Prosody in Mesoamerican Languages

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Abstract

The Mesoamerican linguistic area is rich with prosodic phenomena, including a wide variety of complex tone, phonation, stress, and intonational systems. The diversity of prosodic patterns in Mesoamerica reflects the extreme time-depth and complex history of the languages spoken there. This chapter surveys the prosody of Mesoamerican languages and some past analyses of their structures. Topics include the areal distribution of tonal complexity; interactions between stress, tone, and segmental contrasts; the phonetics of tone and phonation; metrical structure; and higher-level prosodic phenomena. Case studies from different languages also highlight interactions between morphological and word-prosodic structure. These topics underscore the importance of research on Mesoamerican languages to both phonological theory and linguistic typology.

1 Introduction

Mesoamerica spans from Northern-Central Mexico to Costa Rica. Several unrelated language families occupy this territory, including the Oto-Manguean, Mayan, and Totozoquean families (Brown et al. 2011), and a few language isolates, e.g. Huave (Kim 2008), Xinca (Rogers 2010), and Tarascan (Purépecha) (Friedrich 1975). Although the Uto-Aztecan languages Nahuatl and Pipil are spoken in Mesoamerica—in close contact, for centuries, with other Mesoamerican languages—they are not generally considered part of the Mesoamerican *linguistic area* (Campbell et al. 1986).[1] The same is true for for the Chibchan and Misumalpan families. This chapter focuses on word-prosody within the Mesoamerican area and, to a lesser extent, prosodic structure above the word.

The word-prosodic systems of Mesoamerican languages are diverse, owing in part to a developmental time-depth of 4000-6000 years within each family. The practice of equating language names with larger ethnolinguistic groups has also resulted in a vast underestimation of linguistic diversity; e.g. "Mixtec" refers to at least 18 mutually-unintelligible dialect clusters, with roughly 2000 years of internal diversification (Josserand 1983). This chapter is organized into three sections, corresponding to the major language families of Mesoamerica: Oto-Manguean, Mayan, and Totozoquean. The prosodic systems of these languages diverge substantially. Many Mesoamerican languages make use of non-modal phonation in their segmental inventories or word-level prosody. Thus, in addition to stress, tone, and syllable structure, this chapter also examines phonation contrasts.

[1] The prosody of the Uto-Aztecan family, including the various Nahuatl languages, is examined by Caballero and Gordon (this volume).

2 Oto-Manguean Languages

The Oto-Manguean family comprises approximately 180 languages spoken by about 2,148,000 people (INALI 2015). Historically, Oto-Manguean languages were spoken from Northern-central Mexico to as far south as Costa Rica, but all languages spoken south of Mexico are currently dormant/extinct (Chiapanec, Mangue, Subtiaba, and Chorotega). Oto-Manguean is divided into two major branches, East and West, and eight major subgroups: Mè’phàà-Subtiaba, Chorotegan, Oto-Pamean, Chinantecan, Mixtecan, Popolocan, Zapotecan, and Amuzgo (Campbell 2017a). Oto-Manguean languages are morphologically mostly isolating, though verbs generally take one or more tense-aspect-mood (TAM) prefixes. Most words may also take one or more pronominal enclitics. There is a strong tendency for morphophonology to involve fusional changes on the root.

2.1 Lexical tone

All Oto-Manguean languages are tonal, without exception, and many also possess stress. There is a sizeable literature on tone in Oto-Manguean: we report here on a survey of the entire descriptive phonological literature on the family. A total of 94 language varieties were examined.[2] Five relevant prosodic features for each language were extracted: (1) tonal contrasts, (2) maximum number of tones on a single syllable, (3) stress pattern, (4) rime types, and (5) additional suprasegmental features. A summary of the tonal inventory size for each major sub-family is shown in Table 1.

Table 1

Family	Number of Languages	Number of tones 2-3	4-5	6-7	8-9	10-11	Average number of tonal contrasts per syllable
Amuzgo	2	0	0	1	1	0	7
Chinantecan	9	1	1	5	1	1	8
Mè’phàà-Subtiaba	3	3	0	0	0	0	9
Mixtecan	25	19	2	0	3	1	9
Oto-Pamean	15	11	4	0	0	0	3
Popolocan	14	7	7	0	0	0	9
Zapotecan	26	10	11	3	1	1	5
Total	94	51	25	9	6	3	7

Tonal complexity by Oto-Manguean language family.

Table 1 shows that roughly half of all Oto-Manguean languages (51/94 or 54%) possess small tonal inventories (2-3 tones), a sizeable portion (25/94 or 27%) possess intermediate inventories (4-5 tones), and another sizeable portion (18/94 or 19%) possess large inventories (6 or more tones). However, the size of the tonal inventory in an individual language only demonstrates part of the complexity of the tonal system: in most Oto-Manguean languages, more than one tone may surface on an individual syllable. Thus, while certain Zapotecan and Mixtecan languages may possess an equal number of tones, e.g. 3, most Mixtecan languages permit a far greater number of tones on an individual syllable than Zapotecan languages do.

[2]At the time of writing, this reflects all languages known to have been investigated in the Oto-Manguean family (not the total number of languages within each sub-family). There are no living speakers of any Chorotegan language, and no extant descriptions of their tonal systems.

Most Oto-Manguean languages have at least two level tones, and many possess three or more level tones. Languages which permit more than one level tone per syllable (especially Popolocan and Mixtecan) may possess a large number of contour tones. Examples from Ixpantepec Nieves Mixtec are shown in Table 2: high, mid, and low tones combine freely with another tone on the root[3], creating a set of six derived contour tones.

Table 2

k^{w}éé	'slow'	vií	'clean'	t^{j}ìí	'numb'
xĩ́ĩ	'different'	ĩĩ	'one'	vèe	'heavy'
k^{w}ĩ̂ĩ	'skinny'	nĩĩ̀	'corn ear'	ĩ̀ĩ̀	'nine'

Ixpantepec Nieves Mixtec (Carroll 2015; H= /á/, M=/a/, L=/à/).

In most Mixtec languages, roots consist of either a single syllable with a long vowel or two syllables with short vowels (Longacre 1957, Macaulay & Salmons 1995). Consequently, the tonal contours shown above also occur as sequences in disyllabic roots, e.g. /kìki/ 'sew' (cf. [vèe] 'heavy' in Table 2). Since the distribution of tone is sensitive to root shape, researchers have argued that the TBU for many Mixtec languages the bimoraic root, with tones being aligned to moras rather than syllables (Carroll 2015, DiCanio et al. 2014, McKendry 2013). Note that not all contour tones are derived from tonal sequences in Oto-Manguean languages. In some, like Yoloxóchtil Mixtec, contour tones are undecomposable units which contrast with tone sequences, e.g. /ta^{1}.a^{3}/ 'man' vs. /^{n}da^{13}.a^{3}/ 'went up' (periods indicate moraic boundaries) (DiCanio et al. 2014).

Tone sandhi is found in many Oto-Manguean languages as well, most notably in the Mixtecan, Zapotecan, and Popolocan families. Some seminal work on Oto-Manguean tone sandhi dealt with Mazatec and Mixtec languages (Pike 1948). Work on these languages was also important to the development of autosegmental-metrical theory (Goldsmith 1990). Tone sandhi in many Oto-Manguean languages is lexically-conditioned: for example, in the same language, some roots with high tones may condition tonal changes on the following word, while other roots with high tones do not. The tonal systems of Chatino languages (Zapotecan) contain several different types of floating tones which illustrate this pattern. Examples from San Juan Quiahije Chatino (SJQC) are shown in Table 3 below. SJQC has eleven tones (H, M, L, M0, MH, M^, LM, L0, 0L, HL, ML), where "0" reflects a super-high tone and "^" reflects a "slight rise."

