# Prosodic structure in Ixtayutla Mixtec: Evidence for the foot

by

Kevin L. Penner

A thesis submitted in partial fulfillment of the requirements for the degree of

**Doctor of Philosophy**

Department of Linguistics
University of Alberta

Examining committee:

Dr. David Beck, Supervisor
Dr. Anja Arnhold, Supervisory Committee
Dr. Christian DiCanio, Supervisory Committee
Dr. Stephanie Archer, Examiner
Dr. Larry Hyman, External Examiner

## Abstract

Research on Mixtec languages (Otomanguean, Mexico), has long recognized a bimoraic/ bisyllabic "couplet" as an essential structure for the description of the phonology and morphology (e.g. Pike 1948; Josserand 1983); however, what exactly this structure is in terms of the structure of the word, as well as the nature and extent of its influence in the grammar has not been adequately addressed. Most researchers have assumed that the couplet is the root, but this is problematic since some synchronic roots are larger than a couplet, other couplets are multimorphemic and some couplets have a reduced form when not the stressed element in compounds. For a more adequate understanding of this structure, I turn to prosodic phonology where units of higher level phonological organization arranged in what is called the prosodic hierarchy form the domains for phonological patterns and provide the shapes of templates. Of particular relevance to the problem at hand is the foot, which is identified in the literature as a constituent between the syllable and the prosodic word in the prosodic hierarchy (Selkirk 1980a; Selkirk 1980b). Cross-linguistically, the foot is integrally connected to stress assignment, has a small inventory of basic shapes, plays an important templatic function in the synchronic and diachronic phonology of many languages and provides the domain for phonological rules and phonotactic generalizations.

In this dissertation I show that the couplet in Ixtayutla Mixtec (IM), an underdescribed Mixtec variety spoken in Oaxaca, Mexico has all of these properties of the foot. I first show that the couplet is the locus of stress assignment in IM, a structure intermediate in size between the syllable and prosodic word and has the shape identified as a moraic trochee in Hayes' (1995) inventory of foot types. Although IM stress is not the iterative kind usually used in metrical arguments for the foot, Spanish loanword adaptation in IM clearly demonstrates that stress is obligatorily realized in a left-headed, bimoraic structure.

Strong evidence that the couplet is a foot comes from the way this structure to which stress is assigned also functions templatically to create foot-sized structures. As the minimal word/root template, the foot triggers the synchronic augmentation of underlyingly monomoraic /CV(ˀ)/ structures to bimoraic CV(ˀ)V. Fossilized stems also show how subminimal forms were combined to create foot-sized stems at an earlier stage of the phonology, while at the same time the foot provides a template for the truncation of larger structures down to foot-size. Beyond mere size/shape, evidence for foot structure is seen, for instance, in the loss of unfooted, and therefore prosodically weak, pre-couplet vowels, as well as the loss of couplet-medial consonants, which stand in the weak position of the trochaic foot. Like the foot, the couplet also provides the domain for the realization of a number of diverse phonological patterns including distributional restrictions on contrastive laryngealization, nasalized segments, vowels, labial consonants, epenthetic laryngealization and tone. The end result of the foot-based analysis provided is in this dissertation a coherent explanation for a disparate set of phonological patterns encompassing the synchronic and the diachronic dimensions of the phonology.

## Preface

This thesis is an original work by Kevin L. Penner. The research project, of which this thesis is a part, received research ethics approval from the University of Alberta Research Ethics Board, Project Name "Documentation of Ixtayutla Mixtec", ID: MS9_Pro00012477, April 21, 2010 (final renewal March 7, 2018).

# Dedication

In memory of
Alyssa Anne Penner
2006–2010

## Acknowledgments

I would first like to acknowledge my Mixtec friends and consultants, who have spent countless hours helping me learn and explore their language. I am particularly grateful to Primo Quiroz Quiroz, who invited me and my family to live among them, Miguel Quiroz Merino, who was my primary consultant and let our family live in his house for over a year, and Inez Merino Quiroz, who also provided a mountain of data, especially in the early days of my research. Other important Mixtec friends and consultants are Celerina Quiroz Merino, Andrea Hernandez Merino, Francisco Quiroz Merino and Andrés Quiroz Quiroz.

I owe a debt of gratitude to the members of my supervising committee—Dr. David Beck, Dr. Anja Arnhold and Dr. Christian DiCanio—for the many hours they have devoted to this project, their challenging comments/questions and expert advice. I particularly thank my supervisor, David, for his patience, encouragement, expertise, commitment to excellence and repeated attempts to help me remember that this dissertation is just the beginning and not the last word about Ixtayutla Mixtec phonology. Thanks, also, to the other members of my committee, Dr. Larry Hyman and Dr. Stephanie Archer, for taking time to evaluate my dissertation and offer their insights. Thanks to Dr. Keith Snider for his input particularly in regard to the tone analysis; to Dr. Ben Tucker for serving on my candidacy committee, encouraging me and introducing me to acoustic analysis; to Dr. Scott Berthiaume for helping me with the initial analysis of vowel coalescence; to Robert Kirchner for his guidance on my initial descriptions of the tone system; to Dr. Antti Arpe and Stan Guedes for their help with statistics; and to Dr. Inga McKendry for her encouragement. Dr. Andy Black deserves a medal for developing the XLingPaper software I used to write this dissertation and for the one-on-one support he gave me. This dissertation would never have been completed

without the help of these people and it is certainly a much better product for their input; but don't blame them for the shortcomings that it still displays!

My dear wife, Laurel, should be awarded a degree herself for her contribution in this project, preparing production experiment sound files for analysis, helping to populate my tone and Fieldworks databases, transcribing oral texts in ELAN for hours and hours and editing drafts of the dissertation. Beyond these practical helps, however, she has believed in me, when I did not believe in myself, endured my tirades and discouragement and shouldered extra family responsibilities because of my long hours of work. I love you very much, Dear, and it's clear that you love me, too. Thanks, also, to my children, Kyle, Gabrielle and Daniela, for your patience and love during the long journey to complete this project. May Alyssa, who passed away in the first year of my program, experience unbridled joy and peace in the loving arms of Papa.

I also wish to express my gratitude for the considerable help and encouragement I have received from various others, without which I would not have made it through: to my parents for their unceasing prayers and encouragement; to my brother and his wife for letting me stay at their home in Edmonton; to Doug and Connie Inglis for discussions, friendship, coffee at Tim Horton's, meals and a place to stay; to Greg and Chrisie Rector for letting me hide away in their loft to work undistracted for months; to Wayne Nelson for his friendship, hanging out with me early on Saturday mornings, encouraging me and praying with me; to Darcy Austin for his friendship, prayers, breakfasts and encouragement; to the guys in my Monday night group for the prayers and encouragement; and to my parents-in-law for their patience and many prayers. I would also like to thank SIL International for its financial support throughout the duration of my study program.

The most important consequence of this PhD program has not been the linguistic knowledge and expertise I have developed, nor the contribution to the field that I believe my dissertation makes, but rather that it has made me face my fear of failure and taught me to cast myself upon the grace of my Heavenly Papa and to trust him a little more. It is my desire that this ancient heart-cry of the Psalmist would be true of me:

Yet I am always with you;
you hold me by my right hand.
You guide me with your counsel,
and afterward you will take me into glory.
Whom have I in heaven but you?
And earth has nothing I desire besides you.
My flesh and my heart may fail,
but God is the strength of my heart
and my portion forever.[1]

[1] The Holy Bible: New International Version. (1984). (Ps 73:23–26). Grand Rapids, MI: Zondervan.

# Contents

## Abbreviations

**Tone marks and special symbols.** Tones are designated using the following abbreviations and diacritics: H or *á* = high tone, M or *ā* = mid tone, L or *à* = low tone, $^L$ = floating L tone, $^H$ = floating H tone, *â* = HL on a single TBU (used only in underlying representations) and *a* (unmarked) = toneless. A tonal suprafix is indicated with a floating tone and " ⁀ " connecting it to the base: $^L$⁀*kájú* 'is burning'. At times I will also indicate the relative surface pitch of each tone bearing unit schematically using tone bar glyphs, e.g. LH = [_ ¯]. Rising contours and falling contours are indicated by bars slanting upward, [⟋], and downward, [⟍], respectively. The symbol, " ˀ " indicates vowel glottalization. Primary and secondary stress are marked using the IPA symbols " ˈ " and " ˌ ", respectively. These symbols are also used: ° = Tonal Root Node, μ = mora and σ = syllable. Syllable boundaries are indicated with a period, couplet/foot boundaries with round brackets and prosodic word boundaries with square brackets (e.g. *[tú.(sũˀ.mã̀)]*). An etymological morpheme boundary is indicated by " • ".

**Abbreviations.** The following abbreviations are used in this dissertation:

| | | |
|---|---|---|
| 1 | = | first person |
| 2 | = | second person |
| 3 | = | third person |
| *LL | = | constraint against consecutive L tones within a foot |
| AFFIRM | = | affirmative |
| ANML | = | animal classifier |
| CAUS | = | causative |
| CM | = | Chalcatongo Mixtec (ISO 639-3: mig) |
| COMP | = | complementizer |

| | | |
|---|---|---|
| EMPH | = | emphatic |
| EXCL | = | exclusive |
| FEM | = | feminine |
| F | = | foot |
| FLA | = | Floating L Association |
| GEN | = | genitive |
| GNRL | = | general |
| HTS | = | High Tone Spread |
| HUM | = | human classifier |
| IMP | = | imperative |
| INCH | = | inchoative |
| INCL | = | inclusive |
| ILD | = | Initial L Delinking |
| IM | = | Ixtayutla Mixtec (ISO 639-3: vmj) |
| INTS | = | intensification |
| IPFV | = | imperfective |
| IRR | = | irrealis |
| LFTA | = | Leftward Floating Tone Association |
| LOC | = | locative |
| LRS | = | Low Register Spread |
| LTS | = | Low Tone Spread |
| MASC | = | masculine |
| MOT.AW.PR | = | motion in progress away from deictic centre |
| MOT.AW.IRR | = | irrealis motion away from deictic centre |
| NEG | = | negation, negative |
| NEG.SBJV | = | negative subjunctive |

| | | |
|---|---|---|
| OBJ | = | objective |
| OCP | = | Obligatory Contour Principle |
| OPT | = | optative |
| PE | = | plural exclusive |
| PFV | = | perfective |
| PL | = | plural |
| PM | = | Proto-Mixtec |
| PPH | = | Phonological Phrase |
| POL | = | polite |
| PROG | = | progressive |
| PWRD | = | prosodic word |
| PROS | = | prospective aspect |
| Q | = | question particle/marker |
| REAL | = | realis |
| RND | = | round objects classifier |
| REP | = | repetitive |
| RESP | = | respectful |
| RNT | = | roundtrip |
| RTT | = | Register Tier Theory |
| SM | = | San Miguel El Grande Mixtec (ISO 639-3: mig) |
| S | = | single argument of canonical intransitive verb |
| SBJ | = | subject |
| SBJV | = | subjunctive |
| SG | = | singular |
| SE | = | Southeastern Nochixtlán Mixtec (ISO 639-3: mxy) |
| SPHER | = | spherical |

| | | |
|---|---|---|
| SLH | = | Strict Layer Hypothesis |
| TBU | = | Tone bearing unit |
| TRN | = | Tonal Root Node |
| VOC | = | vocative |
| VA | = | Vertical Assimilation |
| WOOD | = | wood objects classifier |

# List of Tables

# List of Figures

# Chapter 1

# Introduction

> A disyllabic unit which we here for want of a better term may call the 'couplet' is the pertinent distributional matrix in M[ixtec]. (Longacre 1955:18)

Research on Mixtec languages has long recognized a bimoraic/disyllabic "couplet" as an essential unit for the description of the phonology and morphosyntax (e.g. Pike 1944; 1945; 1947; 1948; Longacre 1955; Josserand 1983); however, what exactly this unit is in terms of the structure of the word, as well as the nature and extent of its influence in the grammar has not been adequately addressed. This dissertation addresses the question, implied in the epigraph, of what better term there might be for "couplet" in Mixtecan linguistics using data from Ixtayutla Mixtec (IM; Otomanguen, Mexico), an underdescribed Mixtec variety spoken in Oaxaca, Mexico.

Couplet forms are highly restricted and quite uniform across Mixtec varieties. Leaving aside rare couplet initial consonant clusters and vanishingly few word final consonants, couplets in particular languages consist of the following, or a subset of the following, canonical patterns (V = vowel, C = consonant, ˀ = vowel glottalization):

(1) Mixtec couplet canons (Josserand 1983:229)

| | Plain vowels | Glottalized vowels |
|---|---|---|
| a. | CVCV | CVˀCV |
| | VCV | VˀCV |
| b. | CVV | CVˀV |
| | VV | VˀV |

Reference to this unit is considered vital to the description of such things as stress (e.g. Pankratz & Pike 1967; Pike & Oram 1976; Zylstra 1980; Josserand 1983), tone sandhi (e.g. Pike 1948; Mak 1958; Pike & Cowan 1967) and the distribution of phonemes and allophones in general (e.g.

Longacre 1955; Pike & Cowan 1967; Hunter & Pike 1969; Josserand 1983), and particularly, nasal(ized) segments (e.g. Hunter & Pike 1969; Zylstra 1980; Josserand 1983; Marlett 1992), glottalized vowels (e.g. Pike & Small 1974; Josserand 1983; Macaulay & Salmons 1995), vowel cooccurrence patterns (Pike 1947), tones (e.g. Pike 1948; Mak 1958; Daly & Hyman 2007) and allotones (e.g. Hunter & Pike 1969).

Despite the pervasiveness of the couplet in Mixtec analyses, there is an indeterminacy in the literature as to whether it is a morphological unit or a phonological unit, or even a unit that is ambiguously both morphological and phonological as seen, for instance, in North & Shields (1977:21), who state, "The couplet is the nucleus of the phonological word as well as the grammatical word." On the morphological side, Pike (1944; 1945; 1947; 1948) conceived the couplet as the basic form of the Mixtec morpheme, while many other researchers view it as corresponding to or equivalent to the morphological root (e.g. Macaulay 1987b; Macaulay 1996:13; Hinton et al. 1991:13; Gerfen 1996:17; Paster & Beam de Azcona 2005). Both of these conceptions, however, are problematic. Pike (1944) considered the basic form of virtually all morphemes in San Miguel El Grande Mixtec (SM) to be bimoraic/disyllabic, and that monosyllabic forms are reductions (cliticizations) of independent words having an underlying couplet form; however, Macaulay (1987b; 1987a) convincingly demonstrates that closely related Chalcatongo Mixtec (CM) has affixes and clitics, both of which do not meet the bimoraic/disyllabic minimality requirement of free words. These morpheme types are also found in IM, as shown in (2).

(2) a. *í–* 'perfective'
b. *sà–* 'causative'
c. *=ⁿdí* 'first person plural exclusive'
d. *tʃá$^{L}$=* 'what'

These examples include an aspectual prefix (2a), a derivational prefix (2b), an enclitic pronoun (2c) and a proclitic relative pronoun (2d), all of which constitute morphemes in the language that are underlyingly monomoraic—that is, are not couplets.

Equating the couplet with the morphological root comes from the fact that many roots have a couplet form and are both bases for morphological processes and the descriptive unit for morpheme structure rules (Josserand 1983:181–3); however, it can also be demonstrated that the couplet is not equivalent to the morphological root, since some synchronic roots are larger than a couplet, as illustrated by these IM examples, where the couplet boundaries are indicated using round brackets:

(3) a. *ɲã́(jɨβɨ̀)* 'people'
b. *tɨ̀(tʲéˀléᴸ)* 'cockroach'
c. *pè(ɾùú)* 'watermelon'
d. *tɨ̀(nɨ̃́ˀɨ̃́ᴸ)* 'twins'

At the same time, other couplets are multimorphemic, as shown by (4a–b), or were multimorphemic at an earlier stage of the language, as in (4c–d):

(4) a. *(nṹĩ̀)*
*nṹ=ĩ̀*
face=1SG
'my face'

b. *(kã̀ˀĩ́)*
*ᴸ⁀kã́ˀ=í*
IPFV⁀speak=1SG
'I am speaking'

c. *(ku•tʲì)*
bathe:IRR
'will bathe'

d. *(tɨ̃̀•ɲɨ̃̄)*
rat
'rat'

(Etymological morpheme boundaries are indicated here and elsewhere with the symbol, "•".) The couplet in (4a) consists of the noun, 'face', plus an enclitic pronoun (cf. §2.5, §6.2.1), while the couplet in (4b) includes the verb 'to speak', an enclitic pronoun and an aspectual tonal suprafix (cf. §2.4.2, §4.2.2). Historically, (4c) consisted of a verb root 'to bathe' plus a mood prefix (*kù–* 'irrealis') (cf. §2.4.2, §6.2.2.1), and (4d) is a fusion of an old animal classifier prefix, *tì–* (cf. de León 1988; Macaulay 1996:69) with an unknown root (cf. §2.4.1, §6.2.2.1). Data showing multimorphemic couplets like those in (3) and (4) are not unique to IM (e.g. Longacre 1955:19; Josserand 1983:181–3) and illustrate that the couplet is non-isomorphic with the morphological root, even though roots are often realized as couplets.

Another way in which the non-isomorphism of the couplet with morphosyntactic structure can be observed is that couplets with long vowels (cf. (1b)) have a reduced, monomoraic form in compounds when they are not the stressed root (cf. §2.4.1, §6.2.1):

| | | | |
|---|---|---|---|
| (5) | a. | *(ˈjúú$^{L}$)* | 'stone' |
| | | *(ˈkáà)* | 'metal' |
| | | ***jú**(ˈkáà)* | 'sharpening stone' (lit. 'stone (for) metal') |
| | b. | *(ˈβeˀè)* | 'house' |
| | | *(ˈjúkú$^{L}$)* | 'medicine' |
| | | ***βè**(ˈjúkú$^{L}$)* | 'hospital' (lit. 'house (of) medicine') |

In each example, the reduction is seen by comparing the first form given in the example (i.e. the unreduced couplet form) with its corresponding form (in bold) in the final (compound) form in the example. The difference in the shape of the root in these different prosodic positions argues against equating the couplet with the root, since the root is not a "couplet" when it is not the stressed root in the compound and suggests instead that the couplet is a phonological unit.

Longacre (1955) acknowledges the phonological nature of the couplet and various researchers after him explicitly promote the idea that the couplet is a phonological structure, calling it the nucleus of the phonological word (Pankratz & Pike 1967; Pike & Cowan 1967; Hunter & Pike 1969; North & Shields 1977). The analysis of the couplet given by Josserand (1983) in her Proto-Mixtec reconstruction is particularly insightful. She admits that, although there are phenomena that make the couplet look like a morphological unit, in the end this conception is untenable. Instead, the couplet is better characterized as "a phonological or surface frame" (p. 183) into which morphological material is fit for its spoken realization. In this conceptualization of the couplet we see the hallmarks of prosodic structure—that is, a higher level unit of phonological organization, which stands in a particular relationship to the units of morphosyntactic structure. Thus, more recently there has been a growing recognition that the couplet should be identified as a prosodic structure, namely the foot (e.g. Macken & Salmons 1997; Castillo García 2007; McKendry 2013; Carroll 2015), although no one has gone to the trouble of working out the details; that is, systematically laying out the properties of the foot that the couplet exhibits and the different roles of the foot that it fulfills. It is the task of providing a rigorous justification for identifying the couplet as a prosodic foot that is taken up in this dissertation in order to fill this gap and position Mixtec studies both to benefit from the vast amount of literature on prosodic phonology and to maximize their contribution to it.

The particular view of prosodic structure espoused in this work is prosodic hierarchy theory (e.g. Selkirk 1980a; Nespor & Vogel 2007 [1986]; McCarthy & Prince 1996 [1986]; Pierrehumbert & Beckman 1988; Inkelas 1989; Zec 1989). In prosodic hierarchy theory, units of higher level phonological organization are arranged in a hierarchy, such as the one in (6), which gives the prosodic units up to the level of the prosodic word and which is assumed in this dissertation.

(6) Prosodic hierarchy (McCarthy & Prince 1995:320)

ω Prosodic Word (PWRD)
|
F Foot
|
σ Syllable
|
μ Mora

A key property of the hierarchy is that units above the lowest unit are composed of at least one unit of the immediately lower level and never higher level units (e.g. Selkirk 1981:382; 1984:26). The foot, which is the constituent between the syllable and the PWRD, is the most obvious unit to which the couplet might correspond, given that the couplet may be larger than a syllable (cf.

(1a)) and smaller than a PWRD (cf. (3)), while at the same time constituting the minimal PWRD, since by definition PWRDs minimally consist of at least one foot. Theoretical and typological work have converged on additional properties of the foot: It is integrally connected to stress assignment (e.g. Liberman 1975; Liberman & Prince 1977; Selkirk 1980b; Hayes 1980), has a small inventory of licit forms (Hayes 1985; 1987; 1995; McCarthy & Prince 1996 [1986]), plays an important templatic function in the synchronic (e.g. McCarthy & Prince 1996 [1986]) and diachronic (e.g. Macken & Salmons 1997; Smith & Ussishkin 2015) phonology of many languages and provides the domain for phonological rules and phonotactic generalizations (e.g. Selkirk 1980a; Nespor & Vogel 2007 [1986]).

In this dissertation, I show, based on extensive original data, that all of these properties of the foot are found in IM and coincide with the descriptive unit "couplet". In particular, I show that the couplet is the unit to which stress is assigned, and that it has the properties of the moraic trochee from Hayes' (1987; 1995) inventory of foot types, being binary, quantity-sensitive and left-headed. The couplet also plays a templatic role in the synchronic phonology by triggering the augmentation of underlyingly monomoraic roots of the form /(C)V(ˀ)/ so that they surface with a bimoraic structure:

(7) a. ***kóó**<sup>L</sup>*
kó<sup>L</sup>
snake
'snake'

b. ***kóˀó**<sup>L</sup>*
kóˀ<sup>L</sup>
bowl
'bowl'

That roots with this structure are not underlyingly bimoraic can be seen, among other things, by the fact that they are not augmented when they combine with the first and second person enclitic pronouns (=*í*, =*ũ̀*); the pronoun vowel simply fills the second mora of the couplet (e.g. ***kóì*** 'my snake', *kóű̃*$^{L}$ 'your snake', *kóˀì̃* 'my dish', *kóˀű̃*$^{L}$ 'your dish'). Roots with a CVCV couplet structure, on the other hand, are never augmented and the pronouns coalesce with the final vowel of the couplet, taking its height feature (e.g. *tʃítò* 'bed', *tʃíté* 'my bed', *tʃítȍ̃* 'your bed'). Since the couplet is the unit to which stress is assigned and has the properties of the moraic trochee, and since it is a common crosslinguistic function of the foot to serve as a template for minimal words/roots and other types of morphemes, I take the fact that the couplet functions as a synchronic template which creates a form matching a moraic trochee as evidence that it should be identified as a foot.

The IM couplet is also found to function as a diachronic template in several different contexts. For instance, in the formation of realis and irrealis stems at an earlier stage of the language, CV roots combined with mood prefixes (*tʃì̃*– 'REAL', *kù̃*– 'IRR') to form a disyllabic couplet (e.g. *tʃi•tʲì̃* 'bathe:REAL', *ku•tʲì̃* 'bathe:IRR'). The formation of stems with a VCV root structure also resulted in a CVCV couplet through truncation—either the prefix vowel was deleted (e.g. *tʃ•isò* 'carry:REAL', *k•isò* 'carry:IRR'), or (sometimes) the irrealis prefix was labialized (e.g. *kʷ•ãɲũ* 'step on:IRR'). Crucially, the couplets formed have the same stress and phonotactic properties as other CVCV couplets. In the formation of realis/irrealis stems, both the augmentation of stems formed with subminimal CV roots by including the prefix in the couplet, and the truncation of stems formed with VCV roots, show the templatic influence of the couplet in the diachronic development of the language. Since the couplet has the properties of the moraic trochee, and since the foot commonly functions as a diachronic template, I take these data as evidence that the couplet should be identified as a foot.

Josserand (1983:460) identified the diachronic tendency to reduce multisyllabic constructions to couplet form as one of the most important processes in the historical development of Mixtecan languages. Besides the truncation shown in the formation of realis/irrealis stems, truncation resulting in consonant clusters is also found in IM, similar to what is reported by Macken & Salmons (1997) for CM. IM has consonant clusters with the forms *s*C, ʃC and *n̥*$^{n}$*d/n̥n*, which are nearly always located at the onset of the couplet (e.g. *(n̥*$^{n}$*dɨ́kɨ́*$^{L}$*)* 'cattle', cf. *sɨ(*$^{n}$*dɨkɨ)* 'cattle' Jamiltepec

Mixtec; Johnson 1988:21), and never in a couplet-medial syllable onset (e.g. *(*ʃaṇ̥*$^{n}$*dù)*, cf. *(ʃa*$^{n}$*-dù)* 'naval'). In many forms, there is either a form in a related language which has a pre-couplet syllable with a vowel, or synchronic free variation with a form having a pre-couplet syllable with a vowel (e.g. *(ʃk*$^{w}$*ɨ̃́ɲɨ̃́*$^{L}$*)* ∼ *ʃɪ(k*$^{w}$*ɨ̃́ɲɨ̃́*$^{L}$*)* 'type of corn'). Identifying the couplet as a foot and analyzing pre-couplet syllables as unfooted and therefore prosodically weak provides a principled analysis of these clusters: The diachronic truncation process targets precisely those vowels that occur in an unfooted, prosodically weak syllable, and result in a structure which matches the foot template, the canonical root shape. An analysis based solely on the syllable, however, is at a loss to explain why all syllables are not affected equally, or why a process which worsens syllable structure by creating complex onsets (cf. Vennemann 1988) would be allowed.

A final context examined in which the couplet functions as a diachronic template like the foot is known to do is a process, also identified by Macken & Salmons (1997) for CM, by which reflexes to couplet-medial **x*, **w* and **j* (particularly, **j* in IM) are lost (e.g. **weji* 'heavy' > *βéè*). Here again one can see that a syllable-based analysis does not predict the location of the consonant deletion, which worsens syllable structure since it creates a syllable with no onset (cf. Vennemann 1988). While a couplet-based analysis is useful to describe the location of the targeted segment (i.e. the couplet-medial consonant), it provides no motivation for it. If, however, the couplet = a trochaic foot, the process is seen as deleting the onset of the non-head, prosodically weak syllable of the foot.

Perhaps the most extensive crosslinguistic role of the foot, outside of its role in stress assignment, is in providing the domain for phonological rules and phonotactic processes (e.g. Nespor & Vogel 2007 [1986]). There are numerous phonotactic patterns in IM that take the couplet as their domain, including distributional restrictions on nasal segments, vowels, labial consonants and tones, the most significant tonal restrictions being that the couplet is the domain in which root tonal melodies are realized and a surface restriction of a single L per couplet. Several tonal processes also take the couplet as their domain including a rule in which the first H of a LHH sequence deletes, but only if the LH is within a couplet and the second H part of the extended PWRD. IM couplets are also the domain of a glottalization process, which targets only the initial vowel (mora) of the couplet. Consonant lenition targets the onset of the second syllable and epenthetic glottalization the initial vowel of vowel initial couplets, but these processes also target pre-couplet syllables, and therefore do not uniquely single out the couplet. They do, however, fit the overall prosodic structure proposed in this dissertation.

Once the couplet is recognized as a foot, a number of different kinds of phonological phenomena find a coherent, unified analysis—processes of augmentation and truncation, synchronic and diachronic patterns, segmental and suprasegmental phenomena, syntagmatic oppositions like stress and paradigmatic oppositions like tone and glottalization. Moreover, when the couplet = foot is understood within the structure of the PWRD, processes that target positions both within the foot and outside of the foot make sense. Examples of such processes are vowel deletion (and labialization) that occurs in pre-couplet syllables in the formation of realis/irrealis stems and that results in couplet initial consonant clusters, as well as consonant lenition that targets both pre- and post-couplet syllables and the onset of couplet-final syllables. The common denominator in all of these weakening processes is that they target segments in prosodically weak positions. Another example is found in the tonal process L Raising. L tones are "raised" (deleted) in HLH sequences, but only if the L is associated with a prosodically weak pre-couplet or couplet-final TBU; if the L is on the head TBU of the foot it is not raised.

A final consequence of identifying the couplet as a foot explored in this dissertation is Spanish loanword adaptation. A strong constraint maintaining correspondence between the stressed syllable in the source word and the adapted word, and the strategies used to repair situations where the mapping of the stressed syllable to the foot template would violate foot structure confirm the essential link between stress and a quantity-sensitive, trochaic foot. The adaptation of Spanish words with final stress provide the strongest evidence for foot structure, since these words cannot be realized as a trochaic foot without repair. The Spanish sources of these adaptations all have a final consonant in my data and three adaptation strategies are found. The first strategy is to lengthen the final vowel and drop the final consonant to create a CVː foot:

(8) *kù(ˈràá)* ‘corral’ cf. *corral* [ko.ˈral]

A second (infrequently attested) strategy is to keep the final consonant and epenthesize a vowel after the consonant, creating a CV.CV foot:

(9) *mà(ˈⁿdì.lí)* ‘apron’ cf. *mandil* [man.ˈdil]

A third strategy is to shift stress back one syllable, also resulting in a CV.CV foot:

(10) *(ˈkò.tō̃)* ‘shirt’ cf. *cotón* [ko.ˈton]

In the first two strategies, correspondence between the stressed syllable of the source and stressed syllable in the adapted forms is maintained at the cost of augmenting the existing structure. In the third strategy, even though correspondence of the stressed syllables is violated, both the bimoraic shape and the trochaic prominence requirements are upheld. All of the structural changes (vowel lengthening, epenthesis and stress shift) demonstrate the obligatory requirement that stress be realized in a left-headed, bimoraic constituent.

In response to Longacre’s (1955) lack of enthusiasm for the term “couplet” that is evident in the epigraph at the beginning of the chapter, I argue that there is a better term—the Mixtecanist descriptive term, “couplet” should be replaced with the term “foot” from prosodic hierarchy theory. The analysis of the couplet in terms of prosodic hierarchy theory provides a broader and more phonologically integrated conceptualization of the couplet by placing it, identified as a foot, within a theoretical framework which is demonstrated to have wide (putatively universal) cross-linguistic applicability, and which

a. clearly identifies the couplet as a phonological structure and defines its relation to other prosodic structures (e.g. mora, syllable, prosodic word)

b. anticipates a close, though non-isomorphic, and definable relationship (mapping) with morphosyntactic structure

c. makes predictions about the roles it will play in the phonology (i.e. stress assignment, template, domain for phonological patterns) and

d. allows the couplet/foot to be compared to related phenomena in other languages (i.e. the typology of the foot).

By (a), we avoid confusing which language subsystem or level we are dealing with so as to adequately describe the couplet/foot on phonological terms before attempting to relate it to morphosyntactic structure, in line with (b) (cf. Hockett 1955; Halliday 1961; Pike 1967). (c) helps to focus our investigation and description of the phenomena, and once the identity of the couplet as a foot has been established, we are able to compare and contrast the IM foot with what meets the definition of "foot" in other languages (d), due to the vast amount of typological research in prosodic phonology.

It is not that the term "couplet" cannot be defined in such a way as to accomplish each of these things, except for (d), unless one were to develop an entire typology of couplets. Rather, the point is that in using the term "foot" we immediately accomplish all of these things, cashing in, so to speak, on several decades of prosodic phonology research. Identifying the couplet as a foot does not obviate the need to completely describe the various ways it is manifested in IM, or any other Mixtec variety, but, as Beck (2016) points out with respect to well-defined, crosslinguistically comparable terms in general, the task of both the analyst and the typologist is made easier and more succinct for having the well-defined term "foot", and the resulting description is able to contribute to ongoing discussions of the foot—what its criterial properties are, how the Mixtec foot is similar to and contrasts with feet in other languages, what additional foot-based patterns exist in other Mixtec varieties, etc. This dissertation thus contributes to the development and refinement of crosslinguistically comparable terminology, which is essential scientific exercise in linguistics (cf. Beck 2016).

The rest of the dissertation is laid out as follows. In Chapter 2, I give general background information about Mixtec languages and IM in particular, review the literature of the couplet in order to gain a better understanding of what is meant and described by the term and provide a sketch of the morphosyntax that provides many examples of couplets in a variety of morphosyntactic contexts and gives essential background needed to make sense of the examples and discussions in later chapters. Chapters 3 and 4, which describe the non-tonal and tonal phonology, respectively, contribute more material essential to understanding the data and arguments presented in support of the thesis, while at the same time showing many examples of couplet-based generalizations. The task of Chapter 5 is to describe the nature of prosodic structure in general, and to define the term foot as a unit within the prosodic hierarchy, giving its structural properties and common typological roles. In Chapter 6, I show, using data from IM, that the couplet has the properties of the foot identified in Chapter 5, and fulfills each of its typologically common roles, and therefore should be identified as a foot. Finally, Chapter 7 summarizes the findings in support of my thesis that the couplet is a prosodic foot, discusses the implications of these findings and makes recommendations for future study.

The IM data for this dissertation consists of primary data I collected during the time of my residency in the community from February, 2003 – March, 2006, in subsequent trips to the area and through various forms of long-distance communication (Voice Over Internet Protocol, telephone, instant messaging and email). This has resulted in a very large amount of data including a Fieldworks Language Explorer (FLEx) (SIL 2017) lexical database of just over 1400 stems (including borrowed words), a FLEx text corpus of 40,000+ words, a time-aligned corpus of more than 300,000 words of oral texts of various kinds (e.g. traditional stories, personal narratives, elicitations, discussions) transcribed in ELAN (MPI 2017; Brugman & Russel 2004) and a variety of other language recordings. Most of this data come from six native speakers, four male speakers and two female speakers, each of whom is fairly bilingual in Spanish.

Because of the vast amount of data collected, I concentrate on subsets of the data for various parts of the analysis. Phonemic analysis and distributions are primarily based on a filtered FLEx database of 1088 native stems of various sizes, which I was able to analyse using Phonology Assistant software (SIL 2015). Tone analysis, which involves examining words in many different contexts to examine contextual pitch variation, focuses on a smaller corpus of 293 noun couplets, 115 nouns larger than a couplet, 100 verb couplets and 62 adjectives. A large portion of the sound data used for tone analysis are organized into separate databases with single words (667 native words) and combinations of words in grammatical frames (4000+) using Bento software (Filemaker 2012).

In addition to data obtained through elicitations and texts, I also draw on four production experiments conducted by myself: the first experiment (Single Word) examines single words pronounced in isolation, the second (N-N) examines each combination of the underlying tonal melodies found on noun couplets in noun-noun associative constructions pronounced in isolation, the third (N-Pron) examines each noun melody combined with each enclitic pronoun melody in a carrier sentence and the fourth (Large Nouns) examines nouns that are larger than a couplet with various tonal melodies in isolation and in carrier sentences with two different tonal configurations. A full, systematic presentation of the production experiments is beyond the scope of this dissertation. Data from the production studies is only partially analyzed, but enough is analyzed to be used (primarily) to establish the canonical shape of pitch contours in various contexts using plots of time-normalized pitch contours averaged over multiple repetitions and speakers. Detailed descriptions of the experiments are given in Appendix A (Single Word), Appendix B (N-N), Appendix C (N-Pron) and Appendix D (Large Noun).

Chapter 2

# Background to Ixtayutla Mixtec

In this chapter I give general background to the IM language in §2.1, including its genetic affiliation, linguistic context and geographical location. This is followed in §2.2 with a review of how the term "couplet" has been used in the Mixtec literature. I show that, while there has been some ambivalence in the literature as to what it is in terms of the structure of the word, there is a core body of research that recognizes the couplet as essentially a phonological unit that is distinct from, but related to morphological structure. With the development of prosodic phonology, the natural progression has been to view the couplet as a prosodic structure corresponding to the foot, although the task of demonstrating this correspondence has yet to be undertaken, a gap which this dissertation fills. The final sections of this chapter give descriptions of IM syntax (§2.3), morphology (§2.4) and clitics (§2.5), that provide many examples of couplets and give the background necessary to effectively navigate the examples and discussions in later chapters.

## 2.1 Language background

Ixtayutla Mixtec (ISO 693-3: vmj) is an underdescribed language of the Otomanguean phylum spoken by over 8000 people in the municipality of Santiago Ixtayutla, which lies in the southwestern corner of the state of Oaxaca, Mexico.[1] Otomanguean consists of eight language families: four in the Western Otomanguean division—Otopamean, Chinantecan, Tlapanec-Subtiaba and Manguean—and four in the Eastern Otomanguean division—Popolocan, Zapotecan, Amuzgo and Mixtecan (Rensch 1976; 1977; Campbell 2000; Kaufman 2006). Mixtec, together with the Cuicatec and Trique languages, belongs to the Mixtecan family in the Eastern Otomanguean branch

[1] This population estimate is based on the number of speakers of an indigenous language given for the IM speaking towns in the 2010 census (INEGI 2010). There are also some IM speakers in the United States, and it seems likely that at least some of these would be included in the census data.

(see Figure 1). Given that the time depth of Otomanguean is comparable to that of Indo-European (Kaufman & Justeson 2009), these languages have been diversifying for a very long time. This has led to great diversity in the larger Otomanguean family, as well as within the Mixtecan family. Estimates of the number of varieties of Mixtec range from 29 (Suárez 1983:18) to 81 (INALI 2008), and the number of mutually unintelligible varieties is thought to be over a dozen (Josserand 1983:457–8). The number of Mixtec languages listed in the *Ethnologue* (Simons & Fennig 2018) is 52.

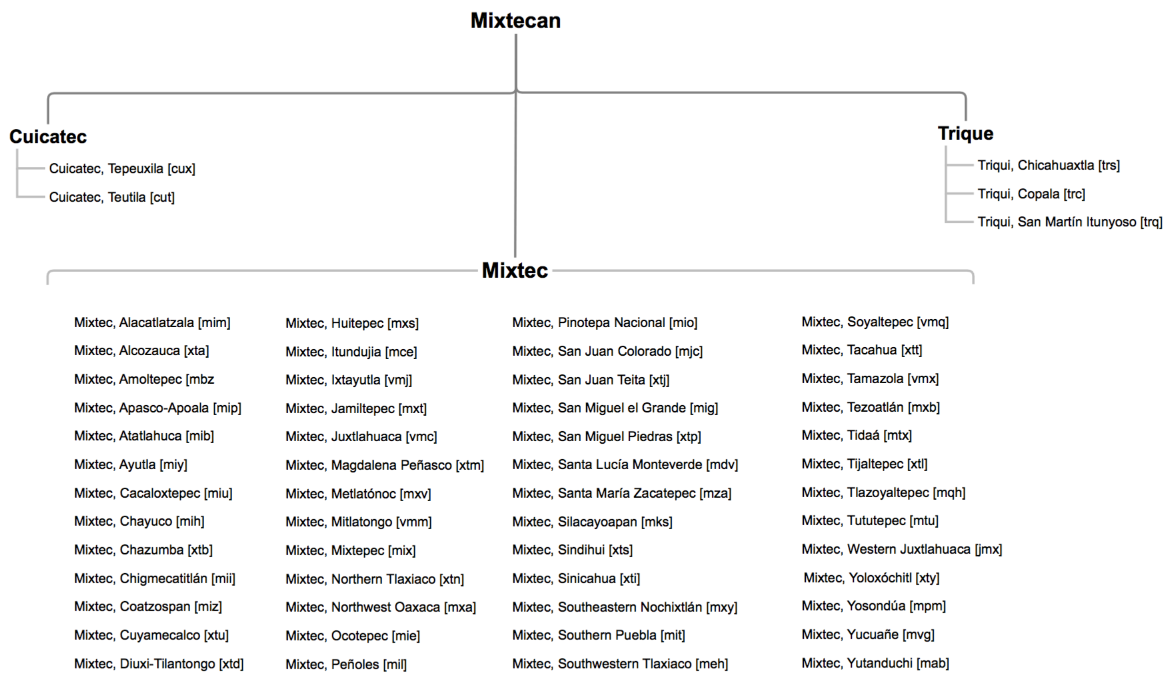



Figure 1. The Mixtecan family (Source: Simons & Fennig 2018)

The natural distribution of Mixtec speakers comprises the states of Oaxaca, Guerrero and Puebla, with by far the vast majority in Oaxaca (Josserand 1983:102). Mixtec is believed to have originated in the north and northeastern region of what is today known as the Highlands Mixtec region (or *Mixteca Alta* in Spanish) around the Nochitxlán valley. From there it expanded mostly westward into (present-day) Puebla and the central Lowlands Mixtec region (*Mixteca Baja*), and then finally into the southern Lowlands, Guerrero and coastal regions of Oaxaca (Josserand

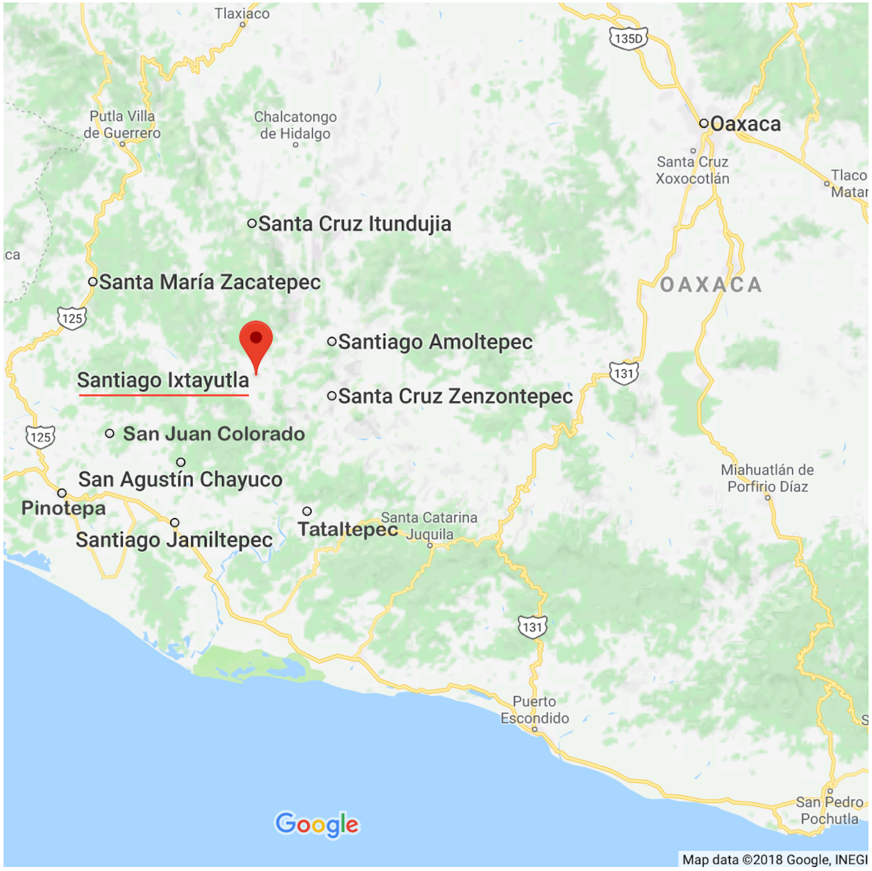



Figure 2. Santiago Ixtayutla where IM is spoken

1983:449–450). IM is spoken in the municipality of Santiago Ixtayutla (see Figure 2) where most of the inhabitants speak IM; however, there are also speakers of Spanish, Chatino and Amoltepec Mixtec (ISO 639-3: mbz).

Josserand (1983) gives twelve major dialect groupings for Mixtec languages (see Figure 3): Northern Lowland ("Baja"), Central Lowland, Western Lowland, Southern Lowland, Tezoatlán, Mixtepec, Guerrero, Northern Highland ("Alta"), Northeastern Highland, Eastern Highland, Western Highland and Coast. The Coast dialects are divided into three sub-groupings: West Coast, East Coast and Acatepec. IM is located in the Eastern Coastal sub-grouping. It is bordered by several other East Coast Mixtec varieties on the south and west—south: Chayuco Mixtec (mih), Jamiltepec Mixtec (mxt); southwest: San Juan Colorado Mixtec (mjc). To the northwest of Ixtayutla is the West Coast dialect, Zacatepec Mixtec (mza), and to the north, across the Río Verde river, are the Western Highlands varieties, Itudujia Mixtec (mce) and Amoltepec Mixtec (mbz) (Simons & Fennig 2018).[2] On the east and southeast edge of IM territory are two Chatino varieties—Zenzontepec Chatino (czn) and Tataltepec Chatino (cta) (Simons & Fennig 2018)—and several towns in the municipality are Chatino speaking (or have Chatino speakers). In addition, my consultants say that there are several Spanish speaking towns, as well as two or three Amoltepec Mixtec speaking towns, in the municipality.

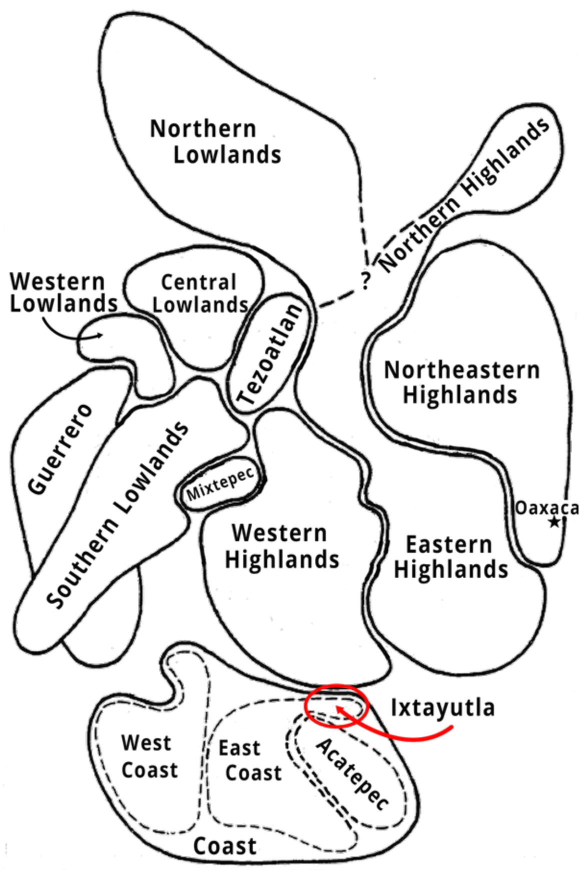



Figure 3. Mixtec dialect areas (based on Josserand 1983:470)

There is little published work on IM apart from work which makes use of wordlists and linguistic survey results such as Holland's (1959) glottalchronological study, Bradley's (1968) prelim-

[2] Ixtayutla's closest Mixtec neighbour, Amoltepec Mixtec (mbz), lies to the north, but it is separated from it by the Rio Verde river. Although it is not part of Josserand's (1983) study, Amoltepec Mixtec probably belongs to the Western Highlands dialect area, rather than to the Coastal Mixtec dialect area.

inary report of his Mixtec intelligibility study, Egland's dialect intelligibility survey report (1978), and Josserand's (1983) Proto-Mixtec (PM) reconstruction. The data used in this dissertation are based on primary data collected during my fieldwork. Much data for this dissertation was collected during my time of residency in the community from 2003–2006; however, the majority of the data have been collected during return trips to the area since that time, as well as some data collected through VOIP, telephone, instant messaging and email. Whenever possible elicitations and discussions were recorded for later transcription, analysis and storage. Early recordings were made (digitally) with a MiniDisk player, but later recordings were made with a Marantz PDM660 solid-state recorder.

## 2.2 The couplet in previous studies

Most modern descriptions of Mixtec make use of the descriptive term "couplet" as an essential unit for the description of such things as stress (e.g. Pankratz & Pike 1967; Pike & Oram 1976; Zylstra 1980; Josserand 1983), tone sandhi (e.g. Pike 1948; Mak 1958; Pike & Cowan 1967) and the distribution of phonemes and allophones in general (e.g. Longacre 1955; Pike & Cowan 1967; Hunter & Pike 1969; Josserand 1983), and particularly, nasal(ized) segments (e.g. Hunter & Pike 1969; Zylstra 1980; Josserand 1983; Marlett 1992), glottalized vowels (e.g. Pike & Small 1974; Josserand 1983; Macaulay & Salmons 1995), vowel cooccurrence patterns (Pike 1947), tones (e.g. Pike 1948; Mak 1958; Daly & Hyman 2007) and allotones (e.g. Hunter & Pike 1969). The term is a shortened form of "Tonemic couplet" that was coined by Ken Pike (1948:79, 81) to refer to the basic and minimal binarity of the phonological form of San Miguel El Grande Mixtec morphemes spoken in isolation and the tonal melodies that are realized on them. Pike generally speaks of the binarity of the couplet in terms of syllables (i.e. couplets are disyllabic), but he also notes that couplets with long vowels are structurally parallel to (C)VCV couplets (i.e. couplets with two short vowels separated by a medial consonant) and that "the term 'mora' might be used instead" (p. 79, fn. 3; cf. also Pike 1944:122).

The structure of the couplet is highly restricted and quite uniform across Mixtec languages (Bradley & Josserand 1982; Josserand 1983), hence the widespread adoption of the term. The basic forms of the couplet are illustrated in (11) using data from IM (C = consonant, V = vowel and ˀ = glottalization).

| | | | | | | |
|---|---|---|---|---|---|---|
| (11) | a. | (C)VCV | *kókó* ‘notch’ | c. | (C)Vː | *kóó*$^{L}$ ‘snake’ |
| | | | *ókó* ‘twenty’ | | | *úú* ‘two’ |
| | b. | (C)VˀCV | *koˀlò* ‘turkey’ | d. | (C)VˀV | *kóˀó*$^{L}$ ‘dish’ |
| | | | *úˀβá* ‘salty’ | | | *ű̃ˀű̃* ‘five’ |

These forms match each of Josserand’s (1983) canonical couplet patterns that were given in (1). In addition to these forms, at least some varieties also have some couplet initial consonant clusters (e.g. Josserand 1983; Macken & Salmons 1997; and the present work cf. §6.2.2.2), and three varieties are known to also have couplet final glottalized vowels (Josserand 1983; McKendry 2013).

Pike’s (1944; 1945; 1947; 1948) choice of morpheme as the morphosyntactic unit to which the couplet corresponds stems from his view that (nearly) all Mixtec morphemes are basically bimoraic/disyllabic, although they frequently reduce to monomoraic forms (i.e. cliticize) in fast speech in the SM dialect he studied. He thus considered it unhelpful to categorize morphemes as bound or free (Pike 1944:113). Most other Mixtec researchers, however, consider the couplet to correspond to or even to be equivalent to the morphological root (e.g. Macaulay 1987b; 1996; Hinton et al. 1991; Macaulay & Salmons 1995; Gerfen 1996:17; Brown 2002; Paster & Beam de Azcona 2005; Castillo García 2007) or stem (e.g. Pike & Cowan 1967; Pike & Wistrand 1974; Pike & Oram 1976). Furthermore, Macaulay (1987a; 1987b), analyzing a Mixtec variety with fast-speech phenomena comparable to the one analyzed by Pike, concludes that an adequate synchronic account of Mixtec must recognize three distinct types of morphemes: free morphemes, affixes and clitics of various kinds, only the first of which is realized as a couplet.

Although many researchers have been content to refer to the couplet as a morpheme or root, it has long been recognized that couplets can be multimorphemic. For instance, in his Proto-

Mixtecan reconstruction, Longacre (1955:19) suggests that "couplet" is a better term than "morpheme" since it is allows for some morphemic complexity within the unit. He therefore focuses on the phonological nature of the couplet, calling it "the pertinent distributional matrix in M[ixtec]" (p. 18) and "a unit of great descriptive convenience" (p. 19) for phoneme distribution. Several researchers follow Longacre's phonological emphasis and identify the couplet as the nucleus of the phonological word (Pankratz & Pike 1967; Pike & Cowan 1967; Hunter & Pike 1969; North & Shields 1977) and the minimal phonological word (Pike & Ibach 1978; Daly & Hyman 2007). The most thorough early treatment of the couplet in this vein, however, is in Josserand's (1983) Proto-Mixtec reconstruction. She recognizes that, although the couplet has aspects that make it appear like a morphological unit in providing the base for building words and phrases, "the couplet as a grammatical unit is too slippery to maintain" (p. 181). She observes that morphemes and couplets do not always have a one-to-one relation; even though some types of words (e.g. unpossessed nouns and adjectives) are frequently monomorphemic couplets, verbs are always multimorphemic even in couplet form in that they are marked tonally for aspect. Furthermore, "multimorphemic constructions are frequently reduced to a single couplet form, by reduction and incorporation of the person postclitic, or causative or possessive markers before the couplet" (p. 182). For these reasons she viewed the couplet as primarily a "phonological concept," yet one which is essential to the description of morphology. She concludes, "It is more satisfying to understand the couplet as a phonological or surface frame for underlying morphological material to fit into, or accommodate itself to, for its spoken realizations" (p. 183).

From today's vantage point, Josserand's (1983) description of the couplet as a "phonological or surface frame" has all the hallmarks of a prosodic unit; however, it was not until prosodic phonology and morphology had been further developed in the 1980s and 90s, along with the whole-word approach to early phonological development (e.g. Vihman & Keren-Portnoy 2013), that an explicitly prosodic view of the couplet was presented by Macken & Salmons (1997). Before discussing their proposal in detail, it should be noted that just prior to their paper, Gerfen's (1996) study of Coatzospan Mixtec was the first to analyze Mixtec stress in terms of the foot and, further, to propose that glottalization is licensed by stress, only occurring on the head mora of the foot. His discussion of the couplet, however, equates it with the root and his nasalization rules are stated in terms of root structure. Although he falls short of calling the couplet a foot, he concludes: "[I]t is imperative that we recognize the essential 'two-ness' in the structure of CM [Coatzospan Mixtec] morphemes. For the purposes of this study, I make the minimal assumption that couplets are necessarily bimoraic, and potentially disyllabic" (p. 51).

Turning now to Macken & Salmons (1997), these authors claim that historically the couplet was the morphological root in Mixtec; however, the contemporary languages have lexicalized trisyllabic forms that can be reconstructed as prefix + root, but which must be considered synchronic morphological roots, as illustrated by these animal names in Chalcatongo Mixtec (CM) that were formed with the fossilized animal classifier prefix *tɨ*–: (The etymological prefix and root are separated by "•".)

(12) Trisyllabic animal names (Macaulay & Salmons 1995:40; from Macaulay 1996:67)
  a. *tɨ̀•ⁿdákú* '(type of) worm'
  b. *tɨ•kàkà* 'raven'
  c. *tɨ•ñṹṹ* 'owl'

The final two syllables in trisyllabic roots continue to act as a special domain for phonological patterns (vowel harmony, tonal melodies, nasalization, etc.) just like roots with a couplet form.

Macken & Salmons (1997) also show that there are disyllabic forms that can also be reconstructed as prefix + root, but whose final two syllables have the same phonological characteristics as other couplets, as shown by these CM examples, which are also animal names:

(13) Disyllabic animal names (Macaulay & Salmons 1995:40; from Macaulay 1996:69)
  a. *tɨ•xi* 'buzzard'
  b. *tɨ•mí* 'bee'

In these examples, a diachronic vowel harmony process that takes the couplet as its domain is extended to the animal classifier (*ɨ* → *i*) when it is included in the couplet.

These facts lead Macken & Salmons (1997:40) to propose that,

> the original presumably greater morphological regularity of the couplet has been lost, replaced by a disyllabic phonological constituent, a foot template, that is the domain for a wide number of phonological processes.

The constant shape of this constituent, which is not a fixed number of segments, is just the disyllabic/bimoraic foot shape that has become commonplace in prosodic phonology and morphology, where the foot is shown to be the domain of phonological rule application cross-linguistically (Nespor & Vogel 2007 [1986]) and to define the shape of minimal words, stems and reduplicants (McCarthy & Prince (1996 [1986]);1995).

In providing evidence for their hypothesis that the Mixtec couplet is a foot template, Macken & Salmons (1997) mention in passing synchronic processes that take the couplet as their domain (e.g. nasalization and glottalization), but primarily focus on a set of diachronic processes, like the vowel harmony process mentioned above, that find a unified explanation in terms of a foot-template. In particular, they argue that certain sound changes in CM tend to strengthen the initial position of the couplet while others weaken the couplet medial position. As an example of initial strengthening, the authors give the development of reflexes of Proto-Mixtec glides with greater consonantal strength (cf. Vennemann 1988:9) (e.g. *w → [b], [ᵐb], [β]), as well as the development of *s*C clusters (i.e. *s* + consonant) only in the couplet initial position. On the other hand, the couplet-medial position is weakened in that reflexes of Proto-Mixtec glides are frequently lost in this position. None of these tendencies are predicted in a syllable-based analysis. As the authors point out, the weakening of the second consonant position of the couplet violates Vennemann's (1988:13) syllable Head Law in weakening (deleting) rather than strengthening the onset of this syllable.[3] Couplet initial clusters also violate this law since they result in onsets with more than one

[3] "A syllable head [onset] is the more preferred: (a) the closer the number of speech sounds in the head is to one, (b) the greater the Consonantal Strength value of its onset, and (c) the more sharply the Consonantal Strength drops from the onset toward the Consonantal Strength of the following syllable nucleus" Vennemann (1988:13–14).

segment. Furthermore, an analysis based solely on syllable structure provides no basis for explaining why the two syllable positions are treated asymmetrically in the grammar, and this asymmetry also means that the intervocalic environment alone is insufficient to condition such weakening. These processes find a unified and cogent explanation, however, if the trochaic foot template with its strong initial syllable and weak final syllable is the basic unit of phonological organization in the language, rather than the syllable. As a result of this foot-based orientation in the grammar, Macken & Salmons (1997:51) argue that CM "prefers a minimal word consisting of exactly two timing units with a single strong consonantal onset." This constituent is further characterized by highly restricted vowel "melodies" (i.e. cooccurrence restrictions) and an apparent elimination of tonal melodies with the most extreme pitch differences (HL, LH). Macken & Salmons' (1997) analysis that the couplet should be identified as a prosodic, rather than a morphological unit, and, specifically, as a trochaic foot template is quite in the spirit of Josserand's (1983:183) earlier characterization of the couplet as "a phonological or surface frame for underlying morphological material to fit into".

Twenty years after Macken & Salmons' (1997) paper, Mixtec researchers seem virtually oblivious to their proposal—two exceptions being DiCanio et al. (2013) and Brown (2002), and none have argued further for the role of the foot in Mixtec diachrony, nor attempted to prove that the couplet should in fact be equated with the foot. Nevertheless, there has been an increasing recognition in recent years that the couplet is a prosodic structure and an assumption that it should be identified as the foot. For instance, although Castillo García (2007:52–56) makes no mention of the couplet (or equivalent term in Spanish), he analyzes roots in Yoloxóchitl Mixtec as comprising a bimoraic foot, which has either a disyllabic form or a monosyllabic form with a long vowel. He argues that the long vowel in the monosyllabic form is the result of a bimoraic minimal word constraint. Words larger than a couplet are considered to be multimorphemic, even those in advanced stages of fossilization (p. 17, 56), and thus roots are always realized as a foot. McKendry

(2013) provides a similar analysis of SE Nochixtlán Mixtec, but additionally argues based on experimental acoustic evidence that stress is assigned to a trochaic foot aligned to the right edge of the (grammatical) word and that syllables preceding the foot (= root) are unfooted.

One final study of particular interest to the topic of this dissertation is Carroll's (2015) study of Ixpantepec Nieves Mixtec. In it he makes explicit his assumption that the couplet corresponds to a bimoraic foot (p. 56). He also provides acoustic evidence to support his claim that stress is realized on the first syllable of the couplet/foot, and somewhat less confidently posits secondary stress in compounds based on phonological patterns in these words. Significantly, Carroll recognizes that, while most morphological roots have a couplet shape, some synchronic roots are larger than a couplet, and some couplets are (or at least historically were) comprised of roots that were smaller than a couplet (cf. §6.2.1). He thus does not equate the couplet/foot with the root, viewing it as a structure distinct from the root and one that is aligned to it and can be considered its canonical form. In spite of this view of the relation of prosodic structure to morphological structure, Carroll goes on to describe the differences in the distribution of long vowels, glottalization and nasality between stressed and unstressed syllables as being "stress-dependent properties" (p. 104ff) that provide evidence for distinguishing between stressed and unstressed syllables, rather than as providing evidence for foot structure.

## 2.3 The syntax of Ixtayulta Mixtec

Throughout this basic overview of IM sentence structure I will discuss the unmarked constituent order by which I mean the order of a sentence that is "narratively focused"—that is, typical of a narrative sequence focused on the flow of events (Beck 1997:103). The description is organized by clause types in the order intransitive, transitive, ditransitive and extended intransitive. IM utilizes a basic VS-VO constituent order (Dryer 1997). Simple intransitive sentences are illustrated by the examples in (14).

(14) a. *īkíʃî* *h$^{w}$ã̀ã́*
í–kíʃì $^{L}$h$^{w}$ã́$^{L}$
PFV–sleep:REAL John
‘John slept’

b. *íju$^{ʔ}$ù* *h$^{w}$ã̀ã́*
í–jù$^{ʔH}$ $^{L}$h$^{w}$ã́$^{L}$
PFV–be.afraid John
‘John was afraid’

c. … *ī$^{n}$dūʃã́ã́* *ētʃî*
í–$^{n}$dù–ʃã́$^{L}$ étʃì
PFV–INCH–fierce Echi
‘Echi got mad’

In the first three examples, the initial word in the sentence is the syntactic predicate which is immediately followed by the subject NP consisting of a bare noun. As shown in (15), pronominal clitics follow the unmarked order for full NPs when expressing the subject argument and attach to the right edge of the verb (when there are no adverbs modifying the verb; see §2.5 for further discussion).

(15) ***īkíʃî**__**ɾà***
í–kíʃì = **ɾà**
PFV–sleep:REAL=3MASC
‘He slept’

In this sentence, the ‘third person masculine’ pronoun = *ɾà* (in bold), provides the subject for the predicate ‘sleep’.

Transitive sentences have the basic constituent order shown in (16).

(16) a. *īsátà* *h$^{w}$ã̀ã̄* *nṹɲĩ́*
í–satà $^{L}$h$^{w}$ã́ núɲí$^{L}$
PFV–buy John corn
‘John bought corn’

b. *ītʃátʃî* *hʷà̰á̰* *ʃítá*
í–tʃàtʃî ᴸhʷá̰ ʃítáᴸ
PFV–eat:REAL John tortilla
'John ate tortillas'

c. *ⁿdʲeˀè* *hʷà̰á̰* *ḭ́ná̰*
∅–ⁿdʲèˀ ᴸhʷá̰ íⁿdá
IPFV–see John dog
'John is seeing the dog'

Again, the initial word in each of these examples is the syntactic predicate, which is immediately followed in the clause by a subject NP consisting of a bare noun. In the unmarked order, the direct object argument, which is also a bare noun in the example, follows the subject. It should also be noted that direct objects consisting solely of an enclitic pronoun always occur with the preposition, *tʃìì* glossed 'objective', as shown in (17), where the object pronoun is in bold font.[4]

(17) a. *īⁿdʲéˀèɾà* *tʃììt**ɨ̀*** ...
í–ⁿdʲèˀ = ɾà tʃì = tɨ̀
PFV–see=3.MASC OBJ=3ANML
'He saw it'

b. ... *ⁿdʲeˀèjò* *tʃìì **tṵ̀*** 
∅–ⁿdʲèˀ = jò tʃì = tṵ̀
IPFV–see=1PL.INCL OBJ=3WOOD
'...we see it'

In these constructions, the preposition serves as the prosodic host for the pronouns, which are unable to form a prosodic word on their own.

Ditransitive clauses have an additional argument following the direct object that is obligatorily introduced with *tʃìì*, as illustrated in (18).

[4] This gloss is not particularly satisfying. As will be seen in the following discussion, *tʃìì* is used to introduce direct and indirect objects of the verb, although the details of when it is required and when it is optional have not been completely worked out.

