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ARTÍCULO

A phonological sketch of the Santo Domingo de Morelos variety of Miahuatec Zapotec

Un esbozo fonológico de la variante del miahuateco hablada en Santo Domingo de Morelos

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Abstract

The phonology of the Santo Domingo de Morelos Miahuatec exhibits the typical features of Southern Zapotec languages: (1) it is a tonal language with two-level tones (high, low), and two contour tones (falling, rising), (2) it has non-modal phonation (laryngealization) (3) it shows an iambic (light-heavy)

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stress pattern, and (4) the fortis-lenis distinction covers both the segmental phonology and the moraic structure. Miahuatec Zapotec also displays some innovative features: (1) the constricted glottis feature is linked on the second mora of stressed syllables, (2) the fortis-lenis contrast is present only on non-sonorant consonants, (3) there are four contrastive tones and a surface extra high tone in the clitic group, (4) it exhibits a rare pattern of consonant clusters based on the fortis-lenis contrast, and (5) the acoustic correlates of stress are the duration of the rhyme instead of vowel duration or intensity, as has been proposed for other Zapotec languages.

Keywords: Otomanguean languages, tonal languages, phonology of underrepresented languages, phonation types

Resumen

La fonología del miahuateco de Santo Domingo de Morelos exhibe los rasgos típicos de las lenguas zapotecas: (1) es una lengua tonal con dos tonos de nivel y dos contornos, (2) manifiesta fonación no modal, (3) exhibe un patrón acentual de tipo yámbico (ligero-pesado) y (4) la distinción fortis - lenis permea tanto la fonología segmental como la estructura prosódica. El miahuateco despliega también algunos rasgos innovadores: (1) el rasgo glotis constreñida se asocia a la segunda mora de una sílaba tónica, (2) el contraste fortis - lenis se presenta solo en las consonantes no sonorantes, (3) además de los cuatro tonos se manifiesta un tono extra alto en el grupo clítico, (4) manifiesta un patrón de secuencias consonánticas regido por el contraste fortis-lenis y (5) el correlato acústico del acento es la duración de la rima y no la duración de la vocal.

Palabras clave: lenguas otomangues, lenguas tonales, fonología de lenguas subrepresentadas, tipos de fonación

1. Introduction

This paper offers a phonological sketch of the Santo Domingo de Morelos Miahuatec (ISO zam), an endangered and undescribed Zapotec language spoken in the Pochutla district of Oaxaca, Mexico. Historically, Miahuatec Zapotec was spoken in the Miahuatlán Valley, but in the years prior to the arrival of the Spaniards there were expansions towards the highlands. Although it is commonly believed that Zapotec is a single language, in reality it is the common name given to one of the largest branches of the Zapotecan family, which belongs to the Otomanguean stock. According to Smith's classification (Smith 2007) there are three major Zapotec groups: Soltec (now extinct), Western Zapotec, and Core Zapotec. The Miahuatecan group belongs to the Core branch of Zapotec (see Figure 1). With San Agustín Mixtepec and San Bartolo Yautepec Zapotec, Miahuatec falls in the Miahuatecan branch. The large internal diversity of the Zapotec family prevents an overall assessment of its vitality. San Agustín Mixtepec Zapotec, for example, had only a small group of speakers in 2019 while, according to the population census of 2010, in Santo Domingo de Morelos there were 10 547 people, 8 112 of whom were Zapotec speakers, that is, 77 percent of the total population. Although the number of speakers in Santo Domingo de Morelos seems to be high, the language has recently been restricted to home use, as Spanish has become dominant in public and social spaces.

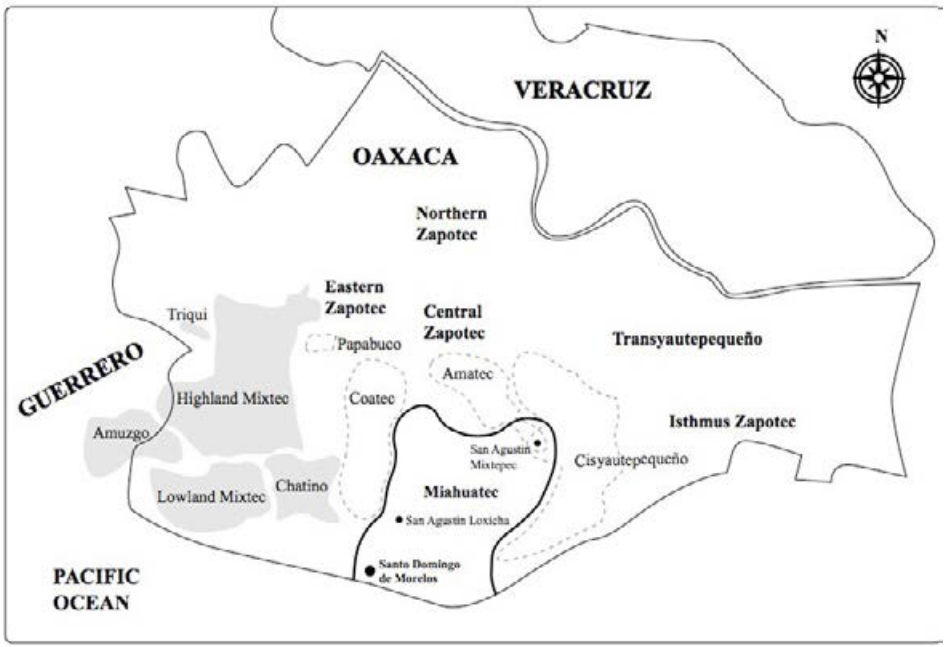

Figure 1. Map showing the location of Miahuatec (continuous line). Dashed lines indicate neighboring languages

Miahuatec has scarcely been studied, the earliest work being the *Vocabulario zapoteco del dialecto de Miahuatlán* (Ruegsegger & Ruegsegger 1955), based on the dialect of Cuixtla. Recently, Hernández (2014; 2019) has studied Santo Domingo de Morelos Zapotec from a diachronic perspective. Beam (2008, 2009, 2015) has studied San Bartolomé Loxicha Miahuatec and Coatec Zapotec from a comparative perspective. She works on morphosyntactic differences between Coatec and Miahuatec and has morphologically analyzed two texts in Miahuatec and Coatec Zapotec (Beam 2013). In 2009, Birtles and Black studied the negation system of

Miahuatec. While this language has been partially explored, this paper is the first one dedicated exclusively to its synchronic phonology.