Table 3

kna^{H}	'snake'	+	ĩ^{ML}	3S	=	kna^{H} ĩ^{ML}	'his/her snake'
kta^{L}	'tobacco'	+	ĩ^{ML}	3S	=	kta^{L} ĩ^{ML}	'his/her tobacco'
sna^{H}	'apple'	+	ĩ^{ML}	3S	=	sna^{H} ĩ^{0}	'his/her apple'
skwã^{L}	'I threw'	+	ĩ^{ML}	3S	=	skwã^{L} ĩ^{0}	'I threw him/her'

San Juan Quiahije Chatino tone sandhi (Cruz 2011).

Table 3 shows that certain high and low tone roots in Chatino are specified with a floating super-high tone ("0") which can replace the tone on the following word. Since floating tones

[3] Given the largely isolating morphology of Oto-Manguean, the terms "root" and "stem" are roughly synonymous for this family.

are lexically-specified, and only surface in phrasal contexts, tonal inventories in these languages may be larger than previously assumed, e.g. if a high tone with no floating tone is taken to be phonologically distinct from one with a floating super-high tone (Cruz & Woodbury 2014).

Tone is not merely lexical within Oto-Manguean languages, but often serves a morphological role, particularly in inflection (Palancar & Léonard 2016). Tone has a high functional load in the morphology of Yoloxóchitl Mixtec (YM) (Table 4). YM has 9 tones, /4, 3, 2, 1, 13, 14, 24, 42, 32/ ("4" is high and "1" is low).

Table 4

	'to break' (TR)	'hang' (TR)	'to change' (INTR)	'to peel' (TR)	'to get wet'
Stem	ta^{3}ʔβi^{4}	tʃi^{3}kũ^{2}	na^{1}ma^{3}	kwi^{1}i^{4}	tʃi^{3}i^{3}
NEG	ta^{14}ʔβi^{4}	tʃi^{14}kũ^{2}	na^{14}ma^{3}	kwi^{14}i^{14}	tʃi^{14}i^{3}
COMP	ta^{13}ʔβi^{4}	tʃi^{13}kũ^{2}	na^{13}ma^{3}	kwi^{1}i^{4}	tʃi^{13}i^{3}
INCOMP	ta^{4}ʔβi^{4}	tʃi^{4}kũ^{2}	na^{4}ma^{13}	kwi^{4}i^{14}	tʃi^{4}i^{4}
1S	ta^{3}ʔβi^{42}	tʃi^{3}kũ^{2}=ju^{1}	na^{1}ma^{32}	kwi^{1}i^{42}	tʃi^{3}i^{2}

Yoloxóchitl Mixtec tonal morphology (Palancar et al. 2016).

Tonal changes in the initial syllable of the YM verb root indicate negation, completive (perfective) aspect, or incompletive aspect. On polysyllabic words, the penultimate syllable's tone is replaced by the morphological tone. In monosyllabic words, the morphological tone is simply appended to the left edge of the syllable, creating complex tonal contours. The 1SG enclitic is realized as tone /2/ at the right edge of the root unless the root contains a final tone /2/ or /1/. In this environment, the allomorph of 1SG is an enclitic /=ju^{1}/. It is possible to combine several tonal morphemes on a single root in YM, e.g. /tʃi^{14}i$^{(3)2}$/ 'I will not get wet.'

Many Oto-Manguean tonal systems are described and analyzed in formal phonological terms in recent work (mostly using autosegmental phonology), e.g. in Mixtecan (Daly & Hyman 2007, DiCanio 2008; 2016, Hernández Mendoza 2017, Hollenbach 1984, Macaulay 1996, McKendry 2013, Paster & Beam de Azcona 2005), Oto-Pamean (Turnbull 2017), Popolocan (Beal 2011), and Zapotecan (Antonio Ramos 2015, Arellanes Arellanes 2009, Chávez Peón 2010, McIntosh 2016, Tejada 2012, Villard 2015). There are three major analytical issues these languages raise: (1) To what extent are contours decomposable into smaller units? (2) What is the TBU? and (3) Is tone sandhi or tonal morphophonology predictable? Can either be modelled by autosegmental rules or general phonological constraints? These issues have been examined in various languages, though for a majority of Oto-Manguean languages, tone is minimally analyzed (and in several cases, not analyzed at all).

2.2 Stress

Stress is usually fixed in Oto-Manguean languages, and is always confined to roots/stems (affixes never receive stress). Most roots/stems are maximally disyllabic and, as a result, root-initial and root-final stress are the norm. The presence of stress in Oto-Manguean phonological systems can be motivated by distributional asymmetries: often, more segmental and tonal contrasts are possible on stressed syllables than unstressed syllables (DiCanio 2008, Hernández Mendoza 2017, Hollenbach 1984). In some languages, like Mazahua (Knapp Ring 2008), tone is only contrastive on the stressed, initial syllable of the root. Of the 94 languages surveyed in §2.1, some description of stress was found for 70 (Table 5).

Table 5

Family	Languages	monosyllabic roots	root-initial	root-final	root-penultimate	variable
Amuzgo	1	0	0	1	0	0
Chinantecan	8	3	0	5	0	0
Mè'phàà-Subtiaba	2	0	0	2	0	0
Mixtecan	14	0	7	4	0	3
Oto-Pamean	12	1	11	0	0	0
Popolocan	9	0	0	5	1	3
Zapotecan	24	8	3	8	3	2
Total	70	12	21	25	4	7

Stress pattern by Oto-Manguean language family.

Of the 58 languages without monosyllabic root structure, 25/58 (43%) have root-final stress and 21/58 (36%) have root-initial stress. Stem-penultimate stress is also described for certain Zapotec languages and for Metzontla Popoloca (Veerman-Leichsenring 1991).[4] Variable (i.e. mobile) stress is found in several Oto-Manguean languages (Diuxi Mixtec (Pike & Oram 1976), Molinos Mixtec (Hunter & Pike 1969), Ayutla Mixtec (Pankratz & Pike 1967), San Juan Atzingo Popoloca (Kalstrom & Pike 1968), Tlacoyalco Popoloca (Stark & Machin 1977), and Comaltepec Zapotec (Lyman & Lyman 1977)). Since tone may also interact with stress, such languages have been of interest within the larger phonological literature (e.g. de Lacy (2002)), though older descriptions of these languages warrant further phonological/phonetic investigation. Given that stress is assigned primarily to roots, secondary stress is absent in most Oto-Manguean languages, though alternating, head-initial trochaic stress is reported for several languages (San Miguel Tenoxtitán Mazahua (Knapp Ring 2008), Déposito Mazahua (Juárez García & Cervantes Lozada 2005), Acazulco Otomí (Turnbull 2017), San Lucas Quiaviní Zapotec (Chávez Peón 2010), and Lachíxio Zapotec (Sicoli 2007)).

Little work has examined the phonetic correlates of stress in Oto-Manguean languages, though stress has been explored instrumentally in a few Mixtecan languages (Ixpantepec Nieves Mixtec (Carroll 2015), Southeastern Nochixtlán Mixtec (McKendry 2013), and Itunyoso Triqui (DiCanio 2008; 2010)). In each of these languages, the main correlate of stress is acoustic duration. Note that 47/94 (50%) of the languages surveyed here also possess a vowel/rime length contrast, and so duration may not be a stress cue in all languages. The phonetics of stress remains an open area of inquiry in Oto-Manguean linguistics.

