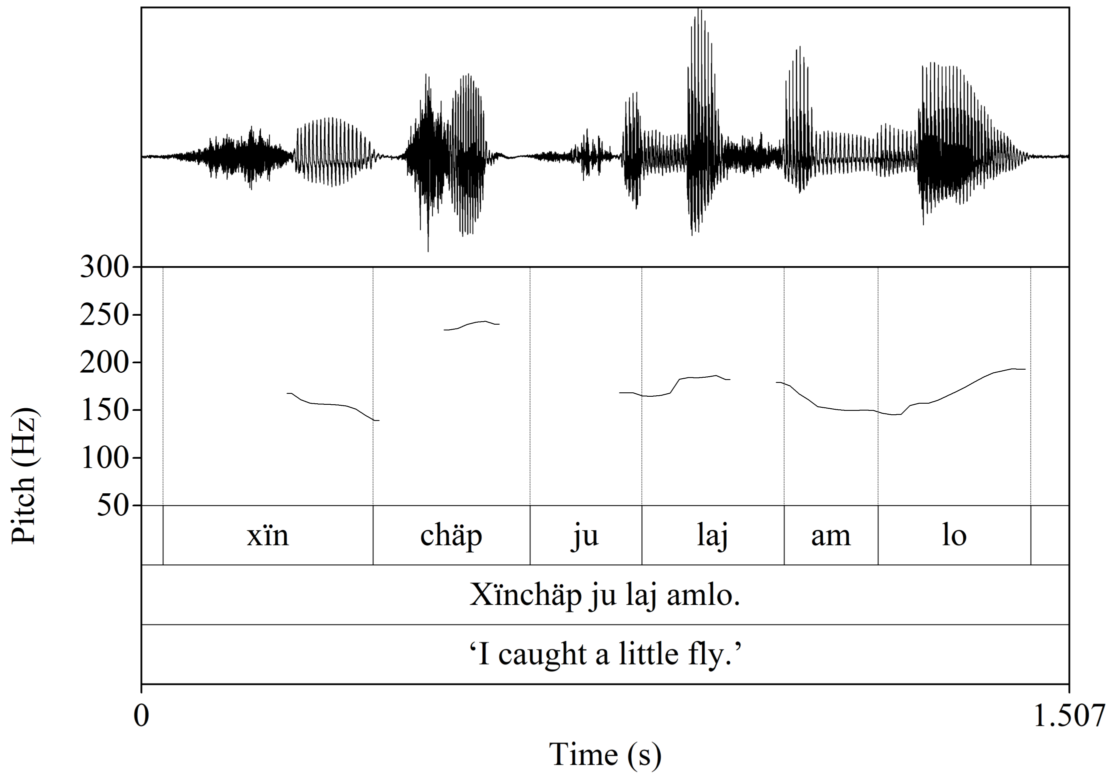


Figure 2.3: Waveform and pitch track of *xinchäp ju laj amlo* 'I caught a little fly', where the verb *xinchäp* 'I caught it' occurs with a high pitch potentially miscategorized as a boundary tone

Here the verb occurs with the highest pitch in the sentence, even slightly higher than the boundary tone on the final syllable *lo* in *amlo* 'fly'.

I do not know why these verbs occur with high tones. They have phrase-medial suffixes and are not at any sort of syntactic boundary expected to line up with an intonational phrase boundary. It is possible that the pitch rises in these cases are due to focus or emphasis intonation: research on the prosody of focused nominal constituents in the Nahualá and Cantel dialects of K'iche' in controlled experimental data shows that contrastive focus is marked through higher pitch peaks, among other cues, as compared to broad focus (Baird 2014b). I set these examples aside for the remainder of this chapter.

2.3.3.2 Verbs without boundary tones but with phrase-final status suffixes

Conversely, of the 2281 verbs that do not occur with a final rise, 206 (9.0%) have unexpected phrase-final status suffixes.

Many of these occur in environments with syntactic boundaries which might be expected to align with intonational phrase boundaries; however, no final pitch rise is present. These include seven verbs preceding quotative verbs (which typically follow the quotation in K'iche'), 32 preceding embedded clauses, three preceding coordinated clauses, three preceding juxtaposed clauses, one preceding a matrix clause, and one preceding an ideophone, as well as 41 preceding fully independent clauses. An example with an embedded clause is shown in 33 and Figure 2.4. There is no pitch rise indicative of a boundary tone on the final syllable of the verb *kqïlö* 'we see it'.

(33) ***Käqïlö*** *ya mq'ïn ch r qt'ü'y chï q'aq'.*

[kə-∅-q-ɪl-ɔ

INCPL-B:3SG-A:1PL-see-SS:F

[	ja	m(ɪ)q'ɪn	ʧ(ɪ)	ɾ(ɪ)	q(ə)-t'ʊʔj	ʧɪ	q'áq'	]CP]CP
	already	hot	again	DET	A:1PL-pot	PREP	fire	

'We see that our pot is now hot on the fire.' (3recipes, 03:11)

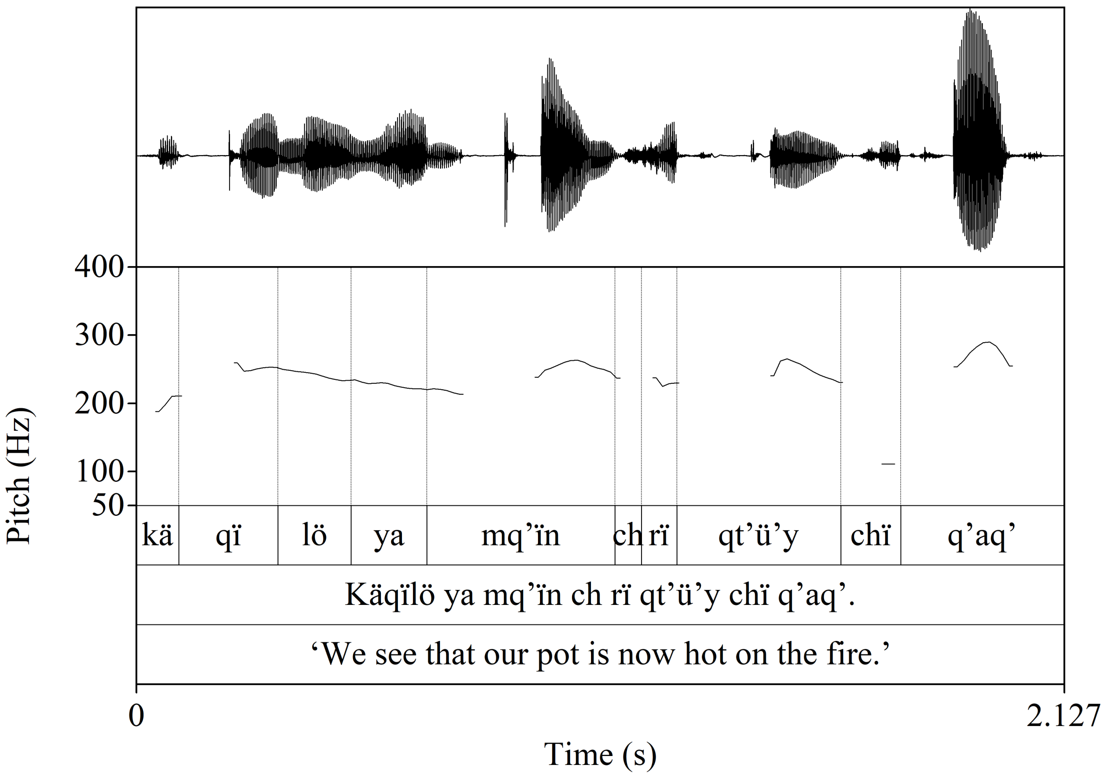


Figure 2.4: Waveform and pitch track of *Käqïlö ya mq'ïn ch rï qt'u'y chï q'aq'*, where the verb *käqïlö* 'we see it' precedes an embedded clause and does not have a boundary tone

In contrast to these examples, most cases in the data of verbs preceding independent clauses - as well as some verbs preceding quotative verbs, other matrix clauses and embedded clauses - do occur with boundary tones, and it is not immediately obvious what causes this difference. For example, 7b above shows a verb preceding an embedded clause which occurs with a boundary tone. Whether a boundary tone appears or not varies in the same syntactic context.

A further 79 verbs with phrase-final status suffixes but no final rise indicative of a boundary tone precede demonstrative or discourse particles. As discussed above in Section 2.3.2.2 one possible analysis of these cases is that there is in fact a clause boundary after the verb, in which case there might also be expected to be a corresponding IP boundary although there is no pitch rise indicative of a boundary tone. An alternate analysis for these cases is that the demonstrative pronouns are prosodic clitics, and phrase-final forms may occur on verbs that are not IP-final if the following material within the IP is a clitic and not an independent prosodic word. This follows the proposal made by Tyers and Henderson (2021) to explain the observed instance of a phrase-final form preceding the reflexive marker *-ib'*, a relational noun (a class of words that are formally nominal but have functional uses; see Section 4.2.1 for more detail on relational nouns). However, it is only when the verb precedes a discourse particle or demonstrative pronoun in the corpus data that it is likely to occur with a phrase-final status suffix. The majority of verbs preceding other function words and particles which might be analyzed as clitics, including *-ib'*, have phrase-medial status suffixes. An example is shown in 34.

(34) ***Käkmül*** *kib'.*

[	kə-∅-k(ɪ)-mʊl-∅	k-íɓ	]$_{CP}$
	INCPL-B:3SG-A:3PL-gather-SS:M	A:3PL-REFL	

'They gather together.' (changes2, 02:04)

Here the verb *käkmül* 'they gather' has a null phrase-medial status suffix and precedes the reflexive *-ib'*.

Finally, among the unexpected occurrences of phrase-final status suffixes according to a prosodic analysis, there are also a number of cases with verbs not expected to precede prosodic boundaries based on the syntactic structure. These include 10 preceding object noun phrases, seven preceding subjects, and 22 preceding various adjuncts and modifiers; one example is shown in 29 above. Under an IP-sensitive analysis of status suffixes, it must be stipulated that an intonational phrase boundary occurs after these verbs despite the lack of boundary tone; it is possible that such a boundary is marked through other phonetic means not considered in this study.

In sum, these results show that in certain types of constructions there is considerable variability in the occurrence of boundary tones and the alternation between phrase-final and phrase-medial status suffixes. This is further clarified in Table 2.7, which summarizes the positions of boundary tones and phrase-final suffixes within a series of different types of syntactic structures. Verbs with final consonant clusters are again excluded because they appear with phrase-final suffixes irrespective of phrase position.

Precedes	Phrase-medial suffix, no boundary tone	Phrase-final suffix, no boundary tone	Phrase-final suffix boundary tone
Independent clause	1 (0.4%)	41 (17.1%)	189 (82.5%)
Coordinated clause	0	3 (9.4%)	29 (90.6%)
Juxtaposed clause	0	3 (13.0%)	20 (87.0%)
Quotative *cha*	0	2 (11.1%)	16 (88.9%)
Other matrix clause	0	1 (12.5%)	7 (87.5%)
Embedded clause (argument)	4 (8.9%)	26 (57.8%)	15 (33.3%)
Embedded clause (adjunct)	2 (10.0%)	6 (30.0%)	12 (60.0%)
Dem/discourse particle	10 (11.2%)	79 (88.8%)	0
Quotative *b'ij*	0	5 (100%)	0

Table 2.7: Variability in the positions of status suffixes and boundary tones in the same syntactic contexts

As this table shows, the pattern varies across different types of clause-final contexts. Phrase-final status suffixes, boundary tones, and clause boundaries all align in most cases as expected for verbs that are at the end of a sentence (precede a fully independent clause), that precede a coordinated clause, that are in an embedded clause and precede another juxtaposed embedded clause, that are part of an embedded clause and immediately precede the matrix clause, or that precede the quotative verb *cha*. In a smaller number of cases in each of these categories the boundary tone is missing, but there are practically no occurrences of phrase-medial status suffixes. This is markedly different from what occurs with the other three categories shown in the table. Verbs preceding a demonstrative or discourse particle usually have a phrase-final status suffix and no boundary tone, but in a smaller number of cases have a phrase-medial status suffix. Verbs preceding an embedded clause are of three different types: they usually have phrase-final status suffixes but may or may not have a boundary tone, and in a small number of cases they have phrase-medial status suffixes. This is true whether the following clause is an argument of the verb (subject or object) or an adjunct phrase (temporal, cause, purpose, or condition phrase). Finally, verbs preceding the quotative verb *b'ij* all have phrase-final status suffixes but no boundary tone.[6] In each of these contexts - preceding a demonstrative/discourse particle, embedded clause, or *b'ij* - the lack of alignment of boundary tones, phrase-final status suffixes and clause boundaries is not a minor exceptional pattern, but a dominant one.

These results show that the existence of a boundary tone is likely in most clause-final contexts, though even in cases where the verb precedes a fully independent sentence there is sometimes no boundary tone. For verbs preceding embedded clauses, discourse particles, and the quotative *b'ij*, in contrast, the lack of a boundary tone is not exceptional but rather quite common, and phrase-medial status suffixes may also occur. The following section presents a proposal for how to account for these results from a prosodic perspective.

2.4 Discussion

The previous section details the results of the corpus study, showing that the alternation between phrase-final and phrase-medial status suffixes follows two independent factors: word-final (underlying) consonant cluster phonotactics and phrase position. The effect of word-final consonant clusters is stark: when a verb would otherwise end in a consonant cluster that cannot be word-final, a phrase-final status suffix appears to prevent this. The effect of phrase position, however, is not entirely explained by either clause boundaries nor the positions of IP-final boundary tones. The correlation between these three phenomena is particularly shaky in contexts where there is syntactic recursion at the level of the clause: that is, for verbs followed by embedded clauses, clause-external discourse particles, and the quotative verb *b'ij*.

In Section 2.4.1 I discuss the results of the consonant cluster variable, showing how they fit into the phonotactics of the language. In Section 2.4.2 I provide an analysis of the phrase-position alternation, arguing that phrase-final suffixes appear at all intonational phrase boundaries, but boundary tones are more limited. In Section 2.4.3 I comment on how this pattern fits into the cross-linguistic typology of prosodic morphology.

[6] Note that unlike the quotative *cha*, *b'ij* is always a full verb in K'iche', receiving aspect and person marking and licensing an indirect object.

2.4.1 Status suffixes and consonant cluster phonotactics

The results of the consonant cluster analysis show that verbs that would otherwise end in most types of consonant clusters must appear with (overt) phrase-final status suffixes in medial environments in place of the expected (null) phrase-medial suffixes. Stems ending in clusters formed of a glide or glottal stop followed by another consonant do not trigger the use of phrase-final suffixes in this environment, and there are also two examples with a nasal-fricative cluster with medial suffixes.

Since phrase-final suffixes appear phrase-medially only when a particular phonological configuration would otherwise be found, this process serves as a repair strategy to avoid an unacceptable phonological shape. When phrase-final suffixes appear in this environment, they are not marking a phrase boundary, but only correcting an invalid syllable structure. This same pattern has been previously reported for status suffixes in a few other Mayan languages, Q'anjob'al (Mateo Toledo 2017) and the San Mateo Ixtatán variety of Chuj (Coon 2019; Royer 2022), though it has never been previously reported for K'iche'.

Allowing only clusters formed of a glottal stop or glide followed by another consonant to be word-final in verbs is similar, but not identical, to the general phonotactics of consonant clusters in other word classes. As discussed in Section 1.2.2, consonant clusters appear freely in word-initial and word-medial environments in Chichicastenango K'iche'. Word-final clusters, in contrast, are very limited. The only word-final clusters found outside of verbs are those formed of a glottal stop followed by another consonant or in recent loanwords. To my knowledge there are no non-verb words that end in a cluster of a glide followed by another consonant.

The fact that clusters with glides are permitted in word-final position only in verbs may result from changes in the stress pattern of verbs combined with inherited syllable shapes: while clusters with glottal stop are inherited from proto-Mayan and occur across the Mayan family, the clusters with glides all result from the deletion of a historic intervening vowel, as in *xik'iyr* /ʃik'ij(ə)ɾ/ 'they grew up'. Stress in verbs occurs on earlier syllables in some cases, including this example, but is always word-final in other word classes, and stress prevents vowel deletion (see Chapter 1 for more detail on stress, and Chapter 4 for more detail on vowel deletion). This means that clusters with glides can never be formed outside of verbs.

It is also interesting to note that the two types of allowable consonant clusters found in verbs are both cases where the status of the first segment as a consonant is contestable. Whether the glottal stops that occur in these complex codas in Mayan languages should be considered consonants or rather features of the preceding vowel continues to be debated (Baird 2011; Bennett 2016b). As for the glides, although they clearly come historically from consonants, they could easily be reanalyzed as vowels in this context and form diphthongs with the preceding vowels.

The occurrence of only two tokens with a word-final nasal-fricative cluster and a null phrase-medial cluster is somewhat of a puzzle. It is not clear to me whether this is in fact a commonly allowed consonant cluster verb-finally, or whether there is a different explanation for these two data points (for instance the fact that this speaker frequently mumbles or the fact that this verb is always followed by the directional particle *kä(nöq)*). In other instances I have encountered of this verb outside of the corpus, it is produced with a vowel breaking up the consonant cluster, as in [kanəχ], as shown in 35. There are no other examples of stem-final consonant clusters of this exact shape in the data to compare to.

(35) ***Kkanäj*** *kä waqïb' ik'.*

[	k-∅-kanəχ-∅	kə	waqɪɓ	ʔḯk'	]CP
	INCPL-B:3SG-stay-SS:M	DIR	six	month	

'She stays for six months.' (pedida, 02:58)

Finally, the fact that most stem-final consonant clusters in Chichicastenango K'iche' result from vowel deletion explains why this factor has not been previously identified in the literature on status suffixes in K'iche'. Vowel deletion is particularly common in Chichicastenango K'iche' and is not a well-studied process in this dialect or any of the others in which it occurs. Vowel deletion is not as frequent in other more studied dialects, such as the Nahualá, Santa Cruz del Quiché, and Santa Lucía Utatlán varieties used for previous research on status suffixes (Henderson 2012; Royer 2022), and therefore in these dialects there are not frequent stem-final consonant clusters with the potential to create phonotactically unacceptable words.

2.4.2 Phrase-final forms in a recursive prosodic structure

The results of this study show that for verbs in most types of constructions, clause boundaries, boundary tones, and phrase-final status suffixes coincide, with a small number of exceptions. However, for verbs that are in constructions with recursion in the syntax at the level of the clause, including those preceding embedded clauses, discourse particles, and the quotative verb *b'ij*, the lack of correlation between these three phenomena is not a rare exception pattern but rather a dominant one. In these contexts, verbs sometimes have a phrase-medial suffix and no boundary tone, sometimes a phrase-final suffix and no boundary tone, and sometimes a phrase-final suffix and a boundary tone.

I argue that these results are consistent with a prosodic distribution of status suffixes. Specifically, verbs that are final in an intonational phrase are marked with a phrase-final status suffix in all cases, but boundary tones occur only on verbs that are final in the highest intonational phrase in the structure, i.e., one that is not contained within another intonational phrase. Recursion at the level of the intonational phrase results from the complex relationship between syntactic and prosodic structure. When there is no recursion at the level of the clause, intonational phrase boundaries are always aligned with the clause boundaries. When there is recursion at the level of the clause, the speaker may either still align intonational phrase boundaries to clause boundaries, resulting in recursive intonational phrases, or produce a flat prosodic structure, parsing the two clauses into one larger intonational phrase or two adjacent non-recursive intonational phrases.[7] This is shown schematically as follows.

A single clause will always be parsed into a single intonational phrase, with the clause and IP boundaries in alignment, as shown in 36.

[7] Prosodic structure is traditionally held to be flat rather than recursive (Selkirk 1996). However, a growing body of work shows that recursion is necessary to account for some prosodic structures (e.g. Wagner 2005; Selkirk 2011). This is discussed further later on in this section.

(36) (*clause*)$_{\text{IP}}$
[*clause*]$_{\text{CP}}$

A verb at the end of a single clause like this will appear with a phrase-final status suffix and a boundary tone, as in 37, repeated from 7c above.

(37) ***Kawïlö.***
( )$_{\text{IP}}$
[k-∅-aw-ɪl-ɔ́]$_{\text{CP}}$
INCPL-B:3SG-A:2SG-see-SS:F
'You see it.' (planting, 08:21)

A structure with recursive clauses, however, can be parsed into multiple prosodic structures: either a recursive intonational phrase structure, one intonational phrase containing the whole structure, or separate non-recursive intonational phrases for each clause. This is shown in 38.

(38) a. (*clause 1* (*clause 2*)$_{\text{IP}}$)$_{\text{IP}}$
[*clause 1* [*clause 2*]$_{\text{CP}}$]$_{\text{CP}}$

b. (*clause 1* *clause 2*)$_{\text{IP}}$
[*clause 1* [*clause 2*]$_{\text{CP}}$]$_{\text{CP}}$

c. (*clause 1*)$_{\text{IP}}$ (*clause 2*)$_{\text{IP}}$
[*clause 1* [*clause 2*]$_{\text{CP}}$]$_{\text{CP}}$

A verb at the end of the first clause in a recursive intonational phrase structure like 38a will appear with a phrase-final status suffix, because it precedes an IP boundary, but no boundary tone, because it is not at the end of the highest IP. This is found in examples like 39a (repeated from 33 above), 39b, 39c, 39d (repeated from 24 above), and 39e.

(39) a. ***Käqilö*** *ya mq'ïn ch r qt'ü'y chï q'aq'.*

(

[kə-∅-q-ɪl-ɔ

INCPL-B:3SG-A:1PL-see-SS:F

(							)IP	)IP
[ja	m(ɪ)q'ɪn	ʧ(ɪ)	ɾ(ɪ)	q(ə)-t'ʊʔj	chu	q'áq'	]CP	]CP
already	hot	again	DET	A:1PL-pot	PREP	fire		

'We see that our pot is now hot on the fire.' (3recipes, 03:11)

b. ***Kkilö*** *su r chak kraj p iglesia.*

(

[k-∅-k-ɪl-ɔ

INCPL-B:3SG-A:3PL-see-SS:F

(						)IP	)IP
[su	ɾ(ɪ)	ʧak	k-∅-ɾ-aχ	p(ə)	iglésia	]CP	]CP
what	det	work	INCPL-B:3SG-A:3SG-want	PREP	church		

'They see what work is needed at the church.' (church, 06:15)

c. ***Ka'anö*** *chër pacha la ïn.*

(	(				)IP	)IP
[k-∅-ɓən-ɔ	[ʧɛɾ	paʧa	la	ín	]CP	]CP
INCPL-B:3SG-A:2SG-do-SS:F	COMP	like	DET	1SG		

'You do that which is like me.' (lxe, 06:53)

d. *Je rï'* ***ku'unö*** *rï'.*

((			)IP		)IP
[[χe	ɾɪʔ	k-∅-u-ɓən-ɔ	]CP	ɾíʔ	]CP
like	DEM	INCPL-B:3SG-A:3SG-do-SS:F		DEM	

'Like that it does it.' (planting, 09:28)

e. *Tzij **kkämïk** xu'ij arë'.*

(( )IP)IP
[[tsiχ k-∅-kəm-ɪk]CP ʃ-∅-u-ɓiχ arέʔ]CP
true INCPL-B:2SG-die-SS:F CPL-B:3SG-A:3SG-say 3SG

'... it is true that she will die, he said.' (owl, 02:00)

A verb at the end of the first of two recursive clauses that is phrased into one large intonational phrase, as in 38b, does not precede an intonational phrase boundary at all, and therefore will appear with a phrase-medial status suffix and no boundary tone. This occurs in examples like 40a (repeated from 23a above), 40b (repeated from 23b above), and 40c.

(40) a. *Je tä r **ki'in** chër kichäpö.*

(
[χe tə ɾ(ɪ) k-∅-i-ɓən-∅
like IRR DET INCPL-B:3SG-A:2PL-do-SS:M

)IP
[ʧɛɾ k-∅-i-ʧəp-ɔ́]CP]CP
COMP INCPL-B:3SG-A:2PL-catch-SS:M

'It's not like that what you do to catch them.' (fishing, 05:23)

b. ***Kqïl** k'ö r kär keq'axïk.*

(
[k-∅-q-ɪl-∅
INCPL-B:3SG-A:1PL-see-SS:M

)IP
[k'ɔ ɾ(ɪ) kəɾ [k-e-q'aʃ-ík]CP]CP]CP
EXIST det fish INCPL-B:3PL-pass-SS:F

'We see there are fish passing by.' (fishing, 03:38)

c. ***Xeqaj*** *rï'.*

( )IP

[[ʃ-e-e-qaχ-∅]CP ɾɪʔ]CP

CPL-B:3PL-go-descend-SS:M DEM

'They arrived.' (mr, 02:52)

There are no examples of this type preceding the quotative verb *b'ij*, but this may be due to the small amount of data in this category (only 5 tokens).

Finally, a verb at the end of the first of two recursive clauses that is phrased into two independent intonational phrases, as in 38c, will have a phrase-final status suffix because it precedes an IP boundary and will bear a boundary tone because it is at the end of an IP that is not contained within another IP. This occurs in examples like 41a, repeated from 7b above, and 41b, repeated from 17 above.

(41) a. ***Kawilö*** *su r kuya r ja'.*

( )IP

[k-∅-aw-ɪl-ɔ́

INCPL-B:3SG-A:2SG-see-SS:F

( )IP

[su ɾ(ɪ) k-∅-u-ja-∅ ɾ(ɪ) χáʔ]CP]CP

what DET INCPL-B:3SG-A:3SG-give-SS:M DET water

'You see what the water gives.' (fishing 10:32)

b. *Bien* ***käpq'öwik*** *rech k'ok' ku'un la qärkil.*

( )IP (

[bien kə-∅-p(ɔ)q'ɔw-ík [ɾ-etʃ

well INCPL-B:3SG-boil-SS:F A:3SG-REL.NOUN

)IP

k'ok' k-∅-u-ɓən-∅ la qə-ɾ(ɪ)kíl]CP]CP

tasty INCPL-B:3SS-A:3SG-do-SS:M DET A:1PL-meal

'It boils well so that our meal will be tasty.' (caldores, 01:01)

This type of structure is not found for verbs preceding discourse particles. This is likely because the discourse particles, most of which are only one syllable long, are too small to form an intonational phrase on their own. This type of structure is also not found for verbs preceding the quotative *b'ij*, but this may be due to the small amount of data in this category (only 5 tokens).

These three surface patterns are found in very similar syntactic structures. For example, 39b and 41a each show the verb *ïl* 'see' followed by an embedded clause introduced by *su* 'what' acting as its object; a boundary tone occurs in 41a but not 39b. 39a and 40b each show the same verb *ïl* 'see' followed by an embedded clause with no overt complementizer; 40b has a phrase-medial status suffix and 39a a phrase-final status suffix. Similarly, 39c and 40a each precede an embedded clause introduced by the complementizer *chër*; 40a has a phrase-medial status suffix and 39c a phrase-final status suffix. Therefore, the exact syntactic structure in each case is not sufficient to predict the prosodic outcome, and speakers must have some degree of choice.

The fact that it is specifically structures with recursion at the clause level where the prosodic output may or may not match the syntax fits well with current understand of the factors involved in the relationship between syntactic and prosodic structure, as it is in these contexts where it is impossible to avoid prosodic recursion while aligning syntactic and prosodic boundaries. Since the beginnings of the study of the relationship between syntax and prosody there has existed the intuition that prosody is somehow flatter than syntax; that is, recursion is absent or less prevalent in prosodic structures than in syntactic structures. Different constraints have been proposed to account for this within the Optimality Theory tradition, including Selkirk's (1996) NON-RECURSION and Myrberg's (2013) EQUAL-SISTERS. However, the fact that these constraints may sometimes be violated and recursion is necessary to fully explain prosodic structure is supported by a growing body of work (e.g. Wagner 2005; Kabak et al. 2009; Schreuder et al. 2009; Selkirk 2011; Ito and Mester 2012; Myrberg 2013; Cheng and Downing 2012). Bennett (2018) argues for the need for recursive prosodic words in Kaqchikel, a language closely related to K'iche'. The need for alignment of clause and IP boundaries, in turn, has been explained through constraints such as Selkirk's (2011) Match constraints, which require that the edges of (illocutionary) clauses correspond to the edges of intonational phrases and vice versa (both Syntax-Prosody faithfulness and Prosody-Syntax faithfulness). The need for a minimum size or preference for balance between sisters at different levels of the prosodic hierarchy is referenced in many works, among them Dehé (2009), Elordieta (2007), and Ghini (1993). The varying prosodic outputs of the same recursive syntactic structures can be seen as prioritizing either the alignment between syntactic and prosodic boundaries or the dispreference for recursive prosodic structures, as either one or the other must be violated when there is clause-level recursion. The outputs for non-recursive clause structures are much more uniform, as there is no tension between these forces.[8]

Having shown that the possibility of recursion at the intonational phrase level can account for the similar but not identical distributions of boundary tones and phrase-final status suffixes, it is worth taking a moment to consider whether a non-recursive analysis is possible. Two possibilities are either that boundary tones and status suffixes are not conditioned by the same prosodic category, or that boundary tones are simply optional. However, neither of these options satisfactorily accounts for the data. Both boundary tones and phrase-final status suffixes are strongly correlated with clause boundaries, but there are some clause boundaries where phrase-final suffixes appear without a boundary tone. If these two phenomena were conditioned by different prosodic boundaries, they would be expected to correlate with different syntactic boundaries, such as the 'illocutionary' clause (highest syntactic projection of the sentence) vs. the 'standard' clause (any CP) (Selkirk 2011). Variability in the surface form, with either *both* phrase-final status suffixes and boundary tones, *only* phrase-final status suffixes, or *neither* phrase-final status suffixes nor boundary tones occurring in the same syntactic contexts would not be expected. If boundary tones were simply optional, this would not explain why they are much less frequent on clause-final verbs that are in contexts with recursive clauses or why phrase-medial status suffixes are sometimes found in these same contexts.

[8]It is worth noting that variable ranking of the same constraints within the same language in different instances is not the usual assumption of Optimality Theory. However, the existence of intraspeaker variation in surface forms in many different linguistic constructions cross-linguistically is clear. One approach to making sense of this variation within Optimality Theory is the notion of 'floating' constraints, which are specified to be ranked anywhere within a particular range (Reynolds 1994).

The types of constructions where phrase-final status suffixes, boundary tones, and clause boundaries fail to align include verbs followed by embedded clauses, discourse particles, and the quotative *b'ij* (which follows its quotation). However, this lack of alignment is not found in some other types of constructions that might at face value be expected to have recursive syntactic structure at the clause level. These include constructions with preverbal clauses introduced by *kuando* 'when' and *si/we* 'if' as well as verbs preceded by the other quotative verb, *cha*. However, there are some additional reasons to consider these fronted clauses syntactically independent or at least outside of the main clause, despite their semantic contributions.

The case is clearest for quotations preceding the quotative verb *cha*. This verb is formally intransitive and has only absolutive agreement with the speaker, meaning that the quotation cannot be a syntactic argument of the quotative verb (see 18 above). This contrasts with what occurs with the other quotative verb, *b'ij*, which is formally transitive and agrees with both speaker (ergative) and quotation (absolutive), and as shown above occurs without a boundary tone on the quotation in all cases indicating a recursive prosodic structure (see 39e above). Thus, the quotation is associated semantically to the quotative verb *cha*, but not syntactically, and does not create a recursive syntactic structure at the level of the clause.

In the case of preverbal *when* and *if* clauses, the structure is less clear and worthy of further research. However, there are still reasons to believe that these clauses may be syntactically independent, or at the very least outside of the main clause. Basic word order in K'iche', and across the Mayan language family, is verb-initial. When constituents occur in a preverbal position, they are commonly analyzed as either focused (through movement) or topicalized (through left-dislocation), following and expanding on a proposal made by Norman (1977) (see e.g. Velleman 2014; Larsen 1988).[9] Topicalized constituents, unlike preverbal focused constituents, are separated from the remainder of the sentence by a prosodic

[9] Velleman (2014) clarifies that focus and movement on the one hand, and topicalization and left-dislocation on the other, do not necessarily always go together, as they are separate concepts. The distinction between movement and left-dislocation is syntactic and that between focus and topic semantic/information structural. However, many Mayanist researchers have assumed a one-to-one relationship between these concepts, and the term 'topicalization' is used loosely here.

boundary (they bear an intonational phrase boundary tone and may be followed by a pause), and this is true whether they are full clauses or not.

It can be difficult to determine whether or not these topicalized phrases are syntactic arguments of the main clause. This is because they often refer to the same entity as the agreement on the main verb and overt subject and object arguments are rare, as is common in pro-drop languages. However, in some cases it is very clear that the topicalized constituent cannot be an argument of the main verb. Two examples from the Chichicastenango K'iche' corpus are shown in 42.

(42) a. *E k' at, mpa ajnab'?*

[e k'(ʊ) át]CP [(χʊ)mpa a-χ(ʊ)náɓ]CP

CT 2SG how.many A:2SG-year

'And you, how old are you?.' (lit: 'as for you, how many are your years?') (mr, 00:38)

b. *Qe öj rï', k'ö wa qtzij k'iche'.*

[q-e ɔχ ɾíʔ]CP

A:1PL-REL.NOUN 1PL DEM

[k'ɔ wa q(ə)-tsiχ k'itʃéʔ]CP

EXIST DET A:1PL-language K'iche'

'But for us there is our K'iche' language.' (lx, 02:47)

In these examples, the topicalized noun phrases cannot be syntactic arguments of the main clause, because they reference the possessor of the subject noun phrase in each case rather than the subject itself. The main clauses each have a non-verbal predicate and overt subject noun phrase: *ajnab'* 'your years' in 42a and *wa qtzij k'iche'* 'our K'iche' language' in 42b.

These examples are of noun phrases, but a similar phenomenon can be observed for *when* and *if* adverbial clauses. In the corpus these types of clauses sometimes have an initial complementizer *kuando* 'when' (borrowed from Spanish), *si* 'if' (borrowed from Spanish), or *we* 'if'. However, in other cases there is no complementizer, but the phrase has the clear semantic contribution of a typical adverbial phrase. An example is shown in 43.

(43) *Ktzäktïk rï qti', käqya uberduras.*

[k-∅-tsək-t(əχ)-ɪk ɾɪ q-tí́ʔ]$_{\text{CP}}$

INCPL-B:3SG-cook-PASS.C-SS:F DET A:1PL-meat

[kə-∅-q(ə)-ja-∅ u-beɾdúɾa-s]$_{\text{CP}}$

INCPL-B:3SG-A:1PL-give-SS:M A:3SG-vegetable-PL

'(When) the meat is completely cooked, we add the vegetables.' (3recipes, 04:40)

In this construction, the first clause *ktzäktïk rï qti'* has the literal meaning 'the meat is finished cooking', and no overt mechanisms by which to connect it to the following phrase *käqya uverduras* 'we add the (soup's) vegetables', thus a literal translation of the whole construction would be 'The meat is finished cooking. We add the vegetables.' However, semantically the two phrases are connected with the first indicating the temporal condition for the second, and a more natural English translation would be 'When the meat is finished cooking, we add the vegetables.' These two phrases are semantically related, but it is not clear that they are syntactically related.

These fronted adverbial phrases may also appear in variable order with (other) topicalized phrases, as shown in 44. In 44a the *when* phrase precedes the topicalized subject noun phrase, whereas in 44b it follows it. In both of these constructions, each of the topicalized phrases ends in a boundary tone, as does the main clause.

(44) a. *Kuando jwert jäb' ku'unö, r qäwnaq rï', ki'e la' b'ï b'äjche'.*

[kuando χwert χəɓ k-∅-u-ɓən-ɔ́]$_{\text{CP}}$

when a.lot rain INCPL-B:3SG-A:3SG-do-SS:F

[ɾ(ɪ) qə-w(ɪ)nəq ɾíʔ]$_{\text{CP}}$

DET A:1PL-person DEM

[k-i-ɓe-∅ laʔ ɓɪ ɓəχʧéʔ]$_{\text{CP}}$

INCPL-B:3PL-go-SS:M DEM DIR early

'When it rains heavily, our people, they go out early.' (mushrooms, 06:16)

b. *We ïn, kuando chër xïnk'äm la ntzij ïn, eh wäjxqïb' njnab'.*

[	w-e	ín	]$_{CP}$	[	kuando	ʧɛɾ	ʃ-∅ɪn-k'əm-∅
	A:1SG-REL.NOUN	1SG			when	COMP	CPL-B:3SG-A:1SG-take-SS:M

la	n-ʦiχ	ín	]$_{CP}$	[	wəχʃ(ə)qɪɓ	n-χ(u)náɓ]$_{CP}$
DET	A:1SG-language	1SG			eight	A:1SG-year

'I, when I started speaking [Spanish], I was eight years old.' (mr, 08:25)

All together, the behavior of these fronted clauses is strikingly similar to what Aissen (1992) calls 'external topics' in the Mayan languages Tzotzil and Jakaltek, which she analyzes as base-generated above the domain of the main clause, outside of the highest CP. External topics in these languages may co-occur with a coreferential noun phrase within the clause, but may also have no syntactic connection to any arguments in the main clause, and constitute separate intonational phrases from the following main clause as indicated by the pitch contour and locations of pauses. Adverbial phrases may be external topics, and in these cases may appear before a topicalized noun phrase.

In sum, fronted *when* and *if* clauses occur with a prosodic break separating them from the main clause and are very similar to constructions where a topicalized noun phrase or first clause is syntactically independent from the main clause, despite a semantic association. These clauses can be variably ordered with topicalized noun phrases and show many similarities with 'external' topics in other Mayan languages which are analyzed as outside of the highest CP (Aissen 1992). Thus it is quite plausible that these clauses are syntactically independent from the following main clause, or at the very least fully outside of the main clause, and therefore not part of a recursive syntactic structure at the level of the clause. No recursive prosodic structures diagnosable through the mismatch of clause boundaries, phrase-final status suffixes, and boundary tones are found because there is no recursion in the syntax at the level of the clause in these constructions.

To summarize the analysis presented in this section, it is argued that phrase-final status suffixes appear on all verbs that precede an IP boundary, whereas boundary tones appear only at the end of an IP not contained within another IP. All clause boundaries have a corresponding intonational phrase boundary, except in constructions with recursion at the level of the clause. In these cases, the recursive syntactic structure may be phrased into either recursive intonational phrases or a flat intonational phrase structure (with either one large IP or two adjacent IPs). The options available for recursive syntactic structures favor either the alignment of syntactic and prosodic boundaries, or the dispreference for recursion at the level of the intonational phrase. This analysis accounts for the highly correlated but not identical distributions of clause boundaries, phrase-final status suffixes and boundary tones found in the data.

2.4.3 Status suffixes in the typology of prosodic morphology

The proposal presented here argues that phrase-final status suffixes occur in two distinct types of environments: on verbs otherwise ending in word-final consonant clusters and on verbs that precede an intonational phrase boundary. While the former restriction represents allomorphy dependent on immediate segmental context which is common across languages, the latter constitutes a type of prosodic morphology sensitive to intonational phrases. Cross-linguistically, this appears to be quite unusual: Paster (2006) finds evidence of affixes that vary in form due to segments, features, tone, stress, syllable or mora count, and foot structure, but none that relate to the higher level of intonational phrase position. Within K'iche', however, this type of contrast is prevalent throughout the grammar, with a large number of morphemes beyond status suffixes (especially functional words) having phrase-final and phrase-medial forms.

Henderson (2012) argues the phrase-final/phrase-medial alternation in K'iche' is optimizing for stress placement, and thus is not so different from patterns that depend on metrical structure at lower levels like word or foot. Specifically, the proposal is that intonational phrases in K'iche' affect stress placement, requiring a stress peak in their right-most position. The syllable in the final position of the intonational phrase must be lexically stressed and is marked with a rising boundary tone, which simultaneously makes this the most prominent syllable of the intonational phrase and also delimits its edge. Of the many K'iche' morphemes which have phrase-final and phrase-medial forms, the majority include a final consonant in the phrase-final form that is absent in the phrase-medial form, creating a syllable more suited for bearing this final prominence. Phrase-final status suffixes, however, are not always directly optimizing in terms of syllable structure, as some of the final suffixes are plain vowels, creating a final open syllable. Henderson argues that they are instead lexically specified for IP prominence, and therefore always stressed and found in the prominent rightmost position of an IP where the boundary tone falls.

However, there are two issues with such an analysis for the Chichicastenango data. First, stress on verbs is not always on the final syllable of the verb in this dialect, and in fact almost never falls on the status suffixes, most of which appear to be outside of the stress domain (see Section 1.2.3.1). When a verb bears a boundary tone, it falls on the status suffix, which is therefore very acoustically prominent. However, this syllable is still not stressed at the word level, as demonstrated through the highly regular vowel deletion pattern: a lax vowel in a CV syllable preceding the stressed syllable would always be expected to be deleted, but deletion never occurs in these types of syllables when preceding the status suffixes *-ïk*, *-öq*, or *-ö/ü* (see Section 4.1.1).

Second, although phrase-final status suffixes *usually* occur with a boundary tone and are acoustically prominent in Chichicastenango K'iche', they do not always. When phrase-final suffixes occur in positions that do not bear boundary tones (such as preceding demonstrative/discourse particles or on phrase-medial verbs ending in consonant clusters) these suffixes are not typically perceptually or acoustically prominent. An example is shown in 45 and in Figure 2.5.