This work is based on firsthand data obtained from fieldwork between 2008 and 2019, including elicitation of Kaufman's (2016) list of Proto Zapotec reconstructions, and Smith Stark's morphosyntax questionnaire (Smith 1982). Each list was recorded in the voice of three native speakers. Additionally, we collected a traditional folktale.

In this paper, Section 1 is dedicated to the consonant and vowel system. The tonal contrast is reviewed in §2. In Section 3 we propose a novel analysis of the [constricted glottis] feature for a Zapotec language. Finally, in Section 4 we describe the metrical and prosodic system. Throughout the paper we discuss the fortis-lenis contrast since it affects both the prosodic and the segmental structure of this language. Finally, in Section 5 we summarize and conclude.

2. Consonants

There are 18 consonant segments in the zam inventory, shown in Table 1. Three points of articulation are active in the plosive series: bilabial, alveolar and velar. The glottal stop is not included in the following chart, since it is not treated as a segment (see below). In the post-alveolar region, there are two affricates and three fricatives. In the glottal region, there is only a fricative. The sonorants are comprised of three nasals, a trill, one lateral approximant, and two approximants.

Table 1. Consonantal inventory

	Bilabial		Alveolar		Post-alveolar		Velar		Glotal
	fortis	lenis	fortis	lenis	fortis	lenis	fortis	lenis	
Plosive	p	b	t	d			k	g	
Affricate					ʧ	ʤ			
Fricative			s	z	ʃ				(h)
Nasal	m		n				ŋ		
Trill				r					
Lateral approximant			l						
Approximant	w				j				

The data below show the contrast for the segments given in the chart. Tones are marked with diacritics as follows: high (á), low (à), raising (ǎ), and falling (â).

(1) Consonantal contrasts

/p/ vs /t/	pój	‘when is it?’	tój	‘it is for sale’
/t/ vs /k/	bt̰í	‘squeeze it!’	kì	‘flame’
/d/ vs /g/	dò	‘wheat spike’	gòb	‘morning dew’
/b/ vs /g/	bìn	‘to harvest’	gîn	‘palm’
/b/ vs /d/	mbín	‘bird’	ndín	‘mouse’

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/b/ vs /g/	mbìd	‘flea’	ŋgíd	‘hen’
/ʧ/ vs /ʃ/	ʧúʃ	‘tomato’	ʃo̰	‘earthquake’
/ʤ/ vs /ʧ/	ɲʤăn	‘soot’	mʧṵ́	‘mosquito’
/ʃ/ vs /s/	ʃôn	‘eight’	són	‘three’
/s/ vs /z/	sĭn	‘tick’	nzín	‘honey’
/h/ vs /g/	hwa̰n	‘something’	gwán	‘wilderness’
/m/ vs /n/	mén	‘people’	nê	‘wilderness’
/n/ vs /l/	nít	‘water’	lĭj	‘it is true’
/ŋ/ vs /n/	bléŋ	‘hunchback’	mén	‘people’
/l/ vs /r/	lô	‘face’	rò	‘mouth’
/r/ vs /j/	rò	‘mouth’	jo̰	‘house’
/w/ vs /j/	wís	‘sun’	jís	‘thorn’

There are two segments with a defective distribution, the affricate /ʤ/ and the velar nasal /ŋ/. The affricate only occurs after a nasal, and /ŋ/ is only present in word-final position as in [bléŋ] ‘hunchback’, and between vowels, as in [bléŋá] ‘s/he is a hunchback.[1] Concerning the affricate, one could speculate a voicing process where /ʧ/ becomes [ʤ] after nasal, but [mʧṵ́s] ‘mosquito’, and [nʧó̰] ‘to cut’ suggest that this is not the case. The velar nasal has a very low frequency in the native lexicon, and it is common in words borrowed from Spanish such as [abjóŋ] ‘plane’ and [kóŋ] ‘with’ (Sp. *avión* and *con* respectively), because the regional variety of Spanish velarizes nasals in final position (where nasal place does not

[1] In this language nasals are not velarized by word-final effect or by the effect of adjacent vowels. There are a lot of words ending in /n/ like /bèn/ ‘crocodile’ that maintain their place when followed by an /a/ like /bèná/ ‘is a crocodile’.

contrast). Interestingly, in zam, when /n/ loses final position, the nasal keeps the place of articulation, which is different to what happens in the regional Spanish where the nasals recover their alveolar localization in a non-final position. For the trill /r/, we identified three main allophones, given in the following examples:

(2) Trill realizations

trill		flap		voiceless fricative	
rén	'blood'	mbɾŏw	'lizard'	lâɕ	'cloth'
ʃkjèrná	'my navel'	láɾá	'it is cloth'		
		nàɾó	'big (for things)'		

This segment is produced as a trill in word-initial position, in coda position and before a consonant (as in 'blood' and 'my navel' respectively). The flap realization appears when /r/ is a member of a consonant group or is intervocalic. Word-finall /r/ is realized as the voiceless fricative [ɕ]. Note that the same morpheme, 'cloth', occurs with a word-final fricative in isolation, but when the addition of a clitic places /r/ in an intervocalic environment there is a tap pronunciation, as shown in Figure 2, with the realization of /lâr/ 'cloth' → [lâɕ] 'cloth', and /lár=á/ → [láɾá], 'it is cloth'.