(18)

| | | | | |
|---|---|---|---|---|
| *ìtʃáˀa* | *sútú* | *ɲâ̰ˀmĩ́* | ***tʃí*** | *ĩ́nã́* |
| í–tʃâˀ | sútú$^{\text{L}}$ | ɲáˀmí$^{\text{L}}$ | **tʃì** | ĩnã́ |
| pfv–give | priest | yam | OBJ | dog |

‘The priest gave a yam **to** the dog’

Here the extra argument, *ĩ́nã́* ‘dog’, which is marked as the indirect object by the preposition, is the recipient of the yam (direct object) given to it by the priest (subject).

An interesting fact of the grammar is that sometimes full noun direct objects are also introduced with *tʃìì*, as in these examples:

(19) a.

| | | | |
|---|---|---|---|
| *ⁿdisò* | *mã́ˀĩ̀* | ***tʃìì*** | *kùsèé* |
| ∅–ⁿdìsò | mâˀ=í | tʃì | kùsé |
| IPFV–carry | mother=1SG | OBJ | José |

‘My mother was carrying José’

b.

| | | | |
|---|---|---|---|
| *tʃãˀɲĩ̀* | *sàpàtā* | ***tʃìì*** | *kàrànsā* |
| ∅–tʃãˀɲì | sàpàtà$^{\text{H}}$ | tʃì | kàrànsà$^{\text{H}}$ |
| IPFV–kill:REAL | Zapatista | OBJ | Caranzista |

‘The Zapatistas were killing the Caranzistas’

c.

| | | | | | | |
|---|---|---|---|---|---|---|
| *tà* | *íkũ̃ɲĩ́* | *lòkó* | *ⁿdʲòó* | ***tʃìì*** | *ɲã́jɨβɨ̀* | … |
| tà | í–kuɲi$^{\text{H}}$ | $^{\text{L}}$lókó | $^{\text{Ln}}$dʲó | tʃì | ɲá(jɨ̀βɨ̀[5] | |
| and | PFV–desire | INTS | God | OBJ | people | |

‘And God loved people so much…’

In these clauses, the direct objects, *kùsèé*, *kàrànsā*, etc. are all introduced with the preposition. More study is needed to determine all of the factors conditioning the use of the objective preposition to introduce direct objects, but it appears that the preposition is required when the event or psychological process expressed by the verb affects or is directed toward a human participant (or a human-like animal, as in the case of animals in traditional stories) and when both the subject and the direct object are full words and not a clitic, as in (19).[6] The examples in (16), on the other hand, do not have human direct objects and therefore the preposition is not used. It also appears

[5] The parenthesis in the underlying form indicates a lexical foot boundary, which will be discussed in §5.4, §6.2.1 and §6.3.2.

[6] I have only found three examples in my data of an inanimate direct object NP introduced by *tʃìì*.

that the use of the preposition with human direct objects is optional when the transitive subject is a pronominal clitic rather than a full word:

(20) a.

| | | |
|---|---|---|
| *ī$^{n}$d$^{j}$é$^{ʔ}$è**rà*** | *sútú* | *ɲ ̀ũ̃ ́* |
| í–$^{n}$dè$^{ʔ}$ = ɾà | sútú$^{L}$ | ɲú |
| PFV–see=3MASC | priest | Ixtayutla |

‘He saw the priest in Ixtayutla’

b.

| | |
|---|---|
| *tʃã$^{ʔ}$ɲĩ̀ **rà*** | *ɲájɨβɨ̀* |
| tʃà$^{ʔ}$ɲì = ɾà | ɲá(jɨβɨ̀ |
| IPFV–kill=3MASC | people |

‘They were killing people’

c.

| | | |
|---|---|---|
| *íkṹɲĩ́* | *ʃã́ã́ɾá* | *ɲã̄jɨβɨ̀* |
| í–kuɲi$^{H}$ | ʃã́ = ɾà | ɲá(jɨβɨ̀ |
| PFV–desire | INTS=3MASC | people |

‘He really loved people’

In each of these sentences, the subject is the clitic, =*ɾà*, and the direct objects are not introduced with the objective preposition even though the direct objects all have a human referent, and the situations described by (20b) and (20c) are essentially the same as those described in (19b) and (19c), respectively.

A final clause type in IM is the bivalent intransitive clause. Some intransitive verbs can add an additional core argument to the clause also by means of the preposition, *tʃìì*:

(21) a.

| | | | |
|---|---|---|---|
| *íju$^{ʔ}$ù* | *étʃì* | ***tʃìì*** | *h$^{w}$ã̀ã́* |
| í–jù$^{ʔH}$ | étʃì | tʃì | $^{L}$h$^{w}$ã́ |
| PFV–be.afraid | Echi | OBJ | John |

‘Echi got scared by John’

b.

| | | | |
|---|---|---|---|
| *à* | *jù$^{ʔ}$ũ̄* | *tʃì* | *kóó* |
| à | ∅–jù$^{ʔH}$ | **tʃì** | kó$^{L}$ |
| Q | IPFV–be.afraid | OBJ | snake |

‘Are you afraid of snakes?’

c. *ī$^{n}$dūʃā́ā́* *ētʃì* ***tʃì*** *tʃìkū*
í–$^{n}$dù–ʃā́$^{L}$ étʃì tʃì tʃìkù$^{H}$
PFV–INCH–fierce Echi OBJ Chico
‘Echi got mad at Chico’

In these examples, the stimulus of the fear (21a–21b) and object of the anger (21c) are added to the clause by means of *tʃì̄*. Example (21b), in which the added argument is non-human, indicates that the preposition may be required for the extra argument in bivalent intransitive clauses regardless of whether they are human or not.

The order of elements in the noun phrase is relatively fixed, following the pattern given in (22).

(22) (Numeral/Quantifier) **Noun** (Adjective/Quantifier) (Possessor/Deictic)

Although NPs with this many elements are rare, an example from a text with each slot filled is given in (23).

(23) *nū́* *t$^{j}$ĩɲū̀* *kãˀnū̀* *iˀjà*
nû t$^{j}$ìɲù kàˀnù ìˀjà
one task big here
‘the one big task here / this one big task’

The head noun in this phrase (which here and throughout the section is underlined) is ‘task’. It is preceded by the numeral, ‘one’, and followed by the adjective ‘big’ and the deictic ‘here/this’.

NPs usually have much fewer elements, the only obligatory element being the noun. An example of a NP consisting of a numeral plus a noun is given in (24).

(24) *í$^{n}$d$^{j}$eˀèɾà* ***úβí*** *kɨtɨ̀*
í–$^{n}$d$^{j}$èˀ = ɾà úβí kɨ̀tɨ̀
PFV–see=3MASC two horse
‘He saw two horses’

Numerals (in bold) precede the head noun in the phrase. An expression like ***kúmí kɨ̀βɨ́***, which quantifies a time period, means ‘four 24 hour periods’; however, reversing the order so that the numeral follows the noun, as in *kɨ́βɨ́ kũ̀mĩ́*, forms a compound meaning, ‘day four’, referring to a specific day, since IM compounds are left-headed.

A NP consisting of just a noun and an adjective is shown in (25).

| (25) | *í$^{n}$dʲéˀèɾà* | *ĩ́nã́* | ***tṹṹ*** |
|---|---|---|---|
| | í–$^{n}$dʲèˀ = ɾà | íná | tũ̀ |
| | PFV–see=3MASC | dog | black |
| | ‘He saw a/the black dog’ | | |

As shown here, the adjective must follow the noun it modifies.

The only element found to have some variability in its positioning within the phrase is a quantifier, as illustrated by these examples:

| (26) | a. | *tà* | *kʷàsáˀáɾá* | *hù$^{n}$dā* | *tà* | *kũ̀ɲĩ̄ɾà* | *ɲĩ́ɟɨβɨ̀* | ***kʷàˀá*** |
|---|---|---|---|---|---|---|---|---|
| | | tà | kʷá–sá$^{\text{ʔL}}$ = ɾà | hù$^{n}$dà$^{H}$ | tà | ∅⌢kuɲi$^{H}$ = ɾà | ɲá(ɟɨβɨ̀ | kʷá$^{\text{ʔL}}$ |
| | | and | PROS–do=3MASC | meeting | and | IPFV–want=3MASC | people | many |
| | | ‘And he is going to have a meeting and he wants many people (to come)...’ | | | | | | |

| | b. | ***kʷáˀá*** | *ʃṹˀṹ* | *ìtʃáˀàɾà* | *tʃîìtʃî* |
|---|---|---|---|---|---|
| | | kʷá$^{\text{ʔL}}$ | ʃṹ$^{\text{ʔL}}$ | ì–tʃâˀ = ɾà | tʃî = tʃì |
| | | many | money | PFV–give:REAL=3MASC | OBJ=3GNRL |
| | | ‘He gave them much money’ | | | |

The quantifier (in bold) can follow the noun, as shown in (26a), or it can precede the noun, as shown in (26b). The difference in order does not appear to change the propositional meaning of the phrases.

A NP consisting of a noun and a deictic is given in (27).

| (27) | *káˀ$^{n}$dʲá* | *jutũ̀* | ***tʃĩ́ɲã́*** | … |
|---|---|---|---|---|
| | kaˀ$^{n}$dʲa$^{H}$ | jùtũ̀ | tʃíɲá | |
| | cut:IRR | tree | that.near.you | |
| | ‘Cut that tree by you…’ | | | |

In this example the deictic, *tʃĩ́ɲã́* (in bold) follows the noun and indicates that the tree to be cut down is the one by the speaker.

Possessors, illustrated in (28), occupy the final position in the NP. (The possessor is given in bold font.)

(28) a. *βeˀè* ***hʷã̀ã́***
βèˀ ᴸhʷã́
house John
'John's house'

b. *βeˀè**ɾà***
βèˀ = **ɾà**
house=3MASC
'his house'

c. *βeˀè* *kãˀnũ̀**ɾà***
βèˀ kàˀnù = **ɾà**
house big=3MASC
'his big house'

The possessor is usually a noun or pronominal clitic immediately to the right of the head noun, as in (28a) and (28b); however, a modifier may intervene between the head noun and the possessor, as shown in (28c).

Nouns can also be used attributively in NPs, as illustrated in (29), where the attributive noun is in bold font.

(29) a. *ìsáˀì* *ɲũnũ̀* ***ⁿdⁱítʲì***
í–sàˀ = í ɲùnù ⁿdⁱítʲì
PFV–make=1SG net.bag green.bean
'I made a green-bean net-bag.' (i.e., a net-bag **used to carry** green beans)

b. *júkú* ***tũsṹˀmã̀***
júkúᴸ túsũ̀ˀmà
medicine scorpion
'scorpion antivenom' (i.e., medicine **to heal** scorpion stings)

c. *júkú* ***tʲōkò***
júkú^L tʲókò
medicine ant
'ant insecticide' (i.e., medicine **to kill** ants)

Attributive constructions have either a conventionalized meaning or one which is heavily dependent on the context. For instance, in the first example, 'net-bag' could be used to carry a variety of things, but this particular one was made to carry green beans. The meaning of the second two examples depend more heavily on the cultural knowledge of scorpions (which sting you) and ants (which are pests), as well as conventionalization, in the interpretation of what kind of "medicine" is being referred to. I will sometimes refer to both attributive constructions and possessive constructions comprising two nouns as associative constructions, or simply as noun-noun (N-N) constructions/phrases.

The modifier in a NP may also be a relative clause. Usually these consist simply of a verb + its arguments immediately following the noun they modify, as shown in (30a), but they may also be introduced by the proclitic complementizer *tʃá^L* =, as in (30b). (The boundaries of the relative clauses are marked with square brackets and the complementizer is in bold font.)

(30) a. *kʷàɲí̋ʔĩ̋jó* *ⁿdʲajù* *[katʃìjò]* *βitʲĩ̏*
kʷá–ɲíʔ^L =jò ⁿdʲàjù kàtʃì =jò βìtʲĩ̏
PROS–obtain=1PL.EXCL food eat:IRR=1PL.EXCL today
'Today we are going to get food that we will eat.'

b. … *ĩ̏jō* *mĩ̏nű̋ũ̏* *kɨtɨ* *[tʃákã̏ʔã̋tʃì* *léʃù]* …
^Líjó mì(nû kɨ̀tɨ̀ **tʃá**^L =káʔ =tʃì ^Léʃù
exist:IPFV one animal COMP=speak=3GNRL rabbit
'…an animal that they call rabbit exists…'

In both types of relative clause there is a "gap" (zero anaphor) in the relative clause that is coreferential with the nominal head. In (30a), 'food' expresses the direct object of both the main clause predicate ('obtain') and the predicate of the relative clause ('eat'), while in (30b), 'animal' expresses the subject of the existential verb in the main clause and the indirect object of the relative clause predicate ('speak') (i.e. 'an animal exists to which they say, "Rabbit"').

## 2.4 Morphology

Mixtec languages are mildly synthetic and generally have relatively few morphemes per word. The grammatical word in IM is often just a bare root, particularly for parts of speech other than verbs. Nevertheless, there are many grammatical words which are larger, due to processes of derivation, compounding and inflection. In order to understand the arguments for prosodic structure made in this dissertation, it will be necessary to understand the basic morphological structure and processes of the language. In this section, therefore, I describe IM morphology in terms of the types of morphemes and morphological processes that are found in the language, focusing particularly on the major parts of speech—nouns (§2.4.1), verbs (§2.4.2) and adjectives (§2.4.3).

IM has the morpheme types given in (31).

(31) a. Lexical roots
b. Prefixes
c. Suprafixes
d. Clitics

Lexical roots in IM are the morphological bases of words, while prefixes are morphologically dependent and combine with roots through the morphological process of prefixation. IM has a fairly small number of prefixes and these are mostly found in the verbal morphology, though a couple derivational prefixes apply to adjectives. Nominal morphology, on the other hand, does not include prefixation, although there is evidence of fossilized classifier prefixes that will be briefly discussed in §2.4.1. Roots also combine with other roots to form new noun and verb lexemes through compounding. Tonal suprafixes, which lack segmental material and consist only of a tone or tonal melody which is added to bases, are found in both the nominal and verbal morphology. IM lacks suffixation, although it has a number of enclitics. Clitics, which are phonologically dependent and are combined with grammatical words in the Postlexical Phonology, are not part of the morphology and are discussed separately in §2.5.

### 2.4.1 Nominal morphology

There is no productive derivational morphology associated with IM nouns, and the only inflectional morphology is a vocative tonal suprafix. Consequently, nouns are frequently bare bi-moraic roots, as illustrated in (32).

(32) a. *ísú* 'deer'
b. *ⁿdaˀà* 'hand'
c. *sɨ̂ɨ* 'saliva'

A considerable number of complex nouns have been formed by compounding, however, which is common in the language. Examples of IM compounds are given in (33).

(33) a. *βeˀè* 'house' + *júkú^L* 'medicine' → *βèjúkú* 'hospital'
b. *júú^L* 'stone' + *káà* 'metal' → *júkāà* 'sharpening stone'
c. *kɨtɨ̀* 'animal' + *ʃa̋a̋^L* 'fierce' → *kɨtɨ̀ʃȁa̋^L* 'animal'[7]

The lefthand member of the compound is the morphological head of the construction and determines its word class, as well as, in the case of these compounds, what kind of thing the compound denotes (i.e. a kind of house (33a), stone (33b) and animal (33c)). It is the righthand member, however, that is stressed and constitutes the prosodic head. Examples (33a) and (33b) illustrate that roots with the surface forms CVˀV and CVV, respectively, are usually realized as a CV syllable when they are the first member of a compound; however, some compounds with this structure, such as (33b), may be pronounced with a bimoraic form with seemingly no impact on their meaning, while others, like (33a), may be ambiguous if the first root has a long form between the compound meaning and a phrasal interpretation (in this case, the long form, *júúkāà*, would be ambiguous between a 'hospital' reading and a 'place where medicine is stored' reading). In addition, a few compounds

[7] The semantics of this compound appear to be shifting. It can mean 'wild animal', which is probably closer to its original meaning, but it can now be used for 'animal' in general. The word *kɨtɨ̀* can also still be used for 'animal', but its primary sense seems to have shifted to be 'horse'. There is also a variant tonal melody—/$^{L}$H/—which appears to be used exclusively for this sense, but the /L/ tonal melody can also be used to mean 'horse'.

with this structure (including one with a partially opaque morphological structure (34c)) have been found where the initial root appears to be preferably long:

(34) a. *júú*$^{L}$ ‘stone’ + *sáβí* ‘rain’ → *júúsàβí* ∼ *júsàβí* ‘hail’
b. *joˀò* ‘rope’ + *jutũ̀* ‘tree’ → *joˀòjutũ̀* ∼ *jòjutũ̀* ‘root’
c. *kóó*$^{L}$ ‘snake’ + *jaˀⁿdʲì* ‘?’ → *kóójáˀⁿdí* ∼ *kójáˀⁿdʲí* ‘rainbow’

On the other hand, when roots with this form are the second item in the compound they are not realized as short CV syllables, as shown in (33b) and (33c).

In addition, IM nouns show evidence of having had a set of derivational prefixes which are the fossilized remains of old noun classifier prefixes (cf. Macaulay 1987a; 1987b; Kaufman 2006). A list of the prefixes attested in IM are given in Table 1.[8]

Table 1. Fossilized noun classifier prefixes

| | **Classifier prefix** | **Example** | **Base** |
|---|---|---|---|
| a. | *tɨ̀–* ‘animal’ (ANML) | *tɨ́kiʃɨ̃̀* ‘moth’ | *kiʃɨ̃̀* ‘glue’ |
| b. | *tɨ̀–* ‘spherical’ (SPHER) | *tɨ́lajɨ̀* ‘toasted tortilla’ | *lajɨ̀* ‘crispy’ |
| c. | *tù–* ‘wood’ (WOOD) | *tùjàtá* ‘plough’ | *játá* ‘spade’ |
| d. | *ɾà–* ‘male, human’ (HUM) | *ɾàⁿdʲíˀí* ‘children’ | *ⁿdíˀí* ‘small’ |
| e. | *ɲà–* ‘female’ (FEM) | *ɲàtʃaˀnù* ‘lady’ | *tʃaˀnù* ‘old’ |

The first column lists the “classifiers” with a gloss indicating the semantic class of the classifier. The second column gives an example word derived with the prefix and the final column gives the base from which it is believed to have been derived. As can be seen, the bases have some property or thing related to the meaning of the derived item. Although the classifiers are believed to have been noun classifiers (de León 1988; Kaufman 2006), clearly they have also been applied to adjectives in IM, as illustrated by examples (b), (d) and (e).

[8] These classifiers come from a larger set of classifiers that are found in part in various other Mixtec languages (de León 1988; Macaulay 1987a; 1987b; 1996; Hollenbach 2015). Although de León argues for the synchronic status of the classifiers in Coatzoquitengo Mixtec, he recognizes their fossilized status in some varieties, such as Jamiltepec Mixtec (Coastal) and Ocotepec Mixtec. Macaulay (1987a; 1987b; 1996) argues that the classifiers are also fossilized in Chalcatongo Mixtec.

The classifier in (a) derives historically from the final syllable of the noun *kɨtɨ̀* 'animal, horse' (Macaulay 1987a; de León 1988). It is found in various words depicting types of animals and is related to an enclitic pronoun for animals having the same form. The classifier for spherical objects (b) is homophonous with the animal classifier, and, according to Hollenbach (2015), this correspondence between the two classifiers is widespread in Mixtec languages. The wood classifier in (c) derives from the noun *jutũ̏* 'tree' and is found in words referring to trees. It has a related enclitic pronoun, =*tũ̏*, that is used to refer to a class of items that is extended to include plants, wood objects and also vehicles.

The final two classifiers in Table 1 are for humans. The classifier, *ɾà–* (d) is related to enclitic and proclitic pronouns with the same form meaning 'third person masculine'. It can have the more general meaning 'human', as in the example given in (d), but it often has the more specific meaning 'male', especially in constructions referring to human age + gender categories, such as *ɾátʃãˀnũ̏* 'gentleman' (cf. *tʃãˀnũ̏* 'old'). Constructions like these contrast with similar words which have the female classifier, such as the word given in (e). The male classifier actually has some limited productivity in constructions with a proper name (e.g. *ɾá–tʃĩkū* 'the man Chico'), which appears to be falling into disuse by younger speakers, and also in traditional stories where it is used to personify animals (e.g. *ɾà–tʲóó* 'Mr. Crab'). The male classifier does not have a corresponding full (bimoraic) noun in IM, but apparently derives historically from **teye* 'man' (Josserand 1983:480). The female classifier, on the other hand, derives from the word for 'woman', *ɲãˀã̏*, and is related to a little used respectful pronoun for women, =*ɲã̏*. Given the kind of reduction that occurs to CVˀV couplets in the initial position of a compound, it is not possible to distinguish constructions with *ɲã̏–* from compounds with *ɲãˀã̏* as the initial member of the construction.

The examples given for the classifier prefixes in column 2 of Table 1 are still parsable into recognizable parts; however, the following examples in (35) illustrate that some words which appear to have a classifier prefix and whose meaning fits the semantic class of the classifier have roots which, to my knowledge, are not attested in modern IM:

(35) a. *tɨ̀lásá*$^{L}$ 'type of worm' cf. *tɨ–* 'ANML'
b. *tɨ́nã̄ã̀* 'plum' cf. *tɨ–* 'SPHER'

In other words derived from classifiers, the prefix has undergone additional phonological changes, as in these examples:

(36) a. *tú•sũ̄ˀmã̀* 'scorpion' cf. *tɨ–* 'ANML' + *sũ̋ˀmã́*$^{L}$ 'tail' [9]
b. *tù•lúlú*$^{L}$ 'round tassel on man's traditional shirt' cf. *tɨ–* 'SPHER'

Here, the prefix has assimilated the labial feature from the labial vowel of the root, but consonant labiality is also assimilated as in *tú•mã̄ˀã̀* 'racoon'. Finally, it should be noted that there are many animal terms that do not have the prefix *tɨ–* or any of its forms.

I turn now to describe the only synchronic morphological process that affect IM nouns, which is the vocative tonal suprafixation illustrated in (37).

(37) a. *ɲã̋ɲĩ́* 'brother' → *ɲã̋ɲĩ̀* 'Brother!'
b. *àté* 'Andrés' → *átè* 'Andrés!'
c. *tʃèlā* 'Andrea' → *tʃélà* 'Andrea!'

The first form in each example gives the noun with its lexical tone pattern and the second shows how each tone pattern is replaced by the HL pattern of the vocative suprafix. Notice also that the suprafix may apply to ordinary nouns, as in (37a), as well as to proper nouns, as in (37b) and (37c). Because IM otherwise lacks evidence of marking syntactic arguments with case, I consider the vocative to be quasi-inflection (Mel′čuk 2006; Beck 2011).

### 2.4.2 Verbal morphology

IM verbs are obligatorily inflected for aspect which has three values—imperfective, perfective and prospective—through a combination of prefixation and tonal suprafixation. The imperfective aspect (IPFV) is signified by a L tonal suprafix and is used for situations that are construed

[9] Cf. Proto-Mixtec **tɨ luʔwẽʔ* 'scorpion' (Josserand 1983:479)

as ongoing, temporally unbounded, or habitual, whether the event occurred in the past, present or future. The perfective (PFV), is marked with the prefix *í–* and construes situations as a complete whole.[10] The prospective aspect (PROS) is indicated by the prefix *kʷá–* and is used essentially as described in Comrie (1976:64): to establish "a relation between a state at one time and a situation at an earlier time".[11] It is translated in English by *going to* and is etymologically related to the Mixtec verb 'go', as will be discussed further below. The data in (38) show three aspectual forms of the intransitive verb, *kú'ú* 'be sick'.

(38) a. ***í**kúˀú* *kɨtɨ́*
**í**–ku$^{ʔH}$ kɨ̀tɨ̀
PFV–be.sick animal
'The animal was sick'

b. ***kʷá**kúˀúɾà*
**kʷá**–ku$^{ʔH}$ = ɾà
PROS–be.sick=3MASC
'He is going to be sick'

c. *kùˀū* *kɨtɨ̀*
$^{L}$⌢ku$^{ʔH}$ kɨ̀tɨ̀
IPFV-be.sick animal
'The animal is/was sick'

The perfective prefix, *í–*, shown in (38a), bears a H tone which is sometimes realized on the following TBU rather than on, or in addition to, the affix itself. The prospective (38b) also bears a

[10] The distinction between "complete whole", which Comrie (1976:18) argues is the proper characterization of the perfective, and "completed", which is an inadequate characterization of the perfective, is difficult to tease out in actual data, and more research is needed to properly understand the perfective aspect in IM. Perfective events are usually in the past and completed, which is typical of perfective categories cross-linguistically (Dahl 1985:79), but the perfective in IM can be also used for a series of past events (e.g. 'He coughed (PFV) seven times, yesterday.'), as well as situations in the future 'When you return from town, I already be finished (PFV) writing (PFV) this document.').

[11] Comrie (1976:64–65) explains the difference between the future tense and the prospective aspect this way: "It is important to appreciate the difference between these expressions of prospective meaning and expressions of straight future time reference, e.g. between *Bill is going to throw himself off the cliff* and *Bill will throw himself off the cliff*. If we imagine a situation where someone says one of these two sentences, and then Bill is in fact prevented from throwing himself off the cliff, then if the speaker said *Bill will throw himself off the cliff*, he was wrong, his prediction was not borne out. If, however, he said *Bill is going to throw himself off the cliff*, then he is not necessarily wrong, since all he was alluding to was Bill's intention to throw himself off the cliff, i.e. to already present seeds of some future situation, which future situation might well be prevented from coming about by intervening factors."

H tone which behaves similarly to the tone of the perfective tone. The imperfective suprafix (38c) (indicated in the interlinear glossing as "$^{L}$⌢") associates L to the first TBU of the base and in some bases, such as the one in the example, also lowers the tone of the final TBU of the base to M. With respect to the imperfective morpheme, it is important to note that it also has a ∅ allomorph (indicated in the interlinear glossing as "∅⌢"). There is a constraint against having more than one L tone in a base: therefore, if the tonal melody of the base already contains L, the ∅ imperfective allomorph must be selected instead.

The perfective prefix may be omitted in certain circumstances leaving behind only its tonal effects:

(39) a. *kèˀī* *tútú*
∅⌢kèˀ=í tútú
IPFV⌢touch=1SG paper
'I am touching the paper'

b. *íkéˀí* *tútú*
í–kèˀ=í tútú
PFV–touch=1SG paper
'I touched the paper'

c. *kéˀí* *tútú*
$^{H}$⌢kèˀ=í tútú
PFV⌢touch=1SG paper
'I touched the paper'

In each example, the verb stem has coalesced with the first person singular enclitic pronoun (cf. §2.5). Observe that the tonal melody of the imperfective verb in (39a) is LM, while the tonal melody of the perfective verb stem is HH, both with the *í*– prefix in (39b), and without the prefix in (39c). When the perfective prefix is omitted, the perfective is indicated in the underlying form as "$^{H}$⌢".

I analyze IM verbs as being inflected for three moods, the indicative, subjunctive and negative subjunctive. The indicative mood, which expresses declarations or statements, is unmarked, and will generally not be indicated in interlinear examples except where contrasting with the subjunctive. The subjunctive, on the other hand, is expressed by the prefix *nà̄*– 'subjunctive' (SBJV) and the negative subjunctive by the prefix *mã́$^{L}$*– 'negative subjunctive' (NEG.SBJV). The subjunctive is used to express a range of attitudes of the speaker towards the action such as desire, intention or expectation (including commands), or that the event is conditional or simply unrealized (i.e. 'when something happens, something else will happen'), while the negative subjunctive expresses a negative desire, intention or expectation. Examples illustrating the positive subjunctive are given in (40a–b), the negative subjunctive in (40c) and in (40d) we see an example of each. (The subjunctive prefixes are in bold font.)

(40) a.

| | | |
|---|---|---|
| *βáˀà* | ***nã̀**kũ̀ˀṹjò* | *tã́ã́* |
| βáˀà | nà–$^{L}$⌢kṹˀ=jò | tã́$^{L}$ |
| good | SBJV–IPFV⌢go:IRR=1PL.INCL | hunting |

'It would be good should we go hunting'

b.

| | | |
|---|---|---|
| *k$^{w}$atù* | *$^{n}$dɨ̀kã̀ˀã́* | ***nã̀**jã̀ˀí* |
| k$^{w}$àtù | $^{n}$dɨ̀(kã́ˀ | nà–$^{L}$⌢jâˀ=í |
| wait:IRR | temporarily | SBJV–IPFV⌢pass.by=1SG |

'Please wait that I may pass by'

c.

***mã̀**kóˀṹ*
má$^{L}$–∅⌢kòˀ=ũ
NEG.SBJV–IPFV⌢drink:IRR=2SG
'Don't drink!'

d.

| | | | | |
|---|---|---|---|---|
| *tàtū* | ***nã̀**kù̃í* | ***mã̀**sáˀá$^{n}$dó* | *βikò* | *tʃáˀĩ̀* |
| tàtù | nà–$^{L}$⌢kú=í | mà$^{L}$–∅⌢sàˀ=$^{n}$dò | βìkò | tʃá$^{ˀL}$=í |
| if | SBJV–IPFV⌢die:IRR=1SG | NEG.SBJV–do=2PL | fiesta | foot=1SG |

'If I should die, don't have a funeral for me'

To date, examples identified as subjunctive only occur in the imperfective aspect, although this is subject to analyzing the low tone on the verb stem in (40a), (40b) and (40d) as the imperfective L suprafix. These examples could alternately be analyzed lacking aspect, and the L on the verb stem as the result of the L tone of the prefix tone spreading to the stem.

The subjunctive mood described here is widely attested in Mixtec languages, although analyzed and labelled in different ways—for example, delibertative/imperative (Mak 1953:95), hortatory (Bradley & Hollenbach 1988–1992), deontic (Macaulay 1990; 1996) and subjunctive (McKendry 2013). An infrequently used minor modal category that is not described here is the counterfactual.

IM also has a relatively small group of irregular verbs (53 in my corpus, at last count) that have two fossilized stems—one for expressing realis mood and one for the irrealis mood. These stems evolved from the combination of verb roots with what, at one time, were mood prefixes (cf. Bickford & Marlett 1988),[12] which in IM appear to have been *kù–* 'irrealis' (IRR) and *tʃì–* 're-alis' (REAL), but the vowel has been deleted in most contemporary forms, as will be discussed in §6.2.2.1. The intricacies of the usage of these forms is beyond the scope of this brief morphosyntactic sketch, but here I simply note that the realis stem is used for situations construed as actual and is used in conjunction with both the imperfective and perfective aspects, while the irrealis mood is used for non-actual (potential) situations including future events, commands, desires and evaluations and not marked for aspect (cf. Bickford & Marlett 1988). Examples showing a realis ~ irrealis pair for the verb 'eat' are given in (41a) and (41b), and for the verb 'tie' in (41c) and (41d).

(41) a.

| | |
|---|---|
| *ítʃatʃìɾà* | *ʃítá* |
| í–**tʃ**àtʃì = ɾà | ʃítá$^{L}$ |
| PFV–eat:REAL=3MASC | tortilla |

'He ate tortillas'

b.

| | | | |
|---|---|---|---|
| *kũ̀ɲĩ̄ɾà* | *tʲì* | ***k**atʃìkē* | *ʃítá* |
| $^{L}$⁀kuɲi$^{H}$ = ɾà | tʲì | **k**àtʃì = kè$^{H}$ | ʃítá$^{L}$ |
| IPFV–want=3MASC | COMP | eat:IRR=3FEM | tortilla |

'He desires that she should eat tortillas'

c.

| | |
|---|---|
| ***tʃ**ũ̀ˀɲĩ̄ɾà* | *kɨ̀tɨ́* |
| $^{L}$⁀**tʃ**uˀɲi$^{H}$ = ɾà | kɨ̀tɨ́ |
| IPFV⁀tie:REAL=3MASC | horse |

'He ties the horse'

[12] It should be noted, however, that Bickford & Marlett (1988) consider the mood prefixes to be part of the synchronic grammar. Macaulay (1996:48) considers the prefixes to be "frozen in combination with the verb roots to which they attach" and "completely nonproductive (that is, no new forms can be created with these prefixes)." She does, however, consider them to "have some synchronic legitimacy" mostly due to the fact that they have a transparent meaning.

d. ***kṹˀɲí̃*** *ⁿdúkú* *βìtʲì̃*
**kuˀɲi**ᴴ ⁿdúkú βìtʲì̃
tie:IRR firewood now
'Tie firewood now!'

As illustrated in these examples, the mood distinction in the realis ~ irrealis pairs is usually signified by a *tʃ* ∼ *k* (in bold) alternation of the initial consonant, with *tʃ* signifying the realis stem ((41a), (41c)), and *k* signifying the irrealis stem ((41b), (41d)). The verbs that follow this pattern were formed through the loss of the prefix vowel (i.e. *tʃì–* → *tʃ*; *kù–* → *k*) before verb roots beginning with a vowel. Example (41a) shows how the perfective aspectual prefix occurs to the left of the realis stem, and (41d) demonstrates the use of the bare irrealis form for commands.

The irrealis form of some verbs in this group have an initial *kʷ* instead of *k*, as illustrated in (42).

(42) ***kʷ****ákùɾà*
**kʷ**ákú = ɾà
IRR–laugh=3MASC
'He will/would laugh'

In these forms, the vowel of the prefix labialized rather than dropping out (*kù–* → *kʷ*) before vowel initial verb roots, as will be discussed in §6.2.2.1. All but one of these roots begin with /a/, although not all roots beginning with this vowel labialized.

The verb 'go', which appears to have the etymological root ã́ˀ, also belongs to this group of verbs and developed further idiosyncratic properties, some of which are shared by a few other motion verbs (cf. Macaulay 1987a; Macaulay 1996; Bickford & Marlett 1988; Merrifield 1992; Williams 1996). A detailed analysis of motion verbs is beyond the scope of this study, but this verb warrants description because of its high frequency and the important influence it has in other areas of the morphology. The verb 'go' ã́ˀ developed two different stems from the combination of the irrealis prefix with the verb root, as shown by the proposed historical derivations given in (43).

(43) a. kù– ‘IRR’+ ã̋ˀ > *kũ̋ˀũ̋* ‘will/would go’

b. kù– ‘IRR’+ ã̋ˀ > *kʷã̋ˀã̋* ‘is/was going’

In (43a), the prefix vowel was, uncharacteristically, retained and spread to the root forming a suppletive irrealis stem to which I assign the underlying form /kũ̋ˀ/ ‘go:IRR’ and which means unrealized movement by the subject away from the deictic centre. The form in (43b), on the other hand, followed the usual phonological pattern labializing the vowel of the irrealis prefix (*kù* → *kʷ*) before the vowel initial root beginning with /a/ (cf. (42)), but created a grammatically novel progressive stem that is used for trips away from the deictic centre that are construed as incomplete (i.e. still in progress).[13] The underlying form for this stem is /kʷã̋ˀ/ ‘go:PROG’ and the root vowel is lengthened for prosodic reasons that will be discussed in §6.2.1.

The combination of the realis prefix with the verb ‘go’, on the other hand, developed only a single stem, /tʃã̋ˀ/, as shown in this proposed derivation:

(44) tʃì– ‘REAL’ + ã̋ˀ ‘go and return’ > *tʃã̋ˀã̋*

This derivation followed the usual phonological pattern of deleting the vowel of the realis prefix (*tʃì* → *tʃ*), and as with the progressive stem, the root vowel was lengthened. However, the realis stem developed irregular semantics. This stem signifies movement away from the deictic centre and a return to it—that is, a round trip (‘go:RNT’). When inflected with the imperfective aspect, the verb signifies habitual round trips, and when inflected with the perfective aspect it refers to round trips that are completed. The progressive stem (43b) has taken over the rest of the semantic space that is usually covered by the imperfective.

Verbs may also bear a number of quasi-inflectional prefixes. Quasi-inflectional morphemes are productive, but do not express obligatory grammatical categories and appear to create new lexes

[13] The progressive is an aspectual value only used in a couple other motion verbs: *βátʃì* ‘is coming’, *kʷánũˀũ̏* ‘is going home’.

of their bases rather than new lexemes (Mel′čuk 2006; Beck 2011). In IM, these prefixes divide into two groups: adverbials and directionals.

There are two adverbial prefixes. The first, *tʃà–* 'already', transparently indicates that the action of the verb is already in progress if the aspect is imperfective (45a), already completed if the aspect is perfective (45b) or about to be undertaken if the aspect is prospective (45c):

(45) a. ***tʃà**tʃatʃìɾà* *ʃítá*
tʃà–tʃàtʃì = ɾà ʃítá$^{\text{L}}$
already–eat:REAL=3MASC tortilla
'He is already eating tortillas.'

b. ***tʃà**ītʃátʃìɾà* *ʃítá*
tʃà–í–tʃàtʃì = ɾà ʃítá$^{\text{L}}$
already–PFV–eat:REAL=3MASC tortilla
'He is already ate tortillas.'

c. *sokò* ***tʃà**kʷàsáˀì* *βitʲìβitʲì̃̀* *hàá*
sòkò tʃà–kʷá–sá$^{\text{ʔL}}$ = í βìtʲì̃̀–βìtʲì $^{\text{L}}$βá
but already–PROS–do=1SG today–today dude
'but I'm about to do it right now, dude'

Examples (45b) and (45c) also illustrates that *tʃà–* is added outside (i.e. further from the root than) the inflectional prefixes (i.e. the perfective and prospective prefixes, respectively, in these examples). When occurring with verbs that have realis and irrealis stems, the prefix only selects the realis stem, as in (45a) and (45b).

The second adverbial prefix, *nà̃–* 'repetitive' (REP), adds the meaning that the action is being done again, although the exact nature of the repetition is dependent on the verb to which it is applied, as can be seen by these pairs of examples where the first example gives the non-repetitive form and the next one gives the repetitive form, both having the same aspect:

(46) a. *kʷásatà$^{n}$dī*
kʷá–sàtà = $^{\text{n}}$dí
PROS–buy=1PL.EXCL
'we will buy (something)'

b. ***kʷānā̋satàⁿdī***
kʷá–nà–sàtà = ⁿdí
PROS–REP–buy=1PL.EXCL
'we will re-buy (something)'

c. *ítʃàtʃī*
í–tʃàtʃì = í
PFV–eat:REAL=1SG
'I ate'

d. ***īnā̋kàtʃī*** *ʃítá*
í–nà–kàtʃì ʃítáᴸ
PFV–REP–eat:IRR
'I resumed eating tortillas'

e. *tʃũ̏ˀɲĩ̄ɾà*
ᴸ⌢tʃuˀɲiᴴ = ɾà
IPFV⌢tie:REAL=3MASC
'he is/was tying'

f. ***nȁ****kũ̏ˀɲĩ̋ɾà*
nà–ᴸ⌢kuˀɲiˀᴴ = ɾà
REP–IPFV⌢tie:IRR=3MASC
'he is/was re-tying'

The repetitive form in (46b) means that the buyer is going to buy something that has already been sold before—that is, something that the seller bought from someone else, not simply repeating the act of buying. The repetitive form in (46d) means that the person stopped eating for a while (e.g. because of sickness) and then resumed eating. And the final repetitive form in (46f) means that the person is re-tying something that was already tied, not simply tying many things repeatedly. These examples also illustrate that the repetitive prefix can be used in each aspect (prospective (46b), perfective (46d) and imperfective (46f)), that it occurs inside (closer to the root than) any aspectual prefixes and that when it is used with the class of verbs that mark realis/irrealis mood, they require the irrealis stem.

The second group of quasi-inflectional prefixes consists of three directional prefixes which indicate that the agent in the event expressed by the verb changes location in order to perform the event, as well as information about the direction and aspect of the motion. The directional prefixes are reduced forms of the different stems of the verb 'go' which were given above in (43) and (44), as are the cognates found in other Mixtec languages (e.g. Pike 1944:133; Bradley & Hollenbach 1988–1992; Mak 1950:83; Macaulay 1996:171; Macken & Salmons 1997:42). The first directional prefix, *kú*– is a reduced form of *kṹˀṹ* 'go:IRR' (43a) and, like the full form, means that the agent's motion is away from the deictic centre and is irrealis (i.e. unrealized):

| (47) | *kũ̀ɲĩ́* | ***kú***–*sàtē* | *nṹũ̀* | *ⁿdítʃẽ̀* |
|---|---|---|---|---|
| | ᴸ⌒kũɲiᴴ = í | nû | kú–ⁿdʲèˀ = í | ⁿdítʃã́ᴸ = í |
| | IPFV⌒want | MOT.AW.IRR–buy=1SG | one | sandle=1SG |

'I want to go buy some sandals'

In this example, the prefix is used to express the fact that the agent would have to go somewhere away from where the conversation takes place in order to buy the sandals. The prefix can also be used in the other kinds of irrealis situations, and is incompatible with both the prospective and perfective aspects.

The second directional prefix, *kʷá*– is a reduced form of *kʷã́ˀã́* 'go:progressive' (43b). It also indicates that the agent moves away from the deictic centre to perform the action expressed by the verb, but the event is construed as still in progress:

| (48) | *túú* | *ĩ́ⁿgà* | *kíβí* | *tà* | ***kʷá***ⁿ*dʲeˀè* | *ɲã̀ɲĩ́ɾà* |
|---|---|---|---|---|---|---|
| | H⌒túᴸ | ĩ̀–ká | kíβíᴸ | tà | **kʷá**–ⁿdʲèˀ | ɲáɲí = ɾà |
| | PFV⌒dawn | another | day | and | MOT.AW.PR–see | brother=3MASC |

*nṹtʃitùɾà*
núᴸ = ᴴ⌒tʃi–tù = ɾà
face=PFV⌒clear.land:REAL=3MASC

'Another day dawned and his brother was going to see where he had cleared land'

It should be noted that, as discussed above, the meaning of this prefix has further grammaticalized to indicate prospective aspect, which has taken over as the predominant usage. At this point, it is not certain that there are two distinct forms (i.e. a prospective form and a directional form); for instance, there are no clear cases where they co-occur. Situations where the action is clearly in progress, and not relating a present state to a future time, like the one depicted in (48), appear to be distinguished by context, such as the time-setting clause at the beginning of the sentence in this example. More study is needed to sort out these factors.

The final directional prefix, *tʃá–* is a reduced form of *tʃa̋ˀa̋* 'go:RNT' (44) and indicates that the agent has moved away from the deictic centre to perform the action expressed by the verb and returned:

(49) *ⁿdúkú ītʃáⁿdùkī*
ⁿdúkú í–**tʃá–**ⁿdùkù = í
firewood PFV–RNT–search=1SG
'I went looking for firewood'

This construes the entire event as completed and, therefore, the prefix is only used with the perfective aspect.

The final prefix to discuss for verbs is the valency altering prefix, *sà–* 'CAUSATIVE' (CAUS). The causative is added to monovalent and to some bivalent verbs to increase the verb's valency by one, adding a causer to the event denoted by the verb. The pair of examples given in (50), contrast between the monovalent verb, *kakù* 'be born' and its bivalent causative derivative, *sàkakù* 'cause somebody to be born'.

(50) a. … *ìkákù lèē*
í–kàkù lèᴴ
PFV–be.born baby
'…the baby was born'

b. *ìsàkákúɾá lèē*
í–**sà–**kàkù = ɾà lèᴴ
PFV–CAUS–be.born=3MASC baby
'He delivered the baby'

In (50a), 'baby' expresses the subject of the predicate (the 'somebody' that is born), but in (50b), a new semantic actant (the causer—'he') is introduced as the subject, and 'baby' becomes the direct object. Examples showing the contrast between the bivalent verb ***tʃatʃì*** 'eat something' and its causative derivative, ***sàkatʃì*** 'cause somebody to eat something', are given in (51).

(51) a. *ɨ̃́ɲã́ kɨ́βɨ́ tʃatʃì ɲã́jɨβɨ̀*
ɨ̃́ɲá kɨ́βɨ́$^{L}$ ∅⌒tʃàtʃì ɲá(jɨβɨ̀
eight day IPFV⌒eat people
'the people eat (something) for eight days'

b. *kʷásá̱kátʃírā ɲã̀jɨβɨ̀*
kʷá–**sà–**kàtʃì = ɾà ɲá(jɨ̀βɨ̀
PROS–CAUS–eat:IRR=3MASC people
'He is going to feed the people (something)'

In (51a), the subject is expressed by 'people', who are the ones eating something, which is an unexpressed direct object argument. By contrast, 'people' becomes the direct object in (51b), and a causer ('he') is introduced as the new subject of the clause.

Verb roots form compounds both with other verbs and, more commonly, with words from other parts of speech. As with nominal compounds (§2.4.1), the morphological head of the compound is the initial root of the construction, while the prosodic head is the final root. Examples of compound verbs are given in (52), where (52a) shows the combination of two verb roots, (52b) is a verb root plus a noun and (52c) is a verb plus an adjective.

(52) a. *tʃatʃìjɨˀɨ̀*
∅⌒tʃàtʃì–jɨ̀ˀ
IPFV⌒eat:REAL–be.inside:REAL
'is/was biting'

b. *ítʲásóˀòɾà*
í–tʲà–sôˀ = ɾà
PFV–lay–ear=3MASC
'He listened'

c. *ìtʲí$^{n}$dʲeèkē*
í–tʲìˀ–$^{n}$dʲè = kē
PFV–put–strong=3FEM
'She helped'

Inflectional affixes are added outside the compound, as shown by the perfective forms in (52b–52c).

### 2.4.3 Adjectives

IM has a robust class of adjectives (Penner 2014). Examples of IM adjectives listed according to Dixon's (1977; 2006) semantic types are given in (53).

(53) Adjectives by semantic type

a. DIMENSION—*kãɲĩ̀* 'long', *kãˀnũ̀* 'big', *kẽ̀ˀẽ̄* 'wide', *kʷɨ̀tɨ̄* 'short', *kũ̀nũ̄* 'deep', $^{L}$*lóˀò* 'small, young', *sùkũ̄* 'tall', *jaʃĩ̀* 'thin'

b. AGE—*tʃaà* 'new', *tʃãˀnũ̀* 'old'

c. VALUE—*ásɨ̃́*$^{L}$ 'delicious', *íí*$^{L}$ 'sacred', *kukà* 'rich', $^{n}$*dàˀβɪ̄* 'poor', *βáˀà* 'good'

d. COLOUR—*àsū* 'blue', *kʷã̀ã̄* 'yellow', *kʷàˀā* 'red', *kʷĩ̀tʃĩ̄* 'white', *kʷɨɨ̀* 'green', *tũũ̀* 'black', *jàˀā* 'brown'

e. PHYSICAL PROPERTY—*tʃátú* 'spicy', *ijà* 'sour', $^{n}$*dítʃĩ́*$^{L}$ 'bright/clear', ɲãã̀ 'dark', *ɲã́mã́* 'light', *βéè* 'heavy', *βɨ̀tā* 'soft', $^{n}$*daβà* 'hard', $^{n}$*datʃã̀* 'agile', $^{n}$*dajɨ̀* 'rough', $^{n}$*dɨɨ̀* 'smooth', $^{n}$*dʲeè* 'strong', *nɨ̀jɨˀɨ̀* 'raw', *ɲĩˀɲĩ̀* 'hot', *βítʃĩ̀* 'cold', *kʷĩ̀ˀjā* 'ugly', *tʲãˀã̀* 'dirty', *úˀβá* 'salty', *βiʃà* 'wet', *βíʃí* 'sweet', *tʲàˀjū* 'rotten'

f. HUMAN PROPENSITY— *soˀò* 'deaf', *sutʃã̀* 'lazy', *ʃã́ã́*$^{L}$ 'fierce/angry', *jɨsɨ̀* 'clever, capable', *kʷaà* 'blind'

g. DIFFICULTY—*jɨɨ̀* 'difficult'

h. SIMILARITY—*sɨ̃ɨ̃̀* 'different/apart'

i. QUALIFICATION—$^{n}$*dáá* 'true'

j. QUANTIFICATION—*kʷáˀá*$^{L}$ 'many'

Adjectives bear no inflection and nearly all have a simple bimoraic structure, as demonstrated by the examples in (53).

This class of words can also function as syntactic predicates, as illustrated in (54):

(54) a. *kãˀnũ̀ βeˀè*
kàˀ$^{n}$nù βèˀ
big house
'The house is big'

b. *kãˀnũ̀ íkúù βeˀè*
kàˀnù í–kù βèˀ
tall PFV–be house
'The house was big'

c. *kʷákúkʷàˀā* *βeˀè*
kʷá–kù–kʷàˀᴴ βèˀ
PROS–be–red house
'The house is going to be red'

In imperfective contexts (54a), adjectives have a zero copula; however, in other aspectual contexts, adjectival predicates must have either an overt copula, as shown in (54b) for the perfective aspect, or a copula prefix, as shown in (54c) for the prospective aspect. The prefix *kù–* is not usually used with adjectives in the imperfective, and when it is, it tends to have an irrealis interpretation or to have an idiomatic meaning.

Adjectives can also bear two verbalizing prefixes—*ⁿdù–* 'inchoative' (INCH) and *sà–* 'causative' (CAUS):

(55) a. *kʷà**ⁿdūt**ʲã́ˀã̀* *sóórá*
kʷá–ⁿdù–tʲã̀ˀ sóᴸ = ɾà
PROS–INCH–dirty clothes=3MASC
'His clothes are going to become dirty'

b. *mã̀**sá**βiʃũ̀* *sóó*
βáᴸ–sà–βìʃà = ũ sóᴸ
SBJV.NEG–wet=2SG clothes
'Don't make the clothes wet!'

c. *trã̀ᵑkā* ***sà**βàˀí*
ᴸtɾáᵑká sà–ᴸ⁀βâˀ = í
gate CAUS–IPFV⁀good=1SG
'I am making a gate'

In the first example *tʲã́ˀã̀* 'dirty' is verbalized by the addition of the inchoative prefix and is inflected with the prospective aspect. In (55b), the causative verb is inflected with the negative subjunctive mood and the prefix *sa–* adds a causer as the grammatical subject (the actant causing the clothes to be wet), while the subject of the non-causative form of the predicate (the clothes) becomes the direct object. The inchoative prefix appears to be compatible with many (or nearly all) adjectives, but I am less certain about the productivity of the causative with adjectives. While examples like the one in (55b) are straightforward, the type frequency of *sa–* + adjective examples in texts is low, and they tend to have a more or less non-compositional meaning like the example (55c).

### 2.4.4 Summary

A summary of IM affixes discussed in this morphosyntactic sketch is given in Table 2. The affixes are given in the first column, glosses in the second, the morphological type of the affix in the third and the primary (or only) word class to which it applies in the last column.

Table 2. Affixes

| **Affix** | **Gloss** | **Type** | **Word class** |
|---|---|---|---|
| **Suprafixes** | | | |
| $^{L}$⁀ | 'imperfective' (IPFV) | inflection | verbs |
| $^{HL}$⁀ | 'vocative' (VOC) | quasi-inflection | nouns |
| | | | |
| **Prefixes** | | | |
| *í–* | 'perfective' (PFV) | inflection | verbs |
| *kʷá–* | 'prospective' (PROS) | inflection | verbs |
| *nà̰–* | 'subjunctive' (SBJV) | inflection | verbs |
| *mà̰–* | 'negative subjunctive' (NEG.SBJV) | inflection | verbs |
| *tʃà–* | 'already' | quasi-inflection | verbs |
| *nà̰–* | 'repetitive' (REP) | quasi-inflection | verbs |
| *kʷá–* | 'motion away:progressive' (MOT.AW.PR) | quasi-inflection | verbs |
| *kú–* | 'motion away:irrealis' (MOT.AW.IRR) | quasi-inflection | verbs |
| *tʃá–* | 'roundtrip' (RNT) | quasi-inflection | verbs |
| *sà–* | 'causative' (CAUS) | derivation | adj, verbs |
| *kù–* | 'be' | derivation | adj |
| *ⁿdù–* | 'inchoative' (INCH) | derivation | adj |

Finally, compounding is found in both verbs and nouns and results in a morphological structure that is left-headed but a prosodic structure that is right-headed. This mismatch between morphological structure and prosodic structure is of particular importance to the arguments that will be made throughout this dissertation, especially the concomitant phonological reduction of initial (C)V(ˀ)V roots in compounds to a simple CV that is generally found in compounds.

## 2.5 Clitics

This section describes two groups of prosodically deficient elements that depend on neighbouring material for their phonological expression. I begin by describing the group of special clitics that are joined to the right edge of adjacent words through enclisis, and follow with a description of those that combine with the left edge of the word through proclisis.

IM, like other Mixtec languages, lacks suffixation, but has a rich set of pronominal enclitics. These are given in Tables 3–5 together with the free form to which they correspond where applicable.

Table 3. First and second person pronominal enclitics and corresponding free forms

| | '1SG' | '1PL.EXCL' | '1PL.INCL' | '2SG' | '2PL' |
|---|---|---|---|---|---|
| **Enclitic** | *=í* | *=ⁿdí* | *=jò* | *=ũ* | *=ⁿdò* |
| **Free form** | *jú'ú* | *ⁿdʲú'ú* | *joò* 'who, 1PL.INCL' | *jò'ō* | *ⁿdʲò'ō* |

Table 4. Third person human pronominal enclitics and corresponding free forms

| | '3FEM' | '3FEM.RESP' | '3MASC' |
|---|---|---|---|
| **Enclitic** | *=kē* | *=ɲã̀* | *=ɾà* |
| **Free form** | | *ɲã'ã̀* 'woman' | |

Table 5. Other third person pronominal enclitics and corresponding free forms

| | '3ANML' | '3WOOD' | '3GNRL' |
|---|---|---|---|
| **Enclitic** | *=tɨ̀* | *=tũ̀* | *=tʃî* |
| **Free form** | *kɨtɨ̀* 'horse, animal' | *jutũ̀* 'tree' | |

The third person pronouns are related to the fossilized noun classifiers that represent the semantic classes animal, wood, male/human and female, which were discussed in §2.4.1. These pronouns are not specified for grammatical number, although the human third person pronouns are used almost exclusively for single persons, while the third person general pronoun is used for third person plural human referents as well as for referents that do not fit semantic types for which there is a specific pronoun.

Pronominal enclitics can serve as either subjects or objects in the verb phrase. When they act as the subject argument, they attach to the right edge of a verb that has no modifiers, as shown in (56). (The enclitic is given in bold fond.)

| | |
|---|---|
| (56) | *kajɨ̀**ɾà*** |
| | ∅⌢kàjɨ̀ = ɾà |
| | IPFV⌢cough=3MASC |
| | ‘He is/was coughing.’ |

However, if there is an adverb following the verb, the clitic will attach to this word instead, as shown in (57).

| | | |
|---|---|---|
| (57) | *kajɨ̀* | *lòkó**ɾà*** |
| | ∅⌢kàjɨ̀ | lòkó = ɾà |
| | IPFV⌢cough | INTS=3MASC |
| | ‘He is/was coughing a lot.’ | |

When pronominal enclitics act as the direct object, they combine with the preposition *tʃìì*:

| | | | | |
|---|---|---|---|---|
| (58) | a. | *ī$^{n}$d$^{j}$é$^{ʔ}$èɾà* | *tʃìì**tɨ̀*** | … |
| | | í–$^{n}$d$^{j}$è$^{ʔ}$ = ɾà | tʃì = tɨ̀ | |
| | | PFV–see=3MASC | OBJ=3ANML | |
| | | ‘He saw it’ | | |
| | b. | *ɲà̃$^{n}$d$^{j}$é$^{ʔ}$ì* | *tʃìì **ɾà*** | |
| | | ɲà$^{L}$ = ∅⌢$^{n}$d$^{j}$è$^{ʔ}$ = í | tʃì = ɾà | |
| | | NEG=IPFV⌢see=1PL.INCL | OBJ=3MASC | |
| | | ‘I don’t see him’ | | |

Since the pronouns are prosodically unable to stand on their own, they require the preposition to provide the prosodic structure necessary to fill this constituent alone.

Pronominal enclitics can also be part of a noun phrase, as in (59), in which case they act as the possessor.

(59) a. *βeˀè**rà***
βèˀ = ɾà
house=3MASC
'his house'

b. *βeˀè kãˀnũ̀**rà***
βèˀ kàˀnù = ɾà
house big=3MASC
'his big house'

Example (59a) shows that an enclitic attached to a noun is the possessor of the head noun (underlined); however, if there is an adjectival modifier following the noun, the clitic possessor attaches to this word instead, as shown in (59b).

It should be noted that the two vowel-initial enclitic pronouns, the first and second person singular enclitics, undergo vowel coalescence when combined with stems with a disyllabic couplet (which always end in a vowel in IM). This is exemplified for the first person singular enclitic pronoun, *=í*, in (60a), and for the second person singular enclitic pronoun, *=ũ*, in (60b).

(60) a. *tʃít**é***
tʃító = í
bed=1SG
'my bed'

b. *tʃít**õ̀***
*tʃító = ũ*
bed=2SG
'your bed'

The coalesced vowel has the backness of the clitic vowel, and the height of the stem vowel. The particulars of vowel coalescence will be spelled out in greater detail in §6.2.1. There are also various tonal processes that apply between the enclitics and the word to which they attach which will be addressed in Chapter 4.

There are also two adverbial enclitics, *=ɲì* ‘only’ and *=ká* ‘more’. Examples with these clitics are given in (61).

(61) a. *nṹũ̀**ɲĩ̀***
nû = ɲì
one=only
‘only one’

b. *ìjō**ká***
$^{L}$⁀íjó = ká
IPFV⁀exist=more
‘there are more’

The adverbial enclitics may be combined with each other and a pronoun, as in (62).

| (62) | *ṹɲã́* | *tã$^{ʔ}$ã̀**ɲĩ̀kātʃì*** |
|---|---|---|
| | úɲá | tã̀$^{ʔ}$ = ɲì = ká = tʃì |
| | eight | relative=only=more=3GNRL |
| | ‘only eight more of them’ | |

The order of the enclitics is fixed as in the example—‘only’ + ‘more’ + pronominal.

The enclitics can also combine with the emphatic particle, *mãã̀* (EMPH), as illustrated in (63). (The emphatic particle is in bold font.)

| (63) a. | *sã́nã́* | ***mã́ĩ́*** | *kuù* | *lèlū* | *ɲã́ɲĩ̀* |
|---|---|---|---|---|---|
| | sáná$^{L}$ | mà = í | ∅⁀kù | $^{L}$lélú | $^{HL}$⁀ɲáɲí |
| | domestic.animal | EMPH=1SG | IPFV⁀be | calf | VOC⁀brother |
| | ‘The calf is one of my cattle, brother.’ | | | | |

| b. | *ɲã̀súú* | *sē$^{ʔ}$è* | *kṹɲṹ* | ***mãã̀**kē* | *kuù* |
|---|---|---|---|---|---|
| | ɲá$^{L}$ = sù | sê$^{ʔ}$ | kúɲú | mà = kè$^{H}$ | kù |
| | NEG=AFFIRM | offspring | flesh | EMPH=3FEM | be |
| | ‘(It) is not her own offspring.’ | | | | |

| c. | ***mãã̀**ɲĩ̀* | *tútú* | *sàβá$^{ʔ}$àɾà* |
|---|---|---|---|
| | mà = ɲì | tútú | sà–βâ$^{ʔ}$ = ɾà |
| | EMPH=only | paper | CAUS–good=3MASC |
| | ‘He only makes documents.’ | | |

The form *mãã̀ɲĩ̀* (63c) is usually pronounced *mãɲĩ*—that is, without the lengthened /a/. (The adverbial enclitic =*ká* ‘more’ has only been found combined with *mãã̀* once in my data.)

Moving on to the process of proclisis, I will discuss five important IM proclitics—three which are relative pronouns, one which is a locative preposition and one which is used for negation. The three relative pronouns are *ɾà*= ‘third person masculine’ and *kè*= ‘third person feminine’ and *tʃa*= ‘what’. These proclitics usually appear in headless relative clauses which act as arguments of the matrix verb, as illustrated in (64). (The relative clauses in each example are marked with square brackets and the relative pronouns are in bold font.)

(64) a.

| | |
|---|---|
| *βátʃì* | *[**kē**$^{n}$dùkʷìˀjā]* |
| βátʃì | kè$^{H}$ = $^{n}$dù–∅⌢kʷìˀjà$^{H}$ |
| come:IPFV | 3FEM=INCH–IPFV⌢sad |

‘She who is sad is coming’

b.

| | | | | |
|---|---|---|---|---|
| *í$^{n}$dʲeˀè* | *jèlí* | *tʃìì* | *[**ɾà**ísatà* | *tútú]* |
| í–$^{n}$dʲèˀ | $^{L}$jélí | tʃì | ɾà = í–sàtà | tútú |
| PFV–see | Miguel | OBJ | 3MASC=PFV–buy | book |

‘Miguel saw him who bought the book’

c.

| | |
|---|---|
| *βátʃì* | *[**tʃá**tʲìì]* |
| βátʃì | tʃá$^{L}$ = tʲì |
| come:IPFV | COMP=get.wet:PFV |

‘What got wet is coming’

In (64a) and (64c), the relative clause is the subject argument of the matrix clause and the relative pronoun expresses the subject in the relative clause. In (64b), the relative clause is the direct object of the matrix clause and the relative pronoun is the subject of the relative clause. The relative clauses introduced by these pronouns are not always complement clauses, however, as shown by these examples:

(65) a.

| | | | | | |
|---|---|---|---|---|---|
| *βatʲì* | *ìjō* | *mĩ̀nṹũ̀* | *kɨtɨ̀* | *[**tʃá**kã̀ˀã́tʃì* | *léʃù]* |
| βàtʲì | $^{L}$⌢ijo$^{H}$ | mì(nû | kɨ̀tɨ̀ | tʃá$^{L}$ = $^{L}$⌢kã́ˀ = tʃì | $^{L}$léʃù |
| because | IPFV–exist | one | animal | COMP=IPFV⌢speak=3GNRL | rabbit |

‘because an animal exists that they call rabbit’ b.

| | | | | |
|---|---|---|---|---|
| *jáˀí* | *tʃátá* | *<u>βéˀé</u>* | *[ɾánãɲĩ̀* | *kèβí]* |
| $^{H}$⌢jâˀ = í | tʃátá$^{L}$ | βèˀè | ɾà = ∅⌢ɲàɲì | $^{L}$kéβí |
| PFV–pass.by=1SG | behind | house | 3MASC=IPFV–be.named | Kevin |

‘I passed behind the house of he who is called Kevin’

In (65a), the relative clause modifies a nominal head (underlined) which expresses the subject of the existential matrix clause. This noun also corresponds to the indirect object argument of the relative clause (‘an animal exists to which they say, “rabbit”’). In (65b), on the other hand, the relative clause is headless and is the possessor of *βeˀè* ‘house’ (underlined).

The fourth proclitic to be examined here is the *nṹ*$^{L}$ =. Based on a sample of ten Mixtecan languages Hollenbach (1995) argues that this proclitic is a grammaticalization of the body part *nṹṹ* ‘face’, which, through a sequence of semantic extensions and shifts in syntactic category, has developed into a preposition with a variety of meanings, into what she calls an “introductory pronoun” with a locative meaning and into a coordinating conjunction. The IM data appear to concur with her findings, except for the use of the proclitic as a coordinating conjunction, and what she calls an “introductory pronoun” I call a relative pronoun. All the various uses of this proclitic will not be explored here in detail, but in (66a) I give an example demonstrating a prepositional use, while examples (66b) and (66c) show its use as a relative pronoun signifying a spatial relation (‘where’) and a temporal relation (‘when’), respectively.

(66) a.

| | |
|---|---|
| *kà$^{n}$dʲàí* | ***nṹ**tʃĩtò* |
| ∅⌢kà$^{n}$dʲá = í | nú$^{L}$ = tʃítò |
| IPFV⌢lie.down=1SG | LOC=bed |

‘I am lying down on the bed’

b.

| | | | | |
|---|---|---|---|---|
| *<u>βeˀè</u>* | *[**nũ̀**jɨ́ˀɨ́* | *kɨ̃̀nɨ̃́]* | *kuù* | *háá* |
| βèˀ | nú$^{L}$ = ∅⌢jɨ̀ˀ | kɨ́nɨ́ | ∅⌢kù | βá |
| house | where=IPFV⌢be.inside | pig | IPFV⌢be | dude |

‘(It) is a house where pigs are contained, dude’

c.

| | | | | | |
|---|---|---|---|---|---|
| *nã́ã́* | *tʲĩ̀ɲũ̀* | *saˀà* | *ɲã̀ɲṹ* | *[**nṹ**ìjáˀā* | *kúʃĩ̀ɲĩ̀$^{n}$dò]* |
| ná | tʲìɲù | $^{L}$⌢sàˀ | ɲáɲú = ũ | nú$^{L}$ = í–jâˀ | $^{H}$⌢kùʃiɲì = $^{n}$dò |
| what | work | IPFV–do | brother=2SG | when=PFV–pass.by | PFV–eat.supper=2PL |

‘What work did your brother do when you finished eating supper?’