(45) ***Kächq'ïjïk*** *rï'.*

[[kə-∅-ʧ(ə)q'ɪχ-ɪk]$_{CP}$ ɾíʔ]$_{CP}$

INCPL-B:3SG-cook-SS:F DEM

'It cooks.' (chilmol, 01:04)

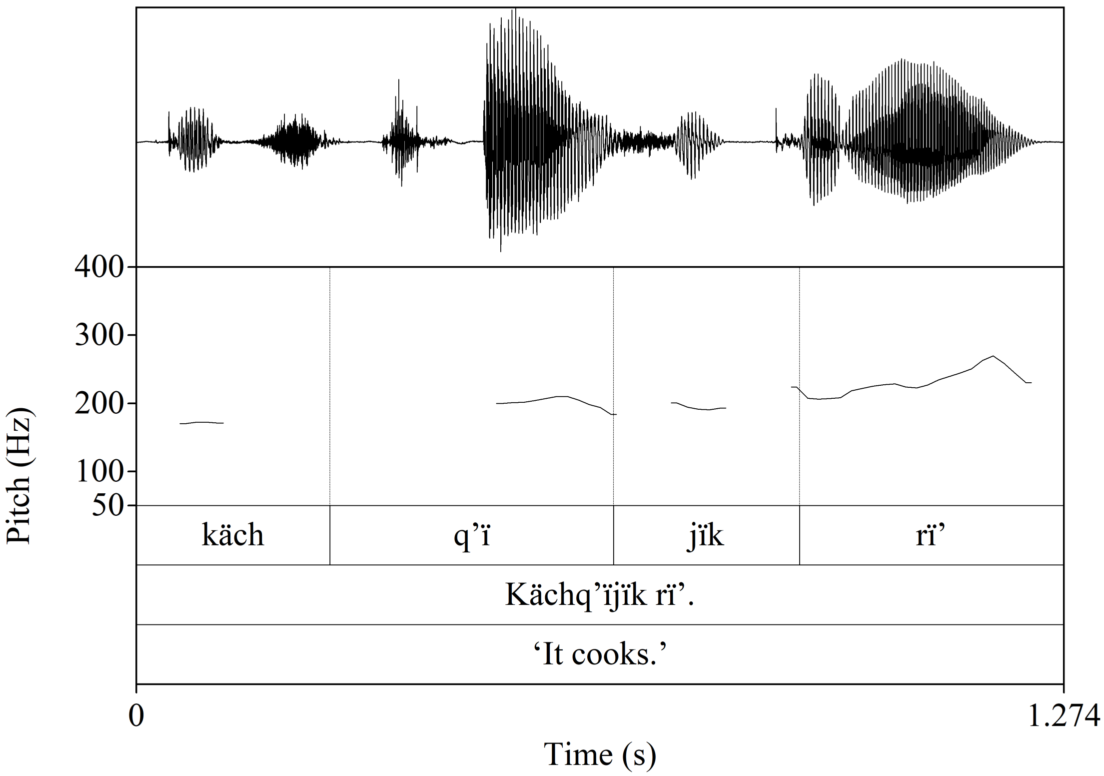


Figure 2.5: Medial verb *kächq'ïjïk* with non-prominent phrase-final status suffix *-ïk*

Here the verb *kächq'ïjïk* 'it cooks' occurs with the phrase-final status suffix *-ïk*. This syllable, as can be seen in the waveform, is very short and of low amplitude – not at all acoustically prominent. The preceding syllable *q'ï* is stressed and is both long in duration and large in amplitude. The verb is followed by the demonstrative *rï'*, which bears the intonational phrase final boundary tone.

Therefore, in Chichicastenango K'iche' the frequent acoustic prominence of phrase-final status suffixes appears to result from their occurrence in a prominent position rather than being inherent or lexically specified. This makes this pattern quite different from others previously described where allomorphy is dependent on metrical structure.

2.5 Conclusion

This chapter reports the results of a corpus-based study of phrase-medial and phrase-final status suffixes in the Chichicastenango dialect of K'iche'. In addition to showing the distribution of the different status suffix types in the broad array of environments in which they may occur in naturalistic data, the study addresses two primary questions: the correlation with syntactic and prosodic boundaries and the effect of word-final consonant clusters.

The results of the consonant cluster analysis show that verb stems ending in underlying consonant clusters cannot occur with null status suffixes unless the first consonant is a glide or a glottal stop, and there are also two examples with a nasal-fricative cluster. If a stem ending in any other type of cluster would be expected to have a null phrase-medial suffix due to its transitivity, mood and phrase-position, the overt phrase-final suffix for the same class is used instead. This prevents these consonant clusters from being word-final.

The results of the phrase position variable show that although there is a majority of phrase-final status suffixes on clause-final verbs and verbs with boundary tones and a majority of phrase-medial suffixes on clause-medial verbs and verbs without boundary tones, neither clause boundaries nor boundary tone positions correlate perfectly with this alternation. Specifically, a lack of alignment between clause boundaries, status suffixes and boundary tones is common on verbs which precede embedded clauses, discourse particles, and the quotative verb *b'ij*, whereas it is uncommon in other contexts. The unifying factor in these cases is that they involve recursion in the syntax at the level of the clause. It is argued that these results are due to the complex relationship between syntactic and prosodic structure. Phrase-final status suffixes appear on all verbs preceding an IP boundary and phrase-medial status suffixes on verbs that do not precede an IP boundary. Boundary tones, however, are licensed only at the end of an IP not contained within another IP. When there is recursion at the clause level in the syntactic structure, speakers are forced to compromise either the alignment between syntactic and prosodic boundaries or the restriction against IP-level recursion in the prosody, producing either a recursive prosodic structure or a flat prosodic structure (either as one large IP or two adjacent IPs). This results in the three surface patterns observed in the data in these contexts: phrase-medial status suffix and no boundary tone, phrase-final status suffix and no boundary tone, or phrase-final status suffix and boundary tone.

To my awareness, this constitutes the first in-depth study of the distribution of phrase-final and phrase-medial status suffixes in a corpus of spontaneous speech of a Mayan language. Positional allomorphy in status suffixes and other word classes is found across the Mayan language family, though especially in the K'iche'an and Q'anjob'alan branches (Polian 2017), e.g. in Sakapulteko (Mó Isém 2007), Uspanteko (Can Pixabaj 2007), Q'anjob'al (Mateo Toledo 2017), Popti' (Tuyuc Sucuc 2001), Chuj (Coon 2019), and Ixil (Adell 2019), among others. However, there has been very little work on this topic for languages other than K'iche' and Chuj, where the primary data came from targeted elicitation. For most other languages the only available descriptions note the existence of "phrase-final" forms, but provide no discussion of the relevant phrasal domain or any apparent exceptions (e.g. Mó Isém 2007, Tuyuc Sucuc 2001, Can Pixabaj 2007). In K'iche' the phrase position alternation is particularly prevalent in the grammar, appearing not only on status suffixes but also for a range of other morphemes, including directional particles (e.g. *lö(q)* 'towards speaker', *b'ï(k)* 'away from speaker'), positional adjectives (e.g. *kü'l(ïk)* 'sitting'), and a number of individual function words such as the existential *k'ö(lïk)*, the irrealis marker *tä(j)* and *chï(k)* 'again, still'. Although it is frequently assumed that all of these alternations are conditioned by the same factors, both within individual languages and across the family, very little work exists to verify this expectation. Status suffixes and other types of phrase-final marking in Mayan languages remain an understudied topic with much potential to inform prosodic and syntactic theory.

Chapter 3

Word-initial vowels and glottalization

3.1 Introduction

In Mayan languages, glottal stop occurs phonemically in intervocalic and word-final positions, as in the contrast between *ja* /χa/ 'house' and *ja'* /χaʔ/ 'water' in Chichicastenango K'iche'. In word-initial position, however, glottal stops do not occur contrastively. There are no existing descriptions of whether initial glottal stops occur in Chichicastenango K'iche'. However, many descriptions of other Mayan languages state that glottal stops occur predictably on all words in these languages which would otherwise begin with a vowel (e.g. Bennett 2016b, Kaufman 2015 on cross-family patterns; Orie and Bricker 2000, Frazier 2009 on Yucatec Maya; England 1983 on Mam; Bennett 2018 on Kaqchikel; DuBois 1981 on Sakapultek; Bennett et al. 2022 on Uspantek; Barrett 1999 on Sipakapense). Whether these word-initial glottal stops are phonemic or epenthetic continues to be debated (Kaufman 2015, Bennett 2016b).

Although the basic description that glottal stop appears on all otherwise vowel-initial words is found in a large number of works on languages across the Mayan family, it is usually presented as a generalization without supporting evidence. These descriptions are primarily based on perceptual impressions of researchers, many of whom are not native speakers of languages where word-initial glottal stop is contrastive, making it very difficult to perceive. Descriptions are not typically supported with acoustic nor quantitative data, and are sometimes based on words produced in isolation or in carefully elicited contexts; data from spontaneous or continuous speech is very underrepresented. Despite the prevalence of statements that all words begin with a consonant, a smaller number of works present more restricted generalizations for individual languages. In the case of K'iche', a number of contradictory descriptions can be found in the literature. López Ixcoy (1997) states that words written with an initial vowel begin in truth with a glottal stop in all cases. Kaufman (2015) says that all otherwise vowel-initial words have an underlying glottal stop, but it is deleted when the previous word ends with a consonant. Barrett (2007) says that all syllables in K'ichean languages must begin with an onset, resulting in the insertion of a glottal stop on otherwise vowel-initial un-prefixed roots. He also notes that a subset of words in each dialect, especially Spanish loans, appear to have phonemic word-initial glottal stops as these segments do not disappear under prefixation. Larsen (1988), however, states that glottal stops are inserted word-initially only on words that are in utterance-initial position, words that follow a word ending in a vowel, and words that are stressed monosyllables.

These diverse descriptions each set out to describe K'iche' as a language rather than a specific dialectal variant. None of these descriptions identify significant cross-dialect diversity with regards to the phonetic distribution of word-initial glottal stops. Furthermore, the authors all rely on data from some of the same or closely related dialects. Barrett (2007) mentions data from Nahualá and Santa Catarina Ixtahuacán. Kaufman (2015) does not state which variety the data came from but in other works discusses fieldwork in Nahualá, Chichicastenango, Cubulco and Rabinal (Kaufman and Justeson 2003). López Ixcoy (1997) is based primarily on her own native variety of Santa Cruz del Quiché, but also includes reference to data from Nahualá and San Miguel Chicaj. Larsen (1988) mentions contact with speakers from Momostenango, Santa María Chiquimula, Nahualá, Santa Catarina Ixtahuacán, Zunil and Cantel. Therefore, dialect variation on its own cannot explain these disparate descriptions.

This chapter presents acoustic and (morpho)phonological data from the Chichicastenango dialect of K'iche' that clarifies the phonetic distribution of word-initial glottal stops as well as their phonological analysis. It is demonstrated that K'iche' does have vowel-initial words, and there is no evidence for underlying word-initial glottal stops. Epenthetic glottal stops appear in the surface form in a set of restricted contexts: on words with otherwise initial stressed vowels, between a vowel-final word and a vowel-initial word, and on a vowel-initial word following a pause. Additionally, glottalized phonation is found as a prosodic marker on vowel-initial words that begin an intonational phrase.

The organization of the chapter is as follows. Section 3.2 reviews some background information on glottal stop and glottalized consonants in K'iche'. Section 3.3 presents a corpus study of the acoustic realization of word-initial glottal stops and vowels, including the methods, results, and interpretation. Section 3.4 presents (morpho)phonological evidence for a structural difference between words apparently beginning with stressed and unstressed vowels: words with initial stressed vowels pattern like words beginning with consonants rather than words beginning with unstressed vowels. This includes evidence from coda elision in proclitics and from vowel quality alternations in initial syllables. Section 3.5 discusses these results, arguing that they demonstrate that word-initial glottal stops are epenthetic in K'iche' as well as showing some problems with previous arguments that these segments must be underlying. Finally, Section 3.6 concludes the chapter.

3.2 Voice quality and glottal(ized) consonants in K'iche'

K'iche' has a phonemic glottal stop, which occurs intervocalically and in coda position. There is also a series of glottalized consonants which cause glottalized phonation on adjacent vowels.

3.2.0.1 Glottal stop

Glottal stop appears phonemically in intervocalic position in K'iche' in a small number of words where a historical VʔV sequence has been maintained, such as *ti'ij* /tiʔiχ/ 'meat' (marriage, 02:40), *u'al* /uʔal/ 'broth, juice' (3recipes, 04:58) or *mi'al* /miʔal/ 'daughter (of a man)' (owl, 01:15). As illustrated in Figure 3.1, the phonemic glottal stop in these words may be realized with a full closure (as in *mi'al* on the left) or reduced to creaky voicing (as in *u'al* on the right), as is common for glottal stops cross-linguistically (Garellek 2013) .

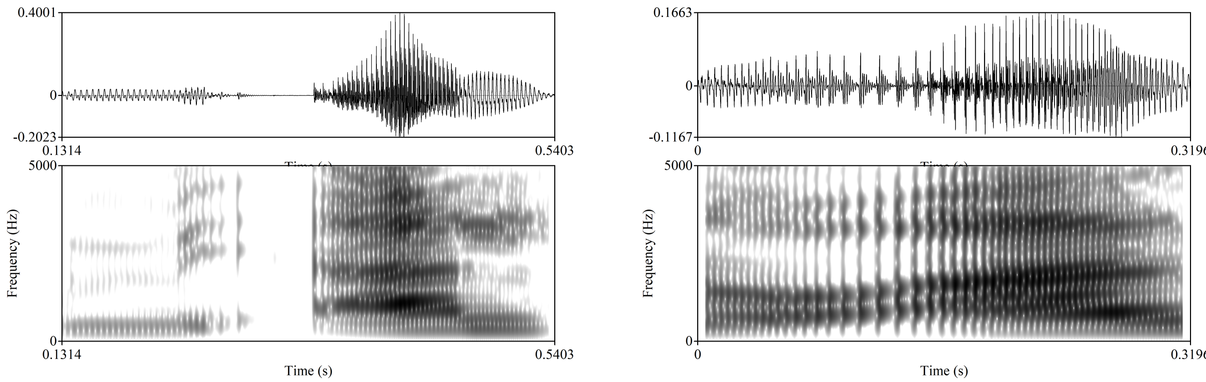


Figure 3.1: Two instances of words with intervocalic phonemic glottal stop: *mi'al* 'daughter' on the left is produced with a full closure and *u'al* 'broth' on the right is produced with a period of creaky voicing

Phonemic glottal stop also occurs frequently in coda positions. This can be seen in minimal pairs such as the following.

(46) a. *ja*
χa
house
'house' (history, 02:19)

b. *ja'*
χaʔ
water
'water' (fishing, 03:00)

(47) a. *che*
ʧ-e
PREP-REL.NOUN
'to it' (planting, 00:54)

b. *che'*
ʧeʔ
tree
'tree' (planting, 03:54)

The contrast between *ja* 'house' and *ja'* 'water' is shown in Figure 3.2.

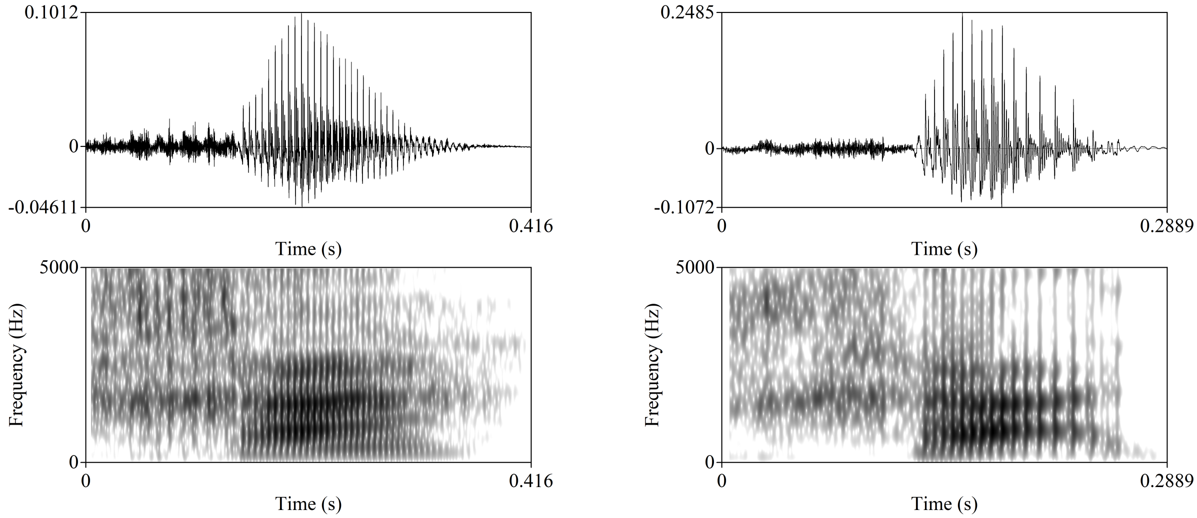


Figure 3.2: Contrast between *ja* 'house' ending in a vowel and *ja'* 'water' with a final glottal stop

In addition to plain codas, sometimes glottal stop appears as the first element of a complex coda. This creates contrasts such as the following:

(48) a. *rij*
ɾ-iχ
A:3SG-back
'its back' (healing, 11:02)

b. *r'ij*
ɾiʔχ
old
'old' (healing, 07:17)

(49) a. *qül*
qʊl
throat
'throat' (healing, 01:51)

b. *qü'l*
qʊʔl
turkey
'turkey' (mxm4, 05:52)

Whether these types of words contain instances of a phonemically modal vowel followed by a glottal stop segment or rather a phonemic glottalized vowel is debated in the literature, both of K'iche' and of similar patterns in related languages (Baird 2011; Bennett 2016b). A phonetic study of K'iche' shows that the phonetic realization of these types of syllables varies by dialect, speaker, and context. However, realizations with full closures as well as those with creaky voicing or other non-modal phonation but no full closure are attested (Baird 2011). In Yucatec Maya, comparable tokens are usually produced with creaky voicing on the second part of the vowel but not full closures (Frazier 2009).

There exists no rigorous acoustic study of these vowels in Chichicastenango K'iche'. However, observation of a number of tokens of several different speakers shows that their realization with a full glottal closure is extremely rare. Rather, these vowels are nearly always produced with a first modal portion followed by a period of creak or aperiodicity which gives the perceptual impression of the presence of the glottal. This would mean that the realization of these vowels in Chichicastenango K'iche' is more akin to that in Yucatec Maya (Frazier 2009) than in other K'iche' dialects (Baird 2011). Figure 3.3 shows several instances of the word *nö's* [nɔʔs] 'turkey' produced by different speakers. In each the second part of the vowel is creaky, of low intensity, or less periodic, but there is no complete closure.

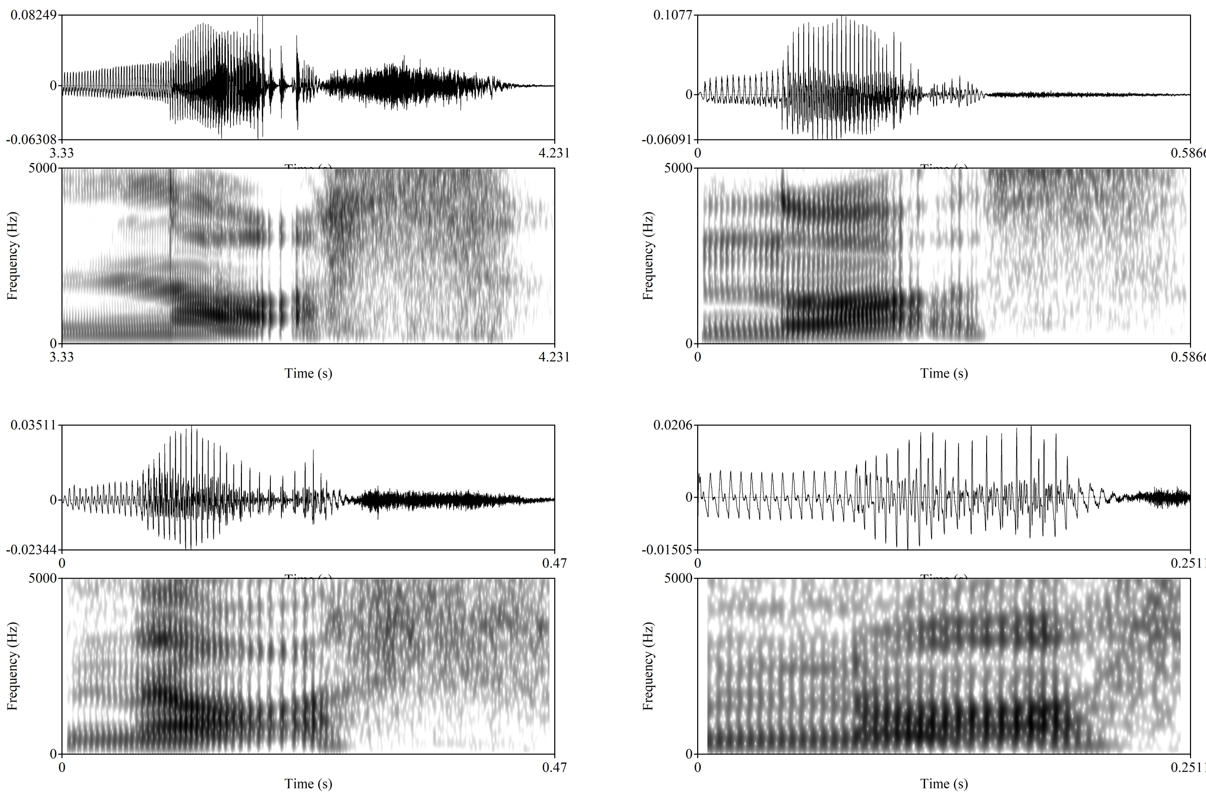


Figure 3.3: Four instances of the word *nö's* 'turkey' by three different speakers

3.2.0.2 Ejective and implosive consonants and allophony with glottal stop

All Mayan languages have a contrast between a set of plain stops and affricates and a corresponding set of consonants typically referred to as 'glottalized' (England and Baird 2017), which may be realized as ejective or implosive depending on the language, place of articulation, and sometimes speaker or instance. Irrespective of the realization as ejective or implosive, these sounds cause glottalized phonation on adjacent vowels. In K'iche' the alveolar, postalveolar, palatal, velar, and uvular glottalized consonants are typically produced as ejectives, while the bilabial counterpart is typically realized as an implosive. These sounds are shown in Table 3.1.

	Bilabial	Alveolar	Postalveolar	Palatal	Velar	Uvular
Plain stop	p	t			k	q
Glottalized stop	ɓ	t'			k'	q'
Plain affricate		ʦ	ʧ			
Glottalized affricate		ʦ'	ʧ'			

Table 3.1: Contrast between plain and glottalized consonants in K'iche'

The glottalized consonants - most commonly ɓ and q' - are sometimes produced phonetically as glottal stops, especially in high-frequency words.[1] For example, *q'aq'* /q'aq'/ 'fire' may sometimes be realized as [q'aʔ] or [ʔaʔ], and the verbs *b'än* /ɓən/ 'do', *b'e* /ɓe/ 'go', *b'in* /ɓin/ 'walk' and b'ij /ɓiχ/ 'say' are commonly realized as [ʔən], [ʔe], [ʔin] and [ʔiχ], respectively, where the glottal stop may be produce with a full closure or reduced to glottalization of adjacent vowels.

Figure 3.4 shows two different productions of the word *q'aq'* 'fire'.

[1]See Barrett (2007) for a more extensive discussion of these processes in various K'ichean languages.

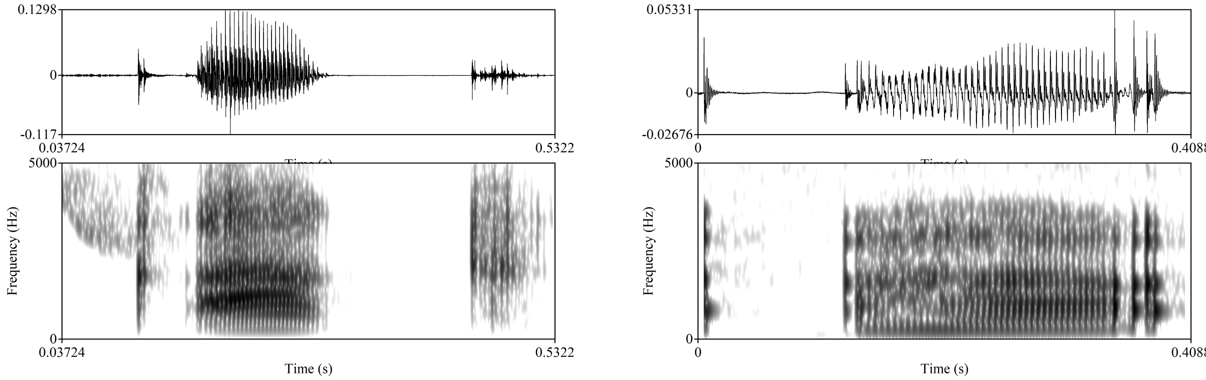


Figure 3.4: Two instances of the word *q'aq'* 'fire': as [q'aq'] on the left and as [ʔaʔ] on the right

3.3 Acoustic evidence for word-initial vowels and glottal stops

In order to clarify the phonetic distribution of word-initial glottal stops and vowels in Chichicastenango K'iche', I studied the acoustics of vowel- and glottal stop-initial words in the corpus. The goals of this study were to see where full glottal closures and other acoustic indications of glottalized phonation occur at the beginnings of words in the corpus, including the time course of these measures throughout initial vowels and what contextual, prosodic or other factors condition their appearance. The following sections detail the methods and results of this study.

3.3.1 Methods

3.3.1.1 Data

The data for this study comes from the corpus of spontaneous narratives described in Section 1.3. Every word in the corpus that begins with a vowel or glottal stop in the transcription was included in this study, with the exception of any uncertain transcriptions, for a total of 2628 tokens.

3.3.1.2 Segmentation

Word-initial vowels and full closures were segmented in Praat (Boersma and Weenink 2023). The boundaries between vowels and consonants were marked primarily with reference to the intensity curve. The beginning of the vowel was marked at the onset of sound when preceded by silence, after the stop burst when preceded by a voiceless stop, and where the amplitude begins to increase when preceded by a fricative, voiced stop, nasal, liquid, or glide. The end of a vowel was marked at the offset of sound when followed by silence, at the offset of voicing when followed by a voiceless stop, and where the amplitude is no longer decreasing when followed by a fricative, voiced stop, nasal, liquid or glide. If these indicators were ambiguous, the onset or offset of formants and antiformants was used as a secondary indicator. The boundary between two vowels in hiatus was located at the middle of the formant transition, or when the formant transitions were unclear, at the location of the sudden change in the intensity curve. When both formants and intensity were ambiguous, the midpoint of the whole VV interval was used instead. Word-initial diphthongs, found in the corpus only in the Spanish borrowings /ue.bon/ 'lazy' and /auk.si.liaɾ/ 'assistant', were segmented together as one vowel unit.

A full glottal closure was segmented separately from the word-initial vowel when it consisted of at least 20 ms of silence or a single glottal pulse followed by silence which altogether lasted at least 20 ms (see Frazier 2009; Baird 2011 for similar metrics in phonetic studies of Mayan languages). An example is shown in Figure 3.5.

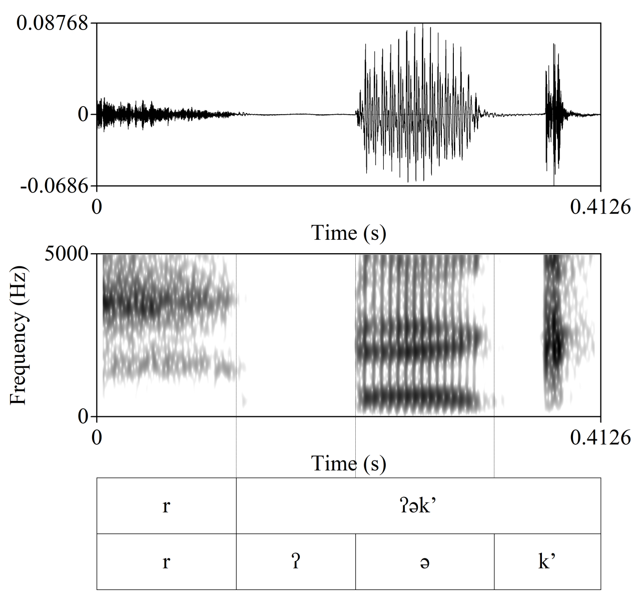


Figure 3.5: Segmentation of a full glottal closure at the beginning of the word *äk'* 'chicken'

Other periods of laryngealized voicing were included in the vowel portion. An example is shown in Figure 3.6.

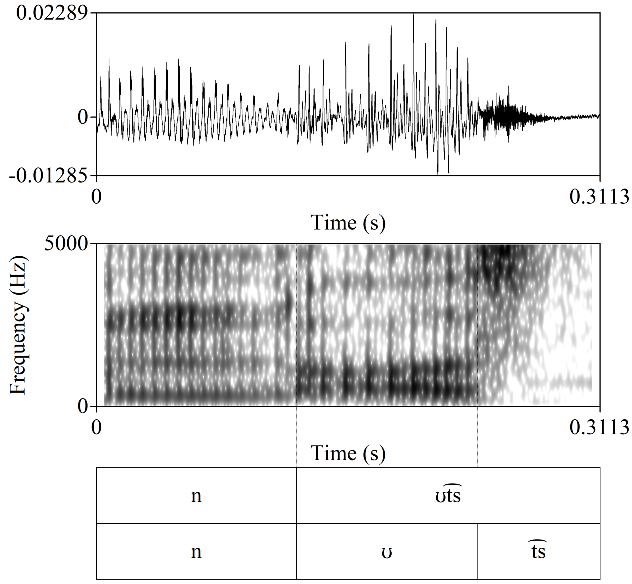


Figure 3.6: Glottalized phonation without a full closure included within the vowel in *ützt* 'good'

3.3.1.3 Measurements

The only measurement of full closures was their presence or absence in each case. For the vowels, however, a Praat (Boersma and Weenink 2023) script was used to measure several acoustic indicators of glottalized phonation, including spectral tilt (H1-H2, H1-A1, H1-A2, H1-A3), periodicity (jitter, shimmer, HNR), and reduction (intensity minimum, pitch minimum), as well as the first and second formant. Each of these measures are described as follows.

The primary indicators were four measures of spectral tilt, which compares the relative amplitude of the fundamental frequency (H1) with that of higher harmonics, such as the second harmonic (H2) or the harmonic closest to one of the formants (A1, A2, A3). H1-H2 correlates with the Open Quotient, or ratio of time that the vocal folds are open during the glottal cycle, which is smaller for glottalized voicing than for modal voicing (Holmberg et al. 1995; Garellek 2013; Blankenship 1997; Hanson et al. 2001; Hanson 1997; Iseli and Alwan

2004; Esposito 2012). H1-A1 in turn correlates with the presence of a posterior opening in the glottis and H1-A2/A3 with the simultaneity or abruptness of the closure (Garellek 2013; Hanson 1997; Gordon and Ladefoged 2001; Shue et al. 2010). Glottalized voicing has lower values for spectral tilt measures than modal voicing does, which in turn has lower values than breathy voicing.

In addition to variation in spectral tilt, glottalized phonation – like other types of non-modal phonation – is often characterized by increased aperiodicity: more noise and more variation between cycles (Hanson et al. 2001). Three measures of aperiodicity were included as secondary indicators. Specifically, harmonics-to-noise ratio (HNR) compares the relative strength of the harmonic frequencies and noise in the signal, jitter measures the variation in duration of successive cycles, and shimmer measures the variation in intensity (Farrús et al. 2007; Gordon and Ladefoged 2001). Glottalized phonation correlates with lower values of HNR and higher values of jitter and shimmer.

A decrease in intensity and pitch is also characteristic of non-modal phonation, though less consistently than the other acoustic measures (Garellek 2013; Gordon and Ladefoged 2001). The minimum intensity and minimum pitch were also included as secondary indicators, and expected to be lower for glottalized phonation.

Finally, the formant measures were made not because particular vowel qualities are expected to have more glottalized voice quality, but because formants affect spectral tilt measures due to their boosting effect on the amplitude of nearby harmonics (Iseli and Alwan 2004; Hanson 1997).

This range of acoustic measures was included due to the exploratory nature of the study and lack of previous research on this topic in K'iche' and other related languages. Previous cross-linguistic work has shown that a wide diversity of articulatory configurations are grouped together under the labels glottalized, laryngealized, or creaky in different languages, and they may have very different acoustic correlates: from "prototypical" laryngealized voicing to vocal fry/creak, diplophonia/multiply pulsed voice, aperiodicity/creaky voice, tense/pressed voice, nonconstricted creak, and glottal squeak (Keating et al. 2015; Redi and Shattuck-Hufnagel 2001; Hedelin and Huber 1990). The specific articulatory or acoustic realization(s) of glottal stop or other instances of glottalization in K'iche' was not known at the outset of the study.

These measurements were taken in each third of every vowel, or for very short vowels in three partially overlapping segments that each were the duration of the inverse of the pitch floor used for measurements of that vowel. In order to ensure the most accurate measurements of F0 and other dependent measures, the pitch range was varied as needed for each speaker and vowel. After finding a range mostly suitable for a given speaker, each vowel was visually inspected using those settings and if necessary individual adjustments were made to the pitch floor, pitch ceiling and voicing threshold until Praat accurately located the pitch pulses in that vowel. These specialized settings were then used in the script to take the final measurements.

3.3.1.4 Categorization

The following factors were included in the study. These cover the range of factors hypothesized to influence rates of glottalization based on previous literature.

- Syllable count (monosyllabic or polysyllabic), based on the number of syllables actually produced by the speaker in the surface form. In some cases longer words were truncated and produced with only one syllable, and were thus categorized as monosyllabic. E.g. the Spanish loanword *hora* /oɾa/ 'hour' was sometimes produced as [ʔoɾ], and the focus particle *are* /aɾe/ was in one instance produced as [aɾ]. Syllable count was included as a factor because Larsen (1988) states that glottal stops are only inserted before stressed monosyllabic words.[2]

- Stress position (initial syllable stressed or unstressed). Initial stress is found on monosyllabic stressed words, such as *ütz* /ʊts/ 'good' as well as some polysyllabic Spanish

[2] In the varieties of K'iche' that Larsen studied, stress is always word-final, with the likely exception of some loanwords which he does not discuss. Therefore, word-initial stress is only found on monosyllables in these dialects. In Chichicastenango K'iche', stress is not always word-final. I suspected that the appearance of glottal stops on stressed monosyllables was entirely due to stress and syllable count was irrelevant, but included both factors separately since they are not correlated in Chichicastenango K'iche', especially when considering the large number of polysyllabic Spanish loanwords with initial stress.

borrowings, such as *año* /aɲo/ 'year'. Polysyllabic native K'iche' words never begin with stressed vowels. Polysyllabic words with stress on later syllables, such as *ali* /a.ˈli/ 'girl' were grouped together with totally unstressed words (function words, like *ïn* /ɪn/ '1sg') as they do not have an initial stressed syllable. Stress was included as a factor because Larsen (1988) states that glottal stops are only inserted before stressed monosyllabic words.

- Word origin (Spanish loan or not). The Spanish loans category includes instances across a spectrum from older loanwords that have been phonologically adapted, such as *akuxa* /a.ku.ˈʃa/ 'needle' from Spanish *aguja* /a.ˈgu.xa/, to instances likely best characterized as code-switching, such as *ayuda* /a.ˈju.da/ 'help'. Word origin was included as a factor because Barrett (2007) describes Spanish loans as typically having phonemic word-initial glottal stops in contrast to most other apparently vowel-initial words.

- Morpheme type (root or prefix). The vowel-initial prefixes that appear in the data include several possessive prefixes (third person singular *u*-, second person singular *a*-/*aw*-, second person plural *i*-) as well as the agentive prefix *aj*-.[3, 4] Examples of words with these prefixes include *achak* /a-ʧak/ 'your work' with the prefix *a*- and *upas* /u-pas/ 'her sash' with the prefix *u*-. Morpheme type was included as a factor because Barrett (2007) describes glottal stops as occurring on all non-prefixed vowel-initial roots, but does not state that glottal stops appear on vowel-initial prefixes.[5]

- Preceding glottalized consonant (yes, no). Glottalized consonants include the ejectives /t' k' q' ʧ' ʦ'/, the implosive /ɓ/, and the glottal stop /ʔ/. An example of a word-initial vowel preceded by a glottalized consonant is the first vowel of *ojer* 'long ago' in

[3]There are no instances of the second person plural prevocalic prefix *iw*- in the data.

[4]However, see Section 3.5.1 below on the prosodic status of *aj*-, which may in fact be a proclitic or otherwise outside of the prosodic word containing the root.

[5]Barrett (2007) states that all words must have an onset, but also specifies that this results in the insertion of an initial glottal stop on un-prefixed roots that begin with a vowel. In his examples, the word that begins with a vowel-initial prefix rather than a vowel-initial root, *aj iik'* [aχʔiːk'] with the agentive *aj*- /aχ-/, does not have a glottal stop before the prefix. Therefore, it was hypothesized that there might be a difference between initial prefixes and roots.

the phrase *quk' ojer* /quk' oχeɾ/ 'with us long ago'. Preceding glottalized consonant was included as a factor due to the expected phonetic effect of a glottalized consonant on the following vowel.

- Preceding vowel (yes, no). An example of a word-initial vowel preceded by a vowel is the first vowel of *ojer* in the phrase *kwa ojer* /k(ɪ)wa oχeɾ/ 'their food long ago'. Preceding vowel was included as a factor because Larsen (1988) states that glottal stops appear on words preceded by a word ending in a vowel.

- Preceding pause (yes, no). An example of a word-initial vowel preceded by a pause is the first vowel of *ojer* in the phrase *r... ojer täq qäwnaq* /ɾ... oχeɾ təq qəwnaq/ 'our ancestors'. Preceding pause was included as a factor because Larsen (1988) states that glottal stops appear on words that are utterance-initial, but does not define this term, which could potentially refer to a preceding pause or prosodic structure.

- Intonational phrase position (initial or non-initial). Words were considered to be IP-initial if the previous word had a high boundary tone, which is found on the ends of most intonational phrases in K'iche' (see Chapter 2), and IP-medial otherwise. This factor was included separately from preceding pause because pauses and boundary tones do not strongly correlate: among words included in this study that are preceded by a pause, 68% follow a word bearing a boundary tone, and among words preceded by a word bearing a boundary tone, 49% follow a pause. Intonational phrase position was included as a factor because Larsen (1988) states that glottal stops appear on words that are utterance-initial, but does not define this term, which could potentially refer to a preceding pause or prosodic structure.

Additionally the morpheme and text (recording code) were noted for each vowel.

3.3.1.5 Hypotheses

If a given factor promotes the realization of a glottal stop at the beginning of an otherwise vowel-initial word, then there should be a significantly higher rate of full glottal closures preceding those vowels and/or significantly higher rates of acoustic cues to glottalization in the early part of the vowel (lower spectral tilt, lower HNR, higher jitter and shimmer, lower minimum intensity and pitch). If glottalization is found consistently throughout the vowel or not found at all, it is not likely to be the result of an initial glottal stop.

Thus, based on the previous descriptions, higher rates of full closures were expected on vowels that follow a word ending in a vowel or pause (Kaufman 2015; Larsen 1988), for words that are initial in the IP (Larsen 1988), for words that are monosyllabic and have initial stress (Larsen 1988), for roots (Barrett 2007), and for Spanish borrowings (Barrett 2007). Lower values of spectral tilt, HNR, intensity and pitch minimum and higher values of jitter and shimmer were expected at the beginning of vowels in these same categories. Lower values of spectral tilt, HNR, intensity and pitch minimum and higher values of jitter and shimmer were also expected at the beginning of vowels preceded by a word ending in a glottal stop or phonemically glottalized consonant.

Additionally, the formant values are expected to have an effect on several of the measures. The expected effects of F1 and F2 on each of the spectral tilt measures are shown in Table 3.2.

	F1	F2
H1-H2	Positive Higher F1 means smaller boost to H2 and therefore higher H1-H2	Positive Higher F2 means smaller boost to H2 and therefore higher H1-H2
H1-A1	Negative Higher F1 means larger boost to A1 from F2 and therefore lower H1-A1	Positive Higher F2 means smaller boost to A1 and therefore higher H1-A1
H1-A2	Negative Higher F1 means larger boost to A2 and therefore lower H1-A2	Positive Higher F2 means smaller boost from F1 on A2 and therefore higher H1-A2
H1-A3	Negative Higher F1 means larger boost to A3 and therefore lower H1-A3	Negative Higher F1 means larger boost to A3 and therefore lower H1-A3

Table 3.2: Expected effects of formant values on spectral tilt measurements

3.3.1.6 Statistical analysis

Results were visualized in R (R Core Team 2020) using the package ggplot2 (Wickham 2016) and analyzed with linear mixed effects models using the package lme4 (Bates et al. 2015). A separate model was made for each acoustic measure in each third of the vowel as well as another model for full closures.

In the first phase, each of the models for each acoustic measure in each third of the vowel included all of the previously defined factors: syllable count, stress position, word origin, morpheme type, preceding glottalized consonant, preceding pause, preceding vowel, IP position, F1 and F2 as fixed effects and initial morpheme and text as random effects. The model of full glottal closures included all of the same factors except for preceding pause, as it is difficult to identify a full closure at the beginning of a word preceded by silence due to a pause. It t was found that the variables syllable count, word origin and morpheme type yielded no or almost no significant effects in any of these models, and thus they were eliminated from the final models. In the second phase, the full closures model and each of the vocalic acoustic measures models included the random effects, the remaining fixed effects (IP position, stress, preceding pause, preceding glottalized consonant, preceding vowel), and additionally each possible interaction of these fixed effects. Preceding pause was again excluded from the full closures model. The baseline categories for each factor were those least expected to contribute to initial glottalization: IP-medial, no initial stress, no preceding glottalized consonant, no preceding pause, and no preceding vowel.