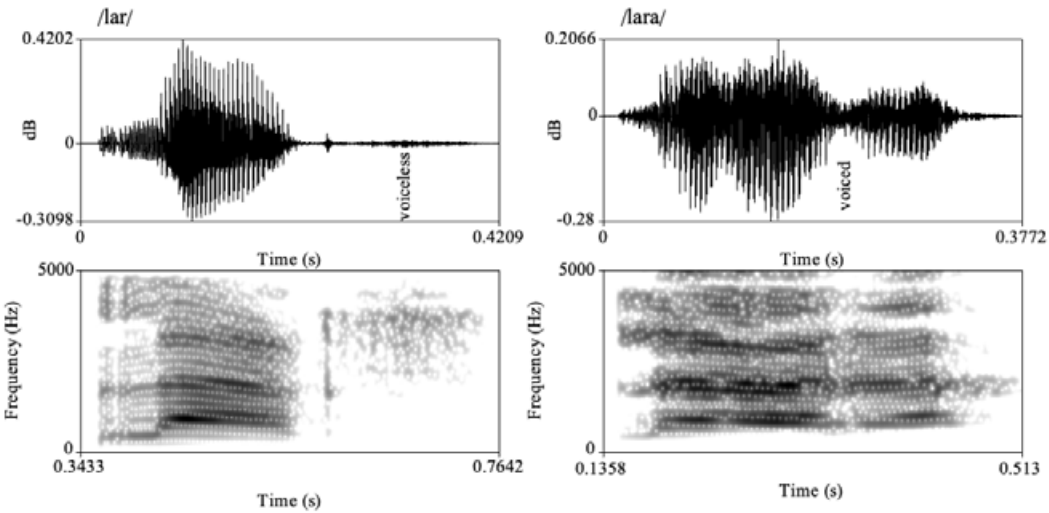


Figure 2. Waveforms and spectrograms for /lâr/ 'cloth', showing the voiceless fricative [ɛ], in word-final position and the voiced tap between vowels in / lár=á/ 'it is cloth'

The postalveolar approximant /j/ tends to have a fricative realization [ʝ] when occurring in word-initial position as in /ji/ → [ʝi] 'rain'

2.1. The fortis-lenis distinction

One of the main features of Zapotec languages is the fortis-lenis distinction on consonants (Jaeger 1983; Esposito 2004; Nellis & Hollenbach 1980; Arellanes 2009, among others). In zam, the fortis-lenis opposition is only present among the plosives /p b t d k g/, the affricates /ʧ ʤ/ and the fricatives /s z/. It is absent among sonorants, and the fricatives /h/ and /ʃ/ also lack the binary distinction. In segmental terms, the

fortis-lenis distinction is analyzed as a difference in the degree of feature specification (Inkelas 1994): fortis consonants are fully specified while lenis consonants are underspecified for voice, continuity, and nasality (Arellanes 2009; Hernández 2019). The fortis consonants /p t k ʧ s/ show great stability in their voicelessness. The plosives /p t k/ are aspirated in final position. Conversely, in world-level position, the lenis plosives /b d g/ have a wide range of realizations; word-initially and between vowels they tend to be fricatives [β ð ɣ]; word-finally /b d/ are voiceless and weakly aspirated, with /b/ sometimes realized as [ɸ], /g/ does not occur in this position; and, finally, lenis consonants are plosives [b d g] only when preceded by a nasal consonant. These four realizations are shown in the next examples:

(3) Lenis realizations of /b d g/

/b/	βa̰	‘grave’	kùβá	‘it is new’	ʃàb̥ʰ		‘peel’	mbák	‘dog’
					ɣòɸ		‘rheum’		
/d/	ða̰	‘petate’	lúðá	‘it is small’	nîd̥ʰ		‘cob’	ndæ̀	‘corn’
/g/	ɣĭs	‘thorn’		nàɣàtá	‘it is black’	---		ŋgò	‘egg’

Although both fortis and lenis plosives are voiceless and aspirated in word-final position, the contrast is preserved by consonant closure length, and preceding vowel length: Fortis consonants have a longer closure and a more vigorous release than lenis ones; vowels are longer before lenis consonants than when preceding fortis ones. This is seen in

Figure 3, with the realization of the near-minimal pair /nít/ ‘water’ and /nîd/ ‘cob’, both /d/ and /t/ have voiceless closure and an aspirate release.

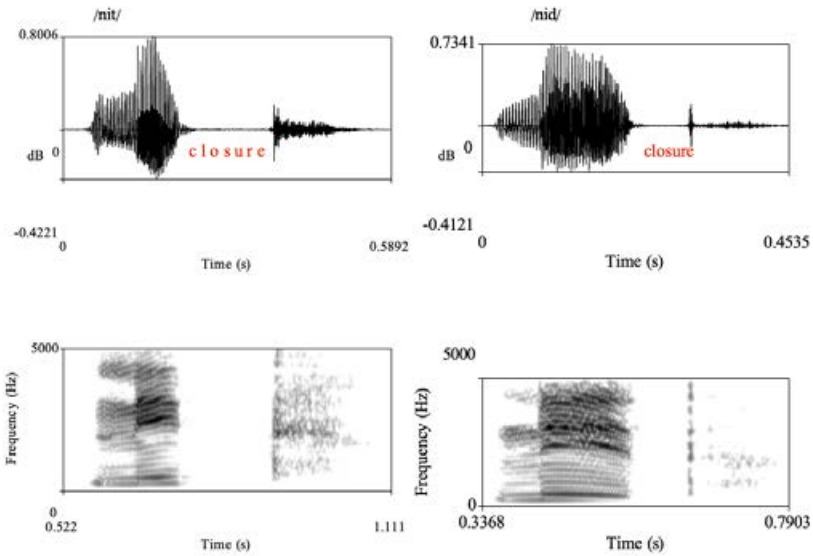


Figure 3. Waveforms and spectrograms of [nítʰ] ‘water’ and [nîd̥ʰ] ‘cob’

In the example, the closure for fortis /t/ is 182 ms. long while lenis /d/ reaches only 135 ms. As for the previous vowels, before the lenis consonant, the vowel is 135 ms., and before the fortis consonant, the vowel is 92 ms. Table 2 displays the average, in ms., for closure duration, as well as the length of the preceding vowel in 19 tokens from the two female speakers. Measurements for closure duration were made from the last voicing pulse of the previous vowel to the consonant release, the burst and the aspirate release were excluded. It is important to note that the

rhyme duration is constant, with relative variation between the duration of the vowel and the closure; this is related to the stress that we will discuss in §5.