For 11 of the 94 languages surveyed, a contrast is reported between "ballistic" and "controlled" stress (all nine Chinantecan languages surveyed, Xochistlahuaca Amuzgo (Buck 2015), and San Jerónimo Mazatec (Bull 1978)). Ballistic syllables, first described by Merrifield (1963) and reviewed in Mugele (1982), may possess some/all of the following phonological characteristics: (1) fortis-initial onsets, (2) shorter vowel duration, (3) an abrupt, final drop in intensity, (4) tonal variation (specifically F_0 raising), (5) post-vocalic aspiration, and/or (6) coda devoicing. Examples from Lalana Chinantec are shown in Table 6.

[4] As some of these languages can possess trisyllabic words, it is currently unclear if the intended generalization in the existing descriptions is that stress is root-initial or truly penultimate.

Table 6

Controlled stress		Ballistic stress	
ɔː^{2}	'mouth'	ɔ́ː^{2}	'bury it!'
dʒi^{3}	'chocolate atole'	dʒí^{3}	'wind'
liː^{23}	'appears'	líː^{23}	'remembers'

Controlled and ballistic syllables (marked with /´/) in Lalana Chinantec. (Mugele 1982:9; 1 = high tone, 2 = mid tone, 3 = low tone).

Though the controlled-ballistic distinction is considered to be a type of 'stress', these contrasts may occur in monosyllabic lexical words, making them fundamentally different from true word-level stress distinctions (Hyman 2006). Mugele argues, on the basis of acoustic data, that the distinguishing feature of ballistic syllables in Lalana Chinantec is an active expiratory gesture which raises subglottal pressure and produces syllables which have most of the characteristics mentioned above (except (1)). Kim (2011) and Silverman et al. (1995) find no evidence for this contrast in San Pedro Amuzgos or Jalapa Mazatec, respectively, despite previous descriptions. Regarding ballistic syllables, Silverman (1997a) states that "a byproduct of this increased transglottal flow (for producing post-vocalic aspiration) is a moderate pitch increase on the latter portion of the vowel, around the onset of aspiration" (p.241). A major question is the extent to which the acoustic features of controlled and ballistic syllables are derivable from a single articulatory parameter. Since little instrumental work has been done on this question, the nature of this unique contrast remains an open area of research.

2.3 Phonation type

Some Oto-Manguean languages possess phonation type contrasts in their consonant, vowel, and/or prosodic systems (see Silverman (1997a)). Phonation type is usually orthogonal to tone in the phonological system, though tone and phonation are interdependent in some Zapotec languages. For instance, Jalapa Mazatec (Popolocan) possesses a three-way distinction between breathy, modal, and creaky vowels, but all three tones (high, mid, low) co-occur with each phonation type (Garellek & Keating 2011, Silverman et al. 1995). Itunyoso Triqui (IT, Mixtecan) has coda glottal consonants (/ʔ/ and /ɦ/) as well as intervocalic /ʔ/: contour tones do not surface on syllables with coda /ʔ/, but most tonal patterns surface on words with intervocalic glottalization or coda /ɦ/ (DiCanio 2008; 2012). Intervocalic /ʔ/ in IT is frequently realized as creaky phonation on adjacent vowels (DiCanio 2012). Table 7 demonstrates that glottal contrasts in IT are orthogonal to tonal contrasts, though may still interact with them in certain ways (e.g. no contour tones surface before /ʔ/.)

In many Oto-Manguean languages, glottalized or creaky vowels are realized in a phased manner (Avelino 2010, DiCanio 2012, Gerfen & Baker 2005, Silverman 1997a;b). Creaky vowels are produced as sequences, i.e. [aa̰a], rather than with a sustained duration of creaky phonation throughout the vowel. In most Zapotec languages, there is in fact a contrast between a checked vowel, i.e. /aʔ/ → [aʔ], and a rearticulated vowel, i.e. /aˀa/ → [aa̰a]. The latter is realized with weak creaky phonation and the former with more abrupt glottal closure. Both vowels behave as single syllabic nuclei in Zapotec (Arellanes Arellanes 2009, Avelino Becerra 2004).[5] A number

[5]This differs from the Triqui data in Table 7, where the /VʔV(ɦ)/ examples are disyllabic (DiCanio 2008).

Table 7

Tone	Modal		Coda /ɦ/		Coda /ʔ/		/VʔV(ɦ)/	
/4/	ββe4	‘hair’	yãɦ^{4}	‘dirt’	tʃiʔ^{4}	‘our ancestor’	ɾã^{4}ʔãɦ^{4}	‘to dance’
/3/	nne3	‘plough	yãɦ^{3}	‘paper’	tsiʔ^{3}	‘pulque’	nã^{3}ʔãɦ^{3}	‘limestone’
/2/	nne2	‘to lie’	nãɦ^{2}	‘again’	ttʃiʔ^{2}	‘10’	ta^{2}ʔaɦ^{2}	‘some, half’
/1/	nne1	‘naked’	kãɦ^{1}	‘naked’	tʃiʔ^{1}	‘sweet’	na^{1}ʔaɦ^{1}	‘shame’
/45/			nãɦ^{45}	‘to wash’			nã^{3}ʔãɦ^{45}	‘I return’
/13/	ββi^{13}	‘two of them’	nãɦ^{13}	‘this (one)’			kã^{1}ʔãɦ^{3}	‘four of them’
/43/	tʃe^{43}	‘my father’	nnãɦ^{43}	‘mother! (voc.)’			ko^{4}ʔo^{43}	‘to drink’
/32/	nne^{32}	‘water’	nnãɦ^{32}	‘cigarette’			sã^{3}ʔãɦ^{2}	‘money’
/31/	nne^{31}	‘meat’					kã^{3}ʔã^{1}	‘wind, breath’

The distribution of Itunyoso Triqui tones in relation to glottal consonants.

of Oto-Manguean languages also possess phonation type contrasts among consonants. Almost all Oto-Pamean and many Popolocan languages have a series of aspirated/breathy and glottalized consonants, e.g. Mazahua /màʔa/ ‘to go’ vs. /m̥âp^{h}ɨ/ ‘nest’ vs. /m̰ása/ ‘grub’ (Knapp Ring 2008). The representation of these complex consonants has been a topic of some theoretical interest (e.g. Golston & Kehrein (1998), Steriade (1994)).

2.4 Syllable structure and length

Many Oto-Manguean languages permit complex rimes, especially in the Oto-Pamean and Zapotecan families (Berthiaume 2004, Jaeger & Van Valin 1982), e.g. Northern Pame /s͡tsʼăhawnt/ ‘tree knot’ and /s͡ts^{h}áwʔ/ ‘ruler’.[6] The distribution of rime types is shown in Table 8. Roughly a third of all languages permit only open syllables (33/94, 35%), while a sizeable number of languages permit only a glottal consonant coda (22/94, 23%) or a single (buccal) coda consonant (27/94, 29%). Seven languages permit closed syllables *only* in non-word-final syllables and five additional languages permit more complex coda types. While not shown here, many Oto-Manguean languages permit complex onsets as well, especially in languages where pre-tonic syncope has taken place via historical sound change, e.g. compare Zenzontepec Chatino /lutzeʔ/ ‘tongue.3S’ to Tataltepec Chatino /ltzéʔ/ (Campbell 2013). Prefixation may also produce complex onset clusters on verbs (Jaeger & Van Valin 1982).

Length contrasts are common in Oto-Manguean languages, occurring in 47/94 (50%) of the languages surveyed. For Mixtec languages, roots are typically bimoraic (see §2.1). Thus, there is a surface contrast between short vowels in polysyllabic words, e.g. CVCV, and long vowels in monosyllabic words, e.g. CVV. This type of root template is not counted as a length contrast here. For Zapotec languages, the contrast between fortis and lenis consonants involves an alternation with vowel length on the root. Long vowels surface before a lenis (or short) consonant but short vowels surface before a fortis (or long) consonant (Arellanes Arellanes 2009, Avelino 2001, Chávez Peón 2010, Leander 2008), e.g. /wdzínː/ ‘arrived’ vs. /dzìːn/ ‘honey’ in Ozolotepec Zapotec (Leander 2008). This trade-off in duration between the vowel and consonant in Zapotec is similar to the C/V trading relation with voicing in languages like English (Luce & Charles-Luce 1985, Port & Dalby 1982) and, in fact, the fortis-lenis contrast in many Zapotec languages has evolved into a voicing contrast among obstruents (Beam de Azcona 2004).