The equations for the final models are shown as follows.

Full closure model:

$glmer(factor($FULL CLOSURE $\sim$ IP POSITION+STRESS+PRECEDING GLOTTALIZED CONSONANT+PRECEDING VOWEL+F1+F2+IP POSITION : PRECEDING GLOTTALIZED CONSONANT +IP POSITION : PRECEDING VOWEL+STRESS : PRECEDING GLOTTALIZED CONSONANT +STRESS : PRECEDING VOWEL+IP POSITION : STRESS+(1|SPEAKER)+(1|LEXICAL ITEM))

Acoustic measures models:

$lmer($MEASURE $\sim$ IP POSITION+STRESS+PRECEDING PAUSE+PRECEDING GLOTTALIZED CONSONANT+PRECEDING VOWEL+F1+F2+IP POSITION : PRECEDING PAUSE

+IP POSITION : PRECEDING GLOTTALIZED CONSONANT+IP POSITION : PRECEDING VOWEL +STRESS : PRECEDING PAUSE+STRESS : PRECEDING GLOTTALIZED CONSONANT +STRESS : PRECEDING VOWEL+IP POSITION : STRESS+(1|SPEAKER)+(1|LEXICAL ITEM))

3.3.2 Results

3.3.2.1 Full closures

Excluding words following a pause, where it is difficult to locate an initial glottal closure based on the metric of silence duration, full closures occur in 8.8% of the overall data. Full closures are practically non-existent in the baseline category (preceding plain consonant, IP-medial and no initial stress). Rates are higher following a vowel or glottalized consonant and in IP-initial position. The highest percentage is found for words with initial stress. The proportion of full closures in each of the experimental categories included in the final statistical model is shown in Table 3.3.

Subset	Percentage
Overall	8.8%
Baseline	1.7%
Preceding vowel	11.8%
Preceding glottal(ized) consonant	13.63%
IP-initial	15.7%
Initial stress	20.8%

Table 3.3: Percentage of full closures in various subsets of the data

The results of the statistical model of full closures are shown in Table 3.4.

	Estimate	Std. Error	Z-value	P-value	
(Intercept)	-3.930	0.760	-5.173	<0.001	***
preceding vowel	0.698	0.415	1.680	0.093	
preceding glottal(ized) consonant	0.884	0.642	1.377	0.169	
IP-initial	1.942	0.387	5.022	<0.001	***
initial stress	3.065	0.478	6.417	<0.001	***
F1	0.001	0.001	1.359	0.174	
F2	-0.001	0.000	-2.212	<0.05	*
preceding vowel, IP-initial	-0.544	0.496	-1.096	0.273	
preceding glott. cons., IP-initial	-0.768	0.698	-1.100	0.272	
IP-initial, initial stress	-1.128	0.507	-2.225	<0.05	*
preceding vowel, initial stress	-0.737	0.484	-1.522	0.128	
preceding glott. cons., initial stress	-0.308	0.723	-0.427	0.670	

Table 3.4: Results of the statistical model of full closures

These results show significant positive effects ($p < 0.05$) of IP position and stress. Words that are initial in the IP and those that have initial stress have significantly higher rates of full closures. The interaction between these two factors is negative. The two effects do not stack: only unstressed vowels show a significantly greater rate of full closures when IP-initial (stressed vowels do not), and only IP-non-initial vowels show a significantly greater rate of full closures when stressed (IP-initial vowels do not). There is also a significant effect of F2: words beginning with vowels with higher F2 (fronter vowels) are significantly less likely to have a full closure; however, the effect size is extremely small (-0.001). There are no significant effects for the factors preceding vowel and preceding glottalized consonant.

3.3.2.2 Acoustic cues to glottalization

The results of the acoustic cues to glottalization in word-initial vowels show considerable agreement between cues. Therefore, only the results for the most informative subset of measures (H1-H2, H1-A1, H1-A2, HNR and intensity minimum) are detailed in the following sections. The full results for the remaining measures (H1-A3, jitter, shimmer and minimum pitch) can be found in Appendix B. After reviewing each of the measures in detail, Section 3.3.2.2.6 summarizes these results, highlighting the main takeaways.

3.3.2.2.1 H1-H2

Figure 3.7 shows the mean values of H1-H2 in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition except for post-pausal is lower in the first third than in the baseline, indicating greater glottalization. By the end of the vowel, the means of all conditions except for IP-initial position are very close to the baseline. IP-initial position remains lower than the baseline by about the same amount as at the beginning of the vowel.

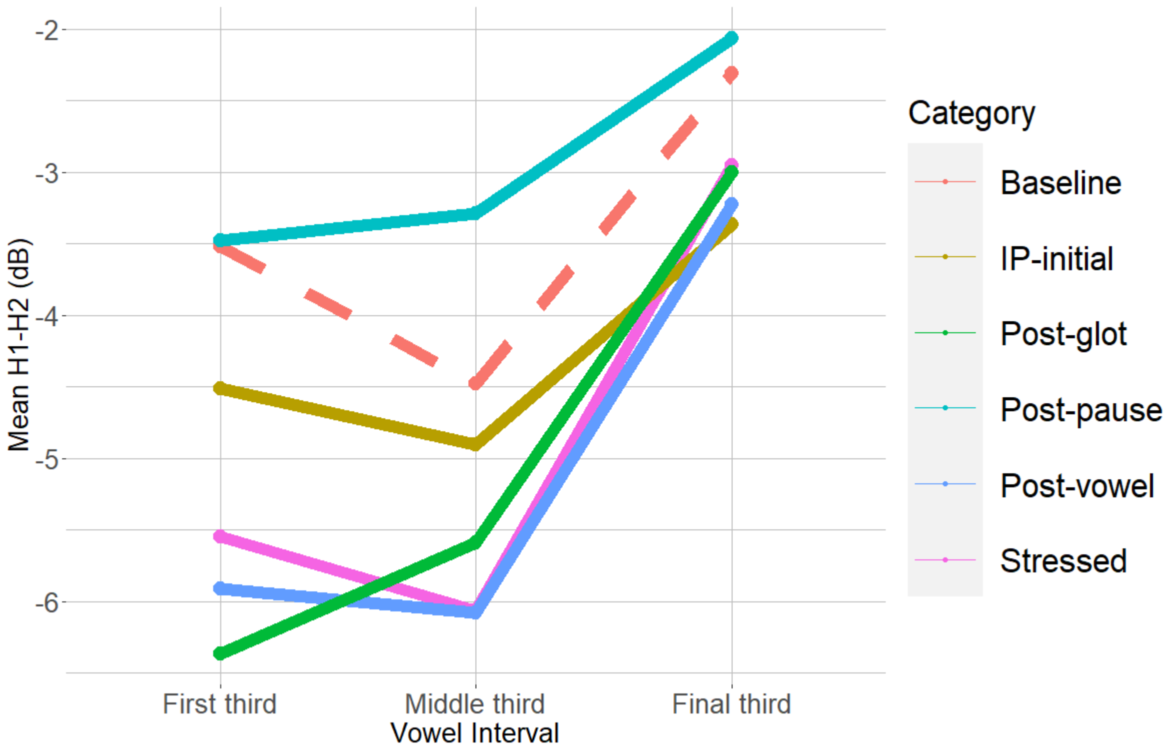


Figure 3.7: Mean value of H1-H2 in each experimental condition, for each third of the vowel

Table 3.5 shows the results of the statistical model for H1-H2 in the first third of the vowel. Compared to the baseline, there is a negative effect of preceding vowel and initial stress, indicating greater glottalization in these conditions. There is also a significant but very small positive effect of F1 and F2, indicating that lower vowels and fronter vowels have higher H1-H2.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-8.507	0.963	-8.838	<0.001	***
preceding pause	0.688	0.664	1.037	0.300	
preceding vowel	-2.194	0.557	-3.936	<0.001	***
preceding glottal(ized) consonant	-2.006	1.041	-1.928	0.054	.
IP-initial	-0.423	0.588	-0.719	0.472	
initial stress	-1.622	0.580	-2.797	<0.01	**
F1	0.006	0.001	5.670	<0.001	***
F2	0.001	0.000	3.720	<0.001	***
preceding pause, IP-initial	-0.306	0.855	-0.358	0.720	
preceding vowel, IP-initial	0.075	0.978	0.077	0.939	
preceding glott. cons., IP-initial	-0.932	1.325	-0.704	0.482	
IP-initial, initial stress	0.195	0.850	0.230	0.818	
preceding pause, initial stress	-0.425	0.956	-0.444	0.657	
preceding vowel, initial stress	1.099	0.848	1.295	0.196	
preceding glott. cons., initial stress	0.969	1.535	0.631	0.528	

Table 3.5: Effects on H1-H2 in the first third of the vowel

Table 3.6 shows the results for H1-H2 in the middle third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-9.600	1.160	-8.278	<0.001	***
preceding pause	2.427	0.641	3.786	<0.001	***
preceding vowel	-1.402	0.536	-2.614	<0.01	**
preceding glottal(ized) consonant	-0.182	0.980	-0.185	0.853	
IP-initial	-0.946	0.583	-1.624	0.105	
initial stress	-1.318	0.694	-1.900	0.060	.
F1	0.005	0.001	3.980	<0.001	***
F2	0.002	0.000	4.158	<0.001	***
preceding pause, IP-initial	0.082	0.812	0.101	0.920	
preceding vowel, IP-initial	0.107	0.921	0.116	0.907	
preceding glott. cons., IP-initial	-0.479	1.244	-0.385	0.700	
IP-initial, initial stress	-0.847	0.822	-1.029	0.303	
preceding pause, initial stress	-1.529	0.908	-1.684	0.092	.
preceding vowel, initial stress	1.083	0.817	1.325	0.185	
preceding glott. cons., initial stress	1.440	1.447	0.995	0.320	

Table 3.6: Effects on H1-H2 in the middle third of the vowel

In the middle third of the vowel, the negative effect of preceding vowel persists, as do the tiny positive effects of F1 and F2. However, there is no significant effect of initial stress. There is also a significant positive effect of preceding pause, indicating less glottalized phonation in this context.

Table 3.7 shows the results for H1-H2 in the final third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-10.533	1.048	-10.047	<0.001	***
preceding pause	2.117	0.733	2.889	<0.01	**
preceding vowel	-0.574	0.615	0.933	0.351	
preceding glottal(ized) consonant	-0.189	1.112	-0.170	0.865	
IP-initial	-2.024	0.674	-3.002	<0.01	**
initial stress	0.753	0.992	0.759	0.449	
F1	0.004	0.001	4.415	<0.001	***
F2	0.003	0.000	7.852	<0.001	***
preceding pause, IP-initial	0.563	0.923	0.610	0.542	
preceding vowel, IP-initial	0.483	1.042	0.463	0.643	
preceding glott. cons., IP-initial	0.721	1.405	0.513	0.608	
IP-initial, initial stress	0.239	0.943	0.253	0.800	
preceding pause, initial stress	-2.609	1.034	-2.523	<0.05	*
preceding vowel, initial stress	-0.887	0.937	-0.946	0.344	
preceding glott. cons., initial stress	0.860	1.637	0.525	0.600	

Table 3.7: Effects on H1-H2 in the final third of the vowel

In the final third of the vowel, the positive effect of preceding pause, F1 and F2 persist. There is also a significant negative effect of IP-initial position, indicating greater glottalization. Finally, there is a significant interaction between preceding pause and initial stress. When looking at the subset of the data preceded by a pause and the subset not preceded by a pause, the coefficient for initial stress is negative in the post-pausal group and positive in the non-post-pausal group, but the effect is not significant in either, as shown in Tables 3.8 and 3.9.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-9.720	2.350	-4.136	<0.001	***
IP-initial	-1.697	0.762	-2.228	<0.05	*
initial stress	-1.76	1.421	-1.236	0.224	
F1	0.006	0.002	3.291	<0.01	**
F2	0.004	0.001	3.504	<0.001	***

Table 3.8: Effects on H1-H2 in the final third of vowels following a pause

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-9.729	1.087	-8.953	<0.001	***
preceding vowel	-0.821	0.438	-1.873	0.061	.
preceding glottal(ized) consonant	0.322	0.687	0.469	0.639	
IP-initial	-1.609	0.528	-3.047	<0.01	**
initial stress	0.250	0.871	0.287	0.775	
F1	0.004	0.001	3.524	<0.001	***
F2	0.003	0.000	6.686	<0.001	***

Table 3.9: Effects on H1-H2 in the final third of vowels not following a pause

3.3.2.2.2 H1-A1

Figure 3.8 shows the mean values of H1-A1 in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition is much lower in the first third than in the baseline, indicating greater glottalization. By the end of the vowel, the means of all conditions are extremely close.

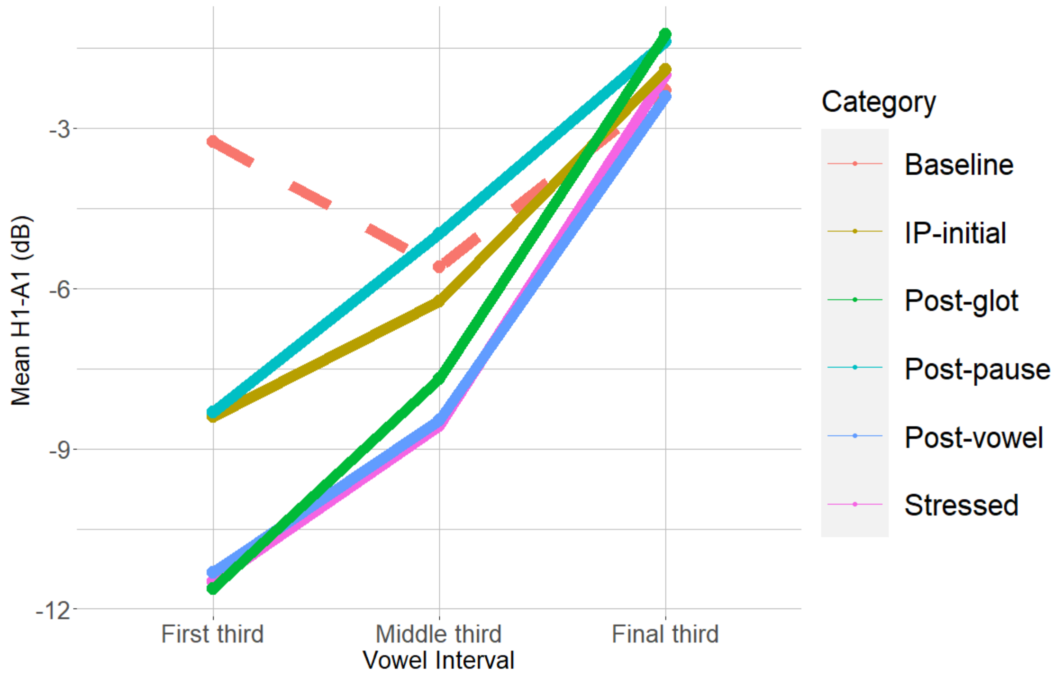


Figure 3.8: Mean value of H1-A1 in each experimental condition, for each third of the vowel

Table 3.10 shows the results for H1-A1 in the first third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-11.265	1.559	-7.227	<0.001	***
preceding pause	-2.557	0.937	-2.730	<0.01	**
preceding vowel	-6.31	0.782	-8.071	<0.001	***
preceding glottal(ized) consonant	-8.198	1.417	-5.784	<0.001	***
IP-initial	-2.881	0.855	-3.372	<0.001	***
initial stress	-4.045	1.171	-3.454	<0.001	***
F1	0.002	0.002	1.490	0.136	
F2	0.004	0.001	7.167	<0.001	***
preceding pause, IP-initial	1.537	1.176	1.307	0.191	
preceding vowel, IP-initial	2.645	1.330	1.989	<0.05	*
preceding glott. cons., IP-initial	1.489	1.794	0.830	0.407	
IP-initial, initial stress	0.507	1.198	0.423	0.672	
preceding pause, initial stress	0.643	1.317	0.488	0.625	
preceding vowel, initial stress	-0.586	1.190	-0.492	0.623	
preceding glott. cons., initial stress	5.458	2.089	2.612	<0.01	**

Table 3.10: Effects on H1-A1 in the first third of the vowel

Compared to the baseline, there is a significant negative effect of preceding glottalized consonant, preceding pause, preceding vowel, initial stress, and IP-initial position, indicating greater glottalization in these contexts. There is also a significant positive but very small effect of F2. There are also significant positive interactions between preceding vowel and IP-initial position and between preceding glottalized consonant and initial stress.

When looking at the subsets of the data preceded by a vowel and not preceded by a vowel, there is no significant effect of IP-initial position when preceded by a vowel, but a significant negative effect when not preceded by a vowel, indicating that the effects of preceding vowel and IP-initial position do not stack. This is shown in Tables 3.11 and 3.12.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-9.479	2.801	-3.384	<0.01	**
IP-initial	-0.693	1.154	-0.601	0.548	
initial stress	-3.608	1.176	-3.067	<0.01	**
F1	-0.008	0.003	-2.527	<0.05	*
F2	0.003	0.001	2.834	<0.01	**

Table 3.11: Effects on H1-A1 in the first third of the vowel when preceded by a vowel

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-13.408	1.714	-7.823	<0.001	***
preceding pause	-1.596	0.613	-2.604	<0.01	**
preceding glottal(ized) consonant	-6.463	0.879	-7.355	<0.001	***
IP-initial	-1.845	0.599	-3.082	<0.01	**
initial stress	-4.000	1.184	-3.378	<0.01	**
F1	0.005	0.002	2.644	<0.01	**
F2	0.004	0.001	6.508	<0.001	***

Table 3.12: Effects on H1-A1 in the first third of the vowel when not preceded by a vowel

Similarly, when comparing the subset of vowels preceded by a glottalized consonant to the subset not preceded by a glottalized consonant, there is a significant negative effect of stress in the latter case but no significant effect in the former case, again showing that these effects do not stack. These results are shown in Tables 3.13 and 3.14.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-10.199	5.829	-1.750	0.088	.
IP-initial	-1.506	1.907	-0.790	0.431	
initial stress	2.714	2.347	1.156	0.264	
F1	-0.013	0.007	-1.836	0.071	.
F2	0.003	0.002	1.669	0.103	

Table 3.13: Effects on H1-A1 in the first third of the vowel when preceded by a glottalized consonant

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-11.274	1.574	-7.164	<0.001	***
preceding pause	-1.845	0.599	-3.082	<0.01	**
preceding vowel	-5.902	0.562	-10.509	<0.001	***
IP-initial	-1.594	0.559	-2.851	<0.01	**
initial stress	-4.349	1.006	-4.321	<0.001	***
F1	0.003	0.002	1.701	0.089	.
F2	0.004	0.001	6.743	<0.001	***

Table 3.14: Effects on H1-A1 in the first third of the vowel when not preceded by a glottalized consonant

Table 3.15 shows the results for H1-A1 in the middle third of the vowel. There is a significant negative effect of preceding vowel and IP-initial position, indicating greater glottalization. There is a significant positive effect of preceding pause, indicating more modal voice. The positive effect of F2 persist, and there is a tiny negative effect of F1. There are no significant interactions.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-8.486	1.794	-4.730	<0.001	***
preceding pause	2.546	0.934	2.726	<0.01	**
preceding vowel	-3.748	0.783	-4.789	<0.001	***
preceding glottal(ized) consonant	-1.620	1.417	-1.144	0.253	
IP-initial	-2.854	0.857	-3.330	<0.001	***
initial stress	-0.458	1.253	-0.366	0.715	
F1	-0.006	0.002	-3.089	<0.01	**
F2	0.004	0.001	6.599	<0.001	***
preceding pause, IP-initial	0.432	1.174	0.368	0.713	
preceding vowel, IP-initial	1.851	1.326	1.395	0.163	
preceding glott. cons., IP-initial	0.996	1.790	0.557	0.578	
IP-initial, initial stress	0.060	1.200	0.050	0.960	
preceding pause, initial stress	0.093	1.314	0.071	0.944	
preceding vowel, initial stress	1.870	1.193	1.567	0.117	
preceding glott. cons., initial stress	0.402	2.084	0.193	0.847	

Table 3.15: Effects on H1-A1 in the middle third of the vowel

Table 3.16 shows the results for H1-A1 in the final third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-17.338	1.406	-12.334	<0.001	***
preceding pause	2.394	0.944	2.534	<0.05	*
preceding vowel	-1.591	0.795	-2.002	<0.05	*
preceding glottal(ized) consonant	-0.612	1.431	-0.427	0.669	
IP-initial	-1.996	0.871	-2.291	<0.05	*
initial stress	2.373	1.467	1.618	0.108	
F1	0.008	0.001	7.060	<0.001	***
F2	0.006	0.001	10.738	<0.001	***
preceding pause, IP-initial	1.412	1.186	1.191	0.234	
preceding vowel, IP-initial	2.657	1.338	1.985	<0.05	*
preceding glott. cons., IP-initial	3.138	1.803	1.741	0.082	.
IP-initial, initial stress	-0.707	1.216	-0.581	0.561	
preceding pause, initial stress	-2.614	1.330	-1.965	<0.05	*
preceding vowel, initial stress	-1.037	1.210	-0.858	0.391	
preceding glott. cons., initial stress	1.256	2.102	0.598	0.550	

Table 3.16: Effects on H1-A1 in the final third of the vowel

The significant negative effects of preceding vowel and IP-initial position persist, indicating greater glottalization. So does the significant positive effect of preceding pause. There is a significant positive effect of both F1 and F2 as well. The interactions between preceding vowel and IP-initial position and between preceding pause and initial stress are also significant.

Comparing the subset of vowels preceded by a pause to the subset not preceded by a pause, the coefficient of the effect of initial stress is negative in the former case and positive in the latter, but is not significant in either, as shown in Tables 3.17 and 3.18.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-14.410	3.118	-4.622	<0.001	***
IP-initial	-1.261	1.032	-1.221	0.223	
initial stress	-1.441	1.899	-0.759	0.451	
F1	0.0010	0.002	4.071	<0.001	***
F2	0.005	0.001	3.981	<0.001	***

Table 3.17: Effects on H1-A1 in the final third of the vowel when preceded by a pause

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-17.252	1.467	-11.761	<0.001	***
preceding glottal(ized) consonant	1.180	0.869	1.358	0.175	
preceding vowel	-1.480	0.559	-2.649	<0.01	**
IP-initial	-0.907	0.679	-1.336	0.182	
initial stress	2.181	1.406	1.552	0.1234	
F1	0.008	0.001	5.893	<0.001	***
F2	0.006	0.001	10.116	<0.001	***

Table 3.18: Effects on H1-A1 in the final third of the vowel when not preceded by a pause

Looking at the subsets of vowels preceded by a vowel and not preceded by a vowel, there is a significant negative effect of IP-initial position for vowels not preceded by a vowel but no significant effect for those preceded by a vowel, indicating that these effects do not stack.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-19.516	2.827	-6.903	<0.001	***
IP-initial	1.067	1.377	0.775	0.439	
initial stress	3.023	1.874	1.614	0.114	
F1	0.007	0.003	2.619	<0.01	**
F2	0.006	0.001	5.040	<0.001	***

Table 3.19: Effects on H1-A1 in the final third of the vowel when preceded by a vowel

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-17.033	1.479	-11.513	<0.001	***
preceding glottal(ized) consonant	1.065	0.867	1.228	0.220	
preceding pause	2.427	0.604	4.020	<0.001	***
IP-initial	-1.485	0.596	-2.492	<0.05	*
initial stress	0.427	1.484	0.288	0.774	
F1	0.009	0.001	6.957	<0.001	***
F2	0.006	0.001	9.425	<0.001	***

Table 3.20: Effects on H1-A1 in the final third of the vowel when not preceded by a vowel

3.3.2.2.3 H1-A2

Figure 3.9 shows the mean values of H1-A2 in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition is lower in the first third than in the baseline, indicating greater glottalization. By the end of the vowel, the means of all conditions are very close.

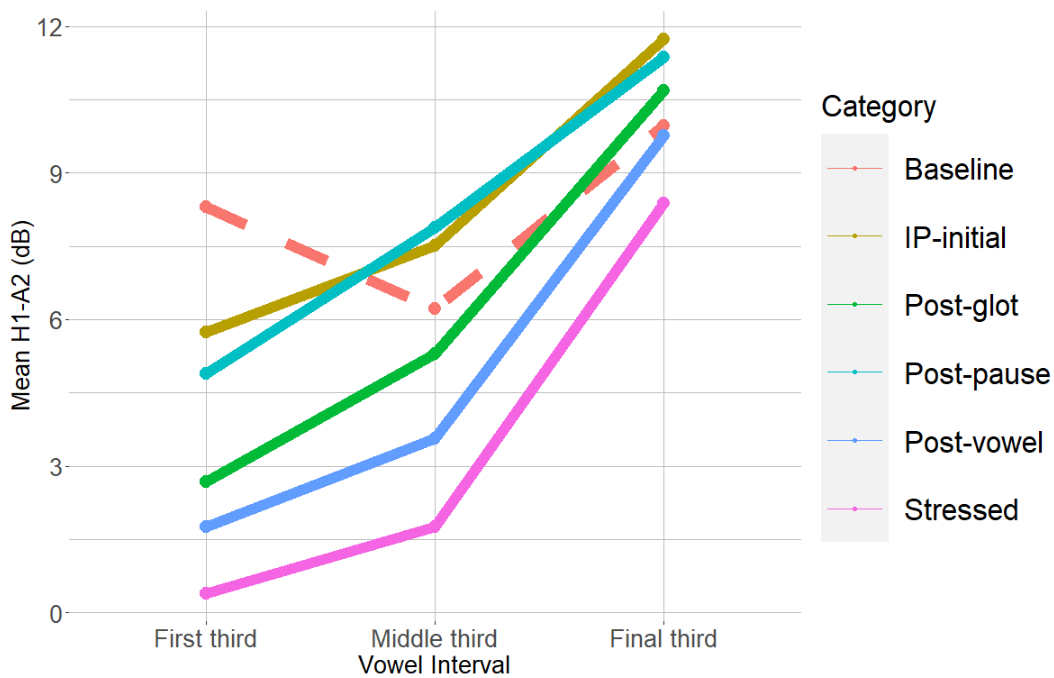


Figure 3.9: Mean value of H1-A2 in each experimental condition, for each third of the vowel

Table 3.21 shows the results for H1-A2 in the first third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-1.475	1.598	-0.923	0.357	
preceding pause	-1.341	0.884	-1.516	0.130	
preceding vowel	-4.381	0.740	-5.918	<0.001	***
preceding glottal(ized) consonant	-5.107	1.336	-3.822	<0.001	***
IP-initial	-0.965	0.809	-1.193	0.233	
initial stress	-3.409	1.190	-2.866	<0.01	**
F1	-0.014	0.001	-9.583	<0.001	***
F2	0.010	0.001	17.690	<0.001	***
preceding pause, IP-initial	-0.243	1.109	-0.219	0.826	
preceding vowel, IP-initial	0.691	1.253	0.552	0.581	
preceding glott. cons., IP-initial	-0.864	1.689	-5.12	0.609	
IP-initial, initial stress	-0.432	1.132	-0.382	0.703	
preceding pause, initial stress	0.399	1.242	0.321	0.748	
preceding vowel, initial stress	-1.014	1.125	-0.901	0.367	
preceding glott. cons., initial stress	2.729	1.967	1.388	0.165	

Table 3.21: Effects on H1-A2 in the first third of the vowel

Compared to the baseline, there is a significant negative effect of preceding vowel, preceding glottalized consonant, and initial stress, indicating greater glottalization. There is also a significant negative effect of F1 and positive effect of F2. There are no significant interactions.

Table 3.22 shows the results for H1-A2 in the middle third of the vowel. The negative effect of preceding vowel persists, as do the effects of F1 and F2. There is also a significant positive effect of preceding pause. There are no significant interactions between the factors.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-2.350	1.682	-1.397	0.163	
preceding pause	2.656	0.833	3.190	$<$0.01	**
preceding vowel	-2.234	0.699	-3.195	$<$0.01	**
preceding glottal(ized) consonant	-1.588	1.262	-1.259	0.208	
IP-initial	-1.160	0.765	-1.516	0.130	
initial stress	-0.866	1.206	-0.718	0.474	
F1	-0.018	0.002	-10.839	$<$0.001	***
F2	0.011	0.001	19.467	$<$0.001	***
preceding pause, IP-initial	-0.650	1.045	-0.622	0.534	
preceding vowel, IP-initial	0.424	1.180	0.359	0.719	
preceding glott. cons., IP-initial	1.287	1.591	0.809	0.419	
IP-initial, initial stress	-0.947	1.071	-0.885	0.376	
preceding pause, initial stress	0.566	1.170	0.484	0.629	
preceding vowel, initial stress	-0.069	1.065	-0.064	0.949	
preceding glott. cons., initial stress	-0.108	1.850	-0.058	0.954	

Table 3.22: Effects on H1-A2 in the middle third of the vowel

Table 3.23 shows the results for H1-A2 in the final third of the vowel.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-7.755	1.315	-5.900	<0.001	***
preceding pause	2.072	0.879	2.357	<0.05	*
preceding vowel	-0.297	0.740	-0.402	0.688	
preceding glottal(ized) consonant	0.175	1.332	0.131	0.895	
IP-initial	-0.777	0.811	-0.958	0.338	
initial stress	1.238	1.408	0.879	0.381	
F1	-0.006	0.001	-5.854	<0.001	***
F2	0.012	0.001	22.595	<0.001	***
preceding pause, IP-initial	-0.550	1.103	-0.499	0.618	
preceding vowel, IP-initial	0.360	1.245	0.289	0.772	
preceding glott. cons., IP-initial	1.095	1.6763	0.653	0.514	
IP-initial, initial stress	-0.055	1.132	-0.049	0.961	
preceding pause, initial stress	-1.775	1.237	-1.435	0.151	
preceding vowel, initial stress	-2.792	1.126	-2.479	<0.05	*
preceding glott. cons., initial stress	-2.268	1.955	-1.160	0.246	

Table 3.23: Effects on H1-A2 in the final third of the vowel

In the final third of the vowel, the negative effect of F1 and positive effect of F2 persist, as does the positive effect of preceding pause. There is also a significant interaction between preceding vowel and initial stress. When looking at the subset of the data preceded by a vowel and the subset not preceded by a vowel, the coefficient for initial stress is negative in the non-post-vowel group and positive in the post-vowel group, but neither effect is significant. This is shown in Tables 3.24 and 3.25.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-10.542	2.722	-3.873	<0.001	***
IP-initial	0.307	1.315	0.233	0.816	
initial stress	0.198	1.935	0.103	0.919	
F1	-0.005	0.003	-1.746	0.081	.
F2	0.012	0.001	10.147	<0.001	***

Table 3.24: Effects on H1-A2 in the final third of the vowel when preceded by a vowel

	Estimate	Std. Error	T-value	P-value	
(Intercept)	-7.095	1.361	-5.214	<0.001	***
preceding pause	1.337	0.559	2.392	<0.05	*
preceding glottal(ized) consonant	0.244	0.803	0.303	0.762	
IP-initial	-1.116	0.552	-2.022	<0.05	*
initial stress	-0.154	1.377	-0.112	0.911	
F1	-0.006	0.001	-5.470	<0.001	***
F2	0.012	0.001	20.374	<0.001	***

Table 3.25: Effects on H1-A2 in the final third of the vowel when not preceded by a vowel

3.3.2.2.4 HNR

Figure 3.10 shows the mean values of HNR in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition except post-vowel is lower than the baseline in the first third of the vowel, indicating greater aperiodicity and therefore greater glottalization. By the end of the vowel, all conditions are very close.

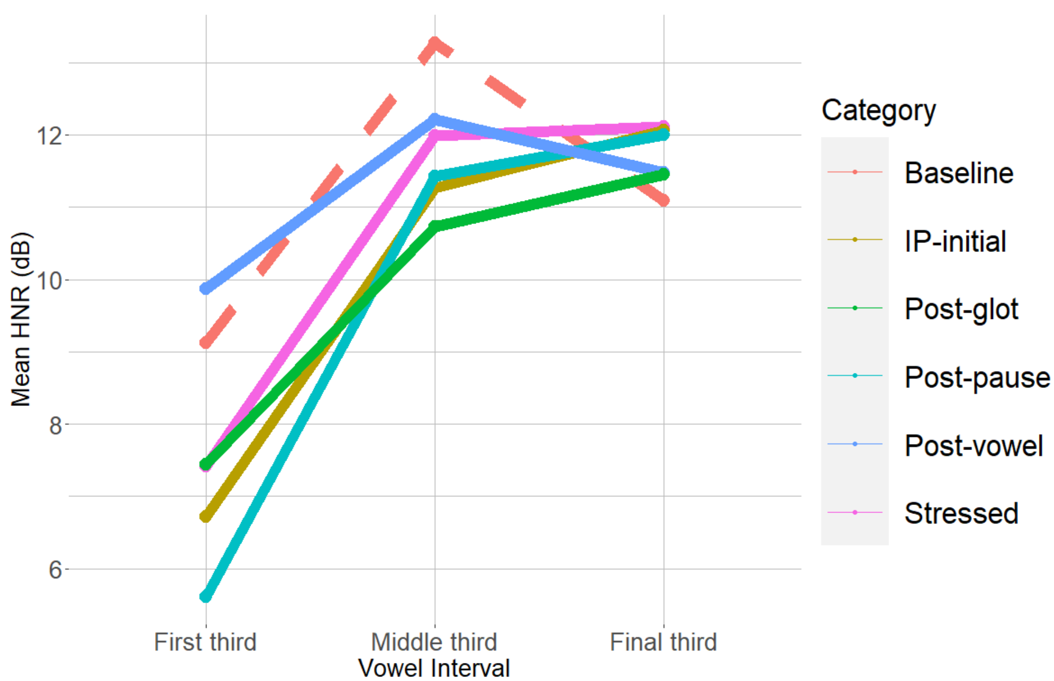


Figure 3.10: Mean value of HNR in each experimental condition, for each third of the vowel

The results for HNR in the first third of the vowel are shown in Table 3.26.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	9.140	0.843	10.847	<0.001	***
preceding pause	-2.875	0.477	-6.027	<0.001	***
preceding vowel	1.892	0.397	4.768	<0.001	***
preceding glottal(ized) consonant	-0.596	0.717	-0.832	0.406	
IP-initial	-2.074	0.433	-4.793	<0.001	***
initial stress	-2.277	0.595	-3.829	<0.001	***
F1	-0.004	0.001	-5.284	<0.001	***
F2	0.001	0.000	3.850	<0.001	***
preceding pause, IP-initial	1.733	0.597	2.902	<0.01	**
preceding vowel, IP-initial	0.566	0.6730	0.841	0.400	
preceding glott. cons., IP-initial	0.399	0.907	0.440	0.660	
IP-initial, initial stress	0.145	0.606	0.239	0.811	
preceding pause, initial stress	2.916	0.667	4.372	<0.001	***
preceding vowel, initial stress	0.186	0.603	0.308	0.758	
preceding glott. cons., initial stress	0.900	1.056	0.852	0.394	

Table 3.26: Effects on HNR in the first third of the vowel

There is a significant negative effect of preceding pause, IP-initial position and initial stress, indicating more noise and therefore more glottalization in these contexts. There is also a significant positive effect of preceding vowel. The effect of F1 is negative and of F2, positive. There is a significant interaction between preceding pause and IP-initial position and between preceding pause and initial stress.

Comparing the subset of vowels preceded by a pause to the subset not preceded by a pause, there is no effect of IP-initial position when post-pausal but a significant negative effect when not post-pausal, indicating that these effects do not stack. The effect of stress when post-pausal is positive, but it is negative when not post-pausal. These results are shown in Tables 3.27 and 3.28.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	7.267	1.086	6.689	<0.001	***
IP-initial	-0.476	0.348	-1.365	0.172	
initial stress	1.139	0.485	2.351	<0.05	*
F1	-0.007	0.001	-6.466	<0.001	***
F2	0.001	0.000	2.505	<0.05	*

Table 3.27: Effects on HNR in the first third of the vowel when preceded by a pause

	Estimate	Std. Error	T-value	P-value	
(Intercept)	8.992	0.964	9.331	<0.001	***
preceding vowel	1.996	0.304	6.576	<0.001	***
preceding glottal(ized) consonant	-0.326	0.472	-0.690	0.490	
IP-initial	-1.713	0.361	-4.740	<0.001	***
initial stress	-2.078	0.582	-3.568	<0.001	***
F1	-0.004	0.001	-4.002	<0.001	***
F2	0.001	0.000	3.312	<0.001	***

Table 3.28: Effects on HNR in the first third of the vowel when not preceded by a pause

The results for HNR in the middle third of the vowel are shown in 3.29.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	17.927	1.141	15.714	<0.001	***
preceding pause	-2.551	0.552	-4.623	<0.001	***
preceding vowel	-1.081	0.463	-2.332	<0.05	*
preceding glottal(ized) consonant	-1.474	0.838	-1.759	0.079	.
IP-initial	-3.040	0.506	-6.013	<0.001	***
initial stress	-0.360	0.693	-0.520	0.604	
F1	-0.009	0.001	-8.553	<0.001	***
F2	0.000	0.000	0.814	0.416	
preceding pause, IP-initial	3.182	0.695	4.580	<0.001	***
preceding vowel, IP-initial	1.351	0.786	1.719	0.086	.
preceding glott. cons., IP-initial	0.589	1.060	0.555	0.579	
IP-initial, initial stress	-1.124	0.709	-1.586	0.113	
preceding pause, initial stress	4.845	0.777	6.234	<0.001	***
preceding vowel, initial stress	1.758	0.705	2.494	<0.05	*
preceding glott. cons., initial stress	1.975	1.234	1.601	0.110	

Table 3.29: Effects on HNR in the middle third of the vowel

There is a significant negative effect of preceding pause, preceding vowel, and IP-initial position. There is also a negative effect of F1. The interactions between preceding pause and IP-initial position, preceding pause and initial stress, and preceding vowel and initial stress are significant.

When comparing the subset of vowels preceded by a pause to the subset not not preceded by a pause, there is a significant negative effect of IP-initial position for non-post-pausal vowels but not those that are post-pausal. There is a significant positive effect of initial stress when post-pausal, but no effect when not post-pausal. These results are shown in Tables 3.30 and 3.31.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	15.374	1.998	7.695	<0.001	***
IP-initial	-0.137	0.536	-0.255	0.799	
initial stress	3.218	0.817	3.941	<0.001	***
F1	-0.010	0.002	-4.819	<0.001	***
F2	0.000	0.001	0.240	0.812	

Table 3.30: Effects on HNR in the middle third of the vowel when post-pausal

	Estimate	Std. Error	T-value	P-value	
(Intercept)	17.451	1.239	14.091	<0.001	***
preceding vowel	-0.278	0.337	-0.825	0.409	
preceding glottal(ized) consonant	-0.965	0.525	-1.836	0.066	.
IP-initial	-2.646	0.405	-6.538	<0.001	***
initial stress	0.470	0.680	0.692	0.491	
F1	-0.009	0.001	-7.358	<0.001	***
F2	0.000	0.000	0.886	0.376	

Table 3.31: Effects on HNR in the middle third of the vowel when not post-pausal

When comparing the subset of vowels preceded by a vowel to the subset not preceded by a vowel, there is a positive effect of initial stress in the former case but no effect in the latter case, as shown in Tables 3.32 and 3.33.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	17.947	1.719	10.437	<0.001	***
IP-initial	-2.184	0.704	-3.104	<0.01	**
initial stress	1.398	0.620	2.254	<0.05	*
F1	-0.012	0.002	-6.102	<0.001	***
F2	0.000	0.001	0.702	0.486	

Table 3.32: Effects on HNR in the middle third of the vowel when preceded by a vowel

	Estimate	Std. Error	T-value	P-value	
(Intercept)	16.819	1.273	13.212	<0.001	***
preceding pause	0.367	0.360	1.019	0.309	
preceding glottal(ized) consonant	-1.049	0.516	-2.033	<0.05	*
IP-initial	-1.876	0.354	-5.304	<0.001	***
initial stress	0.947	0.768	1.234	0.221	
F1	-0.009	0.001	-6.808	<0.001	***
F2	0.000	0.000	0.836	0.4035	

Table 3.33: Effects on HNR in the middle third of the vowel when not preceded by a vowel

The results for HNR in the final third of the vowel are shown in Table 3.34.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	12.488	0.840	14.869	<0.001	***
preceding pause	-0.032	0.442	-0.072	0.942	
preceding vowel	-1.001	0.375	-2.668	<0.01	**
preceding glottal(ized) consonant	-0.090	0.669	-0.134	0.893	
IP-initial	-0.325	0.411	-0.792	0.428	
initial stress	2.450	0.768	3.190	<0.01	**
F1	-0.003	0.001	-4.791	<0.001	***
F2	0.000	0.000	0.350	0.726	
preceding pause, IP-initial	0.860	0.556	1.547	0.122	
preceding vowel, IP-initial	1.359	0.626	2.169	<0.05	*
preceding glott. cons., IP-initial	0.819	0.841	0.973	0.331	
IP-initial, initial stress	-1.217	0.569	-2.139	<0.05	*
preceding pause, initial stress	1.456	0.621	2.344	<0.05	*
preceding vowel, initial stress	0.736	0.568	1.296	0.195	
preceding glott. cons., initial stress	-0.268	0.980	-0.274	0.784	

Table 3.34: Effects on HNR in the final third of the vowel

There is a significant negative effect of preceding vowel and a significant positive effect of initial stress. The negative effect of F1 is also significant. There are significant interactions between preceding vowel and IP-initial position, between IP-initial position and initial stress, and between preceding pause and initial stress.