Table 2. Average, in ms., for the vowel length, fortis-lenis closure, and total rhyme

V/__ CLenis	Closure Lenis	Rhyme	V/__ C Fortis	Closure Fortis	Rhyme
153	83	263	82	178	260

These figures lead us to the conclusion that the fortis-lenis contrast is cued by both the length of the closure and the length of the previous vowel. Before fortis consonants, vowels are 82 ms. in length compared to 153 ms. before lenis consonants. Likewise, the closure is longer for the fortis segments (178 ms.) and shorter for the lenis ones (83 ms.). Ultimately, both fortis and lenis consonants are tied to prosody, as we will describe below. In addition to the above differences, lenis consonants differ from fortis ones in that lenis consonants tend to be accompanied by a short vocalic portion in the word-initial position.[2] This is seen in the next Figure, which shows the waveform for /gûs/ 'yellow', where there is a visible vocalic portion before the fricative realization of the velar plosive.

[2] The vocalic portion is consistently found in isolation words and at the beginning of the phonological phrase in running speech.

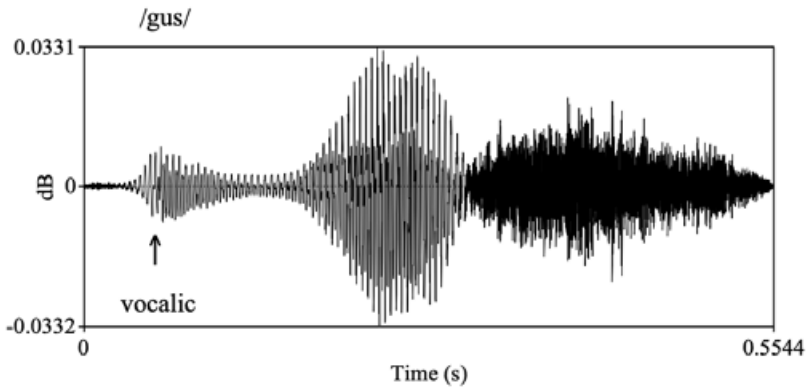


Figure 4. Waveform of /gûs/ 'yellow'. The arrow marks the vocalic portion before the lenis velar consonant.

Finally, for the consonants lenis realization, we add that /z/ tends to be voiceless in word-final position, as in /nĭz/ → [nĭz̥] 'milk', but voiced in intervocalic position; for example, when the suffix /-a/ indicating 'to be', is added /nĭz-á/ → [nízá] 'it is milk', on the other hand, fortis fricatives /s/ are never voiced in intervocalic position; for example, /jís/ → [jís] 'acne', and [jís-á] 'it is acne'. As already mentioned, the set /m n ŋ l r/ does not have lenis counterpart. These segments behave in the same way as fortis ones in relation to the previous vowel's length. That is, vowels are equally short before sonorants as fortis consonants.

2.2. Consonant clusters and syllabic structure

The minimal syllable in zam is CV, as there are virtually no syllables without onsets in native words. The only exception we found in this language, as in many other Zapotec languages, is the word íz 'year'.

(4) CV and CVC syllables

CV		CVC	
pá	'dad'	ʧóp	'two'
tą́	'bean'	sĭn	'tick'
kú	'leg'	zĭh	'bone'
bŏ	'coal'	ròb	'shawl'
dǫ́	'rope'	wán	'grass'
gǫ̂	'sweet potato'		
ʃí	'nose'		
mą́	'animal'		
ná	'1p'		
lá	'leaf'		
ją́	'tree'		

The only consonant that does not appear as the first element of the onset in CV syllables is /h/. This is because /h/ originated historically from /t/ in the final position (see Hernández 2019). Few consonant clusters occur in mono-morphemic syllables. Those that do follow the Sonority Sequencing Principle (SSP), (Jespersen 1904; Saussure 1916; Selkirk 1984; Clements 1990), by which there will be an increase in or maintenance of

sonority in an onset preceding the syllable nucleus. In the following examples, we will show a profile increment in sonority (a-e), and a plateau (f). There are few cases where the profile is descendent as in (g).

(5) The SSP in CCV syllables

a.	bjáz	'plum'
b.	kwè	'genitals'
c.	kwàt	'slap'
d.	kjè	'stone'
e.	bléŋ	'hunchback'
f.	bdǒ	'banana'
g.	bsín	'foam'

Many morphologically complex words and words in which we can recognize a fossilized morpheme show an interesting pattern that violates the sonority sequencing principle. The nasal animacy morpheme assimilates to the point of articulation of the following consonant only if it is a lenis consonant as in (6 a- d); however, if the consonant is a fortis one, this morpheme is expressed as a bilabial nasal consonant as in (e-h). Since nasal obstruent sequences in this language are always hetero-morphemic, we assume that they are underlying clusters rather than singleton segments. These clusters challenge the SSP and the cross-linguistically well-documented restriction against *NC sequences (Pater 1996, 2004). The [mʃ] sequence in (6 h) challenges the restriction against *NFricative. (Herrera Zendejas & Arellanes 2008).

(6) Animacy nasal prefix assimilation

a.	/mbél/	→	[mbél]	‘fish’
b.	/mdín/	→	[ndín]	‘mouse’
c.	/mdʒě/	→	[ndʒě]	‘ant’
d.	/mgón/	→	[ŋgón]	‘ox’
e.	/mtî/	→	[mtî]	‘eagle’
f.	/mʧ̰ús/	→	[mʧ̰ús]	‘mosquito’
g.	/mkî/	→	[mkî]	‘nit’
h.	/mʃì/	→	[mʃì]	‘spider’

Besides the nasal obstruent clusters, it is possible to find triconsonantal onset clusters, and in those cases there is no tendency to increase the sonority or maintain a plateau.