In the first example, *nű́ᴸ* = introduces a locative adjunct indicating the place where the person is lying. It does not appear to be possible for prepositional phrases like this to be modifiers of nouns; however, if *nű́ᴸ* = introduces a relative clause, the relative clause can be a modifier of a noun, as in (66b), where the clause introduced by the relative pronoun modifies the noun *βeˀè* 'house' (underlined) indicating the place where the pigs are contained. The relative clause in (66c), on the other hand, is a headless relative clause which adds a temporal adjunct to the matrix clause.

The final proclitic is the negative marker, *ɲã́ᴸ* = . This proclitic negates verbs (67a), adjectives (67b) and adverbs (67c):

(67) a. ***ɲã́ì**tʃitē* *tʃirà*
ɲáᴸ = í–tʃitò = í tʃì = ɾà
NEG=PFV–know:REAL=1SG OBJ=3MASC
'I did not know him'

b. *βeˀè* ***ɲã́**sukṹ̀* *kuù* *βeˀèɾà*
βèˀ ɲáᴸ = sùkṹ̀ᴴ kù βèˀ = ɾà
house NEG=tall be house=3MASC
'His house is a not tall house'

c. … *sokò* ***ɲã́**ɲĩ̄ˀĩ̀* *kʷáʃitàjò*
sòkò ɲáᴸ = ɲîˀ kʷá–ʃità = jò
but NEG=intensely PROS–pull=1PL.INCL
'but we will not pull intensely'

When it occurs with the relative pronouns, *ɲã́ᴸ* = always immediately follows them, as shown in these examples:

(68) a. *núɲí* ***tʃáɲã́**ikójo* *βáˀà*
ⁿdújíᴸ **tʃáᴸ** = **ɲáᴸ** = i–kójò βâˀ
maize COMP=NEG=PFV–be.shelled good
'maize that was not shelled well'

b. *tãɲĩ̀* ***núɲã̄**ⁿditʃĩ̀*
tàɲì **núᴸ** = **ɲáᴸ** = ⁿdítʃĩ́ᴸ
like LOC=NEG=illuminated
'like where (it) is not illuminated'

In example (68a), the relative pronoun, *tʃá*$^{L}$ =, introduces a relative clause that has been negated, and in (68b), *nṹ*$^{L}$ = introduces a negated property concept describing a location.

A summary of IM clitics discussed in this morphosyntactic sketch is given in Table 6.

Table 6. Clitics

| Clitic | Gloss | Function |
|---|---|---|
| **Proclitics** | | |
| *nṹ*$^{L}$ = | 'locative' (LOC) | prepositional, relative pronoun |
| *tʃá*$^{L}$ = | 'what' | relative pronoun |
| *ɾà* = | 'third person masculine' (3MASC) | relative pronoun |
| *kē* = | 'third person feminine' (3FEM) | relative pronoun |
| | | |
| **Enclitics** | | |
| =*í* | 'first person singular' (1SG) | pronominal |
| =*ⁿdí* | 'first person plural exclusive' (1PL.EXCL) | pronominal |
| =*jò* | 'first person plural inclusive' (1PL.INCL) | pronominal |
| =*ũ̄* | 'second person singular' (2SG) | pronominal |
| =*ⁿdò* | 'second person plural' (2PL) | pronominal |
| =*kē* | 'third person feminine' (3FEM) | pronominal |
| =*ɲã̀* | 'third person feminine respectful' (3FEM.RESP) | pronominal |
| =*ɾà* | 'third person masculine' (3.MASC) | pronominal |
| =*tɨ̀* | 'third person animal' (3ANML) | pronominal |
| =*tṹ̀* | 'third person wood' (3WOOD) | pronominal |
| =*tʃî* | 'third person general' (3GNRL) | pronominal |
| =*ɲĩ̀* | 'only' | adverbial |
| =*ká* | 'more' | adverbial |

## Chapter 3

# Non-tonal phonology

The main purpose of this chapter is to present a basic description of IM phonemes, syllable structure and stress. This description of the basic building blocks of phonological structure is essential to understanding the data and arguments that will be presented in later chapters in support of prosodic structure, particularly, the foot. It also accomplishes a second purpose by providing the first published account of IM segmental phonology, apart from work based on wordlists and linguistic survey results such as Holland's (1959) glottalchronological study, Bradley's (1968) preliminary report of his Mixtec intelligibility study, Egland's (1978) dialect intelligibility survey report and Josserand's (1983) Proto-Mixtec reconstruction. The description presented here is based on my own primary data. I limit the description that follows to the phonology of the native vocabulary, leaving aside phonemes and other phonological issues introduced by loanwords.

The chapter is laid out as follows. I begin with a description of the vowel and consonant phonemes in §3.1 and §3.2, respectively. This is followed by a description of the IM syllable in §3.3 and stress in §3.4.

## 3.1 Vowels

IM has six distinctive vowel qualities—*i, e, ɨ, a, u, o*—which like many languages in the world, exist in several parallel vowel series or sets where they are modified by other features, greatly increasing the number of surface vowel contrasts (Maddieson 1984:127), as shown in Table 7. [1]

[1] Following Maddieson (1984:128), I use "distinctive vowel qualities" to refer to the vowel contrasts described by the features height, backness and rounding, which are the most fundamental features of vowel contrast.

Table 7. IM surface vowel contrasts

| | Front | | Central | | Back | |
|---|---|---|---|---|---|---|
| **High** | *i* | *ĩ* | *ɨ* | *ɨ̃* | *u* | *ũ* |
| | *iˀ* | *ĩˀ* | *ɨˀ* | *ɨ̃ˀ* | *uˀ* | *ũˀ* |
| **Mid** | *e* | *ẽ* | | | *o* | *õ* |
| | *eˀ* | *ẽˀ* | | | *oˀ* | |
| **Low** | | | *a* | *ã* | | |
| | | | *aˀ* | *ãˀ* | | |

In addition to the basic oral set, IM has nasal, glottalized (also referred to as laryngealized; Gerfen & Baker 2005), and nasal glottalized sets. This results in an overall inventory of 23 surface contrasts for short vowels (i.e. in (C)V(ˀ)CV couplets), since /e/ and /o/ are not nasal glottalized in this context; moreover, long vowels mirror the same four vowel sets resulting in 23 additional surface contrasts for long vowels (/o/ does not occur as nasal nor as nasal glottalized). In anticipation of the discussion of contrastive glottalization in §6.3.1, a smaller underlying inventory of vowel phonemes is posited by treating vowel glottalization as a contrastive feature of roots rather than of the individual vowels themselves. In other words, surface contrasts involving glottalized vowels arise when a root is marked for this glottal feature in the lexicon, and when this is the case, the distribution of glottalized vowels within the couplet is systematic (cf. Gerfen 1996). A similar analysis has been proposed by Marlett (1992) for nasalization across Mixtec languages; however, I posit underlying nasal vowels (and consonants) for IM, and in §6.3.2 I discuss the phonotactic patterns of nasal segments that are the result of diachronic processes such as those described by Marlett.

The root-feature analysis of vowel glottalization also applies to the surface contrasts of long vowels that are glottalized. Moreover, in §6.1, I argue that vowel length itself is derived in response to prosodic constraints and is not an underlying property of the vowels themselves. This analysis of long vowels follows in the spirit of Maddieson (1984:127, 162), who considers length to be a suprasegmental feature "not relevant to setting up an inventory of phonological segments" (p. 162) when it affects all and only the basic vowel qualities of the system. In the rest of this section, I present the surface contrasts for vowels beginning with the set of oral vowels, followed by the nasal, glottalized and nasal glottalized sets, in that order. For each set of vowel contrasts, I also present the corresponding surface contrasts with long vowels.

The data in Table 8 illustrate contrasts for the set of six oral vowels in both the first and second syllables of CVCV couplets.

Table 8. Oral vowel contrasts in CVCV couplets

| | **CV̲CV** | | **CVCV̲** | |
|---|---|---|---|---|
| /**i**/ | *kisò* | 'carry:IRR' | *t$^{j}$akì* | 'pretty' |
| /**e**/ | *ketà* | 'go out' | *tɨ̀t$^{j}$é$^{ʔ}$lé$^{L}$* | 'cockroach' |
| /**ɨ**/ | *kɨtɨ̀* | 'animal' | *$^{n}$dɨkɨ̀* | 'horn' |
| /**a**/ | *kakà* | 'walk:IRR' | *$^{n}$d$^{j}$ikà* | 'mamey' |
| /**o**/ | *kotò* | 'know:IRR' | *$^{n}$d$^{j}$ikò* | 'grind' |
| /**u**/ | *kutù* | 'tight' | *$^{n}$dakù* | 'pozole' |

The items in the CV̲CV column show how each vowel in the row header contrasts with the other items in the column in the first vowel position of the disyllabic couplet. The items in the CVCV̲ column likewise show contrasts for each vowel in the second vowel position of the couplet.

Each oral vowel also contrasts in CVː couplets, as shown in Table 9.

Table 9. Oral vowel contrasts in CVː couplets

| | **CVː** | |
|---|---|---|
| /**i**/ | *$^{n}$d$^{j}$iì* | 'sunny' |
| /**e**/ | *$^{n}$d$^{j}$eè* | 'strong' |
| /**ɨ**/ | *$^{n}$dɨɨ̀* | 'smooth' |
| /**a**/ | *$^{n}$dáá* | 'true' |
| /**o**/ | *$^{n}$doò* | 'straight' |
| /**u**/ | *$^{n}$duù* | 'become' |

Here and throughout the dissertation, long vowels are written with two identical vowels which facilitates marking tone for each TBU. With the exception of two words in my data (*ʃɨ́ú*[L] 'abdomen', *àú* 'yes'), couplets lacking a medial consonant always have a long vowel.[2]

The set of six nasal vowels is illustrated in Table 10, where nasalization is indicated with a tilde over the vowel (e.g. *ã*).

Table 10. Oral ~ nasal vowel contrasts in CVCV couplets

| | **Oral** | | **Nasal** | |
|---|---|---|---|---|
| **/i ~ ĩ/** | *βitʃi* | 'pineapple' | *βítʃĩ̀* | 'cold' |
| **/e ~ ẽ/** | *kóké* | 'my notch' | *kòkẽ̄* | 'I am thick'[3] |
| **/ɨ ~ ɨ̃/** | *jɨkɨ* | 'bone' | *jɨkɨ̃̀* | 'squash' |
| **/a ~ ã/** | *káká* | 'lime' | *kákã́* | 'ask for' |
| **/o ~ õ/** | *kókó* | 'notch' | *kokõ̀* | 'thick' |
| **/u ~ ũ/** | *tútú* | 'paper' | *tútṹ*[L] | 'corner' |

Here the final vowel in each example in the Oral column contrasts with the final vowel of the example in the Nasal column. With the exception of /õ/, each nasal vowel may also be lengthened, as shown in Table 11.

Table 11. Oral ~ nasal vowel contrasts in CVː couplets

| | **Oral** | | **Nasal** | |
|---|---|---|---|---|
| **/i ~ ĩ/** | *tʲiì* | 'get wet' | *tʲĩĩ̀* | 'fingernail' |
| **/e ~ ẽ/** | *nàkeè* | 'stretch' | *kẽẽ̀* | 'grab' |
| **/ɨ ~ ɨ̃/** | *tɨɨ̀* | 'tight' | *tɨ̃ɨ̃̀* | 'bark' |
| **/a ~ ã/** | *kaà* | 'go up' | *kã́ã́* | 'perforate' |
| **/o ~ õ/** | *kóó*[L] | 'snake' | ----- | |
| **/u ~ ũ/** | *kúú* | 'die:IRR' | *kũũ̀* | 'go down' |

The quality of nasal vowels is not significantly different from that of the oral variant with the exception of /ũ/, which may be realized as the unrounded [ɯ̃] word finally. It should also be

[2] My main consultant reports that *ʃɨ́ú*[L] 'abdomen' is pronounced *ʃúú*[L] by some speakers.
[3] The phoneme /ẽ/ does not occur in the second syllable of monomorphemic disyllabic couplets.

noted that vowels are often (non-contrastively) nasalized to some degree preceding prenasalized consonants as in *ʃa*$^{n}$*dù* [ʃã$^{n}$dù] 'navel'. This type of nasalization is not indicated in transcriptions.

Although oral and nasal vowels contrast following voiceless obstruents, as shown above, they do not contrast following nasal consonants (where only nasal vowels occur), and contrast in only a very limited way following other voiced consonants due to nasal phonotactics and a rule of progressive nasalization from a nasal consonant to a following vowel. These nasalization patterns are discussed further in the description of consonant phonemes (§3.2.2) and are described in detail in §6.3.2.

Each of the six vowel qualities may also be glottalized (the phonetic realization will be discussed below). The set of six glottalized vowels is given in column two of Table 12, where they are shown to contrast with plain vowels in the first column. Glottalization is indicated with a raised glottal stop (" ˀ ") following the vowel.

Table 12. Oral plain ~ glottalized vowel contrasts in CVCV couplets

| | Plain | | Glottalized | |
|---|---|---|---|---|
| **i ~ iˀ** | *kʷíjá*$^{L}$ | 'year' | *kʷìˀjā* | 'sad' |
| **e ~ eˀ** | *ketà* | 'go out' | *péˀlà* | 'wet' |
| **ɨ ~ ɨˀ** | *tɨ́βɨ́* | 'blow' | *tɨˀβɨ̀* | 'sweep' |
| **a ~ aˀ** | *tʲáβì* | 'beam' | *tʲáˀβì* | 'pay' |
| **o ~ oˀ** | *kójó* | 'fall' | *ɲí*$^{L}$*koˀjò* | 'Mexico City' |
| **u ~ uˀ** | $^{n}$*dúβá* | 'fall over' | $^{n}$*dúˀβá* | 'plain' |

Glottalized vowels may also be lengthened as demonstrated in the following examples:

Table 13. Oral plain ~ glottalized vowel contrasts in CVː couplets

| | Plain | | Glottalized | |
|---|---|---|---|---|
| **i ~ iˀ** | *ʃîi* | 'tough' | *ʃíˀí*$^{L}$ | 'peer inside' |
| **e ~ eˀ** | *βéè* | 'heavy' | *βeˀè* | 'house' |
| | | | *séˀè* | 'offspring' |
| **ɨ ~ ɨˀ** | *sɨ̂ɨ* | 'saliva' | *sɨ̀ˀɨ̄* | 'female' |
| **a ~ aˀ** | *sáá* | 'bird' | *saˀà* | 'do, make' |

| | Plain | | Glottalized | |
|---|---|---|---|---|
| **o ~ oˀ** | *sóó$^L$* | ‘clothing’ | *sóˀò* | ‘ear’ |
| **u ~ uˀ** | *suù* | ‘affirmative’ | *suˀù* | ‘record’ |

Contrastive vowel glottalization in IM is similar to that found in most Mixtec languages in that glottalized vowels may appear in both CVCV and CVː couplets, and that glottalization is sequenced after the modal portion of the vowel associated with the initial mora so that in CVː couplets it is realized as an “interruption” of the long vowel (cf. Silverman 1995; 1997).[4] With the exception of one word in my data ( *tʃɑ̃́ˀṹ* ‘fifteen’), CVˀV couplets always have a single vowel quality throughout the couplet. Vowels associated with word final moras cannot be glottalized, so there are no couplets with the form CVCVˀ or CVːˀ.[5] The data in Table 14 demonstrate another characteristic of glottalized vowels in IM and many other Mixtec varieties: when they occur in CVCV couplets, the medial consonant is voiced.

There is wide variation in the phonetic realization of vowel glottalization in IM, similar to what is reported by Gerfen & Baker (2005) for Coatzospan Mixtec. This is illustrated by the spectrograms and waveforms given in Figure 4 of three tokens of *tɨ̀kaˀà* ‘coconut’ produced by the same IM male speaker.

[4] The mora is a unit of phonological weight such that, in IM, a CVː syllable has two moras, while a CV syllable has only one mora. For a more thorough discussion, see §3.3.

[5] Final glottals are reconstructed for Proto-Mixtec (Josserand 1983:273) on the basis that there are several modern Mixtec varieties which do have final glottals: Ayutla Mixtec, Zacatepec Mixtec and Southwestern Tlaxiaco Mixtec (McKendry 2013:21).

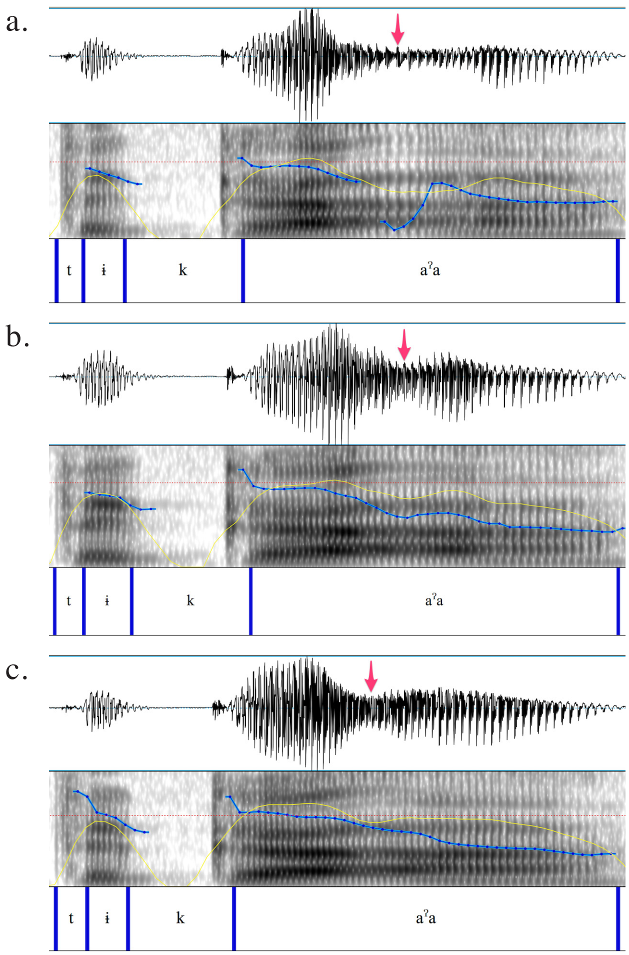



Figure 4. The spectrograms and waveforms (created in Praat; Boersma & Weenink 2016) of three tokens of ***tɨ̀kaˀà*** ‘coconut’ produced by speaker MQM in isolation.

In each figure, the glottalized portion is centred, more or less, around the arrow above the waveform. The token depicted in Figure 4a is produced with audible creak and obvious irregularity in the spacing of glottal pulses (vertical striations) in the spectrogram such that the automatic pitch tracker (blue line) fails to produce a continuous pitch track and there is a corresponding large dip in intensity (yellow line). But the clarity of the acoustic indications of glottalization are considerably diminished in other tokens. In (b), it is acoustically visible only by dips in f0 and intensity, while in (c), the only obvious indication is a dip in intensity.

In addition to contrastive glottalization exemplified in Table 13 and Table 14, there is also epenthetic glottalization, which is non-contrastive and has a different distribution than contrastive glottalization. The distributional characteristics of both contrastive and epenthetic glottalization will be discussed in §6.3.1 and §6.3.5, respectively. There I will argue that both types of glottalization provide evidence for the foot, and posit a more abstract analysis of contrastive glottalization that eliminates the need for underlyingly glottalized vowels, even though the output of the lexical phonology contains glottalized vowels.

The final set of surface vowel contrasts are those that are between vowels that are both glottalized and nasal. These are given in column two of Table 14, where they are shown to contrast with the oral glottalized set in column one.

Table 14. Oral glottalized ~ nasal glottalized vowel contrasts in CVCV couplets

| | **Oral glottalized** | | **Nasal glottalized** | |
|---|---|---|---|---|
| **i ~ ĩˀ** | *kʷĩˀjā* | 'sad' | *kʷĩ́ˀnã́* | 'Devil' |
| **e ~ ẽˀ** | *péˀlà* | 'wet' | ----- | |
| **ɨ ~ ɨ̃ˀ** | *kɨ́ˀβɨ̀* | 'enter' | *kɨ̃ˀmɨ̃̀* | 'having newborn pups' |
| **a ~ ãˀ** | *sáˀβá* | 'frog' | *sãˀmã̀* | 'tortilla cloth' |
| **o ~ õˀ** | *koˀlò* | 'male turkey' | ----- | |
| **u ~ ũˀ** | *júˀβá*ᴸ | 'thread' | *ɲṹˀmã́*ᴸ | 'smoke' |

Observe that two of the six glottalized and nasal vowel qualities—*ẽˀ* and *õˀ*—do not occur in CVCV couplets. However, all but *õˀ* contrast in lengthened vowels, as shown in Table 15, so I include five glottalized nasal vowels in the vowel inventory.

Table 15. Oral glottalized ~ nasal glottalized vowel contrasts in CV: couplets

| | **Oral glottalized** | | **Nasal glottalized** | |
|---|---|---|---|---|
| **/i ~ ĩˀ/** | *tʃiˀī* | 'drink:REAL' | *tʃĩˀĩ̀* | 'with' |
| | | | *kĩˀĩ̀* | 'bring' |
| **/e ~ ẽˀ/** | *keˀè* | 'touch' | *kẽ̀ˀẽ̄* | 'wide' |
| **/ɨ ~ ɨ̃ˀ/** | *tɨˀɨ̀* | 'bump' | *tɨ̃́ˀɨ̃́* | 'narrow' |
| **/a ~ ãˀ/** | *kàˀā* | 'cheap' | *kã́ˀã́* | 'speak' |
| **/o ~ õˀ/** | *koˀò* | 'drink:IRR' | ----- | |
| **/u ~ ũˀ/** | *kúˀú*ᴸ | 'the bush' | *kũˀũ̀* | 'wear:IRR' |

In summary, IM has the 23 surface vowel contrasts given in Table 7.
Six distinctive vowel qualities appear in four vowel sets—oral *i, e, ɨ, a, o, u* (six), nasal *ĩ, ẽ, ɨ̃, ã, õ, ũ* (six), glottalized *iˀ, eˀ, ɨˀ, aˀ, oˀ, uˀ* (six)—and five vowel qualities appear in a nasal glottalized vowel set—*ĩˀ, ẽˀ, ɨ̃ˀ, ãˀ, ũˀ*. The vowels in each of the vowel sets may also be lengthened, except that *õː* and *õˀõ* are not found. Given the analysis of length as a prosodic feature and of vowel glottalization as a contrastive feature of roots that will be fleshed out in Chapter 6, only the oral and nasal contrastive sets are considered vowel phonemes. This results in an inventory of 12 vowel phonemes, with the glottalized and nasal glottalized sets considered to be the consequence of a glottalization rule (cf. §6.3.2), and the long vowel surface contrasts (plain and glottalized) to be the consequence of a prosodic lengthening rule (cf. §6.2.1).

## 3.2 Consonants

The native phonology of Ixtayutla Mixtec contains of 19 consonant phonemes, including four which are considered marginal because of low frequency and greatly restricted distribution in the lexicon. These consonant phonemes, organized by manner and place of articulation, are given in Table 16 with the marginal phonemes in parentheses.

Table 16. IM consonant inventory

| | Bilabial | | Alveolar | | Alveopalatal | | Palatal | Velar | | Labiovelar |
|---|---|---|---|---|---|---|---|---|---|---|
| **Stop** | (p) | | t | | tʲ | | | k | | kʷ |
| **Affricate** | | | | | tʃ | | | | | |
| **Prenasalized** | | (ᵐb) | | ⁿd | | ⁿdʲ | | | (ᵑg) | |
| **Nasal** | | m | | n | | | ɲ | | | |
| **Tap** | | | | (ɾ) | | | | | | |
| **Fricative** | | β | s | | ʃ | | | | | |
| **Approximant** | | | | l | | | j | | | |

Table 16 contains a number of phonetically complex structures—*tʃ*, *kʷ*, *ᵐb*, *ⁿd*, *tʲ*, *ⁿdʲ*, *ᵑg*—which are treated as single phonemes. This decision, which is reflected in many, though not all Mixtec analyses (Josserand 1983), will be discussed below in §3.2.3.

Missing from Table 16 is the glottal stop, which has sometimes been considered a consonant phoneme in analyses of other Mixtec varieties (e.g. Pike 1944; Mak 1958; Pike & Wistrand 1974). As discussed in §3.1, I treat the surface realization of the so-called (couplet internal) glottal stop as vowel glottalization, following Bradley (1970), Josserand (1983), Gerfen (1996) and a number of other Mixtec researchers, rather than a glottal stop in (C)Vˀ(C)V environments. As mentioned above, IM has non-contrastive glottal stop epenthesis in certain environments. Both kinds of glottalization are dealt with in terms of prosodic structure in Chapter 6.

One other sound which is not included in Table 16, is [h]. This sound is found in one native word, *haa*, which is a vocative-like discourse particle occurring at the end of an utterance in male-to-male speech roughly meaning 'dude' (e.g. *kɨtɨ̀ kuù=tɨ̀, haa* 'It is an animal, dude.'). The same morpheme may also be pronounced *βaa* and *ʃaa*, resulting in a lack of contrast between [h] and the phonemes /β/ and /ʃ/.[6]

### 3.2.1 Voiceless consonants

The eight IM voiceless consonant phonemes given in Table 16 consist of one bilabial, the marginal /p/, five coronals—/t, tʲ, tʃ, s, ʃ/—and two dorsals—/k, kʷ/. These divide into five stops—/p, t, tʲ, k, kʷ/—two fricatives—/s, ʃ/—and one affricate—/tʃ/. Voiceless obstruent contrasts in CVː and CVˀV couplets are presented in Table 17.

Table 17. Voiceless obstruent contrasts in CVː and CVˀV couplets

| | **CVː** | | **CVˀV** | |
|---|---|---|---|---|
| **/p/** | *pîi** | 'turkey hen' | *peˀè** | 'lousy' |

[6] Whether or not some sort of pragmatic significance can be linked to one or the other pronunciation of this particle is a matter for further study.

| | | | | | | |
|---|---|---|---|---|---|---|
| **/t/** | | | *tã́ã̀* | ‘quake’ | *tã́ˀã́* | ‘be affected by’ |
| **/tʲ/** | *tʲĩì* | ‘become wet’ | *tʲã́ã́* | ‘forehead’ | *tʲãˀã̀* | ‘dirty’ |
| **/tʃ/** | *tʃĩì* | ‘OBJ’ | *tʃãã̀* | ‘have sex:REAL’ | *tʃã́ˀã́* | ‘go:REAL:PFV’ |
| **/s/** | | | *sáá* | ‘bird’ | *sã́ˀã́ᴸ* | ‘Spanish’ |
| **/ʃ/** | *ʃĩ̂* | ‘tough’ | *ʃã́ã́ᴸ* | ‘fierce’ | *ʃã́ˀã́* | ‘lard’ |
| **/k/** | | | *kã́ã́* | ‘perforate’ | *kã́ˀã́* | ‘speak’ |
| **/kʷ/** | *kʷĩì* | ‘green’ | *kʷã̀ã̄* | ‘yellow’ | *kʷã́ˀã́* | ‘go:REAL:IPFV’ |

*This is the only native example of this phoneme in this environment.

The items in each column contrast with the other items in that column in identical or analogous environments. Contrasts for the same consonants in both the consonant positions of CVCV couplets are given in Table 18.

Table 18. Voiceless obstruent contrasts in CVCV couplets

| | **C̲VCV** | | **CVC̲V** | |
|---|---|---|---|---|
| **/p/** | *paˀlà* | ‘flared’ | | |
| **/t/** | *táˀβíᴸ* | ‘permission’ | *katà* | ‘itch’ |
| **/tʲ/** | *tʲáˀβì* | ‘pay’ | *katʲà* | ‘dig:IRR’ |
| **/tʃ/** | *tʃáˀβí* | ‘reconciliation’ | *katʃã̀* | ‘rain sound’ |
| **/s/** | *sáˀβá* | ‘frog’ | *kasà* | ‘brother-in-law’ |
| **/ʃ/** | *ʃáˀβáᴸ* | ‘dirt bank’ | *kaʃã̀* | ‘sneeze’ |
| **/k/** | *kaˀβì* | ‘read’ | *kákã́* | ‘request:IRR’ |
| | *kajɨ̀* | ‘cough’ | *jáká* | ‘granary’ |
| **/kʷ/** | *kʷaˀjɨ̀* | ‘stolen’ | *takʷã̃* | ‘like that’ |
| | *kʷájɨ́* | ‘sole’ | *jákʷá* | ‘bark fibre’ |

The marginal voiceless bilabial stop, /p/ is unaspirated and does not occur in the second consonant position in native CVCV couplets. Josserand (1983:219, 251) considered it likely to be a loan phoneme in most Mixtec varieties and she does not reconstruct it as a phoneme in Proto-Mixtec. Its occurrence in glottalized words in IM, however, argues for its native (or at least deeply integrated) status in this language, since contrastive vowel glottalization is not found in loanwords in IM.

In terms of contextual effects on consonant realization, the voiceless alveolar stop, /t/, is generally unaspirated, although one female speaker, who had more careful speech, showed some aspiration on /t/ in various prosodic positions. It may also be partially voiced or even have voicing throughout the closure in prosodically weak positions, as will be discussed in §6.2.2.3. The palatalized voiceless alveolar stop, /tʲ/, also may be partly or mostly voiced, and for some speakers the palatal offglide resembles a voiceless fricative or aspiration. The voiceless alveopalatal affricate, /tʃ/, on the other hand, is only likely to assimilate voicing in very weak prosodic positions. It may be realized with very little occlusion (or burst release) or even as [ʃ] in connected speech in weak prosodic positions, and sometimes even in tonic syllables. The voiceless alveolar and alveopalatal sibilants, /s, ʃ/, also rarely assimilate voicing from surrounding voice sounds, although /ʃ/ appears slightly more prone to this than /s/. The phoneme /ʃ/ is also often produced with an audible palatal off-glide ([ʃʲ]) when it is in the couplet initial position.

The alveopalatal coronals, /tʲ, tʃ, ʃ/, also exhibit distributional asymmetries with respect to the alveolar /t, s/ related to their historical development. The alveolar coronals are extremely rare before the front vowels. The phoneme /t/ rarely occurs before /i/ (one of the three most frequent vowels in the language) and never before /e/, while /tʲ/, is unrestricted before front vowels, but never precedes /ɨ/. Similarly, /s/ never occurs before /i/ and only once before /e/, while /ʃ/ occurs preferentially before /i/ and rarely precedes any other vowel except /a/. The distribution of /ʃ/ is particularly weak in the second syllable of the couplet, where the only vowels to follow it besides /i/ are /a/, a few times, and /u/ once. As Bradley & Josserand (1982) and Josserand (1983) demonstrate, the historical development of the language includes rules palatalizing /t/ (→ *tʲ*), /s/ (→ *ʃ*) and **x* (→ *tʃ*) before front vowels, but as the data in Table 17 and Table 18 show, these consonants clearly contrast in the synchronic grammar.

The voiceless velar stop, /k/, is generally unaspirated, although one female speaker, who had more careful speech, showed some aspiration on couplet initial /k/. This phoneme is frequently reduced to [g], [ɣ] or even [ɰ] in prosodically weak positions, as will be discussed further in §6.2.2.3. The labialized velar stop, /kʷ/, is generally realized as a voiceless velar plosive with a voiced labial offglide, although voicelessness may carry into offglide. One speaker had a number of couplet initial tokens that had no burst release and were more like voiceless fricatives. In prosodically weak positions, it may be partly or mostly voiced and spirantized. The labialized velar stop, /kʷ/, occurs more than five times less frequently in my database than /k/. It also occurs much less frequently in the couplet medial position than couplet initially, and never precedes labial vowels, a restriction that will be taken up in greater detail §3.3.

### 3.2.2 Voiced consonants

Eleven voiced consonant phonemes are listed in Table 16, including three marginal phonemes (indicated by parentheses). These group into five manners of articulation: four prenasalized stops—/(ᵐb), ⁿd, ⁿdʲ, (ᵑg)/—one bilabial fricative—/β/—three nasals—/m, n, ɲ/—two approximants—/l, j/—and one tap—/(ɾ)/. As mentioned in §3.1, voiced consonants are the only consonants that can follow a glottalized vowel in CVCV couplets (e.g. *sáˀβá* 'frog'), and all voiced consonants except the three marginal ones enjoy this privilege. It should also be noted that, for the most part, the non-nasal voiced consonants only contrast with the nasal consonants if the nasality of surrounding vowels is ignored. This is because vowels are predictably nasalized following nasal stops, as well as preceding nasal stops within the couplet (i.e. where the medial consonant is a nasal). Conversely, except preceding a prenasalized consonant where vowels are phonetically nasalized (cf. §3.1), vowels are always oral following /β, (ᵐb), ⁿd, ⁿdʲ, (ᵑg), l, (ɾ), j/, nor do these voiced consonants even occur in couplets that have nasal vowels or the nasal stops /m, n, ɲ/. I postpone the detailed discussion of the distribution of nasal segments until §6.3.2, but here it should be noted that I posit both nasal stop phonemes and homorganic voiced oral phonemes based primarily on the predictability of vowel nasalization following nasal consonants both within and without the couplet. In this section I show that, ignoring vowel nasality, there is plenty of evidence for contrast between the non-nasal voiced consonants and the nasals. Furthermore, I show that medial non-nasal voiced consonants and nasals contrast when the second person enclitic pronoun, =*ũ*, coalesces with the final stem vowel resulting in a nasalized vowel. While this is not considered an underlying contrast in the generative sense, it clearly results in a surface contrast between these two classes of consonants preceding nasalized vowels. In the following discussion, I present voiced consonant contrasts by place of articulation in the order: coronal, dorsal and labial.

As with the voiceless consonants, the largest place group is coronal, which has five phonemes. The voiced coronal contrasts are presented in Table 19, where they are also shown to contrast with relevant voiceless coronals in CVː and CV$^{ʔ}$V couplets.

Table 19. Voiced coronal contrasts in CVː and CV$^{ʔ}$V couplets

| | **CVː** | | | | **CV$^{ʔ}$V** | | | |
|---|---|---|---|---|---|---|---|---|
| **/$^{n}$d/** | *$^{n}$dáá* | 'true' | *$^{n}$doò* | 'straight' | *$^{n}$dó$^{ʔ}$ò* | 'adobe' | *$^{n}$da$^{ʔ}$à* | 'hand' |
| **/$^{n}$d$^{j}$/** | *$^{n}$d$^{j}$àā* | 'be seated' | | | *$^{n}$d$^{j}$ò$^{ʔ}$ō* | 'you:PL' | *$^{n}$d$^{j}$á$^{ʔ}$á$^{L}$* | 'hair style' |
| | *$^{n}$d$^{j}$eè* | 'strong' | | | | | | |
| **/l/** | *lèē* | 'baby' | | | *$^{L}$ló$^{ʔ}$ò* | 'small' | | |
| **/ɾ/** | | | *ɾìɾòó* | 'mayor' | | | | |
| **/n/** | *nãã̀* | 'be lost' | | | | | *nã$^{ʔ}$ã̀* | 'strapping' |
| **/t/** | *tã́ã̀* | 'quake' | *tóò* | 'drip' | *tó$^{ʔ}$ó$^{L}$* | 'mestizo' | *tã́$^{ʔ}$ã́* | 'be affected' |
| **/t$^{j}$/** | *t$^{j}$aà* | 'write' | *t$^{j}$óó$^{L}$* | 'crab' | *t$^{j}$ó$^{ʔ}$ó$^{L}$* | 'flea' | *t$^{j}$á$^{ʔ}$á* | 'gourd' |
| **/tʃ/** | *tʃaà* | 'new' | | | | | *tʃá$^{ʔ}$á$^{L}$* | 'foot' |
| **/ʃ/** | *ʃáà* | 'jaw' | | | | | *ʃã́$^{ʔ}$ã́$^{L}$* | 'dirt bank' |

Contrast sets are given by columns and the voiceless coronal phonemes occupy the last four rows. The same set of contrasts is demonstrated in both syllables of CV($^{ʔ}$)CV couplets in Table 20.

Table 20. Voiced coronal contrasts in CV($^{ʔ}$)CV couplets

| | **C̲VCV** | | | | **CVC̲V** | |
|---|---|---|---|---|---|---|
| **/$^{n}$d/** | *$^{n}$dákã́* | 'ask for' | *$^{n}$dà$^{ʔ}$βī* | 'poor' | *ká$^{n}$dá* | 'move' |
| **/$^{n}$d$^{j}$/** | *$^{n}$d$^{j}$áká* | 'plastic' | | | *k$^{w}$à$^{n}$d$^{j}$á* | 'until' |
| **/l/** | *lak$^{w}$à* | 'phlegm' | *lá$^{ʔ}$βì* | 'orphan' | *t$^{j}$ì̃$^{j}$jálá$^{L}$* | 'hair clip' |
| **/ɾ/** | *ɾĩ$^{ŋ}$gí$^{L}$* | 'small wood' | | | *sáléɾú* | 'heron' |
| **/n/** | *nãɲã̀* | 'chayote' | | | *kãnã̀* | 'call' |
| **/t/** | *táká* | 'nest' | *tá$^{ʔ}$βí$^{L}$* | 'permission' | *katà* | 'itchy' |
| **/t$^{j}$/** | *t$^{j}$ákà* | 'fish' | *t$^{j}$á$^{ʔ}$βì* | 'pay' | *kat$^{j}$à* | 'dig:IRR' |
| **/tʃ/** | *tʃakù* | 'cry:REAL' | *tʃá$^{ʔ}$βí$^{L}$* | 'reconciliation' | *katʃã̀* | 'sound of rain' |
| **/ʃ/** | *ʃá$^{ʔ}$βá$^{L}$* | 'dirt bank' | | | | |

The two prenasalized coronals, /ⁿd/ and /ⁿdʲ/, begin with an alveolar occlusion and an open velum, and transition to an oral stop with velic closure. The oral portion of the /ⁿd/ closure is sometimes voiceless [ⁿt], but in /ⁿdʲ/ the voiced stop is released with a palatal offglide, which apparently prevents devoicing. Both prenasalized coronals occur infrequently in the couplet medial position, and /ⁿdʲ/ occurs much less frequently overall than /ⁿd/, due to the fact that it derives historically from the palatalization of /ⁿd/ before front vowels, although it now contrasts with /ⁿd/ because of changes in the vowel system (Josserand 1983).

The alveolar lateral approximant, /l/, occurs somewhat more frequently overall than /ⁿdʲ/, though still much less than /ⁿd/. It occurs roughly the same amount in both syllables of CVCV couplets, and about three times as frequently in the second syllable as both /ⁿdʲ/ and /ⁿd/ where it usually follows glottalized vowels. A couple of matters concerning the phonetic realization of /l/ should be mentioned. First, there is an automatic process whereby an alveolar stop is inserted next to /l/ when it occurs couplet medially between two high vowels, as in the following examples:

| | | | | |
|---|---|---|---|---|
| (69) | a. | *kúlí*ᴸ | type of bird | [ˈkulᵈi] |
| | b. | *mùlī* | mole | [ˈmulᵈi] |
| | c. | *màˈⁿdìlí* | apron | [maˈⁿdiᵈli] |

Interestingly, the stop appears to be inserted at the release of /l/ in the *u_i* environment in (69a, 69b), but at the initial closure of /l/ in the i_i environment in (69c). I analyze this as being similar to the incidental epenthetic stops that have long been noted in English between nasals and following obstruents (e.g. *something* [sʌmpθɪŋ]) and between /l/ and a following sibilant (e.g. *else* [ɛlts]) (Ohala 1974:357–359). I speculate that the high tongue position required to articulate the preceding and following high vowels, particularly the following /i/, results in extended (or additional) contact on the alveolar ridge when articulating /l/ and the audible stop.

The second matter is that there is one native word in my data in which /l/ is pronounced as [lʲ] (or [ʎ]), as shown (70).

(70) *pìlā* [pilʲa] ‘puddle’

This pronunciation of /l/ is also found in the Spanish loanword, [sìʎā] ‘chair’ (cf. *silla*), which was pronounced this way at the time of the Spanish conquest (Clark 1977; Nordell 1984:22). At this point, I analyze this as a palatal offglide conditioned by the presence of the plain high vowel /i/ in the first syllable and a low vowel in the second syllable, but as there are no other data with this exact context it is impossible to confirm the analysis. When both syllables have a high vowel, however, /i/ is realized with an inserted stop, as discussed above.

The marginal phoneme /ɾ/ is usually pronounced as the tap [ɾ], but may be a trill [r] when couplet initial, particularly in some words. It has a very low type frequency, resulting in a less robust contrast with the other coronals (see the empty cells in the tables above), but has a very large token frequency due to its occurrence in the third person male clitic pronoun, =*ɾà*, which also serves as a relative pronoun when a proclitic (*ɾà*=), the archaic noun classifier prefix for humans, *ɾà*–, and in the discourse particle, =*ɾé*, used to indicate that what was said is hearsay. The phoneme /ɾ/ only occurs in one native word in the couplet medial position.

The alveolar nasal, /n/, does not stand in strict contrast with any of the other voiced alveolars in the environments given in Table 19 and Table 20 due to the fact that the nasality of the surrounding vowels is not the same. As will be discussed further in §6.3.2, vowels do not contrast for nasality within the couplet following voiced consonants, and with very few exceptions, /ⁿd, ⁿdʲ, l, ɾ/ do not occur in morphemes that have nasal consonants or vowels. Within the couplet, vowels are generally nasalized preceding and following nasal consonants, and vowels are oral preceding and following voiced oral consonants, except that vowels are phonetically nasalized preceding prenasalized consonants. Data such as the example in (71), however, show the contrast between voiced oral and nasal alveolar consonants in a context preceding nasal vowels.

(71) *kàⁿdȭ* ‘you are/were moving’
*kãnõ̀* ‘you are/were calling’

Here, the couplet final vowel of *kàⁿdȭ* is nasalized when the nasal second person singular clitic fuses to the root (cf. §2.5). With the phonetic nasalization of the initial vowel of *kàⁿdȭ* (from the prenasalized consonant), /ⁿd/ and /n/ effectively contrast in identical environments.

The set of voiced phonemes includes three dorsal contrasts—/j, ɲ, ᵑg/. These are illustrated by the data in Table 21, which also includes contrasts with the voiceless, /k, tʲ/, and the voiced, /ⁿdʲ/ in the final three rows.

Table 21. Voiced dorsal contrasts

| | **CVː** | | **CVˀV** | | **C̲VCV** | | **CVC̲V** | |
|---|---|---|---|---|---|---|---|---|
| **/j/** | *jaà* | ‘tongue’ | *jáˀà* | ‘pass’ | *jáˀβì* | ‘price’ | *kɨ́jɨ́* | ‘clay jug’ |
| **/ɲ/** | *ɲãã̀* | ‘dark’ | *ɲãˀã̀* | ‘woman’ | *ɲã́ˀmĩ́* | ‘yam’ | *ɨ̃ɲɨ̃̀* | ‘stand’ |
| **/ᵑg/** | | | | | | | *rɨ́ᵑgɨ́ᴸ* | ‘small wood’ |
| **/k/** | *kã́ã́* | ‘perforate’ | *kã́ˀã́* | ‘speak’ | *kãˀmĩ̀* | ‘smoke:IRR’ | *jɨkɨ̀* | ‘bone’ |
| **/tʲ/** | *tʲaà* | ‘write’ | *tʲáˀá* | ‘gourd’ | *tʲáˀβì* | ‘pay’ | *katʲà* | ‘dig:IRR’ |
| **/ⁿdʲ/** | *ⁿdʲáá* | ‘be seated’ | *ⁿdʲáˀáᴸ* | ‘hair style’ | *ⁿdʲáˀjúᴸ* | ‘mud’ | *kʷàⁿdʲá* | ‘until’ |

As above, contrast sets are presented in columns. The marginal prenasalized velar stop, /ᵑg/, is very rare, occurring in only six native words in my corpus and only in the medial position of the couplet. As noted for /ⁿd/, vowels preceding /ᵑg/ may be partly or fully nasalized. In fact, in at least some cases, prenasalization has developed from nasalization in the syllable preceding a medial /k/, as can be seen in the compound in (72).

(72) *ĩ́ᵑgá*
ĩ̀=ká
one=more
‘another’

Here, a morpheme with a nasal vowel, *ĩĩ̀* ‘one’ is combined with the oral clitic, =*ká* ‘more’, resulting in a lexical item with a prenasalized velar stop. This explanation is supported by the phonetic realization of the enclitic =*kē* attached to words ending in a nasal labial vowel. In a noun-pronoun production experiment conducted during the research for this dissertation, some tokens of *kòtȍ*=*kē* 'shirt=3FEM' were pronounced with prenasalization by some speakers, [kotõᵑge].

The palatal nasal, /ɲ/, and approximant, /j/, generally pattern only with nasal and oral vowels, respectively, as was noted for /n/ and /ⁿd/. However, these phonemes do contrast preceding nasal vowels in the second syllable of couplets which have coalesced with the second person singular pronoun, as illustrated by the data in (73).

(73) *kajũ̏* 'you are/were coughing'
*kãɲũ̏* 'you are/were beating'

The palatal nasal may be reduced to [j̃] in weak prosodic positions, and /j/ sometimes has frication in the couplet initial or word initial positions, at least for one speaker. Interestingly, both palatal phonemes occur more frequently in the couplet medial position than couplet initially.

The voiced labial consonant contrasts are given in Table 22, together with the voiceless bilabial phoneme and the voiceless labialized velar stop.

Table 22. Voiced labial contrasts

| | **CV:** | | **CVʔV** | | **C̲VCV** | | **CVC̲V** | |
|---|---|---|---|---|---|---|---|---|
| **/ᵐb/** | *ᵐbéé* | 'sheep' | | | | | *tɨ̀rɨ́ᵐbɨ́ᴸ* | 'burl' |
| **/β/** | *βéè* | 'heavy' | *βáˀà* | 'good' | *βítʃĩ̏* | 'cold' | *kɨ̄ˀβɨ̄* | 'enter:IMP' |
| **/m/** | *mãȁ* | 'EMPH' | *mã́ˀȁ* | 'mother' | mĩ́ɲĩ̀ | 'pool' | *kɨ̃̄ˀmɨ̃̏* | 'having new-born pups' |
| **/p/** | *pɨ̂* | 'turkey hen' | *peˀè* | 'lousy' | *paˀlà* | 'flared' | | |
| **/kʷ/** | *kʷèē* | 'slowly' | *kʷáˀá* | 'many' | *kʷãˀnũ̏* | 'grow:IRR' | *tɨ́kʷɨ́* | 'small space' |

The marginal prenasalized bilabial stop, /ᵐb/, is also very rare, occurring in only four native words in my corpus, none of which are frequently used words. It could be that *ᵐbéé* 'sheep' is a Spanish loan (cf. *oveja* 'sheep' or *borrego* 'lamb, sheep'), although this is not the usual loanword tone pattern for loanwords. More likely, however, it is an ideophone expressing the sound that sheep make (Doug Towne p.c.).

The voiced bilabial fricative, /β/, is commonly realized as [β], but at the beginning of a word, particularly if it is the beginning of an utterance, it is sometimes [b]. In connected speech, word medially, and even word initially, it is frequently realized more like the approximant [w]. This phoneme follows the pattern, already described for voiced oral phonemes, of generally not occurring in couplets with nasal consonants or nasal vowels. Conversely, the voiced bilabial nasal, /m/, does not occur in couplets with oral consonants or vowels. However, as described above for /ⁿd/ ~ /n/ and /j/ ~ /ɲ/, /β/ ~ /m/ do contrast before nasal vowels in the second syllable of couplets that have coalesced with the nasal second person singular pronoun, /=ũ/, as illustrated in (74).

(74) *kaˀβũ̏* 'you read!'
*kãˀmũ̏* 'you will smoke'

Interestingly, both /β/ and /m/ occur more frequently couplet medially than couplet initially.

### 3.2.3 Phonetically complex structures

The consonant inventory given in Table 16 contains a number of phonetically complex structures—*tʲ, tʃ*, *kʷ*, *ᵐb*, *ⁿd, ⁿdʲ*, *ᵑg*—which have been assumed to function phonologically as single phonemes in the analyses of other Mixtec varieties (e.g. Pike 1944; Stark 1947, Josserand 1983). In this section, I will give evidence that favours the single-phoneme analysis of these structures for IM, as well as briefly describing a second group of phonetically complex structures with the forms *s* + consonant (*s*C), *ʃ* + consonant (*ʃ*C), *n̥* + *ⁿd/n* (*n̥*N) and *tr*, which are analyzed as constituting the only native consonant clusters in the language.

From the first group, *tʲ*, *tʃ ⁿd*, *kʷ* and *ⁿdʲ* are well attested in the language, while *ᵐb* and *ᵑg* are very rare in native words. All except *ᵑg* occur in both consonant positions of CVCV couplets, as shown in (75).

(75)

| | *t*$^j$ | *tʃ* | *k*$^w$ | $^n$*d* | $^n$*d*$^j$ | $^m$*b* | $^ŋ$*g* |
|---|---|---|---|---|---|---|---|
| **Initial** | *t*$^j$*àkū* 'live' | *tʃakù* 'cry:REAL' | *k*$^w$*akù* 'cry:IRR' | $^n$*dáká̃* 'ask' | $^n$*d*$^j$*áká* 'plastic' | $^m$*béé*$^L$ 'sheep' | |
| **Medial** | *kat*$^j$*à* 'dig:IRR' | *katʃà̃* 'rain sound' | *ják*$^w$*á* 'fibre' | *ká*$^n$*dá* 'move' | *k*$^w$*à*$^n$*d*$^j$*á* 'until' | *tìrí*$^m$*bí*$^L$ 'burl' | *ʃò*$^ŋ$*gí* 'cricket' |

In support of a single phoneme interpretation of these complex sounds, I first observe that these complex structures (except for the marginal $^ŋ$*g*, which is limited to the second syllable of CVCV couplets) have the distribution of individual phonemes (cf. Stark 1947)—that is, unambiguous consonants (e.g. /t/, /k/) are found in any syllable onset in CVCV, CVː and CVˀV couplets and never in syllable codas, which are disallowed in the native phonology, as has been amply illustrated in the data in 3.2.1 and 3.2.2. These contexts are precisely the ones where the complex structures are found, as can be seen in (75), and analyzing them as sequences of phonemes would result in creating additional CCV and CCCV syllable types (cf. 3.3). It can also be observed that were these complex structures considered to be sequences of distinct phonemes, only *tʃ* and *t*$^j$ are comprised of actual phonemes in the language (/t/, /ʃ/ and /t/, /j/, respectively). Although, it is not impossible that the other sequences could be derived contextually by the following relatively straightforward and common processes: /mβ/ → [$^m$b] (manner assimilation), /nt/ → [$^n$d] and /ntj/ → [$^n$d$^j$] (voice assimilation), /nk/ → [$^ŋ$g] (place and voice assimilation) and /kβ/ → [k$^w$] (glide formation), it should be noted these are not synchronic processes in IM. Furthermore, each of the complex structures belongs to the same morpheme (i.e. there is no morpheme break between the supposed parts), which, if it were not the case, would render a single phoneme analysis problematic, since the supposed phoneme would be split between two morphemes (cf. Stark 1947; Maddieson 1984:161).[7] Similarly, it would also make a single phoneme interpretation unfavourable if the parts of the complex structure were shown to belong to separate syllables; however, the fact that they occur word

[7] However, as Larry Hyman (p.c.) points out, it is conceivable that there could be a featural morpheme consisting of [+nasal] which could nasalize the stem initial consonant without adding an additional segmental slot.

initially indicates that, at least in this position, they belong to the same syllable and the initial member of the sequence cannot be analyzed as a coda for a preceding syllable (cf. Stark 1947).[8] Finally, it can also be noted that these particular sounds (perhaps with the exception of $^{n}$*d*$^{j}$) are considered complex segments in various other languages, which supports the plausibility of a single phoneme analysis, while not providing evidence for it (cf. Stark 1947; Maddieson 1984).

Turning now to the second group of phonetically complex structures, there are a number of words with clusters with the general patterns *s*C, *ʃ*C, *n̥*N, *tr*, as illustrated by the examples given in (76). Couplet boundaries are indicated with round brackets.

| | | | | |
|---|---|---|---|---|
| (76) | a. | *(sk*$^{w}$*íí*$^{L}$*)* | 'Llano Verde (town)' | |
| | b. | *(ʃkɨ́jɨ́*$^{L}$*) ∼ ʃí(kɨ́jɨ́*$^{L}$*)* | 'blister' | |
| | c. | *(n̥*$^{n}$*dɨ́kɨ́*$^{L}$*)* | 'cow' | cf. $^{n}$***dɨkɨ̀*** 'horn' |
| | d. | *(trɨ́*$^{m}$*bɨ́*$^{L}$*) ∼ tɨ̀(rɨ́*$^{m}$*bɨ́*$^{L}$*)* | 'bumps' | |

These patterns all begin with a voiceless obstruent. For some words exemplifying these patterns, such as (76b) and (76d), an unreduced variant which includes the pre-couplet vowel is still possible (at least for some speakers), while for others, like (76a), there is no such variant. The example in (76c) is sometimes pronounced *s*$^{n}$*dɨ́kɨ́*$^{L}$ by one speaker, which appears to follow the neighbouring Jamiltepec Mixtec pronunciation, ***sɨ̄***$^{n}$***dikɨ*** (Johnson 1988:21), from which the IM pronunciation undoubtedly developed. It should also be noted that the voiceless portion of words transcribed here as *n̥*$^{n}$*d* is often very short and the essential difference of the structure when compared to plain $^{n}$*d* appears to be more forceful airflow through the nasal cavity and accentuation of the (voiced) nasal portion of the prenasalized stop. These structures are also sometimes pronounced with [h] + a short vowel ([u] or [i]) by some speakers. In addition, my primary consultant, who is able to whistle tone patterns, whistled a tone for the reduced syllable for two *n̥*$^{n}$*d* words (i.e. three tones were whistled), but for two others he did not (i.e. only two tones were whistled), indicating that, at least for some words with *n̥*$^{n}$*d* clusters, the accentuated voiced portion of the prenasalized stop may be

[8] Although the initial member of the complex structure could be considered extrasyllabic, this would be a problematic analysis given that these structures also occur word medially.

considered a TBU. This variation, along with words which only optionally elide the pre-couplet vowel, would also seem to indicate that at least some words with consonant clusters may still be in transition from a phonologically trisyllabic structure to a disyllabic structure.

Besides *skʷ* shown in (76a), the *s*C pattern is also instantiated by *st*, *sj* and *stʲ* as shown in (77).

(77) a. *(stóˀó) ~ tʃí(tóˀó)* 'owner'
b. *(sjúˀmã̀)* 'Llano Escondido (town)'
c. *tũ̀(stʲaβì)* 'stock of the maguey flower' cf. *tũ–* 'WOOD', *jaβì* 'maguey'

Consonant clusters with ʃ also include *ʃkʷ*, as in (78), besides *ʃk* illustrated in (76b).

(78) *(ʃkʷɨ̃́ɲɨ̃́ᴸ) ~ ʃì(kʷɨ̃́ɲɨ̃́ᴸ)* 'type of corn'

And clusters with n̥ include one word with *n̥n*, as shown in (79), in addition to *n̥ⁿd* exemplified in (76c).

(79) *n̥nũ̃(kʷíjá) ~ hunù(kʷíjá)* 'next year' cf. *kʷíjáᴸ* 'year'

This word shows a rare cluster that is not immediately preceding the couplet.

Etymological derivations showing that the pattern is the result of syncope (e.g. (76c)) and evidence that the consonants in some the clusters appear to have historically belonged to separate morphemes (e.g. (76c), (77c) and (79)) point to an explanation for the development of the patterns, although they do not require a cluster analysis. Evidence for a cluster analysis of the *s*C, ʃC, n̥N and *tr* patterns lies in the alternate pronunciations which retain the vowel between the consonants in some of the words. The crucial difference between these phonetically complex structures and the first group of complex structures, however, lies in their different distributions. The first group of complex structures discussed (75) occur in each position of CVCV couplets, except for the marginal *ⁿg* which only occurs couplet medially, whereas the second group of complex structures nearly always occurs couplet initially, and never occurs couplet medially. Example (79) is an exception to the first generalization in that the cluster occurs in the onset of the syllable preceding the couplet (*k$^{w}$íjá*). This word probably was historically a compound consisting of two couplets, the first of which now has its initial syllable reduced creating the cluster *n̥n* at the medial consonant slot of the first (unstressed) couplet in the compound. Clusters are not found medially in the stressed couplet except, perhaps, as a result of fast-speech reduction.

Following a cluster analysis of these consonantal patterns, the attested clusters are *st, sk$^{w}$, st$^{j}$, sj, ʃk, ʃk$^{w}$, tr, n̥$^{n}$d, n̥n*. The only consonants that may serve as the initial member of the cluster are voiceless coronals, *s, ʃ, t, n̥*, and the only consonants that can occur as the second member of the cluster are *t, t$^{j}$, k, k$^{w}$, r, $^{n}$d, n*. Each member of the clusters is a phoneme in the language except *n̥*. In nearly all cases of *n̥*N clusters there is evidence that the cluster derives from a *s*V*$^{n}$d* sequence, as illustrated by (76c), and the additional examples given in (80).

| | | | | |
|---|---|---|---|---|
| (80) | a. | *(n̥$^{n}$dókó) ~ (s$^{n}$dókó$^{L}$) ~ hì($^{n}$dókó$^{L}$)* | 'chicatana (insect)' | cf. *sì$^{n}$dòkó* Chayuco Mixtec (Stark et al. 2003:50) |
| | b. | *n̥$^{n}$dú$^{ʔ}$ù* | 'traditional skirt' | cf. *su$^{n}$du$^{ʔ}$u* Chayuco Mixtec (Josserand 1983:538) |
| | c. | *(n̥$^{n}$dút$^{j}$à) ~ hú($^{n}$dut$^{j}$à) ~ hí($^{n}$dut$^{j}$à) ~ (s$^{n}$dút$^{j}$à) ~ sú($^{n}$dut$^{j}$à)* | 'godfather' | cf. *sutù* 'father'; *$^{n}$dut$^{j}$à* 'water' |
| | d. | *(n̥$^{n}$d$^{j}$íkó$^{L}$)* | 'government position' | cf. Spanish: *síndico* 'government position' |

I therefore analyze *n̥* as an allophone of /s/ before a [+nasal, + alveolar] consonant: /s/ → [n̥] (or [h]) / _C[+nasal, +alveolar].

In summary, IM generally does not allow consonant clusters, however, a number of clusters of the form *s*C, *ʃ*C, *tr*, *n̥*N have developed in the initial consonant slot of the couplet. The precise location of these clusters form an important piece of evidence in support of the prosodic structure proposed in this dissertation, as will be discussed further in §6.2.2.2.

## 3.3 The syllable

IM vowels and consonants are organized into syllables having the following schematically represented structures, where C = consonant and V = vowel: V, CV, Vː, CVː, CCV, CCVː. Examples illustrating each of these syllable types are given in (81) ("." indicates a syllable break).

(81)

| | Example | Syllable structure |
|---|---|---|
| a. | *tú.tú* 'paper' | CV.CV |
| b. | *í.tú* 'cornplant' | V.CV |
| c. | *tuù* 'appear' | CVː |
| d. | *ĩ̃ĩ̀* 'one' | Vː |
| e. | *ʃí.ú$^L$* 'abdomen' | CV.V |
| f. | *státù* 'rest' | CCV.CV |
| g. | *stúú* 'sir' | CCVː |

As in other Mixtec varieties, syllables in the native phonology are always open; codas are not permitted. CV syllables, illustrated in (81a, b, e, f), are by far the most common syllable type, but onsetless syllables are allowed, as shown in (81b, d, e). Couplet initial vowels, like examples (81b, d), are usually supplied with an epenthetic glottal, which is not written in examples. (This will be discussed further in §6.3.5.) Couplets with no medial consonant, nearly always have like vowels (i.e. a constant vowel quality throughout—CVː), like the one given in (81c), and are considered bimoraic monosyllables, as will be discussed further below. Bimoraic syllables can also lack an onset as illustrated in (81d). The three CV.V words in my data which have diverse vowels, like the one given in (81e), are considered disyllabic. As discussed in §3.2.3, only a very small number of onset clusters are permitted in the language, and only couplet initially. This results in the highly restricted CCV and CCVː syllable types illustrated in (81f) and (81g), respectively.

As implied by the schematic syllable representations, all and only the vowels presented in §3.1 can form the nucleus of the syllable (= V) for each of the syllable types, although, due to the rarity of syllable types with initial consonant clusters, many vowels are not attested in CCV and CCVː syllables. It is also implied that all consonants given in Table 16 can occur in each C slot for each syllable type, but this is not quite true. As discussed in 3.2.3, very few consonants can occur in consonant clusters, therefore consonants are not freely distributed in the CCV and CCVː syllable types. In addition, the marginal /ᵑg/ is not attested in CVː syllables.

The claim that all syllables are open is subject to the interpretation of glottalization as a vowel modification feature with no segmental ("X") slot of its own, and not the realization of a glottal stop, as already mentioned in §3.1 and §3.2, and which will be discussed further in §6.3.1. Thus, the laryngeals in CVˀCV couplets are not considered codas, nor are they considered onsets in CVˀV couplets, and the examples in (82a–b) are analyzed as having disyllabic (CV.CV) and monosyllabic (CVː) syllable structures, respectively.

(82)

| | Example | Syllable structure |
|---|---|---|
| a. | *koˀ.lò* 'turkey' | CV.CV |
| b. | *kóˀó$^{L}$* 'dish' | CVː |

Although onsetless syllables are allowed in IM, there is evidence that CV is the preferred syllable type. The first piece of evidence is the high frequency of CV syllables in the language. Second, virtually all affixes and clitics have the CV syllable type. Aside from the imperfective and vocative tonal morphemes, the only other syllable type for affixes and clitics is V, and only the four affixes/clitics given in (83) have this shape.

(83)
a. *í–* 'PFV'
b. *=í* '1SG'
c. *=ũ* '2SG'
d. *à=* 'or'

The third, and strongest piece of evidence for the preference of the CV syllable type in the language is that of the four morphemes listed in (83), only *à=* 'or' (83d) is consistently realized as a V syllable. The perfective morpheme (83a) can be omitted in certain circumstances (while its tone remains), and the enclitic pronouns shown in (83b) and (83c) obligatorily coalesce with the final stem vowel of their prosodic host, which is discussed in detail in §6.2.1.

Besides the highly restricted patterns of consonant-vowel alternation that make up the IM syllable types, there are two phonotactic generalizations which provide additional evidence for the syllable as a prosodic constituent in the language by taking the syllable as their domain of application. The first generalization is that native words do not have syllables with the form /ji/ or /je/, that is, with the palatal approximant as the onset before a front vowel. I refer to this phonotactic restriction as OCP Coronal. These sequences do occur, however, in Spanish loanwords, e.g. *jèlū* 'ice' (cf. Spanish *hielo*), and in constructions with the first person singular enclitic pronoun, *=í*, as in these examples:

(84) a. */tʲájú/* 'stool' + */=í/* '1SG' → *tʲájí* 'my stool'
b. */kʷíjá$^{L}$/* 'year' + */=í/* '1SG' → *kʷíjè* 'my year'

As shown in (84), the pronoun vowel coalesces with the preceding vowel, producing both /ji/ and /je/ sequences (depending on the height of preceding vowel), when the second consonant of (C)V(ˀ)CV couplets is /j/. Curiously, this prohibition does not affect the palatalized consonants /tʲ, $^{n}$dʲ/, as shown in these examples:

(85) a. *tʲítʲí$^{L}$* 'iguana'
b. *$^{n}$dʲítʲì* 'green beans'

The second phonotactic generalization is one that is found throughout the Mixtecan family (Longacre 1955:65; Silverman 1993; DiCanio 2008:48): with few exceptions in the native lexicon,[9] labial consonants—/β/, /m/, /p/, /$^{m}$b/, /kʷ/—do not occur in syllables with labial vowels—/u/, /o/. I refer to this generalization as OCP Labial. Again, this restriction is violated in loanwords such as *βùrú* 'donkey' (cf. Spanish *burro*), and also in constructions where the second person singular enclitic pronoun coalesces with the final vowel of a root with a medial labial consonant, as illustrated in (86).