When comparing the effects for vowels that are initial and non-initial in the intonational phrase, there is no effect of preceding vowel when IP-initial but a significant negative effect when not IP-initial. There is no effect of initial stress when IP-initial, but a significant positive effect when not IP-initial. These results are shown in Tables 3.35 and 3.36.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	11.512	1.234	9.328	<0.001	***
preceding glottal(ized) consonant	0.486	0.606	0.803	0.422	
preceding vowel	0.389	0.573	0.680	0.497	
preceding pause	1.616	0.440	3.669	<0.001	***
initial stress	1.236	0.704	1.757	0.087	.
F1	-0.002	0.001	-2.695	<0.01	**
F2	0.000	0.000	0.317	0.751	

Table 3.35: Effects on HNR in the final third of the vowel when IP-initial

	Estimate	Std. Error	T-value	P-value	
(Intercept)	12.461	0.877	14.214	<0.001	***
preceding vowel	-0.801	0.306	-2.620	<0.01	**
preceding glottal(ized) consonant	-0.229	0.604	-0.380	0.704	
preceding pause	0.331	0.408	0.813	0.416	
initial stress	2.975	0.789	3.770	<0.001	***
F1	-0.003	0.001	-4.268	<0.001	***
F2	0.000	0.0003	0.353	0.724	

Table 3.36: Effects on HNR in the final third of the vowel when not IP-initial

Comparing the subsets of post-pausal and non-post-pausal vowels, there is a significant positive effect of initial stress in both conditions, as shown in Tables 3.37 and 3.38.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	12.376	1.384	8.940	<0.001	***
IP-initial	0.184	0.418	0.440	0.660	
initial stress	2.315	0.688	3.365	<0.01	**
F1	-0.003	0.001	-3.202	<0.01	**
F2	0.000	0.001	0.497	0.619	

Table 3.37: Effects on HNR in the final third of the vowel when following a pause

	Estimate	Std. Error	T-value	P-value	
(Intercept)	12.453	0.876	14.215	<0.001	***
preceding vowel	-0.509	0.272	-1.867	0.062	.
preceding glottal(ized) consonant	0.097	0.421	0.231	0.818	
IP-initial	-0.004	0.332	-0.012	0.991	
initial stress	2.487	0.792	3.139	<0.01	**
F1	-0.002	0.001	-3.591	<0.001	***
F2	-0.000	0.000	-0.015	0.988	

Table 3.38: Effects on HNR in the final third of the vowel when not following a pause

3.3.2.2.5 Minimum intensity

Figure 3.11 shows the mean values of minimum intensity in the baseline condition (red dashed line) and each of the experimental conditions (solid lines).

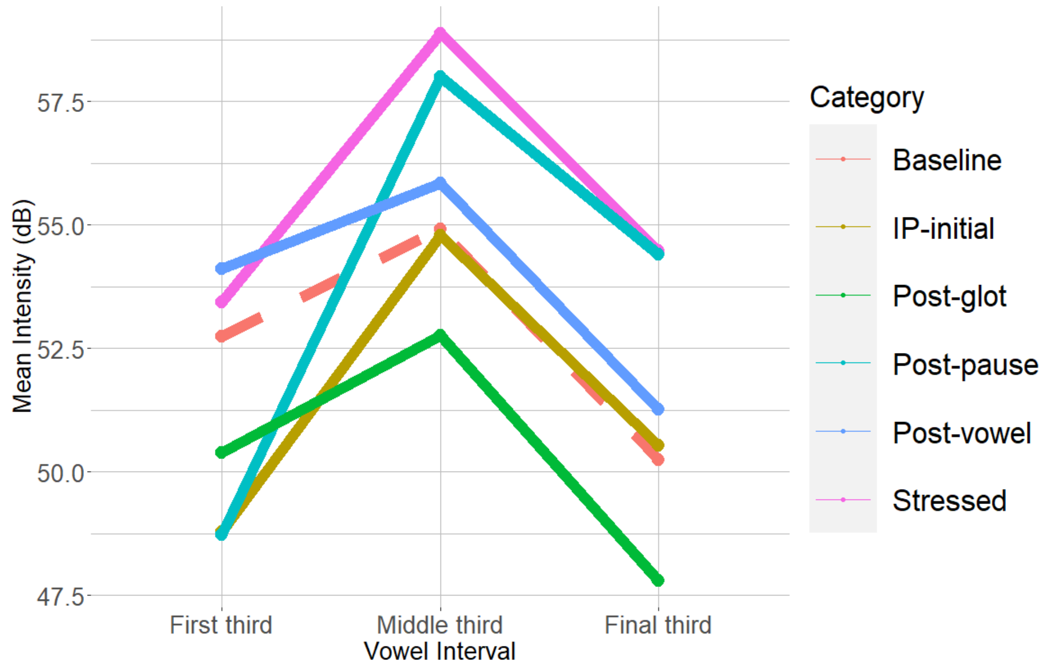


Figure 3.11: Mean value of minimum intensity in each experimental condition, for each third of the vowel

Table 3.39 shows the results for minimum intensity in the first third of the vowel. There is a significant negative effect of preceding pause, IP-initial position and initial stress, consistent with greater glottalization in these contexts. There is also a significant positive effect of preceding vowel, and a significant negative effect of F2. The interactions between preceding pause and initial stress and between preceding vowel and initial stress are significant.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	53.263	1.507	35.341	<0.001	***
preceding pause	-5.423	0.530	-10.224	<0.001	***
preceding vowel	2.160	0.449	4.816	<0.001	***
preceding glottal(ized) consonant	0.887	0.803	1.105	0.269	
IP-initial	-1.572	0.489	-3.212	<0.01	**
initial stress	-2.695	0.869	-3.101	<0.01	**
F1	0.001	0.001	0.911	0.362	
F2	-0.001	0.000	-2.923	<0.01	**
preceding pause, IP-initial	0.885	0.666	1.330	0.184	
preceding vowel, IP-initial	-0.084	0.751	-0.111	0.911	
preceding glott. cons., IP-initial	0.116	1.011	0.114	0.909	
IP-initial, initial stress	0.001	0.682	0.002	0.998	
preceding pause, initial stress	5.865	0.746	7.867	<0.001	***
preceding vowel, initial stress	2.381	0.680	3.500	<0.001	***
preceding glott. cons., initial stress	0.216	1.177	0.183	0.854	

Table 3.39: Effects on minimum intensity in the first third of the vowel

Comparing the subset of vowels that are stressed to the subset of vowels that are unstressed, it can be seen that there is no effect of preceding pause for stressed vowels and a negative effect for unstressed vowels, showing that these effects do not stack. There is a negative effect of preceding vowel for stressed vowels and a positive effect for unstressed vowels. These results are shown in Tables 3.40 and 3.41.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	46.201	2.211	20.897	<0.001	***
IP-initial	-1.253	0.624	-2.009	<0.05	*
preceding glottal(ized) consonant	1.336	1.117	1.197	0.232	
preceding pause	0.403	0.702	0.575	0.566	
preceding vowel	4.315	0.593	7.273	<0.001	***
F1	0.003	0.002	1.982	<0.05	*
F2	0.001	0.001	0.857	0.392	

Table 3.40: Effects on minimum intensity in the first third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	52.400	1.665	31.476	<0.001	***
preceding glottal(ized) consonant	0.941	0.546	1.725	0.085	.
preceding pause	-4.824	0.381	-12.655	<0.001	***
preceding vowel	2.155	0.386	5.578	<0.001	***
IP-initial	-1.298	0.354	-3.670	<0.001	***
F1	0.000	0.001	0.078	0.938	
F2	-0.000	0.000	-0.834	0.404	

Table 3.41: Effects on minimum intensity in the first third of the vowel when unstressed

The results for minimum intensity in the middle third of the vowel are shown in Table 3.42.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	51.944	1.536	33.827	<0.001	***
preceding pause	-0.692	0.450	-1.538	0.124	
preceding vowel	0.204	0.379	0.538	0.591	
preceding glottal(ized) consonant	0.185	0.680	0.271	0.786	
IP-initial	-1.070	0.414	-2.585	<0.01	**
initial stress	1.564	0.725	2.157	<0.05	*
F1	0.006	0.001	6.646	<0.001	***
F2	-0.001	0.000	-2.111	<0.05	*
preceding pause, IP-initial	1.603	0.563	2.846	<0.01	**
preceding vowel, IP-initial	0.280	0.636	0.441	0.660	
preceding glott. cons., IP-initial	-0.280	0.856	-0.327	0.744	
IP-initial, initial stress	-1.517	0.578	-2.627	<0.001	**
preceding pause, initial stress	4.838	0.631	7.671	<0.001	***
preceding vowel, initial stress	1.962	0.576	3.405	<0.001	***
preceding glott. cons., initial stress	1.916	0.997	1.922	0.055	.

Table 3.42: Effects on minimum intensity in the middle third of the vowel

There is a significant negative effect of IP-initial position and a significant positive effect of initial stress. There is also a significant, but very small, positive effect of F1 and negative effect of F2. The interactions between preceding pause and IP-initial position, between IP-initial position and initial stress, between preceding pause and initial stress and between preceding vowel and initial stress are significant.

Looking at the subsets of IP-initial and IP-non-initial vowels, there is a significant positive effect of preceding pause for both IP-initial and IP-non-initial vowels, though the effect is larger for IP-initial vowels. These results are shown in Tables 3.43 and 3.44.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	48.328	2.146	22.519	<0.001	***
initial stress	1.636	0.840	1.947	0.060	.
preceding glottal(ized) consonant	0.209	0.620	0.337	0.736	
preceding pause	2.000	0.454	4.406	<0.001	***
preceding vowel	0.666	0.588	1.132	0.258	
F1	0.009	0.002	4.453	<0.001	***
F2	0.000	0.001	0.005	0.996	

Table 3.43: Effects on minimum intensity in the middle third of the vowel when IP-initial

	Estimate	Std. Error	T-value	P-value	
(Intercept)	51.624	1.591	32.452	<0.001	***
preceding glottal(ized) consonant	0.635	0.623	1.020	0.308	
preceding pause	0.843	0.419	2.010	<0.05	*
preceding vowel	0.855	0.314	2.725	<0.01	**
initial stress	3.510	0.719	4.883	<0.001	***
F1	0.006	0.001	5.660	<0.001	***
F2	-0.001	0.000	-1.884	0.060	.

Table 3.44: Effects on minimum intensity in the middle third of the vowel when IP-non-initial

Looking at the subsets of stressed and unstressed vowels, there is a negative effect of IP-initial position and a positive effect of preceding pause and preceding vowel for vowels that are stressed. There are no significant effects of these factors on unstressed vowels. These results are shown in Tables 3.45 and 3.46.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	53.223	2.053	25.928	<0.001	***
IP-initial	-2.384	0.521	-4.579	<0.001	***
preceding glottal(ized) consonant	1.524	0.937	1.626	0.104	
preceding pause	4.353	0.586	7.426	<0.001	***
preceding vowel	2.117	0.493	4.298	<0.001	***
F1	0.006	0.002	3.646	<0.001	***
F2	-0.001	0.001	-1.048	0.297	

Table 3.45: Effects on minimum intensity in the middle third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	52.329	1.606	32.584	<0.001	***
preceding glottal(ized) consonant	-0.158	0.461	-0.343	0.732	
preceding pause	0.404	0.321	1.258	0.209	
preceding vowel	0.225	0.326	0.690	0.4902	
IP-initial	-0.482	0.300	-1.608	0.108	
F1	0.006	0.001	4.943	<0.001	***
F2	-0.001	0.000	-1.809	0.071	.

Table 3.46: Effects on minimum intensity in the middle third of the vowel when unstressed

The results for minimum intensity in the final third of the vowel are shown in Table 3.47. There is a significant positive effect of preceding pause. There is also a significant but very small positive effect of F1 and negative effect of F2. The interactions between IP-initial and initial stress and between preceding pause and initial stress are significant.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	53.362	1.558	34.260	<0.001	***
preceding pause	1.353	0.529	2.556	<0.05	*
preceding vowel	0.701	0.449	1.562	0.118	
preceding glottal(ized) consonant	-0.007	0.801	-0.009	0.993	
IP-initial	0.735	0.489	1.505	0.133	
initial stress	1.159	1.017	1.140	0.256	
F1	0.002	0.001	2.687	<0.01	**
F2	-0.003	0.000	-7.702	<0.001	***
preceding pause, IP-initial	-0.882	0.663	-1.331	0.183	
preceding vowel, IP-initial	-0.581	0.748	-0.777	0.437	
preceding glott. cons., IP-initial	-1.056	1.005	-1.050	0.294	
IP-initial, initial stress	-1.611	0.681	-2.366	<0.05	*
preceding pause, initial stress	2.061	0.743	2.773	<0.01	**
preceding vowel, initial stress	1.167	0.680	1.717	0.086	.
preceding glott. cons., initial stress	0.879	1.172	0.750	0.453	

Table 3.47: Effects on minimun intensity in the final third of the vowel

Looking at the subsets of stressed and unstressed vowels, there is a significant negative effect of IP-initial position for stressed vowels but no effect for unstressed vowels. There is a significant positive effect of preceding pause for both stressed and unstressed vowels, though the effect is larger when stressed. These results are shown in Tables 3.48 and 3.49.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	52.518	2.258	23.259	<0.001	***
IP-initial	-1.397	0.570	-2.452	<0.05	*
preceding glottal(ized) consonant	0.689	1.008	0.683	0.495	
preceding pause	2.494	0.639	3.905	<0.001	***
preceding vowel	1.575	0.538	2.929	<0.01	**
F1	0.009	0.002	5.370	<0.001	***
F2	-0.004	0.001	-5.254	<0.001	***

Table 3.48: Effects on minimum intensity in the final third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	53.573	1.582	33.871	<0.001	***
preceding glottal(ized) consonant	-0.386	0.562	-0.687	0.492	
preceding pause	1.061	0.390	2.719	<0.01	**
preceding vowel	0.567	0.397	1.427	0.154	
IP-initial	0.251	0.366	0.686	0.493	
F1	0.001	0.001	0.795	0.4268	
F2	-0.002	0.000	-5.954	<0.001	***

Table 3.49: Effects on minimum intensity in the final third of the vowel when unstressed

3.3.2.2.6 Summary of acoustic cues

The following tables summarize the results of the statistical models for each of the acoustic measures of glottalized phonation and each of the fixed effects. Only the coefficients of significant effects ($p < 0.05$) are shown in the tables; blanks indicate no significant effect. Effects consistent with glottalization (negative effect of spectral tilt, HNR, or intensity minimum) are shaded in gray. E.g., in Table 3.50 -8.198 is the coefficient of the effect of preceding glottalized consonant on H1-A1 in the first third of the vowel, and it is shaded in gray because it is consistent with glottalization.

Table 3.50 shows the results for words that are immediately preceded by a word ending in a glottalized consonant or glottal stop. Overall, this table shows greater glottalization in the first third of the vowel.

Measure	1st third	2nd third	3rd third
H1-H2			
H1-A1	-8.198		
H1-A2	-5.107		
HNR			
Intensity min			

Table 3.50: Effects for preceding glottalized consonant

Table 3.51 shows the effects for words immediately preceded by a word ending in a vowel. The results are consistent with greater glottalization than the baseline category throughout the vowel, but the absolute value of the coefficients decreases over time, and most disappear by the final third.

Measure	1st third	2nd third	3rd third
H1-H2	-2.194	-1.402	
H1-A1	-6.310	-3.748	-1.591
H1-A2	-4.381	-2.234	
HNR	1.892	-1.081	-1.001
Intensity min	2.160		

Table 3.51: Effects of preceding vowel.

Table 3.52 shows the significant effects for words that are immediately preceded by a pause. There are effects consistent with glottalization only in the beginning of the vowel, which disappear or are inverted by the third portion.

Measure	1st third	2nd third	3rd third
H1-H2		2.427	2.117
H1-A1	-2.557	2.546	2.394
H1-A2		2.656	2.072
HNR	-2.875	-2.551	
Intensity min	-5.423		1.353

Table 3.52: Effects of preceding pause.

Table 3.53 shows the significant effects for words that have stress on the initial syllable. There is an effect consistent with glottalization for every measure, but these are found only in the first third of the vowel.

Measure	1st third	2nd third	3rd third
H1-H2	-1.622		
H1-A1	-4.045		
H1-A2	-3.409		
HNR	-2.277		2.450
Intensity min	-2.695	1.564	

Table 3.53: Effects of initial stress.

Table 3.54 shows the significant effects for words that are initial in the intonational phrase. The effect of H1-A1 extends thoughout the vowel with no consistent decrease in size. The effect of H1-H2 appears only at the end of the vowel. The supporting measures of HNR and intensity minimum are located at the beginning of the vowel.

Measure	1st third	2nd third	3rd third
H1-H2			-2.024
H1-A1	-2.881	-2.854	-1.996
H1-A2			
HNR	-2.074	-3.040	
Intensity min	-1.572	-1.070	

Table 3.54: Effects of IP-initial position.

As outlined in the detailed results, there were some significant interactions between factors. The majority of the interactions relate to the secondary indicators (aperiodicity and reduction) rather than the primary indicators (spectral tilt). Among these interactions, many appear to reflect cases where synergistic forces do not stack (e.g. IP-initial position leads to lower HNR only for words not preceded by a pause, as preceding pause itself already lowers HNR). Others occur where the experimental factors result in potentially contrary forces (e.g. stress itself may result in increased intensity, but glottalization resultant from stress in a decrease).

3.3.3 Summary of acoustic evidence

The results of this acoustic study of spontaneous speech show that full closures are more likely to occur on words that have initial stress as well as those that are in the initial position of an intonational phrase, following a word that bears a boundary tone. The results of the acoustic measures of glottalization on initial vowels, however, show two distinct types of effects. On the one hand, initial stress, preceding pause, preceding glottalized consonant, and preceding vowel show localized effects at the beginning of the vowel, which either disappear entirely by the end of the vowel or become consistently weaker. Words with initial stress are also more likely to occur with a full glottal closure. The effect of IP-initial position, in contrast, is an increase in glottalization that lasts throughout the vowel with no apparent change in magnitude. This is exemplified in Figure 3.12, which shows two vowels produced by the same speaker within the same recording. Each of these vowels follows a word ending in a fricative. The stressed vowel in *ütz* [ˈʔʊts] 'good' (mushrooms, 07:48) on the left has visible glottalization in the first part only before becoming a fully modal vowel, while the IP-initial vowel [a] in the focus marker *are* [a.ˈɾe] (mushrooms, 05:03) on the right shows visible glottalization throughout.

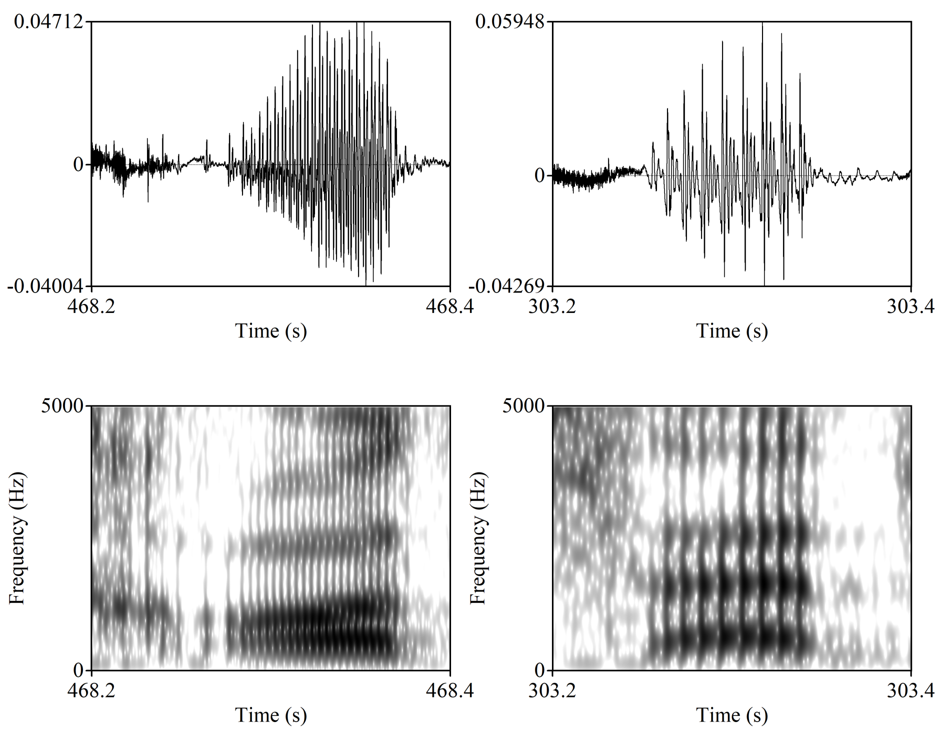


Figure 3.12: Localized glottalization at the beginning of the stressed vowel in [ˈʔʊts] 'good' (left) vs. consistent glottalization on the initial vowel of the focus marker [a.ˈɾe] (right)

The localized effects of initial stress, preceding pause and preceding vowel are very similar to the effects found for words preceded by a glottalized consonant, among them word-final glottal stops. These results are consistent with coarticulation: with the glottalized consonant in the latter case, and with a word-initial glottal stop in the former case, which must occur before the otherwise word-initial vowel. Words with initial stress are significantly more likely to begin with a full glottal closure, likely do to hyperarticulation in this context. These results support Larsen's (1988) description of the locations of word-initial glottal stops in K'iche' as occurring on words that are stressed and monosyllabic (i.e. have initial stress), utterance-initial (i.e. occur after a pause), or preceded by a word ending in a vowel. However, though the target of this initial glottal gesture is a stop, it is often reduced in spontaneous speech, as is common cross-linguistically. Full closures only occur in a minority of cases.

IP-initial position, in contrast to the other factors, results in glottalization cues that are consistent throughout the whole vowel with no clear decrease in magnitude. The persistence of the effect cannot be attributed to being an overall stronger gesture (due to its position at a high level in the prosodic hierarchy) because the effect sizes are similar or smaller than those found at the beginning of vowels showing localized effects: the effect here is longer but not stronger. These results are therefore not consistent with the effects of an initial glottal segment, but rather must be a phonetic or phonologized effect of this initial prosodic position, marking the left edge of intonational phrases. There are also higher rates of full closures in IP-initial position than in baseline conditions; these may represent greater strengthening of this IP-initial glottal constriction gesture.

Finally, the results do not show any significant effect of word origin, syllable count, or morpheme type on either the rate of full closures or other acoustic cues to glottalization on initial vowels. The lack of an effect of word origin is particularly surprising given widespread descriptions of K'iche' and other Mayan languages that say that all or many Spanish loanwords have phonemic word-initial glottal stops, as indicated by their behavior with respect to the possessive prefix allomorphy. This will be discussed further in Section 3.5.1.1.

In sum, the results of the acoustic study support the existence of word-initial glottal stops only in certain restricted cases: particular phrasal contexts (following a pause or vowel) or words beginning with a stressed syllable. The following section shows (morpho)phonological evidence that reinforces the distinction between words with and without initial stress, showing that words with initial stress behave like words beginning in a consonant whereas words without initial stress behave like truly vowel-initial words.

3.4 (Morpho)phonological evidence for word-initial vowels and glottal stops

(Morpho)phonological evidence further shows the difference in syllable structure between words apparently beginning in stressed and unstressed vowels. This is seen in the pattern of elision of the final nasal consonant in three nominal proclitics (Section 3.4.1) as well as the alternation between tense and lax vowel quality in word-initial position (Section 3.4.2). However, this contrast disappears under prefixation (Section 3.4.3).

3.4.1 Shortening of proclitics

Chichicastenango K'iche' has three nominal proclitics which end in a nasal coda: the indefinite article *jün* /χʊn/, the diminutive *sïn* /sɪn/ and the augmentative *man* /man/. These words are unstressed and always precede a noun phrase. The full form of these proclitics can be used in all contexts, especially in careful speech, but a reduced form where the final nasal coda is elided is very common in spontaneous speech.[6] However, this only occurs when the following word begins with either a consonant or a stressed vowel.

Table 3.55 shows examples from the corpus which occur with the shortened form /χu/. These include words beginning in consonants, whether the initial syllable is stressed or unstressed, as well as words beginning in stressed vowels. When the word otherwise begins with a stressed vowel, a glottal stop separates the two vowels.

[6]Note that the vowel quality of *jün* also becomes tense when the final nasal is elided.

Word type	Stress	Orthography	IPA	Gloss	Data source
C-initial	Initial stress	*ju tzij* *ju chköp*	χu ˈtsiχ χu ˈʧkɔp	‘a word’ ‘an animal’	lxe 02:31 kot, 00:35
	No initial stress	*ju tukur*	χu tu.ˈkuɾ	‘an owl’	owl, 00:33
V-initial	Initial stress	*ju ik’* *ju oj* *ju üq*	χu ˈʔik’ χu ˈʔoχ χu ˈʔuq	‘a month’ ‘an avocado’ ‘a skirt’	planting, 05:59 owl, 00:35 sewing, 00:31

Table 3.55: Shortened forms of the indefinite article in the corpus

This contrasts with Table 3.56 which shows words beginning with unstressed vowels. In these cases, the full form with its final coda is required, and the shortened form never occurs.

Word type	Stress	Orthography	IPA	Gloss	Data source
V-initial	No initial stress	*jün ala* *jün ixöq* *jün imül* *jün achi*	χʊn a.ˈla χʊn i.ˈʃɔq χʊn i.ˈmʊl χʊn a.ˈʧi	‘a boy’ ‘a woman’ ‘a rabbit’ ‘a man’	marriage, 00:03 healing, 02:33 mr, 14:09 owl, 00:06

Table 3.56: Full form of the indefinite article in the corpus

The contrast between words beginning in stressed and unstressed vowels is found not only in native K’iche’ words but also in Spanish loanwords. Spanish loans that begin with a consonant or stressed vowel may appear with the short form, but those that begin with an unstressed vowel must appear with the full form *jün*. Examples are shown in Table 3.57.

Word type	Stress	Orthography	IPA	Gloss	Data source
C-initial	Initial stress	*ju dia*	χu ˈdi.a	'a day'	church, 03:10
	No initial stress	*ju regalo*	χu re.ˈga.lo	'a gift'	mr, 14:14
V-initial	Initial stress	*ju or* *ju ocho*	χu ˈʔoɾ χu ˈʔo.ʧo	'an hour' 'some eight-ish'	church, 07:24 marriage, 05:15
	No initial stress	*jün iglesia* *jün istoria* *jün operasion*	χʊn i.ˈgle.sia χʊn is.ˈto.ɾia χʊn o.pe.ɾa.ˈsion	'a church' 'a story' 'an operation'	church, 00:36 mr, 10:49 healing, 00:47

Table 3.57: The indefinite article with Spanish loanwords

The same pattern observed for the indefinite article is found for the diminutive and augmentative: the forms *ma* and *sï* occur preceding consonants or stressed vowels, but the full forms *man* and *sïn* are required preceding a word beginning in an unstressed vowel. Examples are shown in Table 3.58.

Word type	Stress	Orthography	IPA	Gloss	Data source
C-initial	Initial stress	*ma kmätz* *sï che'*	ma ˈkməts sɪ ˈʧeʔ	'big snake' 'little tree'	magicegg, 01:53 fishing, 03:23
	No initial stress	*ma k'ölb'äl* *sï tikö'n*	ma k'ɔl.ˈɓəl sɪ ti.ˈkɔʔn	'big container' 'little plant'	earthquake, 00:42 planting, 06:01
V-initial	Initial stress	*ma oya*	ma ˈʔo.ja	'big pot' (Spanish loan)	marriage, 02:41
	No initial stress	*man almay* *sïn ak'al*	man al.ˈmaj sɪn a.ˈk'al	'big wardrobe' (Spanish loan) 'little child'	earthquake, 00:37 healing, 08:09

Table 3.58: Diminutive and augmentative in the corpus

In sum, the final nasal coda of these proclitics can be deleted in all cases unless the following word begins with an unstressed vowel. In these cases, the final nasal appears to be re-syllabified as the onset of the following word, which lacks an onset. This prevents vowel hiatus, which is strongly avoided in K'iche' and most other Mayan languages (Bennett 2016b). When the following word begins with a consonant, the final nasal is not needed for this purpose and may be elided. This data shows that words which apparently begin with stressed vowels actually pattern like words which begin with consonants rather than words which begin with vowels, showing that these words do not in fact begin with a vowel at all but with a glottal stop. Words beginning with unstressed syllables, in contrast, can be truly vowel-initial.

3.4.2 Vowel quality in initial syllables

The difference in syllable structure between initial stressed and unstressed syllables is also seen in the alternation between tense and lax vowels in word-initial position. Chichicastenango K'iche' has ten contrastive vowel phonemes which belong to two sets: the tense vowels are /a e i o u/ and the lax vowels are /ə ɛ ɪ ɔ ʊ/ (see Section 1.2.1.2). Tense vowels result historically from long vowels and lax vowels from short vowels, and this older pattern is preserved in most other dialects of the language. Chichicastenango K'iche' tense and lax vowels perfectly correspond to long and short vowels in other dialects and in the historical form of the language in most contexts, but not when word-initial and unstressed, where they must always be realized as tense. Examples are shown in the following tables.

Words that begin with consonants may have both tense and lax vowels in the initial syllable, whether it is stressed or unstressed, as shown in Table 3.59.

Realization	Stress	Orthography	IPA	Gloss	Data source
Tense	Initial stress	*mam*	ˈmam	'rooster'	mushrooms, 06:26
		tel	ˈtel	'hole'	healing, 11:35
		tzij	ˈtsiχ	'language'	kot, 02:33
	No initial stress	*chanim*	ʧa.ˈnim	'now'	kot, 00:02
		wakäx	wa.ˈkəʃ	'cow'	cooking, 03:06
		tikö'n	ti.ˈkɔʔn	'plant'	history, 01:41
Lax	Initial stress	*k'üch*	k'ʊʧ	'vulture'	tri 00:48
		chäj	ˈʧəχ	'pine tree'	healing, 10:55
		q'ëq	ˈq'ɛq	'black'	3recipes, 00:50
	No initial stress	*wächb'äl*	wəʧ.ˈɓəl	'image'	history, 02:55
		mïq'na'	mɪq'.ˈnaʔ	'hot water'	caldores, 00:20
		k'ölb'äl	k'ɔl.ˈɓəl	'place'	planting, 03:15

Table 3.59: Vowel quality in C-initial words

The same is true of words beginning in stressed vowels: they may be tense or lax. Examples are shown in Table 3.60.

Vowel realization	Stress	Orthography	IPA	Gloss	Data source
Tense vowel	Initial stress	*aq*	ˈʔaq	'pig'	chilmol 00:15
		oj	ˈʔoχ	'avocado'	healing, 11:05
		ik	ˈʔik	'chile'	atolblanco, 02:44
Lax vowel	Initial stress	*äk'*	ˈʔək'	'chicken'	planting, 04:13
		ütz	ˈʔʊts	'good'	mushrooms, 07:48
		üq	ˈʔʊq	'skirt'	kot, 02:24

Table 3.60: Vowel quality in stressed V-initial words

However, words cannot begin with unstressed lax vowels. When a vowel that is underlyingly lax is present in an unstressed word-initial position, it is realized as the corresponding tense vowel instead. This results in vowel quality alternations between the unpossessed and possessed forms of many multisyllabic nouns: the initial vowel in the bare form is realized as tense, but the same vowel is realized as lax in the possessed form due to the presence of the prefix which provides an initial consonant. Examples are shown in 50-52.[7]

(50) a. *atz'yäq*
ats'.ˈjəq
əts'jəq
clothes
'clothes' (history, 10:25)

b. *qätz'yaq*
qəts'.ˈjaq
q-əts'jəq
A:1PL-clothes
'our clothes' (kot, 02:42)

[7] In many Mayan languages, there are noun classes where vowel length (cognate with tenseness in Chichicastenango K'iche') changes when the noun in possessed (Polian 2017). An example is Nahualá/Santa Lucía Utatlán K'iche' /kinaq'/ 'beans' vs. /ukinaːq'/ 'her/his beans', where the vowel in the second syllable is long when the noun is possessed (Can Pixabaj 2017). Parallel alternations occur in Chichicastenango K'iche' with vowel tenseness; e.g., *knäq'* /k(ɪ)nəq'/ 'beans' (cooking, 01:13) vs. *aknaq'* /ak(ɪ)naq'/ 'your beans' (cooking, 01:14). This is the motive for the change in vowel quality in the second syllable in 50. This is a completely separate pattern from the word-initial quality restriction: it affects the last syllable rather than the first, and the vowel in the possessed form is tense rather than lax.

(51) a. *ixöq*
i.ˈʃɔq
ɪʃɔq
woman
'woman' (healing, 03:00)

b. *rïxqil*
ɾɪ.ʃ(ɔ).ˈqil
ɾ-ɪʃɔq-il
A:3SG-woman-POSS
'his wife' (mr, 35:26)

(52) a. *achi*
a.ˈʧi
əʧi
man
'man' (owl, 00:06)

b. *wächjil*
wə.ʧ(ɪ).ˈχil
w-əʧi-χil
A:1SG-man-POSS
'my husband' (earthquake, 01:26)

In these examples, the initial vowel of the bare noun is realized as a tense vowel. However, when the nouns are possessed and these same vowels are no longer word-initial, they are realized as lax vowels. The addition of a consonant onset to the word allows the vowel to be realized as lax, showing that the bare forms are truly vowel-initial.

A second alternation that affects word-initial vowels further supports this statement. In some cases, vowels which are word-initial in the bare form are deleted in the possessed form rather than surfacing as lax vowels. This is also evidence of an underlying identity as a lax vowel, since tense vowels are not deleted in content words in Chichicastenango K'iche' (see Chapter 4). Examples are shown in Table 3.61.

Here the underlyingly lax vowels in the noun roots are realized as tense when in initial position and deleted when a possessive prefix is added which provides an onset to the word, making an initial CV syllable. When there is no prefix, there is no initial consonant, and the vowel is truly word-initial, preventing it from being deleted.

Bare noun: tense initial vowel			
Orthography	IPA	Gloss	Data source
ulew	u.ˈlew	‘land’	fishing, 04:27
atz’am	a.ˈts’am	‘salt’	atolblanco, 02:08
ichaj	i.ˈʧaχ	‘vegetables’	cooking, 02:12
Possessed noun: vowel deleted			
Orthography	IPA	Gloss	Data source
qlew	q(ʊ).ˈlew	‘our land’	church, 01:21
rtz’am	ɾ(ə).ˈts’am	‘its salt’	3recipes, 03:35
qchaj	q(ɪ).ˈʧaχ	‘our vegetables’	caldores, 00:16

Table 3.61: Vowel deletion alternation in possessed and unpossessed nouns

In sum, the alternation between tense and lax vowels in word-initial syllables, like the behavior of proclitics, shows that words beginning in unstressed vowels are truly vowel initial. Words that apparently begin with stressed vowels, in contrast, pattern with words beginning in consonants. These words actually have an initial consonant: a glottal stop.

3.4.3 Possessive prefix allomorphy

Chichicastenango K’iche’, as is common across the Mayan language family, has two sets of possessive prefixes. Which one is used depends on the structure of the word to which it is attached: specifically, whether it begins in a vowel or a consonant. This is shown in Table 3.62.

	C-initial word	V-initial word
1SG	n̩-	w-
2SG	a-	aw-
3SG	u-	ɾ-
1PL	qə-	q-
2PL	i-	iw-
3PL	kɪ-	k-

Table 3.62: Possessive prefixes in Chichicastenango K’iche’

As this table shows, the prefixes which attach to words beginning with consonants end in vowels (except for the first person singular, which has a final vowel in related dialects but is a syllabic nasal in Chichicastenango K'iche'). The prefixes which attach to words beginning in vowels, in contrast, end in consonants. This adapts to the predominant pattern of alternating consonants and vowels in K'iche' words.[8]

Crucially, the forms which attach to vowel-initial words do so regardless of whether the initial vowel is stressed or not. Examples are provided in Table 3.63.

Unpossessed form			
Orthography	IPA	Gloss	Data source
aq	ˈʔaq	'pig'	chilmol 00:15
achi	a.ˈʧi	'man'	owl, 00:06
chak	ʧak	'work'	church, 01:16
meb'il	me.ˈɓil	'livestock'	history, 01:39
Possessed form			
Orthography	IPA	Gloss	Data source
waq	ˈwaq	'my pig'	lifetmt, 06:36
wächjil	wəʧ.ˈχil	'my husband'	earthquake, 01:26
nchak	n.ˈʧak	'my work'	talentos, 00:41
nmeb'il	n.me.ˈɓil	'my livestock'	lifetmt, 06:49

Table 3.63: Possession of consonant- and vowel- initial words

As this table shows, both the word *aq* 'pig' and the word *achi* 'man' take the prevocalic form of the first person singular possessive prefix, *w*-, indicating they begin in a vowel. Conversely, the words *chak* 'work' and *meb'il* 'livestock' take the preconsonantal form of this prefix, *n*-, because they begin with a consonant.

Although the pattern described here covers most words in the language, many apparently vowel-initial Spanish loanwords appear with the normally preconsonantal prefixes. Examples are shown in Table 3.64.

[8] However, as noted above vowel deletion is very common in Chichicastenango K'iche', and the vowels in the CV- possessive prefixes are often deleted in the surface form of this dialect. See Chapter 4 for more information.

Orthography	IPA	Gloss	Data source
u'ingrediente	u.ʔin.gɾe.ˈdien.te	'its ingredients'	atolblanco, 01:39
a'oja	a.ˈʔo.ja	'your pot'	cooking, 02:29
u'altar	u.ʔal.ˈtaɾ	'its altar'	marriage, 07:57

Table 3.64: Preconsonantal prefixes on vowel-initial Spanish loanwords in Chichicastenango K'iche'

In each of these examples, an apparently vowel-initial word appears with the preconsonantal third person singular possessive prefix *u-* instead of the expected prevocalic form *r-*, and a glottal stop appears between the prefix and the root. The reason for this difference between apparently vowel-initial native K'iche' words and Spanish loans will be discussed further in Section 3.5.1.1.

3.4.4 Summary of (morpho)phonological evidence

The data outlined in the previous sections shows that with respect to vowel quality and proclitic shortening, words beginning with apparently stressed and unstressed vowels diverge in behavior. Those beginning with stressed vowels behave like words beginning in consonants: lax vowels can appear in this position, and the proclitics *jün*, *sïn*, and *man* may appear in their shortened forms without the final nasal coda. Those beginning with unstressed vowels, in contrast, behave like truly vowel-initial words: lax vowels are not allowed, and the proclitics never appear in their shortened forms.

With respect to the possessive prefix allomorphy, however, the pattern is different. Both stressed and unstressed vowel-initial words take prevocalic possessive prefixes, while words beginning in consonants appear with a different set of prefixes. However, many otherwise apparently vowel-initial Spanish loanwords take the preconsonantal prefixes.

3.5 Discussion

The acoustic and (morpho)phonological data reviewed in this paper demonstrate that in Chichicastenango K'iche' not all words begin with consonants: there are in fact vowel-initial words. However, there are no vowel-initial words that begin with stressed syllables, nor do vowel-initial words occur when following a pause or a word ending in a vowel. In these cases, an otherwise vowel-initial word has an initial glottal stop, which may be realized as a full closure or as glottalized phonation at the beginning of the vowel.

The acoustic results also show that there is a second type of phonological process which results in glottalized phonation on word-initial vowels. Words that are at the beginning of an intonational phrase have an initial constricted glottis gesture. However, this operates at the level of the syllable or beyond, and is not due to the presence of a glottal stop segment but rather is similar to phrase-final creak in other languages (Davidson 2021).

The following sections further discuss these results. Section 3.5.1 argues that the evidence shows that word-initial glottal stops, where present, are epenthetic in K'iche'. Section 3.5.2 discusses the results within the literature on Mayan languages. Finally, Section 3.5.3 discusses the pattern in K'iche' within the typology of word-initial glottalization in world languages.

3.5.1 The phonemic status of word-initial glottal stops in Chichicastenango K'iche'

3.5.1.1 Acoustic and (morpho)phonological evidence

The results of the acoustic study and supporting (mopho)phonological evidence shown in the previous sections show that there is a clear difference between words which begin with a stressed vowel (appear with an initial glottal stop consonant) and those which begin with an unstressed vowel (do not appear with an initial glottal stop consonant). However, this contrast disappears when the words are prefixed. The allomorphy of the possessive prefixes demonstrates, as has been argued for many Mayan languages (Bennett 2016b), that the glottal stops that appear on otherwise vowel-initial words with initial stress must be epenthetic rather than phonemic. If words beginning with stressed vowels had an underlying glottal stop in contrast to words truly beginning in unstressed vowels, the fact that these two groups of words pattern together with respect to the possessive prefixes would be very unexpected.

Following this logic, it might be argued that Spanish loanwords that are apparently vowel-initial but nevertheless take preconsonantal possessive prefixes actually have phonemic word-initial glottal stops, in contrast to most apparently vowel-initial words which are truly vowel-initial. This is in fact a common argument in the Mayan literature to explain the unexpected use of preconsonantal prefixes on a minority of apparently vowel-initial words in many different Mayan languages; many of these words are Spanish loanwords (Bennett 2016b).

However, despite the use of preconsonantal prefixes on many Spanish loanwords in the Chichicastenango K'iche' data, a distinction between these words and native K'iche' words with respect to initial glottal stops is not supported in either the acoustic data presented in Section 3.3 nor the pattern of proclitic shortening presented in Section 3.4.1. If these words had phonemic word-initial glottal stops, they would be expected to allow the deletion of the nasal coda in the proclitics irrespective of stress, and would be expected to occur more frequently with full glottal closures or other indications of glottalization than other words, neither of which are borne out in the data. Therefore, the evidence from the possessive prefix used for an individual word is inconsistent with other evidence on the question of whether it truly begins with a vowel or a consonant.