(7) Triconsonantal clusters

a.	ndjólâ̰z	‘embarrassed’
b.	ndlà	‘goes down’
c.	dɾjóʃkâ	‘will awaken’
d.	ndjèn	‘likes’
e.	mbɾŏw	‘lizard’
f.	ʃljè	‘fruit’
g.	ʃkjèr	‘navel’
h.	bljěn̰	‘stay!’

It is only possible to claim that the fortis-lenis distinction rules the onset formation. There are clusters in which all the consonants are lenis or in

which all are fortis. This claim is supported by a morphophonological process in a related language, San Agustín Mixtepec Zapotec. In this language, the possessive prefix ʃ- promotes the fortition of the first consonant of the stem to repair an impossible sequence of fortis-lenis onset clusters.

(8) Fortification process in San Agustín Mixtepec Zapotec (Hernández 2019)

Base	*possessed*	*surface*	*gloss*
tą̲	ʃ-tą̲=ná	ʃtáná	'my bean'
kjè	ʃ-kjè=ná	ʃkjèná	'my rock'
bą̀	ʃ-bą̀=ná	ʃpą̀ná	'my grave'
dǫ̲	ʃ-dǫ̲=ná	ʃtǫ́ná	'my cord'
gą́	ʃ-gą́=na̋	ʃką́na̋	'my necklace'

Additionally, in zam there is a fortition process in compound formation in which a fortis consonant promotes the fortition of the following lenis consonant. This is the case in the compound [jítku] 'skin of the leg', formed by /jíd/ 'skin' and /ku/ 'leg'. When the two consonants are lenis the process does not occur, as in [jèzdǫ̲] 'Miahuatlán', made up of /jèz/ 'town' and /dǫ̲/ 'big'.

3. Vowels

The vowel system of zam is composed by six vowels /i e æ a o u/, two high, two mid, and two low vowels. The contrast among them is shown in the following examples:

(9) Vowel contrast

/i/ vs /u/	mkî	'nit'	kù	'leg'
/i/ vs /e/	nít	'water'	nèt	'urine'
/i/ vs /a/	nǐl	'hominy'	nál	'cold'
/e/ vs /a/	jél	'ice'	jál	'corn field'
/o/ vs /u/	kòb	'dought'	kùb	'new'
/a/ vs /æ/	ndá	'going to'	ndæ̀	'fresh corn'
/ e / vs /æ /	bét	'hiccup'	bæ̀d	'baby'

Although /æ/ contrasts with /e/ and /a/ in the examples above, /æ/ is scarcely present in the lexicon of our speakers. It is due to a merger process of /æ/with /a/ and /e/ in the Miahuatec area. While /æ/ is present in San Bartolo and San Agustín Mixtepec in words as [mbǽkʷ] 'dog' and /mbæ̀l/ 'fish'/, in zam this vowel is realized as [mbák] and [mbèl] 'fish' respectively. In other Zapotec languages some alternations in mid-front vowels are controversial, see Uchihara & Gutiérrez (2020) for the case of Teotitlán del Valle Zapotec.

4. Tone

As already mentioned, the language has four tones: high, low, rising, and falling. The examples below show the tonal contrast on monosyllabic words.

(10) Tonal contrasts

H		L		HL		LH	
lé	'tooth'	lè	'name'	lô	'face'	lě	'hot'
té	'walk!'	tà	'relative'	gǫ̂	'sweet potato'	ŋgǒn	'ox'
mbér	'turkey'	ndæ̀	'corn'	tê	'grease'	lěn	'Elena'
já	'there'	bà	'there'	mbê	'crab'	bǎn	'alive'

Figure 5 shows the surface implementation of the four tones in open syllables, the low tone shows a sustained decline of the F0, the high tone is implemented as a level, the rising tone maintains a sustained rise from the start, and the falling tone exhibits a preparatory ascent and then a downward path.

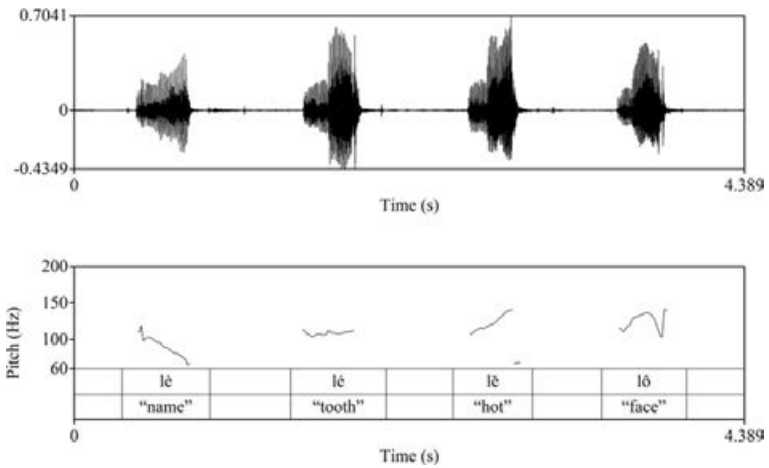


Figure 5. Surface implementation of tonal contrast in the words [lè] 'name', [lé] 'tooth', [lȅ] 'hot' and [lô] 'face'

The surface implementation of tones is more robust on words that end in sonorants. For example, H tone is simply realized as high-level pitch on the vowel when a word ends in an obstruent, but it rises noticeably on sonorant codas. Likewise, the low tone has a level pattern on a vowel before an obstruent, but it falls on a sonorant coda. Contour tones also play out over both the nucleus and any sonorant coda, but the rise or fall begins earlier, on the syllable nucleus, and continues through the end of the sonorant coda. Sonorant codas are thus part of the tonal domain. Tones play out not only on vowel nuclei but over the whole sonorous portion of the rhyme.

Besides this, in zam there is a surface extra high tone that results from the collision of two high tones within a clitic group. This is seen in the following examples, where the extra high tone is marked by the diacritic [˝].