[6] The sole exceptions within Zapotecan are the five Chatino languages, none of which permit codas other than /ʔ/.

Table 8

Family	Languages	Permitted syllable types					Length
		(C)V	(C)V(ʔ/h)	(C)V(C) (but *(C)VC#)	(C)V(C)	(C)V(C)(C)	contrasts
Amuzgo	2	0	2	0	0	0	0
Chinantecan	9	0	6	0	3	0	9
Mè'phàà-Subtiaba	3	2	1	0	0	0	2
Mixtecan	25	19	6	0	0	0	3
Oto-Pamean	15	0	0	7	3	5	4
Popolocan	14	12	2	0	0	0	3
Zapotecan	26	0	5	0	21	0	26
Total	94	33	22	7	27	5	47

Permitted rime types and length contrasts by Oto-Manguean family.

2.5 Intonation and prosody above the word

Given the complexity of word-level prosody in Oto-Manguean languages, fairly little work has been done to date examining prosodic structure above the word. Lexical tone has a high functional load and most morphemes in Oto-Manguean languages are specified for tone. Intonational pitch accents are fairly limited, and evidence for prosodic phrasing must therefore be based on patterns of lengthening and the domains of phonological processes like tone sandhi. Tone production in certain languages is sensitive to phrasal position. Declination and/or final lowering influences the production of tone in Coatlán Lochixa Zapotec, where rising or level tones are realized with a falling F_0 pattern in utterance-final position (Beam de Azcona 2004). In Chicahuaxtla Triqui, a phrase-final tone (/3/) is appended to noun phrases (Hernández Mendoza 2017). In Ixcatec (Popolocan), low tones surface only at the end of a phonological phrase. In phrase-internal (but word-final) position, all low tones neutralize with mid tone (DiCanio, submitted). In the left panel of Figure 1, we observe complete overlap in the production of low and mid tones. These same target words are realized with different tones when they appear in utterance-final position. In the right panel, we also observe a separate pattern of high tone lowering in utterance-final position.

«Insert Figure 1 here»

Tones in utterance non-final and utterance-final position in Ixcatec. The figures show F_0 trajectories for high, mid, and low tones, averaged across four speakers.

Tone sandhi provides the clearest evidence of higher-level prosodic structure in Oto-Manguean languages. In Zenzontepec Chatino, high tones spread rightward onto tone-less syllables (Ø) but adjacent mid (/ā/) or high (/á/) tones undergo downstep. This downstep extends to the end of the intonational phrase (1).

(1) Intonational domains in high tone downstep in Zenzontepec Chatino (Campbell 2014:138)
(Tones in the initial line are underlying. Tones below this are derived.)
(jā kisōʔná=na tāká)$_{IP}$ (maxi k-ii=ą laaʔ nyāʔā)$_{IP}$
Ø Ø.M.H=H ↓(M.H) Ø.Ø Ø=Ø Ø M.M
CONJ MASTER=1PL.INCL EXIST[.3] EVEN.IF POT-FEEL=1PL.INCL LIKE.SO SEE.2SG
'We have our master, even if we think that way, you see.' [la familia 9:36]

Little instrumental research has been done on phonological phrasing within Oto-Manguean languages but, impressionistically, two general patterns typify the family: (1) the verb (with all TAM affixes) and a following NP usually form a phonological phrase, such that no pause is possible between the verb and the following NP; and (2) any pre-verbal free morphemes belong to a separate phonological phrase.[7] The pattern in (1) is grammaticalized in San Ildefonso Tultepec Otomí, where there are two classes of verbs (bound and free), the former of which is used when the verb forms a phonological phrase with the following NP (Palancar 2004). With respect to (2), the pre-verbal domain serves as a position for constituents under argument or contrastive focus in many Oto-Manguean languages (Broadwell 1999, Carroll 2015, Chávez Peón 2010, DiCanio et al. submitted, Esposito 2010, Foreman 2006, McKendry 2013). Finally, new words are formed in many Oto-Manguean languages through compounding, which may involve phonological changes sensitive to constituency. In Southeastern Nochixtlán Mixtec (Mixtecan), auxiliary verbs and verbal prefixes are reduced before verb roots, suggesting that the verbal complex (AUX + PFX-ROOT=ENCLITIC) is a prosodic unit (McKendry 2013). In comparison to research on lexical tone, investigations into higher-level prosodic structure are scarce and remain a robust area for future research.

3 Mayan Languages

The Mayan family comprises some thirty-odd languages, spoken by over 6 million people in a region spanning from southeastern Guatemala through southern Mexico and the Yucatan peninsula (Bennett et al. 2016). The principal subgroups of this family are Eastern Mayan, Western Mayan, Yucatecan, and Huastecan. Huasteco, the most linguistically divergent Mayan language, is spoken far from the Maya heartland in east-central Mexico (Kaufman 1976a). There is evidence of considerable linguistic contact among Mayan languages, and between Mayan and other Mesoamerican languages (Campbell et al. 1986, Law 2013; 2014). Aissen et al. (2017) is a comprehensive source on Mayan languages, their history, and their grammatical structures. On the phonetics and phonology of Mayan languages, see Bennett (2016) and England & Baird (2017). Glossing conventions and orthographic practices in this section follow Bennett (2016), Bennett et al. (2016).

3.1 Stress and metrical structure

Stress is predictable in Mayan languages, with few exceptions. Four distinct patterns of stress assignment are robustly attested within the family:

Fixed final stress: K'ichean-branch Mayan languages and Southern Mam (all Eastern Mayan languages of Guatemala).

(2) Sakapulteko (DuBois 1981:109,124,138; Mó Isém 2007)

a. *axlajuuj* [ʔaʃ.la.ˈxuːx] 'thirteen'
b. *kinb'iinik* [kim.ɓiː.ˈnekʰ] 'I walk'
c. *xinrach'iyan* [ʃin.zə̹.t͡ʃˀi.ˈjaŋ] 'he hit me'

[7] VSO word order is the most common for Oto-Manguean languages (Campbell et al. 1986) and, as alluded to above, the juncture between the root and the following personal clitic is the locus of complex morphophonological patterns across the language family.

d. *kaaqaqapuuj* [kaː.qa.qa.ˈpuːχ] ‘we will go to cut it’

Fixed penultimate stress: Southern Mam

(3) Ostuncalco Mam (England 1990:224-6; England 1983, Pérez Vail & Jiménez 1997, Pérez et al. 2000)

a. *kyaaje’* [ˈk^{j}aː.χeʔ] ‘four’
b. *quniik’un* [qu.ˈniː.k^{ʔ}un] ‘night’
c. *t-xmilaal* [ˈʈʂ̻mi.laːl] ‘his/her body’
d. *kaab’aje* [kaː.ˈɓa.χe] ‘day before yesterday’

Quantity-sensitive stress: Huasteco, as well as some Mamean languages (Northern Mam, Ixil, Awakateko, and Teko; all Eastern Mayan).[8] In Huasteco, stress falls on the rightmost long vowel, otherwise on the initial syllable (Larsen & Pike 1949, Edmonson 1988, Herrera Zendejas 2011). Long vowels also attract stress in Mamean languages, as do syllables ending in [Vʔ], [VʔC], or even [VC], depending on the language. In some cases (e.g. Northern Mam), stress assignment may follow a complex weight scale [Vː] > [Vʔ] > [VC] > [V] (Kaufman 1969, England 1983; 1990).