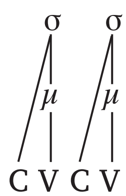
[9] I have come across three exceptions to this restriction in native words: *kãˀmũ* 'owl', *$^{m}$buu* 'bend over' (and related words, e.g. *tʃikaˈ$^{m}$buu* 'crawl') and *βóˀló$^{L}$* 'baloon'.

(86) a. */júβí/* ‘streambed’ + */=ũ/* ‘2SG’ → *júβṹ* ‘your streambed’
b. */ɲṹmã́$^{L}$/* ‘wax’ + */=ũ/* ‘2SG’ → *ɲṹmṍ$^{L}$* ‘your wax’

As in the first person singular construction, the second person singular enclitic pronoun coalesces with the final vowel of the root. The result is a labial vowel, which violates OCP [labial] in CV(ˀ)CV roots where the second consonant is a labial.

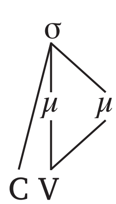
Following an autosegmental view of phonological representations (Goldsmith 1976) and moraic theory (McCarthy & Prince 1996 [1986]; McCarthy & Prince 1995; Hayes 1989; Zec 1989), I adopt the representation of disyllabic CVCV couplets given in (87).

(87) Representation of disyllabic CVCV couplet




Here each short vowel is associated with a mora, which is a unit of phonological weight and a prosodic constituent (cf. Chapter 5). Moras are immediately dominated by a syllable node, giving a disyllabic structure. The onset consonants associate directly to the syllable node. The standard autosegmental representation of long or “geminate” vowels, on the other hand, assumes a single vowel associated with two moras (and a single syllable node), in keeping with the Obligatory Contour Principle (Leben 1973; Goldsmith 1976), which forbids identical adjacent features. Following these assumptions, I represent CVː syllables as shown in (88).

(88) Representation of monosyllabic CVː couplet



The structure represented here constitutes a single heavy (i.e. bimoraic) syllable, whereas the structure in (87) consists of two light (i.e. monomoraic) syllables. There is no other way to form a heavy syllable in IM, a fact that is not surprising given that the language lacks syllable codas, and onsets are not expected to contribute to syllable weight (Hyman 1985).

It should be noted that some researchers consider (C)V(ˀ)V couplets to be disyllabic rather than monosyllabic (e.g. Pike 1944; Pike & Wistrand 1974; Zylstra 1980), while others are ambivalent, considering the data to be inconclusive on the matter (Pike 1948:79, fn. 3; Gerfen 1996:46–52; Macken & Salmons 1997:41–42). Although the phonetic realization of CVː couplets as a single vowel quality articulated throughout the duration argues against a syllable division interrupting the vowel, some Mixtecanists have argued that since CVː couplets host the same number of tones as CVCV couplets they should be considered disyllabic (e.g. Pike 1944). However, if the mora is recognized as the tone bearing unit (cf. §4), there is no need to posit disyllabicity to formally account for the tonal behaviour. Both monosyllabic CVː and disyllabic CVCV couplets are bimoraic and therefore have the same number of TBUs. The monosyllabic analysis of CVː couplets is also to be favoured because of the cross-linguistic and language specific preference that syllables have onsets. In addition, in §6.2.1 I will present further phonological evidence supporting the monosyllabic analysis of CVː couplets based on the difference in behaviour of stems with this structure compared to CVCV stems in vowel coalescence with the first and second person singular pronouns.

In summary, IM syllables have an obligatory nucleus which must consist of a vowel (cf. §3.1), syllable codas are not allowed, and onsets are preferred, though not obligatory. A second onset consonant is rarely permitted, and onset clusters are highly restricted both in terms of which consonants compose the cluster (cf. §3.2.3), and where they can occur. Two phonotactic restrictions that take the syllable as their domain are OCP Coronal and OCP Labial.

While the distribution of vowels and consonants within the different syllable types are described as nearly unrestricted, this can only be said if the position of the syllable within the word is not considered. Once syllable position is taken into account, a number of distributional asymmetries become evident. This and a considerable amount of other evidence make it apparent that not all syllables are treated equally by the grammar and suggests an additional, higher level of prosodic structure, which, as it turns out, is more fundamental to the phonological organization of the language than the syllable. This prosodic constituent corresponds to what has been identified in numerous typological studies as the foot (cf. §5.3), although traditional Mixtec studies have referred to it as the couplet and have, by and large, considered it to be the morphological root. The justification for equating the couplet with the foot is taken up in Chapter 6.

## 3.4 Stress

Every IM lexical word must have one and only one primary stress, thus meeting the obligatoriness and culminativity requirements of Hyman's (2006:231) definition of a stress accent language. Although lacking systematic instrumental study, preliminary observations indicate that the perceived greater perceptual salience or force of articulation of stressed syllables in IM is due to some combination of increased vowel duration, (at least sometimes) greater duration of the preceding and following consonant, perhaps some measurement of intensity, as well as greater preciseness of articulation. Stress is always located within a two syllable window of the right edge of the grammatical word—that is, on the couplet of the word. In words which end in a light syllable, stress is always on the the penultimate syllable—that is, on the first syllable of the disyllabic couplet, as shown in (89). (In these and following examples, syllable boundaries are marked with a period ".", stress is indicated using the IPA symbol " ˈ ", words with internal morphological structure are given in interlinear format and couplet boundaries are indicated with parentheses.)

(89) a. *(ˈsã́.nã́$^{L}$)*
'domestic animal'

b. *(ˈkú.tʃì)*
'bury'

c. *(ˈ$^{n}$dúˀ.βá)*
'plain'

d. *sá.(ˈlé.ɾú)*
‘heron’

e. *kʷà.(ˈkú.tʃì)*
kʷá–kútʃì
PROS–bury
‘are going to bury’

f. *ʃì.(ˈⁿdúˀ.βá)*
‘spider’

However, in words that surface with a heavy final syllable, stress is always on this syllable, as the examples in (90) show.

(90) a. *sà.(ˈnãã̀)*
sà–nà
CAUS–be.lost
‘cause to be lost’

b. *(ˈkuù)*
∅⌒kù
IPFV⌒be
‘is/was’

c. *(ˈɲãˀã̀)*
‘woman’

d. *sá.(ˈɲɨɨ̀)*
‘corncob’

e. *pè.(ˈɾùú)*
‘watermelon’

f. *sà.(ˈɲã̀ˀã́)*
‘to show’

It should be noted that heavy syllables only occur as the final syllable of the grammatical word except occasionally in compounds where the initial member of the compound is a root with the surface form CV(ˀ)V and does not follow the usual pattern of reduction for compounds described in §2.4.1. As a result, there are no lexical words with the forms *ˈCVː.CV or *ˈCVCVː.

Enclitics may added to the right edge of grammatical words, however:

(91) a. *(ˈsá.nã́).ɾá*
sáná^L = ɾà
domestic.animal=3MASC
'his domestic animal'

b. *(ˈkú.tʃì).tʃì*
∅⁀kútʃì = tʃì
IPFV⁀bury=3GNRL
'they bury'

Doing so does not change the placement of stress whether the stressed syllable is light, as illustrated in (91), or heavy, as illustrated in (92).

(92) a. *sà.(ˈnã̀ã̀).ɾà*
sà–nà = ɾà
CAUS–be.lost=3MASC
'he causes it to be lost'

b. *(ˈkuù).tʃì*
∅⁀kù = tʃì
IPFV⁀be=3GNRL
'they are/were'

This can been seen by comparing the stressed syllables of the wordforms in (91) and (92) with the corresponding wordforms in (89) and (90), respectively.

It should also be noted that IM stress and tone are not dependent on each other neither in the sense that the location of stress is determined by the tonal melody nor in the sense that the choice of tonal melody or its location is determined by stress. This is not to say that stress does not affect pitch phonetically (i.e. non-contrastively), which it almost surely does (cf. Carroll 2015). There are also other significant ways in which prosodic structure affects the realization of tone, which will be discussed in detail in Chapter 4.

The generalization that can be made about the location of stress on surface forms, then, is that, while the location is variable in terms of syllables (i.e. either an ultimate heavy syllable or penultimate light syllable), it always occurs on the initial mora of the final couplet of the word, or in other words, within a two mora window of the right edge of the grammatical word.[10]

I also make the somewhat less emphatic claim that IM does not have secondary stress. This claim has also been made by McKendry (2013) for Southeastern Nochixtlán Mixtec based on experimental acoustic investigation. Carroll (2015), on the other hand, claims that there is secondary stress in Ixpantepec Nieves Mixtec based on phonological evidence from compounds. I consider that unreduced compounds in IM (particularly where the initial root in the compound has a disyllabic form, e.g. *$^n$dut$^j$à(βítʃĩ̀)* ‘softdrink’, cf. *$^n$dut$^j$à* ‘water’ + *βítʃĩ̀* ‘cold’) could contain more than one prosodic word and therefore, possibly have secondary stress. More study is needed to investigate the acoustic properties of secondary stress in compounds and in larger words that are not compounds, particularly those containing enclitics, since enclitics appear to have greater duration than the final syllable of the foot at least when the prosodic word in which they are included is the rhematic focus of the sentence.[11]

The facts of IM word stress described here concord with the general state of affairs in Mixtec. Stress on the penultimate syllable or vowel of the couplet (or similar structure with a different descriptive label) is reported in the vast majority of Mixtec descriptions (e.g. Jicaltepec Mixtec, Bradley 1977:17; Acatlán Mixtec, Pike & Wistrand 1974:103; Silacayoapan Mixtec, North & Shields 1977:21; Diuxi Mixtec, Pike & Oram 1976:321–22; Daly 1978:98; Alacatlazala Mixtec, Zylstra 1980:16; Atatlahuca Mixtec, Alexander 1980:6; Coatzospan Mixtec, Gerfen 1996:131; Peñoles Mixtec, Daly & Hyman 2007:167; SE Nochixtlán Mixtec, McKendry 2013; Ixpantepec Nieves Mixtec, Carroll 2015:82; Nuyoo Mixtec, Harris & Harris 2006:2), and Josserand 1983:180

[10] Kager (1999) considers that heavy syllables also bear a strong-weak rhythmic contour at the level of microbeats, of which a heavy syllable has two, one for each mora.

[11] In terms of the information structure of the sentence, the Rhematic Focus is the part of the Rheme (= Comment) that is intended by the speaker to give the specific answer to the underlying question that the sentence is supposed to answer (Mel′čuk 2001:114).

posits stress on the penult syllable of the couplet for Proto-Mixtec. The penultimate stress claims by Gerfen (1996), McKendry (2013) and Carroll (2015) are backed by instrumental studies. Greater vowel duration in the stressed penultimate syllable is supported by all three studies, while Gerfen (1996) and McKendry (2013) also report greater amplitude/intensity in the stressed syllable. Carroll's (2015) study showed that vowel quality was significantly reduced (i.e. more centralization of the first formant) in pre- and post-stress syllables when compared to stressed syllables. In addition, his study showed mixed results for a number of other acoustic measures (intensity, onset duration, following consonant duration, cepstral peak prominence, harmonics-to-noise ratio and F0), which were found to reliably distinguish stressed syllables from only one of the unstressed syllable positions (i.e. pre-stressed or post-stressed) and/or for only one speaker.

Different stress patterns are reported for several Mixtec varieties. A putative interaction between tone and stress is claimed for Ayutla Mixtec (Pankratz & Pike 1967:293), Huajuapan Mixtec (Pike & Cowan 1967:7) and Molinos Mixtec (Hunter & Pike 1969:25), and Zylstra (1980:16) reports that stress shifts from the first syllable of the couplet to the second when followed by the first person singular enclitic pronoun in Alacatlazala Mixtec. In addition, DiCanio et al. (2018) claim that Yoloxóchitl Mixtec has stress on final syllables based on the fact that more tone patterns are allowed on final syllables than couplet initial syllables, vowels analyzed as underlyingly nasal are only found on final syllables and final syllables were found to be phonetically longer than couplet initial syllables in their instrumental study which included items in several different information structure contexts.

Chapter 4

# Tonal phonology

This chapter provides a description of the tonal phonology of Ixtayutla Mixtec, which not only gives essential background for reading tone in the examples throughout the dissertation, but also provides an analysis of the tone system that is crucial to understanding arguments from the tonal phonology in support of the hypothesis that the couplet is a foot that is presented in Chapter 6. In view of this, a primary goal of the chapter is to establish the underlying tonal melodies associated with couplets, and the focus is primarily on couplet-sized words. An underlying melody may be as simple as a single tone (e.g. /H/) associated with each tone bearing unit (TBU) of a structure, or it may be more complex (e.g. /HL/). Since IM has considerable tone sandhi, a critical component in the task of establishing underlying melodies, besides examining the pitch contrasts on individual couplet TBUs, involves understanding the major tonal alternations that affect particular melodies in order to propose a coherent set of representations, tonal processes and constraints that account for the surface realizations. Taking these factors into consideration, I propose that, although the IM tone system has three surface tones, the underlying system is best modelled by only two contrastive levels, plus several abstract analytical devices, including floating tones, TBUs unspecified for tone on the surface and tonal coalescence. This analysis stands in contrast to the usual three tone analyses that have been posited for most Mixtec varieties (Acatlán Mixtec—Aranovich 1994 and Snider 1999; Alacatlazala Mixtec—Zylstra 1980; 1991; Ayutla Mixtec—Pankratz & Pike 1967; Chalcatongo Mixtec—Hinton et al. 1991 and Macaulay 1996; Huajuapan Mixtec—Pike & Cowan 1967; Jamiltepec Mixtec—Johnson 1988; Jicaltepec Mixtec—Bradley 1970; Magdalena Peñasco Mixtec—Hollenbach 2004, Metlatónoc Mixtec—Overholt 1961; Mixtepec Mixtec—Pike & Ibach 1978 and Paster & Beam de Azcona 2005; Molinos Mixtec—Hunter & Pike 1969; Ocotepec Mixtec—Mak 1958; Peñoles Mixtec—Daly & Hyman 2007; San Juan Colorado—Johnson

& Stark n.d.; San Miguel El Grande Mixtec—Pike 1944; 1945; 1948; Silacayoapan—North & Shields 1977; Southeastern Nochixtlán—McKendry 2013), and others that posit four (Acatlán Mixtec—Pike & Wistrand 1974; Atatlahuca Mixtec—Mak 1953; Yoloxóchitl Mixtec—DiCanio et al. 2014).

My approach to describing the tone system is to begin by establishing the tonal melodies found on native noun couplets in §4.1, which constitutes the bulk of the chapter, and then applying those findings to couplets in two other major lexical classes in §4.2. Nouns make a good starting point for the analysis since they are numerous and much simpler morphologically than verbs (cf. Hyman 2014:527; Snider 2017). They are also a good place to begin the presentation of the tone system due to the fact that they exhibit every major tonal process and yet the majority of noun couplets are describable in relatively straightforward terms due to their morphological simplicity. The few nouns that exhibit irregular patterns raise issues and provide important insights that both aid in understanding the tonal phenomena found in verbs and adjectives, and are more fully explained in conjunction with these data.

## 4.1 Tone in noun couplets

The task of establishing the underlying tonal melodies of noun couplets is broken down into several steps. In §4.1.1, I begin with a description of the five surface melodies found on noun couplets in isolation (i.e. citation context). I then discuss the contextual behaviour of each surface melody in §4.1.2–§4.1.5, which reveals two additional underlying melodies and suggests underlying forms for some of the surface melodies that are somewhat more abstract than their surface realizations. In §4.1.6 I adopt a richer system of tonal features that is able to handle a representational issue raised in this discussion, and I end the presentation of nominal tone with a discussion of the phonetic implementation of H in different tonal melodies in §4.1.7.

The primary construction used to explicate the nominal tone system is the noun + clitic pronoun (N-Pron) possessive construction (cf. §2.5) because this construction manifests nearly every major tonal process found in the wider nominal system; moreover, the application of tonal processes in the N-Pron context is quite regular and uniform, whereas in other constructions they apply with less regularity and have more variation. Another construction which will also be used for the same purposes is the noun + noun (N-N) associative construction, where two nouns are juxtaposed in a NP to show possession or attribution (cf. §2.3). In this chapter I also present plots of mean pitch contours of single nouns and of various melody combinations in N-Pron and N-N constructions. These plots were created in R (R Core Team 2017) from time-normalized f0 data collected in three production experiments: Single Word, N-Pron and N-N. In each experiment, time is normalized using ProsodyPro (Xu 2013:61), a script for Praat (Boersma & Weenink 2016) which creates a smoothed F0 curve (Xu 1999:61) and takes a fixed number of f0 samples (n=10) at equidistant points within each designated interval. Plots of mean pitch contour created from the Single Word experiment represent the average of six repetitions per item produced in citation context by each of five male speakers. N-N plots are the average of eight repetitions per item also produced in citation context by five male speakers. The N-Pron plots are the average of eight repetitions per item produced in a carrier sentence by four male speakers and two female speakers. Averaging for the Single Word and N-N mean pitch contour plots was performed on unnormalized f0 data using R scripts created by the author, since these data are used for visualization and not for statistical analysis. Statistical analysis performed on N-N data in §4.1.2 account for individual differences, such as differences in pitch range, by using a linear mixed effects model with speaker as a random (intercept) effect. Linear mixed effects modelling was implemented using the R package, lme4 (Bates et al. 2015), and the significance of the fixed effects was evaluated by the lmerTest package (Kuznetsova et al. 2016). Plots based on the N-Pron experiment were averaged across multiple repetitions of items and multiple speakers by the ProsodyPro script. The script first converts f0 values to logarithms (semitones) to accommodate differences in pitch range among speakers, calculates the average on the logarithmic values and then converts the averages back to Hertz values for plotting. A more detailed description of the methodology of the Single Word, N-N and N-Pron experiments is given in Appendices A, B and C, respectively.

A fourth production experiment (Large Noun), which examines the realization of tonal melodies in words that are larger than a couplet, is not referred to in this chapter but is referred to in Chapter 6. Time-normalization and averaging across repetitions of the same item in this experiment was also accomplished by the ProsodyPro script. Although multiple speakers were recorded in this experiment, only a single subject's data is plotted. A detailed description of this study is given in Appendix D.

### 4.1.1 Surface melodies of noun couplets

IM has the following five surface melodies on noun couplets pronounced in isolation: HH, HL, ∅L, LH and LM. Examples of nouns with each of these melodies by couplet type are given in Table 23.

Table 23. Noun couplets with the five citation tonal melodies by couplet type

| | **CVCV** | **CVˀCV** | **CVː** | **CVˀV** |
|---|---|---|---|---|
| **HH** | *tʃɨ́tɨ́* 'seed' | *kúˀβá* 'amount' | *ɲṹṹ* 'town' | *ɲṹˀṹ* 'fire' |
| **HL** | *tʃítʲì* 'canal' | *ⁿdɨ́ˀjɨ̀* 'pimple' | *sɨ̂* 'saliva' | *nṹˀũ̀* 'tooth' |
| **∅L** | *tʃikì* 'fist' | *koˀlò* 'male turkey' | *ɲɨ̃̀* 'skin' | *ɲũˀũ̀* 'earth' |
| **LH** | *jàkʷĩ́* 'armadillo' | *lùˀlú* 'foal' | | |
| **LM** | *ⁿdɨ̀βɨ̄* 'chicken' | | *ɲũ̀ũ̄* 'night' | |

The row header gives the surface melody for the items in that row in terms of the tones Low (L), Mid (M) and High (H) for each tone bearing unit (TBU), as well as ∅ for a toneless TBU, which will be explained below. Examples of disyllabic couplets—CVCV and CVˀCV—bearing each melody are given in columns one and two, and examples of monosyllabic couplets—CVː and CVˀV—are given in columns three and four. As shown by these data, the same set of tonal melodies are borne by both disyllabic and monosyllabic couplets, a fact which I take as evidence that the TBU is the mora (cf. (6), §5.2). In other words, since, for instance, the HL melody maps H to the first syllable and L to the second syllable of the couplets consisting of two light syllables (e.g. *tʃítʲì* and *ⁿdɨ́ˀjɨ̀*), and maps the same melody onto couplets having a single heavy syllable (e.g. ***sɨ̂ɨ*** and ***nɨ̋ˀɨ̏***) but two moras (cf. §3.3), I conclude that the TBU must be the mora rather than the syllable. Couplets of any shape, therefore, have two TBUs.

The mean pitch contours of the five citation melodies in Table 24 on disyllabic noun couplets are given in Figure 5. This plot was created from data collected in the Single Word production experiment, which is described in detail in Appendix A. The f0 contours represent the average of five male speakers each producing six repetitions of the following exemplars of each tonal melody in isolation: ∅L ***tʃikì*** 'fist', HL ***tɨ́kà*** 'grasshopper', HH ***tʃítɨ́*** 'seed', LM ***kòtō̃*** 'shirt', LH ***kùtʃí*** 'pig'.[1] Since each of the items used to create the plot had voiceless onsets, only the F0 of the vowel portion is plotted. By pitch (or F0) contour I mean the continuous plot of the fundamental frequency (F0) of an utterance over time, which may actually be flat and should not be confused with the term, contour tone, which refers to a tone for which a change in pitch over the course of the tone bearing unit is phonologically significant.[2] In the plot in Figure 5, the F0 of the nucleus of the syllable is labeled, "TBU 1, TBU 2", while voiceless syllable onsets are represented by white space in the plot and are labeled, "C1, C2"

[1] It should be noted that ***kùtʃí*** 'pig' and ***kòtō̃*** 'shirt' are well established loanwords having the tonal melodies LH and LM, respectively. As will be elaborated below, these melodies are extremely rare on native nouns so there are very few from which to choose. These words were chosen because they had the desired melodies and obstruent onsets like the other words in the experiment, making their pitch contours more comparable than words lacking this property.

[2] Conversely, as Hyman (2014) points out, what may be realized phonetically as a contour (i.e., a gliding pitch), "may ultimately be analyzed as a level tone" (p. 527).

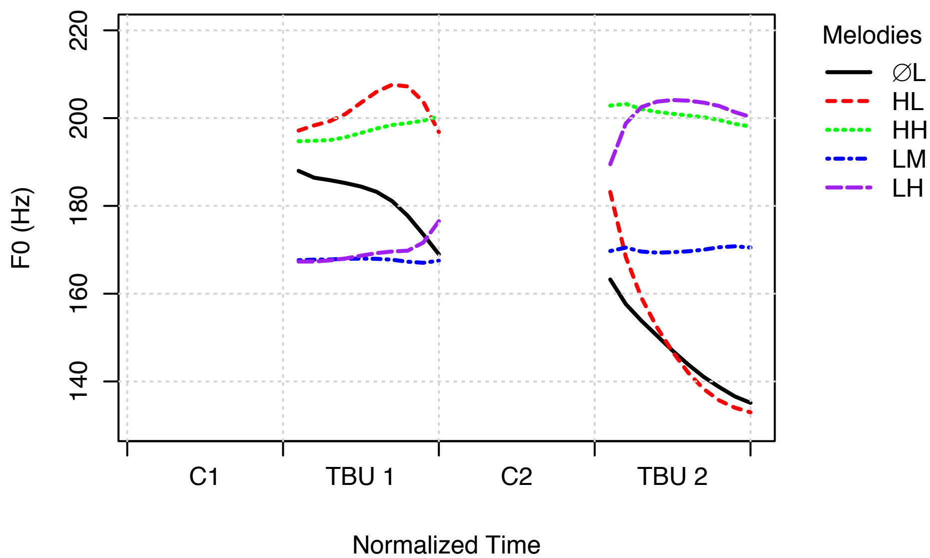



Figure 5. The five citation melodies found on noun couplets

Working from the f0 contours in Figure 5 to the surface melody labels, let us assume, as has always been the practice in Mixtec tone description (e.g. Pike 1948), that the pitch contours can be segmented into sequences of two individual tones (one for each TBU).[3] We can then observe the following: the tonal space of the first TBU divides into three distinct pitch contours with different pitch heights, and the tonal space of the second TBU is also divisible into three distinct pitch contours. Two pitch contours of the first TBU appear to have roughly equivalent counterparts on the second TBU, while one does not, and vice versa. Specifically, the tonal space of each TBU seems to have comparable high pitch contours, and the low pitch contour on the first TBU roughly corresponds to the mid pitch contour on the second TBU. The first TBU, however, has a mid-falling pitch contour which is absent on the second TBU, and the second TBU has an extra low-falling pitch contour which is absent in the tonal space of the first TBU.

If we interpret the pitch contours in Figure 5 to have three tonal possibilities on each TBU—H, M and L—relative to the other pitch contours of that TBU, but not necessarily those

[3] This would seem to be a safe assumption given that even Chinese tone, with its preponderance of contour tones on single syllables, is profitably analyzed by decomposing contours into discreet levels (e.g. Duanmu 1994; Duanmu 2016; Chen 2000).

of the other TBU in the couplet, then we have the surface melodies HH, HL, ML, LH and LM. These melodies are the same as those given in Table 23, except for ML which is ∅L in Table 23 and will be explained below. In other words, an analysis along these lines proposes that the phonetic realization of the L and M tones is somewhat different in each of the TBUs of the couplet: L has a low, level allotone on the first TBU and a falling allotone on the second TBU,[4] while M has a mid-falling tone on the first TBU and a low, level tone on the second TBU (the pitch belonging to the second TBU of the LM melody). Finally, we also observe that the H of HL is slightly higher than the H of HH, but this can be attributed to a dissimilatory process whereby Hs are realized at a higher pitch when followed by L, which has been well documented in a variety of languages in both phonetic and phonological studies (Hyman 2007b:3).

Before going on to consider the contrasts on individual TBUs more rigorously, it is informative to compare the attested surface melodies with what might be expected for bitonal melodies in a three-level system. This can be accomplished using Table 24, which gives counts of the surface melodies found in a database of 293 native noun couplets.

Table 24. Counts of noun couplet surface melodies

| | **2nd TBU** | | |
|---|---|---|---|
| **1st TBU** | **H** | **M** | **L** |
| **H** | 146 (50.0%) | | 56 (18.0%) |
| **M** | | | 82 (28.0%) |
| **L** | 5 (1.7%) | 4 (1.4%) | |

[4] Downgliding Ls word/phrase finally have also been documented in a number of other Mixtec descriptions (Acatlán—Pike & Wistrand 1974; Ayutla—Pankratz & Pike 1967; Alacatlazala, Guerrero—Zylstra 1980; Coatzospan—Pike & Small 1974; Diuxi—Pike & Oram 1976; Huajuapan— Pike & Cowan 1967; Metlatonoc, Guerrero—Overholt 1961; Molinos—Hunter & Pike 1969; Ocotepec—Mak 1958; San Juan Colorado—Johnson & Stark n.d.), and are commonly found phrase finally in Grassfields Bantu languages (Pulleyblank 1986:39, Yoruba (Hombert 1976:5–6), and in most Niger-Congo languages (Snider 1999:46). Furthermore, the apparent extreme difference in the realization of the two L allophones is exaggerated in the citation plot because the final TBU in this context is utterance final and therefore subject to utterance final f0 lowering. When not utterance final, L on the second TBU of the couplet still falls to a lower target, but the difference is not nearly as extreme.

Each of the interior cells of the table represents one of the nine possible bitonal melodies. The tonal melody represented by each cell is read by combining the tone in the row header, which gives the tone of the first TBU of the couplet, with the tone in the column header, which gives the tone of the second TBU. The numbers in each cell indicate the count (and percentage) of that melody in the database. We can see from the table that four melodies—LL, MH, MM, HM—are unattested (= blank cells), and of the melodies that are represented, HH is by far the most prevalent, comprising half of the sample, while LH and LM are severely underrepresented at less than 2% of the sample each. I note, however, that the underrepresented melodies are not uncommon on adjectives and imperfective verbs. Verbs are inflected for imperfective aspect with a L tonal suprafix, and there is evidence that some adjectives were also historically derived by a L tonal suprafix. LH and LM are also the predominant tonal melodies of Spanish loanwords. I will return to address the underrepresented melodies below in §4.1.5, and the overrepresented melodies in §4.1.3, but now I turn to examine the tone contrasts found on individual TBUs of these surface melodies.

Establishing tonal contrast on individual TBUs of stems with two TBUs requires controlling the tone of one of the TBUs (i.e., maintaining equivalence), and seeing what contrasts are found on the other TBU so that the contrasts are made in identical tonal environments (Snider 2014; 2017).[5] Throughout this section I give a schematic pitch representation of the relative pitch height of each tone bearing unit using tone bar glyphs (e.g. [_ ¯]) in order to visually represent the pitch contrasts under discussion. The tone bars represent idealized pitch contours of TBUs for careful speech and are not meant to show variation caused by many factors which are known to affect the implementation of pitch targets (e.g. Pierrehumbert 1980; Laniran 1992; Xu 2001; Xu & Wang 2001). In order to avoid overlooking phonetic detail that could be significant in assigning a tonal category to a particular pitch contour, my general practice has been to examine morphemes judged to have a particular tonal melody in a variety of contexts and pronounced by different speakers in

[5] As recommended by Snider 2014; 2017), when comparing items for the purpose of establishing underlying tonal contrast I also control for other phonological factors such as prosodic domain (all are couplets or minimal words) and CV structure (all have the CVCV structure), as well as grammatical factors such as lexical category (all are are nouns), stem type (all are morphologically simplex) and syntactic environment (citation form).

order to see how the pitch is affected, and (once a tonal category has been assigned) how the tones "behave". I admit that some variation which I have deemed as "phonetic" or due to factors of target implementation (Xu & Wang 2001) could turn out to be phonologically significant (i.e. not a matter of phonetic implementation), but I believe that the system I propose here accounts well for a large portion of the tonal behaviour in the language.

To begin with, consider the contrasts that are found on the first TBU of the couplet when the tone of the second TBU is H, as illustrated by the examples in (93). (Compare the first tones bar in the schematic pitch representations.)

(93) LH: *jàkʷĩ́* 'armadillo' [_ ¯]
HH: *jáká* 'grain bin' [¯ ¯]

This pair of words demonstrates that when the tone of the second TBU is H (the second tone bar in the schematic pitch representation) the only contrast found on the initial TBU (the first tone bar) is between L and H. There is no contrast between L and M or between M and H.

The minimal and near minimal pairs in (94), on the other hand, control for L on the second TBU. (Compare the first tone bars in the schematic pitch representations.)

(94) a. ML: *ɲũˀũ̀* 'earth' [– _]
HL: *ɲṹˀũ̀* 'mountain.spirit' [¯ _]
b. ML: *tʲitʲì* 'avocado' [– _]
HL: *tʃítʲì* 'canal' [¯ _]

These examples show that phonetic M and H contrast on the first TBU in this context, but not L and M or L and H.

Contrasts for the second TBU of the couplet are established in a similar fashion. If we control for H in the first TBU, the examples in (95) show that H and L contrast on the second TBU, but not H and M or L and M. (Compare the second tone bars in the schematic pitch representations.)

(95) a. HH: *ɲű̃ˀű̃* 'fire' [¯ ¯]
HL: *ɲű̃ˀȕ̃* 'mountain spirit' [¯ _]
b. HH: *tʲókó* 'wasp' [¯ ¯]
HL: *tʲókò* 'ant' [¯ _]

As demonstrated in Table 24, L is extremely rare on the first TBU of native noun couplets making it difficult to find comparable data. However, the following pair of native CVCV nouns both have L on the first TBU and contrast M and H on the second TBU:

(96) LM: *lùlū* 'thick tortilla for babies' [_ –]
LH: *jàkʷí̃* 'armadillo' [_ ¯]

(Compare the second tones bar in the schematic pitch representations.) H and L, and L and M, however, do not contrast in this context.

Thus, a three-level system with H, M and L in each TBU has only five of nine possible bitonal melodies. This large gap in the surface inventory makes an underlying three-level contrast suspicious. This suspicion is confirmed when contrasts on individual TBUs are examined in controlled contexts. On the first TBU, there is contrast between H and M, and between H and L, but **no L ~ M contrast**. On the second TBU, there is also a contrast between H and L, and between M and H, but **no L ~ M contrast**. I therefore propose that there is only a two-way contrast on each TBU of the couplet—L and H—and that there is no underlying M level in the tone system. This begs the questions, what is surface "M" and how should it be modeled in this system? The answer is different for "M" on the first TBU (ML) and for "M" on the second TBU (LM). As already indicated in Table 23, I model the "M" of ML as toneless (∅); the M of LM, however, will be modeled as the coalescence of L and H. In the next section I provide a rationale for my analysis of ML, but put off the discussion of LM to §4.1.5 until after I have addressed additional couplet melodies that are manifested in contexts besides the citation context for noun couplets with the HH and HL citation melodies.

### 4.1.2 Noun couplets with the citation melody ML

I posit that the surface melody ML is the realization of the underlying melody /L/ and that the “M”-like surface realization on the initial TBU of the ML citation melody is the result of surface underspecification; that is, ML surfaces as ∅L with a toneless initial TBU of the couplet and a L associated with the second TBU, as given in Table 23. This analysis not only provides a way to model the lack of contrast between L and M on the first TBU, but also makes sense of the contextual variation of the pitch of the first TBU of /L/ couplets which is found to be closely tied to the pitch of the preceding TBU, as I will now demonstrate.

In the N-N production experiment (Appendix B), I examined the productions of five male speakers producing eight repetitions of seven noun phrases consisting of two juxtaposed (disyllabic) nouns, where the tonal melody of the second noun (N2) was always /L/ and the melody of the initial noun (N1) was varied to include each couplet melody. Thus, there was a total of 280 tokens—7 phrases with different melody combinations x 8 repetitions x 5 speakers. An example stimulus from the experiment where the first noun in the phrase has the HH citation melody is *ɲã́ɲɨ̃́ nɨ̃ɲɨ̃̀* ‘corncob’s brother’ (i.e. a corncob that looks like another). When the offset pitch (i.e. the last F0 measurement) of N1 (for all the different tone patterns) is compared to the offset pitch of the first TBU of N2 (i.e. the word with the /L/ tone pattern), the pitch of the first TBU of the /L/ couplet is highly correlated with the pitch height of the preceding TBU. The data were analyzed with a linear mixed effects model with the offset pitch of the first TBU of N2 as the dependent variable, the offset pitch of N1 as a fixed effect and subject as a random effect. The resulting model shows that the offset pitch of N1 is a highly significant predictor of the offset pitch of the first TBU of N2 ($t(247.7) = 30.5$, $p < .001$). The correlation of the two variables is visualized in the scatterplot in Figure 6, which plots the offset pitch of the first word of the construction on the x-axis and the corresponding offset of the first TBU of the second word (= /L/) on the y-axis. As can be seen, the positive slope of the regression line ($y = \mathbf{0.90}x + 6.49$; solid black), which is the coefficient of the highly significant fixed effect of the model, indicates that the greater the offset pitch of the first

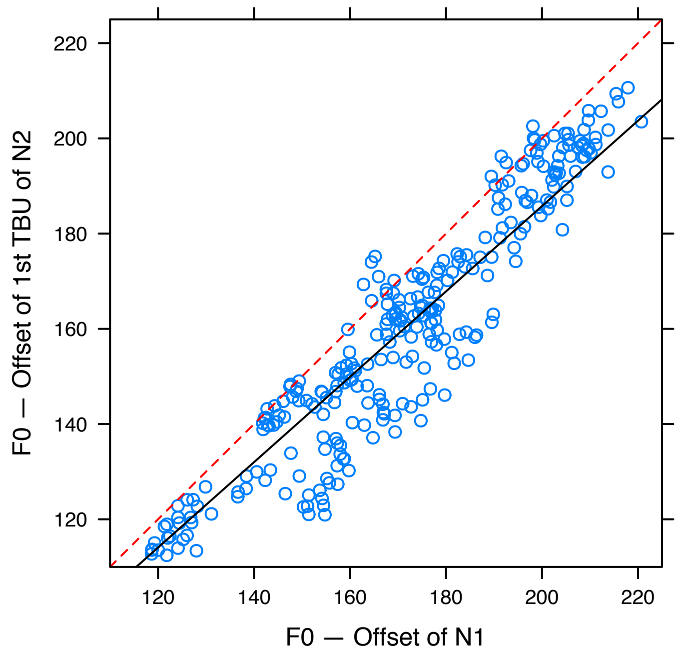



Figure 6. Correlation of offset pitch of the first TBU of /L/ (N2) with the offset pitch of the preceding word (N1); (Solid line = regression line; dashed line [red] is y = x)

word, the greater the offset pitch of the first TBU of the second (/L/) word. Furthermore, this slope differs little from the slope of the y = x line (= 1.0; dotted red), which would indicate a perfect correlation between the two pitches.

The relation depicted in Figure 6 stands in stark contrast to the one shown in the scatterplot in Figure 7, where the second word in the N-N construction has the LM melody rather than the /L/ melody, as in *ɲɑ̋ɲı̋ mı̏lī* 'stew's brother' (i.e. a stew of the same kind as another), and the first word has each of the various noun melodies, as above.[6] A linear mixed effects model predicting the pitch of the offset of the first TBU of N2 (LM) from the offset pitch of N1 with speaker as a random effect based on these data shows that the offset pitch of N1 is not a significant predictor of the offset pitch of the first TBU of N2. The coefficient (slope) of the fixed effect (-0.03) is not significantly different from zero ($t(274) = -1.6$, p = .12), while the intercept coefficient (149.35) is

[6] It should be noted that there was one missing repetition for one of the speakers in this dataset, so n = 279, instead of 280 (7 melodies x 8 repetitions x 5 speakers).

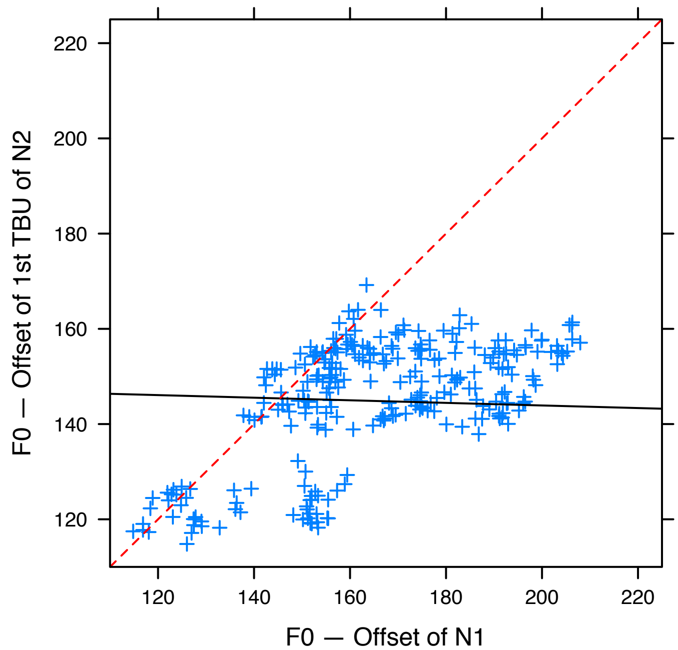


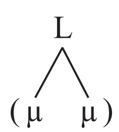

Figure 7. Correlation of offset pitch of the first TBU of LM (N2) with the offset pitch of the preceding word (N1); (Solid line = regression line; dashed line [red] is y = x)

highly significant ($t(5.9) = 22.0$, $p < .001$). This is shown in the plot by the nearly flat regression line ($y =$ **-0.03**$x + 149.35$; solid black). In other words, the offset pitch of the first word in the phrase has very little effect on the offset pitch of the first TBU of a following LM word, which will have a pitch clustered around 149.35 Hz. This is quite the opposite from what we saw above when the second noun in the phrase has the /L/ melody. I take these results as evidence that the first TBU of /L/ couplets is ∅, having no pitch target of its own, whereas LM couplets have a L target in the first TBU, a fact which is also obvious from the citation form of LM given in Figure 5. The fact that the regression line for /L/ in Figure 6 is slightly lower than the y = x line can be attributed to the downward pull of the L target of the final TBU.

The surface representation proposed here for /L/ couplets (∅L) is similar to that proposed by Morén & Zsiga (2006) for /L/ in Thai, which also has a falling pitch throughout the duration of bimoraic syllables reaching its lowest point at the right edge of the domain. The authors consider this as evidence that L tones are only specified on the second mora of these structures and point out that it rests on the assumption that “phonologically toneless moras are phonetically mapped to the neutral/default pitch range with gradually falling pitch during the unspecified span” (p. 134–135). I indicate this orthographically by leaving the first TBU without a tone mark and only marking L on the final TBU of /L/ couplets, as in *tʃikì* ‘fist’.

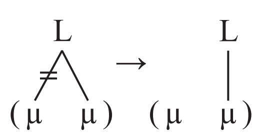
The autosegmental representation of /L/ couplets, following the standard assumptions of autosegmental theory and the OCP (Leben 1973; Goldsmith 1976), would be a single L feature associated with both TBUs of the couplet (just as long vowels were represented as a single vowel associated with both moras of the heavy syllable/couplet), as shown in (97).

(97) /L/




In this representation, TBUs are represented by μ (= mora) which are both connected to a single L feature by association lines. The ∅L surface representation argued for in this section is achieved by a rule delinking L from the initial mora, as formalized in (98).

(98) Initial L Delinking (ILD)




(Delinking is represented here and throughout this dissertation by a double slash “=” through an association line.) The result of this rule is that /L/ couplets surface with a toneless initial mora that is assigned a default pitch at the beginning of an intonation group and whose pitch realization is highly determined by the pitch of the preceding TBU elsewhere.

### 4.1.3 Noun couplets with the citation melody HH

In this section I discuss some idiosyncratic behaviour of the disproportionately large group of noun couplets with the HH citation melody. Words with this surface melody arbitrarily split into two groups based on the tonal behaviour of these words in various contexts. One context which demonstrates this bifurcation is when the nouns are combined with the H toned first person exclusive enclitic pronoun, *=ⁿdí*. In this noun + clitic pronoun construction, 52 of the 137 nouns listed in Table 24 with the HH citation melody surface with the same output tones as input tones; that is, with H tones on the couplet and on the pronoun as illustrated by the examples in (99). (The pronouns in these examples and below are given in bold font.)

(99) a. *tʃítí**ⁿdí***
tʃítí=ⁿdí
seed=1PL.EXCL
'our seed'

b. *káká**ⁿdí***
káká=ⁿdí
lime=1PL.EXCL
'our lime'

c. *tʲájú**ⁿdí***
tʲájú=ⁿdí
stool=1PL.EXCL
'our stool'

d. *ᵐbéé**ⁿdí***
ᵐbéé=ⁿdí
sheep=1PL.EXCL
'our sheep'

The other 85 nouns with this surface melody, however, unexpectedly surface with L on the pronoun instead of H, as shown in (100).[7]

[7] It should be noted that for one speaker in the N-Pron production experiment (Appendix C) conducted as part of the research for this dissertation, the final TBU of the couplet was lowered in this construction rather than the tone of the pronoun, [¯ _ ¯], although this had not been recognized before in elicitations. In addition, the other speaker

(100) a. ***tʃɨ́tɨ́ⁿdì***
tʃɨ́tɨ́ᴸ = ⁿdí
knee=1PL.EXCL
'our knee'

b. ***kʷíjáⁿdì***
kʷíjáᴸ = ⁿdí
year=1PL.EXCL
'our year'

c. ***tʃáʔáⁿdì***
tʃáʔᴸ = ⁿdí
foot=1PL.EXCL
'our foot'

d. ***ⁿdóóⁿdì***
ⁿdóᴸ = ⁿdí
sugar.cane=1PL.EXCL
'our sugar cane'

This is the same tone pattern that is observed when the first group (= nouns with surface HH melody) is combined with the L toned third person masculine singular enclitic pronoun, =*ɾà*, as shown in (101).

(101) a. ***tʃɨ́tɨ́ɾà***
tʃɨ́tɨ́ = ɾà
seed=3.MASC
'his seed'

b. ***kákáɾà***
káká = ɾà
lime=3.MASC
'his lime'

c. ***tʲájúɾà***
tʲájú = ɾà
stool=3.MASC
'his stool'

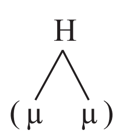
showed lowering of the final TBU of the couplet in addition to lowering the pronoun. At the present I consider these as non-standard pronunciations, the second likely being a fast speech phenomenon, but more study is needed. The important fact is that the lowering is obligatorily applied, albeit with some variation in its realization.

d. $^{m}$***béérà***
$^{m}$béé = ɾà
sheep=3.MASC
'his sheep'

Since the earliest days of modern Mixtec research it has been observed that certain words arbitrarily "perturb" or trigger tonal changes in morphemes that follow them, such as the alternations demonstrated in (100), and that certain words are prone to be perturbed, or undergo tone sandhi (e.g. Pike 1944; 1948). With the advent of autosegmental phonology (Goldsmith 1976), these alternations have come to be analyzed with floating tones in the tonal melody that associate with a following TBU in certain predictable circumstances (e.g. Goldsmith 1990; Hinton et al. 1991; McKendry 2013). Following these analyses, I model the alternations described in (100) as the result of a floating L tone at the right edge of the noun couplets which trigger the tonal alternations. I represent the floating L with a raised L ("$^{L}$"), and I assign these couplets the underlying melody /H$^{L}$/. When combined with the H pronouns, the floating L of /H$^{L}$/ nouns associates with the H pronouns by a process that I will refer to as Floating L Association (FLA). Since there is a constraint in IM against more than one tone per TBU, FLA results in the replacement (total assimilation) of the pronoun tone with the floating tone, rather than the creation of a contour tone. This contrasts with the tonal behaviour of HH couplets in (99) which lack the floating L, and to which I assign the underlying melody, /H/.

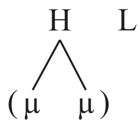
Turning now to autosegmental representations, I represent the /H/ melody on a couplet as a single H feature associated with both TBUs of the couplet, as shown in (102).

(102) /H/




The representation of /H$^{L}$/ couplets is similar, except that there is a floating L feature to the right of the couplet, which is indicated by the lack of an association line, as in (103).

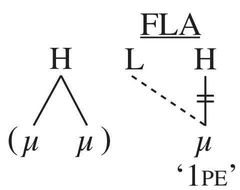
(103) /H$^{L}$/




With these representations in hand, we can now consider how to represent the derivation of the tonal alternation shown in (100).

The derivation of /H$^{L}$/ + =$^{n}$*dí* '1PL.EXCL' is given in (104).

(104) /H$^{L}$/ + /=$^{n}$*dí*/ '1PL.EXCL' → HH=L




The /H$^{L}$/ couplet is represented as in (103) followed by the H of the pronoun. FLA creates an association line (indicated here and throughout this dissertation by a dotted line) rightward from the unassociated L at the right edge of the couplet melody to the first TBU to the right (which belongs to the pronoun). Because IM generally does not allow more than one tone per TBU, the H of the pronoun is delinked and deleted from the output.

The alternation just described for the first person plural exclusive pronoun also occurs when the H toned first person singular enclitic pronoun, =*ɨ́*, combines with nouns having the /H$^{L}$/ melody, providing further evidence for the floating tone. As described in §2.5, this pronoun fuses to the right edge of the stem to become part of the couplet, as illustrated by the examples in (105).

(105) a. ***tʃɨ́tɨ̀***
tʃɨ́tɨ́$^{L}$ = ɨ́
knee=1SG
'my knee'

b. ***kʷɨ́jè***
kʷɨ́já$^{L}$ = ɨ́
year=1SG
'my year'

c. ***tʃáˀì***
tʃáˀᴸ = í[8]
foot=1SG
'my foot'

d. ***ⁿdóì***
ⁿdóᴸ = í[9]
sugar.cane=1SG
'my sugar cane'

When vowel fusion occurs, the tone of the pronoun replaces the tone of the final TBU of the stem. In (105), the pronoun tone has been changed to L just as in (100) and the couplet melody is consequently changed to HL when fusion occurs. The examples in (106) show that this alternation does not occur for words with the /H/ melody, just like the non-sandhi pattern that was demonstrated in (99).

(106) a. ***tʃɨ́tí***
tʃɨ́tɨ́ = í
seed=1SG
'my seed'

b. ***kákɛ́***
káká = í
lime=1SG
'his lime'

c. ***tʲájí***
tʲájú = í
stool=1SG
'my stool'

d. ***ᵐbéí***
ᵐbéé = í
sheep=1SG
'my sheep'

[8] The underlying form of roots which surface with a CVˀV or a CVː couplet are analyzed as /CVˀ/ and /CV/, respectively. These roots are obligatorily realized as a couplet (with two TBUs) on the surface due to prosodic constraints that are discussed in §6.2.1. It is also assumed, that word-level prosodic structure is built within the lexical phonology, as discussed in §5.4.

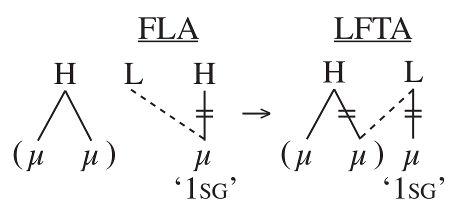
[9] See footnote 8.

e. ***ítí***
ítú = í
cornplant=1SG
'my cornplants'

In each of these examples, the couplet melody remains HH after coalescence has taken place.

The derivation of /H$^{L}$/ + =*í* '1SG' from (105), is similar to the derivation in (104), but involves what is (from a descriptive perspective) a second step whereby the tone of the pronoun replaces the final tone of the couplet when coalescence occurs, as shown in (107).

(107) /H$^{L}$/ + =*í* '1SG' → HL




In the first step of the derivation FLA associates the floating L in the input of the noun melody rightward to the TBU of the pronoun and delinks its H tone, as in (104). In the second step, when the pronoun coalesces with the final vowel of the couplet, its tone is delinked and an association line is created leftward from the pronoun, which has been changed to L, back to the final TBU of the couplet delinking its tone. I refer to the tonal process associating the delinked pronoun tone to the final couplet TBU as Leftward Floating Tone Association (LFTA).[10] This process, which differs from FLA in the direction of association, is restricted to tones that are underlyingly H and are either coerced onto a couplet through coalescence, as we see here, or are part of the underlyingly melody of a couplet, as we will see in §4.1.6. I assume that coalescence also includes the deletion of the mora associated with the pronoun.

The phonetic realization of the sandhi (HL) realization of the couplets in (105) and the non-sandhi (HH) realization of those in (106) is shown by the mean pitch contours in Figure 8 from the Single Word production experiment (Appendix A). Each f0 contour represents the average of six

[10] Leftward tonal association processes are also found in other Mixtecan languages, such as Triqui (DiCanio 2016).

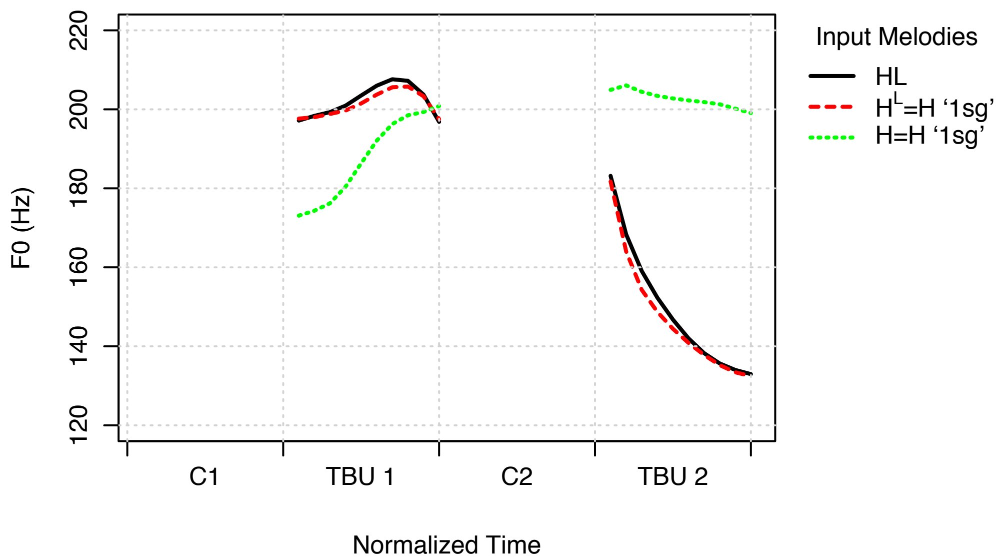



Figure 8. Contrast between /H/ + 1SG and /H$^{L}$/ + 1SG; dotted vertical line = syllable boundary

repetitions by five male speakers pronouncing ***tʃítì*** 'my knee' (105a), which has an underlying /H$^{L}$/ couplet melody, ***ítí*** 'my cornplants' (106e), which has an underlying /H/ couplet melody, and ***tíkà*** 'grasshopper', which has an underlying /HL/ melody and is not combined with the pronoun. The low falling final TBU of the H$^{L}$=H '1SG' f0 contour clearly contrasts with the high final TBU of the H=H '1SG' contour and is indistinguishable from the f0 contour of the lexical /HL/.

FLA is obligatory in the N + clitic pronoun construction; it also occurs frequently, though apparently not obligatorily, from a /H$^{L}$/ couplet to an immediately following couplet with either the /H/ or /H$^{L}$/ melodies in the N-N associative construction:

(108) a. ***níɲí ɲàɲí***
níɲí$^{L}$ ɲáɲí
blood brother
'brother's blood'

b. ***níɲí ⁿdìβí***
níɲí$^{L}$ ⁿdíβí$^{L}$
blood egg
'egg's blood'

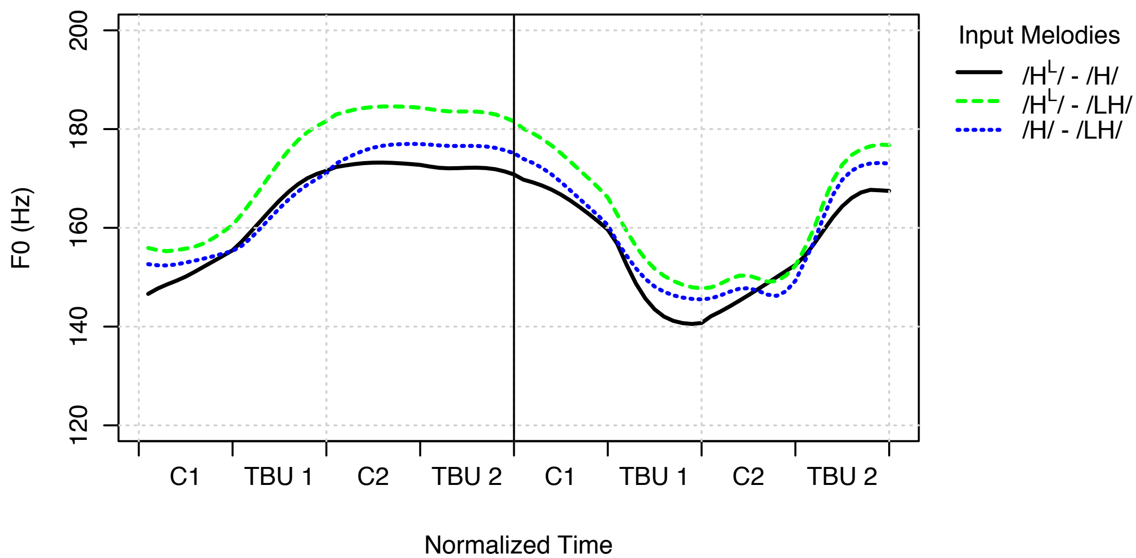
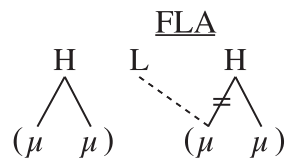



Figure 9. Comparing mean pitch contours of /H$^{L}$/ + /H/, /H$^{L}$/ + /LH/ and /H/ + /LH/ in the N-N construction; dotted vertical line = syllable boundary, solid vertical line = word boundary

The initial word in each example has the /H$^{L}$/ melody, while the second word has the /H/ melody in (108a) and /H$^{L}$/ in (108b). Observe that the final word in each example surfaces with the LH melody due to the application of FLA. The phonetic realization of (108a) is shown by the plot of /H$^{L}$/-/H/ in Figure 9, where it is compared to the f0 contour of the melody combinations /H$^{L}$/-/LH/ (***nɨ̋ɲɨ̋ mà$^{ŋ}$gú*** 'mango's blood') and /H/-/LH/ (***ɲa̋ɲɨ̋ mà$^{ŋ}$gú*** 'mango's brother'), where the second word of the phrase has a lexical LH melody. The f0 contours represent the averages of eight repetitions of each item in citation context by five male speakers from the N-N production experiment (Appendix B). The pitch of the voiced syllable onsets is included in the f0 contours, and syllable boundaries (dotted vertical line) and the boundary between words (solid vertical line) are indicated. Notice that the f0 contour of ***nɨ̋ɲɨ̋ ɲa̋ɲɨ̋*** 'brother's blood' (/H$^{L}$/ + /H/) has a LH tone pattern on ***ɲa̋ɲɨ̋*** when the floating L of ***nɨ̋ɲɨ̋$^{L}$*** 'blood' is realized on its first TBU. Notice also that this sandhi pattern is comparable to the lexical LH in the second word of the f0 contours of /H$^{L}$/ + /LH/ and /H/ + /LH/.

I give the autosegmental derivation of /H$^{L}$/ + /H/ from (108a) in (109).

(109) /H$^{L}$/ + /H/ → HH-LH




FLA creates an association line from the floating L of the first word across a couplet boundary to the initial TBU of the second couplet. The H feature that was associated to this TBU is delinked leaving the H linked to the second TBU. The result is a couplet with L linked to the first TBU and H linked to the second TBU.

While the application of FLA on a following enclitic pronoun basically has a uniform realization (but see footnote [11]), this is not true of the application of FLA to a following couplet in a phrase. In addition to replacing only the initial TBU as in (109), the floating L may also replace the entire melody, as exemplified in (110).

(110) a. *nɨ́ɲɨ́ ɲãɲɨ̃̀* ‘brother’s blood’
b. *nɨ́ɲɨ́ ⁿdɨβɨ̀* ‘egg’s blood’

In contrast to the LH realization of the sandhi form shown in Figure 9, when the floating L replaces the entire melody of the second word it has a high falling contour which is comparable to the realization of /L/ couplets in this context (i.e. following /H$^{L}$/) as shown in Figure 10. This plot gives the average realization of eight repetitions of the melody combination /H$^{L}$/-/L/ (*nɨ̃́ɲɨ̃́ ɲɨ̃ɲɨ̃̀* ‘corncob’s blood’) in citation context by five male speakers from the N-N production experiment (Appendix B). Recall that /L/ surfaces as ∅L, having no initial pitch target of its own, hence the large degree of carryover from the H of the preceding word creating the high falling pitch on the first TBU of the second word.

The autosegmental derivation of the second realization of FLA is shown in (111).

[11] See footnote 7 in chapter 4.

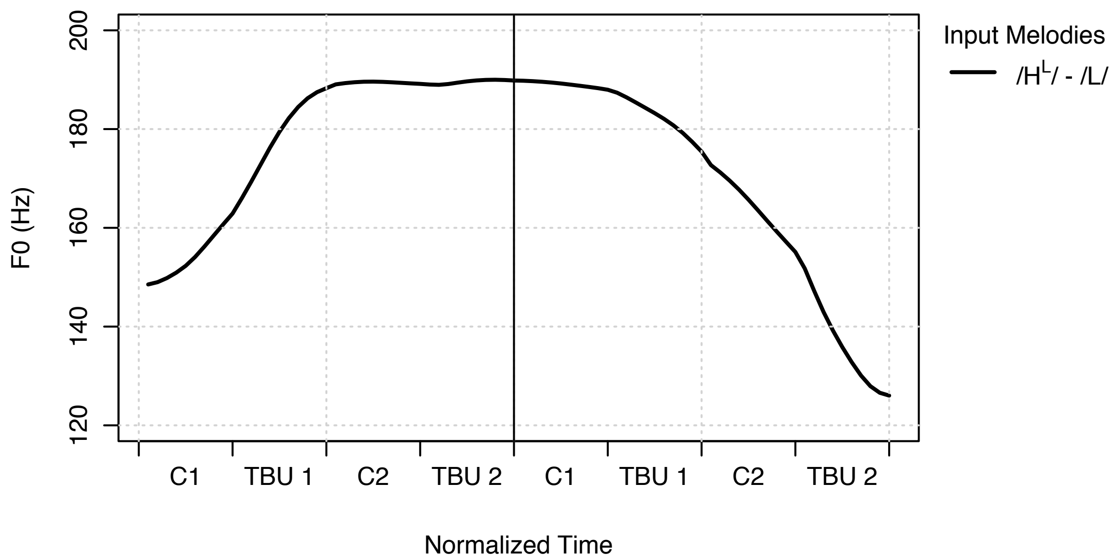
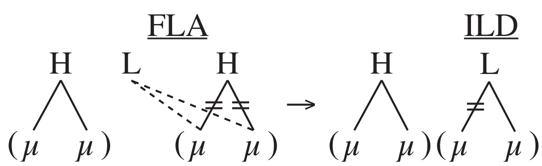



Figure 10. Mean pitch contour of /H$^{L}$/ + /L/ in the N-N construction; dotted vertical line = syllable boundary, solid vertical line = word boundary

(111) /H$^{L}$/ + /H/ → HH-∅L




This derivation begins just like the derivation shown in (109), but then L spreads iteratively to the second TBU couplet and then is delinked from the first TBU by ILD (98).

So far, conditions for determining which of these sandhi forms of FLA will be selected have not been discovered and it seems that one alternation may be preferred over the other for some lexical combinations. As mentioned above, FLA also does not appear to be obligatory in the N-N construction like it is in the noun-enclitic pronoun construction, particularly where the melody of the second couplet is /H$^{L}$/. In a production experiment investigating the N-N construction (Appendix B), all subjects (five male speakers and five female speakers) produced sandhi forms in all three items exemplifying the /H$^{L}$/ + /H/ melody combination, with the most common sandhi form being LH. Subjects were split in their productions of the one /H$^{L}$/ + /H$^{L}$/ item in the experiment, with some subjects producing the LH sandhi form, others producing the L sandhi form and one subject not producing sandhi at all. FLA also occurs in the N-Adj construction, though apparently only optionally for one speaker. This has not been studied experimentally, but informal elicitations so far indicate that only the LH sandhi form is used for /H/ and /H$^{L}$/ adjectives following /H$^{L}$/ nouns in the phrase. More study is needed to determine if it is possible to predict more accurately when and how FLA will apply to a following couplet.

Another tonal process that shows the contrast between the /H$^{L}$/ and /H/ melodies is seen when nouns with these melodies combine with the third person masculine pronoun, *=ɾà*. We already saw in (101) that nouns with the /H/ melody simply surface as HH=L, when combined with the L toned pronoun; curiously, the pronoun surfaces as H when combined with /H$^{L}$/ nouns, as demonstrated in (112).

(112) a. ***tʃɨ́tɨ́ɾá***
tʃɨ́tɨ́$^{L}$ = ɾà
knee=3.MASC
'his knee'

b. ***k$^{w}$ɨ́jáɾá***
k$^{w}$ɨ́já$^{L}$ = ɾà
year=3.MASC
'his year'

c. ***tʃá$^{ʔ}$áɾá***
tʃá$^{ʔL}$ = ɾà
foot=3.MASC
'his foot'

d. ***$^{n}$dóóɾá***
$^{n}$dó$^{L}$ = ɾà
sugar.cane=3.MASC
'his sugar cane'

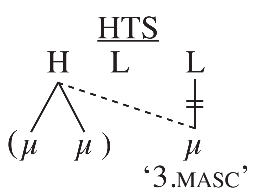
Under the floating L analysis proposed here, the raising of L pronouns following words with a floating L (112), and not following couplets lacking the floating L, is analyzed as a process of high tone spread (HTS) from the stem in order to preserve the distinction between words with and without the floating L in their tonal melody—that is, since the lowering effect of the floating L would be lost by associating the floating L with a pronoun that has L as its underlying melody, spreading H to the pronoun instead is a means of maintaining the distinctiveness of the tonal melody of these couplets from the /H/ couplets which lack the floating tone.[12] Interestingly, there is evidence that there is a floating L after the raised pronoun which is optionally realized on a following /H/ word, as shown in (113).