(11) Extra high tone due to the collision of two high tones

		1	Surface realization	Gloss
mdá	=	^{H}n	mdán	'I ate'
ló	=	^{H}n	lón	'my face'
té	=	^{H}na	té ná	'my butter'
mbé	=	^{H}na	mbé ná	'my crab'

Hernández (2019) proposed the rhyme as the TBU since the pitch path starts in the nucleus, but continues on the coda if it is sonorant, that is if the coda has the necessary phonetic properties to support pitch (Gordon 2001). This behavior has been also described for other Zapotec languages (Arellanes 2009; Chávez-Peón 2012; Antonio 2015; Covarrubias 2020).

4. Non-modal phonation in zam

As in many Zapotecan languages, zam is a laryngeally complex language, that is it is a language where tone and non-modal voice converge (Silverman 1997a, 1997b; Herrera Zendejas 2000, among others). Phonation types in many Zapotec languages have been analyzed as features associated with vowels, such that there are contrasts between modal and non-modal vowels. Some Zapotec languages contrast "laryngealized" vowels, which range from creaky to rearticulated, and checked vowels, which are cut short in a glottal stop. Esposito & Khan (2020) propose that in Zapotec languages vowels are the canonical domain of non-modal voice. Nevertheless, there are at least three Zapotec languages in

which we can find both vowels and laryngealized sonorants, namely San Bartolo Yautepec Zapotec (Covarrubias 2020), Coatec Zapotec (Beam 2004) and zam. Moreover, it has been proposed that non-modal phonation belongs to the domain of moraic structure (the second mora of a bimoraic syllable) in San Bartolo Yautepec and zam and therefore we can find both non-modal vowels and non-modal sonorants like Danish stød (Grønnum 2014).

In what follows we will show that in zam, laryngealization is not associated directly with vowels in the underlying representation. Instead, it is related to moraic structure and, therefore, it is common to find surface laryngealized sonorants in addition to laryngealized vowels (Hernández 2016, 2020). According to Hernández (2016) and Covarrubias (2020), laryngealization is the surface expression of a [constricted glottis] feature that is anchored to the temporal grid. Zam takes the second mora of stressed syllable as the anchor unit. As we have shown previously, the second mora of a bimoraic (stressed) syllable can be associated with a vowel or with a consonant. Phonetic and phonological properties of the coda guide the surface implementation of the [constricted glottis] feature, determining whether it is the nucleus or the coda that is laryngealized. CV and CVC*l* words (phonetically [CV:] and [CV:C] (by minimality requirements) locate laryngealization over the second portion of the vowel because that is the place where the second mora is located. In the same way, CVS locates laryngealization over the sonorant consonant in the coda, because this segment is associated with the second mora. CVC*f* instead locates the [constricted glottis] feature over the vowel because fortis consonants do not have the phonetic properties to support

laryngealization, even though they have the necessary phonological property of moraicity. In 12 we show a set of words and the surface implementation of the constricted glottis feature.

(12) Surface implementation of the constricted glottis feature

CV			
dóʔ	→	[ðóʔ]	‘rope’
táʔ	→	[táʔ]	‘bean’
gáʔ	→	[ɣáa̰]	‘necklace’
CVC_l			
mbæ̀ʔd	→	[mbæ̀æ̰t̄]	‘fox’
jèʔr	→	[jèḛɛ]	‘hole’
nzìʔd	→	[nzìḭt̄]	‘squirrel’
CVC_f			
ʃáʔt	→	[ɸʃá̰t]	‘jump!’
wèʔs	→	[wṵ̀s]	‘soft’
bkéʔʃ	→	[pkḛ́ʃ]	‘roast it!’
CVC*s*			
sínʔ	→	[sín̰]	‘tick’
ʃílʔ	→	[ʃíl̰]	‘cotton’
ʃòʔn	→	[ʃòn̰]	‘eight’

Below we show the anchorage of the [constricted glottis] feature, first, it is done over the temporal grid and then the anchoring of the moraic grid to the melodic tier.

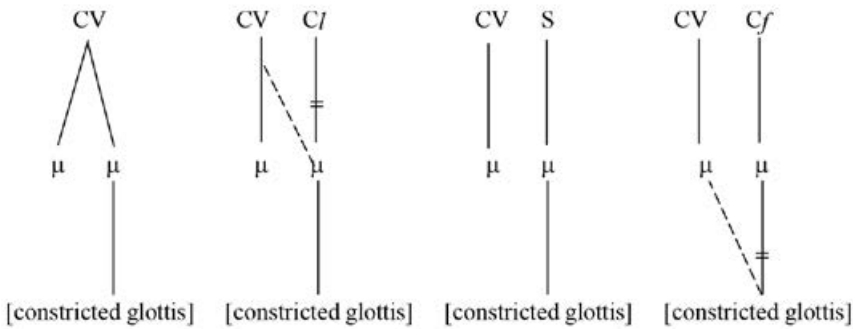


Figure 6. Association of laryngeal, moraic, and melodic tiers

In Figure 7 we give acoustic evidence of the linking unit of the [constricted glottis] feature in zam. In (a) laryngealization is linking on the vowel, but in (b, c, and d) the nasal, the lateral and the glide receive laryngealization.