Furthermore, less frequently vowel-initial Spanish loanwords do appear with prevocalic prefixes. There is only one such example in the corpus, *awros* /aw(ə)ɾos/ 'your rice' with the prevocalic prefix *aw-* /aw-/ (chilmol, 01:23). However, I have encountered other examples in conversation in Nahualá K'iche', such as *relado* /ɾelado/ 'his/her ice cream' with the prevocalic prefix *r-* /ɾ-/ or *wamigo* /wamigo/ 'my friend' with the prevocalic prefix *w-* /w-/.

These facts suggest a different picture: there are two different strategies that a speaker may utilize for determining which possessive prefix to use. The strategy applied to native words is based on syllable structure: a word that begins underlyingly in a vowel takes a prevocalic prefix and a word that begins underlyingly with a consonant takes a preconsonantal prefix. However, when the speaker encounters a foreign word that is not part of the usual paradigm, they may instead adopt a different strategy, applying the 'default' (and much more frequent) prefixes which are those found with consonant-initial roots. If this results in a sequence of vowels, a glottal stop is then inserted to prevent vowel hiatus. Depending on which strategy the speaker adopts, vowel-initial loanwords may surface with either of the possessive prefixes.

The fact that the preconsonantal prefixes are considered the default form by speakers is supported by patterns of hesitations and speech errors. Speakers will often produce a preconsonantal possessive prefix and then hesitate before retrieving the noun, even when the noun ultimately chosen begins with a vowel, as shown in 53.

(53) a. *Käqya ch b'ï* ***u... rchaj.***
kə-∅-q(ə)-ja-∅ ʧ(ɪ) ɓɪ u ɾ-(ɪ)ʧaχ
INCPL-B:3SG-A:1PL-add-SS:M again DIR A:3SG A:3SG-vegetable
'Again we add its... its vegetables.' (caldores, 00:42)

b. *r* ***u... rächjil***
ɾ(ɪ) u ɾ-əʧ(ə)χil
DET A:3SG A:3SG-husband
'...her... her husband' (marriage, 03:11)

In each of these examples, the speaker initially produces the preconsonantal third person singular possessive prefix *u-* before correcting with the prevocalic form *r-* upon realizing the word begins with a vowel. Notably, the opposite pattern does not occur: prevocalic possessive prefixes are not produced while the speaker is hesitating and searching for a word. This cannot be attributed to pronounceability because the prevocalic prefixes are perfectly pronounceable on their own in Chichicastenango K'iche'. For instance, the distal determiner *rï* is often produced as a plain *r*, identical in form to the prevocalic third person singular possessive prefix; this determiner can occur in the same types of hesitation frames with no problems.

In conclusion, the appearance of preconsonantal possessive prefixes on many Spanish loanwords cannot be attributed to the existence of a phonemic word-initial glottal stop on these words, but it can be explained through the default use of these prefixes with words that are not part of the usual paradigm. This means that there is no evidence for any phonemic word-initial glottal stops in the Chichicastenango K'iche' corpus.

3.5.1.2 Considering previous arguments for phonemic status

Having shown evidence from the possessive prefix allomorphy that word-initial glottal stops in K'iche' must be epenthetic rather than phonemic, I now review two arguments made by Kaufman (2015) for the phonemic status of these segments. These include the argument from reduplication and the argument from the agentive prefix *aj-*.

The reduplication argument is that when K'iche' words such as *ox* 'three' are reduplicated, creating forms like *ox-ox* 'three by three', a glottal stop occurs between the two morphemes, demonstrating that there must be an initial glottal stop in the underlying form. However, there are two problems with this argument. First, the glottal stop could be inserted into the reduplicated form for other reasons. McCarthy and Prince (1995) show that epenthetic segments are reduplicated in a number of languages. Second, it is not clear what the phonological structure of these reduplicated words is, and whether the two morphemes are part of the same phonological word or not. It is possible that the glottal stop occurs between the morphemes because the root is prosodic word-initial and stressed, rather than due to its underlying status. Therefore, the appearance of a glottal stop in reduplicated words does not demonstrate its underlying status.

The second argument presented by Kaufman (2015) is that when vowel-initial words appear with the agentive prefix *aj-*, a glottal stop occurs between prefix and root, as in *aj iitz* [aχ ˈʔiːʦ] 'witch'. If there were no underlying glottal stop on the root, the presence of a phonetic glottal stop between prefix and root would be surprising. However, Larsen (1988) points out that a glottal stop only occurs following the agentive when it attaches to a word that is monosyllabic (and therefore has initial stress). There is no glottal stop in forms such as *aj uwachulew* [aχ u.wa.ʧu.ˈlew] 'inhabitant of the earth', where stress falls on a later syllable. Therefore, the notion that this demonstrates that there are phonemic word-initial glottal stops on all otherwise vowel-initial words is problematic.

Furthermore, it is not clear that the agentive is indeed a prefix at all, rather than a proclitic or otherwise outside of the prosodic word. The evidence on this point is mixed. On the one hand, as pointed out by Bennett et al. (2018) in a discussion of comparable forms in the closely related language Kaqchikel, nouns formed with *aj-* can be possessed, in which case the possessive prefix precedes *aj-*. An example from the Nahualá dialect of K'iche' is *wajtiij* 'my teacher'. Similarly, words formed with *aj-* can also bear the plural suffix *-Vb'*, which only attaches to human nouns. It is *aj-* which derives these words into human nouns. Examples from the Chichicastenango K'iche' corpus include *aj maxïb'* 'Maxeños' (people from Chichicastenango, named after *Max* 'Thomas', mr, 09:25) and *aj pätnïb'* 'cofradía members' (from *p(ä)tän* 'cofradía', mr, 02:46).

On the other hand, Larsen (1988) notes that *aj-* can precede not only nominal roots but also adverbs and even prepositional phrases in K'iche', as in *chi q'iij* 'by day', *aj chi q'iij* 'day laborer'. In the Chichicastenango K'iche' corpus *aj-* also sometimes occurs separated from the following nominal root by the proclitic *täq* (plural marker), as in *r aj täq chuchqaw* 'the Mayan priests' (changes2, 00:37); *aj-* cannot be a prefix of *chuchqaw* in this phrase if *täq* is a proclitic.

Bringing these observations together, it is not at all clear that *aj-* behaves as a typical prefix in K'iche'. It appears to be a prefix in some contexts but a proclitic in others. It is possible that the status of this morpheme is in shift. Alternately, it is possible that it is always a proclitic, forming a phonological phrase with the root, or otherwise outside of the minimum prosodic word of the root (see Bennett et al. 2018 for a detailed proposal along these lines for Kaqchikel). In any case, the fact that glottal stops appear between *aj-* and (some) vowel-initial roots is not clear evidence for the phonemic status of these consonants.

3.5.2 Word-initial glottalization in Mayan languages

The results of the acoustic study showed two types of glottalization: localized effects on stressed vowels and in certain phrasal conditions are due to the presence of an initial glottal stop on these words, while smaller but more persistent effects in IP-initial position act as a prosodic marker similar to phrase-final creak in other languages (Davidson 2021).

The occurrence of IP-initial glottalization has not been reported previously for Mayan languages. However, languages across the Mayan family have patterns of final sonorant devoicing, [h] insertion on vowels, and aspiration of stops, which have been analyzed in Yucatec Maya and K'iche' as due to a domain-final spread glottis feature (AnderBois 2008;

Henderson 2012; Bennett 2016b). Combined, the occurrence of domain-final spreading and domain-initial glottalization maximize the contrast in voice quality between initial and final positions, enhancing the boundary between them.

Descriptions of other Mayan languages show different patterns of initial glottal stop than revealed here for K'iche'. Bennett (2018) shows that stress is not relevant to the insertion of word-initial glottal stop in Kaqchikel. A minimal contrast can be seen in examples like Kaqchikel [in ʔu.ˈmʊl] 'I am a rabbit', where there is a glottal stop before the initial unstressed [u], compared to Chichicastenango K'iche' *öj achlal* [ɔχ atʃ.ˈlal] 'we are siblings', with no glottal stop before the initial unstressed [a] (lifeejl, 04:45). Bennett et al. (2022) show that in Uspanteko epenthetic initial glottal stops are not only found on all otherwise vowel-initial words but also appear with certain prefixes, as in [ʃinʔoːk] 'I entered' from the root /oːk/ 'enter', which contrasts with Chichicastenango K'iche' *xok* [ʃoːk] 'she entered' (earthquake, 01:09). If there are truly glottal stop segments in these words, then the pattern is not uniform across all Mayan languages, or even the closely related languages of the K'ichean branch.

Finally, the use of preconsonantal possessive prefixes on a subset of otherwise apparently vowel-initial words, many of which are Spanish loanwords, has been described for many Mayan languages. Examples from a number of K'ichean languages are shown in Table 3.65.

	Orthography	IPA	Gloss
Nahualá K'iche' (Barrett 2007)	*nu'eek'*	nuʔeːk'	'my bromeliad plant'
	nu'axuux	nuʔaʃuːʃ	'my garlic' (Spanish *ajo*)
Kaqchikel (Barrett 2007; Bennett 2018)	*nu'okox*	nuʔokoʃ	'my mushroom'
	nu'oj	nuʔoχ	'my avocado'
	nu'ixin	nuʔiʃin	'my corn'
	ru'alambre	ɾuʔalambɾe	'his/her wire' (Spanish *alambre*)
Tz'utujil (Dayley 1985)	*nuu'ojb'*	nuːʔoχɓ	'my phlegm'
	n'o'on	nʔoʔon	'my iguana'
	n'aarka	nʔaːrka	'my bow' (Spanish *arco*)
Sakapultek (DuBois 1981)	*nu'utoy*	nuʔutoj	'my agouti'
	ni'am	niʔam	'my spider'
Sipakapense (Barrett 1999; Barrett 2007)	*n'utiw*	nʔutiw	'my wolf'
	n'aj tiij	nʔaχ tiːχ	'my teacher'
	n'aanx	nʔaːnʃ	'my garlic' (Spanish *ajo*)
	n'imul	nʔimul	'my rabbit'
Uspantek (Bennett et al. 2022)	*in'aab'*	ʔinʔaːɓ	'my hammock'
Q'eqchi' (Campbell 1974)	*inimul*	inimul	'my rabbit'
	ininup	ininup	'my ceiba tree'
	inuk'	inuk'	'my louse'
	inis	inis	'my yam'
	inoq'ob'	inoq'oɓ	'my liquidamar tree'
	inib'oy	iniɓoj	'my armadillo'

Table 3.65: Preconsonantal possessive prefixes on apparently vowel-initial words in K'ichean languages

As this table shows, the exceptional use of preconsonantal prefixes is not limited only to Spanish loanwords in these languages but also occurs with a small number of native words. As many of these authors note, the native words which behave this way are not random words of the language, but many of them are words that are infrequently possessed, such as plants or wild animals (Campbell 1974; Dayley 1985; Larsen 1988; Barrett 1999; Orie and Bricker 2000). Examples from the table include 'bromeliad', 'iguana', 'agouti', 'spider', 'wolf', 'rabbit', 'louse', 'ceiba tree', 'liquidamar tree', and 'armadillo'. Some descriptions also note that although these words sometimes appear with preconsonantal prefixes, they may also appear with prevocalic prefixes, e.g. Sakapultek [ʔam] 'spider' is alternately possessed as [wam] or [niʔam] (DuBois 1981), and Q'eqchi' [ik'oj] 'huicoy', [o] 'avocado' and [okoʃ] 'mushroom' are found with both types of prefixes (Campbell 1974).

The fact that these words tend to be infrequently possessed and may sometimes also be produced with prevocalic prefixes suggests that, like what occurs with Spanish loanwords in Chichicastenango K'iche', the use of preconsonantal prefixes may reflect a default use rather than the existence of a phonemic glottal stop consonant at the beginnings of these words. Like loanwords, infrequently possessed words do not belong to the usual possession paradigm and speakers will have rarely encountered their possessed forms.[9]

The default use of preconsonantal prefixes for words that do not have an established possessive form would also shed some light on the sporadic distribution of these forms in different Mayan languages. As has been observed in the literature (Barrett 2007), the otherwise vowel-initial words attested with preconsonantal possessive prefixes are not consistent across languages or even dialects of the same language, creating a confusing challenge for historical reconstruction. This is explained if these words don't in fact have phonemic word-

[9]This is similar to what Campbell (1974) argues for Q'eqchi': he also suggests that the preconsonantal possessors are more 'basic' than the prevocalic forms. But there are some crucial differences. Campbell argues that the words that take prevocalic possessors must all be learned piecemeal, rather than from a rule, as the phonologically conditioning environment is no longer productive. I argue that there is a rule, but it is in competition with another available rule: to use the default form. The fact that the phonologically conditioned alternation is sometimes applied to recent Spanish loans in K'iche' like *aros* 'rice' or *elado* 'ice cream' is evidence that it is still productive. Campbell also says that although the otherwise vowel-initial words where the preconsonantal possessors are typically infrequent vocabulary items, there is nothing odd about them being possessed. I disagree: even Campbell's examples are primarily plants and wild animals.

initial glottal stops, but instead individual speakers sometimes apply the default forms of the possessive prefixes rather than the forms expected based on syllable structure. When only a few tokens are available for each dialect in a variable distribution, this may artificially indicate cross-dialect or cross-language differences that are not truly present.

This leaves open the possibility that certain words in these languages may have truly phonemic word-initial glottal stops. A small number of the examples cited in the literature are neither loanwords nor rarely possessed, such as [ʔaːɓ] 'hammock' in Uspantek (Bennett et al. 2022) or [ʔoχ] 'avocado' in San Antonio Aguas Calientes Kaqchikel (Barrett 2007), and a default use of preconsonantal prefixes would be unlikely. Furthermore, Bennett (2016b) points out that if a given root usually occurs in its isolation form because it is uncommonly possessed, and therefore typically has an initial glottal stop, this may be easily reanalyzed by speakers as an underlying consonant. More extensive data for different languages is needed to test how consistent speakers are in their use of preconsonantal prefixes for these words and what other evidence exists for whether they begin with phonemic glottal stops.

3.5.3 Initial glottalization in world languages

The results of the acoustic study presented in this chapter show that word-initial glottal stop insertion is affected by the phrasal context (preceding vowel, pause or glottal(ized) segment) and prosody (stress). These factors are commonly found to affect glottalization in many other languages. Glottalization has been found to be more likely following a pause in Dutch (Jongenburger and Heuven 1991), English (Dilley et al. 1996; Garellek 2012), Finnish (Lennes et al. 2006) and German (Kohler 1994). Effects of the pressure to resolve vowel hiatus are also found in Dutch (Jongenburger and Heuven 1991) and English (Dilley et al. 1996; Umeda 1978). Higher frequency is also reported in English for words following glottalized segments (Dilley et al. 1996; Garellek 2012). With respect to prosody, higher frequency of glottalization is found on stressed initial syllables in Dutch (Jongenburger and Heuven 1991), German (Alber 2001; Pompino-Marschall and Żygis 2011; Kohler 1994) and English (Dilley et al. 1996; Garellek 2012). Similarly, higher rates of glottalization have been found for syllables with pitch accents in English (Dilley et al. 1996; Garellek 2012). These previous studies of word-initial glottalization have been primarily focused on English and a few other

(Indo-)European languages. This study shows that similar effects are found in a geographically distant and genetically unrelated language, emphasizing the prevalence of these factors cross-linguistically.

The appearance of glottalized phonation as a prosodic marker in IP-initial position in K'iche', in contrast, is a pattern opposite to what is found in many world languages. Creaky phonation occurs at the *ends* of prosodic domains in many languages, such as English (Garellek 2015; Crowhurst 2018; Davidson 2021), Portuguese (Mata et al. 2014), Finnish (Ogden 2001), Estonian (Aare et al. 2017) and Mandarin (Kuang 2018). Word-initial glottal stop epenthesis is more likely following a prosodic boundary in Maltese (Mitterer et al. 2019), English (Dilley et al. 1996; Garellek 2012) and German (Pompino-Marschall and Żygis 2011), but this cannot explain the pattern found in K'iche' where the glottalization cues on these words are longer in duration but weaker in degree to what is found with epenthetic glottal stops. Therefore, the K'iche' pattern is typologically quite unusual.

3.6 Conclusion

This chapter argues that K'iche' has words which begin underlyingly with both consonants and vowels. When an underlyingly vowel-initial word begins with a stressed syllable, a glottal stop is inserted as an initial consonant. Glottal stops are also inserted on words that follow a pause or vowel. Other underlyingly vowel-initial words are vowel-initial in the surface form. This analysis is supported by both acoustic and (morpho)phonological evidence.

The acoustic study shows that full glottal closures are more frequent on word beginning with a stressed syllable or occurring at the beginning of an intonational phrase (following a word with a boundary tone). Nevertheless, even in these cases they represent a minority of the data. However, other acoustic cues to glottalization are found on word-initial vowels. Word-initial vowels that are stressed or that follow a pause or vowel show stronger cues to glottalization in the first third of the vowel, which disappear or diminish over the course of the vowel. These results, similar to the effect of following a word ending in a glottal stop or glottalized consonant, are consistent with the existence of a glottal stop at the beginning of the word, though it is commonly reduced in production. Word-initial vowels that are in the initial position of an intonational phrase, in contrast, show consistent glottalization throughout the vowel, indicating a prosodic boundary marker and not the presence of a glottal stop. The occurrence of initial glottalization contrasts with the domain-final spread glottis found in K'iche' (Henderson 2012), providing a sharp contrast between final and initial positions that enhances the boundary between them.

The phonological and morphophonological data support the surface contrast between the syllable structure of words beginning with stressed and unstressed vowels. Unstressed word-initial vowels must be realized as tense and do not permit the deletion of the final nasal coda on a preceding proclitic; that is, they behave phonologically like vowel-initial words. Stressed (apparently) word-initial vowels, in contrast, may be realized as lax and permit the deletion of the final nasal of the proclitics, patterning in these respects like words beginning in consonants. Initial stressed and unstressed vowels pattern together, however, with respect to the possessive prefix allomorphy, both receiving prevocalic prefixes in contrast to the preconsonantal prefixes that appear on consonant-initial words. This data shows that word-initial glottal stops are absent on words that begin with an unstressed syllable but epenthesized (rather than underlying) on words that begin with a stressed syllable.

The analysis presented in this chapter - that glottal stops are epenthesized at the beginnings of vowel-initial words only when they follow a vowel or pause or begin with a stressed syllable - aligns very closely with Larsen's (1988) description of K'iche'. However, this differs substantially from other more recent works (López Ixcoy 1997; Barrett 2007; Kaufman 2015), where glottal stops are argued to have a much less restricted distribution in word-initial position. Because these works focus on the interpretation of the distribution of glottal stops rather than their surface realizations, it is not clear what source of evidence these authors relied on in their descriptions of the generalizations. It is possible that there are differences across speakers or time. However, the authors all use data from the Nahualá dialect, among others, and do not note the existence of any cross-dialect variation in their descriptions, so dialect variation is not likely to be responsible for these differences. These results highlight the need to reconsider the frequent statements that all words in Mayan languages must begin with a consonant, and instead assess the pattern for each language and dialect. Due to the non-contrastive status of glottal stop in word-initial position in Mayan languages and the range of different phenomena which can cause variations in voice quality, such as the IP-initial glottalization pattern discussed in this chapter, acoustic and quantitative data is particularly valuable for this task.

Chapter 4

Vowel deletion

4.1 Introduction

One of the most salient characteristics of the Chichicastenango dialect of K'iche', to both linguists and speakers of other dialects, is the prevalence of vowel deletion, which has a marked effect on both production and comprehension of the language. In content words deletion applies obligatorily to all lax vowels in unstressed non-final CV syllables adjacent to a stressed syllable; deletion never occurs to tense vowels, stressed vowels, or vowels in onsetless or closed syllables, and the same vowels are always deleted in each instance of the word with no optionality (Wood 2020). In function words, however, vowel deletion does not follows these restrictions, and deletion is attested of apparently tense vowels (e.g. the conditional [w(e)], word-initial vowels (e.g. 1st person plural [(ɔ)χ]) and in closed syllables (e.g. the diminutive [s(ɪ)n]). The same words may have multiple forms in different contexts (e.g. [we ∼ w], [ɔχ ∼ χ], [sɪn ∼ sn]). It is unclear what factors condition deletion in function words or how this process relates to phrase structure or other prosodic categories.

The variable productions of the same function words in different contexts make this a topic that is very difficult to capture accurately using elicitation methods, which usually trigger the use of careful speech. This is particularly true for Chichicastenango K'iche', which is a stigmatized dialect of the language. Speakers are aware of how speakers from other towns speak, and feel pressured to use these prescriptively correct forms when asked how their language is spoken. Therefore, studying this topic requires using data from speakers focused on the content rather than the form of their words. A corpus of spontaneous speech is ideal for this task.

This chapter presents a statistical analysis of vowel deletion in function words in Chichicastenango K'iche'. The chapter is organized as follows. Section 4.1.1 discusses previous research on vowel deletion in Chichicastenango K'iche' and outlines the rule observed for content words. Section 4.1.2 shows how these restrictions are sometimes broken in function words, which appear to have a much more variable realization. Section 4.2 details the methods of the corpus study, including the data, categorization, and statistical analysis. Section 4.3 presents the results of the study, showing that the rate of vowel deletion is affected by vowel quality, syllable structure, segmental context, and phrase position, but these forces act as statistical tendencies rather than fully determining the outcome. Any and all vowels in function words are optionally deleted. Section 4.4 discusses these results and how they inform understanding of prosodic structure in the language. Section 4.5 concludes the chapter.

4.1.1 Vowel deletion in content words

Wood (2020) considers vowel deletion in content words using data from the same corpus of spontaneous narratives used for this dissertation as well as supporting elicitation materials. After observing words with a wide range of syllable shapes, it was concluded that vowels must be deleted in content words when they are lax and in unstressed, non-final CV syllables adjacent to the stressed syllable. The same form is found in all cases for a given word, with apparently no variable productions, indicating that this is an obligatory rule. Because this is a complex rule involving a conjunction of several different conditions, each of the conditions are briefly discussed as follows, showing minimally distinct cases where each condition is met, and the vowel is deleted, and not met, and the vowel is preserved.

4.1.1.1 Vowel quality

In content words deletion is restricted to lax vowels. No examples of the deletion of a tense vowel are attested. This contrast is exemplified in 54, where the tense vowel /a/ is preserved in 54a and the lax vowel /ʊ/ in the same prosodic position is deleted in 54b. These vowels are each in unstressed, non-final CV syllables adjacent to the stressed syllable.

(54) a. *chanim*
ʧa.ˈnim
ʧanim
now
'now' (kot, 00:02)

b. *jnab'*
χ(ʊ).ˈnaɓ
χʊnaɓ
year
'year' (planting, 00:06)

Although both tense and lax vowels do occur in non-final (and therefore usually unstressed) syllables, tense vowels are rare in this position because K'iche' underwent a historical neutralization process where long vowels became short in non-final syllables. Non-final long (tense in Chichicastenango) vowels that exist in the modern language, such as that in 54a, result from one of two sources: compensatory lengthening of a previously short vowel upon the loss of a following glottal fricative or adaptation of a stressed vowel in a Spanish word that is borrowed into K'iche' (Larsen 1988). In Chichicastenango K'iche' word-initial unstressed vowels are also uniformly realized as tense (see Chapter 3). All other non-final vowels in K'iche' are short (lax in Chichicastenango) regardless of their realization when in a final syllable and are therefore susceptible to deletion. An example is shown in 55.

(55) a. *aj ptan*
aχ p(ə).ˈtan
aχ pətan
AG cofradía
'cofradía member' (mr, 09:02)

b. *aj pätnïb'*
aχ pə.t(ə).ˈnɪɓ
aχ pətən-ɪɓ
AG cofradía-PL
'cofradía members' (mr, 02:46)

The vowel in the final syllable of *ptan* 'cofradía' in 55a is tense /a/. However, when a suffix is added and this vowel is no longer in the final syllable of the word, it becomes lax /ə/ and can be deleted.

4.1.1.2 Stress

Vowels in the (primary) stressed syllable of the word are never deleted. This is exemplified in 56, with two forms of the verb *köj* 'wear'.

(56) a. *kuköjö*
ku.ˈkɔ.χɔ
k-∅-u-kɔχ-ɔ
INCPL-B:3SG-A:3SG-use-SS.F
'she uses it' (mxm2, 27:23)

b. *ukjom*
u.k(ɔ).ˈχom
∅-u-kɔχ-om
B:3SG-A:3SG-use-PERF
'she has used it' (mxm2, 14:28)

In 56a, the vowel /ɔ/ in the verb root is in the stressed syllable and is not deleted. In 56b, the same vowel is in an unstressed syllable, as stress occurs on the suffix *-om*. This unstressed vowel is deleted. At a segmental level, the context for these two vowels is very similar. These vowels are both in non-final CV syllables adjacent to the stressed syllable.

Adjacency to a stressed syllable is a condition for deletion to occur. For example, in words composed of two unstressed syllables followed by a final stressed syllable it is the second unstressed syllable, right before the stressed one, which suffers deletion. Examples are shown in 57.

(57) a. *rïxqil*
ɾɪ.ʃ(ɔ).ˈqil
ɾ-ɪʃɔq-il
A:3SG-woman-POSS
'his wife' (mr, 35:26)

b. *q'äb'rel*
q'ə.ɓ(ə).ˈɾel
q'əɓəɾ-el
drunk-NOM
'drunkard' (TLJ2, 33:13)

Each of these deleted vowels are lax and are in unstressed, non-final CV syllables adjacent to the stressed syllable.

In words where stress falls on a non-final syllable, which occurs in verbs with heavy non-final syllables (see Chapter 1), deletion also occurs in the post-tonic syllable. Examples are shown in 58.

(58) a. *kïntz'ib'nïk*
kɪn.ˈtsi.ɓ(ə).nɪk
k-ɪn-tsiɓ-ə-n-ɪk
INCPL-B:1SG-write-TV-ANT-SS:F
'I write' (tjl2, 09:14)

b. *kesxïk*
ˈke.s(ə).ʃɪk
k-∅-e-sə-ʃ-ɪk
INCPL-B:3SG-exit-CAUS-PASS-SS:F
'it was removed' (talentos, 05:26)

In each of these examples the vowel /ə/ is deleted in the syllable following the stressed syllable. These vowels are each lax and in unstressed, non-final CV syllables adjacent to the stressed syllable.

There are few words with more than three syllables, and those that do exist are mostly verbs. However, there are a few long nouns with final stress that therefore have only one syllable adjacent to the stressed syllable; nevertheless deletion may occur in more than one syllable. Examples are shown in 59.

(59) a. *ki'ktmal*
kiʔ.k(ɔ).t(ɛ).ˈmal
kiʔkɔt-ɛm-al
happy-NOM-NOM
'happiness' (mushrooms, 08:35)

b. *q'b'ärlab'*
q'(ə).ɓə.ɾ(ɛ).ˈlaɓ
q'əɓəɾ-ɛl-aɓ
drunk-NOM-PL
'drunkards' (tjl2, 33:00)

In 59a, in addition to the vowel immediately preceding the stressed syllable, the vowel in the previous syllable is also deleted. In 59b, deletion occurs in alternating syllables. In these examples deletion affects a vowel that does not meet all of the conditions of the obligatory deletion rule. It is possible that there is a second deletion rule that occurs in these contexts. Due to the very limited number of words of this type, it is unclear what the exact conditions are under which multiple vowels in longer words are deleted. However, I want to highlight that in these cases deletion is still completely regular: the same vowels are always deleted in every instance of these words.

4.1.1.3 Syllable shape

Vowels are deleted in (underlying) open syllables but not in closed syllables. This assumes that a single consonant that occurs between two vowels acts as the onset of the second syllable rather than the coda of the first, whereas when two consonants occur between vowels the first acts as the coda of the first syllable and the second as the onset of the second syllable. This contrast is exemplified in 60.

(60) a. *säqwäch*
sәq.ˈwәʧ
sәq-wәʧ
white-face
'potato' (chilmol, 00:53)

b. *snïk*
s(ә).ˈnɪk
sәnɪk
ant
'ant' (naturalmed, 07:22)

The vowel /ә/ in the closed syllable /sәq/ in 60a is not deleted while the same vowel in the open syllable /sә/ in 60b is deleted. These vowels are each lax and in unstressed, non-final CV syllables adjacent to the stressed syllable.

Vowels are also restricted from being deleted in onsetless syllables (i.e. in word-initial position). This is exemplified in 61.

(61) a. *atz'am*
a.ˈʦ'am
әʦ'am
salt
'salt' (atolblanco, 02:08)

b. *rtz'am*
ɾ(ә).ˈʦ'am
ɾ-әʦ'am
A:3SG-salt
'its salt' (3recipes, 03:35)

The vowel /ә/ in the onsetless syllable /ә/ in 61a is not deleted, and in fact surfaces as tense /a/ due to being in word-initial position (see Chapter 3). This vowel is underlyingly lax and in an unstressed, non-final syllable. When the same word receives a prefix which adds an initial consonant onset to this syllable, the vowel is deleted (61b). This vowel meets all of the conditions for obligatory deletion: it is lax and in an unstressed non-final CV syllable.

4.1.1.4 Syllable position

According to Wood (2020), vowels are not deleted in the final syllable of the word, whether or not it is stressed. This is exemplified in 62.

(62) a. *kawïlö*
ka.ˈwɪ.lɔ
k-∅-aw-ɪl-ɔ
INCPL-B:3SG-A:2SG-see-SS:F
'you see it' (planting, 08:21)

b. *kïlq'oj*
kɪ.l(ɔ).ˈq'oχ
kɪ-lɔq'-oχ
A:3PL-buy-NOM
'their purchases' (history, 00:52)

The vowel /ɔ/ is not deleted in word-final position in 62a, while the same vowel in a segmentally identical syllable is deleted when not word-final in 62b. These vowels are each in unstressed CV syllables adjacent to the stressed syllable.

However, there are a few cases where a vowel appears to be deleted in the final syllable of a word. This occurs in verbs with non-final stress where the deletion of the vowel results in one of a very restricted set of consonant clusters.

(63) a. *xöjkown*
ʃɔχ.ˈko.w(ɪ)n
ʃ-ɔχ-kow(ɪ)n-∅
CPL-B:1PL-be.able-SS:M
'we were able to' (church, 01:39)

b. *xik'iyr*
ʃi.ˈk'i.j(ə)ɾ
ʃ-i-k'ijəɾ-∅
CPL-B:3PL-grow-SS:M
'they grew' (history, 03:23)

In each of these examples, the vowel in the final syllable is deleted, resulting in a final consonant cluster composed of a glide followed by another consonant. These vowels are deleted despite not meeting all of the conditions for the obligatory deletion rule. It is not clear why deletion occurs in cases like these but not in 62a above. It is possible that these reflect cases of historical vowels that are fully lost in the modern language, and therefore there is nothing to delete; I am not aware of any examples where these roots appear with the vowel in Chichicastenango K'iche'. Alternately, it is possible that the final vowel in examples like 62a resists deletion because it is a full morpheme and if deleted the meaning would be lost, or because it is an inflectional morpheme and outside of the domain of deletion in content words just as it is outside of the domain of stress (see Section 1.2.3.1). It is difficult to reach any firm conclusions about this due to the scarcity of examples of this type.

In sum, vowels are deleted in content words in Chichicastenango K'iche' when they are lax and occur in unstressed non-final CV syllables adjacent to a stressed syllable. This rule applies obligatorily to all vowels which meet these conditions; no exceptions are found in the data. Vowels are also deleted in some final syllables and in some syllables not adjacent to a stressed syllable in longer words. There is insufficient data to determine exactly what conditions deletion in these cases, but the pattern is still regular: all instances of a given word appear with the same vowels deleted.

4.1.2 Vowel deletion in function words

In contrast to the pattern established for content words, where nearly all instances of the same word appear to have the same surface form with regards to vowel deletion, the pattern in function words appears to be much more variable, breaks many of the restrictions observed for content words, and is not well understood. Some examples are shown as follows.

The examples in 64 show two instances of the determiner *rï*. In 64a this word appears with a vowel in the surface form which is absent in the same word in 64b.

(64) a. *Kawïl* ***rï*** *pö't.*

k-∅-aw-ɪl-∅	ɾɪ	pɔʔt
INCPL-B:3SG-A:2SG-see-SS:M	DET	blouse

'You see the blouses.' (kot, 02:23)

b. *Kel lö* ***r*** *pö't.*

k-∅-el-∅	lɔ	ɾ(ɪ)	pɔʔt
INCPL-B:3SG-go.out-SS:M	DIR	DET	blouse

'The blouses are made' (lit: 'The blouses go out.') (kot, 02:13)

Similarly, 65 shows two instances of the TAM particle *chï*, translated as 'now', 'already' or 'anymore'. The vowel is present in 65a but absent in 65b.

(65) a. *Xöj'e t **chï** Chja rï'.*

ʃ-ɔχ-ɓe-∅	t(ə)	ʧɪ	ʧχa	ɾɪʔ
CPL-B:1PL-go-SS:M	IRR	anymore	Chichicastenango	DEM

'We didn't go to Chichicastenango anymore.' (church, 03:16)

b. *N köj'e t **ch** p rï tïnamït Chja.*

n(ə)	k-ɔχ-ɓe-∅	t(ə)	ʧ(ɪ)	p(ə)	ɾɪ	tɪnamɪt	ʧχa
NEG	INCPL-B:1PL-go-SS:M	IRR	anymore	PREP	DET	town	Chichicastenango

'We don't go into the town of Chichicastenango anymore.' (church, 00:57)

When deletion occurs in function words, it sometimes breaks the restrictions that appear to condition deletion in content words. Examples are observed of the deletion of tense vowels, as in 66a, vowels in onsetless syllables, as in 66b, vowels in closed syllables, as in 66c, and vowels in syllables that are (function) word-final, as in 66a.

(66) a. *Kiki'j **n** kib'.*

k-i-k-iʔχ	n(a)	k-iɓ
INCPL-B:3PL-A:3PL-wait	still	A:3PL-REFL

'They still wait for each other.' (marriage, 04:13)

b. *Köjcha **j** che.*

k-ɔχ-ʧa	(ɔ)χ	ʧ-e
INCPL-B:1PL-say	1PL	PREP-REL.NOUN

'We call it.' (fishing, 05:50)

c. *Köjchkün p **tq** sabado.*

k-ɔχ-ʧ(ə)kʊn-∅	p(ə)	t(ə)q	sabado
INCPL-B:1PL-work-SS:M	PREP	PL	Saturday

'We work on Saturdays.' (talentos, 01:33)

The tense vowel in the word *na* is deleted in 66a; this vowel is also word-final. In 66b the vowel in *öj*, which is word-initial and in an onsetless syllable, is deleted. In 66c the vowel in *täq*, a closed syllable, is deleted.

Based on these observations, vowel deletion in function words appears to operate very differently from deletion in content words, and the pattern is not clear. The remaining sections of this chapter detail a corpus study of vowel deletion in function words.

4.2 Methods

This chapter presents a corpus study of vowel deletion in function words in Chichicastenango K'iche'. The following sections outline the methods used for the study.

4.2.1 Data

The data for this study comes from the corpus of spontaneous narratives described in Section 1.3. For the purposes of this study, function words are defined as all words that are not nouns, verbs, adjectives, or adverbs. These include words such as prepositions, complementizers, determiners, pronouns, directional particles, TAM particles, negation markers, existential particles, and nominal modifiers. Out of all of the function words used in the language, a given lexical item was included in the study unless it met one of the restrictions described as follows.

Relational nouns were excluded from the study because they are formally nominal, and therefore not clearly function words. Relational nouns are a set of words in Mayan languages that are formally nouns (receiving nominal morphology like possessive prefixes) but have functional uses. Relational nouns express meanings such as location, time, purpose, cause, and other circumstantial meanings. Temporal and locative relational nouns combine with prepositions, while others do not. Two examples of relational nouns are shown in 67.

(67) a. *Krïqtïk lö* ***kmal*** *rï'.*

k-∅-ɾɪq-t(əχ)-ɪk	lɔ	k-(ʊ)mal	ɾɪʔ
INCPL-B:3SG-find-PASS.C-SS:F	DIR	A:3PL-because	DEM

'It is found by them.' (mushrooms, 07:24)

b. *Kïnch'äw* ***puwï'*** *ju oj.*

k-ɪn-ʧ'əw-∅ p-u-wɪʔ χu ʔoχ

INCPL-B:1SG-talk-SS:M PREP-A:3SG-top DET avocado

'I'll call out from the top of an avocado tree.' (owl, 00:35)

67a shows the relational noun -*ümal* 'because of', which appears with the 3rd person plural possessive prefix *k*-. 67b shows the locative relational noun -*wï'* 'on top of', which combines with the preposition *pä* and the 3rd person singular possessive prefix *u*-.

Spanish borrowings, such as *si* 'if' or *porke* 'because', were excluded from the study because my observation from working on the language is that vowel deletion does not tend to occur in these words.

Words that are composed of only a single vowel in the phonemic form, such as the plural marker *e*, were excluded, as it is not possible to know if such a word is present if its sole vowel is deleted.

Finally, words with less than 10 tokens in the corpus were excluded in an effort to have a reasonably representative sample of each included word.

Following these restrictions, the function words that were included in the study are summarized in Table 4.1.

Table 4.1: Function words included in the study

Category	Word	Gloss	N
Prepositions	ʧɪ	general preposition	164
	pə	'in, at'	251
Complementizers	ʧɪ	'that'	31
	ʧɛɾ	'that, which'	123
	we	'if'	39
	la	polar question	29
Determiners	χu	indefinite article (pre-C)	296
	χʊn	indefinite article (pre-V)	118
	wa	proximal demonstrative	81

Continued on next page

Table 4.1 – continued from previous page

Category	Word	Gloss	N
	le	medial demonstrative	186
	ɾɪ	distal demonstrative	577
Pronouns	ɪn	1SG	95
	ɔχ	1PL	154
	at	2SG	27
	aɾɛʔ	3SG/PL	99
	χun	'one'	89
	waʔ	proximal demonstrative	146
	laʔ	medial demonstrative	102
	leʔ	medial demonstrative	87
	ɾɪʔ	distal demonstrative	537
	ʧɪ	'where'	29
	ʧɪʔ	end of where question	28
	su	'what'	138
	tan	component of 'why'	21
	kaʔj	component of 'what' (phrase-medial)	43
	χʊmpa	'when, how much/many'	22
Directionals	ɓɪ	'here to there' (phrase-medial)	145
	ɓik	'here to there' (phrase-final)	86
	kə	'in place' (phrase-medial)	109
	kənɔq	'in place' (phrase-final)	60
	kɔq	'inwards' (phrase-final)	17
	lɔ	'there to here' (phrase-medial)	143
	lɔq	'there to here' (phrase-final)	134
	pə	'over/across' (phrase-medial)	10
TAM, negation and existential	ʧɪ	'already, now' (phrase-medial)	252
	ʧɪk	'already, now' (phrase-final)	133
	na	'still, necessary, future'	138
	nə	negation	173
	tə	irrealis (phrase-medial)	201
	təχ	irrealis (phrase-final)	76
	k'ɔ	existential (phrase-medial)	470
	k'ɔlɪk	existential (phrase-final)	66
Discourse, syntax and information structure	aɾe	focus	245
	ɓaʔ	'then'	14
	χeʔ	'like, as'	237

Continued on next page

Table 4.1 – continued from previous page

Category	Word	Gloss	N
	k'ʊ	'then' (phrase-medial)	37
	tɛʔ	'then'	94
	qəs	'truly'	10
	wɪ	trace of focused prepositional phrase	95
	ʃa	'only'	116
	ʃəq	'only'	87
	ʃew	'only'	34
Nominal modifiers	ʧi	'truly'	38
	ma	augmentative (pre-C)	30
	sɪ	diminutive (pre-C)	112
	sɪn	diminutive (pre-V)	28
	təq	plural/distributive	151
TOTAL			7053

Every known instance of the selected words present in the corpus was included in the study, with the exception of instances where the word is repeated multiple times as a speech error or instances where the speaker doesn't complete a grammatical sentence and instead immediately restarts with a new sentence after the word in question. Additionally, in some cases there were gaps or uncertainties in the transcriptions, and no words from these portions were included to avoid categorization errors. Finally, for words with more than 500 tokens, a randomized subset were included due to time considerations: every third instance of the determiner *rï* (1730 total tokens, 577 included) and every other instance of the pronoun *rï'* (1073 total tokens, 537 included). This led to a total of 7053 words included in the study.

For each lexical item the underlying form was determined based on comparison of any surface forms produced in the corpus. If a vowel occurred in at least one instance of that word, it was included as an underlying vowel in all instances of that word. This also agrees completely with the locations of vowels in these words in other dialects of K'iche' where deletion is much less prevalent (Larsen 1988; Ajpacajá Tum 2001; Ajpacajá Tum et al. 2005; Can Pixabaj 2015). There were only a few lexical items included in the study which do not appear in these previous works and where it was not possible to confirm the locations of underlying vowels through cross-dialectal comparison. In total, there were 7547 underlying (whether present or deleted) vowels included in the study.

4.2.2 Categorization

Each potential vowel was classified according to the factors VOWEL PRESENCE, VOWEL QUALITY, PRECEDING CONTEXT, FOLLOWING CONTEXT, syntactic PHRASE-INITIAL, syntactic PHRASE-FINAL, LEXICAL ITEM and SPEAKER. The independent variables are each inspired by conditions observed to affect the deletion rule for content words, but modified to fit the grammar of function words.

4.2.2.1 Dependent variable: vowel presence

Depending on the segmental context, the following visual metrics were used in Praat (Boersma and Weenink 2023) to determine if a vowel was present or deleted.