(113) *íʃìkòɾà* *ɲɨ̋ɨ̋ɾá* ***ɲù̏***ű
í–ʃìkò=ɾà ɲɨ́ᴸ=ɾà ɲú
PFV–sell=3.MASC salt town
'He sold his salt in town'

In this example, *ɲɨ̋ɨ̋ᴸ* 'salt' has the /Hᴸ/ melody. H spreads from *ɲɨ̋ɨ̋ᴸ* to the third person masculine enclitic pronoun, =*ɾà*, changing its tone to H resulting in a floating L at the right edge of the pronoun. This floating L is realized on the final word, *ɲű̋ű* 'town', which has the /H/ melody, by lowering its initial TBU (in bold) so that it is realized as LH.

The autosegmental derivation of /Hᴸ/ + =*ɾà* '3.MASC' from (112), where the HTS process occurs from the /Hᴸ/ couplet to a L pronoun, is depicted in (114).

(114) /Hᴸ/ + =*ɾà* '3.MASC → HH=Hᴸ'




[12] Paster (2006) discusses a somewhat similar situation in the Yucunany dialect of Mixtepec Mixtec. In that language, the first person singular enclitic pronoun is marked by a L tonal suprafix that associates at the right edge of its host except when the host ends in a L tone, in which case the allomorph, =*yù*, is selected instead. She argues that the selection of =*yù* in precisely those environments where the use of the tonal suprafix would lead to homophony serves to maintain the distinction between forms marked with the pronouns and those that are not. While the IM situation described here involves a lexical distinction (i.e. the realization of a floating L that is part of the lexical melody of a stem) rather than allomorphy, the principle of contrast preservation where underlying tonal contrast would be obscured by the context is the same. In precisely the environment where the effect of the floating tone of the stem would be lost, we find high tone spreading.

Here HTS creates an association line rightward from the H tone of the couplet to the TBU of the pronoun and delinks the L tone that was associated with it. Since the L at the right edge of the /H$^{L}$/ couplet is floating, no association lines are crossed in this process. Based on the evidence in (113), I assume that either the original floating L or the L that has been delinked from the pronoun remains in the output.

HTS is another process that iteratively spreads through the couplet. As with FLA, HTS applies obligatorily from a /H$^{L}$/ couplet to a following L pronoun, but the process also optionally applies from a /H$^{L}$/ couplet to a following /L/ couplet in the N-N associative construction, in which case it spreads iteratively to both TBUs of the couplet, as shown in these examples:

(115) a. *$^{n}$dʲáˀjú júkú*
$^{n}$dʲáˀjú$^{L}$ jùkù
mud mountain
'mountain's mud'

b. *tʃáˀá jútṹ*
tʃáˀ$^{L}$ jùtũ̀
foot tree
'tree's foot'

c. *tʃíkí ɲṹˀṹ*
tʃíkí$^{L}$ ɲùˀ
hill land
'land's hill'

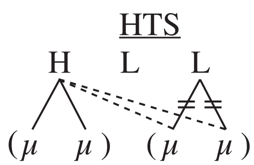
The initial word in each example has the /H$^{L}$/ melody and the following word has the /L/ melody. H optionally spreads from the first word to both TBUs of the second word. When this happens the second word in the phrase has a floating L to its right, as shown by this example:

(116) *tʃíkí ɲṹˀṹ$^{n}$**dì***
tʃíkí$^{L}$ ɲùˀ=$^{n}$dí
hill land=1PL.EXCL
'our hill's land'

Notice that when the H enclitic pronoun (in bold) is added to the phrase from (115c), which has undergone iterative HTS, the pronoun tone is lowered to L, indicating the presence of a floating L after 'land'. In other words, when HTS applies to a couplet, it has the effect of completely replacing its /L/ melody with /H$^{L}$/.[13]

The autosegmental derivation of iterative HTS is given in (117).

(117) Iterative HTS within couplets: /H$^{L}$/ + /L/ → HH HH$^{L}$




H spreads rightward across a couplet boundary to each TBU of a following /L/ couplet. As with HTS in the N-Pron construction, there is a floating L in the derived H$^{L}$ couplet, whether the original floating L of the /H$^{L}$/ couplet or the L that is delinked from the /L/ couplet as a result of the spreading.

It should also be noted that if a L enclitic is added to the phrase in (115c), the L pronoun also undergoes HTS, as shown in (118).

(118) *tʃíkí* *ɲű́ˀű́**ɾá**$^{L}$*
tʃíkí$^{L}$ ɲùˀ=ɾà
hill land=3MASC
'his hill's land'

As above, H spreads from the initial /H$^{L}$/ noun to the /L/ noun, changing its melody to H$^{L}$, and a L pronoun (in bold) added to the end of the phrase also undergoes HTS. These facts can be taken as an indication that the iterative domain of HTS includes both a couplet and enclitics, or that there is an iterative HTS rule that applies within a couplet as well as a HTS rule that applies within the prosodic word from a couplet to L enclitics. Note that the iterative rule in (117) must have a couplet boundary after the initial /H$^{L}$/ couplet and before the /L/ couplet, whereas the rule that was given

[13] A process similar to the optional HTS process described here for the N-N construction also applies obligatorily from a prefix or proclitic with the /H$^{L}$/ melody to a following /L/ couplet, but with the difference that the tone of the prefix/proclitic dissimilates to L after spreading H to the couplet.

in (114), which applies from a /H$^{L}$/ couplet to a following L enclitic, only requires the first couplet boundary, since the enclitic to which H spreads is not a couplet and therefore spreading cannot be iterative.

In this section we have seen that the overly large group of noun couplets with the HH surface melody (50% of the sample) is actually comprised of two couplet melodies based on their contextual behaviour. Using the noun + enclitic pronoun construction, it was demonstrated that one group of these nouns (comprising 20% of the sample) do not cause tone sandhi in following H and L pronouns, whereas a second group (comprising 30% of the sample) cause H toned pronouns to be lowered to L and L toned pronouns to be raised to H. This discovery makes the very lopsided distribution in Table 24 much more evenly distributed, although there are still asymmetries that will be addressed below. I have analysed the sandhi triggering couplets with a floating L at their right edge. This floating tone is generally not realized on the couplet itself, but instead associates to a TBU to the right. The strategy of marking the sandhi triggering morphemes with a floating tone in their underlying representation captures the generalizations that a) it is a lexical phonological property of these words that triggers the sandhi, and b) the effect on the following morpheme is that of providing it with a L tone. I assign the non-sandhi HH nouns the underlying melody /H/ and the sandhi triggering group the underlying melody /H$^{L}$/.

A number of tonal processes have also been introduced in this section in order to demonstrate the contrast between the /H/ and /H$^{L}$/ melodies. FLA is a process whereby a floating L tone associates rightward across a couplet boundary to an adjacent TBU. This process applies obligatorily in the N-Pron construction from a /H$^{L}$/ couplet to a following H enclitic pronoun (cf. (104), (107)), but also applies optionally in the N-N associative construction from a /H$^{L}$/ couplet to a following couplet with the /H/ or /H$^{L}$/ melodies. When this happens, it may either associate the floating L across the couplet boundary to the first TBU, creating a LH couplet (cf. (109)), or it may apply iteratively to both TBUs creating a ∅L couplet (cf. (111)). LFTA is an obligatory process that associates the tone of an enclitic pronoun that has been left floating through vowel coalescence leftward across a couplet boundary to the preceding TBU (cf. (107)). Finally, HTS occurs obligatorily from a /H$^{L}$/ couplet to a following /L/ pronoun (cf. (114)). It also occurs optionally in the N-N associative construction, where it applies iteratively to both TBUs of a following /L/ couplet (cf. (117)).

### 4.1.4 Noun couplets with the citation melody HL

In this section we will see that the group of noun couplets with the HL citation melody (cf. Table 23 and Table 24) also splits into two groups based on the tonal behaviour of these couplets when combined with the first person singular enclitic pronoun, requiring the addition of another underlying couplet melody to our repertoire. The vast majority of noun couplets with the HL citation melody surface with HH when combined with the first person singular pronoun, as illustrated by the data in (119a).

(119) a. ***tʃíté***
tʃítò = í
bed=1SG
'my bed'

b. ***ⁿdɨ́ˀjɨ́***
ⁿdɨ́ˀjɨ̀ = í
pimple=1SG
'my pimple'

c. ***séˀí***
sêˀ = í
offspring=1SG
'my child'

d. ***káí***
kâ = í
metal=1SG
'my metal'

Given the facts of tonal association when pronouns coalesce with couplets that were established in the preceding section, the tonal behaviour of these couplets is straightforward. The H tone of the pronoun replaces the tone of the final TBU of the stem (in bold font) by LFTA resulting in a HH surface melody. I assign these couplets the underlying melody /HL/.

In terms of autosegmental representations, /HL/ couplets have the representation given in (120), with each tone of the melody associated to its own TBU.

(120) /HL/

H L
| |
( μ μ )

The tonal derivation of /HL/ + =*í* '1SG' coalescence that was exemplified in (119), then, can be represented as in (121).

(121) /HL/ + =*í* '1SG → HH'

LFTA
H L H
( *μ* *μ* ) *μ*
'1SG'

Since no tonal processes have modified the pronoun tone, when segmental coalescence occurs and the tone of the pronoun replaces the tone of the final TBU of the couplet by LFTA, the result is a HH couplet.

A second group of 10 native noun couplets with the HL citation melody, however, undergo an unexpected tonal alternation in this context, as shown by these examples:

(122) a. ***tʃòké***
L tʃókò=í
opossum=1SG
'my opossum'

b. ***làβé***
L láβà=í
lizard=1SG
'my lizard'

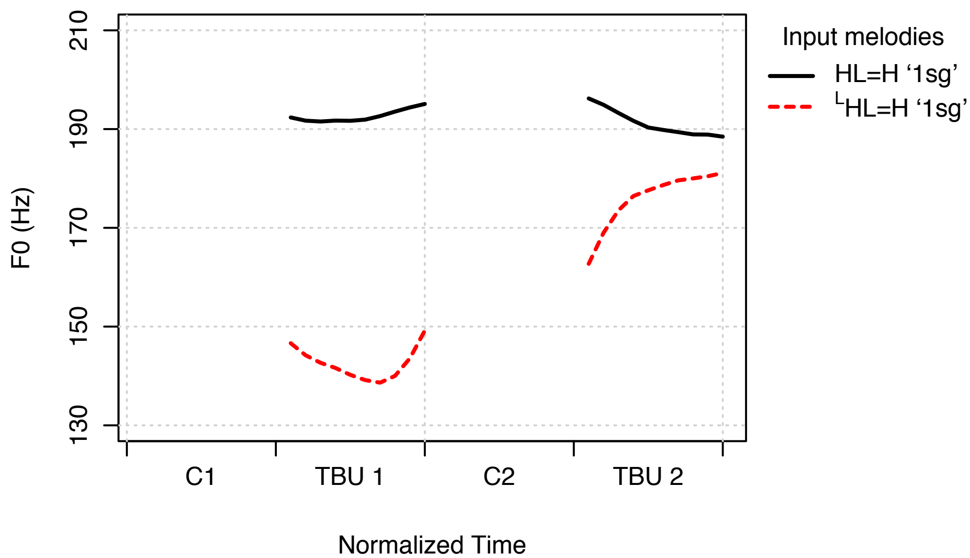



Figure 11. Mean pitch contours of ***tʃíté*** 'my bed' and ***tʃòké*** 'my opossum' by subject MQM

c. ***lɨ̀ˀjí***
ᴸlɨ́ˀjɨ̀ = í
chick=1SG
'my chick'

d. ***pìí***
pî = í
turkey.hen=1SG
'my turkey hen'

While the tone of the final TBU of the couplet is still replaced by the H tone of the pronoun in these data, as in (119), the initial couplet TBU is also unexpectedly lowered to L. The contrast between this group of words and those given in (119) is clearly shown in Figure 11 which gives the mean pitch contours of eight repetitions each of (119a) and (122a) by one male speaker from the N-Pron production experiment (Appendix C). The behaviour of this group of words indicates that they have a different underlying representation, and in order to better understand how that difference should be represented, it is helpful to consider what happens to the first group (119) when they follow a noun with a floating L.

The examples in (123) show a noun with the /H$^{L}$/ melody combined with a noun with the /HL/ melody in the N-N associative construction. (Examples (a)–(c) are also combined with the *toneless* second person singular enclitic pronoun.)

(123) a. ***tʃáˀá sēˀũ̏***
tʃáˀᴸ sêˀ = ũ
foot offspring=2SG
'your child's foot'

b. ***júú sēˀũ̏***
júᴸ sêˀ = ũ
stone offspring=2SG
'your child's stone'

c. ***ʃɪ̋ɲɪ̋ tʃīsȍ***
ʃíɲíᴸ tʃísò = ũ
head father.in.law=2SG
'your father-in-law's head'

d. ***sókó tʲōkò***
sókóᴸ tʲókò
arm ant
'ant's arm'

In each example, the initial TBU of the second (/HL/) word in the phrase is realized as M rather than L, showing that FLA has *not* applied as described in §4.1.3. This is due to the fact that the tonal melody of these couplets already has a L, and IM has a constraint against more than one L TBU within a couplet, which I refer to as *LL. Thus, instead of FLA the first TBU of the /HL/ words undergoes a vertical assimilation process (VA) (cf. Hyman & Schuh 1974; Hyman 1975:221–2; 2007b): H → M / ᴸ)(__L (round brackets = couplet boundaries)—that is, the initial H of the /HL/ couplet becomes M when preceded in a phrase by a word ending in a floating L resulting in a ML surface melody for this word.[14] What is crucial for our discussion of the tonal alternation in (122)

[14] This process will be formalized in autosegmental terms below in §4.1.6, but it should be noted here that this derived ML is formally and phonetically distinct from the surface "ML" that was shown in Figure 5 and is analyzed as ∅L.

is what happens to a /HL/ noun in the same context if it is coalesced with the H toned first person singular pronoun:

(124) a. *tʃáˀá* ***sèˀí***
tʃáˀᴸ sêˀ=í
foot offspring=1SG
'my child's foot'

b. *júú* ***sèˀí***
júᴸ sêˀ=í
stone offspring=1SG
'my child's stone'

c. *ʃĩ́ɲĩ́* ***tʃȉ****sé*
ʃíɲíᴸ tʃísò=í
head father.in.law=1SG
'my father-in-law's head'

Heres, as in (119), the H tone of the pronoun replaces the final L tone of the couplet and the resulting couplet no longer has L in its tonal melody. Thus, FLA is no longer blocked and the floating L is associated with the first TBU creating a LH surface melody on this word.

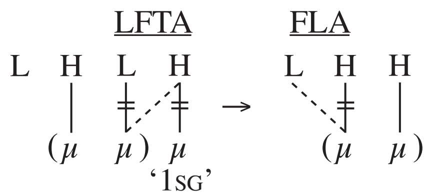
I propose that the tonal derivation described for the data in (124) is just what is happening with the idiosyncratic group of HL nouns represented in (122) except that the floating L does not belong to a preceding word, but to the word that undergoes the alternation to LH. I therefore represent the underlying tonal melody of the nouns in (122) as /ᴸHL/ with a floating L at the left edge of the associated HL tones, as shown in the autosegmental representation in (125).

(125) /ᴸHL/

```
L   H   L
    |   |
   (μ   μ)
```

The derivation of /ᴸHL/ + *=í* '1SG' /ᴸHL/ can then be modelled as shown in (126).

(126) /$^{L}$HL/ + =*í* '1SG' → LH




In the first part of the derivation, LFTA applies first changing the final TBU of the couplet from L to H (e.g. *tʃókò* + =*í* → $^{L}$*tʃóké*). In the second part, since *LL would no longer be violated, FLA applies, replacing the initial TBU of the couplet with the floating L from the input melody resulting in a LH couplet (e.g. $^{L}$*tʃóké* → *tʃòké*).

Further support for positing a floating L at the left edge of these words comes from their behaviour in the N-N construction. In this construction, VA (cf. (123)) also occurs in /$^{L}$HL/ couplets not only when they follow /H$^{L}$/ couplets, but also following couplets with all other tonal melodies except /L/ and LM, as demonstrated by the data in (127).

(127) a. *ɲə̋ɲı̋* **lōmȅ**
ɲáɲí $^{L}$lómȅ
brother bat
'bat's brother'

b. *nı̋ɲı̋* **lōmȅ**
níɲí$^{L}$ $^{L}$lómȅ
blood bat
'bat's blood'

c. *mı̋ɲȉ* **lōmȅ**
míɲì $^{L}$lómȅ
pool bat
'bat's pool'

d. *láβà* **lōmȅ**
láβà $^{L}$lómȅ
lizard bat
'bat's lizard'

e. ***màᵑgú*** ***lōmè̏***
màᵑgú ᴸlómè̏
mango bat
‘bat’s mango’

In each example, the melody of the initial word in the construction varies: it is /H/ in (127a), /Hᴸ/ in (127b), /HL/ in (127c), /ᴸHL/ in (127d) and /LH/ in (127e). At the same time, the second word of the construction always has the /ᴸHL/ melody. As can be seen by the surface tone of the first TBU of *ᴸ**ló**mè* in each example, regardless of the initial melody, VA occurs creating M on the first TBU of the second word of the phrase (in bold). Since only in (127b) does the initial word of the phrase have a floating L in its melody, the lowering of HL to ML in the other examples must be attributed to the floating L in the melody of the second /ᴸHL/ word itself. This alternation is robustly attested in the N-N production experiment (Appendix B). Figure 12 gives the mean pitch contour of eight repetitions of (127a) by five male speakers compared to those of the /Hᴸ/ + /HL/ phrase, *nɨ̋ɲɨ̋ mɨ̄ɲɨ̏* ‘pool’s blood’, and the /H/ + /HL/ phrase, *ɲa̋ɲɨ̋ mɨ̋ɲɨ̏* ‘pool’s brother’, in the same experiment. The plot shows that the /HL/ couplet is not lowered following the /H/ couplet in the /H/-/HL/ f0 contour, but, as expected, it is lowered following the /Hᴸ/ couplet in the /Hᴸ/-/HL/ f0 contour. Crucially, the /ᴸHL/ couplet in the /H/-/ᴸHL/ f0 contour shows the same kind of lowering when it follows a /H/ couplet, which lacks a floating L. Comparing the derived ML in the second word of the /Hᴸ/-/HL/ and /H/-/ᴸHL/ f0 contours to the high falling pitch contour of /L/ in the plot of /Hᴸ/-/L/ in Figure 10, shows a clear contrast and provides support for the representation of the surface melody of /L/ as ∅L rather than ML. The simple tonal feature system employed thus far has no way to represent a partial assimilation like this (i.e. H → M / ᴸ_L) so I will put off the representation of this process until §4.1.6, where I will introduce a richer set of autosegmental tonal features.

The /ᴸHL/ data allow us to speculate as to a plausible source of the floating L on these nouns. Interestingly, all native /ᴸHL/ noun couplets in my database are animal names, as can be seen by the complete list given in (128).

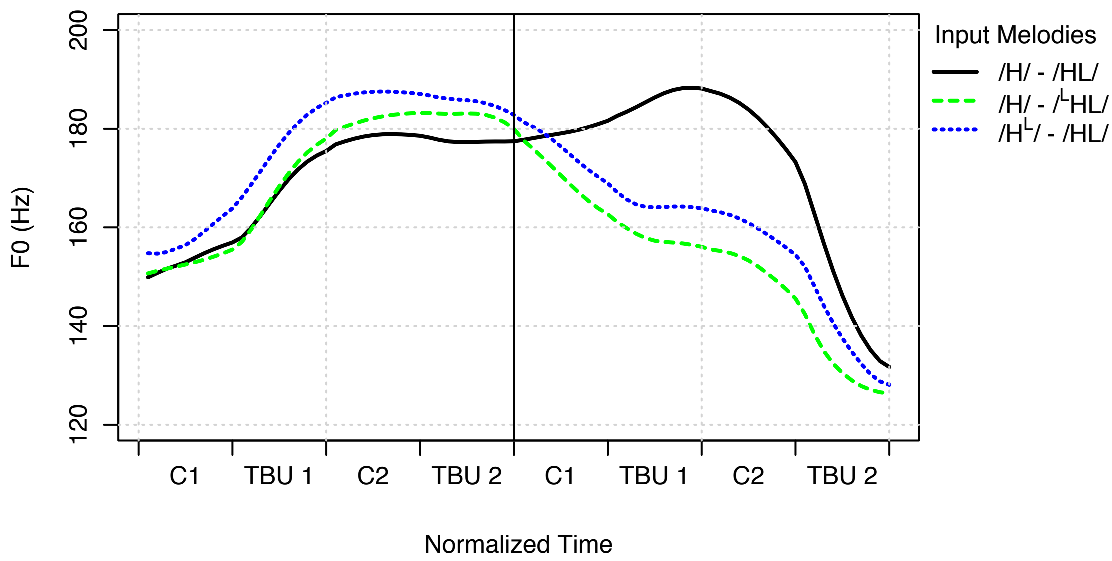



Figure 12. Mean pitch contours of N-N phrases with the melody combinations /H/ + /HL/, /H/ + /$^{L}$HL/ and /H$^{L}$/ + /HL/; dotted vertical line = syllable boundary, solid vertical line = word boundary

(128) /$^{L}$HL/ nouns
- a. $^{L}$*βí̃lù* ‘cat’
- b. $^{L}$*βí̃ʃî* ‘squirrel’
- c. $^{L}$*látʃà̃* ‘chachalaca (bird)’
- d. $^{L}$*láβà* ‘lizard’
- e. $^{L}$*léˀlà* ‘sow’
- f. $^{L}$*lɨ́ˀjɨ̀* ‘chick’
- g. $^{L}$*lómè̃* ‘bat’
- h. $^{L}$*pî̃* ‘turkey hen’
- i. $^{L}$*tʃókò* ‘opossum’
- j. $^{L}$*úʃù̃* ‘puppy’

As described in §2.4.1, Mixtec has an archaic noun classifier system, which included a L toned animal classifier, *tɨ̀–*, which is still overtly present in some words in the language. It seems likely, then, that at some point in the history of the language these few words were also preceded by the L toned animal classifier and that subsequently the segmental material was lost and the L tone remained. In fact, Dürr (1987:27) hints at the possibility of tonal marking of lexical fields in his Proto-Mixtec tone reconstruction, noting that numerals, some animal names and several kinship terms have similar tone patterns, although he does not suggest that this is due to the loss of an affix or a tonal suprafix.

In this section, we have seen that noun couplets with the HL citation melody split into two groups based on their tonal behaviour when they combine with the H toned first person singular pronoun and the pronoun tone replaces the tone of the final TBU of the couplet. Most of these nouns surface as HH in this context as expected and are assigned the underlying melody /HL/. A small group, however, become LH when their final TBU is changed to H. This, we saw, is just what happens to the /HL/ couplets when they follow a word with a floating L in a phrase if their final TBU is changed to H through coalescence of the couplet with the first person singular pronoun—that is, FLA associates L to the initial TBU of /HL/ + =*í* '1SG' constructions and they become LH, but if the final L of /HL/ couplets is not changed to H, FLA cannot associate L to their initial TBU due to the *LL constraint. In that case, the floating L triggers VA instead, and the initial H of the second couplet is realized as M. Based on these facts, I assign the second group of nouns the underlying melody /$^{L}$HL/, which has a floating L at the left edge of the couplet.

The tonal processes/constraints introduced in this section were VA and *LL. In VA, the H of a /HL/ couplet undergoes partial assimilation to a preceding floating L to be realized as M. *LL is a constraint in IM which prohibits both TBUs of a couplet from being associated with L.

Finally, it should be noted that, while four of my consultants gave the LH sandhi form for the /$^{L}$HL/ + =*í* '1SG' construction shown in (122), two consultants did not for most of the /$^{L}$HL/ words that were tested (although one of these consultants would accept the sandhi form, even though she preferred the non-sandhi form). Despite this evidence that the pattern may be losing ground in the synchronic grammar and the fact that it affects such a small set of words, the analysis of this group of irregular nouns not only makes the analysis of noun couplet melodies more complete, but also provides a basis for understanding the behaviour of the L toned imperfective verbal suprafix that will be discussed in §4.2.2.

### 4.1.5 Noun couplets with the citation melodies LH and LM

In this section I address noun couplets with the surface melodies LH and LM and consider how these melodies should be represented. As noted in Table 24, these melodies are found on only a handful (3.1%) of native noun couplets in my database. A complete list of these words is given in Table 25.

Table 25. Native noun couplets with the LH and LM tonal melodies

| **LH** | | **LM** | |
|---|---|---|---|
| *jàkʷĩ́* | 'armadillo' | *ⁿdɨ̀βɨ̄* | 'chicken' |
| *kɨ̀tɨ́* | 'horse' | *lùlū* | 'thick tortilla for babies' |
| *ʃòᵑgí* | 'cricket' | *lèē* | 'baby' |
| *tɨ̃̀ɲɨ̃́* | 'rat' | *ɲũ̀ũ̄* | 'night' |
| *lùˀlú* | 'foal' | | |

It should be noted that *tɨ̃̀ɲɨ̃́*, *kɨ̀tɨ́* and *jàkʷĩ́* are alternately pronounced with the /L/ melody by some speakers and *lùˀlú* is sometimes pronounced LM.[15] In the case of *kɨ̀tɨ́*, the LH pronunciation appears to be used exclusively to mean 'horse', while the /L/ pronunciation means more generally 'animal', in which case it often forms a compound with the adjective *ʃã́ã́ᴸ* 'fierce', but can also mean 'horse'.

These melodies differ phonetically by the pitch height of their final TBU. This difference is obvious when couplets with these melodies combine with the third person male pronoun, *=ɾà*, as in the examples in (129).[16]

[15] Also, *ᴸlúʔlù* (different tonal melody) means 'small' in IM and many other Mixtec varieties (from **luʔu*; Josserand 1983:642ff), although the more common IM word for small is *ᴸlóʔò*. The meanings 'small' and 'foal' (= small horse) are semantically related and it would appear that the noun developed from the adjective 'small' given that this word is so widespread among Mixtec varieties that it has been reconstructed for Proto-Mixtec.

[16] The nouns *kùtʃí* 'pig' and *kòtȭ* 'shirt' are not in Table 25 because they are loanwords. My choice to use them in these examples is because they were used in the N-Pron production experiment due to their phonetic compatibility with the other stimuli. These words behave phonologically just like native words with these melodies.

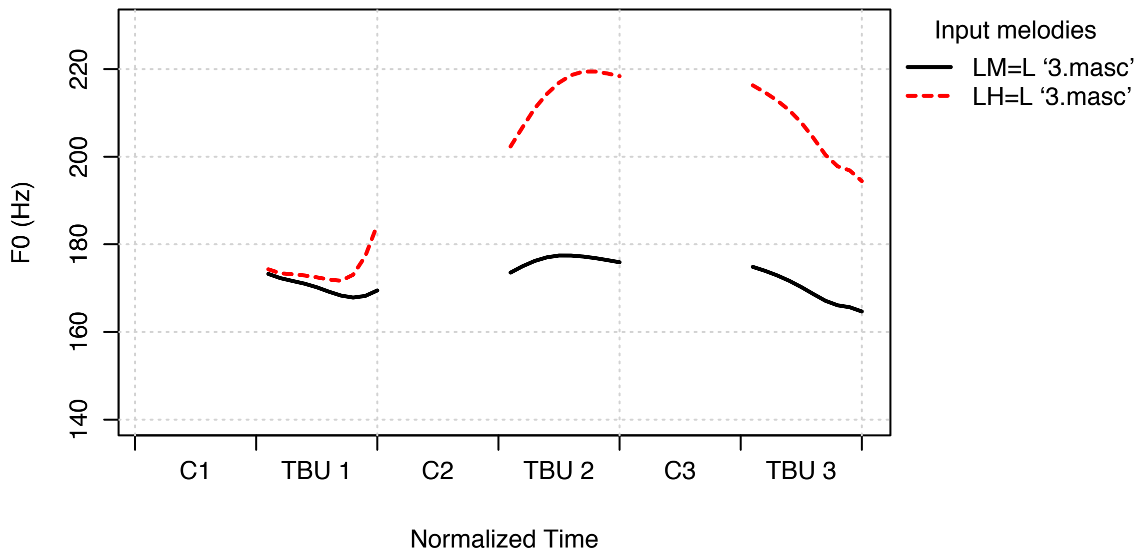



Figure 13. Mean pitch contours of *kùtʃí=ɾà* and *kòtō̄=ɾà*

(129) a. *kùtʃíɾà* 'his pig'
b. *kòtō̄ɾà* 'his shirt'

No sandhi occurs in this context. As can be seen in the mean pitch contours of these words produced by four male speakers and two female speakers in the N-Pron experiment (Appendix C) given in Figure 13, the H pitch (TBU 2) of the LH couplet has a considerably higher pitch than the M (TBU 2) of the LM couplet. The high falling pitch of the pronoun in the LH=L f0 contour is due to insufficient time to complete the fall to L in the experimental context.

The phonological contrast on the final couplet TBU of words with the LM and LH melodies is neutralized when they combine with the first person singular pronoun, as shown in (130).

(130) a. *kùtʃí* 'my pig'
b. *kòtẽ́* 'my shirt'

In both cases the H pronoun replaces the final couplet TBU, albeit with no apparent result in the case of *kùtʃí*, so that both words are realized as LH.

The surface melodies LM and LH are peculiar melodies in the nominal tone system—not only are they extremely rare, but they are the only noun couplet melodies that begin with L. I contend that this is no coincidence since L initial melodies are common in other grammatical contexts where there is synchronic derivation or evidence that morphemes have a complex diachronic history. To begin with, it can be observed that all of the LH noun couplets, though only one LM couplet, are animal names (cf. Table 25). Given our speculation that the floating L in /$^{L}$HL/ nouns, which are also all animal names (cf. (128)), originated with the loss of the L toned animal classifier, *tɨ̀*–, we can further speculate that the LH words may also have received their L tone from the same source. If these couplets had an underlying /H/ melody, the addition of a L tonal suprafix (at an earlier stage of the language) would not be blocked from associating with the initial TBU by *LL, as is the case with the /$^{L}$HL/ and would always surface as LH.

More importantly, it is also the case that both LH and LM are common realizations of imperfective verb couplets of every structural type, as illustrated by the data in Table 26. Significantly, the imperfective aspect is derived by a L tonal suprafix that will be described more fully in §4.2.2. In other words, the initial L that is found in these couplets comes from a source other than the couplet's basic melody.

As we saw in §4.1.3, LH is also synchronically derived by FLA in the N-N construction when /H/ and /H$^{L}$/ couplets follow a /H$^{L}$/ couplet in the phrase (cf. (108)). Another context where LH is optionally derived in the N-N construction is when /H/ and /H$^{L}$/ couplets follow a /L/ couplet in the phrase. As shown by the examples in (131), L spreads from the initial word in the phrase to the first TBU of the second word, which has the /H/ melody in (131a) and the /H$^{L}$/ melody in (131b), by a process I call low tone spread (LTS):

(131) a. *nɨ̃ɲɨ̃̀* *ɲã̀ɲĩ́*
nɨ̀ɲɨ̀ ɲáɲí
corncob brother
'brother's corncob'

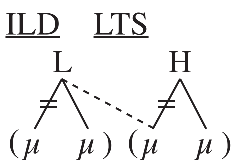
Table 26. Imperfective verbs with the LH and LM tonal melodies

| | CVCV | CVˀCV | CVː | CVˀV |
|---|---|---|---|---|
| **LH** | *kìʃí* | *tʲàˀjú* | *tʃàá* | *kã̀ˀã́* |
| | 'is sleeping' | 'is rotting' | 'will arrive' | 'is speaking' |
| **LM** | *tʃàʃī̄* | *kàˀⁿdɨ̄* | *kã̀ã̄* | *kùˀū* |
| | 'is crushing' | 'explode' | 'is perforating' | 'is sick' |

b. *nĩ̄ɲɨ̃̀* *nĩ̀ɲɨ̃́*
nɨ̀ɲɨ̀ nɨ́ɲɨ́ᴸ
corncob blood
'blood's corncob'

I give the autosegmental representation of this process in (132).

(132) /L/ + /H/ → ∅L LH




An association line is created across the couplet boundary from L in the first word of the phrase to the initial TBU of the following /H/ couplet, delinking its tone. ILD (cf. (98)) also applies to the first word delinking L from its first TBU to satisfy the *LL constraint. It should be noted that LTS is frequent, but like FLA in the N-N construction, it is not obligatory, at least not for all speakers.[17] The average phonetic realization of LTS in (131a) by five male speakers in citation context from the N-N experiment (Appendix B) is given in Figure 14. It is clear that L spreads from the final

[17] In the N-N production experiment, 6 speakers (all 5 male speakers and 1 female speaker) produced LTS in the /L/-/H/ item (/nĩ̀ɲɨ̃̀ ɲáɲí/ 'brother's corncob'), another female speaker produced 4 LTS tokens and a third female speaker produced 1 LTS token and 2 female speakers never produced LTS in this item. In the same experiment, only 2 male speakers produced LTS in the /L/-/H/ item (/nĩ̀ɲɨ̃̀ nɨ́ɲɨ́ᴸ/ 'blood's ear of corn'), and one of these produced it both with and without sandhi. The other three male speakers and all five female speakers did not produce LTS for this item. Productions are also split between sandhi and non-sandhi realizations for both of these melody combinations in informal elicitations.

TBU of the first word in the construction, into the first TBU of the second /H/ word, producing a LH tone pattern.

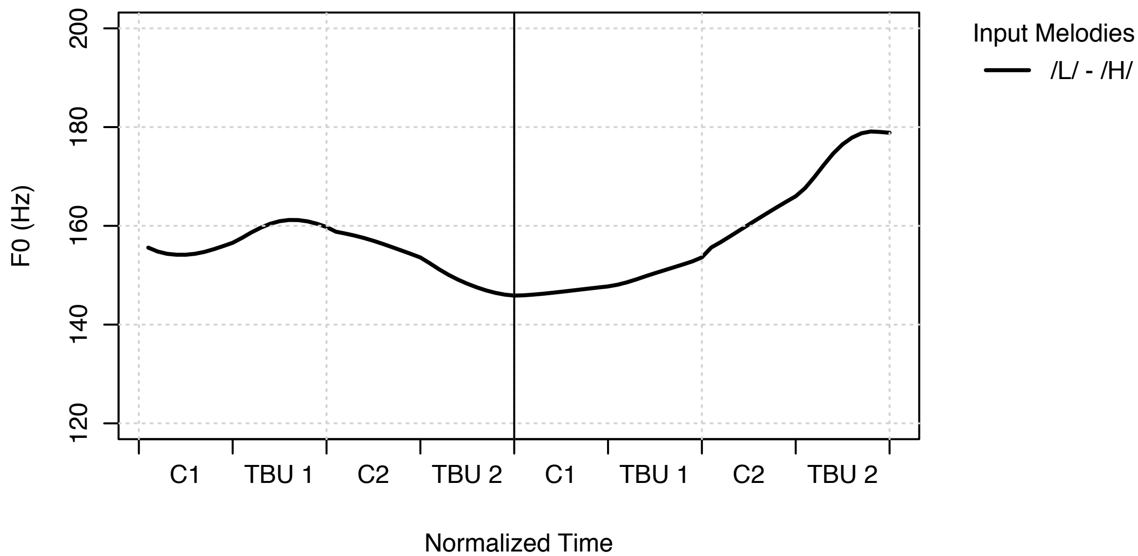



Figure 14. Mean pitch contour of /L/ + /H/ in the N-N construction; dotted vertical line = syllable boundary, solid vertical line = word boundary

LM (but not LH) is also a common melody of adjectives, as shown by the examples in Table 27.[18] Furthermore, a few adjectives in my data with this tone pattern (less than a dozen) appear to have been historically derived from nouns by a tonal suprafix, as illustrated by the examples in Table 28. The specifics of the tonal derivation are no longer consistent across the contemporary nominal forms, but it seems clear that the derivation involved a L tonal suprafix, and most of the derived words have the LM melody, like the first two in Table 28.

Table 27. LM adjectives by couplet type

| | **CVCV** | **CVˀCV** | **CVː** | **CVˀV** |
|---|---|---|---|---|
| **LM** | *kʷı̃̀tʃı̃̄* 'white' | *ⁿdàˀβī* 'poor' | *kʷã̀ã̄* 'yellow' | *kèˀẽ̄* 'wide' |

[18] There is only one native LH adjective in my data, *ʃı̃̀ɲṹ* 'shiny'.

Table 28. Noun ~ Adjective tone pairs

| Noun | Adjective |
|---|---|
| *súkṹ*$^{L}$ ‘throat’ | *sùkū̃* ‘tall’ |
| *ʃá̃ˀá̃* ‘lard’ | *ʃà̃ˀā̃* ‘fat’ |
| *sóˀò* ‘ear’ | *soˀò* ‘deaf’ |

In addition to imperfective constructions, the LM melody is also synchronically derived in all /L/ couplets regardless of their lexical class when they coalesce with the first person singular enclitic pronoun, as in these examples:

(133) a. *tʃìkī*
tʃìkì = í
fist=1SG
‘my fist’

b. *kòˀlē*
kòˀlò = í
turkey=1SG
‘my turkey’

c. *ɲȉ̃ī̃*
ɲɨ̀ = í
skin=1SG
‘my skin’

d. *ɲṹˀī̃*
ɲùˀ = í
earth=1SG
‘my land’

Since the underlying tone of the pronoun is H, it might be expected that /L/ couplets would surface as LH when combined with this pronoun; however, recall from the discussion of the /H$^{L}$/ + *=í* ‘1SG’ construction (cf. (105) and (107)), that tonal processes apply to the pronoun first, then the pronoun coalesces with the final TBU of the couplet replacing its tone. With this in mind, consider the data in (134), which show /L/ couplets combined with the first person plural exclusive pronoun, *=ⁿdí*, which does not coalesce with the couplet.

(134) a. *tʃìkìⁿdī*
tʃìkì = ⁿdí
fist=1PL.EXCL
'our fist'

b. *jutũ̀ⁿdī*
jùtũ̀ = ⁿdí
tree=1PL.EXCL
'our wood'

c. *ɲũˀũ̀ⁿdī*
ɲùˀ = ⁿdí
earth=1PL.EXCL
'our land'

d. *jaàⁿdī*
jà = ⁿdí
tongue=1PL.EXCL
'our tongues'

These data show that M is also derived on the H pronoun even though it does not coalesce with the couplet.

The resemblance between the tone of the pronouns in (134) and that of the first person singular pronoun in (133) is borne out in the plot in Figure 15. These f0 contours give the mean pitch contours of eight repetitions of *tʃìkī* 'my fist' (133a), *tʃìkìⁿdī* 'our fist' (134a) and *tʃítíⁿdí* 'our seed' (106a) with H pronouns, and *tʃìkìrà* 'his fist' with a L pronoun, by four male and two female speakers from the N-Pron production experiment (Appendix C). Observe the clear distinction between L, M and H on the second TBU of the f0 contours, where the first person singular pronoun = M and also contrasts with the couplet L of *tʃìkìrà* and the couplet H of *tʃítíⁿdí*. The same contrast is evident on the final TBU where the first person plural exclusive pronoun = M and also contrasts with the corresponding TBUs of *tʃìkìrà* and *tʃítíⁿdí*. Furthermore, the pitch of the final TBU of *tʃìkī*, which bears the lowered H tone of the first person singular pronoun, is comparable to the pitch of the final TBU of *tʃìkìⁿdī*, which bears the lowered H tone of the first person plural exclusive pronoun. I take these data as evidence that both H pronouns undergo VA following /L/ couplets—that is, they

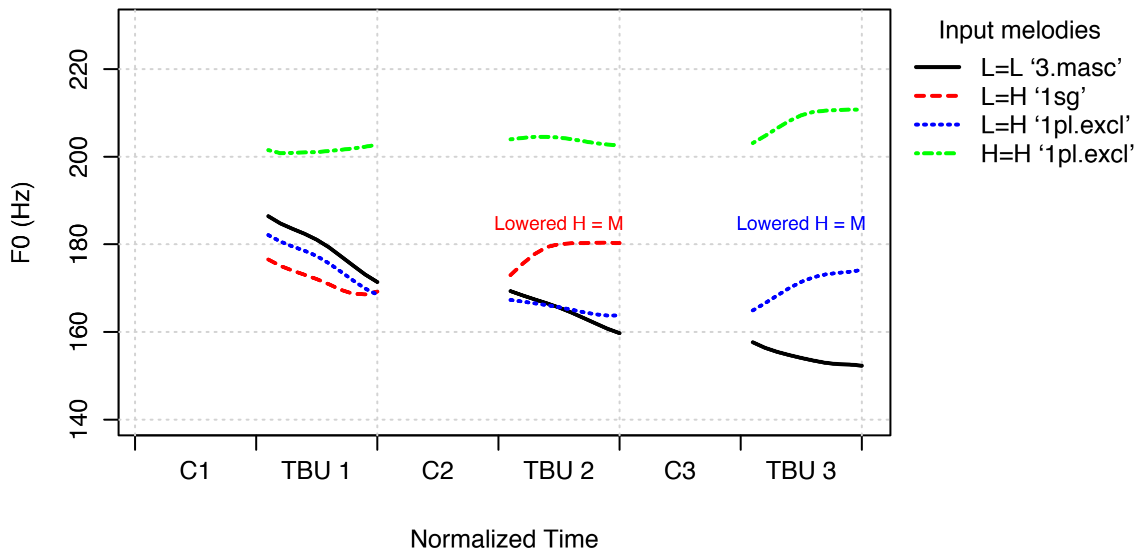


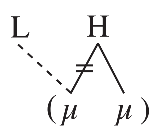

Figure 15. Mean pitch contours of /L/ + 1SG, /L/ + 1PE, /L/ + 3MASC and /H/ + 1PE

partially assimilate to the preceding L, and that it is this assimilated tone that replaces the tone of the final TBU of /L/ couplets when the first person singular pronoun coalesces with it. The domain of this rule is the prosodic word, since enclitics are part of the same prosodic word as their couplet host, as will be discussed in §6.1. This contrasts with the domain of LTS in (131) and (132) which is phrasal, since couplets form separate prosodic words. VA can occur on the initial TBU of the couplet, however, as was demonstrated in (123a) and (127). The condition for this to occur is that a HL couplet be preceded by a floating L. As we saw in that discussion, if the couplet melody is HH rather than HL, or is changed to HH through coalescence with the first person singular pronoun, then FLA will occur instead of VA.

In this section, we have seen that LH and LM are not only rare surface melodies on noun couplets, they are the only surface melodies that begin with L. This state of affairs gains significance in light of the fact that these melodies are common in other grammatical contexts where the melodies are derived by rule in the synchronic grammar or where there is evidence of morphological complexity at some earlier stage of the language. Examples of synchronic rule-derived LH and LM melodies are found in verbs due to the L tonal suprafix, LH is derived in the N-N construction by FLA and LTS and the LM melody results when /L/ couplets coalesce with the H toned first person singular pronoun, =í. LM is also a common melody for adjectives, some of which show evidence that they were derived from nouns by what appears to have been a L tonal suprafix. Further, all LH nouns are animal names which gives rise to speculate that they might have received their initial L from the loss of the L toned animal classifier prefix as was speculated for the /$^{L}$HL/ nouns in §4.1.4, which are also all animal names, and are analyzed with a floating L at the left edge of the couplet.

Based on the above, I propose to give noun couplets with the surface melody LH the underlying melody /$^{L}$H/. These couplets automatically undergo FLA and surface as LH, as shown in (135).

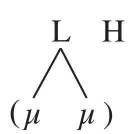
(135) /$^{L}$H/ → LH



FLA creates an association line from the initial L, which is floating in the underlying form, to the initial TBU of the couplet and delinks the H tone that was associated to it resulting in a LH surface form.

The underlying form of LM noun couplets, on the other hand, draws particularly on the behaviour of the /L/ + =í '1SG' construction, where the M is derived by vertical assimilation of a H that becomes floating when its mora is deleted during fusion with a preceding L. I assign LM couplets the underlying melody /L$^{H}$/, which has the autosegmental representation given in (136).

(136) /L$^{H}$/



The floating H at the boundary of these couplets undergoes VA before associating with the final couplet TBU so that they surface with LM; however, since the simple features used thus far do not handle partial assimilations, I put off the autosegmental derivation of /$L^{H}$/ → LM until §4.1.6.

The underlying tonal melodies proposed here for LH and LM are somewhat more abstract than those of the other couplet melodies; nevertheless, I believe that this makes for a better analysis. In §4.1.1 I demonstrated that M does not occur on the initial TBU of noun couplets and that there is no contrast between L and M on the final couplet TBU. The distribution of L and M on the second couplet TBU can be summarized as follows:

- M only occurs on the second TBU of the couplet when the first TBU is L
- L never occurs on the second TBU of the couplet when the first TBU is L

Resolving the situation with a rule lowering H following L within the couplet (H → M / [L__]), however, is not an option since H also occurs on the final couplet TBU when the first TBU is L (i.e. LH) and the result of such a rule would preclude LH couplets. Nevertheless, it would be undesirable to add M to underlying forms since a three-way underlying contrast would lead to a proliferation of unattested tonal melodies, as demonstrated in Table 24. Furthermore, there is evidence that M is productively derived on the second TBU of /L/ couplets when they coalesce with the H toned first person singular pronoun. The analysis of LM noun couplets as underlyingly /$L^{H}$/ avoids positing M as an underlying tone and derives it using tonal processes that are independently motivated.

Another piece of evidence in favour of this analysis comes from the phonological behaviour of M. The L and H tones are phonologically active in the tonal processes of FLA, HTS and LTS, and one might expect M to either be active in spreading M, as described by McKendry (2013:151) for M in SE Nochixtlán Mixtec, or to be a phonologically inactive, unmarked tone, as described for M in Peñoles Mixtec (which is analyzed as /∅/) by Daly & Hyman (2007:172ff). As it turns out, M is phonologically active in IM, but it spreads H, not M, as I will now show.

First, the following data show that M does not spread to the H toned first person enclitic pronouns:

(137) a. *ⁿdɨ̀βɨ̄ⁿdí*
ⁿdɨ̀βɨ̀ᴴ = ⁿdí
chicken=1PL.EXCL
'our chicken'

b. *ⁿdɨ̀βí*
ⁿdɨ̀βɨ̀ᴴ = í
chicken=1SG
'my chicken'

Given the obligatoriness and uniformity of tonal processes from couplets to enclitic pronouns, if M were to spread, it would be expected to spread in this context, yet, these examples show that the pronoun tone remains H following the LM noun, and in the case of the first person singular (137b), it is this tone which replaces the final tone of the couplet as a result of coalescence. This is not what happens, however, when the H pronouns follow /L/ couplets. As we saw in (133) and (134), following /L/ the H pronouns partially assimilate (VA) to the L of the couplet and surface as M.

Next, recall from §4.1.3 that HTS only spreads H from /Hᴸ/ nouns to a following /L/ pronoun in the N-Pron construction, and not from the other melodies that end in an associated H—/H/ and /ᴸH/. This is not the case, however, in the noun-adjective construction, where HTS usually (albeit not in all cases for every speaker) spreads from all three of these melodies to a following /L/ adjective, as shown in these data:

(138) a. *ísú ka̋ˀnű*
ísú kȁˀnù
deer big
'big deer'

b. *tʃáˀá tʲa̋ˀa̋*
tʃáˀᴸ tʲȁˀ
foot dirty
'dirty foot'

c. *kùtʃí* *já<sup>ʔ</sup>βí*
ᴸkútʃí jà<sup>ʔ</sup>βì
pig expensive
'expensive pig'

The second word in each of these examples is an adjective with the /L/ melody, while the initial noun of the phrase has the melody /H/, /H$^{L}$/ and /$^{L}$H/, respectively. The adjective surfaces as HH with all three of these initial melodies. Crucially, when the noun has the LM citation melody, it also usually spreads H to a following /L/ adjective, as shown by these examples:

(139) a. *ⁿdɨ̀βɨ̄* *kã́ʔnṹ*
ⁿdɨ̀βɨ̀ᴴ kã̀ʔnù
chicken big
'big chicken'

b. *ⁿdɨ̀βɨ̄* *jáʔβí*
ⁿdɨ̀βɨ̀ᴴ jàʔβì
chicken expensive
'expensive chicken'

c. *ⁿdɨ̀βɨ̄* *tʃã́ʔnṹ*
ⁿdɨ̀βɨ̀ᴴ tʃã̀ʔnù
chicken old
'old chicken'

Even though the initial word in the construction lacks an overt H, the /L/ adjective still surfaces as HH. This does not happen, however, when the initial word has the /L/ melody, as shown in (140a–b) or the HL melody, as in (140c–d).[19]

(140) a. *ⁿdaʔà* *kãʔnũ̀*
ⁿdàʔ kã̀ʔnù
hand big
'big hand'

[19] It should be noted that there was one /HL/ + /L/ noun-adjective construction, *tʲúʔβà tʃãʔnũ̀* 'old hammock', that was pronounced [¯ ⸜ _ _], like the /HL/ + /L/ examples given in (140c–d), and also as LM-HH [_ – ¯ ¯]—that is, with the /HL/ noun realized as LM and the /L/ adjective raised to H—by two different speakers. This does not fit with the rest of the data and I do not have an explanation for it.

b. *suβì* *ja*$^{ʔ}$*βì*
sùβì jà$^{ʔ}$βì
tamale expensive
'expensive tamale'

c. *$^{n}$dáβà* *kã*$^{ʔ}$*nũ̏*
$^{n}$dáβà kȁ$^{ʔ}$nù
wood.bar big
'big wood bar'

d. *kɨ́sɨ̀* *t*$^{j}$*ã*$^{ʔ}$*ȁ*
kɨ́sɨ̀ t$^{j}$ȁ$^{ʔ}$
clay.pot dirty
'dirty clay pot'

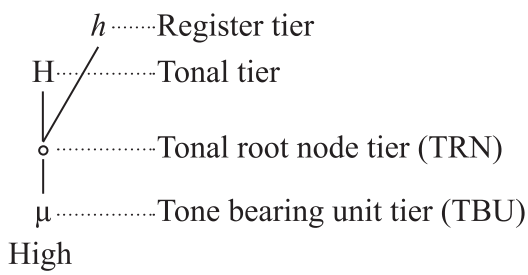
The result in (139) is hard to explain if the M in the LM noun is underlying, but if the underlying melody is /L$^{H}$/, the $^{H}$ in the underlying form provides a plausible source for the H spreading. I take this as support for the abstract underlying representation of LM words as /L$^{H}$/.

### 4.1.6 Representing partial tonal assimilation

Thus far I have been giving autosegmental representations using two non-decomposable tone features, L and H. This simple system works well for most of the representations that are needed; however, it is not possible to represent a derived M using these features. A derived M, we have seen, is produced when VA applies to HL from a preceding floating L (cf. (123)), when it applies to a H pronoun following a /L/ couplet (cf. (133), (134)) and in the derivation of lexical LM (cf. (136)). In order to represent these derivations, a richer feature system that includes both register features and pitch features that may spread independently of each other is needed. There are a number of feature systems that include both tonal features and register features, each having many similarities and some real differences (see Bao 1999 for a survey). The system I will use is Snider's (1999) Register Tier Theory (RTT). In this section, I will briefly sketch out the basics of RTT features, how IM tonal melodies are represented using these features and, particularly, how to represent the derivation of M.

RTT recognizes the autosegmental register features *h(igh)* and *l(ow)*, and tonal (pitch) features, *H(igh)* and *L(ow)*, each existing on separate register and tonal tiers, respectively. These tiers are linked at a structural node called the tonal root node (TRN) which is linked to TBUs, as diagrammed in (141).

(141) Tonal geometry in Register Tier Theory (RTT) (adapted from Snider 1999:23)



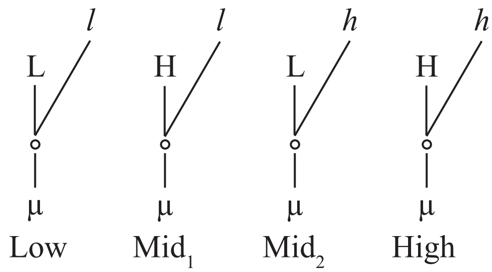

The register features *h* and *l* are defined as in (142a), while tonal features *H* and *L* are defined as in (142b):

(142) a. Effect a register shift *h* = higher, and *l* = lower relative to the preceding register setting. (Snider 1999:25)
b. Realize this TBU at *H* = high pitch, and *L* = low pitch relative to the current register. (Snider 1999:25)

The inherent relativity of tone is incorporated directly into the definition of the features. The tonal features are interpreted relative to the register to which they are linked—*h* or *l*—and the registers are defined as higher (*h*) or lower (*l* ) than the preceding register. Snider likens the concept of register to the key of a piece of music—like the same musical melody can be played in a higher or lower key, a tonal feature—*H* or *L*—may be pronounced in a higher or lower register.

The features defined in (142) allow for the following four phonemic level tones:

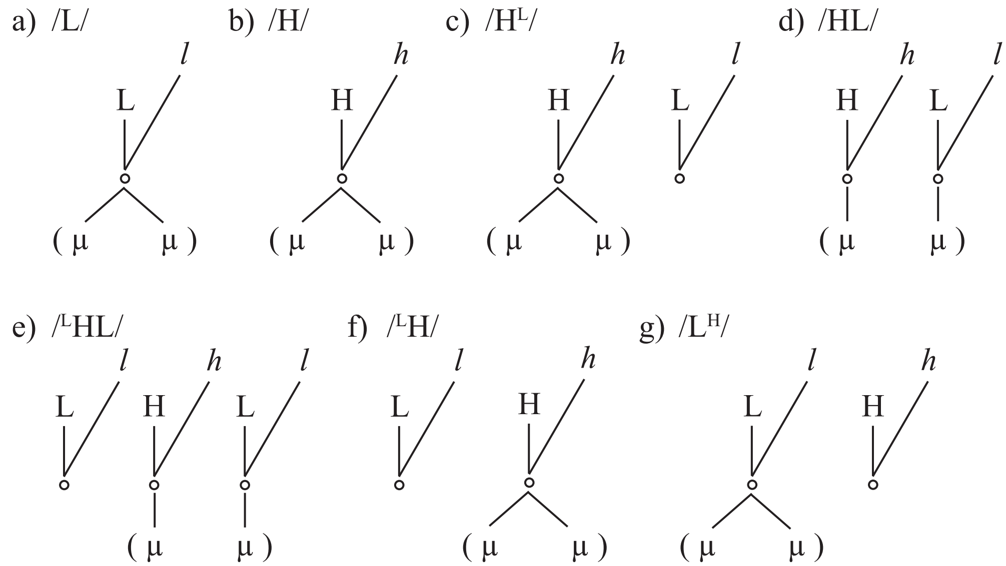
(143) Representation of four level tones (adapted from Snider (1999:24)




The lowest tone is defined as having a *l* register feature and a *L* tonal feature, and the highest tone is defined as having a *h* register feature and a *H* tonal feature. Two mid tones are defined with opposite register and tonal features—*l-H* and *h-L*. The key property of the formalism for our purposes is that of separating the features into different autosegmental tiers which allows for each feature to spread independently. This property is required to formally represent the partial assimilation process, VA, that results in a M, as distinct from tone replacement (total assimilation) processes such as FLA, HTS and LTS.

Based on the above geometry and feature definitions, I redefine the non-decomposable L and H features that I have been using so far as Low and High in (143). The simple representation of couplet melodies (/L/ (97), /H/ (102), /$H^L$/ (103), /HL/ (120), /$^L$HL/ (125), /$^L$H/ (135) and /$L^H$/ (136)) translate straightforwardly to RTT representations by substituting tones in (143) for L and H, as shown in (144).

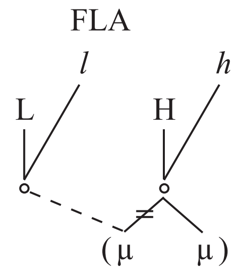
(144) Couplet melodies in RTT




The boundaries of the couplet are marked in the representation with round brackets. Floating tones are indicated by the fact that there is no TBU (μ) associated with the TRN (°). It should be noted, however, that the configurations given in (144) represent the output of the lexical phonology. As briefly discussed in 4.1.8 and will be dealt with fully in §6.2.1, roots which are realized as (C)V($^{ʔ}$)V couplets are analyzed as underlyingly /(C)V($^{ʔ}$)/ and thus do not have two moras in their underlying form. These forms are expanded to a bimoraic couplet in the lexical phonology due to prosodic constraints (cf. §5.4). The forms in (144), therefore, represent the forms after prosodic structure has been assigned.

Before looking at partial assimilation in RTT, let us consider an example of total assimilation. Total assimilations in RTT are represented by spreading from the TRN, to which are associated both the register and tonal features of the tone, to the TBU and delinking the tone associated with it. To illustrate this, consider the derivation of /$^{L}$H/ → LH by FLA (from (135)) which is recast in (145) using RTT features.

(145) Floating L Association (FLA) in the derivation of LH



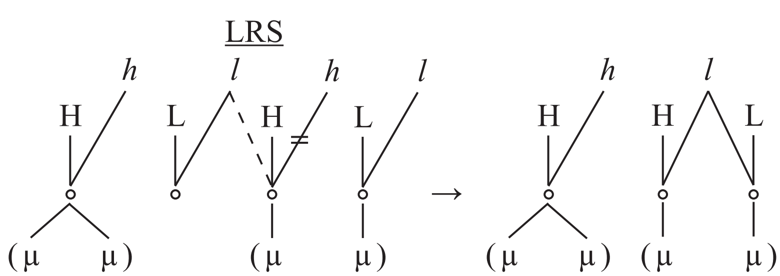

In this example, since the couplet tone pattern does not contain L, FLA applies associating the TRN of the floating L rightward to the adjacent TBU and delinking the tone associated with it. The result is a couplet with L associated with the initial TBU and H associated with the second TBU.

Partial assimilation, by contrast, spreads from a tonal or register feature to a TRN. The first case of partial assimilation (VA) we encountered was when a HL couplet follows a /H$^{L}$/ couplet in a N-N construction, as in (146), repeated from (123a).

(146) ***tʃáˀá sēˀũ̏***
tʃáˀᴸ sêˀ = ũ
foot offspring=2SG
'your child's foot'

FLA is blocked from applying in this construction by *LL since *séˀũ̏* has L in the couplet and replacing the initial TBU with L would juxtapose two Ls in the couplet. What happens instead is the partial assimilation of the H to the preceding floating L, which I represent as spreading the *l*-register feature from the floating L of the first word to the initial TBU of the HL word resulting in ML, as illustrated in (147).

(147) L Register Spread (LRS) — /H$^{L}$/ + /HL/ → HH-ML



LRS is indicated by the dotted line from the *l*-register of the floating L at the right edge of the first word to the TRN of the first TBU of the second word and the delinking of the *h*-register associated with it. The result is a *l*-register associated with a *H*-tonal feature on the initial couplet TBU and a *L*-tonal feature on the second couplet TBU. Thus, the surface melody is ML, where M is the Mid$_1$ tone defined in (143). Based on this derivation, we can reformulate the *LL constraint as a ban against consecutive *L*-tonal features in the couplet.

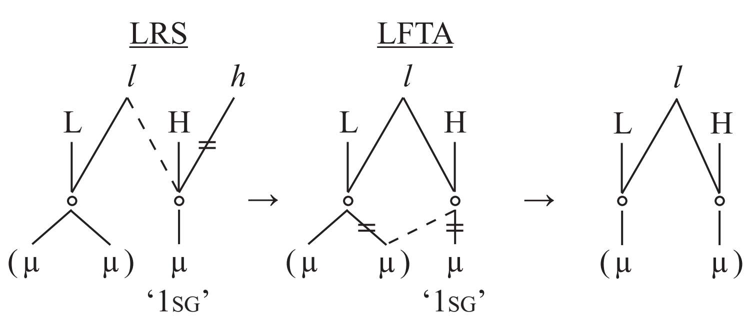
The second context in which M was derived through partial assimilation with a preceding L was in the N-Pron construction where /L/ couplets combined with the first person singular and plural exclusive pronouns *=í* and *=$^{n}$dí*, respectively. These combinations are illustrated by the data in (148), repeated from (133a) and (134a).

(148) a. *tʃīkī*
tʃìkì=í
fist=1SG
'my fist'

b. *tʃīkì$^{n}$dī*
tʃìkì=$^{n}$dí
fist=1PL.EXCL
'our fists'

Both derivations derive M in the same way, but the /L/ + *=í* '1SG' has the extra coalescence step, so I give that derivation in (149).

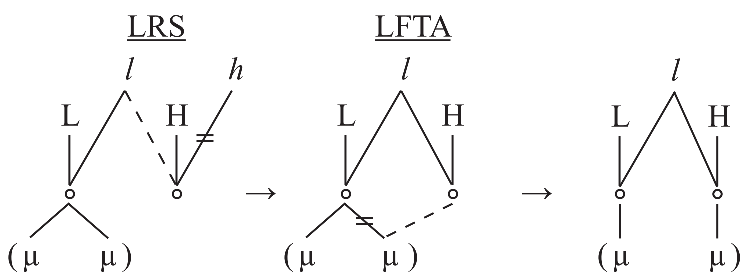
(149) L Register Spread (LRS) — /L/ + *=í* '1SG' → LM



The first step is the association of the *l*-register of the final couplet TBU to the TRN of the pronoun, delinking its *h*-register. The second step involves delinking the pronoun from its TBU, and then LFTA creates an association line from the TRN of the pronoun to the final TBU of the couplet and delinks it from L. There are a couple differences between this derivation and the one given in (147). First, in this derivation, LRS occurs from an associated L to the following H TBU, rather than from a floating L, and second, this process does not require that the TBU following the targeted H be L. Both of these differences have to do with the fact that LRS applies from a couplet to an enclitic pronoun in this construction, whereas in (147), the process occurs from one couplet to another. The domain of this second process is the prosodic word, since enclitics are part of the same prosodic word as their couplet host, as discussed in §6.1, whereas the domain of the process in (147) is phrasal, since couplets form separate prosodic words.

The final context where we have encountered a derived M is the lexical derivation /L$^{H}$/ → LM (cf. (136)). This derivation, given in (150), differs little from that of (149).

(150) Lexical L Register Spread (LRS) — /L$^{H}$/ → LM




The domain of LRS here is also the prosodic word. The only difference is that the H to which LRS applies is floating in the input, rather than associated to the first person singular pronoun, so no delinking from a TBU is needed. Thus, we see that the M of words with the LM citation melody is derived using tonal processes that are already independently required by the grammar.

### 4.1.7 Are all Hs the same?

The analysis presented so far has indicated that there are seven underlying melodies for noun couplets—/L/, /H/, /H$^{L}$/, /HL/, /$^{L}$H/, /$^{L}$HL/ and /L$^{H}$/. Implicit in these representations is that each H in the underlying forms represents the same kind of tone. For instance, it is implied in §4.1.3 that both groups of nouns with the surface melody HH contain H in their underlying melody, but contrast in that the group which causes sandhi in enclitic pronouns (and elsewhere) has a floating L at its right edge. There is, however, some experimental data, as well as some elicitation data, indicating that the Hs in words which I have designated /H$^{L}$/ and /HL/ have a somewhat higher pitch than Hs in words with the /H/ melody. This can be seen in the plot in Figure 16 which shows the mean pitch contours of five male speakers producing eight repetitions of N-N constructions with the melody combinations /H/ + /H$^{L}$/ and /H/ + /HL/ in isolation from the N-N production experiment (Appendix B).[20] In both of these f0 contours, the initial noun in the phrase with the /H/ melody (***ɲã́ɲĩ́*** ‘brother’) has a lower pitch than the Hs in the following word in the phrase, which have the melodies /H$^{L}$/ and /HL/, respectively. The highest pitch for H is in the /H/ - /HL/ f0 contour (***ɲã́ɲĩ́ mĩ́ɲĩ̀*** ‘pool’s brother’), where the pitch of the first TBU of the second (HL) word is considerably higher than the pitch of the Hs of the first word in the same f0 contour. The f0 contour of /H/ - /H$^{L}$/ (***ɲã́ɲĩ́ nĩ́ɲɨ̃́***$^{L}$ ‘blood brother’) shows that the Hs of the second (H$^{L}$) word also have a somewhat higher pitch than those of the initial (H) word.