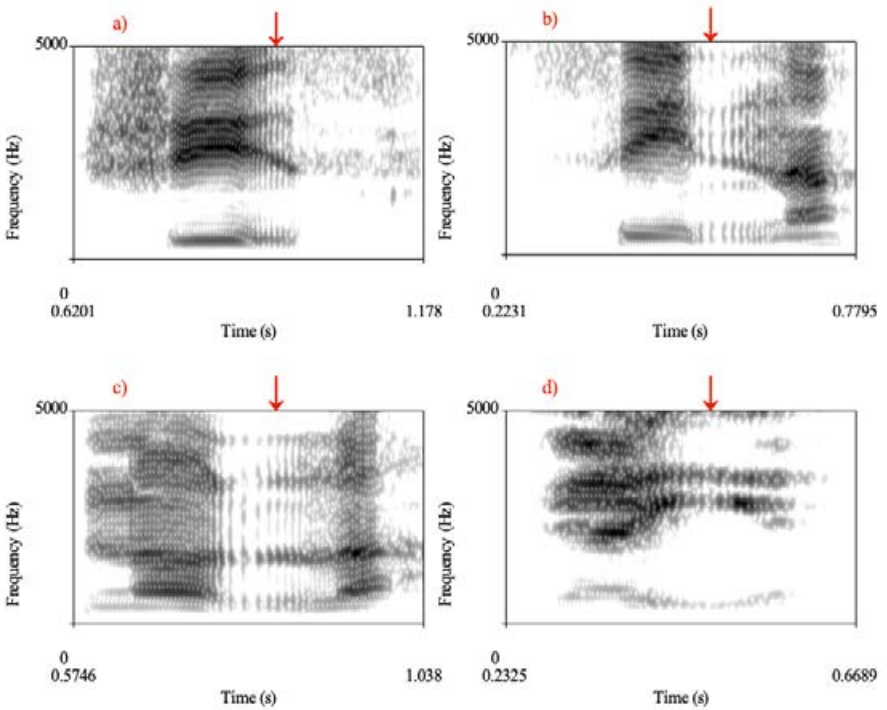


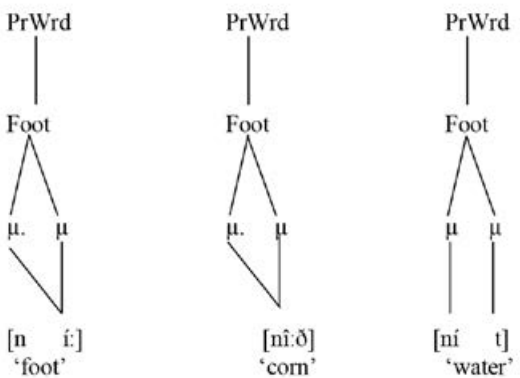
Figure 7. Spectrograms of [ʃi̯s] 'pineapple' (a), [sín̯á] 'they are fifteen' (b), [nól̯á] 'it's long'(c) and [ɣáj̃á] 'they are five' (d)

5. Prosodic word, syllable structure, and stress

Miahuatec, like other Southern Zapotec languages, is a monosyllabic language, meaning that the lexicon is composed of mostly monosyllabic roots (Michaud 2012). Words greater than one syllable are recently

incorporated loans or are morphologically complex. Monosyllabicity is related to universal requirements of word structure. According to Prince & Smolensky (2008: 56), the prosodic word (PrWd) must contain at least one foot; a foot will contain at least two moras; hence, lexical words are minimally bimoraic. In Miahuatec the minimal requirements are satisfied by a monosyllabic bimoraic foot. The first mora is always linked to the vowel but the second mora of the minimal word can be linked to the vowel or to a consonant: If the consonant is in coda position and it is a fortis consonant, the second mora is associated to the consonant. That is to say, fortis consonants are capable of being associated with a mora, in contrast to lenis consonants, which are incapable of being associated with a mora. Below we show three zam words: A word with no coda, a word with a lenis coda, and finally a word with a fortis coda.

(12) Moraic association in prosodic words



Even though zam is a monosyllabic language, there are disyllabic morphologically complex words that reveal an iambic stress pattern. The stressed syllable is always heavy while unstressed syllables are always light (Sicoli 2007; Arellanes 2021, among others). This means that bimoraicity is related to both stress and minimality. The prosodic requirement that the minimal word be a bimoraic foot, even when it is a monosyllable, is because a stressed syllable is bimoraic and a prosodic word must have a stressed syllable. Table 3 shows the words [kàː] 'to move' and [níː] 'foot' in isolation, and finally the compound [kàníː] 'to dance'. The compound word is formed by an unbalanced iambic foot, a canonical iamb according to Hayes (1995).

Table 3. Miahuatec metrical structure

PrWd	*	*		*
Foot	*	*		*
Syllable	*	*	*	*
	[kàː]	[níː]	[kà	níː]
	'to move'	'foot'	'to dance'	

Cross-linguistically, the stressed syllable is cued by four acoustic cues: Duration, intensity, fundamental frequency, and the formant stability of the vowel. As we saw in the previous sections, in this language the duration of the vowel is predictable through the type of consonant in

coda position. This is why it is possible to find short and long vowels in the stressed syllable, so the duration of the vowel can't be the main cue of stress. On the other hand, although the intensity of the vowel is closely linked to a phonation type, zam has a constricted glottis feature that can be attached to the vowel under the conditions shown above. Regarding the fundamental frequency, in this language it is related to lexical and grammatical tone. The vowel stability dimension is also related to non-modal phonation, given that creaky and tense voice increase the F1 (Maddieson & Ladefoged 1990; Blankenship 2002; Herrera Zendejas 2000). In this paper we follow Hernández (2020) claim about the duration of the rhyme as the main acoustic correlate of stress. In the following table we show the difference between the intensity of unstressed and stressed vowels in morphologically complex words with CVCV template. The difference in intensity is as small as 1.7 dB. These measures suggest that intensity is not a correlate of stress.

Table 4. Difference of intensity between unstressed and stressed vowels in CVCV words

n=51	Unstressed vowel	Stressed vowel	/
	59.52 dB	61.23 dB	1.7 dB

Regarding to duration, Tables 5 and 6 show the difference in the duration of unstressed and stressed vowels in two different syllabic templates. Table 5 shows a difference of 068 ms. between unstressed and stressed vowels in a CVCV template, while Table 6 shows a small difference in favor of the unstressed vowel. The difference is indeed minimal but, in

that case, we can safely say that the unstressed and stressed vowels are equal in terms of their duration. This is because, as we have seen before, the fortis-lenis contrast is related to the duration of the vowel of stressed syllables.