For underlying vowels between voiceless segments, any indication of voicing (voicing bar, periodicity) was sufficient to categorize a vowel as present. Examples are shown in Figure 4.1.

On the left of Figure 4.1 is shown the preposition *pä* and the first consonant of the following word *klew* 'their land' in the phrase *pä klew* 'on their land' (planting, 02:46). There is clear voicing after the release of the /p/ before the closure for the /k/, and the vowel in *pä* was categorized as present. On the right of the figure is shown the same preposition *pä* followed by the first consonant of the word *sü't* 'cloth' in the phrase *p sü't* 'in cloths' (planting, 13:04). There is no voicing between the /p/ and the following /s/. The frication immediately follows the stop burst. In this case, the underlying vowel in *pä* was categorized as deleted.

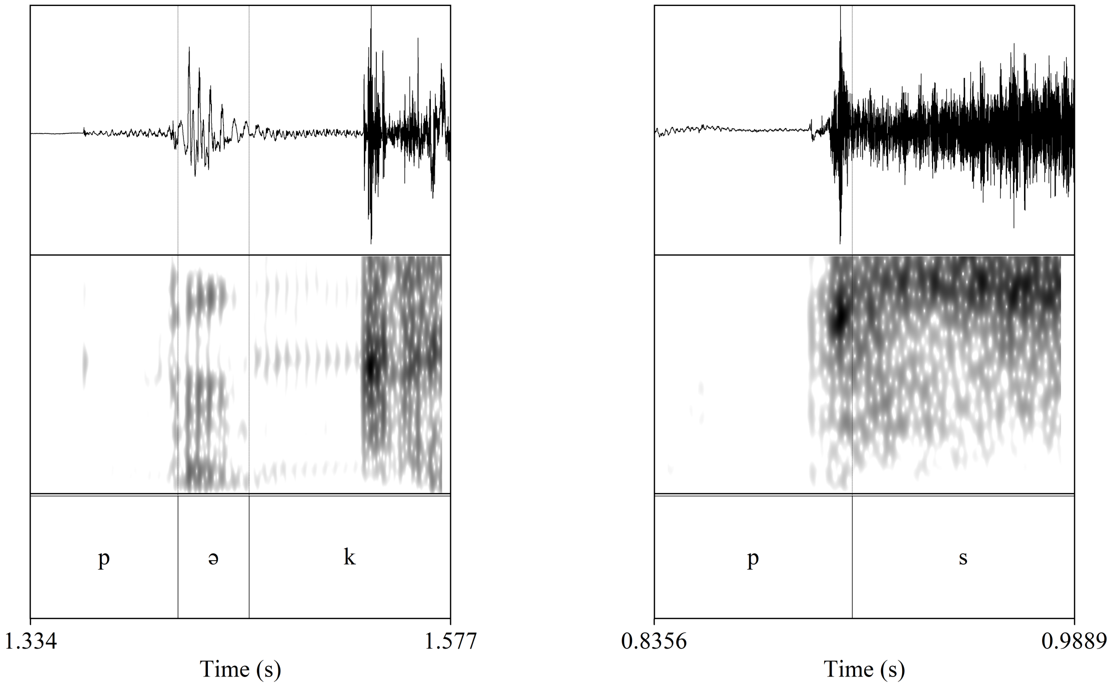


Figure 4.1: Present vs. deleted vowels between voiceless segments.
Left: [pə k], right: [p(ə) s].

For underlying vowels adjacent to a voiced consonant (implosive, nasal, glide or liquid), a vowel was determined to be present or deleted based on the number of segments visible in the voiced portion. The vowel was determined to be present if the voiced portion showed a relatively abrupt change in formants or intensity marking a boundary between two segments. If there was only one segment in the voiced portion, the vowel was categorized as deleted. Examples are shown in Figure 4.2.

On the left of Figure 4.2 is the word *na* 'still' followed by first consonant /k/ of *komo* 'since' in the phrase *köjiwi'j na komo* 'you wait for us still since' (marriage 01:31). There is a sharp boundary in both the formant structure and the intensity curve between the initial nasal /n/ and the following vowel /a/. This vowel was categorized as present. On the right of the figure is the same word *na* followed by the first consonant /k/ of *kib'* 'themselves' in the phrase *kiki'j n kib'* 'they wait for each other' (marriage, 04:13). Here the entire voiced portion forms one segment with no sharp boundaries between them. The whole portion is of

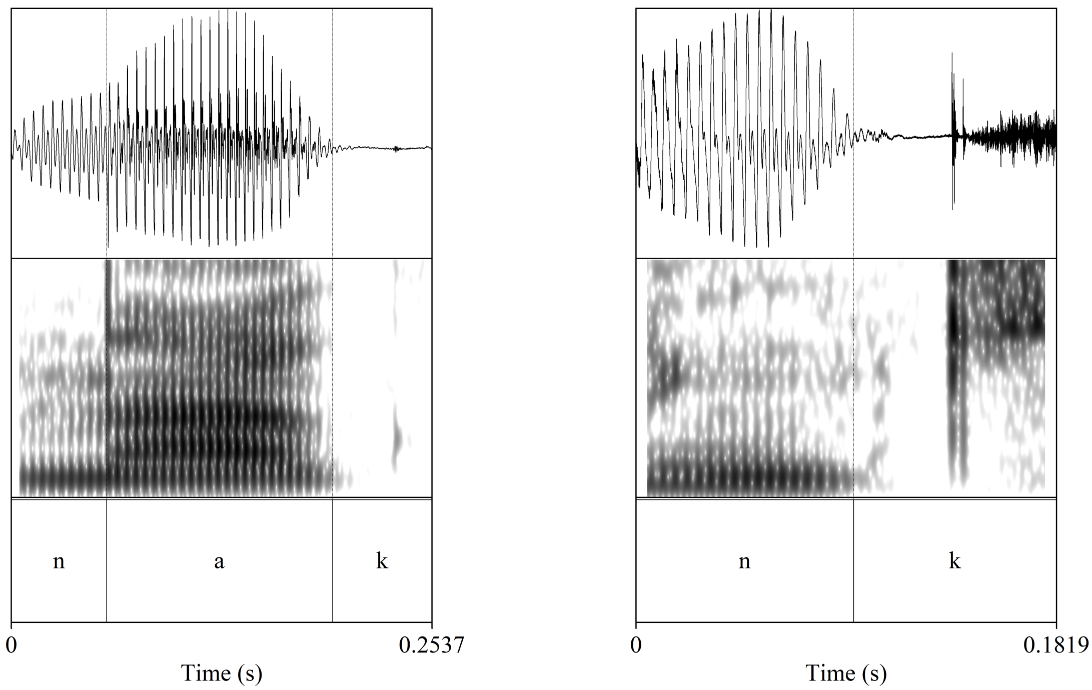


Figure 4.2: Present vs. deleted vowels after a voiced segment.
Left: [na k], right: [n(a) k].

low intensity and displays antiformants. The underlying vowel in this word was categorized as deleted in this token.

For underlying vowels adjacent to a vowel, a vowel was determined to be present if the vowel portion showed a change in the formants corresponding to the two expected vowels, an abrupt shift in intensity marking a boundary between two vowels, or evidence of glottalization in the middle of the vowel portion marking a boundary between two vowels. When only one vowel segment was present, which of the vowels was deleted was determined based on the formants. When the two underling vowels were identical in quality and there was only one vowel segment produced, the first underlying vowel was categorized as deleted and the second as present. Examples are shown in Figure 4.3.

On the left is shown the directional particle *b'ï* followed by the first two segments of the word *ufideo* 'its noodles' in the phrase *käqya ch b'ï ufideo* 'we add its noodles' (caldores 00:44). During the vowel portion, F2 clearly shifts from a high position to a lower position

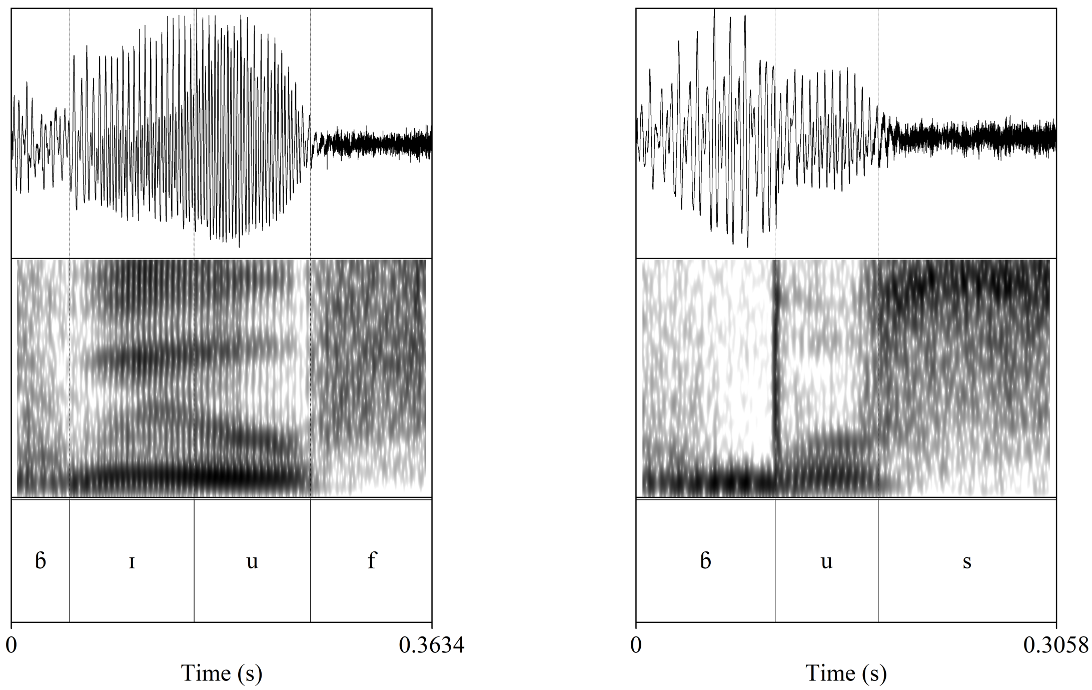


Figure 4.3: Present vs. deleted vowel preceding another vowel.
Left: [ɓɪ uf], right: [ɓ(ɪ) us].

(front vowel to back vowel). The vowel /ɪ/ in the directional was categorized as present in this token. On the right is shown the same directional particle followed by the first two segments of the word *usopa* 'its broth' in the phrase *käqya b' usopa* 'we add its broth' (caldores 00:47). Here the vowel portion forms one segment with no shift in formants or intensity. F2 is low, indicating a back vowel. The underlying vowel in the directional particle was categorized as deleted in this token.

In total there were 6084 present vowels and 1463 deleted vowels in the data.

4.2.2.2 Independent variables: vowel quality, segmental/syllabic context, syntactic phrase position, lexical item, speaker

4.2.2.2.1 Vowel quality

In content words, lax vowels may be deleted while tense vowels are not. Therefore, each underlying vowel was categorized as either tense /a e i o u/ or lax /ə ɛ ɪ ɔ ʊ/ to see whether the same restriction applies to function words.

In some cases this was not a trivial task as the contrast between tense and lax vowels can be very hard to distinguish perceptually, especially for function words which are often unstressed and reduced in pronunciation. In this study the phonemic vowel was designated with reference to the perception of the sound over many different tokens and comparing its formant structure to those of tense and lax vowels of the same type produced by the same speaker in the surrounding context. When this was ambiguous (both tense-like and lax-like perceptions and formant comparisons were frequent in the data), the designation was made through comparison to the form found in other dialects and in the historical form of the language. For example, the vowel in the complementizer *chï* varies perceptually between tense-like and lax-like in Chichicastenango, but it corresponds to a short vowel in other K'iche' dialects (Ajpacajá Tum 2001; Ajpacajá Tum et al. 2005) and was categorized as lax. Meanwhile the vowel in the exclusive particle *xa* 'only' also varies perceptually between tense-like and lax-like in Chichicastenango, but corresponds to a long vowel in other K'iche' dialects (Ajpacajá Tum 2001; Larsen 1988) and was categorized as tense.

In total, there were 5142 lax vowels and 2405 tense vowels included in the data.

4.2.2.2.2 Segmental/syllabic context

In content words deletion only affects vowels in CV syllables. Most function words are monosyllabic and may or may not have a final consonant. However, it is unknown whether a final consonant in a function word (if any) syllabifies as an onset to a following word, and if so in what contexts. Therefore, as an approximation of syllable shape, vowels were categorized according to the preceding and following segmental context, paying attention to the morpheme each consonant is a part of. Each underlying vowel was categorized as being preceded in the surface form within the larger context by a pause, vowel, single coda (morpheme-external) consonant, single onset (morpheme-internal) consonant, heterosyllabic (morpheme-external + morpheme-internal) consonant cluster, or coda (morpheme external) consonant cluster. Each vowel was also categorized as being followed in the surface form by a pause, vowel, single coda (morpheme-internal) consonant, single onset (morpheme-external) consonant, heterosyllabic (morpheme-internal + morpheme-external) consonant cluster, coda (morpheme-internal) consonant cluster, or onset (morpheme-external) consonant cluster. Examples are shown in Table 4.2.

Factor	Levels	Example	Number of tokens
Preceding context	Pause	... **a**ɾe ɾɪʔ	161
	Vowel	o **a**ɾe	177
	Coda consonant	kɪnwɪl **ɪ**n	262
	Onset consonant	k'ɔ χ**u**	3212
	Heterosyllabic cluster	katɪχ χ**u**	3715
	Coda cluster	ʃɔχkown **ɔ**χ	20
Following context	Pause	χ**u** ... nɪmlaχ	112
	Vowel	p**ə** ulew	366
	Coda consonant	χ**ʊ**n amlo	845
	Onset consonant	χ**u** tukuɾ	3055
	Heterosyllabic cluster	χ**ʊ**n joʔk	2033
	Coda cluster	su k**a**ʔj	43
	Onset cluster	χ**u** ʧkɔp	1093

Table 4.2: Examples and number of tokens for each of the preceding and following segmental/syllabic contexts

4.2.2.2.3 Syntactic phrase position

In content words deletion is restricted to non-final syllables within the word. As an adaptation of this factor to function morphemes, each vowel was categorized according to whether or not the syllable it belongs to is preceded and followed by another syllable within the same syntactic phrase. Vowels were categorized as phrase-initial if they are in the first syllable of the syntactic phrase and not phrase-initial if there is a preceding syllable within the syntactic phrase. Similarly, vowels were categorized as phrase-final if they are in the last syllable of the syntactic phrase and not phrase-final if there is a following syllable within the syntactic phrase.

For the purposes of this study, syntactic phrases include verbal arguments (subject or object noun phrases are each a separate syntactic phrase), adjuncts (prepositional or adverbial phrases are each a separate syntactic phrase), and the verb complex (verb together with dependent particles but excluding its arguments or adjuncts forms a syntactic phrase). Any material that precedes the verb complex, such as complementizers or conjunctions, was excluded from the verb phrase and considered to form a separate phrase. Examples are shown in 68 - 69 with syntactic phrase boundaries in parentheses.

(68) *Të' k'ü rï' r jün ali n xraj täj.*

(tɛʔ	k'ʊ	ɾɪʔ)	(ɾ(ɪ)	χʊn	ali)	(n(ə)	ʃ-∅-ɾ-aχ	təχ)
then	then	DEM	DET	one	girl	NEG	CPL-B:3SG-A:3SG-want	IRR

'Then the girl didn't want to.' (owl, 00:13)

(69) *Para que rï wnäq kikjön p rï kanton.*

(paɾa	ke)	(rɪ	w(ɪ)nəq)	(k-i-k(ɔ)χɔn-∅)	(p(ə)	ɾɪ	kanton)
so	that	DET	person	INCPL-B:3SG-believe-SS:M	PREP	DET	community

'So that the people believe in the community.' (church, 00:39)

68 is composed of three syntactic phrases: the adverbial phrase *te' k'ü rï'* 'then', the subject noun phrase *r jün ali* 'the girl', and the verb complex *n xraj taj* 'didn't want to'. 69 is composed of four syntactic phrases: the introductory material *para ke* 'so that', the subject noun phrase *rï wnäq* 'the people', the verb *kikjön* 'they believe', and the prepositional phrase *p rï kanton* 'in the community'.

In total there were 3631 non-initial tokens and 3916 phrase-initial tokens. There were 3956 non-final tokens and 3591 phrase-final tokens. The factors of phrase-final and phrase-initial are not highly correlated: 1463 words are both phrase-initial and phrase-final (i.e., in a phrase on their own), 2453 are phrase-initial but not phrase-final, 2128 are phrase-final but not phrase-initial, and 1503 are neither phrase-initial nor phrase-final.

4.2.2.2.4 Lexical item

Each vowel was categorized according to the lexical item (function word) it belongs to.

There are two types of function words that have multiple forms depending on the context they occur in. Some words have so-called 'phrase-final' and 'phrase-medial' forms, which alternate according to intonational phrase position, where the 'phrase-final' form has an additional final consonant or syllable (see Chapter 2). Another group of function words have a form that appears before a word beginning in a consonant and another that appears before a word beginning in a vowel, where the prevocalic form has an additional final consonant (see Chapter 3). Examples of the phrase-medial and phrase-final variants of the directional particle *b'ï(k)* are shown in 70 and examples of the preconsonantal and prevocalic variants of the diminutive *sï(n)* are shown in 71.

(70) a. *Kak'äm **b'ï** p motor.*

k-∅-a-k'əm-∅	ɓɪ	p(ə)	motoɾ
INCPL-B:3SG-A:2SG-take-SS:M	DIR:M	PREP	mill

'You take it to the mill.' (atolblanco, 00:46)

b. *Kk'äm **b'ik**.*

k-∅-k(ɪ)-k'əm-∅	ɓik
INCPL-B:3SG-A:3PL-take-SS:M	DIR:F

'They take it.' (mushrooms, 03:06)

(71) a. *Kutïj r **sïn** ak'al.*

k-∅-u-tɪχ-∅	ɾ(ɪ)	sɪn	ak'al
INCPL-B:3SG-A:3SG-consume-SS:M	DET	DIM	child

'The little child drinks it.' (healing, 08:09)

b. *Mismo **sï** q'yes.*

mismo	sɪ	q'(ə)jes
same	DIM	plant

'In the same way, it is a little plant.' (healing, 05:45)

Phrase-final and phrase-medial forms, as well as preconsonantal and prevocalic forms, were each included as separate lexical items in the analysis as they have different syllabic structures.

Finally, for disyllabic function words such as the phrase-final directional *känöq* /kənɔq/

‘in place’ or the focus marker *are* /are/, each syllable was included as a separate lexical item in order to individually identify each vowel.

4.2.2.2.5 Speaker

Each word was categorized according to the speaker who produced it. There are twelve different speakers represented in the data.

4.2.2.2.6 A note about stress

Stress affects vowel deletion in content words, as stressed vowels are never deleted (see Section 1.2.3.1 on the stress pattern of Chichicastenango K’iche’ in content words). Some previous works on K’iche’ have argued that some function words bear stress while others are unstressed. For example, Henderson (2012) argues that the ‘phrase-final’ forms of directionals and other particles are stressed and the ‘phrase-medial’ forms unstressed. However, there is reason to suspect that the long forms of function words, at least in Chichicastenango K’iche’, are not lexically stressed but rather their acoustic prominence is due to commonly occurring in a prominent phrase-final position and therefore bearing a boundary tone. When these words do not bear a boundary tone, they can be very reduced and not perceptually prominent at all (see Chapter 2 for a discussion of acoustic prominence and ‘phrase-final’ forms of verbs). Other function words which are sometimes perceptually very prominent include words which are often focused, such as the exclusive particles or the independent pronouns which in basic clauses are not present but appear when topicalized or focused. When these words are not focused, they are often quite reduced. Therefore, it is not clear whether any of these words are truly stressed at the word level, and if so how this interacts with phrase-level intonation. Because of this, stress was not considered as a potential factor in this study. However, it is worthy of further research.

4.2.3 Statistical analysis

The data was visualized in R (R Core Team 2020) with the package ggplot2 (Wickham 2016) and analyzed with mixed effects logistic regression using the package lme4 (Bates et al. 2015). The response variable was VOWEL PRESENCE (present, deleted). The fixed effects were VOWEL QUALITY (lax, tense), PRECEDING CONTEXT (pause, vowel, single coda consonant, single onset consonant, heterosyllabic cluster, coda cluster), FOLLOWING CONTEXT (pause, vowel, single coda consonant, single onset consonant, heterosyllabic cluster, coda cluster, onset cluster), PHRASE-INITIAL syllable (no, yes), PHRASE-FINAL syllable (no, yes). An interaction between PRECEDING CONTEXT and PHRASE-INITIAL syllable, and one between FOLLOWING CONTEXT and PHRASE-FINAL syllable, were also included. SPEAKER and LEXICAL ITEM were included as random effects. The equation is shown as follows.

$glmer(factor($VOWEL PRESENCE $\sim$ VOWEL QUALITY$+$
PRECEDING CONTEXT$*$PHRASE-INITIAL$+$FOLLOWING CONTEXT$*$PHRASE-FINAL
$+(1|$SPEAKER$)+(1|$LEXICAL ITEM$)))$

The baseline categories for each variable were those the most frequent level of each: present vowel, lax vowel quality, preceding heterosyllabic consonant cluster, following single onset consonant, phrase-initial syllable, and not phrase-final syllable.

The included factors reflect adaptations of the factors known to affect deletion in content words to the grammar of function words. The interactions between segmental context and phrase position were included to explore the limits of the contextual factors. Other interactions were not included in order to avoid creating subsets with excessively small numbers of tokens, since the data comes from spontaneous speech, and therefore there are very different numbers of tokens in the different categories.

4.2.4 Hypotheses

Based on previous research on deletion in content words, as well as initial observation of the data, deletion was expected to be more frequent for lax vowels than tense vowels, for non-final syllables than final syllables, for vowels preceded by a single onset consonant than those preceded by a heterosyllabic consonant cluster, and for vowels followed by a vowel or single onset consonant than those followed by a single coda consonant or consonant cluster.

4.3 Results

Table 4.3 shows the results of the statistical analysis (rounded to three decimal places). As stated above, the baseline level for the dependent variable is present, and for the experimental factors VOWEL QUALITY: lax, PRECEDING CONTEXT: heterosyllabic consonant cluster, FOLLOWING CONTEXT: single onset consonant, PHRASE-INITIAL: yes, and PHRASE-FINAL: no.

	Estimate	Std. Error	Z-value	P-value	
Intercept	-0.462	0.586	-0.789	0.430	
VOWEL QUALITY: tense	-2.899	0.756	-3.837	<0.001	***
PRECEDING CONTEXT: onset consonant	-0.072	0.148	-0.484	0.628	
PRECEDING CONTEXT: coda consonant	-0.646	1.352	-0.478	0.632	
PRECEDING CONTEXT: coda cluster	-16.401	62.303	-0.263	0.792	
PRECEDING CONTEXT: vowel	0.955	1.293	0.739	0.460	
PRECEDING CONTEXT: pause	0.583	1.323	0.440	0.660	
PHRASE-INITIAL: no	-0.553	0.194	-2.853	<0.01	**
FOLLOWING CONTEXT: onset cluster	-2.065	0.177	-11.692	<0.001	***
FOLLOWING CONTEXT: heterosyllabic cluster	-3.427	0.909	-3.770	<0.001	***
FOLLOWING CONTEXT: coda consonant	-1.601	0.965	-1.659	0.097	
FOLLOWING CONTEXT: coda cluster	-14.407	50.549	-0.285	0.776	
FOLLOWING CONTEXT: vowel	2.798	0.319	8.781	<0.001	***
FOLLOWING CONTEXT: pause	-0.919	0.422	-2.177	<0.05	*
PHRASE-FINAL: yes	-1.785	0.251	-7.101	<0.001	***
PRECEDING CONTEXT: onset consonant & PHRASE-INITIAL: no	0.868	0.213	4.077	<0.001	***
PRECEDING CONTEXT: coda consonant & PHRASE-INITIAL: no	1.325	0.728	1.819	0.069	
PRECEDING CONTEXT: coda cluster & PHRASE-INITIAL: no	2.315	74.277	0.031	0.975	
PRECEDING CONTEXT: vowel & PHRASE-INITIAL: no	-0.471	0.604	-0.780	0.436	
FOLLOWING CONTEXT: onset cluster & PHRASE-FINAL: yes	1.614	0.285	5.656	<0.001	***
FOLLOWING CONTEXT: heterosyllabic cluster & PHRASE-FINAL: yes	1.769	0.829	2.135	<0.05	*
FOLLOWING CONTEXT: coda consonant & PHRASE-FINAL: yes	-2.046	1.086	-1.884	0.060	
FOLLOWING CONTEXT: vowel & PHRASE-FINAL: yes	-0.771	0.479	-1.607	0.108	
FOLLOWING CONTEXT: pause & PHRASE-FINAL: yes	-0.632	0.609	-1.037	0.300	

Table 4.3: Results of the full model of vowel deletion

As compared to the baseline, there is a significant negative effect (with $p < 0.001$) of tense vowel quality, showing that vowels are less likely to be deleted when they are tense than when they are lax. The percentage of present and deleted vowels according to vowel quality is shown in Figure 4.4.

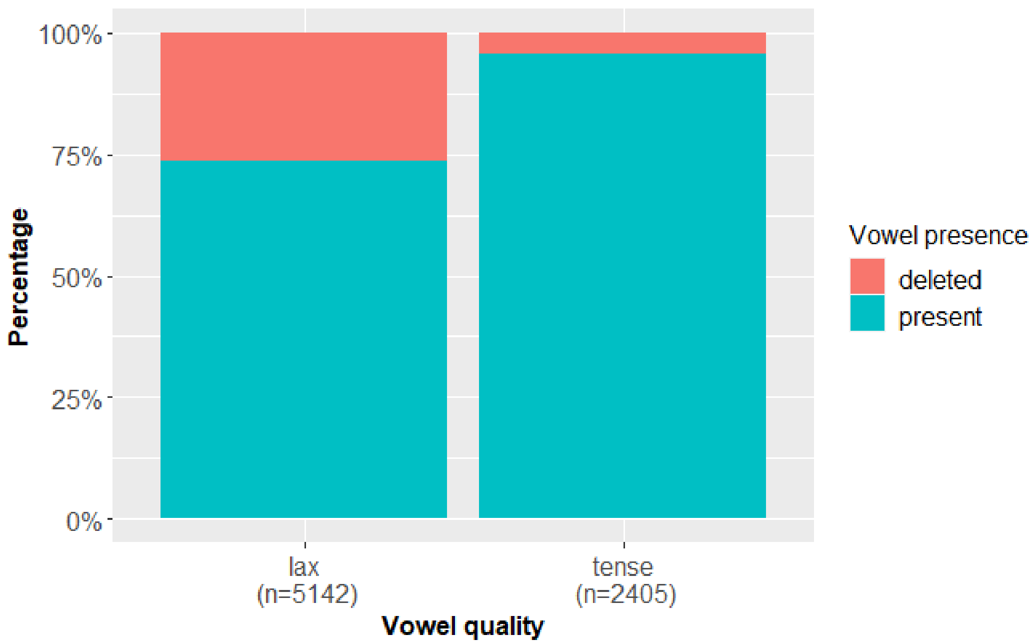


Figure 4.4: Present vs. deleted vowels according to vowel quality

For the preceding context variable, there are no significant fixed effects, though there is a significant positive interaction between preceding onset consonant and non-phrase-initial position. The percentage of vowels present and deleted according to preceding context is shown in Figure 4.5.

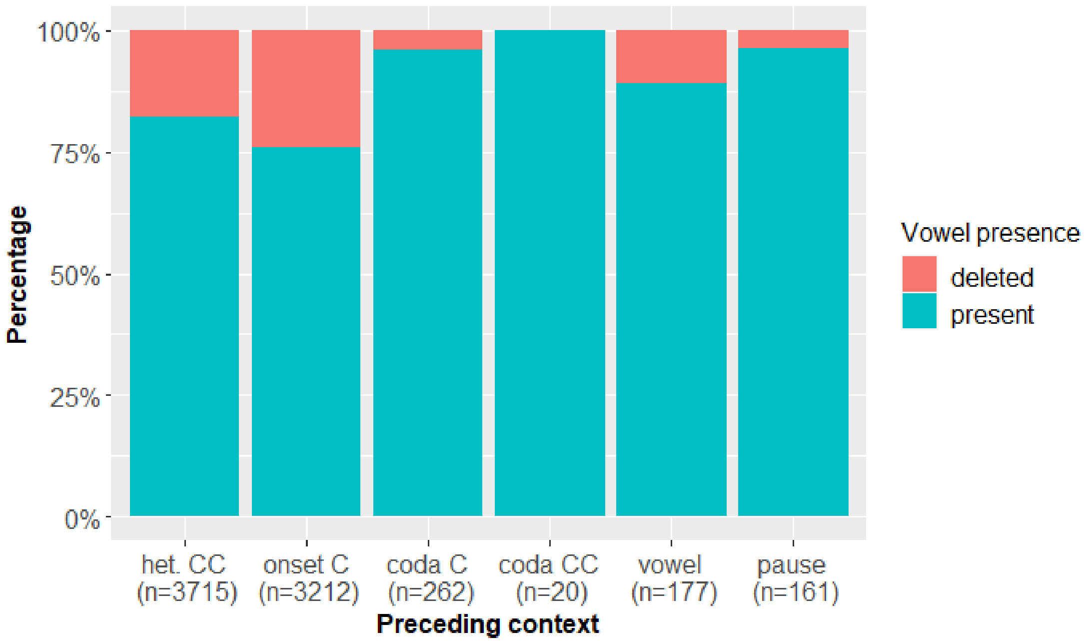


Figure 4.5: Present vs. deleted vowels according to preceding context

For the following context variable, there is a significant negative effect of following onset cluster, heterosyllabic cluster, and pause, and a significant positive effect of following vowel. Vowels are most likely to be deleted when followed by another vowel, and least likely to be deleted when followed by a consonant cluster or pause. There is no significant fixed effect of following single coda consonant or coda cluster. There is also a significant interaction between each of the following consonant clusters and phrase-final position; these effects are positive. The percentage of vowels present and deleted according to the following context is shown in Figure 4.6.

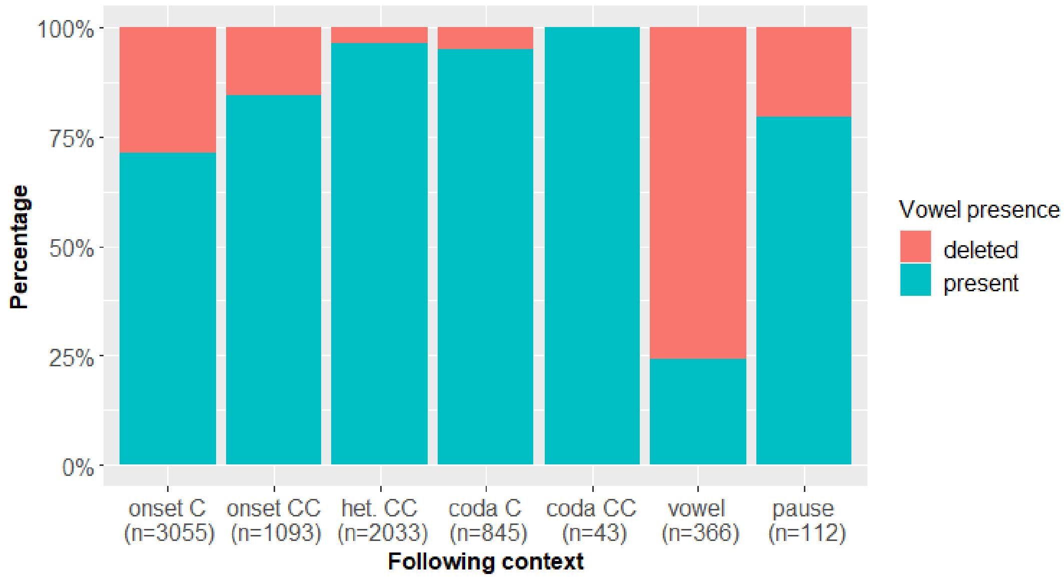


Figure 4.6: Present vs. deleted vowels according to following context

There is a significant negative effect of non-phrase-initial position, meaning that vowels are less likely to be deleted when they are not phrase-initial. Despite this significant effect, the percentage of deletion in phrase-initial and non-phrase-initial positions appears to be very similar, as shown in Figure 4.7.

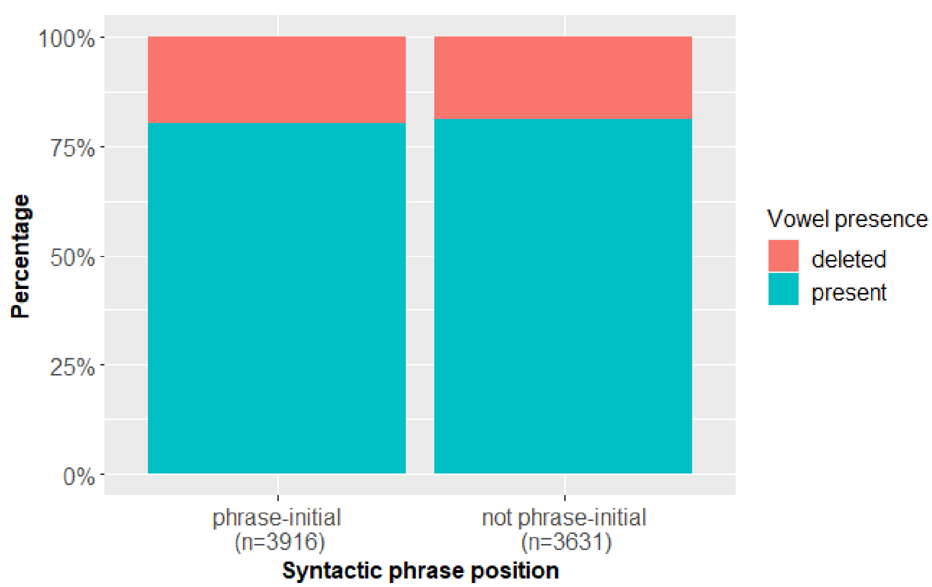


Figure 4.7: Present vs. deleted vowels according to syntactic phrase-initial position

There is also a significant negative effect of phrase-final position, meaning that vowels are less likely to be deleted when they are in syntactic-phrase-final position than when they are not syntactically phrase-final. The percentage of vowels present and deleted according to syntactic phrase-final position is shown in Figure 4.8.

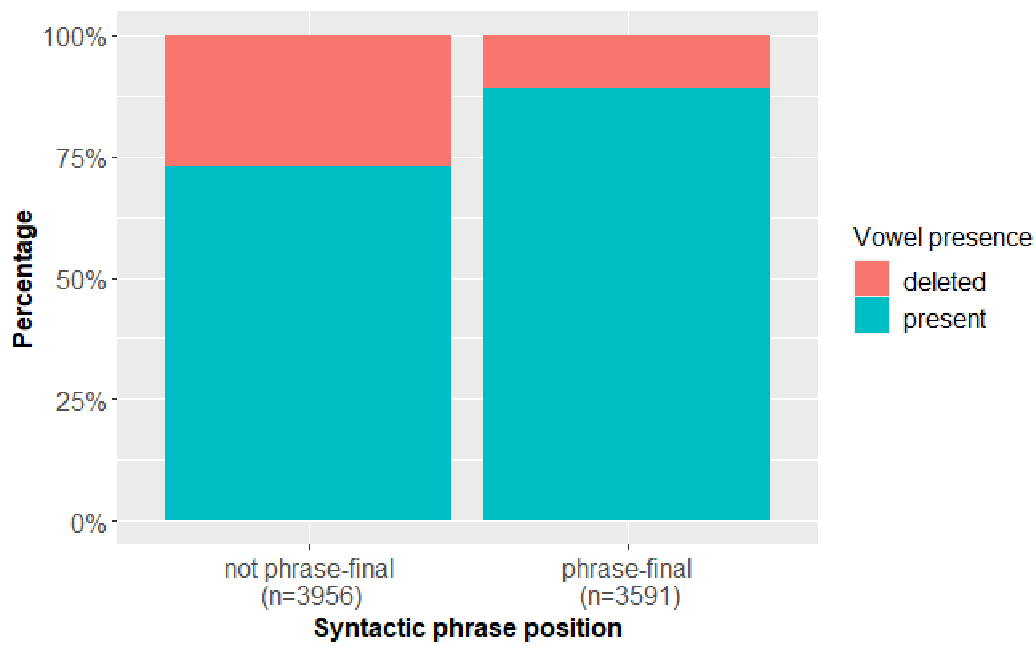


Figure 4.8: Present vs. deleted vowels according to syntactic phrase-final position

Each of these results conform to the hypotheses: tense vowels, those followed by a consonant cluster, and those in phrase-final and phrase-initial position resist deletion. However, as briefly noted in the previous discussion, there are also significant interactions between the phrase position variables and the segmental context variables.

Given these significant interactions, additional models were run to tease apart these effects. A model without phrase position as a factor and where the segmental context factors were included as fixed effects was run for the subset of the data that is phrase-final and for the subset of the data that is phrase-initial.

The results for vowels that are in the initial syllable of a syntactic phrase (PHRASE-INITIAL: yes) are shown in Table 4.4.

	Estimate	Std. Error	Z-value	P-value	
Intercept	-2.243	0.545	-4.116	<0.001	***
VOWEL QUALITY: tense	-1.966	0.800	-2.456	<0.05	*
PRECEDING CONTEXT: onset consonant	0.051	0.131	0.390	0.696	
PRECEDING CONTEXT: coda consonant	-1.489	1.304	-1.142	0.254	
PRECEDING CONTEXT: coda cluster	-15.661	62.094	-0.252	0.801	
PRECEDING CONTEXT: vowel	-0.089	1.251	-0.071	0.943	
PRECEDING CONTEXT: pause	-0.337	1.277	-0.264	0.792	

Table 4.4: Results for phrase-initial subset

For vowels that are in the first syllable of a syntactic phrase, there is a significant effect of vowel quality but no significant effects of preceding context.

The results for vowels that are not in the initial syllable of a syntactic phrase (PHRASE-INITIAL: no) are shown in Table 4.5.

	Estimate	Std. Error	Z-value	P-value	
Intercept	-3.460	0.622	-5.558	<0.001	***
VOWEL QUALITY: tense	-3.334	0.990	-3.366	<0.001	***
PRECEDING CONTEXT: onset consonant	0.718	0.144	4.977	<0.001	***
PRECEDING CONTEXT: coda consonant	0.281	1.824	0.154	0.878	
PRECEDING CONTEXT: coda cluster	-13.265	39.984	-0.332	0.740	
PRECEDING CONTEXT: vowel	0.050	1.848	0.027	0.740	

Table 4.5: Results for non phrase-initial subset

For vowels that are not in the first syllable of a syntactic phrase, there is a significant negative effect of vowel quality (less deletion of tense vowels), but also a significant positive effect of preceding onset consonant. This means that vowels are less likely to be deleted when preceded by a heterosyllabic consonant cluster than when preceded by a single onset consonant.

The results for vowels that are in the final syllable of a syntactic phrase (PHRASE-FINAL: yes) are shown in Table 4.6.

	Estimate	Std. Error	Z-value	P-value	
Intercept	-1.680	0.681	-2.466	<0.05	*
VOWEL QUALITY: tense	-2.093	0.946	-2.12	<0.05	*
FOLLOWING CONTEXT: onset cluster	-0.510	0.2285	-2.231	<0.05	*
FOLLOWING CONTEXT: heterosyllabic cluster	-3.127	0.906	-3.452	<0.001	***
FOLLOWING CONTEXT: coda consonant	-5.186	1.119	-4.633	<0.001	***
FOLLOWING CONTEXT: coda cluster	-15.493	36.761	-0.421	0.673	
FOLLOWING CONTEXT: vowel	1.962	0.373	5.254	<0.001	***
FOLLOWING CONTEXT: pause	-1.585	0.435	-3.646	<0.001	***

Table 4.6: Results for phrase-final subset

For vowels that are in the last syllable of a syntactic phrase, there is a significant effect of vowel quality as well as a significant effect of following context. Vowels are less likely to be deleted when followed by an onset cluster, heterosyllabic cluster, single coda consonant, or pause as compared to the baseline single onset consonant, and more likely to be deleted when followed by a vowel.

The results for vowels that are not in the final syllable of a syntactic phrase (PHRASE-FINAL: no) are shown in Table 4.7.

	Estimate	Std. Error	Z-value	P-value	
Intercept	-1.116	0.716	-1.559	0.119	
VOWEL QUALITY: tense	-2.809	0.973	-2.886	<0.01	**
FOLLOWING CONTEXT: onset cluster	-2.060	0.179	-11.526	<0.001	***
FOLLOWING CONTEXT: heterosyllabic cluster	-2.750	1.034	-2.661	<0.01	**
FOLLOWING CONTEXT: coda consonant	-1.021	1.081	-0.944	0.345	
FOLLOWING CONTEXT: vowel	2.793	0.320	8.722	<0.001	***
FOLLOWING CONTEXT: pause	-0.913	0.422	-2.161	<0.05	*

Table 4.7: Results for non phrase-final subset

For vowels that are not in the last syllable of a syntactic phrase, there is a significant effect of vowel quality (less deletion of tense vowels) as well as a significant effect of following context. Vowels are less likely to be deleted when followed by an onset cluster, heterosyllabic cluster, or pause, and more likely to be deleted when followed by another vowel, as compared to the baseline of single onset consonant.