A similar situation can also be seen by comparing N-N constructions where the initial melody is /$^{L}$H/ (→ LH) and the second melody in the construction is alternately /H/, /H$^{L}$/ and /HL/, as shown by the plot in Figure 17 from the same experiment. In each of these constructions the initial word in the phrase is ***mã̀ᵑgú***, which has the surface melody LH. As can be seen in the f0 contour of /$^{L}$H/ - /H/ (***mã̀ᵑgú ɲã́ɲĩ́***), the pitch of the Hs in a following /H/ word are considerably

[20] It should be noted that one speaker (PQQ) had only six tokens of /H/ + /H$^{L}$/, which means that this pitch contour is based on n = 38, rather than n = 40 (8 repetitions x 5 speakers) that the other f0 contours are based on.

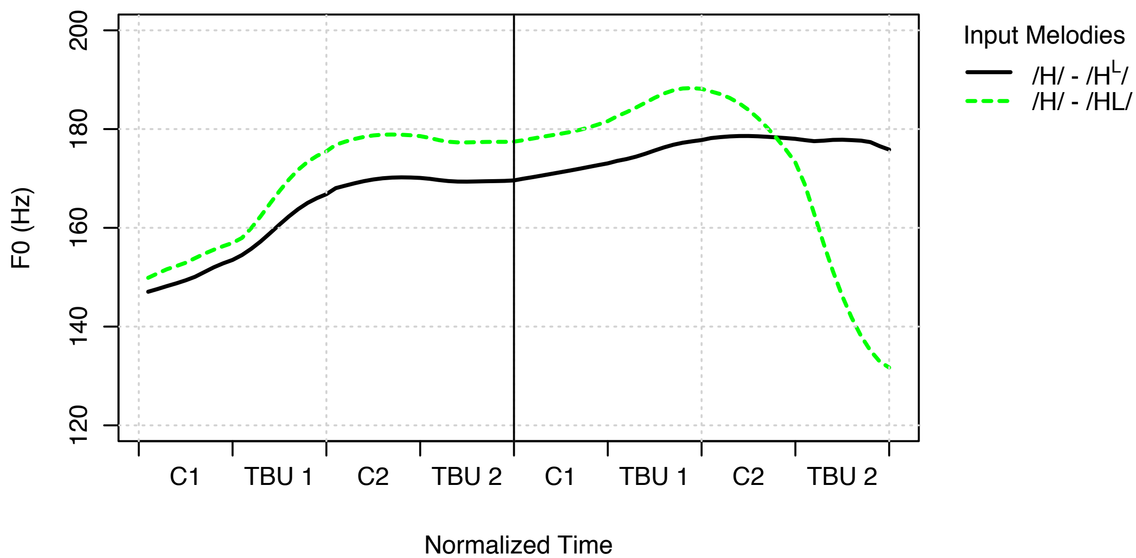



Figure 16. Mean pitch contours of N-N phrases with the melody combinations /H/ + /H$^{L}$/ and /H/ + /HL/; dotted vertical line = syllable boundary, solid vertical line = word boundary

lower than that of the Hs of the second word in the /$^{L}$H/ - /H$^{L}$/ (***mã̀ᵑgú nɨ̃́ɲɨ̃́***$^{L}$) and /$^{L}$H/ - /HL/ (***mã̀ᵑgú mɨ̃́ɲɨ̃̀***), which have the /H$^{L}$/ and /HL/ melodies, respectively.[21]

Despite the differences in the pitch between the Hs of /H/, on the one hand, and /H$^{L}$/ and /HL/, on the other, that are evident in the contexts shown in Figures 16 and 17, there are several good reasons to consider that all of the tones designated as H in these melodies are, in fact, the same type of tone. The first reason is that the pitch difference may not be as great as suggested by the plot above when the segments are identical and the context different. For example, the pitch contours of the homophonous ***tʃítí*** 'seed' with the /H/ melody, and ***tʃítí***$^{L}$ 'knee' with the /H$^{L}$/ melody, are nearly identical in citation context, as shown by the mean pitch contours of six repetitions by five male speakers from the Single Word production experiment (Appendix A) given in Figure 18.

A second and more important reason is evidence that in IM H is predictably raised when it is followed by L, as shown by the data in Figure 19, which repeats the f0 contours from Figure 16 and adds f0 contours of N-N constructions with the melody combinations /H/ + /L/ (***ɲã́ɲĩ́ nɨ̃ɲɨ̃̀***

[21] It should be noted that one speaker (AQQ) had only seven tokens of /$^{L}$H/ + /HL/, which means that this f0 contour is based on n = 39, rather than n = 40 (8 repetitions x 5 speakers) that the other pitch contours are based on.

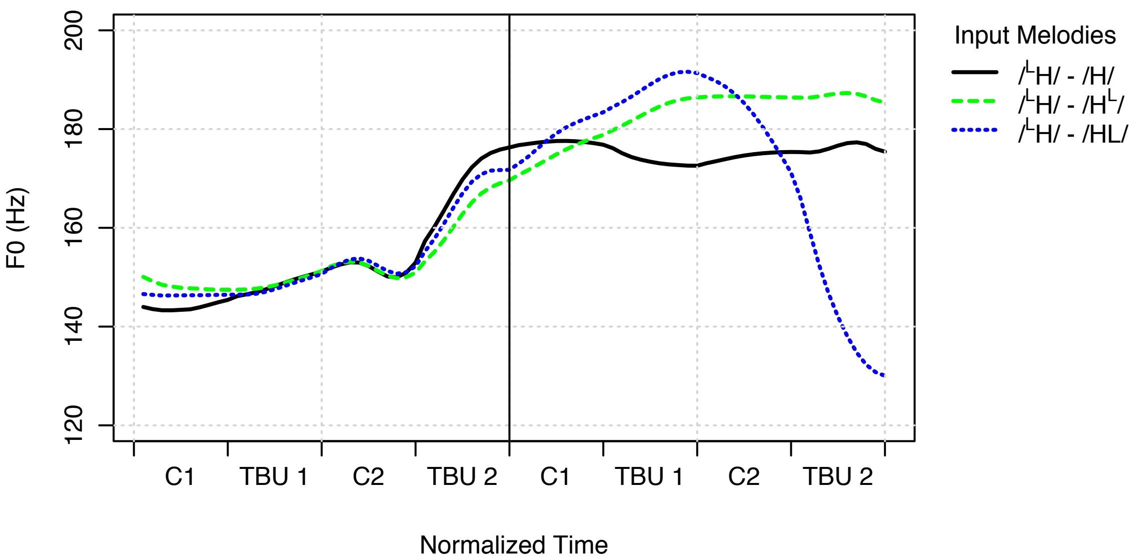



Figure 17. Mean pitch contours of N-N phrases with the melody combinations /ᴸH/ + /H/, /ᴸH/ + /Hᴸ/ and /ᴸH/ + /HL/; dotted vertical line = syllable boundary, solid vertical line = word boundary

'corncob's brother') and /Hᴸ/ + /L/ (*nɨ̃́ŋɨ̃́ nɨ̃ŋɨ̃̀* 'corncob's blood'). The /H/ - /L/ and /Hᴸ/ - /L/ f0 contours clearly demonstrate that the initial words in the phrases, which have the melodies /H/ and /Hᴸ/, respectively, are realized at the same pitch height (see the offset pitch at the solid vertical line) when they are followed in the phrase by a word with the /L/ melody. In other words, when /H/ and /Hᴸ/ are both followed in the construction by a word with the /L/ melody, the pitch difference that is apparent in the /H/ - /Hᴸ/ f0 contour is neutralized; moreover, the height of these words is comparable to the height of the H of HL in the /H/ - /HL/ f0 contour.

The plausibility of this analysis is supported by the fact that the raised pitch of H tones before L tones has been well documented in a wide variety of languages in both phonetic and phonological studies (Hyman 2007b:3; Abua—Pike 1970; Bimoba—Snider 1998; Engenni—Thomas 1974:14 and Hyman 1993:85; Kirimi—Hyman 1993:99; Krachi—Snider 1990; Luobuzhai Qiang—Aston et al. 2010; Mandarin—Xu 1993; Thai—Gandour et al. 1994:483; Yoruba—Connell & Ladd 1990:18, Laniran 1992 and Laniran & Clements 2003). Furthermore, a number of these languages—Yoruba (Laniran 1992:52), Engenni (Hyman 1993:85), Kirimi (Hyman 1993:99) and Bimoba (Snider 1998:87)—also attest that the phenomena is triggered by floating L. The implication

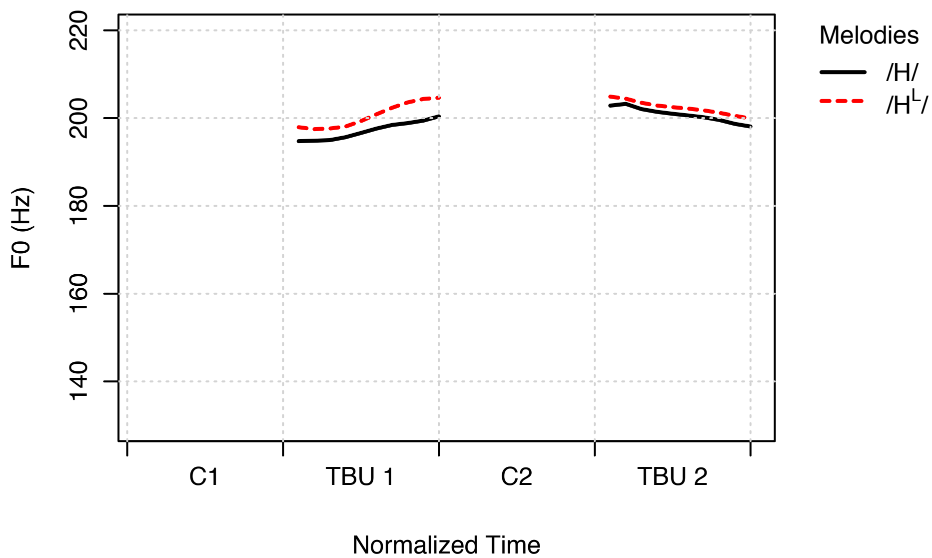



Figure 18. Mean pitch contours of ***tʃítí*** ‘seed’ and ***tʃítí***$^{L}$ ‘knee’

of these findings for this discussion is that it should not be surprising to find that the Hs of words with the /H$^{L}$/ and /HL/ melodies have a higher pitch than the Hs of words with the /H/ melody by virtue of the fact that the Hs in the former melodies are followed by L.

I consider the raising of H before L to be a matter of phonetic implementation; if the output of the phonological component of the grammar contains H followed by L, whether floating or associated, it triggers raising, although associated Ls trigger the greatest amount of raising. The data from the N-N production experiment indicate that this occurs even if the triggering L belongs to a following couplet, but that this effect is mostly or entirely nullified if the second couplet (i.e. the second couplet which contains the L) has the melody /$^{L}$H/ (→ LH) rather than /L/. The effect is still recognizable, however, if the triggering couplet has the melody /L$^{H}$/ (→ LM), though not as great as if the couplet is /L/. The data also indicate that the raising affects the entire couplet melody where both TBUs are H.

Aside from the phonetic reasons for considering all Hs to be the same type, there are also phonological reasons. One reason is that FLA applies to both /H/ and /H$^{L}$/ (cf. (108)), though admitted less frequently to /H$^{L}$/. Though it is not unreasonable to think that this process could

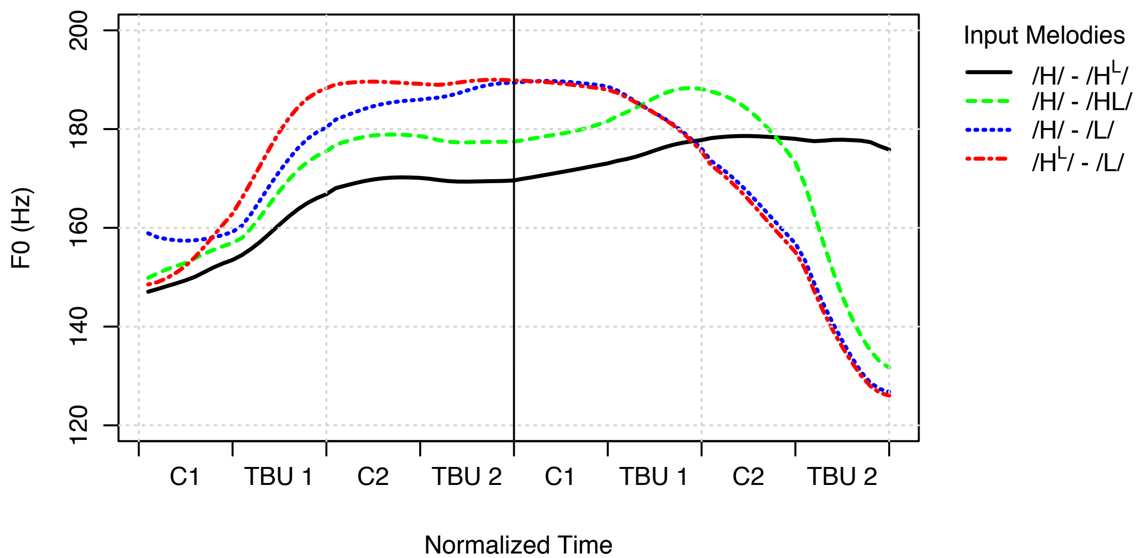



Figure 19. Mean pitch contours of N-N phrases with the melody combinations /H/ + /H$^L$/, /H/ + /HL/, /H/ + /L/ and /H$^L$/ + /L/; dotted vertical line = syllable boundary, solid vertical line = word boundary

apply to two different tones, say M (for what I have called /H/) and H (for /H$^L$), in both cases the result is a LH couplet on words with both melodies, as demonstrated in Figure 9. If /H/ is analyzed as M rather than H, this result requires an additional unmotivated rule raising the final M to H when it undergoes FLA. The same can also be said of LTS which also applies to both /H/ and /H$^L$/ (cf. (131)), though less frequently to /H$^L$/. Again, the result of LTS on /H/ is to create a LH couplet, as shown in Figure 14, which is hard to explain if /H/ is M.

Additional phonological evidence comes from considering HTS. Although HTS applies from a /H$^L$/ couplet to a L enclitic pronoun, but not from a /H/ couplet, we saw that this difference serves the functional purpose of maintaining the contrast between the two melodies within the domain of the prosodic word. However, as was shown in (138a) and (138c), HTS does apply from both /H/ and /$^L$H/ nouns to a following /L/ adjective. This is completely arbitrary if the words triggering this process do not actually have H in their melodies.

In light of the fact of the similar phonological behaviour of /H/ and /H$^L$/, as well as the fact that the elevated pitch of /H$^L$/ and /HL/ is predictable from the process of H raising before L, which is robustly established cross-linguistically, I conclude that the Hs in these melodies are instances of the same tonal category and that the differences in pitch are, more or less, attributable to the fact that /H$^{L}$/ and /HL/ have L in their melody. Making /H/ into another tone level in the tone system (e.g. /M/) would obfuscate these generalizations and complicate the analysis by requiring rules that would raise the putative M to H in various contexts, such as those described above. In other words, the contrast between words with the /H/, /H$^{L}$/ and /HL/ melodies is at the level of the melody, not because the H tones within these melodies represent different tonal categories.

### 4.1.8 Summary of noun melodies

In the preceding sections we have seen that noun couplets have the five citation melodies—∅L, HH, HL, LH and LM; however, tonal alternations revealed in various contexts, particularly the N-Pron construction, reveal seven underlying melodies. Four of these melodies, /L/, /H/, /H$^{L}$/ and /HL/ account for 94% of the native noun couplets in my database (n = 293), as shown in Table 29.

Table 29. Majority tonal melodies of noun couplets

| | **CVCV** | **CVˀCV** | **CVː** | **CVˀV** | **Count** |
|---|---|---|---|---|---|
| **/L/** | *tʃikì* 'fist' | *koˀlò* 'turkey' | *ɲɨ̃̀* 'skin' | *ɲũˀũ̀* 'earth' | 82 (28.0%) |
| **/H/** | *tʃɨ́tɨ́* 'seed' | *kúˀβá* 'amount' | *ɲṹṹ* 'town' | *ɲṹˀṹ* 'fire' | 57 (19.5%) |
| **/H$^{L}$/** | *tʃɨ́tɨ́*$^{L}$ 'knee' | *ɲúˀmá*$^{L}$ 'smoke' | *ɲɨ̃́*$^{L}$ 'salt' | *ʃṹˀṹ*$^{L}$ 'money' | 89 (30.4%) |
| **/HL/** | *tʃɨ́tʲì* 'canal' | $^{n}$*dɨ́ˀjɨ̀* 'pimple' | *sɨ̂* 'saliva' | *nṹˀũ̀* 'tooth' | 46 (15.7%) |
| | | | | **Total:** | **274 (94%)** |

The remaining three melodies—/$^{L}$HL/, /$^{L}$H/ and /L$^{H}$/—account for the remaining 6% of the native noun couplets, as shown in Table 30.

Table 30. Minority tonal melodies of noun couplets

| | **CVCV** | **CVˀCV** | **CVː** | **CVˀV** | **Count** |
|---|---|---|---|---|---|
| **/$^{L}$HL/** | $^{L}$*tʃókò* 'opossum' | $^{L}$*lɨ́ˀjɨ̀* 'chick' | $^{L}$*pɨ̂* 'turkey hen' | | 10 (3.4%) |
| **/$^{L}$H/** | *jàkʷɨ́* 'armadillo' | *lùˀlú* 'foal' | | | 5 (1.7%) |

| | CVCV | CVˀCV | CV: | CVˀV | Count |
|---|---|---|---|---|---|
| **/L$^{H}$/** | *$^{n}$dɨ̀βɨ̄* ‘chicken’ | | *ɲɨ̀ɨ̄* ‘night’ | | 4 (1.4%) |
| | | | | **Total:** | **19 (6%)** |

It should also be noted that with underlying contrasts like /HL/ ~ /H$^{L}$/ ~ /$^{L}$HL/ and /$^{L}$H/ ~ /L$^{H}$/ there is no way to derive the surface melodies for couplets unless the tones which are not floating are underlyingly associated. For instance, a left-to-right association of tones to TBUs would result in a HL couplet from both the /HL/ and the /H$^{L}$/ (= /HL/ if all tones are underlyingly unassociated) melodies. Fully specifying each couplet TBU of the underlying form of /H$^{L}$/ as /HHL/, in violation of the OCP, would solve this problem, since left-to-right tonal association would produce HH$^{L}$, but the association of tones in the /$^{L}$HL/ (i.e. /LHL/) melody would not work, since this melody would surface as LH$^{L}$.

Another matter that needs to be addressed is the underlying forms of CV: and CVˀV couplets. In §6.2.1 I argue that roots which are realized with these couplet structures should be analyzed as underlyingly /CV/ and /CVˀ/, respectively, and that they surface with a bimoraic form due to prosodic constraints. Given that tonal melodies must be considered underlyingly associated, it is necessary, then, to state that the constraint against more than one tone per TBU only holds over surface forms in order to accommodate words like *sɨ̂ɨ* ‘saliva’ and *nɨ̋ˀɨ̏* ‘tooth’, which are assigned the underlying forms, /sɨ̂/ and /ɲɨ̂ˀ/, respectively.

## 4.2 Tone in other word classes

With the analysis of noun tonal melodies results in hand, I now compare the distribution of the tonal melodies established for nouns with their distribution in the other major word classes in Table 31. Each of these melodies will be exemplified in §4.2.1 for adjectives and in §4.2.2 for verbs, where I will also demonstrate their utility in describing the tonal behaviour of words with these parts of speech. Before doing so, however, I will make a few preliminary observations about their distributions. First, I note that the tonal melodies established for nouns are nearly sufficient for the analysis of both the adjectival and verbal tone systems. It turns out that one additional melody—/$^{H}$/—is required for the description of verbs, as will be discussed further in §4.2.2. It is also obvious in Table 31 that each of the majority noun melodies are attested in both adjectives and verbs, though /H$^{L}$/ not nearly as strongly for either of these word classes, nor /HL/ for adjectives. Minority noun melodies, on the other hand, are virtually absent for verbs, which, we will see below, is not because they are unattested for verb couplets, but because they are almost entirely restricted to the imperfective verbs and are therefore not considered to be underlying verb melodies. In regards to adjectives, given that the minority noun melodies, /$^{L}$HL/ and /$^{L}$H/, were hypothesized to have derived historically from the loss of a L toned classifier prefix, it is also not surprising that these melodies are not well attested in this word class. By contrast, the status of the /L$^{H}$/ melody in adjectives is clearly anomalous; it is the second most attested adjective melody whereas it is extremely rare for both nouns and verbs.

Table 31. Counts of couplet melodies in major lexical classes

| | **Nouns** | **Adjectives** | **Verbs** | **Total** |
|---|---|---|---|---|
| **/L/** | 82 (28.0%) | 24 (39.7%) | 53 (53%) | **160 (35%)** |
| **/H/** | 57 (19.5%) | 11 (17.5%) | 15 (15%) | **83 (18%)** |
| **/H$^{L}$/** | 89 (30.4%) | 4 (6.3%) | 4 (4%) | **97 (21%)** |
| **/HL/** | 46 (15.7%) | 5 (7.9%) | 12 (12%) | **63 (14%)** |
| **/$^{L}$HL/** | 10 (3.4%) | 2 (3.2%) | 0 (0%) | **12 (3%)** |
| **/$^{L}$H/** | 5 (1.7%) | 1 (1.6%) | 0 (0%) | **6 (1%)** |
| **/L$^{H}$/** | 4 (1.4%) | 14 (22.6%) | 1 (1%) | **19 (4%)** |
| **/$^{H}$/** | | | 15 (15%) | **15 (3%)** |
| | **293** | **62** | **100** | **455** |

### 4.2.1 Tone in Adjective couplets

Looking first at adjectives, Table 32 gives examples of each underlying melody by couplet structure.

Table 32. Tonal melodies of adjective couplets

| | CVCV | CVˀCV | CV: | CVˀV | Count |
|---|---|---|---|---|---|
| **/L/** | *βiʃà* 'wet' | *kã̄ˀnṹ̀* 'big' | *tʃaà* 'new' | *soˀò* 'deaf' | 24 (39.7%) |
| **/H/** | *ɲã́mã́* 'light weight' | *úˀβá* 'salty' | $^{n}$*dáá* 'true' | *tɨ́ˀɨ́* 'narrow' | 11 (17.5%) |
| **/H$^{L}$/** | *ásɨ́*$^{L}$ 'delicious' | | *ʃã́ã́*$^{L}$ 'fierce' | *kʷáˀá*$^{L}$ 'many' | 4 (6.3%) |
| **/HL/** | *βítʃĩ̀* 'cold' | | *βéè* 'heavy' | *βáˀà* 'good' | 5 (7.9%) |
| **/$^{L}$HL/** | | $^{L}$*lúˀlù* 'small' | | $^{L}$*lóˀò* 'small' | 2 (3.2%) |
| **/$^{L}$H/** | *ʃĩ̀ɲṹ* 'shiny' | | | | 1 (1.6%) |
| **/L$^{H}$/** | *kʷìtʃī̃* 'white' | $^{n}$*dàˀβī* 'poor' | *kʷã̀ã̄* 'yellow' | *kʷàˀā* 'red' | 14 (22.6%) |
| | | | | **Total:** | **62 (100%)** |

The majority noun melodies are presented in the first four rows. The numbers given here only include words that are considered to be adjectives based on appropriate diagnostics, as described in Penner (2014).[22] It should be noted that there is a sizeable number of additional property concept words (cf. Dixon 1977) that have not been sufficiently analyzed and therefore not included. These words mostly have the /L/ and /L$^{H}$/ melodies.

Although the sample represented in Table 32 is small and, admittedly, far from complete, several useful generalizations can be made. The first is that, of the majority noun patterns in Table 29, only the /L/ and /H/ melodies are well attested for adjectives. /L/ is by far the most prevalent adjective melody, and its proportion is likely only to increase upon completing the analysis of the remaining property concept words given the large number of additional property concept words with this melody. The most unusual pattern in Table 32 when compared to noun couplet melodies, however, is that the /L$^{H}$/ melody is the second most frequent melody, comprising nearly a quarter of the sample. This compares to only 1.4% of nouns with this melody (cf. Table 30). We have noted that a few adjectives appear to have been historically derived through L tone suprafixation (cf. Table 28), and it seems possible that the rest of the adjectives with this melody were too, but at this point

[22] The diagnostics applied to the words here focus on establishing property concept words as unmarked modifiers of nouns and differentiating them from verbs, which are unmarked syntactic predicates and able (in IM) to bear aspect without further measures taken (Penner 2014). While adjectives also need to be differentiated from nouns, I have allowed some words into this sample which have not been rigorously tested for the noun-adjective distinction, since this is not the issue in IM that it is in some other languages (e.g. Hausa Beck 2002).

this is speculation. The final pattern of note in Table 32 is that the /ᴸHL/ and /ᴸH/ melodies, which were severely underrepresented in noun couplets (cf. Table 30), are also infrequent for adjectives.

Evidence for the adjective melodies in Table 32 is found by combining adjectives with each couplet melody with the first person singular pronoun (although I do not have data for /ᴸH/ adjective + this pronoun) and demonstrating that they exhibit the same tonal behaviour we have observed for noun couplets when combined with this pronoun. An example of an adjective with the /H/ melody in this construction is given in (151).

(151) *ɲá̋mé̋*
ɲámá = í ∅
light=1SG be
'I am light'

In this construction the adjective is the syntactic predicate, which takes a zero copula, as described in §2.4.3. The adjectival predicate thus does not take the L imperfective suprafix that verbs do, as is evident by the fact that the initial TBU of the predicate is not lowered to L (cf. §4.2.2). Rather, like /H/ nouns which are combined with this pronoun (cf. (106)), /H/ adjectives remain HH.

/Hᴸ/ adjectives, on the other hand, become HL when they coalesce with the first person singular pronoun:

(152) *ʃá̋ȉ*
ʃá̋ᴸ = í [23] ∅
fierce=1SG be
'I am fierce'

As demonstrated for /Hᴸ/ nouns (cf. (105)), the floating L of the couplet changes the pronoun tone to L by FLA, and then the pronoun tone replaces the final tone of the couplet by LFTA.

Adjective couplets with the /L/ melody become LM when combined with the first person singular pronoun:

[23] See footnote 8.

(153) *kȁˀnĩ̄*
kȁˀnù = í ∅
big=1SG be
'I am big'

Like nouns (cf. (148a)), the pronoun assimilates to the L of the couplet (VA) and then replaces its tone by LFTA.

An /HL/ adjective in the Adj + '1SG' construction is realized as HH:

(154) *βéí*
βê = í [24] ∅
heavy=1SG be
'I am heavy'

The final couplet TBU is replaced with H, as we saw also happens for nouns in this context in (119).

/ᴸHL/ adjectives in this construction surface as LH:

(155) *lòˀí*
lôˀ = í [25] ∅
small=1SG be
'I am small'

The derivation is just like the one given for nouns with the same melody in (126): the pronoun tone replaces the final couplet TBU with H by LFTA, and then FLA associates the floating L at the left edge of the couplet to the initial couplet TBU.

Finally, when /Lᴴ/ adjective couplets combine with the first person singular pronoun they surface as LH.

(156) *kʷìtʃĩ́*
kʷìtʃȉᴴ = í ∅
white=1SG be
'I am white'

[24] See footnote 8.
[25] See footnote 8.

These couplets, which have the citation melody LM, have their final tone replaced by the pronoun H by LFTA, as was seen for the few nouns with this melody in (137b).

### 4.2.2 Tone in Verb couplets

My purpose in this section is not to give a complete description of verb tone, which is more complicated than other areas of the grammar and not as well studied. Rather, I aim to demonstrate how the couplet melodies identified in nouns are also useful in the analysis of verb couplets. Table 33 gives the underlying tonal melodies attested in a sample of 100 IM verbs.

Table 33. Tonal melodies of verb couplets

| | **CVCV** | **CVˀCV** | **CV:** | **CVˀV** | **Count** |
|---|---|---|---|---|---|
| **/L/** | *kuβì* ‘be’ | *kaˀβì* ‘read’ | *tʲaà* ‘write’ | *$^{n}$dʲeˀè* ‘see’ | 53 |
| **/H/** | *kúsú* ‘sleep’ | *tʲáˀjú* ‘be rotten’ | *tʃáá* ‘arrive’ | *kã́ˀã́* ‘speak’ | 15 |
| **/H$^{L}$/** | *$^{n}$dɨ́jɨ́$^{L}$* ‘be burned’ | *tʲíˀjó$^{L}$* ‘be cooked’ | | *ɲĩ́ˀĩ́* ‘obtain’ | 4 |
| **/HL/** | *kútʃî* ‘bury’ | *tʲáˀβì* ‘pay’ | *$^{n}$dóò* ‘remain’ | *$^{n}$dɨ́ˀɨ̂* ‘need’ | 12 |
| **/$^{L}$HL/** | | | | | 0 |
| **/$^{L}$H/** | | | | | 0 |
| **/L$^{H}$/** | | | | *jùˀū* ‘be afraid’ | 1 |
| **/$^{H}$/** | *káʃĩ́* ‘be crushed’ | *káˀ$^{n}$dɨ́* ‘explode’ | *kã́ã́* ‘perforate’ | *kúˀú* ‘be sick’ | 15 |
| | | | | **Total:** | **100** |

Here again it should be noted that there are, of course, many other verbs that await tonal analysis, so these numbers are not necessarily representative; nevertheless, some valuable generalizations can be drawn. The four majority noun melodies are well attested in this sample, except for /H$^{L}$/, and, like adjectives, the /L/ melody is by far the most prevalent verb melody (53%). One word does appear to have /L$^{H}$/ as its basic melody since it behaves tonally like /L$^{H}$/ in non-imperfective contexts. The final melody, /$^{H}$/, will be explained below as I demonstrate the utility of the underlying couplet melodies in Table 33 in representing the tonal behaviour of verb couplets with imperfective aspect.

The basic tonal melody for verb couplets from which the imperfective tone pattern is derived is generally found to be the same as that of the bare form of the verb, which is used as an imperative. (This form is also the basic couplet melody for perfective and prospective aspects, though with some complexities that will not be addressed here.) To begin with, consider the verb *kã́ˀã́* 'speak', which has the bare imperative form given in (157).

(157) *kã́ˀã́*
∅⌒kã́ˀ
IMP⌒speak
'Speak!'

As shown, this verb surfaces as HH and is assigned the underlying melody /H/. When used with the imperfective aspect, it undergoes the tonal alternations shown in (158).

(158) a. *kã̀ˀṹ*
ᴸ⌒kã́ˀ = ũ
IPFV⌒speak=2SG
'You are speaking'

b. *kã̀ˀã́ɾà*
ᴸ⌒kã́ˀ = ɾà
IPFV⌒speak=3.MASC
'He is speaking'

In (158a) the /H/ couplet has coalesced with the toneless second person singular pronoun, and in (158b) it is combined with the L toned third person singular enclitic pronoun. In each example, the L imperfective suprafix associates with the initial TBU by FLA changing it to L, and results in a LH couplet melody. When the H toned first person singular pronoun coalesces with imperfective couplets having this melody, as expected, the surface melody is also LH, as shown in (159).

(159) *kã̀ˀĩ́*
ᴸ⌒kã́ˀ = í
IPFV⌒speak=1SG
'I am speaking'

The tonal behaviour of verbs with this melody is the same as that of /$^{L}$H/ nouns (cf. (129a), (130a) and (135)), which are hypothesized to have a floating L in their underlying melody due to a lost animal classifier prefix. In this case, however, the equivalent of the floating L is the imperfective tonal suprafix.

A few verbs have also been identified with the /H$^{L}$/ melody, having a floating L at their right edge. One such verb is *tʲíˀjó*$^{L}$ 'be cooked'. The bare couplet used as an imperative has the HH melody, as shown in (160).

(160) *tʲíˀjó*<br>
∅⁀tʲíˀjó$^{L}$<br>
IMP⁀be.cooked<br>
'Be cooked!'

As described for nouns in §4.1.3, the floating L associates with a following H TBU by FLA if it does not belong to a couplet with an associated L in its melody. This tonal behaviour is demonstrated in (161) where *tʲíˀjó*$^{L}$ is followed by the /H$^{L}$/ noun, *nṹɲĩ́*$^{L}$ 'corn', in a verb-subject construction.

| | | |
|---|---|---|
| (161) | *tʲìˀjó* | *nũ̀ɲĩ́* |
| | $^{L}$⁀tʲíˀjó$^{L}$ | núɲí$^{L}$ |
| | IPFV⁀be.cooked | corn |
| | 'The corn is cooking' | |

Notice that the imperfective suprafix is realized on the initial TBU of *tʲíˀjó*$^{L}$ as it is for /H/ verbs (cf. (158) and (159)) creating a LH couplet melody on the verb. The first TBU of *nṹɲĩ́*$^{L}$ is also realized as L due to the floating L in the verb couplet melody similar to what we saw in (108b) when two /H$^{L}$/ nouns are juxtaposed in a N-N construction.

It is interesting to observe what happens when imperfective verbs with the /H$^{L}$/ melody coalesce with the first person singular pronoun since they have a L tonal suprafix at their left edge (the imperfective suprafix) and a lexical floating L at their right edge. In /H$^{L}$/ nouns, which only have a floating L at their right edge, a HL couplet is created when the first person singular pronoun (which is lowered by FLA) replaces the tone of the final TBU of the couplet, as was shown in (105), repeated here as (162).

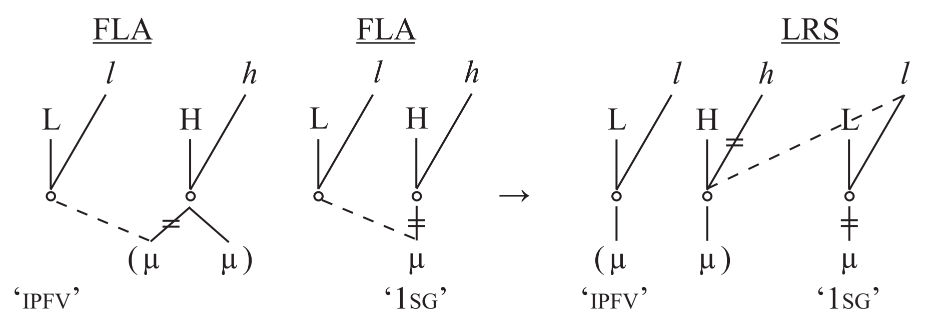
(162) *tʃɨ́tɨ̀*
tʃɨ́tɨ́$^{\mathrm{L}}$ = í
knee=1SG
'my knee'

/H$^{\mathrm{L}}$/ imperfective verbs, on the other hand, surface as LM, as shown in (163).

(163) *tʲìˀjē*
$^{\mathrm{L}}$⁀tʲíˀjó$^{\mathrm{L}}$ = í
IPFV⁀be.cooked=1SG
'I am being cooked'

A *LL conflict results since the imperfective prefix associates L to the initial couplet TBU and coalescence requires that the pronoun tone, which is changed to L by the lexical floating L, also be realized on the couplet. This is resolved by triggering partial (vertical) assimilation (i.e. LRS) from the pronoun to the final couplet TBU creating a derived M (= *l*-register feature, *H*-tonal feature; cf. (143)), instead of total assimilation (i.e. LFTA), which would replace the final couplet tone with L:

(164) Imperfective /H$^{\mathrm{L}}$/ + =*í* '1SG'




The derivation can be described in two steps: In the first step, the imperfective suprafix (at the left edge of the couplet) replaces the initial TBU of the couplet by FLA and the lexical floating L (at the right edge of the couplet) replaces the pronoun tone also by FLA. In the second step, since the initial TBU of the couplet is L, LFTA is blocked since L is already associated with the couplet and instead, the pronoun spreads its *l*-register to the couplet final H (LRS), changing it to M.

As briefly mentioned in §2.4.2, the L imperfective suprafix is blocked from verb couplets with an associated L in their melody due to the *LL constraint, and a ∅ allomorph is selected instead. This is shown in (165) for an imperfective /HL/ verb.

(165) *tʃáˀàɾà*
∅⌒tʃâˀ = ɾà
IPFV⌒give:REAL=3.MASC
'he is giving'

Observe that the initial tone bar of the schematic pitch representation of (165) is high rather than low, indicating that the L imperfective suprafix is not present; however, when the final TBU of the couplet is changed to H through coalescence with the first person singular pronoun, as shown in (166), the L suprafix is able to apply, resulting in a LH couplet melody.

(166) *tʃàˀí*
ᴸ⌒tʃâˀ = í
IPFV⌒give:REAL=1SG
'I am giving'

This is just what we have seen happens with /ᴸHL/ nouns (122) and adjectives (155), but in this case the floating L is morphological.

The imperfective L suprafix is also blocked from applying to verb couplets with the /L/ melody, as in these data:

(167) a. *tʲaàɾà*
∅⌒tʲà = ɾà
IPFV⌒write=3.MASC
'He is writing'

b. *tʲàī*
∅⌒tʲà = í
IPFV⌒write=1SG
'I am writing'

In the first example the mid-falling pitch on the initial TBU indicates that the L suprafix is absent. When this couplet coalesces with the first person singular pronoun, as in (167b), the result is LM just as we saw for nouns (148a) and adjectives (153). Of course, it is possible to say that the suprafix applies vacuously in (167b)—that is, with no audible result since the initial TBU would be L even without the imperfective suprafix as it is in nouns and adjectives, but this would be at odds with the way *LL is formulated, since the couplet melody contains an associated L. I therefore conclude that /L/ verbs always take the ∅ imperfective allomorph.

It was shown in Table 26 that there are imperfective verbs that surface as LH and LM, but exactly how the underlying representation for the group that surface as LM should differ from those that surface as LH is not immediately obvious. It appears that /H/ could be the basic melody from which the imperfective form of both groups is derived. It has already been shown in (158) and (159) that the group that surfaces as LH in the imperfective is straightforwardly represented with an underlying /H/ melody to which the imperfective suprafix applies, replacing the initial TBU; but consider the imperative form of *kű̃ɲĩ́* 'want' given in (168).

(168) *kű̃ɲĩ́* 'Want!'

The surface melody of this bare form of the verb is also HH like the corresponding form for *kã́ˀã́* 'speak' in (157); however, when inflected for imperfective aspect, the couplet emerges as LM rather than LH, as illustrated by these examples:

(169) a. *kȕ̃ɲĩ̄rà*
ᴸ⌒kũɲiᴴ = ɾà
IPFV⌒want=3.MASC
'He is wanting'

b. *kũ̏ɲĩ̄̄* *lèē* *mùlī*
ᴸ⌒kũ̃ɲi$^{H}$ lè$^{H}$ mùlì$^{H}$
IPFV⌒want baby stew
'The baby is wanting stew'

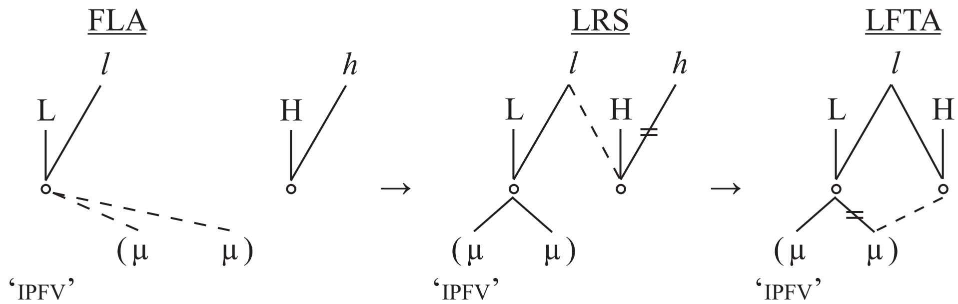
Like LM (i.e. /L$^{H}$/) nouns (130b) and adjectives (156), this verb also surfaces as LH when it coalesces with the first person singular pronoun, as shown in (170).

(170) *kũ̏ɲĩ́*
ᴸ⌒kũ̃ɲi$^{H}$ = í
IPFV⌒want=1SG
'I am wanting'

As above, the H pronoun, which has not undergone any tonal processes, replaces the final TBU of the couplet during coalescence (LFTA).

It would appear, then, that the group surfacing as LM require additional (partial) spreading of the L suprafix to the couplet final H, and there does not seem to be a principled way to formulate the rule so that L spreads to the final TBU in one group and not in the other if they both have the same underlying representation. I believe my solution for noun couplets in §4.1.5 points to a way to resolve the representational problem with LH/LM imperfective verbs. There I proposed to represent nouns with the LH citation melody as /$^{L}$H/ and those with the LM citation melody as /L$^{H}$/. FLA applies to /$^{L}$H/ words and they surface as LH (cf. (135)). /L$^{H}$/ words, on the other hand, spread the *l*-register from the couplet L to the floating H (LRS), which then replaces the final TBU of the couplet creating LM (cf. (150)), similar to the way LM is derived in /L/ + =*í* '1SG' constructions. Following a similar approach, I suggest that verbs that surface as LM in the imperfective do have a H melody but that the H is unassociated in the underlying form—/$^{H}$/—and because it is floating, the imperfective suprafix associates with the entire couplet in the initial stage of the derivation, as shown in (171).

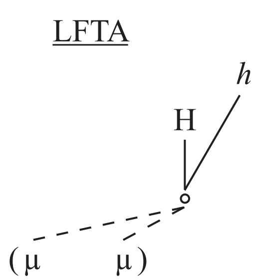
(171) Derivation of imperfective /H/ couplets




The derivation is described in three stages. The floating tones are associated from left to right so in the first stage the imperfective suprafix associates iteratively to both (toneless) TBUs of the couplet by FLA, as shown by the left side of the first arrow in (171). Since the underlying H of the verb root is not associated with the couplet, LRS occurs from the couplet L to the floating H lowering it to M in the second stage of the derivation. It is this tone that associates with the final TBU of the couplet by LFTA, as shown in the third stage. This derivation is similar to what we saw for /L/ + =*í* ‘1sg’ constructions (cf. (149)), except that here the L on the couplet comes from the tonal suprafix and not the root itself, and the H is floating in the underlying melody rather than as a result of coalescence with the couplet.

When the imperfective suprafix is not present in the derivation—that is, in other grammatical contexts—LFTA occurs, associating the underlying H to both TBUs of the couplet, as shown in (172).

(172) Derivation of non-imperfective /H/ couplets




The condition for this rule to apply iteratively to the initial TBU is that it be toneless.

The rightward shift of the H tone off the end of the word suggested by the representation of /$^{H}$/ verbs and /L$^{H}$/ nouns and adjectives is a tonal process that has been robustly attested diachronically and synchronically in a number of tonal languages as typologically disparate as Zhenhai (Chinese, Wu, China; Chen 2000:64ff), Kuki-Thaadow (Tibeto-Burman, NE India and Myanmar; Hyman 2007a; Hyman 2011a) and Bantu languages such as Kikuyu (Kenya; Clements & Ford 1979) and Zulu (South Africa; Downing 1990). More importantly, rightward tone shift has been documented in other Mixtec varieties, albeit Highlands varieties, by Hollenbach (2003) and McKendry (2013). McKendry claims that most tonal melodies in SE Nochixtlán Mixtec are shifted so that the initial tone of the underlying melody associates with the second couplet TBU and the second tone of the melody is floating and shows up when combined with other words in various constructions. This is demonstrated for the /LH/ melody in Table 34. (" $^{n}$ " = morpheme level nasalization.)

Table 34. Tone shifting in Highlands Mixtec

| | XTA | MXY | MIG | Gloss |
|---|---|---|---|---|
| **/LH/** | *kòʔó* | *kōʔò*$^{H}$ | *kōʔò*$^{H}$ | 'bowl' |
| **/LH/** | *nùní*$^{n}$ | *nūnì*$^{nH}$ | *nūnì*$^{nH}$ | 'corn (grains)' |
| **/LH/** | *kòó* | *kōò*$^{H}$ | *kōò*$^{H}$ | 'snake' |

(McKendry 2013:145)

The melody aligns with the left edge (no tone shift) for Alcozauca Mixtec (XTA), but is shifted one TBU to the right in SE Nochixtlán Mixtec (MXY) and San Miguel El Grande Mixtec (MIG), resulting in a default M on the first syllable and a floating H at the end of the word. Misalignment of tone melodies with respect to the root TBUs results in a proliferation of floating tones which cause rampant tone sandhi.

What I argue for in IM is that H tones which have shifted to the right are required by the grammar to associate to the couplet to which they belong underlyingly, unlike the floating L of /H$^{L}$/ couplets. This differential treatment of a floating L and a floating H is similar to what Clements &

Ford (1979) report for Kikuyu. In that language, underlying tones are shifted one TBU to the right so that the first tone in the underlying melody associates with the second TBU and spreads leftward to fill the empty initial TBU, and the remaining tones are associated one to each remaining TBU, as illustrated in (173). (L = *ā*, LH rising tone = *ā́*)

(173) /LLH/ ***mōrāŋgī́*** ‘bamboo’ (adapted from Clements & Ford 1979:187, 191)

mo ra ŋgi
L L H

This sometimes results in an extra tone at the end of the word because there are more tones than available TBUs, as in (173). When this happens, if the extra tone is H, a special rule associates it to the final TBU if it is L, creating a rising contour tone. Crucially, this rule only applies to floating Hs and not to other floating tones. The difference between this situation and the one in IM is that IM does not allow contour tones and therefore partial assimilation occurs creating M instead of a contour tone.

Evidence for tone shifting in other Mixtec varieties notwithstanding, demonstrating the diachronic origin of tone shift in the case of IM using comparative data is not easy since IM belongs to the small “Area B” group of Mixtec languages from Dürr’s (1987) Proto-Mixtec tone reconstruction. This group did not fit his reconstructed tonal categories and so cannot be straightforwardly compared to the “Area A” languages, discussed by Hollenbach (2003) and McKendry (2013), which did. Thus, the all-important step of demonstrating correspondences between words with shifted melodies in IM with unshifted melodies in other varieties will have to await further study.

The only remaining tonal melody from Table 33 is /L$^{H}$/, which has only one attestation, ***jùˀū*** ‘be afraid’. The L in this verb is analyzed as part of the underlying melody rather than as the imperfective suprafix since it shows up in other grammatical contexts. The bare form of the verb (which I do not have as an imperative in my data) is LM, as shown in (174a).

(174) a. *jù$^{ʔ}$ū*
jù$^{ʔH}$
be.afraid
'to be afraid'

b. *jù$^{ʔ}$í*
∅⌢jù$^{ʔH}$ = í
IPFVbe.afraid=1SG
'I am afraid'

c. *íjù$^{ʔ}$í*
í–jù$^{ʔH}$ = í
PFV–be.afraid=1SG
'I was afraid'

When the imperfective of this verb coalesces with the first person singular pronoun, given in (174b), it surfaces as LH, as expected (cf. (130b)); however, in (174c) we see that the perfective form of this verb plus the first person singular pronoun also has L on the first couplet TBU. This can be compared to the perfective form of ***kú$^{ʔ}$ú*** 'be sick', which has the /$^{H}$/ melody, combined with the first person singular pronoun:

(175) *íkú$^{ʔ}$í*
í–kú$^{ʔ}$ = í
PFV–be.sick=1SG
'I was sick'

Words with the /$^{H}$/ melody do not have L on the first TBU in the perfective, even though they have LM as their imperfective form (cf. (169)). Thus, I analyze ***jù$^{ʔ}$ū*** 'be afraid' as having L in its underlying melody and therefore, I claim that it takes the ∅ imperfective allomorph.

Chapter 5

# Prosodic structure

In the preceding chapters I have given basic descriptions of IM morphosyntax, tonal phonology and non-tonal phonology with only limited reference to the organization of phonological material into higher level units of structure—§3.3 described the syllable structure, and there have been many references to the descriptive term "couplet" as well as to the mora. The primary claim of this dissertation, however, is that the Mixtec couplet shows all the hallmarks of a prosodic domain—specifically, the prosodic foot. Before launching into that discussion in chapter 6, this chapter will lay the theoretical groundwork for prosodic structure in general and the foot in particular. Having established what the properties of the foot are, we will be ready to evaluate the IM evidence for the foot in the next chapter.

## 5.1 Defining prosodic structure

The term "prosody" (and the adjectival form "prosodic") has a great variety of meanings—so much so that it might justifiably be considered simply a "grab-bag of things that are hard to write with a string of symbols" (Ladd 2014:74). Nevertheless, Ladd goes on to point out that phenomena that are labelled prosodic fall into two main clusters: those with phonetic properties that are often considered as "running in parallel with the segmental string" (p. 74) and which apply to more than a single segment of the speech string, and those that involve the hierarchical (phonological) organization of speech and syntagmatic relations. An example of the former sense would be pitch, which is produced independently of segmental articulation (e.g. Lehiste 1970; Ladd 2014). The latter sense, on the other hand, can be seen in the prosodic organization of segments into syllables and even higher levels of prosodic structure, and the way in which an accented syllable is defined in relation to the surrounding syllables in a unit of speech (i.e. syntagmatically) (e.g. Beckman

1986; Hyman 2006; Ladd 2008; 2014).[1] Although this dissertation certainly deals with phenomena that are prosodic in the first sense (e.g. tone, nasalization), I will use the term "prosodic" in the second sense. By "prosodic structure" I refer to the organization of the string of speech into higher level phonological units which have particular ordering relations. These prosodic units and their ordering relations will be defined in §5.2.

Before attempting a more detailed description of prosodic structure, however, it is helpful to consider why one might want to posit prosodic structure in addition to morphosyntactic structure in the first place. I believe that there are two main reasons for doing so. One reason is that the units provided by morphosyntax do not always meet the requirements of the phonology—that is, the phonology needs to reference a portion of the phonological string that does not constitute any morphosyntactic unit (e.g. Selkirk 1980a; 1980c; 1986; Nespor & Vogel 2007 [1986]). Examples of this abound with respect to syllables. In fact, two such phonotactic restrictions of the IM syllable have already been noted—OCP Coronal and OCP Labial, which restrict the co-occurrence of coronal and labial features, respectively, within syllables. The string necessary to define the locus of these restrictions does not constitute any type of morphosyntactic unit, but as demonstrated in §3.3, this domain is straightforwardly definable in terms of phonological elements (e.g. consonants, vowels and moras) and principles (e.g. sonority sequencing; cf. Clements 1990). It is generalizations such as these which motivate positing that the unit "syllable" is a prosodic domain in Mixtec, and probably all other languages,[2] but there is also abundant evidence for the need for prosodic constituents that are larger than the syllable which do not coincide with morphosyntactic units, as will be discussed below.

A second reason for adopting prosodic structure to handle the business of phonology is conceptual. Linguists have long held the view that the analysis of language involves different levels of linguistic analysis corresponding to the different subsystems of language and that these

[1] It should be noted that the two types of prosodic structure can interact as in boundary tones, for instance, where pitch, which is prosodic in the first sense, is used to mark the boundary of a prosodic constituent, which is prosodic in the second sense.

[2] However, see Hyman (1985; 2011b) for a discussion of whether the syllable is a prosodic constituent in Gokana.

levels, while certainly interrelated with each other, have different kinds of abstractions and therefore different kinds of units or categories (Halliday 1961:268; cf. Hockett 1955; Pike 1967). This idea was instantiated in the separate morphosyntactic, lexical and phonological hierarchies of these early linguists. This view of linguistic analysis, then, would lead us to expect to find mismatches between the units required by the phonology and those provided by the morphosyntax since they represent different kinds of abstractions.

Despite this prevailing view of linguistic analysis in pre-generative linguistics, "classical" generative phonology (Chomsky & Halle 1968) had no role for higher level phonological units in its theory of phonological representations, and it was not until the mid-1970s and 1980s, that generative phonologists began to explicitly incorporate a hierarchy of purely phonological units into their phonological theory (Fox 2000). This research program was kick-started by attempts to represent prominence relations, rhythm and intonation in terms of higher level prosodic structures by practitioners of metrical phonology and the autosegmental-metrical theory of intonation (Liberman 1975; Liberman & Prince 1977; Hayes 1980; Selkirk 1980b; Pierrehumbert 1980), but was expanded into a more general phonological theory in prosodic phonology (Selkirk 1980a; Selkirk 1980c; Selkirk 1981; Selkirk 1986; Nespor & Vogel 2007 [1986]; Inkelas 1989; Zec 1989) and prosodic morphology (McCarthy & Prince 1996 [1986]; McCarthy & Prince 1990a; McCarthy & Prince 1990b; McCarthy & Prince 1993; McCarthy & Prince 1995). The central idea pursued in this work, which was first advanced by Selkirk (1980a; 1980b; 1980c; 1981), is that there is a fixed set of prosodic (phonological) units that are arranged in hierarchical relation in what is called the prosodic hierarchy. Prosodic phonology, in particular, further claims that phonological generalizations should be stated with respect to prosodic units rather than directly referencing the units provided by morphosyntax; the units of the prosodic hierarchy, therefore, mediate between the phonological component and the other components of the grammar (e.g. Nespor & Vogel 2007 [1986]; Inkelas 1989; Inkelas & Zec 1990:xiii).

## 5.2 The prosodic hierarchy

A fairly standard version of the prosodic hierarchy that will be assumed in this study is given in (176) (cf. Selkirk 1980a; Nespor & Vogel 2007 [1986]; McCarthy & Prince 1996 [1986]; Pierrehumbert & Beckman 1988; Inkelas 1989; Zec 1989).

(176) The Prosodic hierarchy

| | |
|---|---|
| Utt | Utterance |
| \| | |
| IP | Intonational Phrase |
| \| | |
| ϕ | Phonological Phrase (PPH) |
| \| | |
| ω | Prosodic Word (PWRD) |
| \| | |
| F | Foot |
| \| | |
| σ | Syllable |
| \| | |
| μ | Mora |

This dissertation will only be concerned with the lower level prosodic units—prosodic word, foot, syllable and mora—but particularly the foot and the mora. The foot will be discussed in detail in §5.3; the mora, which is the lowest/smallest unit in this hierarchy, is a unit of phonological weight (Hyman 1985; McCarthy & Prince 1996 [1986]; 1995; Hayes 1989; Zec 1989) such that a light syllable (e.g. CV) has a single mora and a heavy syllable (e.g. CVː) has two (McCawley 1978:114). The status of the mora as a prosodic unit and constituent in the prosodic hierarchy has been somewhat ambivalent in the literature and it is not included by many researchers, being considered by some to be a property of syllables and segments rather than an actual constituent in the hierarchy (McCarthy & Prince 1993; Itô & Mester 2003 [1992]; 2009a). Nevertheless, Zec (1989) argues for its inclusion as a prosodic unit based on the fact that the sonority requirements for moras are different from those of syllables, and on the necessity in some languages for the mora as a prosodic licenser in the sense of Itô (1986). The mora has also been included in the hierarchy by various other authors (e.g. Pierrehumbert & Beckman 1988; Kager 1993; Kager 1999; McCarthy & Prince 1995; Bennett 2012; Smith & Ussishkin 2015), and I include it as a prosodic unit primarily on the basis that it is the prosodic unit to which tones are associated in IM and other varieties of Mixtec (cf. McKendry 2013; DiCanio et al. 2014).

Standard prosodic hierarchy theory imposes strict conditions on the composition and ordering relations of the units of the hierarchy by means of Selkirk's (1981:382; 1984:26) Strict Layer Hypothesis (SLH).[3] Informally, the SLH stipulates that constituents at each (non-terminal) level of the hierarchy are comprised of at least one unit from the immediately lower level in the hierarchy and no other types of units. A consequence of the SLH is that recursion is excluded in prosodic structure in order to reflect the fact that prosodic structure is relatively "flat" when compared to syntactic structure, which is another way in which prosodic structure demonstrates its non-isomorphism with syntactic structure.

The highly restrictive original version of the SLH has now been abandoned by most researchers. An approach that appears to be more compatible with empirical findings, and which will be assumed in this work, is given by Selkirk (1996), who breaks the SLH into four component constraints—two violable and two inviolable. The two inviolable constraints are Layeredness and Headedness ($C^n$ = a prosodic category):

(177) Inviolable constraints on prosodic structure (Selkirk 1996:190)
 a. *Layeredness*
  No $C^i$ dominates a $C^j$, $j > i$ (e.g. no σ dominates a F)
 b. *Headedness*
  Any $C^i$ must dominate a $C^{i-1}$, except if $C^i$ is the lowest level of the hierarchy (e.g. a PWrd must dominate a F)

[3] "[A] category of level i in the hierarchy immediately dominates a (sequence of) categories of level i−1" (assuming that the syllable is level 1 and each higher level one greater than the preceding level) (Selkirk 1984:26).

Layeredness (177a) prohibits a prosodic category from dominating higher level categories, while Headedness (177b) requires that it dominate at least one unit from the next lower level.

The two violable constraints on prosodic structure are Exhaustivity and Nonrecursivity:

(178) Violable constraints on prosodic structure (Selkirk 1996:190)

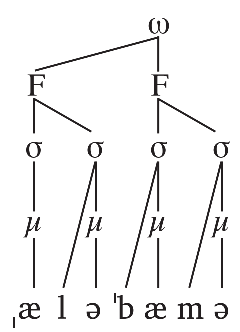
a. *Exhaustivity*
No $C^i$ immediately dominates a constituent $C^j$, $j < i-1$ (e.g. no PWRD immediately dominates a σ)

b. *Nonrecursivity*
No $C^i$ dominates $C^j$, $j = i$ (e.g. no F dominates a F)

Exhaustivity prohibits a prosodic structure that is composed of a unit more than one level below it (i.e. no skipping levels), nor may a prosodic structure be composed of a unit of the same type as itself by Nonrecursivity.

As an example of a prosodic structure which conforms to all of the constraints in (177) and (178), consider the prosodic structure of the English word *Alabama*:

(179) Prosodic structure of *Alabama* (based on Kager 2007:369)




Each vowel in the word is associated with a mora which is immediately dominated by a syllable. Each subsequently higher level in the prosodic structure is strictly layered such that syllables are composed only of moras, feet only of syllables and the prosodic word only of feet. This particular presentation of prosodic structure brings out another commonly held assumption regarding prosodic constituents, which is that one of the elements of a constituent is the head and other elements of the constituent are dependents.[4] The formalism in (179), derived from Hammond (1984), uses a vertical line between two levels in the diagram, or "tree", to indicate that the constituent on the lower level is the head of the constituent on the higher level, while slanted lines indicate dependency. Thus, the vertical line from each mora to each syllable node indicates that the mora is the head of the syllable, while the slanted line from the onset consonant to the syllable node indicates that it is a dependent of the syllable. Similarly, since English has left-headed feet, the first syllable in each foot has a vertical line to the foot node showing it to be the head of the foot (= most prominent syllable), and the head foot of the PWRD is the rightmost foot. The syllable with the greatest prominence (= primary stress) in the PWRD, then, is the syllable that heads the most prominent foot, which necessarily has a vertical line extending from the bottom to the top of the tree. The initial foot, by contrast, has a slanted line at the level of the PWRD, and bears secondary stress since its level of prominence does not reach as high in the tree as that of the final foot.

Exhaustivity (178a) violations are found in a number of studies, including the present one, where, for instance, unfooted syllables attach directly to the PWRD (e.g. Itô & Mester 2003 [1992]; 2009a; Selkirk 1996; Booij 1996; Booij 1999; Bennett 2012), as illustrated by the English data in (180).

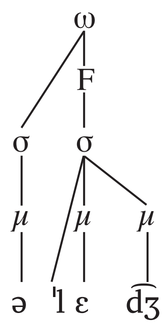
(180) Exhaustivity violations in English (Itô & Mester 2009a:152)
   a. *allege* [ə(ˈlɛd͡ʒ)]
   b. *banana* [bə(ˈnænə)]

In these words the foot (demarcated with round brackets) is aligned to the right edge of the prosodic word (demarcated with square brackets), leaving the initial syllable unfooted, which is obvious by

[4] It should be noted that the notion of head and dependent is sometimes restricted to feet and not to other prosodic constituents (e.g. Bennett 2012). In addition, this notion of head is not equivalent to the headedness principle of the SLH, which only speaks to what is allowed to dominate what. Although the headedness principle of the SLH stipulates what kind of element constitutes an obligatory element of a particular prosodic constituent (e.g. a syllable must head a foot), which is part of the standard notion of headedness in phonology (e.g. Anderson & Ewen 1987), it says nothing about the dependency relations *within* a constituent—that is, where there is more than one element within a constituent, one is the head and all others are dependents—a concept that is essential to the general notion of phonological headedness (e.g. Anderson & Ewen 1987; van Oostendorp 2013).

the lack of a full vowel in these syllables. Itô & Mester (2009a) analyze these “stray” syllables as adjoining directly to the PWRD, as shown by the tree diagram for (180a) given in (181).

(181) Prosodic structure of *allege*




Since the English foot is bimoraic and coda consonants are moraic (i.e. they count as a unit of weight and are associated with a mora) (e.g. Hayes 1980; 1995), the final bimoraic syllable forms a foot. The initial light syllable, however, is not associated with a foot in this analysis, but rather attaches directly to the PWRD.

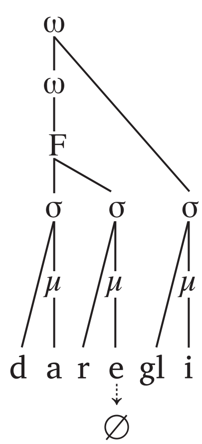
Limited recursion in prosodic units is also argued for by a number of researchers (e.g. Ladd 1986; 2008; Selkirk 1996; Booij 1996; Itô & Mester 2007; 2009a; 2009b; 2013; Bennett 2012), in violation of constraint (178b). Recursion is said to impossible for the categories foot and syllable (McCarthy & Prince 1993:85), however, by the independent principles of foot theory and syllable theory which “license a very limited set of expansions of foot and syllable,” which does not include recursion.[5] One kind of prosodic recursion that factors into the analysis of IM is the recursive PWRD. As an example of PWRD recursion, Booij (1996:225) cites the following Italian data from Nespor (1991):

[5] Nevertheless, it should be noted that Bennett (2012) argues in favour of foot recursion in order to unify the the analysis of the distribution coda [h] epenthesis in Huariapano with the location of stress. For other examples of recursive foot structures see, for instance, Selkirk (1980b), Anderson (2005), Martínez-Paricio (2013) and Kumagai (2016).

(182) a. dare = gli → *dargli (*daregli)* 'give them'
b. fare lezione → *far(e) lezione* 'to teach'

Italian has a vowel deletion rule that obligatorily applies to a word + clitic construction, as shown in (182a); however, in sequences of words that are part of the same PPh, the rule is optional, as shown in (182b). Booij's analysis of the prosodic structure of (182a) is that a PWrd is formed over the lexical word, and the syllable of the clitic is adjoined to this by creating a superordinate PWrd that encompasses the inner PWrd and the clitic—*[[dare]$_{PWrd}$ gli]$_{PWrd}$* , as diagramed in (183).

(183) Recursive PWrd structure (adapted from Booij 1996:225)




The rule can then be stated as deleting the final vowel of a PWrd before a consonant; it applies obligatorily within an extended PWrd, and optionally in the PPh.

Based on the discussion above we can say that evidence for the existence of a prosodic constituent lies in the identification of a string of phonological elements that functions as a unit with respect to phonological patterns and which corresponds to a unit in the prosodic hierarchy defined in (176). Minimally, this unit must conform to the properties of Layeredness (177a) and Headedness (177b). The strongest evidence for the distinctness of prosodic constituents from morphosyntactic constituents is evidence showing that the unit required to describe phonological patterns does not have a one-to-one correspondence with any unit provided by the morphosyntax (e.g. Selkirk 1980a;

1980c; 1986; Nespor & Vogel 2007 [1986]). Such phonological patterns may include rules governing phonological alternations, phonotactic generalizations or patterns of metrical prominence (Nespor & Vogel 2007 [1986]). A string is considered to function as a unit if it provides the domain for the application of a phonological rule or phonotactic generalization, or if it must be referenced by a phonological rule, as in a rule creating a foot from two syllables or moras (cf. Nespor & Vogel 2007 [1986]).