(4) Chajul Ixil (Ayres 1991:8-10; Poma et al. 1996, Chel & Ramirez 1999)

a. Default penultimate stress:
   (i) *ib’otx’* [ˈʔi.ɓo͡ʈʂ̻^{ʔ}] ‘vein’
   (ii) *amlika’* [ʔam.ˈli.kaʔ] ‘sky’

b. Stress attraction to final [Vː], [VʔC#]
   (i) *ixi’m* [ʔi.ˈʂ̻iʔm] ‘corn’ (~[ˈʔi.ʂ̻iʔm])
   (ii) *vitxoo* [βi.ˈ͡ʈʂ̻oː] ‘his/her animal’

Phrasally-determined stress: Several languages in the Q’anjob’alan subgroup of Western Mayan have variable stress conditioned by phrasal position: stress is normally on the first syllable of the word or root, but shifts to the final syllable in phrase-final position. Phrasally-conditioned stress is well-documented for Q’anjob’al (5), and its close relatives Akatek and Popti’ (Day 1973, England 2001).

(5) Q’anjob’al (Mateo Toledo 2008:94-6; Mateo Toledo 1999, Baquiax Barreno et al. 2005)

A naq Matin max kokolo’, naq kawal miman.
[a naq^{x} ˈma.tin maʂ̻ ko.ko.ˈloʔ, naq^{x} ˈka.wal mi.ˈman]
FOC CLF Matin COM.B3SG A1PL.help.TV CLF TNS big.E3SG
‘It was Matin who we helped, the big one.’

It remains unclear whether ‘stress shift’ in this pattern actually affects word-level stress, or instead reflects the addition of a non-metrical, intonational prominence to phrase-final syllables (i.e. a boundary tone; see Gordon 2014 for discussion). Descriptions of Yucatecan and Western Mayan

[8] More restricted patterns of quantity sensitivity are attested in Uspanteko (section 3.2) and possibly K’iche’ (Henderson 2012). These cases involve additional conditioning by tone and/or morphological structure (also reported for quantity-sensitive stress in Mamean languages, e.g. England 1983).

languages (particularly the Greater Tseltalan subgroup) commonly report complex interactions between stress, phrase position, sentence type, and intonation (section 3.5). For example, Vázquez Álvarez (2011:43-5) states that Ch'ol has word-final and phrase-final stress in declaratives, but initial stress in polar questions (6) (see also Attinasi 1973, Warkentin & Brend 1974, Coon 2010, Shklovsky 2011).

(6) a. *buchuloñtyokula* [bu.t͡ʃu.loɲ.tʲo.ku.ˈla] 'yes, we are still seated'

b. *buchuloñäch* [ˈbu.t͡ʃu.lo.ɲɨt͡ʃ] 'Is it true that am I seated?'

Such patterns may indicate that 'stress' is phrasal rather than word-level in some Mayan languages (as claimed by e.g. Polian 2013 for Tseltal), or that phrasal stress and intonation mask the position of word-level stress in certain contexts. Given these uncertainties, the description of word- and phrasal-prosody in the Western Mayan and Yucatecan languages would benefit from more targeted investigation.

There is little consensus over stress assignment in Yucatec. Since the influential early study of Pike (1946), Yucatec has been described as having some mix of quantity-sensitive and initial/final stress (e.g. Fisher 1973, Fox 1978, Bricker et al. 1998, Gussenhoven & Teeuw 2008; see Bennett 2016 for more references). Existing analyses are not all mutually compatible, and the actual phonetic cues to stress in Yucatec remain obscure. It has even been suggested that Yucatec, a tonal language (section 3.2), may lack word-level stress altogether (Kidder 2013).

Chontal (Western Mayan) is the only language in the family which provides clear evidence for phonemic stress, e.g. *u p'isi* [ʔu ˈpˀi.si] 'he measured it' vs. *u p'isi* [ʔu pˀi.ˈsi] 'he wakened him' (Keller 1959, Knowles 1984, Pérez González 1985). However, many minimal pairs for stress in Chontal are morphologically or syntactically conditioned (e.g. *a sutun* [ʔa su.ˈtun] 'you turn it over' vs. *sutun* [ˈsu.tun] 'Turn it over!'; Knowles 1984:61-2).

Most Mayan languages lack word-level secondary stress, apart from morphological compounds composed of two or more independent words (e.g. Ch'ol *matye' chityam* [ma.ˌtʲe t͡ʃi.ˈtʲam] 'wild boar'; Vázquez Álvarez 2011:44). However, there are a few scattered claims of secondary stress in non-compound words as well (Bennett 2016:497).

Perhaps because most Mayan languages lack rhythmic, alternating stress, not much has been written about abstract foot structure in this family. Bennett & Henderson (2013) argue that foot structure conditions stress, tone, and segmental phonotactics in Uspanteko. In their analysis, final stress involves iambic footing (e.g. *inb'eweroq* [ʔim.ɓe(we.ˈroq)] 'I'll go to sleep'), whereas penultimate stress (with tone) involves trochaic footing (e.g. *intéleb'* [in(ˈté.leɓ)] 'my shoulder') (Can Pixabaj 2007:57,224). Bennett & Henderson support this analysis by arguing that foot-internal vowels are more susceptible to deletion than foot-external vowels, under both iambic and trochaic footing.

3.2 Lexical tone

Most Mayan languages lack lexical tone, and the modern consensus is that Proto-Mayan and its immediate daughters were not tonal languages (though see McQuown 1956, Fisher 1973; 1976 for dissenting views). However, lexical tone has emerged several times within the Mayan family, mostly as a reflex of post-vocalic [h ʔ], which were often lost in the process of tonogenesis (see Fox 1978, Bennett 2016, Campbell 2017b, England & Baird 2017). Yucatec is the best-studied tonal language in the family (Pike 1946, Blair 1964, Bricker et al. 1998, Frazier 2009a;b; 2013, Sobrino Gómez 2010, and many others). Lexical tone is also attested in Southern Lacandon (Yucatecan), Uspanteko (Eastern Mayan), Mocho' (Western Mayan), and possibly one variety of Tsotsil (Western Mayan; see below). Incipient tone is reported for both Teko and the Ixtahuacán variety of Mam (Eastern Mayan, England & Baird 2017), as well as Tuzanteco (Western Mayan, Palosaari 2011).

Yucatec has a contrast between high /V́ː/ and low /V̀ː/ on long vowels (e.g. *miis* /mìːs/ 'cat' vs. *míis* /míːs/ 'broom'; Sobrino Gómez 2010). Short vowels are realized with pitch in the low-mid range, and are standardly analyzed as phonologically unspecified for tone. Additionally, 'rearticulated' /VʔV/ vowels (phonologically a single nucleus, section 3.3) are realized with a sharply falling pitch contour. The phonetic realization of tone, particularly high /V́ː/, varies with phrasal position and intonational context in Yucatec (e.g. Kügler & Skopeteas 2006, Gussenhoven & Teeuw 2008). Southern Lacandon, another member of the Yucatecan branch, is described as having a contrast between high /V́ː/ and toneless /Vː/ long vowels; as in Yucatec, short vowels are phonologically toneless (Bergqvist 2008:64-6; cf. Fisher 1976).