Unlike preceding context, which had an effect on vowel deletion for vowels in non-phrase-initial position but not those in phrase-initial position, following context affects both phrase-final and non-phrase-final vowels. In both cases, deletion is more likely preceding another vowel and less likely preceding a consonant cluster or pause. However, there is one context category that behaves differently in the two subsets. For vowels in the final syllable of a syntactic phrase, deletion is more likely when followed by a single onset (morpheme- and phrase-external) consonant than a single coda (morpheme- and phrase-internal) consonant. For vowels not in the final syllable of the syntactic phrase where either a following onset or a following coda are phrase-internal, there is not a significant difference between these contexts.

4.4 Discussion

The results of the statistical analysis show that vowel deletion in function words in Chichicastenango K'iche' does not follow an obligatory rule, as it does in content words. Instead, deletion of vowels in function words is optional, but is influenced by a number of prosodic and segmental factors. These include vowel quality (more deletion of lax vowels), segmental context (more deletion adjacent to a vowel and less adjacent to a consonant cluster), and syntactic phrase position (more deletion when medial in the phrase than when initial or final). The effects of segmental context and phrase position interact with each other, with an effect of following context appearing in all phrase positions, but mediated by phrase position, and the effect of preceding context appearing only when the vowel is not in the first syllable of a syntactic phrase.

None of these outlined factors fully requires nor prohibits deletion: there are instances of deletion of tense vowels, those in phrase-initial and phrase-final syllables, and those adjacent to consonant clusters, and there are also instances of preservation of lax vowels, those in phrase-medial syllables, and those adjacent to vowels. Of the 62 unique vowel types in the data (57 lexical items, 5 of which are disyllabic), 42 are deleted at least once, and every single one is present at least once. Therefore, these results do not reflect the existence of an obligatory deletion rule, nor even a rule that identifies vowels that are suitable for deletion but is applied optionally. Rather, deletion is possible for any vowel in a function word, but follows a probabilistic distribution based on these phonological and prosodic factors.

The following sections further discuss the variability observed in the deletion rates in the data and the insights these results have for prosodic phrase structure in the language.

4.4.1 Variability in vowel deletion

Although each of the factors considered in this study influences the rate of vowel deletion, the results show that they do not fully determine the result, but rather behave as tendencies. The same words can be produced with or without the vowel in very similar contexts, as shown in the following examples.

(72) a. *Katïj r* ***sïn*** *u'al sï salbiasanta.*

k-∅-a-tɪχ-∅	ɾ(ɪ)	sɪn	uʔal	sɪ	salbiasanta
INCPL-B:3SG-A:2SG-consume-SS:M	DET	DIM	broth	DIM	sage

'You drink the infusion of sage.' (healing, 01:47)

b. *Kutïj b'ik r* ***sn*** *u'al limon.*

k-∅-u-tɪχ-∅	ɓik	ɾ(ɪ)	s(ɪ)n	uʔal	limon
INCPL-B:3SG-A:3SG-consume-SS:M	DIR:F	DET	DIM	broth	lime

'He/she drinks the lime juice.' (healing, 12:34)

In 72a, the vowel in the diminutive *sïn* /sɪn/ is preserved, whereas it is deleted in 72b. These words occur in very similar segmental and prosodic contexts. Another example is shown in 73.

(73) a. *Näj i* ***k' wï*** *känöq.*

nəχ	i	k'(ɔ)	wɪ	kənɔq
far	3PL	EXIST	PP.TRACE	DIR:F

'They are far away.' (mushrooms, 05:21)

b. *Chpam in **k'ö w** känöq.*

ʧ-(u)-pam	ɪn	k'ɔ	w(ɪ)	kənɔq
PREP-A:3SG-stomach	1SG	EXIST	PP.TRACE	DIR:F

'I was inside.' (earthquake, 01:14)

In 73a, the vowel in the existential *k'ö* /k'ɔ/ has been deleted, whereas the vowel in the following particle *wï* /wɪ/ is present. In 73b, the vowel in the existential is present, and that in the following particle is deleted. In both cases these words are followed by the same directional particle *känöq* and occur in a very similar prosodic and syntactic context.

Each of the factors which influence vowel deletion in function words have parallels in the deletion pattern of content words. However, where there is variability in the surface forms produced for function words, reports of vowel deletion in content words present particular environments as definite (Campbell 1977; Wood 2020). Comparing the results of the corpus study with the overview of deletion in content words shown in Section 4.1.1, it can be seen that tense vowels are never deleted in content words, whereas they are less likely to be deleted in function words. Word-initial vowels are not deleted in content words, while vowels in function words that form the first syllable of a syntactic phrase resist deletion. In content words, vowels in the final syllable are almost never deleted, whereas vowels in phrase-final function words more weakly resist deletion. Finally, deletion in content words is restricted to open syllables, while deletion in function words is more weakly affected by the surrounding segmental context (which highly correlates with syllable structure).

Whether there is indeed more variation in deletion patterns in content words than initially thought remains to be seen, as deletion in content words has not been studied systematically in a corpus of spontaneous speech. However, if it is more variable in function words than content words, this is not surprising, as function words are often reduced in natural speech, leading to a greater facility for deletion.

Variability in deletion of segments in casual speech is reported cross-linguistically. For example, schwa deletion is optional in English (Oshika et al. 1975) and French (Dell 1981; Bürki et al. 2011). Optional vowel deletion patterns are also reported in regionally and genetically disparate languages such as Yoruba (Pulleyblank 1988), Margi (Tranel 1993), and Italian (Nespor 1990). Vowel quality, phrasing and surrounding context are common conditioning factors.

4.4.2 Vowel deletion and prosodic phrasing

These results are informative for the question of prosodic structure in K'iche' at the level of word and phrase, as the preceding and following segmental context affect the rates of vowel deletion in function words but in a way that is mediated by phrase structure. The following segmental context can affect vowel deletion regardless of the syntactic structure, but there are differences observed between phrase positions, with a single coda consonant restricting deletion over a single onset consonant when the vowel is in the final syllable of a syntactic phrase, but not when the vowel is not phrase-final. The preceding context, in turn, affects deletion patterns only for words that are not initial in a syntactic phrase. These results suggest that there is a prosodic equivalent of the syntactic phrase, which could be referred to as a phonological phrase. The surrounding context affects the likelihood of deletion, but only or more strictly within the phonological phrase.

Though these function words form a prosodic phrase with surrounding words, they are not within the prosodic word of the content word that they attach to. Function words and prefixes have a different effect on the word they precede with regard to deletion: while prefixes can permit the deletion of a previously word-initial vowel in the content word, function words (including proclitics) never have this effect, even when the full structure created would be conducive to deletion based on the potential syllable structure. This can be seen by comparing the examples in 74.

(74) a. *rïxqil*
ɾɪ.ʃ(ɔ).ˈqil
ɾ-ɪʃɔq-il
A:3SG-woman-POSS
'his wife' (mr, 35:26)

b. *täq ulew*
təq u.ˈlew
təq ʊlew
PL land
'the lands' (fishing, 04:27)

The intermediate lax vowel /ɔ/ in *wïxqil* 'my wife' in 74a, which is in a CV syllable preceding a stressed syllable, is deleted. The lax vowel /ʊ/ at the beginning of the word *ulew* 'land' in 74b, when preceded by the proclitic *täq*, occurs in the same type of segmental context: preceded by a single consonant and followed by a stressed syllable. However, it is not deleted, and furthermore, the vowel is realized with tense quality as occurs with word-initial unstressed vowels in Chichicastenango K'iche' regardless of their phonemic identity, as shown in Chapter 3. This shows that *täq*, whether or not it is resyllabified with the following word at a later stage, is not within its prosodic word. The same pattern is observed for the other function words considered in this study: whether or not their vowels are deleted is affected by the surrounding context, but the presence of a function word preceding a content word never permits the deletion of the content word's initial vowel.

The variable application of deletion outside of the prosodic word, but following similar constraints to those that condition obligatory deletion within the word, is similar to previous reports of similar rules applying lexically and postlexically but with different details. For example, Kiparsky (1985) points out that assimilation of nasals in English is obligatory within words but optional postlexically.

4.5 Conclusion

This chapter presents a study of vowel deletion in function words in a corpus of spontaneous speech. The results show that deletion is affected by the quality of the vowel (more deletion of lax vowels than tense vowels), the syntactic phrase position of the syllable containing the vowel (more deletion in medial syllables than initial and final syllables), and the surrounding surface segmental context (more deletion adjacent to a vowel and less adjacent to a consonant cluster as compared to adjacent to a single consonant). Syntactic phrase position further mediates the effects of the surrounding context: preceding context only affects rates of deletion in non-phrase-initial syllables, and a following coda (morpheme-internal) consonant limits deletion more when the vowel is in the final syllable of a syntactic phrase than when it is not phrase-final. The interaction between phrase position and segmental context suggests the existence of a phonological phrase corresponding to the syntactic phrase; an effect of surrounding context is prevented or weakened across phrase boundaries.

As compared to previous reports - and my own observation - of deletion patterns in content words, these results are much more variable. Very similar examples can be found of the same words in nearly identical contexts and produced by the same speakers, where the vowel is deleted in one case and preserved in the other. However, the factors that influence the rates of deletion have parallels to those which condition deletion in content words: vowel quality, syllable position, and surrounding segmental/syllabic context. These factors are also similar to those reported for other Mayan languages. Vowel deletion is attested in many Mayan languages, including Mam, Tektitek, Ixil, Uspantek, Tz'utujil, Sakapultek, Tseltal, Yucatec Maya, Tojolab'al, Mocho', and Huastec, as well as in a number of K'iche' dialects though to a much lesser degree than in Chichicastenango (Bennett 2016b; Par Sapón and Can Pixabaj 2000). Like K'iche', vowel deletion in these languages is typically restricted to short (corresponding to lax) vowels and often reinforces phonotactic rules. It is also common for vowels that are unstressed, non-initial, and non-final, factors which condition deletion in content words in Chichicastenango K'iche', though their influence on function words is less clear (Bennett 2016b; López Ixcoy 1994; Par Sapón and Can Pixabaj 2000).

Chapter 5

Conclusion

5.1 Prosodic structure in Chichicastenango K'iche'

Each of the topics addressed in this dissertation sheds light on the prosodic structure of Chichicastenango K'iche', at different levels of the prosodic hierarchy. When brought together, these results show evidence for prosodic structure corresponding to the level of the word, the phrase, and the clause.

Evidence for a prosodic category corresponding to the morphological word (a root plus its affixes), which could be called the prosodic word, comes from the study of initial glottalization. Vowels that are initial in the word cannot be deleted and must be realized with tense vowel quality (Section 3.4.2). Furthermore, a glottal stop is inserted at the beginning of a word which begins with a stressed syllable, causing it to interact with preceding material as consonant-initial (Sections 3.3, 3.4). Function words are outside of the domain of this prosodic word, as unlike affixes they do not allow the deletion or lax realization of word-initial vowels (Section 4.4.2) and cause the insertion of glottal stops between them and a following word (Section 3.3). Stress is sensitive to the right edge of the prosodic word in non-verbs, falling on the final syllable of these words (Section 1.2.3.1).

Evidence for a prosodic category corresponding to the syntactic clause (a predicate plus its dependent arguments and modifiers), which is referred to in this dissertation as the intonational phrase, comes primarily from the study of status suffixes. A verb which occurs at the end of an intonational phrase bears a phrase-final suffix, while the same verb followed by additional material within the intonational phrase bears a phrase-medial suffix (Section 2.4.2). Boundary tones also appear at the ends of intonational phrases when not contained within another intonational phrase. The study of glottalization also showed that glottalized phonation is found throughout word-initial vowels on words that follow a word bearing a boundary tone, marking the left edge of the intonational phrase (Section 3.3).

Finally, there is evidence for an additional prosodic category that falls between these two levels, corresponding to the syntactic phrase (a word plus dependent functional elements), which could be referred to as the phonological phrase. This evidence comes primarily from the study of vowel deletion in function words. This study shows that the likelihood of deletion is affected by surrounding segmental/syllabic context, but in a way that is mediated by phrase structure. The preceding context affects only vowels that are not in the initial position of a syntactic phrase. The following context affects vowels that are final or not final in the syntactic phrase in different ways, with following consonants outside of the syntactic phrase not having the same effect as those that are phrase-internal (Section 4.3). This prosodic phrase is clearly larger than the prosodic word, because the functional elements within this phrase do not cause deletion or glottal stop insertion at the beginning of a following content word (prosodic word) (Section 4.4.2).

These results are represented schematically in Figure 5.1.

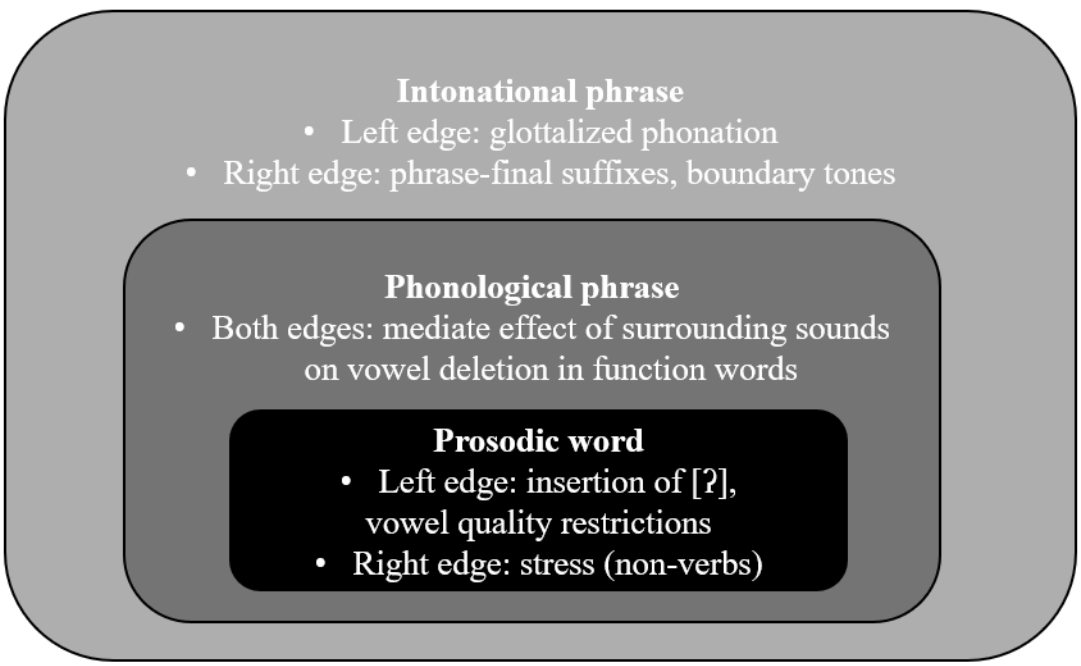


Figure 5.1: Prosodic hierarchy in Chichicastenango K'iche'

Brought together, the studies in this dissertation also show the far-reaching effects of the phonotactics of the language. The restriction against adjacent vowels results in the insertion of glottal stops to break up vowel sequences. This can be seen both within and across word boundaries: a glottal stop is inserted at the beginning of a word that begins with a vowel when the preceding word ends in a vowel (Section 3.3), and is also inserted between a vowel-final prefix and vowel-initial stem (Section 3.5.1.1). The same restriction can explain the pattern of proclitic shortening: the final nasal of the words *jün*, *sïn* and *man* is deletable unless the following word begins with a vowel, which would result in a sequence of vowels (Section 3.4.1). The dispreference for adjacent vowels is also apparent in the pattern of vowel deletion in function words: a likelihood of deleting a vowel is higher when it is adjacent to another vowel (Section 4.3).

The restriction against word-final consonant clusters, in turn, results in the use of phrase-final status suffixes in medial environments when a verb stem ends in a consonant cluster, with the exception of those composed of a glide or glottal stop followed by another consonant (Section 2.3.1). This restriction is also apparent in the vowel deletion pattern. Vowels are not deleted in word-final syllables in content words if the resulting word would have a disallowed consonant cluster (Section 4.1.1.4). Vowels are also less likely to be deleted in function words when they are in the last syllable of a syntactic phrase and are followed by a morpheme-internal (coda) consonant, thereby avoiding the creation of a phrase-final consonant cluster (Section 4.3). The fact that the avoidance of word-final consonant clusters is so strong is particularly interesting because long and complex consonant clusters of many types appear in word-initial and word-medial position as a result of vowel deletion (Section 1.2.2).

5.2 Spontaneous speech as linguistic data

Each of the studies presented in this dissertation is based on a corpus of spontaneous, narrative speech from Chichicastenango K'iche' speakers. The reliance on spontaneous speech is a unique aspect of this dissertation, as historically the majority of research in phonetics and phonology, especially on understudied languages, has been primarily based on targeted elicitation of careful speech.

There are several challenges in using spontaneous speech as data for linguistic study. Due to the greater complexity of spontaneous speech over carefully controlled elicitation, a deeper knowledge of the grammar and lexicon of the language of study is necessary in order to be able to understand a wide range of different utterances. If the data is collected and curated by the researcher performing the analysis, there is also a large time investment for transcription, translation, and data processing. This is especially challenging for understudied languages where large or even small corpora may not exist, may be difficult to access, or may require extensive processing in order to be usable for these types of studies. Additionally, using spontaneous speech means there is no control over the number of tokens or the specific contexts they occur in, resulting in highly variable amounts of data in different experimental categories depending on their natural frequency and the topics or genres of discussion. Finally, in natural speech data it may be unclear where to locate the boundary between grammatical but rare constructions and true speech errors, as speakers focused on the content of their speech tend to self-correct what they consider to be errors in meaning but not grammatical errors.

However, there are also many benefits to using spontaneous speech as linguistic data. Although much can be learned from elicited data, it may also be influenced by prescriptive knowledge of the target language, the grammar of the contact language, or even social dynamics between consultant and researcher (Chelliah 2001). In the course of my work on status suffixes presented in Chapter 2, I asked several speakers about the grammaticality of phrase-medial and phrase-final status suffixes in a number of example sentences constructed to be similar to those attested in the corpus. Some of these speakers had a certain prescriptive knowledge of K'iche' grammar, as they worked as bilingual education teachers in local schools or with the K'iche' language academy. Others lacked this prescriptive knowledge and were illiterate in K'iche' (though literate in Spanish). When I asked these speakers about sentences where a verb immediately precedes a demonstrative pronoun acting as a discourse marker, the speakers with prescriptive knowledge assured me that these verbs should only have phrase-medial suffixes because they are not at the end of a sentence. The speakers without prescriptive knowledge accepted phrase-final suffixes in this position. As shown in Chapter

2, around 90% of the time that this construction occurs in spontaneous speech phrase-final suffixes are used. This is one example which demonstrates how there can be a very stark difference between grammaticality judgments about a particular construction and how it is produced in naturalistic contexts.

Furthermore, a description based on elicited sentences is limited to those contexts which the researcher asks about and can easily miss aspects of language which depend on discourse or a larger context for grammaticality (Chelliah and De Reuse 2010). When using spontaneous speech, a wide range of complex constructions may appear that may have no easy translations into a target language or are not otherwise easily elicited. Early in my work on Chichicastenango K'iche', I attempted to elicit information about the incorporated movement construction in K'iche', where a prefix grammaticalized from a verb of motion appears after the set B (absolutive) prefix on a verb and indicates that the subject moved somewhere in order to perform the action of the verb (see example 12b in Chapter 2). Because there are no corresponding constructions in Spanish, I used two-verb Spanish constructions for elicitation, and speakers tended to provide two-verb K'iche' translations instead of the intended one-verb forms with incorporated movement prefixes. I found it practically impossible to elicit these constructions, and had to offer options to the speakers and ask if they were grammatical. This limited my understanding of incorporated movement in Chichicastenango K'iche' to what I expected from knowledge of other K'iche' dialects. In the corpus, in contrast, 213 of the total of 2772 verbs included in the study of status suffixes in Chapter 2 have incorporated movement, and they demonstrate various ways that these verbs can be used that I would never have guessed to ask about.

Naturalistic data is particularly important to understanding linguistic phenomena active in casual speech, where many aspects of the language may be better described through optional rules or statistical tendencies. Variable rules are very difficult to observe in elicited data, which represents more careful speech. These types of rules can be seen very clearly in both the study on status suffixes and that on vowel deletion. In each of these cases, variable surface forms exist for similar underlying structures. A verb preceding an embedded clause may appear with a phrase-medial status suffix, a phrase-final status suffix but no boundary tone, or a phrase-final status suffix and a boundary tone, reflecting different prosodic structure for the same syntactic structures (see e.g. 39, 40 and 41 in Chapter 2). Function words may appear with or without underlying vowels in very similar prosodic and segmental contexts, even as produced by the same speaker close in time (see e.g. 72 and 73 in Chapter 4).

Using spontaneous speech as data gives a broader, more complex perspective on linguistic structure which more closely resembles the language as it is actually used by speakers. This helps avoid some of the simplification and overgeneralization inherent to the use of highly controlled data. Using spontaneous speech for the three studies presented in this dissertation resulted in a more nuanced understanding of these aspects of the language than I believe would have been achieved through a study of careful elicited speech.

Appendices

Appendix A

Abbreviations

The following abbreviations are used in example glosses in this document:

1: first person

2: second person

3: third person

A: set A (ergative and possessive)

ACT: active

AFF: affect verb

AG: agentive

ANT: antipassive

AUG: augmentative

B: set B (absolutive)

CAUS: causative

CAUS.POS: causative of a positional

COMP: complementizer

CPL: completive aspect

CT: contrastive topic

DET: determiner

DEM: demonstrative

DIM: diminutive

DIR: directional

EXIST: existential

F: phrase-final form

IDEO: ideophone

IMP: imperative

INCPL: incompletive aspect

INC.MOV: incorporated movement

INSTR: instrumental verb form

IRR: irrealis

M: phrase-medial form

NEG: negation

NOM: nominalization

PL: plural

PASS: passive

PASS.C: completive passive

PERF: perfect

POS: positional adjective

PP.TRACE: prepositional phrase trace

PREP: preposition

QUOT: quotative particle

REFL: reflexive

REL.NOUN: relational noun

SG: singular

SS: status suffix

TV: thematic vowel

VER: versive

Appendix B

Statistics

The following sections detail the statistical results for the remaining acoustic measures of glottalization not included in Chapter 3 (H1-A3, jitter, shimmer and minimum pitch).

B.0.0.0.1 H1-A3

Figure B.1 shows the mean values of H1-A3 in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition is lower in the first third than in the baseline, indicating greater glottalization. By the end of the vowel, the means of all conditions are closer.

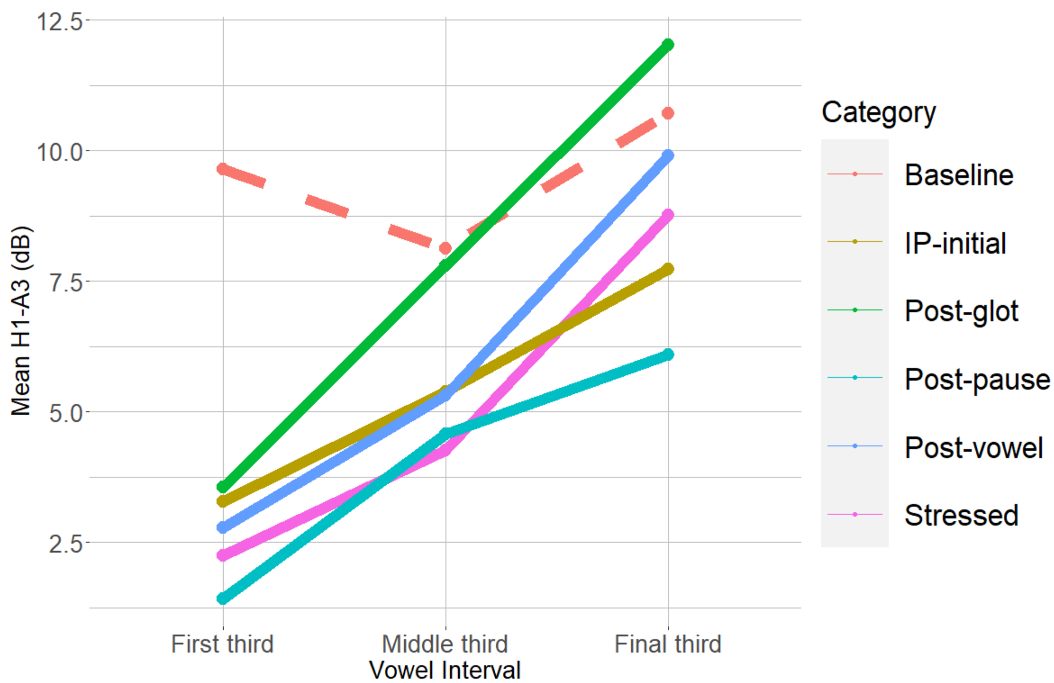


Figure B.1: Mean value of H1-A3 in each experimental condition, for each third of the vowel

The results for H1-A3 in the first third of the vowel are shown in Table B.1.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	19.582	2.775	7.058	<0.001	***
preceding pause	-0.657	0.855	-0.769	0.442	
preceding vowel	-4.657	0.714	-6.521	<0.001	***
preceding glottal(ized) consonant	-3.516	1.276	-2.755	<0.01	**
IP-initial	-1.207	0.782	-1.543	0.123	
initial stress	-2.783	1.018	-2.733	<0.01	**
F1	-0.009	0.001	-6.458	<0.001	***
F2	-0.002	0.001	-2.828	<0.01	**
preceding pause, IP-initial	0.670	1.077	0.622	0.534	
preceding vowel, IP-initial	2.275	1.212	1.878	0.061	.
preceding glott. cons., IP-initial	-1.608	1.625	-0.990	0.322	
IP-initial, initial stress	-0.857	1.083	-0.792	0.429	
preceding pause, initial stress	-0.077	1.195	-0.064	0.949	
preceding vowel, initial stress	-0.311	1.080	-0.287	0.774	
preceding glott. cons., initial stress	1.481	1.897	0.781	0.435	

Table B.1: Effects on H1-A3 in the first third of the vowel

There is a significant negative effect of preceding vowel, preceding glottalized consonant and initial stress, indicating greater glottalization in these contexts. There is also a significant negative effect of F1 and F2. There are no significant interactions.

The results for H1-A3 in the middle third of the vowel are shown in Table B.2. The negative effect of preceding vowel persists. There is also a negative effect of IP-initial position, indicating greater glottalization in these contexts. There is a positive effect of preceding pause. There are also negative effects of F1 and F2. There are no significant interactions.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	20.709	2.7838	7.439	<0.001	***
preceding pause	3.416	0.820	4.163	<0.001	***
preceding vowel	-3.092	0.687	-4.501	<0.001	***
preceding glottal(ized) consonant	0.785	1.223	0.642	0.521	
IP-initial	-1.625	0.748	-2.173	<0.05	*
initial stress	0.190	1.072	0.177	0.860	
F1	-0.013	0.002	-7.673	<0.001	***
F2	-0.002	0.001	-2.936	<0.01	**
preceding pause, IP-initial	0.270	1.032	0.261	0.794	
preceding vowel, IP-initial	1.752	1.158	1.513	0.130	
preceding glott. cons., IP-initial	0.203	1.556	0.130	0.896	
IP-initial, initial stress	-1.767	1.042	-1.696	0.090	.
preceding pause, initial stress	-0.718	1.146	-0.627	0.531	
preceding vowel, initial stress	1.494	1.040	1.437	0.151	
preceding glott. cons., initial stress	-1.895	1.814	-1.045	0.296	

Table B.2: Effects on H1-A3 in the middle third of the vowel

The results for H1-A3 in the final third of the vowel are shown in Table B.3.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	11.968	2.835	4.222	<0.001	***
preceding pause	2.445	0.847	2.888	<0.01	**
preceding vowel	-0.849	0.724	-1.172	0.242	
preceding glottal(ized) consonant	2.783	1.266	2.199	<0.05	*
IP-initial	-1.567	0.782	-2.005	<0.05	*
initial stress	2.077	1.324	1.568	0.119	
F1	-0.001	0.001	-0.935	0.350	
F2	0.001	0.001	1.210	0.2264	
preceding pause, IP-initial	-0.0224	1.066	-0.021	0.983	
preceding vowel, IP-initial	0.823	1.219	0.675	0.500	
preceding glott. cons., IP-initial	-0.423	1.601	-0.264	0.792	
IP-initial, initial stress	-0.240	1.092	-0.220	0.826	
preceding pause, initial stress	-2.068	1.190	-1.737	0.083	.
preceding vowel, initial stress	-2.588	1.096	-2.362	<0.05	*
preceding glott. cons., initial stress	-3.754	1.872	-2.005	<0.05	*

Table B.3: Effects on H1-A3 in the final third of the vowel

There is a significant positive effect of preceding pause and preceding glottalized consonant, and a significant negative effect of IP-initial position. There are also significant interactions between preceding vowel and initial stress and preceding glottalized consonant and initial stress.

When looking separately at the subsets of vowels with and without initial stress, there is no effect of preceding glottalized consonant for stressed vowels but a significant positive effect for unstressed vowels. There is a significant negative effect of preceding vowel for stressed vowels, but no effect for unstressed vowels. These results are shown in Tables B.5 and B.4.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	23.022	3.431	6.710	<0.001	***
IP-initial	-1.563	0.889	-1.759	0.079	.
preceding glottal(ized) consonant	-1.484	1.576	-0.942	0.347	
preceding pause	0.261	0.999	0.261	0.794	
preceding vowel	-3.052	0.840	-3.633	<0.001	***
F1	-0.010	0.003	-3.772	<0.001	***
F2	-0.002	0.001	-1.572	0.117	

Table B.4: Effects on H1-A3 in the final third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	10.416	2.996	3.476	<0.01	**
preceding glottal(ized) consonant	2.413	0.902	2.676	<0.01	**
preceding pause	2.310	0.633	3.649	<0.001	***
preceding vowel	-0.617	0.645	-0.958	0.338	
IP-initial	-1.505	0.591	-2.545	<0.05	*
F1	-0.000	0.001	-0.193	0.847	
F2	0.001	0.001	2.011	<0.05	*

Table B.5: Effects on H1-A3 in the final third of the vowel when unstressed

B.0.0.0.2 Jitter

Figure B.2 shows the mean values of jitter in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition is higher in the first third than in the baseline, indicating greater aperiodicity and therefore greater glottalization. By the end of the vowel, the means of all conditions are much closer to the baseline.

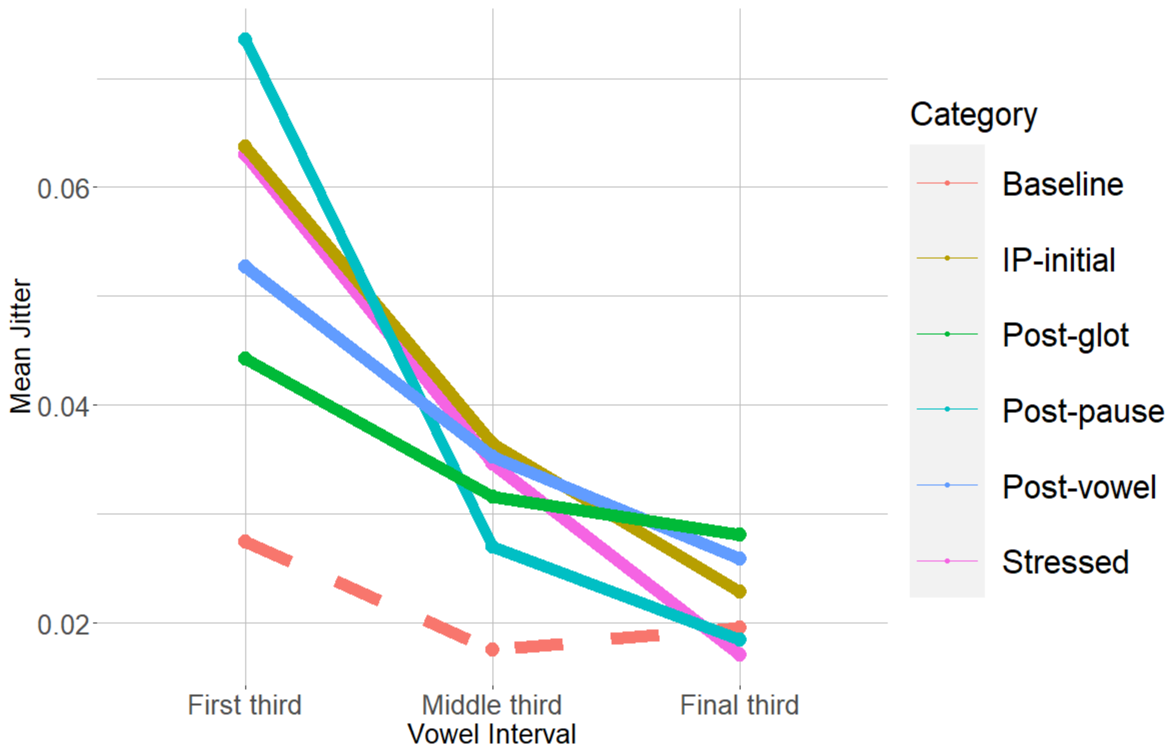


Figure B.2: Mean value of jitter in each experimental condition, for each third of the vowel

The results for jitter in the first third of the vowel are shown in Table B.6. There is a significant positive effect of preceding pause, IP-initial position and initial stress, consistent with more aperiodicity and therefore more glottalization in these contexts. There is also a significant interaction between preceding vowel and initial stress.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.026	0.014	1.834	0.068	.
preceding pause	0.029	0.011	2.555	<0.05	*
preceding vowel	0.001	0.009	0.106	0.915	
preceding glottal(ized) consonant	0.015	0.016	0.925	0.355	
IP-initial	0.0246	0.010	2.576	<0.05	*
initial stress	0.023	0.010	2.303	<0.05	*
F1	-0.000	0.000	-0.097	0.923	
F2	0.000	0.000	0.362	0.718	
preceding pause, IP-initial	-0.005	0.014	-0.332	0.740	
preceding vowel, IP-initial	-0.021	0.015	-1.384	0.166	
preceding glott. cons., IP-initial	-0.019	0.020	-0.948	0.343	
IP-initial, initial stress	-0.013	0.014	-0.928	0.354	
preceding pause, initial stress	-0.016	0.015	-1.036	0.301	
preceding vowel, initial stress	0.030	0.0129	2.330	<0.05	*
preceding glott. cons., initial stress	-0.020	0.023	-0.877	0.381	

Table B.6: Effects on jitter in the first third of the vowel

When looking at the subsets of stressed and unstressed vowels, there is a significant positive effect of preceding vowel for stressed vowels but no effect for unstressed vowels. These results are shown in Tables B.7 and B.8.

	Estimate	Std. Error	T-value	P-value
(Intercept)	0.046	0.0319	1.439	0.152
IP-initial	0.004	0.015	0.295	0.768
preceding glottal(ized) consonant	-0.009	0.025	-0.342	0.733
preceding pause	0.015	0.017	0.881	0.379
preceding vowel	0.031	0.013	2.289	<0.05 *
F1	-0.000	0.000	-0.208	0.835
F2	0.000	0.000	0.549	0.585

Table B.7: Effects on jitter in the first third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.024	0.014	1.728	0.088	.
preceding glottal(ized) consonant	0.007	0.010	0.683	0.495	
preceding pause	0.031	0.007	4.478	<0.001	***
preceding vowel	-0.002	0.007	-0.374	0.709	
IP-initial	0.019	0.006	3.125	<0.01	**
F1	0.000	0.000	0.359	0.720	
F2	0.000	0.000	0.238	0.812	

Table B.8: Effects on jitter in the first third of the vowel when unstressed

The results for jitter in the middle third of the vowel are shown in Table B.9.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.030	0.011	2.733	<0.01	**
preceding pause	0.010	0.008	1.319	0.187	
preceding vowel	0.013	0.007	1.999	<0.05	*
preceding glottal(ized) consonant	0.007	0.013	0.572	0.567	
IP-initial	0.031	0.007	4.352	<0.001	***
initial stress	0.011	0.007	1.646	0.102	
F1	0.000	0.000	0.372	0.710	
F2	-0.000	0.000	-2.010	<0.05	*
preceding pause, IP-initial	-0.034	0.010	-3.392	<0.001	***
preceding vowel, IP-initial	-0.023	0.012	-1.953	0.051	.
preceding glott. cons., IP-initial	-0.013	0.016	-0.849	0.396	
IP-initial, initial stress	0.015	0.010	1.443	0.149	
preceding pause, initial stress	-0.014	0.011	-1.259	0.208	
preceding vowel, initial stress	-0.009	0.010	-0.857	0.392	
preceding glott. cons., initial stress	-0.034	0.018	-1.862	0.062	.

Table B.9: Effects on jitter in the middle third of the vowel

There is a significant positive effect of preceding vowel and IP-initial position. There is also a negative effect of F2. The interaction between preceding pause and IP-initial position is significant.

Comparing the subsets of IP-initial and IP-non-initial vowels, there is a significant negative effect (more periodicity) of preceding pause when IP-initial but no significant effect when not IP-initial. These results are shown in Tables B.10 and B.11.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.049	0.021	2.373	<0.05	*
initial stress	0.014	0.009	1.659	0.098	.
preceding glottal(ized) consonant	-0.013	0.012	-1.099	0.272	
preceding pause	-0.027	0.008	-3.172	<0.01	**
preceding vowel	-0.009	0.011	-0.828	0.408	
F1	0.000	0.000	0.572	0.568	
F2	-0.000	0.000	-0.249	0.803	

Table B.10: Effects on jitter in the middle third of the vowel when IP-initial

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.028	0.012	2.396	<0.05	*
preceding glottal(ized) consonant	-0.003	0.011	-0.252	0.801	
preceding pause	0.005	0.006	0.724	0.469	
preceding vowel	0.011	0.005	2.099	<0.05	*
initial stress	0.005	0.006	0.790	0.433	
F1	0.000	0.000	0.925	0.356	
F2	-0.000	0.000	-2.095	<0.05	*

Table B.11: Effects on jitter in the middle third of the vowel when not IP-initial

The results for jitter in the final third of the vowel are shown in Table B.12. There is a significant positive effect of preceding vowel, but no other significant effects. None of the interactions are significant.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.019	0.009	2.187	<0.05	*
preceding pause	-0.002	0.007	-0.293	0.770	
preceding vowel	0.013	0.006	2.033	<0.05	*
preceding glottal(ized) consonant	-0.009	0.011	-0.866	0.387	
IP-initial	-0.000	0.007	-0.032	0.974	
initial stress	-0.011	0.007	-1.569	0.120	
F1	0.000	0.000	0.334	0.738	
F2	0.000	0.000	0.299	0.765	
preceding pause, IP-initial	0.002	0.009	0.231	0.818	
preceding vowel, IP-initial	-0.010	0.010	-0.936	0.349	
preceding glott. cons., IP-initial	0.018	0.014	1.264	0.206	
IP-initial, initial stress	0.011	0.009	1.292	0.196	
preceding pause, initial stress	-0.005	0.010	-0.506	0.613	
preceding vowel, initial stress	-0.003	0.009	-0.321	0.749	
preceding glott. cons., initial stress	0.026	0.016	1.674	0.094	.

Table B.12: Effects on jitter in the final third of the vowel

B.0.0.0.3 Shimmer

Figure B.3 shows the mean values of shimmer in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean for every condition is higher than in the baseline in the first third of the vowel, indicating greater aperiodicity and therefore greater glottalization. By the end of the vowel, the means of all conditions are very close to the baseline.