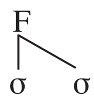
## 5.3 The foot

The prosodic structure of primary concern in this study is the foot, which is the prosodic constituent between the syllable and the prosodic word in the prosodic hierarchy (cf. (176)). I subscribe to the standard assumptions that a foot always dominates at least one syllable (cf. Headedness (177b)), and that it is dominated by a PWRD but never by a lower level constituent (cf. Layeredness (177a)). On the other hand, the prosodic structures posited in this research violate Nonrecursivity (178b) at the level of the PWRD, and I assume that not all syllables are grouped into feet, nor are PWRDs exhaustively parsed (divided) into feet, in violation of Exhaustivity (178a).

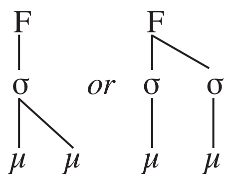
Evidence for the foot initially arose from the analysis of stress in metrical phonology, where the phonological string is parsed into binary groupings of strong-weak elements in order to compute the overall prominence profile (i.e. primary and secondary stresses) of the string (Liberman 1975; Liberman & Prince 1977), as was illustrated in (179). Based on the binary groupings required by stress patterns in his large survey of stress systems, Hayes (1985; 1987; 1995) proposed the following small set of putative universal foot types:

(184) Universal inventory of basic foot types (Hayes 1987; 1995)

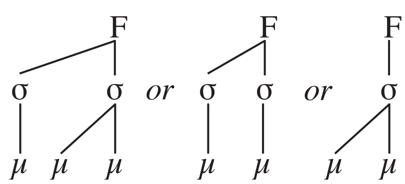
a. Syllabic trochee — Left-headed, quantity-insensitive




b. Moraic trochee — Left-headed, quantity-sensitive




c. Iamb — Right-headed, quantity-sensitive




All feet in the inventory are binary either in terms of having two syllables or two moras. According to the inventory in (184), the Syllabic trochee (a) has only a single licit form, while the Moraic trochee (b) and Iamb (c) foot types have acceptable alternative forms. Two parameters on which the three foot types contrast are which element of the foot is the head (i.e. the strongest or most prominent; sometimes also called "headedness", e.g. Crowhurst 1991; Kager 1993), and whether the foot is quantity-sensitive. If the left element in the foot is the head, the foot is said to be trochaic (184a–b), and if the right element is the head, it is an iamb (184c). The second parameter has to do with whether feet are constructed over syllables irrespective of their weight (i.e. their mora count), in which case they are quantity-*in*sensitive feet, or whether the weight of the syllable plays a role in foot construction, in which case the feet are quantity-sensitive. Phonological weight is determined on a language-specific basis; in some languages, syllables with either long vowels or codas count as heavy syllables, but in others only syllables with long vowels are considered heavy (Hyman 1985). Missing from the inventory is the right-headed, quantity-*in*sensitive foot, which reflects a putative typological gap (Hayes 1987; 1995). While iambs prefer an uneven rhythm (e.g. the first foot template given in (184c)), where the second element is not only more prominent than the first but also has greater weight, trochees are said to prefer an even rhythm even if they are quantity-sensitive, thus the absence of (ˈμμ.μ) as a moraic trochee foot template (Hayes 1987; 1995; Prince 1991 [1990]; however, see Harris & Urua (2001) for the claim that this foot type is a morphological template in Ibibio).

In this study I do not take a strong position as to whether the foot types in (184) are the only foot types that exist. They are certainly the most prevalent types attested cross-linguistically and should probably be considered as basic foot types from which other types are derived (e.g. Prince 1985; 1991 [1990]). The foot types in (184) are sufficient for describing the IM data, and in chapter 6 I will argue that the moraic trochee (184b) is the foot type that plays a central organizational role in IM phonology and morphology.

Classical metrical theory also allowed for unbounded feet—that is, feet which do not have a size restriction (Hayes 1995; Kager 1995). In stress systems with unbounded feet, words can consist of a single foot encompassing the entire word; however, various authors have argued that feet are strictly binary, ruling out unbounded feet (Prince 1985; 1991 [1990]; McCarthy & Prince 1996 [1986]; Kager 1989; 1993; Bennett 2012). By relaxing the requirement to exhaustively parse all syllables into feet (cf. the violable Exhaustivity constraint (178a)), stress assignment in languages with so-called unbounded feet is adequately handled by the construction of a single, bounded foot (Prince 1985; McCarthy & Prince 1993; Kager 1999; Bennett 2012).[6] Moreover, as Bennett (2012) argues, at least some "unbounded" systems show evidence for a binary foot from phonological patterns besides stress. This is the view that the IM data presented in chapter 6 support.

While the definitional property of the foot is often considered to be the vital role it plays in determining the location of word-level stress, numerous researchers have argued that the foot is independently required to describe other types of phonological patterns besides stress in a broad

[6] Prince (1985) actually assumes (inviolable) Exhaustivity but argues for a rule (Stray Adjunction) that takes syllables that are not parsed in initial creation of a single, binary foot, and creates a larger "derived foot".

range of languages. For instance, feet play a templatic role in many languages as minimal word templates, templates for morphological processes (McCarthy & Prince 1996 [1986]; McCarthy & Prince 1995) and as templates for sound change (e.g. Macken & Salmons 1997; Smith & Ussishkin 2015). In some languages, the foot also triggers processes of lengthening or shortening that have nothing to do with word/root minimality, but simply to ensure that feet that conform to the patterns in (184b–c) (Prince 1991 [1990]). Moreover, feet are also essential as domains for numerous phonological rules and phonotactic generalizations (e.g. Kiparsky 1979; Selkirk 1980a; Selkirk 1980b; Nespor & Vogel 2007 [1986]; Bennett 2012). In fact, Bennett (2012:2) argues convincingly that the foot can play a "central organizational role" even in phonological systems where stress assignment is not crucially based on iterative foot parsing, and that the foot should be considered a structure with a more general role in the phonological organization of words. In the rest of this section I will demonstrate the prototypical role of the foot in stress assignment in §5.3.1, its templatic role in 5.3.2 and its role in providing the domain for phonological processes and phonotactic generalizations in §5.3.3. In chapter 6, I show that each of these roles the foot is played by the couplet in IM, leading to the conclusion that the couplet should be identified as a foot.

### 5.3.1 The foot and stress

The prototypical role of the foot is the computation of stress in languages where stress has a rhythmic, alternating pattern, and longer words have multiple feet and therefore multiple syllables with prominence (e.g. Liberman 1975; Liberman & Prince 1977; Hayes 1980; 1995; Selkirk 1980b). In these languages, stress is said to be iterative and the string of phonemes is chunked or parsed into feet beginning at one edge of the word or the other, allowing, in some cases, for some constituent to be skipped at the edge of a domain (i.e. considered extrametrical) (Hayes 1980; 1995). A brief example of metrical parsing for stress computation has already been given in (179); for a more extended example we will consider stress assignment in Mansi (Uralic; Western Siberia).

Following Bennett (2012), Mansi stress is computed by constructing syllabic trochees from left to right beginning at the left edge of the word without skipping any syllables:

(185) Mansi stress (Bennett 2012:13–14; original data: Vaysman 2009:212–15)

| | | | |
|---|---|---|---|
| a. | [(ˈsa.mɛ)] | ‘its eye’ | (ˈσ σ) |
| b. | [(ˈa.tɛ)nəl] | ‘its smell (ablative)’ | (ˈσ σ)σ |
| c. | [(ˈo.ma)(ˌtɛ.nəl)] | ‘its mother (ablative)’ | (ˈσ σ)(ˌσ σ) |
| d. | [(ˈpo.ca)(ˈˌɣa.nəl)nəl] | ‘their (dual) drips (ablative)’ | (ˈσ σ)(ˌσ σ)σ |
| e. | [(ˈta.kʷə)(ˌsa.ɣə)(ˌnəl.nəl)] | ‘their (dual) autumns (ablative)’ | (ˈσ σ)(ˌσ σ)(ˌσ σ) |

Feet are required to be binary, thus words which have an odd number of syllables, like (185b) and (185d), end up with a single unfooted syllable at their right edge that does not bear stress. Words with an even number of syllables (185a, c, e), on the other hand, are exhaustively parsed into feet. Mansi feet are left-headed, so the first syllable in each foot is stressed. The leftmost foot is the head of the word and therefore bears primary stress, while the heads of the other feet bear secondary stress. Thus, primary and secondary stress fall out as a result of the organization of syllables into feet and feet into words. This was graphically illustrated by the metrical tree for the English word *Alabama* in (179), but in that language primary stress falls on the final foot of the word.

In languages where stress is located at or near one of the edges of the word and does not have an alternating pattern like we see in Mansi, one might wonder whether there is sufficient reason to posit foot structure (i.e. the existence of a single foot in prosodic words) since stress could simply be calculated with respect to the edge of the word. This question is addressed by Bennett (2012), who argues that in (at least some) languages of this sort there are reasons to posit foot structure apart from stress, since there are other phonological patterns which take the foot as their domain. One language he cites as providing evidence of this type is Uspanteko (Mayan, Guatemala). According to Bennett (2012), stress and (privative H) tone in this language always fall within a two-syllable window at the right edge of the word, and stress shifts within this domain so that it coincides with the syllable bearing H, if one is present. This binary unit, which the author takes to be a foot, is also the domain of an optional and gradient process of vowel syncope in the weak syllable of the foot, as well as a restriction on the distribution of tone with respect to vowels—based on the vowel sonority scale, low > mid > high/ə, the foot can only bear tone if the vowels in the foot (from left to right) have an equal sonority (e.g. ***rúxib'*** 'his/her/its aroma') or decreasing sonority (e.g. ***ánim*** 'woman'), otherwise, if the vowels increase in sonority (e.g. ***chukej*** 'cramp'), the foot cannot bear tone (Bennett 2012:172–3). Given the independent need for the foot as a prosodic structure to describe non-stress phenomena, Bennett (2012) takes the strong stance that stress is always assigned to the head of a foot regardless of whether some other computational scheme is possible (cf. Hayes 1995 and Halle & Vergnaud 1987 for unbounded feet, and Prince 1983 for a metrical grid approach that does not use feet).

### 5.3.2 The foot as a template

The property of the foot whereby it imposes a fixed shape upon morphological elements can be referred to as its templatic role (cf. McCarthy & Prince 1996 [1986]; 1995), and the foot patterns given in (184) are referred to as "shapes". These shapes are defined in terms of the number and kind of prosodic units (e.g. syllables, moras) with which they are composed rather than in terms of sequences of consonants and vowels (or skeletal slots). In many languages, the foot functions templatically as the minimal word or root shape (e.g. McCarthy & Prince 1996 [1986]; Hayes 1995:88). Sometimes this is simply seen in the static generalization that words or roots always minimally have this shape, but in others it is actively enforced, causing alternations in surface forms. A particularly vivid illustration of this is the minimal word template of the Lardil (Australian), which has been widely discussed in the literature (e.g. Wilkinson 1988; McCarthy & Prince 1996 [1986]; 1995), and warrants a closer look here because of the way it sheds light on the facts of IM.

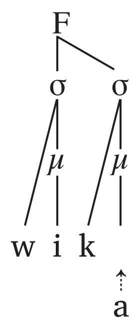
McCarthy & Prince (1995) describe the Lardil minimal word as a quantity-sensitive, bimoraic foot, where CVV(C) syllables count as heavy and CV(C) as light. The foot templatically triggers augmentation of subminimal forms and blocks a truncation process when it would create a subminimal form. First, consider the nominative and accusative forms of the bimoraic bases in Table 35.

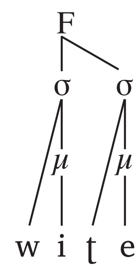
Table 35. The minimal word in Lardil (McCarthy & Prince 1995:222)

| | Underlying | Nominative | Accusative | Gloss |
|---|---|---|---|---|
| **Bimoraic base** | /wiṯe/ | *wiṯe* | *wiṯe–n* | ‘inside’ |
| | /peer/ | *peer* | *peer–in* | ‘ti-tree species’ |
| **Monomoraic base** | /wik/ | *wika* | *wik–in* | ‘shade’ |
| | /ter/ | *tera* | *ter–in* | ‘thigh’ |
| **Long bases** | /mayara/ | *mayar* | *mayara–n* | ‘rainbow’ |
| | /kantukantu/ | *kantukan* | *kantukantu–n* | ‘red’ |

Since these roots already fill out the bimoraic foot template, they are unchanged in the nominative and the accusative. Monomoraic roots, on the other hand, are subminimal and, therefore, are augmented with an epenthetic vowel in the nominative so that they will have two moras (/wik/ → *wika*). Augmentation is unnecessary in the accusative, however, since the accusative suffix *–in* supplies a second mora and no epenthesis occurs (/wik/ → *wikin*). At the same time, long bases are truncated—final vowels are deleted in the nominative (/mayara/ → *mayar*), as are consonants that are unable to form a licit coda with the preceding syllable; however, this process is blocked with bimoraic roots, since this would produce a subminimal structure. Both the process of augmentation and the suppression of truncation in this language find a unified explanation in positing that the minimal word is a bimoraic foot:

(186) a. Vowel epenthesis—/wik/ ‘shade’ b. Truncation blocked—/wiʈe/ ‘inside’





As illustrated in (186a), the trigger for epenthesis in the nominative of ‘shade’ is subminimality—that is, the failure of this form to fill the foot template. By the same token, (186b) shows that since the nominative of ‘inside’ exactly fills the foot template, deleting the final vowel would result in an an unfilled position of the template and therefore truncation is blocked.

The foot also functions templatically in a number of languages to stipulate the shape of reduplicative morphemes (e.g. McCarthy & Prince 1996 [1986]). Since this type of prosodic morphology is not present in IM I will not discuss it further; however, with the success of prosodic morphology in the analysis of nonconcatenative morphological processes like reduplication, historical phonologists began to recognize the templatic effects of higher level prosodic structure like the foot in sound change. This function of the foot, that has been receiving increasing attention in recent years, is of considerable interest to the discussion of the IM data and will be elaborated further.

One early analysis along these lines was Macken & Salmons’ (1997) analysis of several Highland Mixtec varieties that was discussed in §2.2. Their study showed how a trochaic foot template provides a coherent explanation for a number of diverse sound changes in those languages ranging from the location of consonant clusters to patterns of strengthening and weakening, consonant loss and vowel harmony. The intervening years have seen additional studies exploring the role of the foot in sound change (e.g. Holsinger 2000; 2008; Smith 2004; 2007; 2009; Simpson 2009). Nearly 20 years later, Smith & Ussishkin (2015) reiterate the call to consider the templatic role of prosodic structure, particularly the foot, in providing grounded explanations for otherwise disparate sound changes across languages. Citing more recent evidence from Germanic and Semitic studies, as well as Mixtec data from Macken & Salmons (1997), the authors argue that evidence from these unrelated language families "show[s] pervasive effects of foot-based prosodic templates in shaping the outcome of language change over time" (p. 284). To illustrate this, I consider examples from two different branches of West Germanic which parallel foot-conditioned sound changes in IM.

Vowel loss in Old Saxon provides an example of foot conditioned sound change that brings out the quantity-sensitive nature of the early Germanic foot. Smith & Ussishkin (2015) describe Germanic nouns as formed with a root, a thematic vowel and an inflectional suffix (number and case), as in Old Saxon *ferd+i–o* 'journey–PL.GEN'. As many inflectional endings were lost, the thematic vowels came to be in the word final position and thus also subject to loss. The facts concerning the loss of the theme vowels of the so-called *i*-stem noun class in Old Saxon illustrate the influence of prosodic structure in determining whether the thematic *i* was retained or lost.

The nominative/accusative data in Table 36 show that the theme vowel was lost after stems ending in VCC (e.g. *fard* (m.) 'journey') or V:C (e.g. *ti:d* (m.) 'time'), and retained after VC stems (e.g. *sel+i* 'room'). Observe that the data in the first two columns, which give words that had the stem structures (C)VCC and (C)V:C, respectively, have no theme vowel (*i*) at their right edge, whereas the words in the final column, which contains words that had the stem structure (C)VC, preserve the stem final theme vowel (in bold).

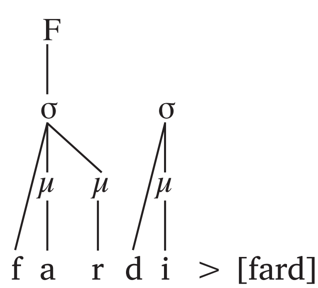
Table 36. *i*-loss and retention in Old Saxon *i*-stem nouns (Smith 2004:18–19)

| **(C)VCC stems** | **(C)V:C stems** | **(C)VC stems** |
|---|---|---|
| *fard* (f.) 'journey' | *ti:d* (m.) 'time' | *sel**i*** (m.) 'room' |
| *gast* (m.) 'guest' | *qua:n* (f.) 'woman' | *sted**i*** (f.) 'city' |
| *burg* (f.) 'town, city' | *thra:d* (m.) 'thread' | *win**i*** (m.) 'friend' |
| *wurm* (m.) 'worm' | *wa:g* (m.) 'wave' | |

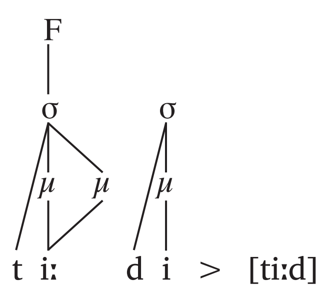
The explanation for why the vowel was lost after the (C)VCC and (C)Vː C stems and not after the (C)VC has to do with the way the stem + theme vowel were mapped to the foot template. The Germanic foot was a moraic trochee (184b) that was satisfied by a single heavy syllable ($\sigma_{\mu\mu}$), consisting of either a syllable with a short vowel and a coda consonant (VC) or a long vowel (Vː), or by two light syllables ($\sigma_{\mu}\sigma_{\mu}$) which had short vowels. In the stage of the language before the theme vowel was lost, the theme vowel formed a syllable with the final consonant as its onset with each type of stem in Table 36 (e.g. *far.di* 'journey', *tiː.di* 'time', *se.li* 'room'). The reason the theme vowel was lost with the (C)VCC and (C)Vː C stems is that when the stems were mapped to the foot, as shown in (187), the final syllable with the theme vowel was outside the foot, since the stem consisted of a heavy syllable and thus a complete foot.

(187) Foot structure before i-loss (based on Smith 2004:48)

a. *fard* 'journey'

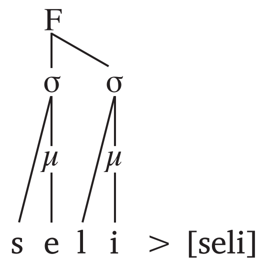



b. *tiːd* 'time'




The combination of the (C)VC stems with the theme vowel, on the other hand, resulted in two light syllables that formed a single foot that included the theme vowel:

(188) Foot structure of words with *i*-retention (based on Smith 2004:48)
*seli* 'room'




The generalization governing the loss of the theme vowels, then, is that when the theme vowel could be mapped to the foot template, it was retained, but when it could not, it was lost. As Smith & Ussishkin (2015) point out, both the deletion of the unfooted theme vowels and the retention of the theme vowel when it could be footed result in conformity with the trochaic foot template governing the shape of the *i*-stem noun class: On the one hand, an extraneous syllable is eliminated resulting in a single foot aligned to the right edge of the stem—$(\sigma_{\mu\mu})\sigma_{\mu} \rightarrow (\sigma_{\mu\mu})$, and on the other, the structure which retains *i* also forms a single trochaic foot aligned to the right edge of the stem—$(\sigma_{\mu}\sigma_{\mu})$.

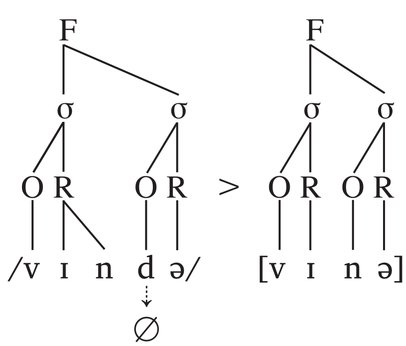
Turning now to consonantal phenomena, Holsinger (2000) has demonstrated that an array of phonetically dissimilar lenition processes (e.g. flapping, voicing, deletion, spirantization) in West Germanic languages can be given a unified analysis in terms of the templatic influence of a trochaic foot. The left syllable in the trochaic foot is the head (strong) and therefore expected to license the greatest variety of contrasts, as well as be the locus of fortition processes, while the second, non-head syllable is weak, and therefore expected to license fewer contrasts and undergo processes of lenition and neutralization (Macken 1996; Harris 1997; 2004; Macken & Salmons 1997; Holsinger 2000; 2001; Harris & Urua 2001). As an example of consonantal sound changes attributed to the trochaic foot in West Germanic, Smith & Ussishkin (2015) give the data in Table 37 showing the deletion of /d/ in Buttelstedt German (Thuringian, East Central German) as compared with Standard German (the Standard German data is given in German orthography).

Table 37. Medial consonant loss (Smith & Ussishkin 2015:273)

| | Buttelstedt | Standard | Gloss |
|---|---|---|---|
| **Inflection** | *wind, winə* | *Wind, Winde* | ‘wind, winds’ |
| | *khind, kinr̩* | *Kind, Kinder* | ‘child, children’ |
| | *blind, blinr̩* | *blind, blinder* | ‘blind, blind (masc.sg.strong.adj)’ |
| **Derivation** | *wind, winɪχ* | *Wind, windig* | ‘wind, windy’ |
| | *hund, hunəχn̩* | *Hund, Hündchen* | ‘dog, doggy’ |
| | *rind, rinr̩* | *Rind, geil sein* | ‘cow, randy’ |

Each pair of Standard German words show the retention of /d/ in the final position of the foot/word (e.g. Wind ‘wind’) and in the foot medial position (e.g. Winde ‘winds’). The Buttelstedt German data, in contrast, show that /d/ is only retained in the foot/word final position (e.g. *wind* ‘wind’), and is deleted foot medially (e.g. *winə* ‘winds’), even though the consonant is in the syllable onset, a syllable position which is typically subject to strengthening (Vennemann 1988). This diachronic process, which is not explained by recourse to the syllable, receives a straightforward explanation in a foot-based analysis since the deletion occurs precisely in the weak syllable of the trochaic foot. The historical derivation of winə ‘winds’ based on Smith & Ussishkin (2015) is given in (189).

(189) Foot-medial consonant loss in Buttelstedt German (Smith & Ussishkin 2015:274)




(They give the syllable structure of the foot template in terms of O = onset and R = rhyme instead of moras.) The target of the deletion process is easily singled out in the prosodic analysis as the the onset of the weak syllable of the trochaic foot. Moreover, the deletion also has the effect of reducing the weight of the initial syllable, which creates a balanced disyllabic foot.

The foot also plays a templatic role in the adaptation of loanwords in various languages where, among other things, it can cause truncation and augmentation in adapted forms. For instance, Silverman (1992) demonstrates that the Cantonese foot plays a templatic role in the adaptation of English words. He argues that Cantonese speakers truncate English words by "constructing a binary foot from left to right (as opposed to English right-to-Ieft foot construction)" (p. 316), as shown by these examples:

(190) Cantonese truncation (adapted from Silverman 1992:316)

a. b.


'resident' 'university library'

Adaptations of single word forms construct the foot over the first two syllables, as in (190a), while multi-word adaptations target the initial syllables forming a bisyllabic foot in the adapted form, as in (190b). Unfooted material (in parentheses), is deleted. He further demonstrates the influence of the foot in English loanword adaptation by showing that liquids in word initial consonant-liquid clusters are preserved only in monosyllabic forms. Although these forms constitute a (monosyllabic) bimoraic foot in English, since the codas bear a mora, they are mapped to a disyllabic foot template during adaptation, as in (191a).

(191) Cantonese liquid retention/deletion (adapted from Silverman 1992:319)

a. b.


'print' 'printer'

When *print* is mapped to the disyllabic foot template, the liquid *r* (adapted as *l*) maps to the onset of the second syllable and a vowel is epenthesized as the nucleus of the first syllable. The disyllabic word *printer* (191b), on the other hand, is able to map its two syllables to the two syllables of the foot template obviating the need to create a syllable from the initial cluster; the illicit cluster is consequently repaired by deleting the liquid.

Another example of how the foot functions templatically in loanword adaptation that is particularly relevant in light of the IM data to be discussed in chapter 6 is provided by English loanword adaptations in Fijian. By way of background, Kenstowicz (2007) describes Fijian as having a vowel length contrast:[7]

(192) Vowel length in Fijian (Kenstowicz 2007:317)
- a. *ˈkila* ‘wild’
  *kiˈlaː* ‘know it’
- b. *maˈkawa* ‘old’
  *ˌmaːˈcawa* ‘week’
  *ˌmacaˈwaː* ‘worthless’

Words are parsed iteratively into bimoraic trochaic feet from right to left, with long vowels constituting a bimoraic monosyllabic foot, and the rightmost foot bearing primary stress:

(193) Alternating trochaic stress in Fijian (Kenstowicz 2007:317)
*ˌkataˈkata* ‘hot’
*maˌtanaˈvotu* ‘visible world’
*ˌvakaˌtaːkiˈlaː* ‘reveal it’

Since the right edge of the word must be aligned with a foot, when a long vowel occurs in a penultimate syllable, it is shortened in order to ensure that the final foot is bimoraic and aligned with the right edge of the word:

[7] Transcriptions are given in Fijian orthography. I have substituted IPA symbols for the primary and secondary stress accent diacritics given in Kenstowicz (2007). The example *bu–qu* ‘my grandmother’ in (194b) did not have an accent mark in the source, but apparently should.

(194) Trochaic shortening in Fijian (Kenstowicz 2007:317)

a. ˈ*taː* ‘chop’
   ˈ*ta–y–a* ‘chop it’

b. ˈ*buː* ‘grandmother’
   *bu–qu* ‘my grandmother’

In these examples, the underlyingly long vowels in ˈ*taː* and ˈ*buː* are both shortened when the concatenation of other morphemes results in a trimoraic CVːCV stem in order to match the bimoraic foot template (→ CVCV), since a CV(VCV) parse would violate syllable integrity (cf. Prince 1976).

Turning now to templatic effects in loanwords, Kenstowicz (2007) notes that stress in adaptations that have the same number of syllables as their English source is predictable based on the location of stress in the source word, but various metrical adjustments occur to ensure that stress is realized in a bimoraic foot aligned to the right edge of the word. Two and three syllable English words with penultimate stress and a final open syllable present no challenge to metrical structure and trigger no changes syllable weight, as shown by these examples:

(195) English loanwords in Fijian (Kenstowicz 2007:319)

| | English | Fijian | English | Fijian |
|---|---|---|---|---|
| a. | *ˈjelly* | ˈ*jeli* | *ˈfever* | ˈ*fiva,* ˈ*viva* |
| b. | *toˈbacco* | *ta*ˈ*vako* | *paˈjama* | *pa*ˈ*jama* |

These words are straightforwardly adapted with a final disyllabic foot and the initial syllable, if there is one, is unstressed. Deletion of final consonants apparently is not an acceptable repair as these adaptations with penultimate stress and a final consonant show:

(196) English loanwords in Fijian (Kenstowicz 2007:319)

| | English | Fijian | | English | Fijian |
|---|---|---|---|---|---|
| a. | *ˈcabin* | ˌ*keː*ˈ*bini* | b. | *ˈlettuce* | ˌ*leː*ˈ*tisi* |

Without recourse to consonant deletion, a vowel is epenthesized after the final consonant to match the disyllabic foot template. Primary stress is consequently shifted to this foot, since the rightmost foot must be stressed. In addition, the initial syllable, which bore primary stress in the English source, is lengthened to match the monosyllabic foot template, allowing it to bear secondary stress. Note that word final ***r*** in English *fever* is orthographic and not pronounced except as rhotacization on the vowel.

English words with antepenultimate stress also conflict with Fijian metrical constraints and are adapted in a similar manner to those in (196):

(197) English loanwords in Fijian (Kenstowicz 2007:319)

| | **English** | **Fijian** | | **English** | **Fijian** |
|---|---|---|---|---|---|
| a. | *ˈcolony* | *ˌkoːˈloni* | b. | *ˈtaffeta* | *ˌtaːˈfeta* |

These words already end in an open syllable so no epenthesis is needed at the end of the word; however, as above, the vowel of the initial stressed syllable is lengthened to form a foot that bears secondary stress, and primary stress is shifted to the final foot.

A final type of Fijian adaptation to be considered are English words with final stress:

(198) English loanwords in Fijian (Kenstowicz 2007:319)

| | **English** | **Fijian** | **English** | **Fijian** |
|---|---|---|---|---|
| a. | *baˈzaar* | *baˈzaː* | *guiˈtar* | *qiˈtaː* |
| b. | *baˈlloon* | *baˈluni* | *perˈcent* | *paˈsede* |

Here again the final orthographic ***r*** is not pronounced in the examples in (198a), but in order to maintain the correspondence of stress in the adaptation with the stressed syllable of the source, the final vowel in this syllable must be lengthened to form a proper foot, matching the monosyllabic foot template. By contrast, the words with final stress in the examples in (198b) form a foot by epenthesizing a vowel after the final consonant to match the disyllabic foot template, as in (196). What is significant is that both strategies achieve the same result; the stressed syllable in the adaptation corresponds to the stressed syllable in the source word, and stress is realized in a proper foot that is aligned to the right edge of the word.

### 5.3.3 The foot as a domain for phonological processes and phonotactics

The third role for the foot is that it provides the domain for numerous phonological processes and phonotactic generalizations. In §5.3.1, we have already mentioned the case of Uspanteko (Mayan, Guatemala), where the foot, which is the domain of stress and tone placement, is also the domain of stress shift, a tone-vowel sonority interaction and an optional process of vowel syncope (Bennett 2012). In Applecross Gaelic (van der Hulst & Smith 1982), the foot is described as the domain of nasal spreading. In that language, nasalization spreads leftward and rightward from a stressed vowel until it reaches a blocking segment (an oral stop or /e, o, ə/) or a foot boundary:

(199) Nasalization in Applecross Gaelic (van der Hulst & Smith 1982:319; from Ternes 1973:134–5)
a. /ˈkʰɔ̃ispaxk/ → [(ˈkʰɔ̃ĩs̃paxk)] ‘wasp’
b. /kʰɔ + ˈvĩaˑt/ → [kʰɔ(ṽĩãˑt)] ‘how much’

In (199a), the nasal feature associated with the stressed vowel /ɔ/ cannot spread leftward to the initial stop, but spreads rightward up until it encounters /p/. In (199b), by contrast, the spread of nasalization to the initial /ɔ/ is blocked by a foot boundary.

As discussed in §5.3.2, the second syllable of a trochaic foot is weak and thus consonants and vowels in this position tend to be weakened and lost. This foot position is also the locus of synchronic weakening processes in various languages with this foot type. An example from English is flapping, where /t/ is aspirated in the foot initial position and flapped (→ [ɾ]) in the foot medial position, as in *potato* → pʰə(ˈtʰeɪ.ɾoʊ) (Kiparsky 1979:438; Harris 1997). Medial weakening is also found in the Nigerian language Ibibio (Lower Cross), which is described as lacking stress accent. Non-geminate stops /p, t, k/ undergo lenition to [β, r, ɣ] in the foot medial position, but not in the foot final position:

(200) Foot-medial lenition in Ibibio (Harris & Urua 2001:90)
  a. *(tóp)* tie   *(tó**β**ó)* 'tie oneself'
  b. *(bèt)* 'shut'  *(bè**ɾ**é)* 'be shut'
  c. *(fʌ́k)* 'cover' *(fʌ́**ɣ**ɔ́)* 'cover onself'

The first example in each pair shows the nonlenited version of the stops in the final position of the foot/word and the second example shows that the stop is lenited in the foot medial position (in bold). Stops that are in the initial position of the foot also do not undergo lenition even if they are intervocalic:

(201) Foot-initial stops in Ibibio (Harris & Urua 2001:90–1)
  a. *ú–(**t**áŋ)* 'plaiting'  **úɾáŋ*
  b. *ú–(**k**ʌ́p)* 'covering'  **úɣʌ́p*
  c. *í–(**b**àttá)* 's/he is not counting' **íβàttá*

Ibibio aligns the left edge of roots with the left edge of the foot, therefore, *t, k, b* are in the initial position of the foot in these examples and therefore do not weaken.

The Hare dialect of Slave (Athapaskan, Canada) is an example of a language where the foot has extensive influence throughout the phonology and morphology, including providing domains for phonological processes. Rice (1990) contends that the foot is a "basic organizing unit" (p. 201) in the phonology and morphology of the language. Besides providing the domain for phonological processes, the foot is also the domain of stress assignment and serves as a minimal word template and a base for affixation. I will focus this discussion on several of the foot-based phenomena in the verbal phonology, but it should be noted that there is also strong evidence for the foot in other lexical categories, though with some differences.

The Hare foot is described as a two syllable sequence consisting of a prestem syllable and a stem syllable (foot boundaries are indicated with round brackets; stems are in bold font):[8]

[8] See Rice (1990:207) for more detail on the Athapaskan verb word. In interlinear glosses I have shortened "conjugation/primary aspect" to "primary.aspect". She gives following explanation of the orthography used in examples is given: V́ = high toned vowel, V = low toned vowel, sh = [š], zh = [ž, y], gh = [ɣ], ch = [č], wh = voiceless w, w' = glottalized w, ɬ = voiceless lateral fricative, l = voiced lateral fricative, C' = ejective consonant, d, g, dz, dl, j = voiceless unaspirated stops, t, k, ts, tɬ, ch = voiceless aspirated stops. A hyphen before a verb stem indicates that it is preceded by some syllabic material. I have rendered her nasalized vowels as Ṽ, instead of V̨.

(202) a. *(dɛ**hjɛ̃**)* Rice (1990:211)
dɛ–h–jɛ̃
INCEPTIVE–1SG.SBJ–sing
'I start to sing'

b. *(hɪ̃́**dze**)gɛ*[9] Rice (1990:218)
hɛ–ndzég–ɛ
EPENTHETIC–be.sticky–STEM.FORMATIVE
'it is sticky'

c. *wɛ(ne**lu**)* Rice (1990:214)
wɛ–nɛ–lu
PRIMARY.ASPECT–2SG.SBJ–net:PFV
'you netted'

In (202a), the foot is coextensive with the word, but when the stem is disyllabic (202b), only the initial syllable of the stem is included in the foot. Similarly, when there is more than one prestem syllable (202c), only the one that is closest to the stem is footed, and an additional prestem syllable is extrametrical.

Rice (1990) indicates that it is this disyllabic unit that is the domain stress, with the initial syllable being "phonetically more prominent, having greater stress and fuller vowel quality" (p. 221). The stressed syllable does not change if the verb is suffixed, as in (202b) or preceded by another syllable, as in (202c). Since quantity-sensitivity is not mentioned, we can therefore conclude that the Hare foot is the syllabic trochee (184a) from the set of foot types.

The Hare foot also plays a templatic role as the minimal verb word. Verb words like the one in (202a) have a syllabic prestem morpheme (*dɛ–* 'inceptive') and thus the disyllabic minimum is met; however, when no prestem syllable is available a morphologically empty syllable, *hɛ*, is epenthesized:

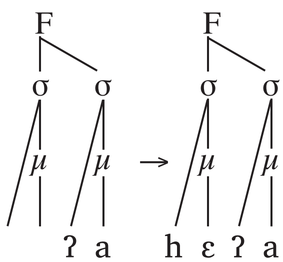
(203) a. *(hɛ**hjɛ̃**)* Rice (1990:211)
hɛ–h–jɛ̃
EPENTHETIC–1SG.SBJ–sing
'I sing'

[9] Rice (1990:220) includes the final root consonant, *g*, in the foot and only considers the stem formative suffix, ɛ, as extrametrical; however, it seems unlikely to me that this consonant would not form an onset for the final syllable and that this entire syllable would not be extrametrical by syllable integrity Prince (1976).

b. ***(hɛ́ʔa)*** Rice (1990:214)
hɛ–ʔá
EPENTHETIC–eat
‘s/he eats’

The derivation of (203b) in terms of prosodic structure is given in (204).

(204) Augmentation of deficient verbs (based on Rice 1990:219–20)




The left-hand side of the derivation shows the prosodic deficiency of the bare verb stem, which does not fill out the foot template. The requirement that verbs contain a foot as defined above triggers the augmentation of verbs lacking a prestem syllable through epenthesis so that the foot template is filled, as shown in the right-hand side of the derivation.

The foot is also the domain of a tone shifting process in Hare verbs. Verb stems are analyzed as either underlyingly H or toneless (phonetically realized with a low pitch). H tones, however, always appear on the prestem syllable rather than on the verb stem itself. That the tone is part of the lexical entry of the stem rather than the prestem syllable is easily demonstrated, since the same prestem morpheme is H when followed by a H stem and low when followed by a toneless stem:

(205) a. ***(nɛdõ)*** Rice (1990:216)
nɛ–dõ
2SG.SBJ–drink
‘you drink’

b. ***(nɛ́*ʔa)** Rice (1990:216)
nɛ–ʔá
2SG.SBJ–eat
'you eat'

Notice that the initial syllable of the foot (in bold), which is the second person singular subject agreement marker, *nɛ–*, in both examples, has an unspecified tone in (205a) but a H in (205b). This difference is due to the to the fact that 'drink' is toneless whereas 'eat' has H in its underlying representation. This H also shows up on an epenthetic syllable. An example of this has already been given in (202b) above, where the stem, ***ndéz*** 'be sticky' has a H tone which is realized on the epenthetic prestem syllable. This example also shows that the presence of a stem suffix (in this case, the stem formative *–ɛ*) does not affect the placement of the H tone.

Some roots are used to form both noun and verb stems. When the root with a H tone forms a noun stem the H tone appears on the stem, as indicated in the first column in (206); however, when the same root forms a verb stem the H tone shifts to the initial syllable of the foot, as shown by the examples in column two, where the root morpheme is in bold font.

(206)

| | Noun | Verb |
|---|---|---|
| a. | *t'é* 'charcoal' | ***(hɛ́ht'e)*** 'I cook' |
| b. | *xá* 'club' | *ʔɛ(dɛ́h**xa**)* 'I hit with club' |
| c. | *jí* 'baited hook' | *xa(dɛ́h**ji**)* 'I hook one after another' |

(Rice 1990:217)

We thus see that the foot is the domain of tone shifting in verb words and the only domain where verbal tone shift occurs. Rice (1990) suggests that this process should be taken as additional evidence for the prominence of the left branch of the foot—that is, the H tone is attracted to the position of prominence in the foot, a phenomena which has been demonstrated in various other languages (e.g. de Lacy 2002).

As a final example of a foot-based phonological process in Hare, consider the segmental process of vowel assimilation, which also takes the foot as its domain of application. Rice (1990) reports that the mid front nontense vowel is tensed (/ɛ/ → [e]) before a following tense vowel—/i, e, u/ (oral or nasal), but only within the foot:

(207) a. *(hehlĩ)* Rice (1990:214)
hɛ–h–lĩ
EPENTHETIC–1SG.SBJ–be
'I am'

b. *(néde)* Rice (1990:214)
nɛ–dé
2SG.SBJ–eat.piece.by.piece
'you eat piece by piece'

In (207a), the vowel of the epenthetic syllable (in bold), *hɛ*, assimilates the tenseness of the stem vowel /i/, since it falls with in the foot. Similarly, in (207b) the vowel of *nɛ–* assimilates the tenseness of the stem vowel /e/. Tenseness assimilation does not extend to a syllable preceding the foot, however, as demonstrated by these examples:

(208) a. *(welu)* Rice (1990:214)
wɛ–∅–lu
PRIMARY.ASPECT–3.SBJ–net:PFV
's/he netted'

b. *(nélu)* Rice (1990:214)
nɛ–lú
2SG.SBJ–net
'you net'

c. *wɛ(nelu)* Rice (1990:214)
wɛ–nɛ–lu
PRIMARY.ASPECT–2SG.SBJ–net:PFV
'you netted'

The first two examples show that the vowel of the prestem morphemes *wɛ–* and *nɛ–*, respectively (in bold), assimilate the tenseness of the stem vowel, /u/. When the verb contains both of these morphemes, however, as in (208c), only the morpheme (*nɛ–*) that immediately precedes the stem, and is therefore part of the foot, undergoes tenseness assimilation. Thus, the very same disyllabic unit which is the domain of stress assignment and tone placement in the verb, is also necessary to describe the domain of vowel assimilation.

In summary of the Hare data, we have seen that a disyllabic, trochaic foot is an important organizational structure in the verbal phonology and morphology. It is the locus of stress assignment and functions as a minimal word template which triggers the augmentation of deficient verbs through epenthesis. In support of the claim made in this section, the foot is also the domain of the non-templatic phonological processes tone shift and vowel assimilation.

## 5.4 Assigning prosodic structure

In this dissertation I make the fairly standard assumption that prosodic structure in the sense defined in §5.1 is generally not present in underlying forms (e.g. Selkirk 1980a; Nespor & Vogel 2007 [1986]). I also assume that prosodic structure stands in a close, though non-isomorphic, relationship to morphosyntactic structure and that there are rules or constraints that map morphosyntactic structure to prosodic structure (e.g. Selkirk 1980a; 1986; 2011; Nespor & Vogel 2007 [1986]; Booij & Lieber 1993; Booij 1999). In addition, I follow Booij & Rubach (1984) and various others (e.g. Booij 1988; Booij & Lieber 1993; Anderson 2005) in assuming that prosodic structure up to and including the level of the PWRD is assigned in the Lexical Phonology (Kiparsky 1982; Mohanan 1982).

An exception to the first assumption that has bearing on the analysis of IM is the case where the phonological consequences of a morphological boundary persist after the complex form has become fossilized and the morphological boundary no longer exists in the synchronic grammar. In order to solve a phonological problem of this type in Jita (Bantu, Tanzania), Kenstowicz (1993) includes prosodic boundary information in underlying forms, following proposals by Halle (1990) and Idsardi (1991).[10] In certain circumstances, a H tone in this language shifts one syllable to the right of the position it had in its etymological source, even across a word boundary. Nouns with

[10] It should be noted that Kenstowicz (1993) is a metrical analysis of data for which Downing (1988; 1990) provides a non-metrical analysis.

a final H in isolation shift their tone to the initial syllable of a following word, as shown by these examples:

(209) a. *i:ndará* 'leopard'
b. *ya:Bilima* 'ran'
c. *i:ndara yá:Bilima* 'the leopard ran'
(Kenstowicz 1993:266)

The word for 'leopard' (209a) has H on the final syllable in its isolation form, while the word 'ran' (209b) does not have a H tone; however, when 'ran' follows 'leopard' in a sentence (209c), the H from 'leopard' is realized on the first syllable of 'ran'.

Nouns with H on the penultimate syllable in isolation break into two groups, one in which the H does not shift, and one in which the H does shift. An example from the group where H does not shift is given in (210).

(210) a. *eBitu:ngúru* 'onions'
b. *mucikápo* 'in the basket'
c. *eBitu:ngúru mucikápo* 'onions in the basket'
(Kenstowicz 1993:266)

Observe that both of the first two examples have H on the penultimate syllable and this does not change when the words are put together in a phrase in (210c). In contrast, the data in (211) demonstrate how H shifts from the penultimate syllable of the word for 'pineapple', which belongs to the second group.

(211) a. *linanáji* 'pineapple'
b. *lya:malí:Bwa* 'was eaten'
c. *linanají lya:malí:Bwa* 'the pineapple was eaten'
(Kenstowicz 1993:266)

In isolation this word is stressed on the penultimate syllable, as shown in (211a); however, in (211c) we see that the H tone shifts to the ultimate syllable when it is followed by another word.

Kenstowicz (1993) argues that the phonological system has been reinterpreted such that syllables which bore the etymological H are now considered to mark the beginning of "a binary right-headed metrical constituent" (which we recognize as the foot), the head of which (i.e. the second syllable) is marked with a H tone. He proposes to mark this prosodic boundary in the lexicon with a left bracket, as shown in (212), which gives the metrical analysis of the data from (209), (210) and (211).[11]

(212) a. *i:nda(ra yá:)Bilima*
i:nda(ra ya:Bilima
leopard ran
'the leopard ran'

b. *eBi(tu:ngú)ru mucikápo*
eBi(tu:nguru mucikapo
onions in.the.basket
'onions in the basket'

c. *lina(nají) lya:malí:Bwa*
lina(naji lya:malí:Bwa
pineapple was.eaten
'the pineapple was eaten'

Foot boundaries in the examples are only provided for the nouns. In (212a), a left foot boundary occurs in the underlying form of 'leopard' at the beginning of the syllable *ra*. When this word is footed in the postlexical phonology, the left boundary of the foot is taken from the lexicon and the right boundary is supplied in the metrical parse. When another syllable is available to its right, as in this example, it forms the second syllable of the foot, and since feet in this language are right-headed, this syllable is the head and receives the H tone; however, when 'leopard' is pronounced in isolation (cf. (209a)), a degenerate (i.e. non-binary) foot is formed and the H tone is on the final syllable of the noun. Example (212b), on the other hand, has the underlying foot boundary before

[11] It should be noted that the interlinearization in (212) is not a complete morpheme-by-morpheme analysis, since this was not provided by Kenstowicz (1993). The metrical bracketing is my own, but is based on Kenstowicz's metrical analysis for the nouns in isolation.

the syllable, *tuː*, and thus the location of the H does not change since the foot always consists of *tuːngu*. In the final example (212c), the foot boundary is on the penultimate syllable and thus the foot is formed with the last two syllables of 'pineapple' in the sentence 'the pineapple was eaten' and the final syllable receives the H tone. Kenstowicz analyzes final syllables as extrametrical in this language and therefore the final syllable of 'pineapple' cannot be footed in the isolation form which results in H on the penultimate syllable (cf. (211a)).

## 5.5 Summary

The focus of this dissertation is on prosodic structure at the lower end of the prosodic hierarchy up to the prosodic word, but particularly on the foot. Various properties of the foot fall out from prosodic hierarchy theory (§5.2) and from the putative universal foot types that were given in (184) (Hayes 1987; 1995). These properties are given in (213) and I will refer to them as structural properties of the foot.

(213) Structural properties of the foot
a. The foot is built up from moras and syllables
b. The foot constitutes a unit of prosodic structure between the syllable and the prosodic word
c. The foot is a binary structure either in terms of syllables or moras
d. Feet may be quantity-sensitive or quantity-insensitive
e. The foot is a headed structure having a single strong element and all other elements being dependent or weak

In addition, foot structures matching the properties in (213) have been found to serve a number of recurrent roles or functions cross-linguistically. I refer to these as typologically common roles or functions of the foot:

(214) a. The foot is the locus of stress assignment (§5.3.1)
b. The foot is a structure which templatically affects the shape of morphemes (§5.3.2)
c. The foot is a structure which provides the domain of phonological rules and phonotactic generalizations (§5.3.3)

In the remainder of this dissertation, I will show that the IM couplet has the structural properties of the foot and fulfills the typologically common roles of the foot, and therefore should be considered a prosodic foot.

# Chapter 6

## The couplet is a foot

Building on the discussion of prosodic structure in Chapter 5, in this chapter I argue, based on data from Ixtayutla Mixtec, that the descriptive unit "couplet" from Mixtecan studies has the structural properties and fulfills the typologically common roles of the foot and therefore should be identified as a prosodic foot. I begin in §6.1 by showing that the couplet is the unit to which stress is assigned in IM, the prototypical property of the foot (cf. §5.3.1), and that the couplet has the structural properties of the moraic trochee from Hayes' (1995) inventory of foot types. In §6.2, I demonstrate that the couplet also functions templatically to affect the shape of morphemes, another cross-linguistically typical role of the foot. In both the synchronic phonology and the diachronic phonology, the couplet is shown to act as a minimal word/root template triggering the augmentation of subminimal forms so that they surface as a proper stress foot. A number of diverse sound changes also receive a unified explanation if the couplet is available in the grammar as a point of reference or diachronic template, another cross-linguistically common role of the foot discussed in §5.3.2. In the third major section (§6.3), I demonstrate that the couplet also provides the domain for the realization of a number of diverse phonological patterns including distributional restrictions on contrastive glottalization, nasal segments, vowels, labial consonants, epenthetic glottalization and tone. Providing the domain for the realization of phonological rules and phonotactic generalizations is a well-established role of the foot and crucial to the interface of the phonological component with other components of the grammar (cf. 5.3.3). The phonological patterns which take the couplet as their domain provide evidence that the couplet is a unit in the IM grammar, and since it is also the domain of stress and has the structural properties of the foot (§6.1) this unit should be identified as a prosodic foot. Having established the identity of the couplet as a foot in the first three major sections of the chapter, in §6.4 I show how the prosodic analysis provided for IM makes sense of a tonal process where L tones are raised in prosodically weak positions. In the final section (§6.5), I show that, just like the foot plays an important role in the adaptation of foreign words into languages like Cantonese and Fijian (cf. §5.3.2), the foot that is ubiquitous in the native phonology of IM also plays a pivotal role in the adaptation of Spanish words into the language.

## 6.1 The couplet and stress

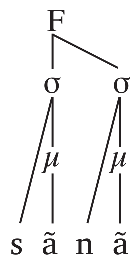
In the description of IM stress in §3.4, it was demonstrated that the location of stress on surface forms is variable in terms of syllables (i.e. either an ultimate heavy syllable or penultimate light syllable), but always occurs on the initial mora of the couplet—that is, stress always occurs on the penultimate mora of the grammatical word whether the couplet is disyllabic, as in (215a–b), or a bimoraic monosyllable, as in (215c–d).

(215)

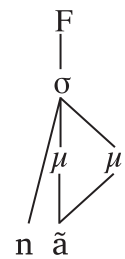
| | CV.CV | | | CV: | |
|---|---|---|---|---|---|
| a. | *(ˈsá̃.ná̃ᴸ)* | ‘domestic animal’ | c. | *(ˈnã̀ã̀)* | ‘to be lost’ |
| | *sá.(ˈlé.ɾú)* | ‘heron’ | | *sà.(ˈnã̀ã̀)* | ‘cause to be lost’ |
| b. | *(ˈⁿdúˀ.βá)* | ‘plain’ | d. | *(ˈɲã̀ˀã̀)* | ‘woman’ |
| | *ʃì.(ˈⁿdúˀ.βáᴸ)* | ‘spider’ | | *sà.(ˈɲã̀ˀá̃)* | ‘to show’ |

According to the metrical theory of stress, stress is assigned within feet (e.g. Liberman 1975; Liberman & Prince 1977; Selkirk 1980b; Hayes 1980; 1985; 1987; 1995), and when we take a look at the putative inventory of foot types in (184), we find that the form of the couplet—one heavy syllable or two light syllables—is precisely what has been identified in typological studies as a left-head, quantity-sensitive foot known as the moraic trochee (184b). This is demonstrated for the couplets *(ˈsá̃.ná̃ᴸ)* (215a) and *(ˈnã̀ã̀)* (215c) in (216).

(216) a. CV.CV couplet




b. CV: couplet

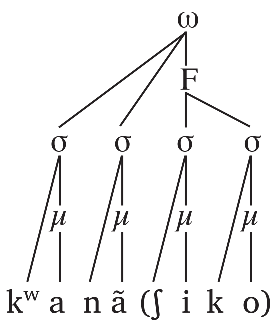



The disyllabic couplet (216a) exactly matches the disyllabic foot template from (184b), with stress on the initial syllable, and the monosyllabic couplet (216b) matches the monosyllabic foot template, with stress on the only syllable of the foot. On this account, the generalization for stress assignment in IM can be restated as assigning stress within a foot aligned to the right edge of the grammatical word, where the foot is a moraic trochee.

Although this dissertation is about the foot, it is necessary to discuss briefly how the foot fits into the structure of the IM prosodic word (PWRD). The definitional property of the IM PWRD is that it contains only one stress and thus, minimally consists of one prosodic foot (as in (216)), which serves as its obligatory nucleus or minimal PWRD. However, the PWRD may optionally contain syllables preceding the foot, as in (218), which gives the prosodic structure of *kʷānā̃́ʃīkò* 'going to resell':

(217) *[kʷānā̃́(ʃīkò)]*
kʷá–nà–ʃìkò
PROS–REP–sell
'going to resell'

(218) Pre-foot syllables in the IM prosodic word



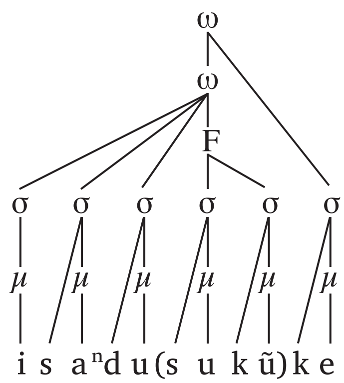

‘going to resell’

Given my current understanding of the data as lacking secondary stress in words that contain additional syllables to the left of the couplet (or of shifting primary stress) (cf. §3.4), I suggest that only a single foot is constructed in the PWRD and that it is aligned to the right edge of the PWRD. As shown, additional syllables are unfooted and attach directly to the PWRD in violation of the Exhaustivity constraint (cf. (178a)), but in keeping with various recent proposals (e.g. Itô & Mester 2003 [1992]; 2009a; Selkirk 1996; Booij 1996; Booij 1999; Bennett 2012).

As discussed in §5.4, structure such as that depicted in (218) is built in the Lexical Phonology, but the data also indicate that enclitics (cf. §2.5) are added to the PWRD in the Postlexical Phonology. These syllables also do not cause stress to shift (cf. §3.4) and are analyzed as unfooted, but with the difference (from material preceding the foot) that they are adjoined to the existing PWRD by the creation of a recursive PWRD (cf. §5.2), as shown in (220), which gives the prosodic structure of *ìsá$^{n}$dúsùkũ̄ké* ‘I caused (it) to become taller’:

(219) *[[ì.sá.$^{n}$dú(ˈsù.kũ̄)]ké]*
í–sà–$^{n}$dù–sùkũ̀$^{H}$ = ká = í
PFV–CAUS–INCH–tall=more=1SG
‘I caused (it) to become taller’

(220) The extended IM prosodic word




‘I caused (it) to become taller’

Here we see that the morphological stem, *sùkṹ̄* ‘tall’, appears as the stress foot and therefore the nucleus of a complex construction containing both prefixes and enclitics. The only foot in this structure is located at the right edge of the grammatical word and the right edge of the (inner) PWRD that is created in the Lexical Phonology. This lexical prosodic structure is preserved in the Postlexical Phonology where enclitic syllables are added to it by creating a superordinate PWRD, following the “affixal clitic” analysis of Selkirk (1996; cf. also Anderson 2005; Itô & Mester 2009a) in violation of the Nonrecursivity constraint (178b). The primary and only stress of the PWRD falls on the head of the foot, which is the first syllable of *sù.kṹ̄*. I leave open the possibility that some compounds could contain more than one PWRD and therefore have secondary stress. More study is needed to investigate the acoustic properties of stress in compounds and in larger words that are not compounds, particularly those containing enclitics, since enclitics are observed to (at least sometimes) have greater duration than the final syllable of the foot at least when the prosodic word in which they are included is the rhematic focus of the sentence.[1]

The PWRD structure given in (220) predicts not only that PWRDs will have a single stress, but that unfooted syllables both preceding and following the foot will be prosodically weak, a fact that is borne out in the data and discussed particularly in §6.2.2 and §6.4. It also predicts a close

[1] In terms of the information structure of the sentence, the rhematic focus is the part of the rheme (= comment) that is intended by the speaker to give the specific answer to the underlying question that the sentence is supposed to answer (Mel′čuk 2001:114).

and unique relation between the foot and enclitics, which is also found in the data, particularly in the obligatory tonal processes that occur between couplets and enclitics, but which only optionally apply from one couplet to the other (as discussed in Chapter 4). If instead of a recursive PWRD the enclitics were analyzed as attaching directly to the phonological phrase (PPH), another option presented in Selkirk (1996), the application of tonal processes might be predicted to be the same in couplet + enclitic and couplet + couplet constructions, since both would constitute a PPH.

It could be argued that instead of positing foot structure in IM, the location of stress could be computed by simply counting moras from the edge of the word, or using a metrical grid without recourse to prosodic structure (greater than the mora), as advocated, for instance, by Prince (1983) and Selkirk (1984), and this is certainly true; however, like Bennett (2012), I point out that this approach is then at a loss to adequately explain the many other generalizations that take the foot as their domain. As observed by Nespor & Vogel (2007 [1986]) in their arguments for the foot as a prosodic constituent, in the end we would have to reiterate the definition of the foot in the statement for each generalization. This loss of generalization surely represents a less parsimonious description of the language.

The same arguments can be made against analyzing IM as having a so-called unbounded foot—that is, with a single foot encompassing the entire word. Bennett (2012) has taken the strong stance that stress is always assigned to the heads of feet even in so-called "unbounded" stress systems based on evidence that these languages, like IM, still have phonological patterns that coincide with a binary foot which is also the locus of stress. This is unexpected if the foot encompasses the entire word; however, if the unit to which stress is assigned is binary we then see a convergence of evidence pointing to a binary foot. That being the case, Bennett reiterates the position of early prosodic phonology researchers (e.g. Selkirk 1980a; 1980b; 1980c; Nespor & Vogel 2007 [1986]; McCarthy & Prince 1996 [1986]) that the foot is a more general structure in phonology—that is, one which not only plays a part in stress assignment, but is a formal structure generally available in the grammar for other types of rules and phonotactic generalizations. Freedom from the assumption of Exhaustivity (cf. (178a)) allows us to construct a single foot at the right edge of the IM word, and it is this foot that serves as the formal unit to which the description of both stress and other phonological patterns refer.

As the first piece of evidence that the couplet should be considered a prosodic foot, therefore, I submit that the couplet is the unit that describes the locus of stress assignment in IM and that this unit has the properties of the moraic trochee from the inventory of foot types having a binary form that is quantity-sensitive and left headed. Both of the attested forms of the couplet—two light syllables ((C)V(ˀ)CV) (216a) and one heavy syllable ((C)V(ˀ)V) (216b)—are precisely the templates provided by the theory for this foot type (cf. (184b)). Moreover, the couplet is a unit that is intermediate between the syllable and the PWRD, as shown in (218). The placement of stress in IM can thus be straightforwardly described by saying that IM has a trochaic (left-headed) foot aligned with the right edge of the grammatical word.

## 6.2 The couplet as a template

In this section I present evidence to show that the couplet acts as a template affecting the shape of words in IM. Since it has been shown that feet have a similar templatic role in many other languages (cf. §5.3.2), and since the structures created have the form of the moraic trochee from the inventory of foot types (cf. (184b)), this evidence argues that the couplet should be considered a foot. §6.2.1 shows that the couplet acts synchronically as a template for the minimal word and root. In §6.2.2, I then show how the couplet acts as a canonical word/stem template for various types of sound changes.

### 6.2.1 Synchronic augmentation

In this section I show that there are good reasons to analyze IM couplets with the surface (C)V(ˀ)V as underlyingly monomoraic /(C)V(ˀ)/ and undergoing a synchronic process of vowel lengthening in order to satisfy the monosyllabic foot template (cf. §5.3.2) and meet the requirement that IM words be minimally a foot. I then demonstrate that when additional morphemes are concatenated to these monomoraic roots, they are not included in the foot with the root; instead, the root vowel is still lengthened and the prefixes or enclitics are joined to the couplet base. I take this as evidence that the foot is, more specifically, the minimal shape of *roots* in IM. The monomoraic roots demonstrate both the distinctness of morphological and prosodic structure, and also the fact that they are aligned to one another, as has been claimed in the analyses of two other Mixtec varieties—Coatzospan Mixtec (Gerfen 1996) and Ixpantepec Mixtec (Carroll 2015). I close the section by discussing (C)V($^{ʔ}$)V couplets in fossilized words that are larger than a couplet. Although the couplet of these words no longer constitutes the morphological root, it still has the same properties of other (C)V($^{ʔ}$)V couplets. These words provide additional evidence that the couplet is a prosodic structure which is non-isomorphic with morphosyntactic structure. Since the foot boundary is no longer predictable in these words based on morphological structure, I propose to include it in the lexical representation.

As shown in Chapter 3, IM has a large number of lexical roots that surface as a couplet having the shape (C)V($^{ʔ}$)V; however, there are reasons to argue that the underlying structure of these words is monomoraic, having the form /(C)V($^{ʔ}$)/. First, consider that surface (C)V($^{ʔ}$)V structures virtually always have a single vowel quality, and that, with the exception of the occasional occurrence in compounds (cf. §2.4.1), these long vowels are restricted to the couplet portion of the word—that is, to the final (heavy) syllable of the grammatical word, as illustrated by these examples: (The couplet is indicated in the examples with round brackets.)

(221) a. *tù(k$^{w}$áá$^{L}$)* ‘orange’
b. *tùk$^{w}$á(juù)* ‘guava’
c. *tùkútʃí($^{m}$búú)* ‘type of insect’
d. *ɲã̀(sɨ̀$^{ʔ}$ɨ̄)* ‘wife’
e. *$^{n}$dut$^{j}$à(ɲũ$^{ʔ}$ũ̀)* ‘floodwater, ocean’

Significantly, when a root with the surface form (C)V($^{ʔ}$)V is nonfinal in a compound, it is usually realized as a light CV syllable. This can be seen in (221b), which is a compound of ***tùk$^{w}$áá$^{L}$*** ‘orange’

(221a) and *júú*$^{L}$ 'stone', and (221d), which is a compound of *ɲãˀã̀* 'woman' and *sɨ̀ˀɨ̄* 'female mate'. In both examples, the vowel is long when that root is in the stressed couplet, and short when it is the first (unstressed) root in a compound (for other examples see (33) in §2.4.1). Since roots with the surface structure (C)V(ˀ)V alternate to a short CV when they are not the stressed couplet of the word, and since couplets always have a bimoraic structure, the restriction of vowels to this context argues that they are underlyingly short (i.e. /CV/ and /CVˀ/) and are lengthened in order to fulfill the requirements of a couplet template.

As mentioned, occasionally roots with this structure do surface with long vowels in compounds even when they are not in the couplet of the word as illustrated by these examples (repeated from (34)):

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (222) | a. | *júú*$^{L}$ | 'stone' | + *sáβí* | 'rain' | → *júúsàβí* ~ *júsàβí* | | 'hail' |
| | b. | *joˀò* | 'rope' | + *jutũ̀* | 'tree' | → *joˀòjutũ̀* ~ *jòjutũ̀* | | 'root' |
| | c. | *kóó*$^{L}$ | 'snake' | + *ja*$^{ʔn}$*dɨ̀* | '?' | → *kóójá*$^{ʔn}$*dí* ~ *kójá*$^{ʔn}$*d*$^{j}$*í* | | 'rainbow' |

While the long form may be acceptable (and even be preferred for the first two examples), a short form is a viable option; however, when roots such as these occur as the couplet of the word, as in the examples in (221), the vowels are obligatorily long.

Another argument for considering surface (C)V(ˀ)V to be underlyingly monomoraic is that this representation falls out naturally from what is known about the early historical development of couplets with this structure. Longacre (1955:195) and Mak & Longacre (1960:27) postulate that some Proto-Mixtecan *CV and *CVˀ monosyllabic morphemes lengthened in Mixtec (and other Mixtecan languages) to CVV and CVˀV structures, respectively (see also Josserand 1983:459. This development can be interpreted as the movement of Mixtecan languages, and Mixtec in particular, towards a general foot orientation in the phonology (cf. Macken & Salmons 1997).

The final, and most compelling, reason to consider (C)V(ˀ)V forms underlyingly monomoraic is their behaviour when combined with the first person singular, =*í*, and second person singular,

$=\tilde{u}$, enclitic pronouns.[2] When these two vowel initial enclitics combine with the right edge of words (which always end in a vowel), the vowel hiatus results in coalescence if the couplet of the base has the form (C)V(ˀ)CV (i.e. when the couplet is disyllabic, having a medial consonant); however, if the base has a (C)V(ˀ)V couplet structure (i.e. the couplet is monosyllabic having no medial consonant), there is no coalescence. Examples showing vowel coalescence are given in Table 38.