Uspanteko has a contrast between high (or falling) tone /V́ː/ and low (or unspecified) tone /Vː/ on long vowels in stressed, word-final syllables (e.g. *chaaj* [ˈt͡ʃáːχ] 'ash' vs. *kaaj* [ˈkaːχ] 'sky'; Can Pixabaj 2007:69,110; see also Bennett & Henderson 2013). Additionally, words with short vowels in the final syllable show a contrast between toneless [. . . σˈσ] and tonal [. . . ˈσ́σ], in which both stress and high tone occur on the penult (e.g. *ixk'eq* [ʔiʃ.ˈkˀeq] 'fingernail' vs. *wixk'eq* [ˈwíʃ.kˀeq] 'my fingernail'). (See Kaufman 1976b, Campbell 1977, Grimes 1971; 1972 for different descriptions of stress and tone in Uspanteko.)

Palosaari (2011) describes nouns in Mocho' as having a three-way contrast in stressed, final syllables between toneless long vowels (e.g. *kaanh* [ˈkaːŋ] 'four'), long vowels with falling tone (marked as low, e.g. *kaanh* [kàːŋ] 'sky'), and toneless short vowels (e.g. *k'anh* [ˈkˀaŋ] 'loud') (see also Martin 1984). Sarles (1966) and Kaufman (1972) report that the variety of Tsotsil spoken in San Bartolomé de los Llanos (a.k.a. San Bartolo or Venustiano Carranza Tsotsil) has a contrast between high and low tone on roots, and predictable tones on affixes. This characterization of the data is disputed by Herrera Zendejas (2014), who argues that pitch variation across vowels in San Bartolo Tsotsil reflects allophonic conditioning by glottalized consonants rather than true phonological tone (see also Avelino et al. 2011:fn.1). It appears to be an open question whether this, or any other variety of Tsotsil, might have phonological tone contrasts.

Several languages in the Mayan family have incipient tone: some vowels appear to be specified for a particular pitch level or contour, though pitch is at least partially predictable from context (e.g. Hyman 1976, Hombert et al. 1979). For example, in Ixtahuacán Mam (Eastern Mayan), /Vːʔ/ sequences are realized as [V̂ː], with falling tone and no apparent glottal closure corresponding to the underlying /ʔ/:

(7) Ixtahuacán Mam (England 1983:32-41, England & Baird 2017)

a. *i'tzal* /iʔt͡sal/ → [ˈʔḭʔ.t͡sal] 'Ixtahuacán'
b. *sii'* /siːʔ/ → [ˈsḭ̂ː] 'firewood'
c. *a'* /aʔ/ → [ˈʔa̰ʔ] 'water'
d. *waa'ya* /waːʔja/ → [ˈwâ̰ː.ja] 'my water'

Similar cases of quasi-tonemic pitch conditioned by /ʔ/ are reported for Teko (Eastern Mayan Kaufman 1969, Pérez Vail 2007) and Tuzantec (Western Mayan, possibly a dialect of Mocho', which is tonal; Martin 1984, Palosaari 2011). To our knowledge there are no instrumental studies of incipient tone in Mayan languages.

3.3 Phonation

Several Mayan languages have laryngeally complex vowels. In the Yucatecan languages, modally voiced vowels contrast with so-called 'rearticulated' vowels /V_xʔV_x/ (8). While typically transcribed as a sequence, these are phonologically single segments: words like Mopan *ch'o'oj* [t͡ʃˀoʔoh] 'rat' (Hofling 2011:5,172) are monosyllabic (Bennett 2016:§2.3).

(8) Itzaj (Hofling 2000:4-5,10)

a. *kan* [ˈkan] 'snake'
b. *ka'an* [ˈkaʔan] 'sky'
c. *taan* [ˈtaːn] 'front'
d. *ta'an* [ˈtaʔan] 'lime'
e. *a'* [ʔaʔ] DET

In Yucatec, rearticulated vowels are associated with a sharp high-low pitch contour, /$\acute{V}_x$ʔ$\grave{V}_x$/. Phonetically, rearticulated vowels in Yucatec are usually produced with creaky voice rather than a full glottal stop; Frazier (2009a;b; 2013) argues that a more appropriate phonetic transcription for these vowels would be [V́V̰]. Gussenhoven & Teeuw (2008) report that glottalization is strongest in phrase-final position.

Attinasi (1973) and Coon (2010) argue for a second type of laryngeally complex vowel in Ch'ol (Western Mayan), 'aspirated' /V͡h/~/V͡V̥/ (e.g. *k'ajk* [kˀahk]~[kˀaḁk] 'fire' vs. *pak'* [pakˀ] 'seed'). However, many authors treat the voiceless portion of 'aspirated' vowels as an independent consonant rather than contrastive vowel phonation (e.g. Schumann Gálvez 1973, Vázquez Álvarez 2011). Polian (2013:105,112-7) notes that [VhCCV] clusters are the only triconsonantal clusters permitted in Oxchuc Tseltal (Western Mayan), which may indicate that [h] is in fact a vowel feature rather than a true consonant in this context (see also Vázquez Álvarez 2011:19,46-7 on Ch'ol).

Both phonemic and epenthetic glottal stops are pervasive in Mayan, and are frequently realized as creakiness on adjacent vowels rather than a full stop (Frazier 2009a; 2013, Baird 2011, Baird & Pascual 2011). The realization of /Vʔ C/ sequences often includes an 'echo' vowel, [V_xʔ^{V_x}C], making them superficially similar to 'rearticulated' vowels in the Yucatecan languages. England & Baird (2017) note that the phonological behavior of /ʔ/ in some Mayan languages suggests that /ʔ/ is both a consonant and a feature of vowels.

3.4 Syllable structure

Mayan languages differ substantially in their consonant cluster phonotactics. Yucatecan and Western Mayan languages tend to allow clusters of no more than two consonants, as in Ch'ol *kpech* [k-pet͡ʃʰ] 'my duck' (Vázquez Álvarez 2011:19,46-7). Eastern Mayan languages are often more permissive, e.g. Sipakapense *xtqsb'jaj* [ʃtqsɓχaχ] 'we are going to whack him/her/it' (Barrett 1999:32). Complex clusters in Eastern Mayan are frequently the result of prefixation and/or vowel syncope; as a consequence, word-final clusters are often simpler than initial or medial clusters even in languages (like Sipakapense) which allow long strings of consonants (Barrett 1999:23-33). It should be noted that the actual *syllabification* of consonant clusters, phonologically speaking, remains unclear for many Mayan languages (see Bennett 2016:§4). Sonority does not seem to influence consonant cluster types in Mayan, though certain clusters are avoided (e.g. adjacent identical consonants; García Matzar et al. 1999:29 for Kaqchikel, Bennett 2016:§§2.4.4,4 generally).

Root morphemes typically conform to a /CV(:)C/ template, though more complex roots like Kaqchikel *k'u'x* /kˀuʔʃ/ 'heart' are attested as early as Proto-Mayan (Kaufman 1976a; 2003). These root shape restrictions are statistical regularities rather than absolute requirements, and hold more strongly for some lexical classes (e.g. verbs) than for others (e.g. nouns). The /CV(:)C/ root template may reflect independent syllable shape requirements, with the caveats that (i) some languages seem to allow syllables which are more complex than /CV(:)C/, while still enforcing root shape requirements; and (ii) there are other phonotactic conditions in Mayan languages which hold directly over roots and which do not apply to syllables as such (e.g. consonant co-occurrence restrictions; Bennett 2016:§5).

3.5 Intonation

Many primary sources on Mayan languages describe intonation across different clause types, but there are no large-scale surveys of intonation in the family. Additionally, the relationship between morpho-syntactic structure and higher prosodic domains has not been studied systematically for most Mayan languages.