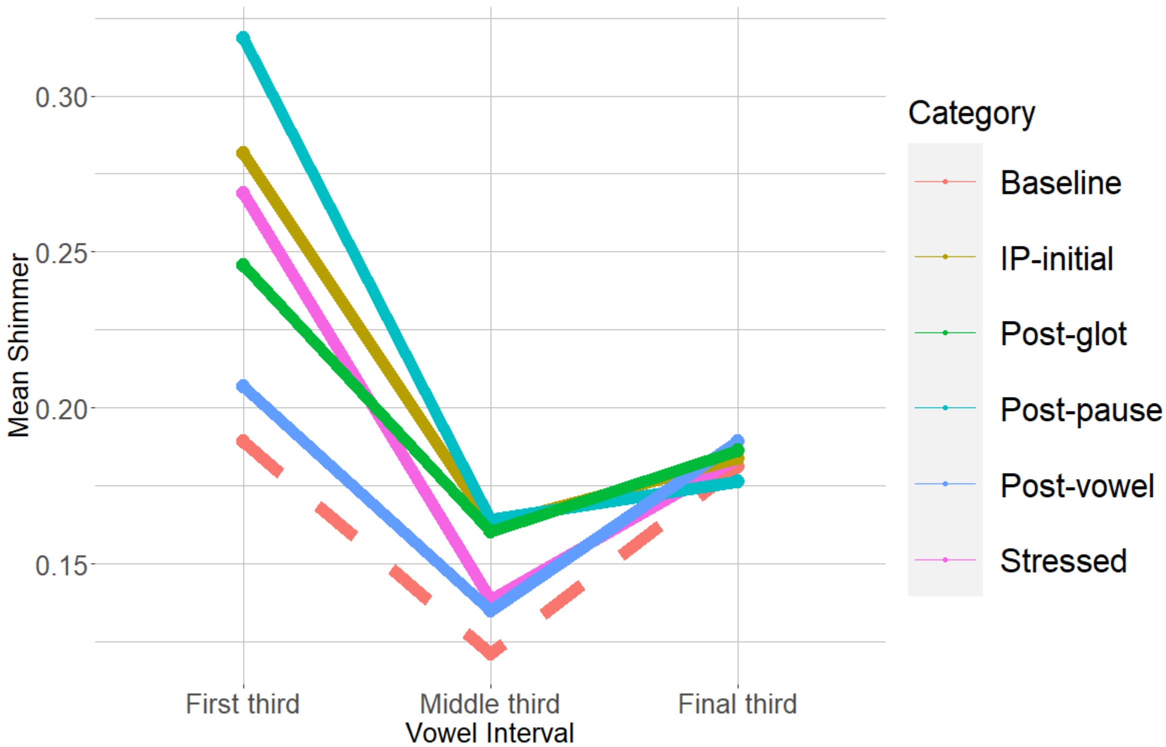


Figure B.3: Mean value of shimmer in each experimental condition, for each third of the vowel

The results for shimmer in the first third of the vowel are shown in Table B.13. There is a significant positive effect of preceding pause, IP-initial position, and initial stress, indicating greater aperiodicity and therefore greater glottalization in these contexts. The interaction between preceding glottalized consonant and IP-initial position as well as between preceding pause and initial stress are significant.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.236	0.044	5.360	<0.001	***
preceding pause	0.102	0.034	2.954	<0.01	**
preceding vowel	-0.028	0.026	-1.060	0.289	
preceding glottal(ized) consonant	0.087	0.047	1.876	0.061	.
IP-initial	0.074	0.029	2.564	<0.05	*
initial stress	0.068	0.030	2.278	<0.05	*
F1	0.000	0.000	0.579	0.563	
F2	-0.000	0.000	-1.817	0.071	.
preceding pause, IP-initial	-0.041	0.043	-0.969	0.333	
preceding vowel, IP-initial	-0.012	0.044	-0.276	0.783	
preceding glott. cons., IP-initial	-0.129	0.059	-2.193	<0.05	*
IP-initial, initial stress	0.027	0.041	0.659	0.510	
preceding pause, initial stress	-0.104	0.047	-2.239	<0.05	*
preceding vowel, initial stress	-0.013	0.039	-0.332	0.740	
preceding glott. cons., initial stress	-0.055	0.065	-0.850	0.395	

Table B.13: Effects on shimmer in the first third of the vowel

When comparing the subsets of IP-initial and IP-non-initial vowels, it can be seen that there is a positive effect of preceding glottalized consonant in IP-non-initial position but not in IP-initial position, indicating that these effects do not stack. This is shown in Tables B.14 and B.15.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.345	0.100	3.444	<0.001	***
initial stress	0.026	0.043	0.617	0.542	
preceding glottal(ized) consonant	-0.046	0.053	-0.884	0.377	
preceding pause	0.060	0.038	1.561	0.119	
preceding vowel	-0.035	0.050	-0.704	0.482	
F1	0.000	0.000	0.872	0.389	
F2	-0.000	0.000	-2.153	<0.05	*

Table B.14: Effects on shimmer in the first third of the vowel when IP-initial

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.223	0.044	5.047	<0.001	***
preceding glottal(ized) consonant	0.074	0.036	2.083	<0.05	*
preceding pause	0.052	0.027	1.952	0.051	.
preceding vowel	-0.031	0.018	-1.687	0.092	.
initial stress	0.050	0.026	1.947	0.057	.
F1	0.000	0.000	0.411	0.681	
F2	-0.000	0.000	-0.843	0.400	

Table B.15: Effects on shimmer in the first third of the vowel when not IP-initial

Similarly, when comparing the effects in the subsets of stressed and unstressed vowels, there is no significant effect of preceding pause when stressed but a positive significant effect when unstressed, again showing that these effects do not stack. These results are shown in Tables B.16 and B.17.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.286	0.080	3.574	<0.001	***
IP-initial	0.069	0.040	1.714	0.087	.
preceding glottal(ized) consonant	-0.007	0.064	-0.112	0.911	
preceding pause	-0.006	0.045	-0.122	0.903	
preceding vowel	-0.046	0.036	-1.258	0.209	
F1	0.000	0.000	1.012	0.312	
F2	-0.000	0.000	-1.191	0.240	

Table B.16: Effects on shimmer in the first third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.279	0.051	5.428	<0.001	***
preceding glottal(ized) consonant	0.019	0.031	0.607	0.544	
preceding pause	0.086	0.023	3.773	<0.001	***
preceding vowel	-0.028	0.021	-1.296	0.195	
IP-initial	0.047	0.020	2.351	<0.05	*
F1	-0.000	0.000	-0.348	0.728	
F2	-0.000	0.000	-1.762	0.079	.

Table B.17: Effects on shimmer in the first third of the vowel when unstressed

The effects on shimmer in the middle third of the vowel are shown in Table B.18.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.143	0.033	4.290	<0.001	***
preceding pause	0.069	0.021	3.202	<0.01	**
preceding vowel	0.009	0.020	0.436	0.663	
preceding glottal(ized) consonant	0.024	0.035	0.672	0.502	
IP-initial	0.042	0.021	1.981	<0.05	*
initial stress	0.016	0.019	0.831	0.407	
F1	-0.000	0.000	-0.154	0.878	
F2	-0.000	0.000	-0.608	0.545	
preceding pause, IP-initial	-0.074	0.029	-2.565	<0.05	*
preceding vowel, IP-initial	-0.002	0.034	-0.050	0.961	
preceding glott. cons., IP-initial	-0.016	0.045	-0.363	0.717	
IP-initial, initial stress	0.021	0.029	0.738	0.461	
preceding pause, initial stress	-0.090	0.031	-2.868	<0.01	**
preceding vowel, initial stress	-0.028	0.029	-0.980	0.327	
preceding glott. cons., initial stress	-0.056	0.052	-1.066	0.286	

Table B.18: Effects on shimmer in the middle third of the vowel

There is a significant positive effect of preceding pause and IP-initial position. The interactions between preceding pause and IP-initial position, and between preceding pause and initial stress, are also significant.

Comparing the subsets of post-pausal and non-post-pausal vowels, it can be seen that IP-initial position has a significant positive effect when not post-pausal but no effect when post-pausal, showing that these effects do not stack. Initial stress, in turn, has a significant negative effect (more modal phonation) when post-pausal and no effect when not post-pausal. These results are shown in Table B.19 and B.20.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.221	0.059	3.760	<0.001	***
initial stress	-0.058	0.021	-2.780	<0.01	**
IP-initial	-0.030	0.019	-1.569	0.117	
F1	0.000	0.000	0.166	0.869	
F2	-0.000	0.000	-0.813	0.417	

Table B.19: Effects on shimmer in the middle third of the vowel when following a pause

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.150	0.040	3.704	<0.001	***
preceding glottal(ized) consonant	0.005	0.022	0.203	0.839	
preceding vowel	-0.002	0.014	-0.165	0.869	
initial stress	0.002	0.017	0.109	0.913	
IP-initial	0.041	0.017	2.446	<0.05	*
F1	-0.000	0.000	-0.181	0.857	
F2	-0.000	0.000	-0.578	0.565	

Table B.20: Effects on shimmer in the middle third of the vowel when not following a pause

The effects of shimmer in the final third of the vowel are shown in Table B.21. None of the main effects are significant. There is a significant interaction between preceding glottalized consonant and initial stress.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.223	0.025	9.065	<0.001	***
preceding pause	-0.020	0.017	-1.154	0.249	
preceding vowel	0.001	0.016	0.062	0.951	
preceding glottal(ized) consonant	-0.011	0.027	-0.410	0.682	
IP-initial	-0.003	0.017	-0.160	0.873	
initial stress	-0.027	0.020	-1.308	0.193	
F1	-0.000	0.000	-1.109	0.268	
F2	-0.000	0.000	-0.625	0.532	
preceding pause, IP-initial	0.026	0.022	1.199	0.231	
preceding vowel, IP-initial	-0.008	0.025	-0.310	0.757	
preceding glott. cons., IP-initial	-0.014	0.033	-0.410	0.682	
IP-initial, initial stress	-0.010	0.021	-0.491	0.623	
preceding pause, initial stress	0.017	0.023	0.744	0.457	
preceding vowel, initial stress	0.014	0.022	0.619	0.536	
preceding glott. cons., initial stress	0.090	0.037	2.411	<0.05	*

Table B.21: Effects on shimmer in the final third of the vowel

When comparing vowels with initial stress and without initial stress, it can be seen that there is a significant positive effect of preceding glottalized consonant for stressed vowels but no effect for unstressed vowels. These results are shown in Tables B.22 and B.23.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.177	0.043	4.133	<0.001	***
IP-initial	-0.005	0.015	-0.316	0.752	
preceding glottal(ized) consonant	0.071	0.027	2.667	<0.01	**
preceding pause	0.012	0.016	0.720	0.472	
preceding vowel	0.013	0.014	0.919	0.359	
F1	-0.000	0.000	-1.053	0.293	
F2	0.000	0.000	0.549	0.584	

Table B.22: Effects on shimmer in the final third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	0.226	0.027	8.332	<0.001	***
preceding glottal(ized) consonant	-0.023	0.020	-1.146	0.252	
preceding pause	-0.001	0.013	-0.080	0.936	
preceding vowel	-0.002	0.014	-0.152	0.879	
IP-initial	0.002	0.012	0.190	0.850	
F1	-0.000	0.000	-0.632	0.528	
F2	-0.000	0.000	-1.122	0.263	

Table B.23: Effects on shimmer in the final third of the vowel when unstressed

B.0.0.0.4 Minimum pitch

Figure B.4 shows the mean values of minimum pitch in the baseline condition (red dashed line) and each of the experimental conditions (solid lines). The mean is lower than the baseline in every experimental condition in the first third of the vowel. By the end of the vowel, the means of each experimental condition are higher than the baseline.

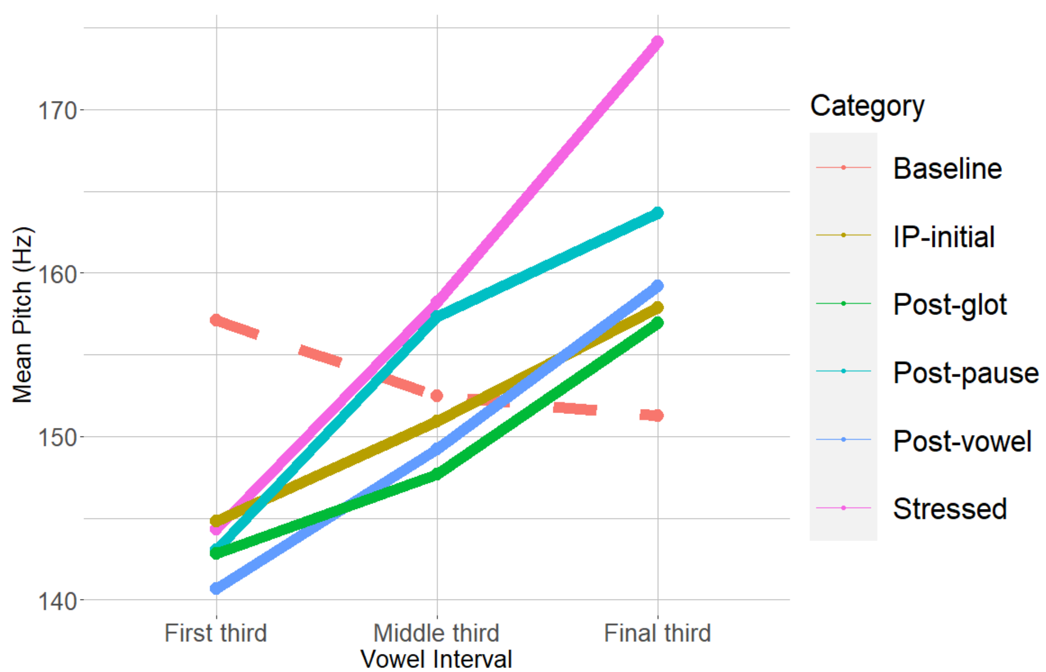


Figure B.4: Mean value of minimum pitch in each experimental condition, for each third of the vowel

The results for minimum pitch in the first third of the vowel are shown in Table B.24.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	143.353	9.113	15.731	<0.001	***
preceding pause	-9.715	4.587	-2.118	<0.05	*
preceding vowel	-14.678	3.745	-3.919	<0.001	***
preceding glottal(ized) consonant	-8.878	6.814	-1.303	0.193	
IP-initial	0.197	4.164	0.047	0.962	
initial stress	-8.521	5.589	-1.525	0.130	
F1	-0.005	0.007	-0.723	0.470	
F2	0.012	0.003	4.364	<0.001	***
preceding pause, IP-initial	-4.064	5.776	-0.704	0.482	
preceding vowel, IP-initial	3.170	6.429	0.493	0.622	
preceding glott. cons., IP-initial	-12.016	8.621	-1.394	0.164	
IP-initial, initial stress	-9.952	5.816	-1.711	0.087	.
preceding pause, initial stress	23.778	6.397	3.717	<0.001	***
preceding vowel, initial stress	3.867	5.721	0.676	0.499	
preceding glott. cons., initial stress	24.991	9.947	2.512	<0.05	*

Table B.24: Effects on minimum pitch in the first third of the vowel

There is a significant negative effect of preceding pause and preceding vowel, consistent with greater glottalization in these contexts. There is also a significant but very small positive effect of F2. There are significant interactions between preceding pause and initial stress and between preceding glottalized consonant and initial stress.

When comparing the subsets of stressed and unstressed vowels, there is no effect of preceding pause or preceding glottalized consonant when stressed but a significant negative effect when unstressed. These results are shown in Tables B.25 and B.26.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	115.780	15.208	7.613	<0.001	***
IP-initial	-11.534	5.342	-2.159	<0.05	*
preceding glottal(ized) consonant	8.170	9.364	0.872	0.383	
preceding pause	10.058	5.995	1.678	0.094	.
preceding vowel	-11.117	5.026	-2.212	<0.05	*
F1	-0.001	0.015	-0.065	0.948	
F2	0.021	0.006	3.556	<0.001	***

Table B.25: Effects on minimum pitch in the first third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	155.861	9.457	16.480	<0.001	***
preceding glottal(ized) consonant	-16.709	4.629	-3.610	<0.001	***
preceding pause	-11.129	3.254	-3.420	<0.001	***
preceding vowel	-15.016	3.198	-4.695	<0.001	***
IP-initial	-1.3789	2.920	-0.472	0.637	
F1	-0.008	0.008	-0.974	0.330	
F2	0.007	0.003	2.167	<0.05	*

Table B.26: Effects on minimum pitch in the first third of the vowel when unstressed

The results for minimum pitch in the middle third of the vowel are shown in Table B.27.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	147.217	9.394	15.672	<0.001	***
preceding pause	2.714	4.048	0.671	0.503	
preceding vowel	-12.357	3.412	-3.622	<0.001	***
preceding glottal(ized) consonant	-1.506	6.121	-0.246	0.806	
IP-initial	-9.179	3.733	-2.459	<0.05	*
initial stress	9.752	5.331	1.829	0.070	.
F1	-0.010	0.008	-1.260	0.208	
F2	0.010	0.003	3.777	<0.001	***
preceding pause, IP-initial	2.344	5.104	0.459	0.646	
preceding vowel, IP-initial	4.123	5.754	0.717	0.474	
preceding glott. cons., IP-initial	-4.759	7.754	-0.614	0.539	
IP-initial, initial stress	-12.511	5.195	-2.408	<0.05	*
preceding pause, initial stress	22.771	5.694	3.999	<0.001	***
preceding vowel, initial stress	12.200	5.179	2.356	<0.05	*
preceding glott. cons., initial stress	16.483	9.087	1.814	0.070	.

Table B.27: Effects on minimum pitch in the middle third of the vowel

There is a significant negative effect of preceding vowel and IP-initial position, as well as a significant but very small positive effect of F2. The interactions between initial stress and IP-initial position, preceding pause, and preceding vowel are significant.

Comparing the subsets of stressed and unstressed vowels, there is a significant negative effect of IP-initial position for stressed vowels and unstressed vowels, with a larger effect size in the former case. There is also a positive effect of preceding pause for stressed vowels, but no effect for unstressed vowels. There is a significant negative effect of preceding vowel for unstressed vowels, but no effect for stressed vowels. These results are shown in Tables B.28 and B.29.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	152.288	16.637	9.154	<0.001	***
IP-initial	-20.963	4.970	-4.218	<0.001	***
preceding glottal(ized) consonant	10.405	8.941	1.164	0.245	
preceding pause	23.063	5.571	4.140	<0.001	***
preceding vowel	1.134	4.722	0.240	0.810	
F1	-0.003	0.017	-0.183	0.855	
F2	0.008	0.006	1.374	0.171	

Table B.28: Effects on minimum pitch in the middle third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	150.711	9.697	15.542	<0.001	***
preceding glottal(ized) consonant	-5.471	4.074	-1.343	0.179	
preceding pause	4.986	2.833	1.760	0.079	.
preceding vowel	-11.645	2.852	-4.083	<0.001	***
IP-initial	-7.654	2.598	-2.946	<0.01	**
F1	-0.014	0.009	-1.657	0.099	.
F2	0.010	0.003	3.425	<0.001	***

Table B.29: Effects on minimum pitch in the middle third of the vowel when unstressed

The results for minimum pitch in the final third of the vowel are shown in Table B.30. There is a significant positive effect of preceding pause and initial stress. The interaction between IP-initial position and initial stress is significant.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	153.214	7.268	21.082	<0.001	***
preceding pause	9.378	3.601	2.604	<0.01	**
preceding vowel	-4.932	3.035	-1.625	0.104	
preceding glottal(ized) consonant	4.046	5.536	0.731	0.465	
IP-initial	-1.776	3.354	-0.530	0.596	
initial stress	34.437	4.668	7.377	<0.001	***
F1	-0.000	0.004	-0.098	0.922	
F2	0.003	0.002	1.458	0.145	
preceding pause, IP-initial	-5.314	4.566	-1.164	0.245	
preceding vowel, IP-initial	-1.558	5.145	-0.303	0.762	
preceding glott. cons., IP-initial	-3.469	6.965	-0.498	0.618	
IP-initial, initial stress	-14.007	4.645	-3.015	<0.01	**
preceding pause, initial stress	9.813	5.096	1.926	0.054	.
preceding vowel, initial stress	-0.643	4.626	-0.139	0.890	
preceding glott. cons., initial stress	2.818	8.047	0.350	0.726	

Table B.30: Effects on minimum pitch in the final third of the vowel

When comparing the subsets of stressed and unstressed vowels, it can be seen that there is a significant negative effect of IP-initial position for stressed vowels, but no effect for unstressed vowels. These results are shown in Tables B.31 and B.32.

	Estimate	Std. Error	T-value	P-value	
(Intercept)	190.741	14.113	13.515	<0.001	***
IP-initial	-18.885	4.515	-4.183	<0.001	***
preceding glottal(ized) consonant	6.584	8.053	0.818	0.414	
preceding pause	14.147	5.063	2.794	<0.01	**
preceding vowel	-6.016	4.259	-1.413	0.158	
F1	0.008	0.013	0.590	0.556	
F2	-0.002	0.005	-0.380	0.704	

Table B.31: Effects on minimum pitch in the final third of the vowel when stressed

	Estimate	Std. Error	T-value	P-value	
(Intercept)	151.601	7.023	21.585	<0.001	***
preceding glottal(ized) consonant	1.981	3.6422	0.544	0.587	
preceding pause	7.147	2.512	2.845	<0.01	**
preceding vowel	-5.107	2.530	-2.019	<0.05	*
IP-initial	-3.619	2.318	-1.561	0.119	
F1	-0.004	0.005	-0.869	0.385	
F2	0.005	0.002	2.390	<0.05	*

Table B.32: Effects on minimum pitch in the final third of the vowel when unstressed

These results support the results for H1-H2, H1-A1, H1-A2, HNR and intensity minimum, showing very similar patterns in the same experimental categories as the other measures of spectral tilt, periodicity, and reduction, respectively, outlined in Chapter 3.

References

Aare, Kätlin, Pärtel Lippus, and Juraj Simko. 2017. Creak as a feature of lexical stress in Estonian. In: *Proceedings of Interspeech 2017*, pp. 1029–1033.

Adell, Eric James. 2019. The phonetics, phonology, and morphology of Chajul Ixil (Mayan). PhD thesis. The University of Texas at Austin.

Aissen, Judith L. 1992. Topic and focus in Mayan. *Language* 68.1, pp. 43–80.

Ajpacajá Tum, Pedro Florentino. 2001. *K'ichee' Choltziij*. Guatemala: Editorial Cholsamaj.

Ajpacajá Tum, Pedro Florentino, M. I. Chox Tum, F. L. Tepax Raxulew, and D. A. Guarchaj Ajtzalam. 2005. *Diccionario K'iche'*. 2nd edition. Guatemala: Proyecto Lingüístico Francisco Marroquín.

Alber, Birgit. 2001. Regional variation and edges: Glottal stop epenthesis and dissimilation in standard and southern varieties of German. *Zeitschrift für Sprachwissenschaft* 20.1, pp. 3–41.

AnderBois, Scott. 2008. Strong positions and laryngeal features in Yukatek Maya. In: *Proceedings of the 39th Annual Meeting of the North East Linguistic Society*. Ed. by S. Lima, K. Mullin, and B. Smith. Amherst, Massachusetts.

Baird, Brandon O. 2011. Phonetic and phonological realizations of 'broken glottal' vowels in K'ichee'. In: *Proceedings of formal approaches to Mayan linguistics: MIT working papers in linguistics*. Vol. 63, pp. 39–49.

Baird, Brandon O. 2014a. Acoustic correlates of stress in K'ichee': a preliminary analysis. In: *Proceedings of Formal Approaches to Mayan Linguistics II*, pp. 21–34.

Baird, Brandon O. 2018. Dialectal evolution of the vowel systems of K'ichee'. In: *Production and Perception Mechanisms of Sound Change*. Ed. by Daniel Recasens and Fernando Sánchez-Miret. Lincom GmbH, pp. 203–217.

Baird, Brandon Orrin. 2014b. An acoustic analysis of contrastive focus marking in Spanish-K'ichee'(Mayan) bilingual intonation. PhD thesis. The University of Texas at Austin.

Barrett, Edward Rush. 1999. A grammar of Sipakapense Maya. PhD thesis. The University of Texas at Austin.

Barrett, Rusty. 2007. The evolutionary phonology of glottal stops in K'ichean. In: *Proceedings of the Annual Meeting of the Berkeley Linguistics Society*. Vol. 33. 1, pp. 19–29.

Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 67.1, pp. 1–48. DOI: 10.18637/jss.v067.i01.

Bennett, Ryan. 2016a. La tensión vocálica en el kaqchikel de Sololá, Guatemala: un estudio preliminar. In: *Fonología segmental: procesos e interacciones*. Ed. by Esther Herrera Zendejas and Verónica Reyes Taboada. Colegio de Mexico, pp. 13–46.

Bennett, Ryan. 2016b. Mayan Phonology. *Language and Linguistics Compass*, pp. 469–514.

Bennett, Ryan. 2018. Recursive prosodic words in Kaqchikel (Mayan). *Glossa: a journal of general linguistics* 3.1, pp. 1–33.

Bennett, Ryan, Boris Harizanov, and Robert Henderson. 2018. Prosodic smothering in Macedonian and Kaqchikel. *Linguistic inquiry* 49.2, pp. 195–246.

Bennett, Ryan, Meg Harvey, Robert Henderson, and Tomás Alberto Méndez López. 2022. The phonetics and phonology of Uspanteko (Mayan). *Language and Linguistics Compass* 16.9, e12467.

Blankenship, Barbara. 1997. The time course of breathiness and laryngealization in vowels. PhD thesis. University of California, Los Angeles.

Bliss, Heather and Martina Wiltschko. 2020. Stsíkiistsi ki stsíkiistsi: The ubiquity of Blackfoot demonstratives in discourse. In: *Demonstratives in Discourse*. Ed. by Ashild Naess, Anna Margetts, and Yvonne Treis. Berlin: Language Science Press, pp. 123–147.

Boersma, Paul and David Weenink. 2023. *Praat: doing phonetics by computer*. [Computer program]. Version 6.3.14. http://www.praat.org/.

Bunzel, Ruth. 1952. *Chichicastenango: A Guatemalan village*. Seattle: University of Washington Press.

Burdin, Rachel Steindel, Sara Phillips-Bourass, Rory Turnbull, Murat Yasavul, Cynthia G Clopper, and Judith Tonhauser. 2015. Variation in the prosody of focus in head-and head/edge-prominence languages. *Lingua* 165, pp. 254–276.

Bürki, Audrey, Cécile Fougeron, Cedric Gendrot, and Ulrich H Frauenfelder. 2011. Phonetic reduction versus phonological deletion of French schwa: Some methodological issues. *Journal of Phonetics* 39.3, pp. 279–288.

Campbell, Lyle. 1974. Theoretical implications of Kekchi phonology. *International Journal of American Linguistics* 40.4, Part 1, pp. 269–278.

Campbell, Lyle. 1977. *Quichean linguistic prehistory*. Berkeley: University of California Press.

Campbell, Lyle. 2017. Mayan history and comparison. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 3, pp. 43–61.

Can Pixabaj, Telma and Nikté María Juliana Sis Iboy. 2004. Contextualizando posicionales. In: *Lengua y mantenimiento cultural en Mesoamérica: Un simposio*. Oxlajuuj Keej Maya Ajtz'iib'.

Can Pixabaj, Telma A. 2017. K'iche'. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 18, pp. 461–499.

Can Pixabaj, Telma Angelina. 2007. *Jkemiik yoloj li uspanteko: Gramática uspanteka*. Guatemala: Fundación Cholsamaj.

Can Pixabaj, Telma Angelina. 2015. Complement and purpose clauses in K'iche'. PhD thesis. The University of Texas at Austin.

Chelliah, Shobhana L. 2001. The role of text collection and elicitation in linguistic fieldwork. In: *Linguistic fieldwork*. Ed. by Paul Newman and Martha Ratliff. Cambridge University Press, pp. 152–165.

Chelliah, Shobhana L. and Willem J. De Reuse. 2010. Semantics, pragmatics, and text collection. In: *Handbook of Descriptive Linguistic Fieldwork*. Dordrecht: Springer, pp. 413–448.

Cheng, Lisa Lai-Shen and Laura J. Downing. 2012. Recursion and the definition of universal prosodic categories. *Languages* 6.3, pp. 125–153.

Christenson, Allen J. N.d. K'iche'-English Dictionary and Guide to Pronunciation of the K'iche'-Maya Alphabet. Unpublished manuscript, available at http://www.famsi.org/mayawriting/dictionary/christenson/index.html.

Cojtí Ren, Iyaxel Ixkan. 2019. The Emergence of the Ancient Kaqchikel Polity: A case of Ethnogenesis in the Guatemalan Highlands. PhD thesis. Vanderbilt University.

Coon, Jessica. 2019. Building verbs in Chuj: Consequences for the nature of roots. *Journal of Linguistics* 55.1, pp. 35–81.

Crowhurst, Megan J. 2018. The joint influence of vowel duration and creak on the perception of internal phrase boundaries. *The Journal of the Acoustical Society of America* 143.3, EL147–EL153.

Davidson, Lisa. 2021. The versatility of creaky phonation: Segmental, prosodic, and sociolinguistic uses in the world's languages. *Wiley Interdisciplinary Reviews: Cognitive Science* 12.3, e1547.

Dayley, Jon Philip. 1985. *Tzutujil grammar*. University of California Press.

Dehé, Nicole. 2009. Clausal parentheticals, intonational phrasing, and prosodic theory. *Journal of Linguistics* 45.3, pp. 569–615.

Dell, François. 1981. On the learnability of optional phonological rules. *Linguistic Inquiry* 12.1, pp. 31–37.

Dilley, Laura, Stefanie Shattuck-Hufnagel, and Mari Ostendorf. 1996. Glottalization of word-initial vowels as a function of prosodic structure. *Journal of phonetics* 24.4, pp. 423–444.

DuBois, John William. 1981. The Sacapultec language. PhD thesis. University of California, Berkeley.

Elordieta, Gorka. 2007. Minimum size constraints on intermediate phrases. In: *Proceedings of the International Congress of Phonetic Sciences, Saarbrucken.*

England, Nora C. 1983. *A grammar of Mam, a Mayan language*. University of Texas Press.

England, Nora C. and Brandon O. Baird. 2017. Phonology and phonetics. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 7, pp. 175–200.

Esposito, Christina M. 2012. An acoustic and electroglottographic study of White Hmong tone and phonation. *Journal of Phonetics* 40.3, pp. 466–476.

Farrús, Mireia, Javier Hernando, and Pascual Ejarque. 2007. Jitter and shimmer measurements for speaker recognition. In: *Proceedings of the 8th Annual Conference of the International Speech Communication Association*, pp. 778–81.

Frazier, Melissa. 2009. The production and perception of pitch and glottalization in Yucatec Maya. PhD thesis. The University of North Carolina at Chapel Hill.

Garellek, Marc. 2012. Glottal stops before word-initial vowels in American English: distribution and acoustic characteristics. *UCLA Working Papers in Phonetics* 110.1.

Garellek, Marc. 2013. Production and perception of glottal stops. PhD thesis. University of California, Los Angeles.

Garellek, Marc. 2015. Perception of glottalization and phrase-final creak. *The Journal of the Acoustical Society of America* 137.2, pp. 822–831.

Ghini, Mirco. 1993. Phi-formation in Italian: a new proposal. In: *Toronto working papers in linguistics*. Vol. 12. 2, pp. 41–78.

Gordon, Matthew and Peter Ladefoged. 2001. Phonation types: a cross-linguistic overview. *Journal of phonetics* 29.4, pp. 383–406.

Gruhn, Ruth. 1969. *An introduction to Chichicastenango*. University of Alberta.

Hanson, Helen M. 1997. Glottal characteristics of female speakers: Acoustic correlates. *The Journal of the Acoustical Society of America* 101.1, pp. 466–481.

Hanson, Helen M, Kenneth N Stevens, Hong-Kwang Jeff Kuo, Marilyn Y Chen, and Janet Slifka. 2001. Towards models of phonation. *Journal of Phonetics* 29.4, pp. 451–480.

Hedelin, Per and Dieter Huber. 1990. Pitch period determination of aperiodic speech signals. In: *Proceedings of the International Conference on Acoustics, Speech, and Signal Processing*, pp. 361–364.

Henderson, Robert. 2012. Morphological alternations at the intonational phrase edge: The case of K'ichee'. *Natural Language & Linguistic Theory* 30.3, pp. 741–787.

Holmberg, Eva B., Robert E. Hillman, Joseph S. Perkell, Peter C. Guiod, and Susan L. Goldman. 1995. Comparisons among aerodynamic, electroglottographic, and acoustic spectral measures of female voice. *Journal of Speech, Language, and Hearing Research* 38.6, pp. 1212–1223.

Hopkins, Nicholas A. 2012. *A dictionary of the Chuj Mayan language, as spoken in San Mateo Ixtatán, Huehuetenango, Guatemala ca. 1964-65*. Jaguar Tours.

Instituto Nacional de Estadística, Guatemala. 2019. *XII Censo Nacional de Población y VII de Vivienda*. https://www.ine.gob.gt/.

Iseli, Markus and Abeer Alwan. 2004. An improved correction formula for the estimation of harmonic magnitudes and its application to open quotient estimation. In: *Proceedings of the International Conference on Acoustics, Speech, and Signal Processing*. Vol. 1, pp. 669–672.

Ito, Junko and Armin Mester. 2012. Recursive prosodic phrasing in Japanese. In: *Prosody Matters: Essays in Honor of Elisabeth Selkirk*. Ed. by Toni Borowsky, Shigeto Kawahara, Mariko Sugahara, and Takahito Shinya. Elsevier, pp. 280–303.

Jongenburger, Willy and Vincent J van Heuven. 1991. The distribution of (word initial) glottal stop in Dutch. *Linguistics in the Netherlands* 8.1, pp. 101–110.

Jun, Sun-Ah. 2005. Prosodic typology. In: *Prosodic typology: The phonology of intonation and phrasing.* Oxford: Oxford Academic, pp. 430–458.

Kabak, Baris, Anthi Revithiadou, and Janet Grijzenhout. 2009. An interface approach to prosodic word recursion. In: *Phonological domains: Universals and deviations.* Ed. by Janet Grijzenhout and Baris Kabak. De Gruyter Mouton, pp. 105–133.

Kaufman, Terrence. 1990. Algunos rasgos estructurales de los idiomas mayances con referencia especial al k'iche'. In: *Lecturas sobre la lingüística maya.* Ed. by Nora England and Stephen Elliott. Antigua Guatemala: Centro de Investigaciones Regionales de Mesoamérica, pp. 59–114.

Kaufman, Terrence. 2015. Initial glottal stop in Mayan languages. Unpublished manuscript.

Kaufman, Terrence and John S. Justeson. 2003. *A preliminary Mayan etymological dictionary.* Foundation for the Advancement of Mesoamerican Studies. http://www.famsi.org/reports/01051/.

Keating, Patricia A., Marc Garellek, and Jody Kreiman. 2015. Acoustic properties of different kinds of creaky voice. In: *Proceedings of the 18th International Congress of Phonetic Sciences.* 1, pp. 2–7.

Kiparsky, Paul. 1985. Some consequences of lexical phonology. *Phonology* 2, pp. 85–138.

Kohler, Klaus J. 1994. Glottal stops and glottalization in German. *Phonetica* 51.1-3, pp. 38–51.

Kuang, Jianjing. 2018. The influence of tonal categories and prosodic boundaries on the creakiness in Mandarin. *The Journal of the Acoustical Society of America* 143.6, EL509–EL515.

Larsen, Thomas Walter. 1988. Manifestations of Ergativity in Quiché Grammar. PhD thesis. University of California, Berkeley.

Lennes, Mietta, Eija Aho, Minnaleena Toivola, and Leena Wahlberg. 2006. On the use of the glottal stop in Finnish conversational speech. In: *The Phonetics Symposium.* Vol. 53. Department of Speech Sciences, University of Helsinki, pp. 93–102.

López Ixcoy, Candelaria Dominga. 1997. *Gramática K'ichee'.* Guatemala: Fundación Cholsamaj.

López Ixcoy, Candelaria Dominga. 1999. *Los demostrativos en k'ichee'.* Undergraduate thesis, Universidad Rafael Landívar.

López Ixcoy, Saqijix Candelaria Dominga. 1994. *Las vocales en K'ichee'*. Guatemala: Oxlajuuj Keej Maya' Ajtz'iib'.

Mata, Ana Isabel, Helena Moniz, and Fernando Batista. 2014. Comparing phrase-final patterns across speech styles and groups in European Portuguese. *Noveaux cahiers de linguistique francaise* 31, pp. 171–176.

Mateo Toledo, Eladio. 2017. Q'anjob'al. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 20, pp. 533–569.

Max Planck Institute for Psycholinguistics, The Language Archive. 2023. *ELAN*. [Computer program]. Version 6.7. https://archive.mpi.nl/tla/elan.

McCarthy, John J. and Alan Prince. 1995. Faithfulness and reduplicative identity. In: *Papers in Optimality Theory, University of Massachusetts Occasional Papers in Linguistics*. Ed. by Jill Beckman, Laura Walsh Dickey, and Suzanne Urbanczyk. Amherts, MA: University of Massachusetts, pp. 249–384.

Mitterer, Holger, Sahyang Kim, and Taehong Cho. 2019. The glottal stop between segmental and suprasegmental processing: The case of Maltese. *Journal of Memory and Language* 108, pp. 1–19.

Mó Isém, Romelia. 2007. *Rikemik li tujaal tzij: Gramática sakapulteka*. Guatemala: Fundación Cholsamaj.

Mondloch, James Lorin. 1981. Voice in Quiche-Maya. PhD thesis. State University of New York at Albany.

Myrberg, Sara. 2013. Sisterhood in prosodic branching. *Phonology* 30.1, pp. 73–124.

Nespor, Marina. 1990. Vowel deletion in Italian: the organization of the phonological component. *The Linguistic Review* 7, pp. 375–398.

Nielsen, Kuniko. 2005. Kiche intonation. *University of California, Los Angeles Working Papers in Phonetics* 104, pp. 45–60.

Norman, William. 1977. *Topic and focus in Mayan*. Presentation at the Mayan Workshop II, San Cristóbal de las Casas, Chiapas, Mexico.

Ogden, Richard. 2001. Turn transition, creak and glottal stop in Finnish talk-in-interaction. *Journal of the International Phonetic Association* 31.1, pp. 139–152.

Orie, Olanike Ola and Victoria R Bricker. 2000. Placeless and historical laryngeals in Yucatec Maya. *International Journal of American Linguistics* 66.3, pp. 283–317.

Oshika, Beatrice, Victor Zue, Rollin Weeks, Helene Neu, and Joseph Aurbach. 1975. The role of phonological rules in speech understanding research. *IEEE Transactions on Acoustics, Speech, and Signal Processing* 23.1, pp. 104–112.

Par Sapón, María Beatriz and Telma Angelina Can Pixabaj. 2000. *Ujunamaxiik ri K'ichee' Ch'ab'al: Variación Dialectal en K'ichee'*. Guatemala: Oxlajuuj Keej Maya' Ajtz'iib', Cholsamaj.

Paster, Mary Elizabeth. 2006. Phonological conditions on affixation. PhD thesis. University of California, Berkeley.

Polian, Gilles. 2017. Morphology. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 8, pp. 201–225.

Pompino-Marschall, Bernd and Marzena Żygis. 2011. Glottal marking of vowel-initial words in German. In: *Proceedings of the 17th International Congress of Phonetic Sciences*. Vol. 52, pp. 1626–1629.

Pulleyblank, Douglas. 1988. Vowel deletion in Yoruba. *Journal of African Languages and Linguistics* 10.

R Core Team. 2020. *R: A Language and Environment for Statistical Computing*. [Comupter program]. Version 4.0.3. Vienna, Austria. https://www.R-project.org/.

Redi, Laura and Stefanie Shattuck-Hufnagel. 2001. Variation in the realization of glottalization in normal speakers. *Journal of Phonetics* 29.4, pp. 407–429.

Reynolds, William Thomas. 1994. Variation and phonological theory. PhD thesis. University of Pennsylvania.

Romero, Sergio. 2009. Phonological markedness, regional identity, and sex in Mayan: The fricativization of intervocalic /l/ in K'iche'. *Variation in indigenous minority languages* 25, pp. 281–297.

Romero, Sergio. 2016. Bill Gates speaks K'ichee'! The corporatization of linguistic revitalization in Guatemala. *Language & Communication* 47, pp. 154–166.

Romero, Sergio. 2017. The labyrinth of diversity: The sociolinguistics of Mayan languages. In: *The Mayan Languages*. Ed. by Judith Aissen, Nora C. England, and Roberto Zavala Maldonado. 1st edition. London: Routledge Ltd. Chap. 15, pp. 379–400.

Royer, Justin. 2022. Prosody as syntactic evidence: The view from Mayan. *Natural Language & Linguistic Theory* 40.1, pp. 239–284.

Sam Colop, Luis Enrique. 1990. Bosquejo de algunos temas de la gramática K'iche'. In: *Lecturas sobre la lingüística maya*. Ed. by Nora C. England and Stephen R. Elliott. Centro de Investigaciones Regionales de Mesoamerica, pp. 127–144.

Schreuder, Maartje, Dicky Gilbers, and Hugo Quené. 2009. Recursion in phonology. *Lingua* 119.9, pp. 1243–1252.

Selkirk, Elisabeth. 1984. *Phonology and Syntax: The relation between sound and structure*. Cambridge, MA: MIT Press.

Selkirk, Elisabeth. 1996. The prosodic structure of function words. In: *Signal to Syntax*. Ed. by James L. Morgan and Katherine Demuth. Mahwah, NJ: Lawrence Erlbaum, pp. 187–213.

Selkirk, Elisabeth. 2011. The syntax-phonology interface. In: *The Handbook of Phonological Theory, 2nd edition*. Ed. by John Goldsmith, Jason Riggle, and Alan Yu. Blackwell Publishing, pp. 435–483.

Shattuck-Hufnagel, Stefanie and Alice E. Turk. 1996. A prosody tutorial for investigators of auditory sentence processing. *Journal of Psycholinguistic Research* 25.2, pp. 193–247.

Shue, Yen-Liang, Gang Chen, and Abeer Alwan. 2010. On the interdependencies between voice quality, glottal gaps, and voice-source related acoustic measures. In: *Proceedings of the Eleventh Annual Conference of the International Speech Communication Association*, pp. 34–37.

Tranel, Bernard. 1993. Tone sandhi and vowel deletion in Margi. *Studies in African Linguistics* 23.2, pp. 111–184.

Tuyuc Sucuc, Cecilio. 2001. *Stxolb'anil ab'xub'al popti': Gramática descriptiva jakalteka (popti')*. Guatemala: Academia de las Lenguas Mayas de Guatemala, Comunidad Lingüística Poptí.

Tyers, Francis and Robert Henderson. 2021. A corpus of K'iche' annotated for morphosyntactic structure. In: *Proceedings of the First Workshop on Natural Language Processing for Indigenous Languages of the Americas*, pp. 10–20.

Umeda, Noriko. 1978. Occurrence of glottal stops in fluent speech. *The Journal of the Acoustical Society of America* 64.1, pp. 88–94.

Velleman, Leah Bridges. 2014. Focus and movement in a variety of K'ichee'. PhD thesis. The University of Texas at Austin.

Wagner, Michael. 2005. Prosody and recursion. PhD thesis. Massachusetts Institute of Technology.

Wickham, Hadley. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York. ISBN: 978-3-319-24277-4. https://ggplot2.tidyverse.org.

Wood, Elizabeth Anne. 2020. Vowels and stress in Chichicastenango K'iche'. MA thesis. University of Texas at Austin.

Yasavul, Murat. 2013. Prosody of focus and contrastive topic in K'iche'. In: *Ohio State University Working Papers in Linguistics*. Ed. by Mary Beckman, Marivic Lesho, Judith Tonhauser, and Tsz-Him Tsui. Vol. 60. Columbus, OH: The Ohio State University, Department of Linguistics, pp. 129–160.

Zavala Maldonado, Roberto. 1993. Clause integration with verbs of motion in Mayan languages. MA thesis. University of Oregon.