Table 5. Difference of duration between unstressed and stressed vowels in CVCV words

n=51	Unstressed vowel	Stressed vowel	/
	075 ms.	144 ms.	

Duration as an acoustic cue of stress becomes relevant if we consider the duration of the rhyme as a whole, that is, the entire moraic domain of the stressed syllable. In Table 6 we show the difference between unstressed and stressed vowels, and unstressed and stressed rhymes. Note that vowel duration is similar between stressed and unstressed syllables by the effect of the complementary distribution of vowel length and the fortis-lenis contrast in coda position. The difference between vowels is 002 ms., but the difference in the rhyme is 155 ms., which is almost double the unstressed rhyme duration, this means that the acoustic correlate of stress in this language is the duration of the rhyme, not the duration of the vowel. It is important to remember that only stressed syllables are bimoraic.

Table 6. Difference in duration between unstressed and stressed vowels, and rhymes in CVCVCf words

n=45	Unstressed vowel	Stressed vowel	C*f*	/ Vowel	/ Rhyme
	085 ms.	087 ms.	153 ms.	002 ms.	155 ms.

Finally, we show qualitative evidence through spectrograms. First, we show a disyllabic, morphologically complex word that contains the stative prefix. Secondly, we show three words with different syllabic shapes: CV, CV*l,* and CVC*f.* Figure 8 shows that there are no obvious differences between unstressed and stressed vowels, but if we look at the difference in the duration of the rhyme, we will notice an evident difference.

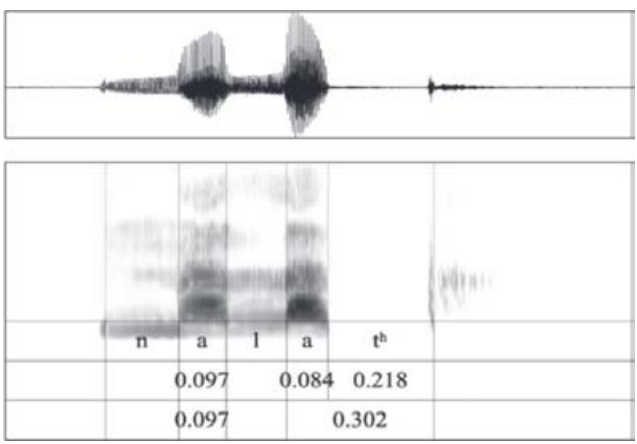


Figure 8. Difference between unstressed and stressed syllables in the word [nàˈlát] ‘s/he is thin’

Figure 9 shows the duration of the vowel and rhyme in three different syllabic shapes. First, we have a cv syllable in which the vowel lasts 243 ms. Second, we have a cvc*l* word, in which the vowel lasts 128 ms. while the coda consonant lasts 095 ms. Lastly, we show a syllable closed by a fortis consonant with 072 ms. for the vowel and 175 ms. for the consonant. It is important to notice that the duration of the rhyme is equivalent in all three cases regardless of the duration of the nucleus and the coda separately.

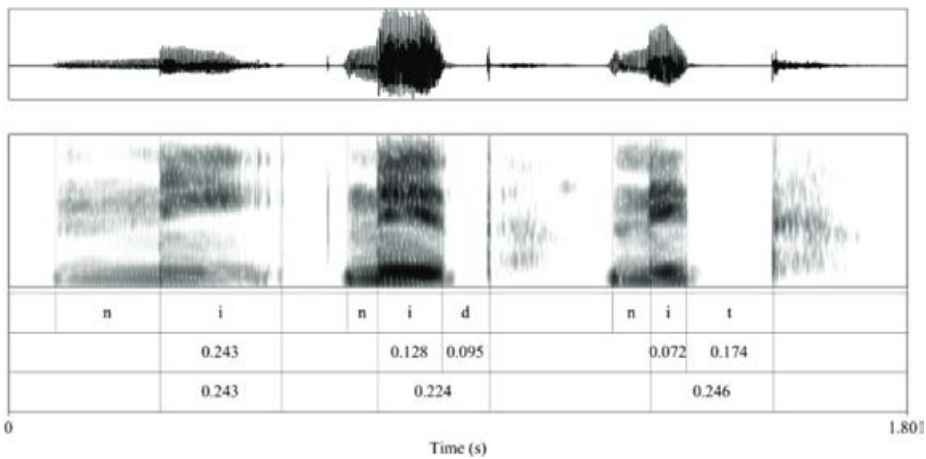


Figure 9. Difference between stressed rhymes in different syllable types

In sum, the most prominent cue of stress in Santo Domingo de Morelos Zapotec is the duration of the rhyme.

6. Summary

This paper represents the first work related to the synchronic phonology of the Santo Domingo de Morelos variety of the Miahuatec Zapotec language. We have shown that zam exhibits the typical features of Zapotec languages, but it also shows many innovative or less common features in general Zapotec phonology. For example, we have shown that in zam the [constricted glottis] feature is linked to sonorant consonants in addition to vowels. Contrary to Valley Zapotec (Esposito 2004), in zam the fortis-lenis contrast is restricted to non-sonorants (plosives, fricatives, and affricates). Phonetically, the fortis-lenis contrast is related to quantity: The fortis consonants are longer than the lenis ones and the vowels are longer when a lenis consonant closes the syllable. This lengthening is related to stress. The stressed syllable is necessarily bimoraic. We also showed how the fortis-lenis contrast relates to syllable structure, with a constraint against alternating fortis-lenis sequences.

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Abbreviations

1:	first person
C:	consonant
CF:	fortis consonant
CL:	lenis consonant
V:	vowel
S:	sonorant
H:	high tone
L:	low tone
HL:	falling tone
LH:	rising tone
H:	floating high tone,
μ:	mora
SP.:	Spanish
SSP:	Sonority Sequencing Principle
DB:	decibels
MS.:	milliseconds
*NC:	constraint against nasal/ voiceless obstruent sequences
HZ:	hertz
TBU:	tone bearing unit
PRWRD:	Prosodic word
F1:	first formant
N:	total number of tokens analyzed

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