A few generalizations nonetheless emerge from the existing descriptive literature. In both Eastern and Western Mayan one finds languages in which simple declarative sentences are canonically produced with a final rising pitch contour (e.g. Berinstein 1991, Aissen 1992; 2017b, Palosaari 2011, Shklovsky 2011, and references there). Such languages go against the typological trend toward falling intonation in declaratives (e.g. Gussenhoven 2004:Ch.4). Nuclear stress tends to occur in phrase- or utterance-final position (e.g. K'iche' and Q'eqchi', Eastern Mayan, Berinstein 1991, Nielsen 2005, Henderson 2012, Baird 2014, Burdin et al. 2015, Wagner 2014; Ch'ol, Western Mayan, Warkentin & Brend 1974; Huasteco, Larsen & Pike 1949).

Many Mayan languages have clitics or affixes whose form and/or appearance is conditioned by phrasal position (e.g. Skopeteas 2010, Aissen 2000; 2017b). In K'iche', for instance, intransitive verbs are marked with the 'status suffix' /-ik/ when occurring at the end of an intonational phrase (IP), but not in IP-medial position (Henderson 2012):

(9) a. X-in-kos-<u>ik</u>.
COMPL-B1SG-tire-SS
'I am tired.'

b. X-in-kos r-umal nu-chaak.
COMPL-B1SG-tire A3SG-cause A1SG-work
'I am tired because of my work.'

These edge-marking morphemes can be a useful diagnostic for intonational domains in Mayan (e.g. Aissen 1992).

Most research on the intonation of Mayan languages has dealt with the prosody of topic and focus constructions. Almost all Mayan languages have VS(O) or V(O)S as their basic word order (England 1991, Clemens & Coon to appear; Huasteco is an exception, Edmonson 1988:565).

Discourse topics may appear in a preverbal position (10c) (Aissen 1992; 1999; 2017a). Focused constituents may also be fronted, typically to a position between the verb and a preverbal topic, if present (10c). *In situ* focus is possible as well, sometimes with additional morphological marking or focus particles (10b) (see also Velleman 2014).

(10) Tsotsil (Aissen 1987; 1992; 2017a)

a. [Tseb San Antrex]$_{\text{F}}$ la te s-ta-ik un.
girl San Andrés CL there A3-find-PL ENCL
'It was a SAN ANDRÉS GIRL that they found there.'

b. ja' i-kuch yu'un i [soktometik]$_{\text{F}}$
FOC COMPL-work by DET Chiapanecos
'It was THE CHIAPANECOS that won.'

c. [A ti prove tzeb-e]$_{\text{TOP}}$ [sovra]$_{\text{F}}$ ch'ak'bat.
TOP DET poor girl-ENCL leftovers was.given
'It was LEFTOVERS that the poor girl was given.'

In some Mayan languages, preverbal topics are followed by a relatively strong prosodic boundary, indicated by phrase-final intonational contours, the possibility of pause, pitch reset, and phrase-final morphology (Aissen 1992, Avelino 2009, Can Pixabaj & England 2011, Bennett 2016, England & Baird 2017). Fronted foci are typically followed by a weaker boundary, and in some languages (e.g. Tz'utujil, Aissen 1992) even topics appear to be prosodically integrated with the rest of the clause (see also Curiel Ramírez del Prado 2007, Yasavul 2013, Burdin et al. 2015).

In Yucatec, fronted foci do not appear to be prosodically marked (at least with respect to duration and pitch excursions, Kügler & Skopeteas 2006; 2007, Kügler et al. 2007, Gussenhoven & Teeuw 2008, Avelino 2009; *in situ* foci *may* be followed by pauses, Kügler & Skopeteas 2007). K'iche' may also lack prosodic marking for focus (Yasavul 2013, Velleman 2014, Burdin et al. 2015); however, Baird (2014) found that duration, pitch range, and intonational timing were potential cues to focus in this language, particularly for *in situ* focus.

4 Toto-Zoquean

The Toto-Zoquean language family consists of two major branches, Totonacan and Mixe-Zoquean (Brown et al. 2011). The Totonacan languages, consisting of 3 Tepehua and approximately 16 Totonac varieties, are spoken in the states of Veracruz and Puebla, Mexico. The Mixe-Zoquean languages, consisting of 7 Mixe and 5 Zoque (also called Popoluca[9]) varieties, are spoken further south in the states of Oaxaca and Chiapas, Mexico (Wichmann 1995).

4.1 Syllable structure, length, and phonation type

Most Toto-Zoquean languages permit up to two onset and coda consonants, i.e. (C)(C)V(V)(C)(C). In most languages, there is a phonemic contrast in vowel length as well. In Ayutla Mixe, up to four coda consonants are possible, though more complex clusters are usually heteromorphemic,

[9] Not to be confused with *Popoloca*, which is Oto-Manguean.

e.g. /t-ʔaˈnuˀkʂ̥-nɤ-t/, 3A-borrow-PERF-PL.DEP, [tʔaˈnuˀkʂ̥n̥t] ‘*they borrowed it*’ (Romero-Méndez 2009:79). Examples showing varying syllable types are given in Table 9.

Table 9

Rime	CVC		CV:C		CVCC		CV:CC	
/V/	hut	‘hole’	huːt	‘take it out!’	tʌt͡sk	‘ear’	waːn=s	‘few=1S’
/Vˀ/	puˀt͡s	‘short’	puˀut͡s	‘rotten’	jhɤˀkʂ̥	‘it gets hot’	jhɤˀɤkʂ̥	‘it got hot’
/Vʰ/	pʌʰk	‘bone’	nʌːʰʂ̥	‘ground’	kʌʰpʂ̥	‘speak!’	kʌːʰpʂ̥	‘he spoke’

Syllable structure in Ayutla Mixe (data from Romero-Méndez (2009))

Table 9 also demonstrates the contrast between short and long vowels in Ayutla Mixe. The length contrast is orthogonal to voice quality on vowels (modal /V/, creaky /Vˀ/, and breathy /Vʰ/). Though the maximal syllable structure is CCV:CC in Ayutla Mixe, complex codas are rare after long vowels in uninflected stems, and are often heteromorphemic or expone verbal inflection. Similar syllable structure constraints are found throughout the family, e.g. in Alotepec Mixe (Reyes Gómez 2009), Chuxnabán Mixe (Jany 2011), Tamazulápam Mixe (Santiago Martínez 2015), Sierra Popoluca (de Jong Boudreault 2009), Filomena Mata Totonac (McFarland 2009), Huehuetla Totonac (Kung 2007), Misantla Totonac (MacKay 1994; 1999), Zacatlán Totonac (Aschmann 1946), and Pisaflores Tepehua (MacKay & Treschel 2013).

Phonation type is contrastive on vowels in most Toto-Zoquean languages. Modal vowels contrast with glottalized/creaky vowels, often transcribed as /Vˀ/ when short and /VˀV/ when long. In certain varieties of Mixe (Alotepec, Ayutla, Chuxnabán, Totontepecano) (Jany 2011, Reyes Gómez 2009, Romero-Méndez 2009, Suslak 2003) and Sayula Popoluca (Clark 1959), breathy vowels also occur. In Chuxnabán Mixe, short glottalized vowels are realized with creaky phonation at the end of the vowel portion, while long glottalized vowels are “rearticulated”, realized with glottalization at the vowel midpoint (Jany 2011, Santos Martínez 2013). Breathy vowels are realized with final aspiration or breathiness near the end of the vowel nucleus, regardless of length. The same pattern of vowel-glottal phasing (cf. Silverman (1997b)) is described impressionistically for Alotepec Mixe Reyes Gómez (2009), Sierra Popoluca (de Jong Boudreault 2009), and Zacatlán Totonac (Aschmann 1946). In Metepec Mixe, rearticulated vowels contrast with long, glottalized vowels, i.e. /VˀV/ vs. /Vːˀ/, (Santos Martínez 2013). Glottalized consonants are found in both Huehuetla Totonac (Kung 2007) and Pisaflores Tepehua, but glottalized vowels do not occur (MacKay & Treschel 2013). In both languages, bilabial and alveolar stops are realized as implosives in word-initial position, whereas more posterior stops/affricates are realized as ejectives.

Vowel length is contrastive in many Toto-Zoquean languages and may interact with phonation type. In Ayutla Mixe (above) and in Totontepecano Mixe (Suslak 2003), both glottalized and breathy vowels contrast for length. However, in Alotepec Mixe, length is non-contrastive in breathy vowels (Reyes Gómez 2009). A three-way contrast in vowel length has been described for Coatlán Mixe, e.g. /poʃ/ ‘guava’, /poːʃ/ ‘spider’, and /poːːʃ/ ‘a knot’ (Hoogshagen 1959). Subsequent work on the closely-related Guichicovi Mixe variant showed that this three-way contrast was not phonemic, but partially conditioned by a previously undescribed contrast in consonant length (lenis vs. fortis consonants). In a phonetic study on Guichicovi Mixe, Bickford (1985) found that short and long vowels shorten before fortis consonants, e.g. /kappɨk/ [kăpːɨk] ‘carry it (IMP)’, but lengthen before lenis consonants, e.g. /kapɨk/ [kaːpɨk] ‘no (QUOT).’ An alternation between vowel and consonant length is phonologized in Alotepec Mixe, where ‘weak’ consonants surface after long vowels (/Vː, Vˀ V/) and not before short vowels (Reyes Gómez 2009). Phonetically, short vowels in Ayutla Mixe are more centralized than long vowels are (Romero-Méndez 2009) and impressionistic work on Zacatlán Totonac and Tlachichilco Tepehua suggests a similar pattern (Aschmann 1946, Watters 1980). However, little instrumental work has been done to date on these vowel length contrasts and associated consonant mutations.

4.2 Stress and Intonation

Four types of primary stress systems are observed in Toto-Zoquean languages, differing slightly from those observed in Mayan languages (§3.1): quantity-sensitive stress, morphologically-conditioned stress, fixed stress, and lexical stress. Primary and secondary stress are observed in most languages, and evidence of tertiary stress in Sierra Popoluca is discussed in de Jong Boudreault (2009). Primary stress usually surfaces at the right edge of the morphological word, but the conditions on its assignment vary.

The most common stress pattern in Toto-Zoquean is primary stress on the final heavy syllable, but otherwise on the penult, as in Sierra Popoluca (de Jong Boudreault 2009), Misantla Totonac (MacKay 1999), Pisaflores Tepehua (MacKay & Treschel 2013), Huehuetla Totonac (Kung 2007), and Texistepec Popoluca (Wichmann 1994). The phonological criteria for categorizing syllables as light or heavy varies by language. In Pisaflores Tepehua, syllables with long vowels and/or sonorant codas are heavy, but syllables with obstruent codas are light (MacKay & Treschel 2013). In Huehuetla Totonac, only syllables with codas are classified as heavy (open syllables are light) (Kung 2007). A unique pattern is found in Misantla Totonac, where syllables with a coda coronal obstruent are light, but syllables with any other coda or with a long vowel are heavy (MacKay 1999) (Table 10).

Table 10

Penultimate	/min-kiɬ-nḭ/	[ˌmiŋˈkiɬnḭ]	‘your mouth’	/min-siksi/	[ˌmiˈsiksi]	‘your bile’
	/paːɬka̰/	[ˈpaːɬka̰]	‘comal’	/kḭspa̰/	[ˈkḭspa̰]	‘corn kernel’
	/mukskut/	[ˈmukskut]	‘fire’	/maː-kit͡sis/	[maːˈkit͡sis]	‘five’
Ultimate	/min-paː-luː/	[ˌmimˌpaːˈluː]	‘your intestines’	/min-laː-qa-pḭn/	[ˌmiˌlaːqaˈpḭn]	‘your ribbons’
	/ɬukuk/	[ɬuˈkuk]	‘pierced’	/sapa̰p/	[saˈpa̰p]	‘warm’

Segment-based quantity-sensitive stress in Misantla Totonac nouns (MacKay 1999)

Table 10 also illustrates weight-sensitive secondary stress in Misantla Totonac. Primary stress is assigned at the right edge, but secondary stress surfaces on all preceding heavy syllables in the word, a pattern also observed in Pisaflores Totonac (MacKay & Treschel 2013). Secondary stress occurs on every other syllable preceding the primary (rightmost) stressed syllable in both Texistepec Popoluca (Wichmann 1994) and Huehuetla Totonac (Kung 2007).

Primary stress is morphologically-driven in many Toto-Zoquean languages. Table 10 reflects the stress pattern found on nouns in Misantla Totonac, but verbs have fixed final stress (i.e. no weight-sensitivity). Despite otherwise having right-edge primary stress, ideophonic words in Huehuetla and Filomena Mata Totonac have initial stress (Kung 2007, McFarland 2009). Moreover, morpheme-specific exceptions to these stress patterns occur throughout the family (Romero-Méndez 2009). In some languages, the domain of primary stress assignment is the nominal or verbal root rather than the morphological word, e.g. Ayutla and Tamazulápam Mixe (Romero-Méndez 2009, Santiago Martínez 2015). Lexical stress occurs in Filomena Mata Totonac, though almost 85% of the lexicon displays morphologically-conditioned stress (McFarland 2009:51) (Table 11). In such cases stress is not quantity-sensitive: final light syllables may receive stress when they follow heavy penults, and light penults or antepenults may receive stress when the final syllable is heavy. Fixed stress is rare within Toto-Zoquean languages. Primary stress is fixed in penultimate syllables in Chimalapa Zoque (Johnson 2000), Chapultenango Zoque (Herrera Zandejas 1993), and Chiapas Zoque (Faarlund 2012), but word-initial in Alotepec Mixe (Reyes Gómez 2009).

Table 11

Antepenultimate		penultimate		ultimate	
ˈskawawʔḁ	‘dry tortilla’	ˈʃtiːlan	‘chicken’	naˈku	‘heart’
		ˈsasan	‘skunk’	tʃaaˈli	‘tomorrow’
		piˈtʃawaʔḁ	‘eagle’	ɬtoˈxox	‘backpack’

Lexical stress in Filomena Mata Totonac (McFarland 2009).

There are only some impressionistic descriptions of the intonational patterns in Toto-Zoquean languages. For Tlachichilco Tepehua, Watters (1980) describes statement intonation as consisting of a downglide from the stressed syllable if stress is utterance-final, but a high pitch and subsequent fall if the stressed syllable is not final. Question intonation is described as having a high pitch on the pre-tonic syllable and a low target pitch on a final stressed syllable. In Zacatlán Totonac, statements are described as involving an utterance-final fall, but content questions consist of a final rise (Aschmann 1946). Apart from the patterns mentioned here, there are a large number of segmental processes which are sensitive to prosodic domains and stress in Toto-Zoquean languages, such as consonant weakening, glottalization, and the domain of palatalization rules. Readers are referred to the descriptions of individual languages mentioned here for more information on these patterns.

5 Conclusion

The three major language families of Meso-America (Oto-Manguean, Mayan, and Toto-Zoquean) display an extreme diversity of word-prosodic patterns, including complex lexical tone systems, distinct stress alignment patterns, simple and complex syllable structure, and myriad phonation contrasts which interact with other prosodic phenomena. Generally speaking, there is a paucity of linguistic research on higher-level prosodic structure in Meso-American languages. Moreover, despite the observed complexity, a large number of languages remain minimally described; the descriptive work consists of either older unpublished sources or brief statements found within more general grammatical descriptions. The patterns summarized here serve both as a brief overview of the typological complexity within this linguistic area and as a motivation towards future fieldwork and research.

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