Table 38. Vowel coalescence in disyllabic couplets

| | **Noun** | **N + /=*í*/ '1SG'** | **N + /=*ũ*/ '2SG'** |
|---|---|---|---|
| /**i**/ | *títʃî* 'stomach' | *títʃí* 'my stomach' | *títʃũ̏* 'your stomach' |
| /**ɨ**/ | *kɨtɨ̀* 'horse' | *kɨ̀tī* 'my horse' | *kɨtũ̏* 'your horse' |
| /**u**/ | *ⁿdákù* 'broom' | *ⁿdákí* 'my broom' | *ⁿdákũ̏* 'your broom' |
| /**e**/ | *tɨ̀tʃéˀlé^L* 'cockroach' | *tɨ̀tʃéˀlè* 'my cockroach' | *tɨ̀tʃéˀlő̃^L* 'your cockroach' |
| /**o**/ | *tʃítò* 'bed' | *tʃíté* 'my bed' | *tʃítȍ̃* 'your bed' |
| /**a**/ | *káká* 'lime' | *káké* 'my lime' | *kákő̃* 'your lime' |

Each of the nouns in the first column end in one of the six IM vowels. The result of coalescence with the first and second person singular pronouns is given in columns two and three, respectively. The vowel hiatus and coalescence patterns from Table 38 are shown in (223).

(223)

| | **First person singular** | | **Second person singular** | |
|---|---|---|---|---|
| | **Input** | **Output** | **Input** | **Output** |
| a. | *i* + *i* → | *i* [cor, +high] | *i* + *ũ* → | *ũ* [+back, +high] |
| b. | *ɨ* + *i* → | *i* [cor, +high] | *ɨ* + *ũ* → | *ũ* [+back, +high] |
| c. | *u* + *i* → | *i* [cor, +high] | *u* + *ũ* → | *ũ* [+back, +high] |
| d. | *e* + *i* → | *e* [cor, -high] | *e* + *ũ* → | *õ* [+back, -high] |
| e. | *o* + *i* → | *e* [cor, -high] | *o* + *ũ* → | *õ* [+back, -high] |
| f. | *a* + *i* → | *e* [cor, -high] | *a* + *ũ* → | *õ* [+back, -high] |

The first vowel in each input column is the final vowel of the base and the second vowel is the pronoun vowel. The vowel in the output column is the result of coalescence and its distinctive features are given. As can be seen, the output vowel when combined with the first person singular

[2] I thank Scott Berthiaume for his insights on the original analysis of these pronouns.

pronoun is always coronal, which is the place feature of the pronoun vowel, even though the place of the base vowels varies (only the base vowels of (a) and (d) are coronal). The height of the output vowel, on the other hand, varies according to the height of the base vowel; that is, it is [+high] when the base vowel is [+high] (a–c), and it is [-high] when the base vowel is [-high] (d–f). Similarly, when combined with the second person singular pronoun, the output vowel is always [+back] (which also implies [+round] in IM) and is nasalized. These are all features of the pronoun vowel. The height of the output vowel, however, varies with the height of the base vowel, just as described for the first person singular pronoun data.

In contrast to the CVCV data presented in Table 38, consider the data in Table 39 and Table 40 showing bases with CVV and CVˀV couplets, respectively, in combination with the first person singular and second person singular pronouns.

Table 39. No vowel coalescence in CVV couplets

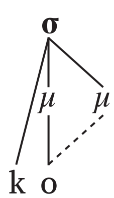
| | Noun | N + /=*í*/ '1SG' | N + /=*ũ*/ '2SG' |
|---|---|---|---|
| **/i/** | $^L$*pĩ̂* 'turkey hen' | *pĩ̀ĩ́* 'my turkey hen' | *pĩ́ũ̏* 'your turkey hen' |
| **/ɨ/** | *jɨ̃ɨ̃̀* 'husband' | *jɨ̃̀ɨ̃̄* 'my husband' | *jɨ̃ũ̏* 'your husband' |
| **/u/** | *júú*$^L$ 'rock' | *júì* 'my rock' | *júũ̋* 'your rock' |
| **/e/** | *lèē* 'baby' | *lèí* 'my baby' | *lèũ̏* 'your baby' |
| **/o/** | *kóó*$^L$ 'snake' | *kóì* 'my snake' | *kóũ̋* 'your snake' |
| **/a/** | *káà* 'metal' | *káí* 'my metal' | *káũ̏* 'your metal' |

Table 40. No vowel coalescence in CVˀV couplets

| | Noun | N + /=*í*/ '1SG' | N + /=*ũ*/ '2SG' |
|---|---|---|---|
| **/i/** | *mĩˀĩ̏* 'garbage' | *mĩ̏ˀũ̿* 'my garbage' | *mĩˀũ̏* 'your garbage' |
| **/ɨ/** | *sɨ̃̋ˀɨ̃̋* 'forked post' | *sɨ̃̋ˀĩ̋* 'my forked post' | *sɨ̃̋ˀũ̋* 'your forked post' |
| **/u/** | *juˀù* 'mouth' | *jùˀī* 'my mouth' | *juˀũ̏* 'your mouth' |
| **/e/** | *βeˀè* 'house' | *βèˀī* 'my house' | *βeˀũ̏* 'your house' |
| **/o/** | *joˀò* 'rope' | *jòˀī* 'my rope' | *joˀũ̏* 'your rope' |
| **/a/** | $^n$*daˀà* 'hand' | $^n$*dàˀī* 'my hand' | $^n$*daˀũ̏* 'your hand' |

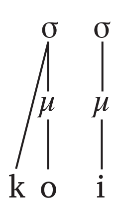
These data show no coalescence with the final root vowel (although tone rules apply, as described in Chapter 4). Rather, the segmental form of the pronoun is always ***i*** for the first person singular pronoun and ***ũ*** for the second person singular pronoun. I analyze the lack of coalescence in (C)V(ˀ)V couplets as an indication that there is no underlying vowel associated with the second mora for the clitic pronouns to coalesce with like there is in (C)VCV couplets. The roots of (C)V(ˀ)V couplets are underlyingly monomoraic /(C)V(ˀ)/ and only surface with long vowels to fulfill the requirements of the couplet template, as illustrated in (224).

(224) Augmentation of ***kóó***$^{L}$ 'snake'




However, when the first and second person enclitic pronouns, which are integrated into the root, are present, the second mora of the template is filled by the pronoun vowel and no coalescence or lengthening of the root vowel occurs, as shown in (225).[3]

(225) No augmentation in ***kói̋*** 'my snake'




This analysis receives interesting support from the pronunciation of a word that has both CVˀ**C**V and CVˀV variants. The word for 'cockroach' is pronounced both with a CVCV couplet, ***tı̀(tʲéˀlé***$^{L}$***)*** and with a CVˀV couplet, ***tı̀(tʲéˀé***$^{L}$***)***, by (at least) one speaker. This speaker gave ***tı̀tʲéˀlè***, with vowel

[3] At first glance, the integration of the vowel pronouns into the foot appears to be motivated by the goal of reducing larger structures down to foot-sized words. However, it is also consistent with a phonological constraint requiring that syllables have an onset, and since these pronouns also coalesce with other enclitics (e.g. *=ká* 'more' + *=í* '1SG' → *=ké* 'more:1SG'), avoiding onsetless syllables is likely the real motivation.

coalescence, as the first person singular form for the alternant with the CVCV couplet, and ***tɨ̀tʲéˀɨ̀***, without coalescence, for the form with the CVˀV couplet.[4]

To summarize this discussion so far, roots with the surface structure CVV and CVˀV are analyzed as underlyingly monomoraic /CV/ and /CVˀ/, respectively. Support for this analysis comes from the fact that they virtually always have identical long vowels which suggests a representation having a single vowel associated with two structural positions. This representation dovetails with the fact that long vowels are distributionally restricted to the couplet in noncompounds, and in compounds they are usually short if they are not the final root of the compound (and therefore the couplet), but must be long if they are. The picture that emerges, then, is that the couplet is a structure that is required to have a bimoraic shape and that vowels are long precisely when they belong to roots which must be realized in a couplet. This is corroborated by the fact that at least some roots with this structure are known to derive historically from /CV/ and /CVˀ/ structures. The final key piece of evidence for the analysis is the behaviour of these roots with respect to vowel coalescence with the first and second person enclitic pronouns. Unlike roots with CVCV couplets, roots which surface with (C)V(ˀ)V couplets do not undergo vowel coalescence when they combine with these vowel initial enclitics; the pronoun vowels simply fill the final vowel slot of the couplet. I argue that this is because there is no underlying vowel in this couplet position to coalesce with. This analysis provides a vivid example of how the couplet is, in Josserand's (1983:183) words, "a phonological or surface frame for underlying morphological material to fit into, or accommodate itself to, for its spoken realizations", and why I argue that the couplet cannot be considered a morphosyntactic structure like a root. The possessed couplets in Table 39 and Table 40 contain two distinct morphemes (root and pronoun) which do not even overlap in terms of their segmental makeup since there is no vowel coalescence.

[4] The three known (C)V(ˀ)V words with different vowels (***ʃíú***$^{L}$ 'abdomen', ***àú*** 'yes' and ***tʃáˀṹ*** 'fifteen') are analyzed as disyllabic with the second vowel specified underlyingly. Unfortunately, these words all end in a [+high] vowel (as do the pronoun vowels), so it is impossible to test definitively whether they would display the coalescence patterns of (C)V(ˀ)CV bases or of (C)V(ˀ)V, since the height of the base vowel in each of these words is the same as the height of the pronoun vowel, so coalescence would not result in a vowel height alternation (cf. Table 38a–c).

The property of the couplet whereby it provides the minimal size and shape which words or roots must satisfy is a well-attested property of the foot, which serves as the minimal word template in numerous languages (e.g. McCarthy & Prince 1996 [1986]; Hayes 1995:88). More importantly, the augmentation that occurs in IM monomoraic roots creates a structure that matches the monosyllabic template of the moraic trochee (cf. (184b)). This type of augmentation is just like the augmentation of Lardil monomoraic bases in the nominative case that was shown in Table 35 (§5.3.2), except that in IM the process is one of vowel lengthening, whereas in Lardil it is accomplished through vowel epenthesis. Similarly, just like the combination of monomoraic bases with the accusative suffix (*–in*) in Lardil satisfies the bimoraic template and blocks augmentation, so the concatenation of monomoraic roots with the first and second person singular pronouns satisfies the monosyllabic foot template and blocks augmentation in IM. I therefore conclude that, given the equivalence of the couplet forms with the foot templates of the moraic trochee established in §6.1, this behaviour of triggering the augmentation of /(C)V($^{ʔ}$)V/ roots to match the bimoraic template counts as strong evidence that the couplet should be considered a prosodic foot. This analysis will receive further corroboration from the analysis of Spanish loanword adaptations presented in §6.5, where Spanish words with final stress undergo similar vowel lengthening so that stress is realized in a bimoraic foot.

Up to this point the discussion has focused on lexical words where the failure to augment would result in a subminimal word and the couplet has functioned as a minimal word template. The data in (226), however, show that augmentation occurs not only when word minimality would be violated, but also when additional morphemes are present which could be used to create a proper foot and yet they are not parsed into the foot.

(226) a. *sà($^{n}$dóò)$^{n}$dò*
sà–$^{n}$dô = $^{n}$dò
CAUS–remain=2PL
'Leave (it) you guys!'

b. *kʷá(kú'ú)ɾà*
kʷá–ku'ᴴ = ɾà
PROS–be.sick=3MASC
'He is going to be sick'

These examples have the monomoraic roots, /ⁿdô/ and /ku'ᴴ/, respectively. As can be seen, in neither example are the enclitic pronouns (= *ⁿdò* '2PL' and = *ɾà* '3MASC') included as the final syllable of the foot, which would result in the erroneous parsings, **sà(ⁿdóⁿdò)* and **kʷá(kú'ɾà)*, respectively. At the same time, neither are the causative (*sà–*) and the prospective aspect (*kʷá–*) prefixes included as the initial syllable in the foot, as in the fallacious parsings, **(sàⁿdó)ⁿdò* and **(kʷákú)ɾà*, respectively. Instead, the monomoraic roots are expanded to fill the foot template just like when they are the only morpheme in the word. This type of augmentation cannot be viewed as creating a minimal word, but as creating a minimal root. It is clear from data like this that there is a rule requiring the morphological root to be mapped to the foot template, and specifically, that the left edge of the root be aligned to the left edge of the foot. A special rule, then, must be postulated which allows the vowel initial enclitics to be included in the foot.

The final aspect of (C)V(')V couplets to discuss is their occurrence in fossilized forms that are larger than a couplet, as illustrated by these examples: (The "•" symbol indicates a hypothesized etymological morpheme boundary.)

(227) a. *mà̃(ⁿdoò)*
mà•ⁿdò
turtle
'turtle'

b. *ɾì(ɾòó)*
ɾì•ɾó
mayor
'mayor'

c. *tú(mã'ã̀)*
tú•mà'
raccoon
'raccoon'

d. *tù(βéˀé)*
tú^L•βèˀ
area.outside.of.house
'area outside the house'

Each of these examples end in a stressed heavy syllable (couplet), which has the form CV: for (227a) and (227b), and CVˀV for (227c) and (227d). Based on the examples in (226), the phonological form of these words leads us to expect a morphological root boundary at the location of "•" in the second interlinear line, that the roots of each example would be /ⁿdò/, /ɾó/, /mà̰ˀ/ and /βèˀ/, respectively, and that the roots are augmented to fill out the couplet. This is not the case, however, since these elements are not synchronic roots, but are hypothesized to be etymological roots.[5] Nevertheless, these words still behave like the /(C)V(ˀ)/ roots described above when combined with the first person singular pronoun, as shown in (228).

(228) a. *mà̰ⁿdòī*
mà•ⁿdò=í
turtle=1SG
'my turtle'

b. *ɾìɾòí*
ɾì•ɾó=í
mayor=1SG
'my mayor'

c. *túmà̰ˀḭ̄*
tú•màˀ=í
raccoon=1SG
'my raccoon'

[5] The internal structure of (227a) and (227b) is completely opaque, while elements of the second two examples can still be reconstructed, but involve fossilized elements and have undergone a phonological process that is no longer part of the synchronic grammar. In (227c), *tú* can be confidently identified as deriving historically from the fossilized animal classifier, *tɨ–*, and has undergone labial assimilation (no longer a synchronic process) and tonal dissimilation with the etymological root. The etymological root could be related to *má̰ˀà̰* 'mother', but has the /L/ tonal melody rather than /HL/. In (227d), the root is clearly identifiable as *βeˀe* 'house', which has undergone tone sandhi due to the element that precedes it. I hypothesize that the preceding element comes from the final syllable of *tʃátá^L* 'back', which also underwent labial assimilation with the initial root consonant. This seems plausible because *tʃátá βéˀé* 'behind the house' is a common contemporary expression with a related meaning and this etymology would also explain the kind of tone sandhi seen in this word.

d. *tùβé'ĩ*
   túᴸ•βè' = í
   area.outside.of.house=1SG
   ‘area outside my house’

Although the final vowel in each example is [-high], the pronoun vowel does not coalesce and become *e* (cf. (223)), it simply fills the final slot in the foot template just as observed in Tables 39 and 40 for (C)V(ˀ)V roots. In other words, although this element that I have called the etymological root has no synchronic status, it still behaves phonologically like it is a monomoraic root to which the foot must be aligned and which has no underlying vowel for the pronoun to coalesce with. Creating a foot that included the initial CV (e.g. **(mã̀ⁿdò)* (227a), **(ɾìɾó)* (227b), **(túmã̀ˀ)* (227c), **(tùβéˀ)* (227d)) would not only incorrectly predict vowel coalescence, but would also result in the wrong stress pattern as well as other kinds phonological patterns violating foot-phonotactics that will be discussed in §6.3.

The proper footing of these words, then, depends on establishing a foot boundary at the location of the etymological root. What I propose, following Kenstowicz’s (1993) analysis of H tone shifting in Jita (Bantu, Tanzania) that was discussed in §5.4, is that the etymological root boundary has been reinterpreted in the grammar as a prosodic boundary. Since this boundary is no longer predictable from the morphological structure, I propose to mark the left boundary of the foot at the left edge of the etymological root in the lexical entries for words like these, as shown in (229).

(229) a. /mà(ⁿdò/ → *mã̀(ⁿdoò)* ‘turtle’
  b. /ɾì(ɾó/ → *ɾì(ɾòó)* ‘mayor’
  c. /tú(màˀ/ → *tú(mãˀã̀)* ‘raccoon’
  d. /tùᴸ(βèˀ/ → *tù(βéˀé)* ‘area outside of the house’

When these words are parsed into feet, the left boundary of the foot is supplied by the lexicon for these words, and the right boundary is determined by the foot template which triggers augmentation (cf. (224)). In (C)V(ˀ)V couplets where the etymological root = the morphological root, the left edge of the morphological root is aligned with the left edge of the foot template.

### 6.2.2 Diachronic templatic effects

In this section, we will examine IM data showing that various types of diachronic processes have occurred which create couplet sized structures, but which are no longer part of the synchronic grammar and therefore demonstrate the importance of the couplet shape as a point of reference in sound change. In some cases, subminimal forms were augmented to create a couplet, while in others, forms that were larger than a couplet were truncated down to couplet size. Since it has already been established that the IM couplet has the structural properties of a moraic trochee (cf. (184b)), and since it was demonstrated in §5.3.2 that the foot commonly functions as a template for sound change, I take these data as evidence that the IM couplet should be identified as a foot.

#### 6.2.2.1 The couplet in word-formation

In this section I examine fossilized forms of historic word formation processes in IM and show how the couplet acts as a template stipulating the minimal form of the stems that are formed and also the canonical maximal form. In these examples, minimality is satisfied for the most part not through vowel lengthening, as in the preceding section, but through combining roots with other morphemes to form couplet-sized stems. On the other hand, truncation of longer forms to satisfy the canonical maximum is also observed. Josserand (1983:460) identified the tendency to reduce multisyllabic constructions down to “the favored two-syllable couplet form” as one of the most important processes at work in Mixtecan languages and in the earlier development of Mixtecan from Proto-Otomanguean. In IM, this diachronic influence of the couplet can be seen in the deletion of the vowel of the etymological (CV) prefix or relegating it to a secondary articulation on its onset consonant. The principle examples of this type come from the class of verbs that mark a realis/irrealis mood distinction through separate stems that evolved from the combination of verb roots with the now fossilized mood prefixes. After describing the influence of the couplet templates in this old word-formation process, I describe similar, though more limited, examples from the formation of animal words with the old animal classifier prefix.

In §2.4.2, I described a relatively small group of irregular verbs that have fossilized realis and irrealis stems that were formed with the mood prefixes, ***kù***– 'irrealis' and ***tʃì***– 'realis'. Historically, this class of verbs had a small number of monomoraic roots consisting of a single CV and when these roots formed a stem with the mood prefixes they did not follow the usual strategy of vowel lengthening described in §6.2.1. Rather, the mood prefixes were included in the couplet forming a disyllabic stem, as shown by these examples:

Table 41. Irrealis/realis stems with CV roots

| **Root** | **Gloss** | **Irrealis *kù*– 'IRR'** | | **Realis *tʃì*– 'REAL'** | |
|---|---|---|---|---|---|
| */tʲì/* | 'bathe' | *ˈku•tʲì* | **kuˈtʲiì* | *ˈtʃi•tʲì* | **tʃiˈtʲiì* |
| */tù/* | 'clear land' | *ˈku•tù* | **kuˈtuù* | *ˈtʃi•tù* | **tʃiˈtuù* |
| */ɲì/* | 'hear' | *ˈkũ•ɲĩ̀* | **kuˈɲĩĩ̀* | *ˈtʃĩ•ɲĩ̀* | **tʃiˈɲĩĩ̀* |
| */nù/* | 'run' | *ˈkũ•nũ̀* | **kuˈɲũũ̀* | *ˈtʃĩ•nũ̀* | **tʃiˈɲũũ̀* |
| */tò/* | 'know' | *ˈko•tò*[6] | **kuˈtoò* | *ˈtʃi•tò* | **tʃiˈtoò* |

The etymological root and its gloss are given in the first two columns, followed by the synchronic form of the irrealis stem (formed with ***kù***–) and the realis stem (formed with ***tʃì***–). In each example, the mood prefix is included as the stressed syllable of the couplet rather than forming a pre-couplet syllable plus a CVː root couplet, as illustrated by the unattested (starred) forms to the right of each example.

This verb class also had roots with a VCV shape which met the bimoraic minimality constraint before the addition of the prefix. What is interesting is that the realis and irrealis stems formed from these roots are contracted so that they also conform to a disyllabic couplet pattern. In the majority of cases, this involved the loss of the prefix vowel as in these examples:

[6] The irrealis prefix in this example undergoes a process of vowel harmony with the root vowel.

Table 42. Prefix V deletion in realis-irrealis stems

| Root | Gloss | Irrealis ***ku–*** '**IRR**' | | Realis ***tʃi̵–*** '**REAL**' | |
|---|---|---|---|---|---|
| /asɨᴴ/ | 'close' | *k•ásɨ́* | **kuˈasɨ* | *tʃ•àsɨ̄* | **tʃi̵ˈasɨ* |
| /ãnũᴴ/ | 'destroy' | *k•ã́nũ̋* | **kuˈãnũ* | *tʃ•ã̏nũ̄* | **tʃi̵ˈãnũ* |
| /ìsò/ | 'carry' | *k•isò* | **kuˈiso* | *tʃ•isò* | **tʃi̵ˈiso* |
| /ósó/ | 'sprinkle' | *k•ósó* | **kuˈoso* | *tʃ•òsó* | **tʃi̵ˈoso* |
| /ũˀɲĩᴴ/ | 'tie' | *k•ũ̋ˀɲĩ́* | **kuˈũˀɲĩ* | *tʃ•ũ̏ˀɲĩ̄* | **tʃi̵ˈũˀɲĩ* |

In each example, the synchronic stem consists of the prefix consonant plus the root. To the right of the stem is given the unattested form without vowel deletion. This form may have been the original form of the stem; however, it is also possible that this verb class was always constrained to a couplet shape, as will be discussed further below.

Another strategy used to truncate the prefix + root to form a single couplet was glide formation whereby the nucleus of the the *kù–* prefix was relegated to the syllable onset through labialization. This allowed the entire prefix to map to the initial consonant position of the couplet, as in these examples:

Table 43. Prefix labialization in irrealis stems

| Root | Gloss | Irrealis ***ku–*** **IRR** | | Realis ***tʃi̵–*** **REAL** | |
|---|---|---|---|---|---|
| /ákú/ | 'laugh' | *kʷ•ákú* | **kuˈaku* | *tʃ•àkú* | **tʃi̵ˈaku* |
| /ã́ɲú/ | 'step on' | *kʷ•ã́ɲṹ* | **kuˈãɲũ* | *tʃ•ã̏ɲṹ* | **tʃi̵ˈãɲũ* |
| /ã̏ˀnù/ | 'grow' | *kʷ•ãˀnũ̏* | **kuˈãˀnũ* | *tʃ•ãˀnũ̏* | **tʃi̵ˈãˀnũ* |
| /ã̏/ | 'have sex' | *kʷ•ãã̏* | **kuˈãã, *ˈkũã* | *tʃ•ãã̏* | **tʃi̵ˈãã, *ˈtʃuã* |
| /ã́ˀ/ | 'go' | *kʷ•ã́ˀã́* | **kuˈãˀã, *ˈkũãˀ* | *tʃ•ã́ˀã́* | **tʃi̵ˈãˀã, *ˈtʃũãˀ* |

All but one of the roots which follow this strategy of truncation begin with /a/, although not all roots beginning with this vowel labialized the irrealis prefix (cf. Table 42). Corresponding realis stems, on the other hand, deleted the prefix vowel and did not undergo glide formation. The unpredictability of *kù–* labialization shows that this word-formation process involved lexically conditioned allomorphy and supports the analysis that the the realis/irrealis stems are fossilized.[7] Note also that the final two examples have vowel initial monomoraic roots. The root vowel is lengthened (cf. §6.2.1) creating CVː and CVˀV couplets, respectively, rather than allowing the mood prefixes to form the initial syllable of the couplet like the CV monomoraic roots in Table 41. This follows from the nearly total prohibition against different vowels in monosyllabic couplets in IM (cf. §3.1) apart from roots that combine with the first and second person enclitic pronouns (cf. §6.2.1), and the requirement of this class of verbs that couplet-shaped stems be formed with the mood prefixes + the verb root.[8]

From the preceding discussion one might wonder whether the truncation observed in Table 42 and Table 43 is not merely the avoidance of hiatus. While this may be part of the motivation for these processes, it must be noted that hiatus is tolerated in the synchronic morphology at the couplet boundary:

(230) a. *kʷàkú(àsū)*
kʷá–kù–àsù^H
PROS–be–blue
'going to be blue'

b. *íkū(úˀβì)ɾà*
í–kù–úˀβì = ɾà
PFV–be–hurt=3MASC
'was hurt'

These examples demonstrate the productive process of deriving deadjectival verbs using *kù–* 'be', which is homophonous with the fossilized irrealis prefix. In each of the examples there is vowel hiatus between a pre-couplet syllable and a vowel initial couplet, yet neither prefix vowel deletion

[7] It can also observed that there are stem pairs, *kã́ˀnṹ/tʃã́ˀnṹ* 'break' and *kʷãˀnũ̀/tʃãˀnũ̀* 'grow', where the irrealis stems would be segmentally homophonous except that in the former the prefix vowels was deleted, while in the latter the prefix vowel labialized. The prefix vowel is deleted in both realis stems and they are segmentally homophonous.

[8] A couple of VCV roots—*iɲɨ* 'be standing' and *iyo* 'exist'—pattern with the verbs discussed in the next dataset (231), which have CVCV roots, in that they use the bare root in the imperfective aspect, while the realis stem, which truncates to a couplet, is only used with the perfective aspect. They are the only two verbs I know of that can form a vowel initial couplet.

nor labialization is triggered. Instead, the vowel initial couplet is subject to epenthetic glottalization, which is discussed in §6.3.5.

A few verbs with realis/irrealis stems have a CVCV root structure and do not show any truncation in the realis and irrealis stems formed with the mood prefixes, as illustrated in (231).

(231) a. *(ⁿdʲìkṹ)tɨ̀*
ᴸ⁀ⁿdʲíkṹ
IPFV⁀be.tied=3ANML
‘it is tied’

b. ***ítʃī*** *(ⁿdʲíkũ̀)tɨ̀*
í–tʃì•ⁿdʲíkũ̀ = tɨ̀
PFV–be.tied:REAL=3ANML
‘it was tied’

c. *ìtʲã́ã́* ***kù****(ⁿdʲíkũ̀)tɨ̀*
ì(tʲã́ kù•ⁿdʲíkũ̀ = tɨ̀
tomorrow be.tied:IRR=3ANML
‘tomorrow it will be tied’

Most roots with this structure use the bare root in the imperfective, as shown in (231a), and only use the realis stem in the perfective aspect, as shown in (231b). As can be seen, the fossilized realis prefix (in bold) is completely external to the couplet; the same is also true of the irrealis prefix (in bold) in (231c).

The discussion above shows that the formation of realis/irrealis stems has obviously been subject to the templatic influence of the bimoraic couplet. When the root had a monomoraic CV shape, a disyllabic CVCV couplet was formed by simply including the prefix as the first syllable of the couplet, e.g. *kù–tʲì* → *(ku•tʲì)* ‘will bathe’. This can be viewed as augmenting the deficient root to form a minimal, couplet-sized stem required by this class of verbs. On the other hand, when the verb root had the VCV shape, stem formation (potentially) created a trimoraic stem which was larger than the couplet template. These stems were truncated down to a CVCV couplet usually by deleting the prefix vowel—for example, *kù–(ásɨ́)* → *(k•ásɨ́)* ‘will close’—and also, in the case of the irrealis prefix, by labializing the prefix—for example, ***kù–(ákú) → kʷákú*** 'will laugh'. Monomoraic roots lacking an onset demonstrate an interesting interaction between the morphological requirement to form couplet-sized stems with the mood prefixes and the phonotactic requirement that monosyllabic couplets have a single vowel quality—the roots were augmented by vowel lengthening, and the prefix was truncated, resulting in CV(ˀ)V couplets—***kù–ã̀ → kù–(ãã̀)*** ***→ (kʷ•ãã̀)*** 'will have sex'; ***kù–ã́ˀ → kù–(ã́ˀã́) → kʷ•ã́ˀã́*** 'is going'. Verbs from this class with CVCV roots already had the ideal CVCV couplet structure and demonstrate that there are limits to how much deviation from the input is tolerated in order to achieve template satisfaction. For instance, were the form ***kù–ⁿdʲíkũ̀*** (231c) to be truncated to ****k–ⁿdʲikũ***, the resulting onset cluster ***kⁿdʲ*** would be an unacceptable violation of syllable structure, and deleting the initial root consonant to produce ****kʷikũ*** (or ****kikũ***) or deleting the entire prefix (****ⁿdʲikũ***), would remove signifiers essential to the meaning. The very fact that the imperfective forms of these verbs, by and large, do not use the ***tʃi–*** prefix, may itself be due to pressure from the system towards couplet-sized structures.

The correspondence between root structure and realis/irrealis stem structure are summarized in Table 44, with the couplet boundaries marked in the stem structure.

Table 44. Correspondence between root structure and realis/irrealis stem structure

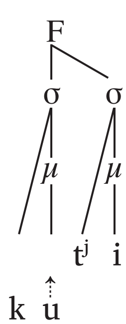
| **Root** | **Stem** | **Comment** |
|---|---|---|
| V | (CVV) | |
| Vˀ | (CVˀV) | |
| CV | (CVCV) | /ⁿdʲá/ 'sit' patterns with CVCV roots[9] |
| VCV | (CVCV) | /ɨɲɨ̀/ 'stand', /iyoᴴ/ 'exist' pattern with CVCV roots |
| CVCV | (CVCV) | imperfective |
| | CV(CVCV) | perfective, irrealis |

[9] This is one CV root in this verb class, /ⁿdʲá/ 'sit', which follows the lengthening strategy of augmentation and surfaces as ***ⁿdʲàā*** in the imperfective, ***ì–tʃí•(ⁿdʲáá)*** in the perfective and the irrealis stem is ***kù•(ⁿdʲáá)***. The realis and irrealis prefixes are completely external to the couplet and the realis stem is only used in the perfective following the typical pattern of CVCV roots, that will be discussed below.

At this point, it is not certain whether the couplet initially served as a morphological template for the stem formation process so that intermediate forms (e.g. *kù–(ásɨ́)*, *kù–(ákú)*, *kù–(ãã̀)*, *kù–(ã́ˀã́)*) never surfaced due to a requirement that the output of this process be a couplet, or whether the intermediate forms were the original output of the stem formation process and the couplet served as a template that triggered subsequent sound changes. Whatever the case may be, the overall result is that couplets of every type (cf. (11), (215)) were produced by this verb stem formation process, although CVCV couplets were highly preferred and CV(ˀ)V couplets came about only as a last resort, so to speak, when monomoraic roots contained no onset consonant and thus could not serve as the second syllable of a CVCV couplet.

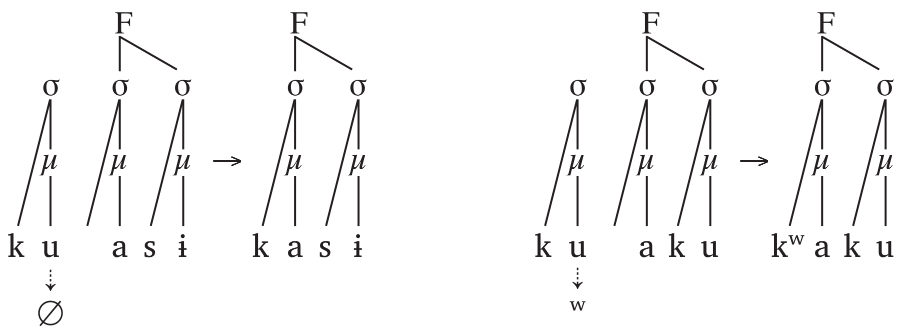
The templatic influence of the couplet described here with respect to the realis/irealis stems, whether as a morphological template at some earlier stage of the language, or a template for sound change, is a very common function of the foot cross-linguistically, as was demonstrated in §5.3.2. I therefore regard this as further evidence that the couplet should be considered a foot. CV roots of this verb class were right aligned in the foot similar to the alignment of verb stems to the foot in Hare (cf. (204)), while the prefix filled the initial syllable of the foot template:

(232) Foot structure of CV roots—*ku•tʲì* 'will bathe'




Foot structure also provides the means of both describing the phonological locus of vowel loss/labialization in VCV roots and of motivating it:

(233) a. Vowel deletion—***k•ásɨ́*** ‘will close’ b. Labialization—***kʷ•ákú*** ‘will laugh’




In terms of location, the vowel loss/labialization occurred in an unfooted syllable preceding the foot. The motivation is three-fold: First, prefix vowels which are lost or labialized are in an unfooted syllable and therefore a weak prosodic position (cf. §5.3.2). By contrast, the prefix vowel is never lost/labialized when it is internal to the couplet, as in (232). This is similar to the situation in Old Saxon ***i***-stem nouns discussed in §5.3.2, where the theme vowel was lost when it was not footed and retained when it was (cf. (187) and (188)). A second way that the foot motivates prefix vowel loss/labialization before VCV roots is that the foot provides the canonical word shape, which may have been the required shape of these stems (within limits). Therefore, the processes of vowel deletion and labialization created the ideal foot structure. In fact, the maximally articulated CVCV foot, aligned to the right edge of the grammatical word appears to have been strongly preferred by this class of verbs, as demonstrated in Table 44. This explains why roots which already had a CVCV shape were left alone—they already had the ideal structure. The third motivation for vowel loss/labialization is that these processes phonetically strengthen the initial and phonologically strong position of the foot by providing the VCV roots with an onset (cf. Macken & Salmons 1997; Vennemann 1988).

Several things are particularly significant about the couplet-sized stems in Tables 41, 42 and 43. One is that these stems, which were historically multimorphemic structures, display the same phonological patterns (to be described in §6.3) that characterize other couplets, including glottalization (cf. §6.3.1), nasalization (cf. §6.3.2) and tone patterns and processes (cf. §6.3.6), etc. It is also significant that in the case of CV roots, the mood prefix ends up as the stress bearing syllable, contrary to the usual state of affairs where stress always falls on the root. The reason for this apparent stress shift is due to the irregular mapping of these verbs to the foot template. Usually, the left edge of the root maps to the left edge of the foot (e.g. /sà–/ 'CAUS' + /ⁿdô/ 'to remain' → *sà(ⁿdóò)* 'to leave'; cf. §6.2.1); however, similar to what we saw for Hare (cf. (202)), these verbs map the left edge of the *stem* formed with a mood prefix + a root to the left edge of the foot, as shown in (232), and the syllable mapped to the head of the foot is stressed regardless of whether it is the morphological head or not. This indicates another mismatch between prosodic structure and morphosyntactic structure in IM, though at an earlier stage of the language. Finally, the crucial fact is that when these elements combine to form a stem, no lengthening of the morphological root is observed (e.g. *kù–tʲì → (ku•tʲì)* 'will bathe', **kù(tʲìì)*; cf. 6.2.1) since the requirements of the foot templates (184b) are met by integrating the prefix into the foot.

Though not as extensive, another sector of the lexicon with examples of templatic effects similar to those of the realis/irrealis stems is animal names. As discussed in §2.4.1, a number of animal names were formed from the combination of the fossilized animal classifier prefix, *tì–*, plus a root. Two examples which show the prefix included in the couplet together with a monomoraic CV root, like the realis/irrealis stems in Table 41, are given in (234).

(234) a. *tȉ•ɲɨ̋* 'rat' cf. **tijĩʔ* (Josserand 1983:480)
b. *tɨ́•kà* 'grasshopper'

Interestingly, the cognates of both of these words as well as several other animal names in Chalcatongo Mixtec (CM) have two free variant forms: one form is a disyllabic couplet consisting of the prefix + root, like those in (234), and the other form follows the root augmentation strategy discussed in §6.2.1 and lengthens the root vowel to satisfy the couplet template (data from Macaulay 1996:235–6):

(235) a. *tĩ́•ñṹṹ* ∼ *tĩ́•ñĩ́* ‘rat’
b. *ti•kàà* ∼ *ti•kà* ‘grasshopper’
c. *tĩ•ñṹṹ* ∼ *te•ñṹ* ‘owl’
d. *ti•xíi* ∼ *ti•xi* ‘buzzard’
e. *ti•míí* ∼ *ti•mí* ‘bee’

The IM words for ‘owl’ (*kã$^{ʔ}$mũ̀*), ‘bee’ (*ɲúɲú$^{L}$*) and possibly ‘buzzard’ (*màtʃìì*) do not appear to be cognate with the CM words. These data, which apply both strategies of template satisfaction, corroborate the analysis that the forms in (234) include the animal prefix inside the couplet, since the same forms in (235) have a variant where the prefix is outside the couplet, but more importantly, they provide strong support for the existence of a bimoraic template within the larger Mixtec family which has both a disyllabic and a single heavy syllable form. If a prefix is integrated into the couplet, then no lengthening occurs; however, if it is not, then the root vowel is lengthened so that it surfaces as a bimoraic foot.

Truncation similar to the labialization of the irrealis prefix that was demonstrated in Table 43 is also found in animal names. A number of animal names formed with *ti–* have also been truncated down to a couplet-sized structure as illustrated in Table 45.

Table 45. Truncation by glide formation in animal names

| **IM form** | | **Forms in other Mixtec varieties** | |
|---|---|---|---|
| *tʲákà* | ‘fish’ | *ti•jáká* ∼ *tʃáká* | (SM; Dyk & Stoudt 1965:12, 46) |
| *tʲúkũ̀* | ‘fly’ | *ti•júkṹ* ∼ *tʃúkṹ* | (SM; Dyk & Stoudt 1965:15) |
| *tʲókò* | ‘ant’ | *ti•jókó* ∼ *tʃókó* | (SM; Dyk & Stoudt 1965:14) |
| *tʲóó$^{L}$* | ‘crab’ | *ti•joo* | (Chayuco Mixtec; Pensinger 1974:48) |
| *tʲó$^{ʔ}$ó$^{L}$* | ‘flea’ | *ti•jòʔó* ∼ *tʃòʔó* | (SM; Dyk & Stoudt 1965:15) |

Comparing the IM forms with those of other Mixtec varieties (San Miguel El Grande (SM), Dyk & Stoudt 1965 and Chayuco Mixtec, Pensinger 1974) shows that the form evolved from a combination of the animal prefix and a root with an initial palatal glide, which is, in fact, how Dürr (1987:55) reconstructs the proto-form of *tʲákà* ‘fish’—**ti–jakaʔ* ‘fish’. A likely scenario is that the adjacency of the high vowel of the animal prefix to the initial palatal glide induced the loss of the prefix vowel and then *t* was palatalized (*tj* → *tʲ*). According to Josserand (1983:259, 263–4, 456–7), palatalization was a major phonological process in the development of modern Mixtec throughout the Mixteca, particularly among the eastern coastal dialects, where IM lies. Further, de Leon's (1988:140) study on Mixtec classifiers identified ***ti, tʃ, tj*** and ***si*** as variants of the animal classifier, and the SM forms still showed free variation between the full form and the palatalized form at the time Dyk & Stoudt (1965) was published (and possibly still do). In the following examples, which do not have a root initial glide, the animal classifier appears to have been lost altogether in IM:

Table 46. *tì–* loss in animal names

| IM form | | Forms in other Mixtec varieties | |
|---|---|---|---|
| *sáá* | 'bird' | *ti•saā* ∼ *saā* | (SM; Dyk & Stoudt 1965:101)[10] |
| *íná* | 'dog' | *ti•ʔinā* ∼ *inā* | (SM; Dyk & Stoudt 1965:101)[11] |

This also results in reduction to a couplet, but additionally, the loss of the morphological information of the prefix.

It should be noted that examples like *tʲóó$^L$* 'crab' and *tʲóˀó$^L$* 'flea' in Table 45 show that the prefix was not always included as the initial syllable of the couplet with CV roots, since the etymological roots of these forms are /jo/ and /joˀ/, respectively (cf. also *tì•ⁿdʲíí$^L$* 'type of insect' and *tì•ɲíˀí$^L$* 'skunk', which have lengthened root vowels). What is non-negotiable in the grammar is that the word be at least a bimoraic couplet. The normal means to accomplish this for monomoraic roots is through lengthening the root vowel, as demonstrated in §6.2.1; however, for whatever reason, the two forms listed in (234) satisfied the template by including the prefix in the couplet.

It should also be kept in mind that the truncation demonstrated in Table 45 occurs in a very limited context—that is, where the animal prefix precedes a *j*-initial root. In other contexts, the prefix vowel has not deleted in animal names, as shown by these examples:

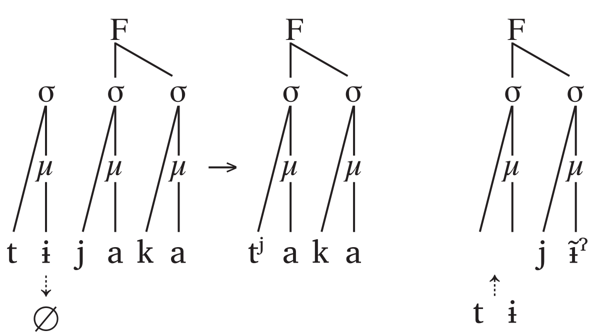
[10] Cf. **ti laa* Proto-Mixtec (Josserand 1983:479)

[11] However, Dürr (1987:43, 53) gives the proto-form **ina* 'dog', even though 6/17 (possibly 7) sources have the prefix (or a reduced form of it), and one (SM) has it optionally, which he doesn't note.

(236) a. *tɨ́•kiʃĩ̀* 'moth'
b. *tɨ́•$^{n}$dakù* 'worm'
c. *tɨ̀•t$^{j}$é$^{ʔ}$lé$^{L}$* 'cockroach'
d. *tú•mã$^{ʔ}$ã̀* 'racoon'[12]

Deletion also appears to be restricted to the morphological context of the animal prefix, since it does not occur in *nì(ji$^{ʔ}$i)* 'raw' and *tɨ̀(jɨ́ɨ́)* 'type of land formation'. It is important to remember, however, that the context of the vowel deletion still must be described in terms of the couplet—that is, it is the vowel of the syllable preceding the couplet. Significantly, *ɨ*-deletion and palatalization did not occur in (234a) (cf. the proto-form **tɨ•jĩ$^{ʔ}$*) where the segmental sequence *tɨj* is internal to the couplet. The conditions for the rule are not only that the couplet initial consonant be /j/ and the /ɨ/ belong to the animal prefix, but also that *tɨ* be external to the couplet. This is very similar to the conditions of prefix vowel loss/labialization in realis/irrealis stems and also to the templatically governed *i*-deletion in Old Saxon *i*-stem nouns. Not all vowels were deleted in those stems, but the deletion site of the theme vowel is predictable based on foot structure: if the theme vowel was external to the foot (cf. (187)), the vowel was deleted; however, if it was footed with the stem, it was not (cf. (188)). Following the foot-based analysis of Old Saxon and the IM realis/irrealis stems above, I also take the facts of *ɨ*-deletion in IM as evidence that the couplet should be considered a prosodic foot. The foot-based account of the process is given in (237).

(237) a. Vowel deletion—*t$^{j}$ákà* 'fish' b. No vowel deletion—**tɨ•jĩ$^{ʔ}$* 'rat'




12 The etymological prefix has undergone labial assimilation with the labial consonant of the root.

When the prefix vowel is left unfooted and the initial C of the foot was /j/, the vowel was deleted, as shown in (237a); however, when the prefix fell within the foot, as in (237b), the vowel was not deleted. Seen in this light, *ɨ*-deletion is sanctioned due to the weak prosodic position of the vowel and it results in a canonical word structure consisting of a single CVCV foot aligned to the right edge of the grammatical word. This process also results in strengthening the initial C position of the foot, just like vowel deletion/labialization in realis/irrealis stems, since the consonantal strength of the palatalized stop /tʲ/ is higher than that of the approximant /j/ (Murray & Vennemann 1983:519; Vennemann 1988:9). In the next section, we will see that this same location is the site of deletion of other vowels.

6.2.2.2 Couplet-initial consonant clusters

An important piece of evidence presented by Macken & Salmons (1997) in support of their hypothesis that the Mixtec couplet is a foot template is the fact that *s*C clusters (i.e. *s* + consonant) have developed only in the initial position of the couplet in CM. They take this, together with the tendency of proto-glides (**w, *j*) to be realized as obstruents couplet-initially in that language as evidence for strengthening the initial position of the trochaic foot. This process is complementary to diachronic weakening in the couplet-medial position in CM, in particular, which is seen in the tendency of glides (approximants) to be realized as glides in this position (i.e. not strengthened to obstruents) or to be lost altogether. Both tendencies, they argue, result in an overall trend towards a CVV template that worsens the syllable structure according to Vennemann's (1988) syllable preference laws, which state that the ideal syllable onset is exactly one consonant, since complex onsets are created couplet initially and syllables lose their onsets couplet medially. A syllable-based analysis fails to capture the distribution of the consonant clusters or to motivate them; however, if the fundamental organizational unit is the trochaic foot rather than the syllable the distribution falls out naturally. The *s*C clusters are formed through diachronic processes at the onset of the foot, which is the precise location where clusters might be expected to be tolerated (if anywhere), since the initial syllable of the trochaic foot is strong, and therefore sanctions the greatest number of contrasts (Macken 1996; Harris 1997; 2004; Macken & Salmons 1997; Dresher & van der Hulst 1998; Harris & Urua 2001).

In this section I examine similar evidence from IM and show that IM not only has *s*C clusters, but also several other kinds of clusters with similar characteristics. The following data illustrate the *s*C clusters that are found in IM with the boundaries of the couplet marked with round brackets:

| | | | | |
|---|---|---|---|---|
| (238) | a. | *(skʷíí^L)* | 'Llano Verde (town)' | |
| | b. | *(sjúˀmã̀)* | 'Llano Escondido (town)' | |
| | c. | *(stúú)* | 'sir' | |
| | d. | *(stóˀó) ~ tʃí(tóˀó)* | 'owner' | |
| | e. | *tɨ̃̀(stʲaβì)* | 'stock of maguey flower' | cf. *jaβì* 'maguey' |
| | f. | *stá(tʃaˀà)* | 'liver' | cf. *ʃítá^L* 'tortilla', *tʃáˀá^L* 'foot' |

As shown by these examples, *s*C clusters in IM also typically occur at the left edge of the couplet, just as Macken & Salmons (1997) claim for CM; however, example (238f) (and a few others discussed below) show that this generalization must be qualified. The strong generalization that the IM data support is that consonant clusters do not occur couplet medially, but in compounds such as (238f), syncope may occur in the initial syllable of the first root in the compound.[13]

Macken & Salmons (1997) state that *s*C clusters evolved by the coalescence of *s*V syllables prefixed to roots in CM, but give no examples. A clear conditioning pattern for this type of cluster does not emerge from the IM *s*C data alone due to a lack of etymological information on the unreduced form of most of the words; however, IM also has *ʃ*C and *ɲ̥ⁿd* clusters (which Macken & Salmons do not mention for the languages discussed in their paper) that give a clearer picture. The data in (239) show words with /ʃi/ preceding the couplet, in which the high vowel /i/ is frequently devoiced or elided creating an initial *ʃ*C cluster.

[13] It is also possible, at least in rapid speech, to contract the preposition-pronoun combination, *tʃìì=tɨ̀* 'to it', to *stɨ*. I have not studied this sufficiently to say whether this contracted form forms a couplet (with augmentation, cf. §6.2.1) or leans prosodically on a neighbouring lexical word. At this point, I consider this kind of contraction to be a fast-speech phenomena and do not pursue it further.

(239) a. *(ʃkɨ́jɨ́$^{L}$) ~ ʃì(kɨ́jɨ́$^{L}$)* ‘blister’
b. *(ʃkẽˀẽ̀) ~ ʃì(kẽˀẽ̀)* ‘fly’
c. *(ʃkʷɨ̃́ɲɨ̃́$^{L}$) ~ ʃì(kʷɨ̃́ɲɨ̃́$^{L}$)* ‘type of corn’

In these words, pronouncing /i/ in the pre-couplet syllable is acceptable, but in fast speech or even “normal” speech it is lost.[14] In other words with a pre-couplet /ʃi/ syllable, there is usually at least a slight trace of the /i/ and the vowel is not usually completely elided. There are also several compounds (or apparent compounds), such as the one given in (240), with /ʃi/ as the first syllable of an initial disyllabic root of a compound that also may optionally undergo reduction of /ʃi/ creating a ʃC cluster similar to (238f), at least for some speakers.

(240) *ʃità(kaà) ~ ʃtà(kaà)* ‘pull’ cf. *ʃità* ‘pull’

Here, the optional ʃC is not at the onset of the couplet, but in the onset of the word.

Yet another type of cluster in IM involve a voiceless nasal before /$^{n}$d/, as shown in Table 47.

Table 47. Consonant clusters with a voiceless nasal

| | IM | Gloss | Cf. |
|---|---|---|---|
| a. | *(n̥$^{ń}$duʔù) ~ hú($^{n}$duˀù)* | ‘traditional skirt’ | *sunduʔu*, Chayucu Mixtec (Josserand 1983:538) |
| b. | *(n̥$^{n}$dókó$^{L}$) ~ (s$^{n}$dókó$^{L}$)* | ‘chicatana’ | *si̱ndo̱ko̱*, Xochapa Mixtec (Stark et al. 2003:147) |
| c. | *(n̥$^{n}$dɨ́kɨ́$^{L}$) ~ (s$^{n}$dɨ́kɨ́$^{L}$)* | ‘cattle’ | *sɨndɨkɨ*, Jamiltepec Mixtec (Johnson 1988:21) |
| d. | *(n̥$^{ń}$dutʲà) ~ hú($^{n}$dutʲà) ~ hí($^{n}$dutʲa)* | ‘godfather’ | probably from *sutù* ‘father’ + *$^{n}$dutʲà* ‘water’ |
| e. | *kà(n̥$^{n}$dóˀò) ~ kasà($^{n}$dóˀò)* | ‘Jamiltepec’ | Spanish *casa* ‘house’ + *$^{n}$dóˀò* ‘adobe’ |
| f. | *(n̥$^{n}$dàɾū)* | ‘soldier’ | Spanish *soldado*; *sɨ$^{n}$daɾu*, Jamiltepec Mixtec (Johnson 1988:76) |

[14] It is possible that the vowel is sometimes voiceless rather than elided, but the amount of frication following the sibilant makes it very difficult to determine the difference between, for instance, *ʃi̥ˈkɨ́jɨ́$^{L}$* and *ʃkɨ́jɨ́$^{L}$*.

g. *n̥nũ̃(kʷĩjá) ~ hu̥nù(kʷĩjá)* 'next year' cf. *kʷĩjá$^L$* 'year'

As can be seen, all of these unusual words have alternate pronunciations, some with [h] and a vowel, and some with /s/. In each example, a cluster with an initial voiceless nasal is formed with a voiced nasal, which is /ⁿd/ in all cases except (g), where it is /n/. Also, in every example but (g), there is reason to posit that the cluster developed from a pre-couplet syllable with *s* as the onset, as indicated by the cognate forms in the last column, and in all but (e), the vowel appears to have been a high vowel. Example (g), which apparently developed from a compound consisting of two CVCV roots, the first of which is now lost, is also exceptional in that the cluster is word initial rather than couplet initial. Examples (e–f) are interesting because they show that this process has been extended to well entrenched loanwords ((e) is a toponym).

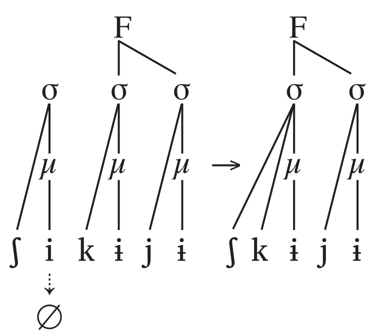
One further type of consonant cluster which has developed in IM is *tɾ*. All attested forms of this cluster in my data are given in (241).

(241) a. *(tɾɨ́ᵐbɨ́$^L$) ~ tɨ̀(ɾɨ́ᵐbɨ́$^L$)* 'burl'
b. *(tɾɨ́ˀⁿdɨ́$^L$)* 'bumps'
c. *(tɾẽ́ˀẽ́$^L$)* 'boogers'

This cluster begins with a voiceless obstruent, but not with a sibilant, and involves the marginal phoneme /ɾ/. Notice also that (241a) has an alternate pronunciation which includes a vowel in the pre-couplet syllable. While *tɾ* clusters differ somewhat from the generalizations made above about *s*C, *ʃ*C and *n̥ⁿd* clusters, they share the property that the initial C is an obstruent, and crucially, that they do not occur in the second syllable of the couplet. In fact, all attested *tɾ* clusters occur at the onset of the couplet, which can not quite be said of the other types of clusters.

In summary, four types of consonant clusters have been demonstrated in this section—*s*C, *ʃ*C, *n̥ⁿd/n̥n* and *tɾ*. Some of the words with these clusters have variable realizations which may at times include an intervening voiced or voiceless vowel, indicating that the sound change is not yet complete for these words. From these words, and from cognate forms in other Mixtec varieties which include a CV syllable rather than a cluster, it is clear that clusters in words that do not have alternate forms have evolved through vowel syncope. Although the facts differ somewhat between the various clusters, one thing that is common to them all is that the clusters are never found couplet-medially, and are nearly always located at the onset of the first syllable of the couplet. This raises the question, Why should this syllable be treated specially? An analysis based solely on syllables has no answer, but moving up the prosodic hierarchy to the foot provides a ready explanation. If the couplet is identified as a foot, the consonant clusters have primarily developed at the onset of the foot, which is also the strongest position of the trochaic foot. This is illustrated by the derivation of the reduced form of 'blister' from (239a) in (242).

(242) Vowel syncope: ***ʃìkɨ́jɨ́***$^L$ → ***ʃkɨ́jɨ́***$^L$ 'blister'




The foot is aligned to the right edge of the grammatical word, leaving the initial syllable ***ʃi*** unfooted and thus prosodically weak. It is this vowel that the syncope process targets, which is exactly where vowel deletion occurred in the development of realis/irrealis stems (233a) and some animal names (237a). The prosodic conditions on vowel syncope discussed here are also similar to templatically governed theme vowel deletion in Old Saxon ***i***-stem nouns discussed in §5.3.2; if the theme vowel could be footed with the stem, it was retained (cf. (188)), but if it could not, it was lost (cf. (187)). Following Macken & Salmons (1997), I take the facts of consonant cluster formation in IM as evidence for a foot template which must serve as a point of reference for the description of this pattern and which provides an explanation for the location of the clusters. Since the initial syllable is prosodically strong in the trochaic foot, this is the location where one would expect to find the greatest number of contrasts (Harris 1997) and thus where the otherwise anomalous consonant clusters would be permitted (Macken & Salmons 1997).

Several examples of compounds were also given ((238f), (240), Table 47 (g)) where the vowel of the first syllable of an initial CVCV root in a compound is syncopated resulting in a consonant cluster which is located at the onset of the word rather than the foot. Here it can be noted that all syllables preceding the couplet are unfooted and therefore weak (cf. (218)), but also that the resulting cluster occurs at the initial boundary of another prosodic structure, the prosodic word. The net effect of the truncation processes that result in consonant clusters is to create a structure that, in most cases consists solely of a single foot or canonical word, and which in any case is closer to the ideal size dictated by the foot template. Furthermore, in both cases the initial boundary of a higher level prosodic structure is strengthened. An analysis based on syllables has no explanation for why clusters never occur at the onsets of syllables inside the foot and usually occur at the foot boundary, but it makes perfect sense if the prosodic foot is considered a basic structural unit in the phonology.

#### 6.2.2.3 Couplet-medial weakening

Macken & Salmons (1997) point out that complementary to the formation of consonant clusters at the onset of the couplet discussed in the preceding section, other processes result in weakening the final syllable of the couplet in CM by deleting the couplet medial consonant. That language shows a strong tendency to lose present-day reflexes of Proto-Mixtec (PM) continuants *$w$, *$j$ and *$x$ in the couplet medial position compared to the neighbouring dialect, SM, though SM also shows the tendency in a few forms when compared to PM. Further, they claim that glides tend to surface as glides outside the couplet, be strengthened to obstruents couplet initially (e.g. *$j \rightarrow ʒ$) and be lost couplet medially. This, they argue, is counter to Vennemann's (1988:13–14) Head Law of syllable preference, which would predict that medial onsets should also be strengthened (with respect to Vennemann's consonant strength hierarchy) like any other syllable onset rather than weakened. However, if the basic unit of phonological organization is the foot, this discrepancy disappears since the initial position of the trochaic foot is strong and the medial position weak (Macken 1996; Harris 1997; 2004; Macken & Salmons 1997; Harris & Urua 2001). The IM data also provide support for this argument. In this section I will begin by examining diachronic patterns of couplet-medial weakening due to the loss of medial consonants in IM, though not the different realization of glides in different prosodic positions. I will show that, while IM does not share most losses of **w* and **x* in the couplet medial position that are found in CM and SM, it has a number of similar losses that CM does not appear to have, particularly, with respect to the loss of couplet medial **j*. I will close this section with a brief discussion of evidence for synchronic reduction in prosodically weak positions.

Looking first at medial **x*, Table 48 gives IM cognates of the four examples from SM and CM given by Macken & Salmons (1997), together with PM reconstructions from Josserand (1983).

Table 48. Couplet-medial **x* loss (Macken & Salmons 1997:47; Josserand 1983:479ff)

| | Gloss | SM | CM | PM | IM |
|---|---|---|---|---|---|
| a. | ‘come:REAL:IPFV’ | *βài ∼ βàxi* | *bèi* | **wexi* | *βátʃi* |
| b. | ‘eat:REAL:IPFV’ | *xei ∼ kaxi* | *žée* | **xexiˀ* | *tʃatʃi* |
| c. | ‘come:IRR’ | *kii* | *kii* | **kixi* | *kítʃi* |
| d. | ‘true’ | *ⁿdaa* | *ⁿdiža ∼ ⁿdia* | **ⁿdixe* | *ⁿdáá* |

The reflexes of **x* (where they exist) are *x* in SM, *ž* (i.e. *ʒ*) in CM and *tʃ* in IM. Notice that all PM forms have a medial **x*, and two of the SM examples (a, b) and one CM example (d) vary between forms with and without the medial consonant. Except *ⁿdáá* ‘true’ (d), however, the IM cognates do do not instantiate the pattern of medial consonant loss. PM **x* only occurred before front vowels (Bradley & Josserand 1982:292), which resulted in palatalization and affrication in the IM reflex. This had the effect of increasing rather than weakening the consonantal strength (cf. Vennemann 1988:9), which I speculate contributed to its resistance to deletion in this context.

Examples of the loss of **w* reflexes in CM vis-a-vis SM, discussed by Macken & Salmons (1997) are given in Table 49 together with corresponding IM forms, and PM forms (where available) from Josserand (1983).

Table 49. Couplet-medial **w* loss (Macken & Salmons 1997:44–46; Josserand 1983:479ff)

| Gloss | SM | CM | PM | IM |
|---|---|---|---|---|
| **Cɨ(ˀ)wɨ** | | | | |
| ‘egg’ | *ⁿdivɨ̀* | *ⁿdiù* | **ⁿdɨwiʔ* | *ⁿdɨ́βɨ́ᴸ* |
| ‘enter’ | *kɨ̀vɨ* | *kɨu* | | *kɨ́ˀβɨ* |
| ‘day’ | *kɨvɨ̀* | *kɨù* | **kɨwiˀ* | *kɨ́βɨ́ᴸ* |
| ‘sky’ | *aⁿdɨ́vɨ́* | *aⁿdɨ́ú* | | *àⁿdɨβɨ̀* |
| ‘world’ | *ñužɨ́vɨ* | *ñũžɨ́u* | | *ɲã́jɨ́βɨ́ᴸ* |
| ‘people’ | *ñãživɨ* | *ñãžɨ́ű* | | *ɲã́jiβɨ̀* |
| ‘spit’ | *sɨ̀ʔvɨ* | *tesɨ̀ʔu* | | *tʲàsɨ̂*[15] |
| ‘to have hiccups’ | *kakɨ̀ʔvɨ* | *kákɨʔɨ* | | *kakiˀɨ*[16] |
| | | | | |
| **Ca(ˀ)wi** | | | | |
| ‘maguey’ | *žau* | *žau* | **jawiˀ* | *jaβì* |
| ‘rain’ | *saù* | *saù* | **sawiˀ* | *sáβɨ́ᴸ* |
| ‘price’ | *saù* | *saù* | | *jáˀβì* |

In these examples, the SM reflex of **w* is *v*, the reflex is completely missing in the CM cognates and in IM it is *β*. The CM data exhibit two basic patterns with respect to the SM data and PM reconstructions—C*ɨ(ˀ)wɨ* and C*a(ˀ)wi* (where *w* = the modern reflex of **w*), but the sound change is the same in both: a couplet-final **w*V syllable becomes *u*. This process affects only two of the IM cognates (the words for ‘spit’ and ‘to have hiccups’), and in these the medial C is simply deleted; however, a similar sound change is found in IM in C*u(ˀ)wi* couplets. IM words showing this type of medial consonant loss are given in Table 50.

[15] I am uncertain of the tone of this word.
[16] I do not know the tone of this word.

Table 50. Couplet-medial *w loss in IM

| IM form | | Forms from PM/other Mixtec varieties | |
|---|---|---|---|
| *kuβì ∼ kuù* | 'to be' | **kúwí* | (PM; Dürr 1987:53) |
| *suβì ∼ suù* | 'affirmative' | | |
| *tuβi ∼ tuù* | 'appear' | | |
| *úβí ∼ úú* | 'two' | **uwi* | (Josserand 1983:480) |
| *jùˀū* | 'be.afraid' | **juʔwi* | (Josserand 1983:480) |
| *kúú* | 'die:IRR' | *kuβi* | Coatzospan Mixtec (Gerfen 1996:48) |

The first four examples show synchronic variation between forms with and without the medial consonant, while the sound change is complete in the last two examples—that is, they are always pronounced without the medial consonant.

Turning now to the final PM glide, Macken & Salmons (1997) give the following examples showing the loss of medial *j, three of which involve nasal contexts where it is realized as *ñ* (= *ɲ*):

Table 51. Couplet-medial *j loss examples from Macken & Salmons (1997:47–48)

| | Gloss | SM | CM | PM | IM |
|---|---|---|---|---|---|
| a. | 'work' | *tiñu* | *tĩũ* | **tijõ* | *tʲĩɲũ̀* |
| b. | 'griddle' | *xio* | *šío ∼ šoò* | **xijoˀ* | *tʃíjóᴸ* |
| c. | 'fingernail' | *tíñu* | *tĩ̃́* | **tijĩˀ* | *tʲĩ̃̀* |
| d. | 'language, Spanish' | *sañì* | *sã̃̀ĩ* | | *sã́ˀã́ᴸ* |

In two of these forms (a, b), the IM words show no loss of the medial glide, and in two they do (c, d). Interestingly, none of the nasalized morphemes (a, c, d) lose their nasalization when the medial nasal consonant is lost. Besides these few examples, IM has additional examples of the loss of medial *j in oral contexts that Macken & Salmons do not mention for SM and CM:

Table 52. Couplet-medial *j loss (PM data from Josserand 1983:479–80)

| Gloss | IM | PM | Lost C |
|---|---|---|---|
| 'heavy' | *βéè* | **weji* | **j* |
| 'house' | *βeˀè* | **weʔji* | **j* |

| Gloss | IM | PM | Lost C |
|---|---|---|---|
| ‘armpit’ | *tʃáˈʃèˀé* | **leʔjiʔ* | **j* |
| ‘sickness’ | *kʷéˀéᴸ* | **kʷeʔji* | **j* |
| ‘offspring’ | *séˀè* | **saʔji* | **j* |
| ‘slowly’ | *kʷèē* | **kʷeje* | **j* |
| ‘see’ | *ⁿdʲeˀè* | **ⁿdeʔja* | **j* |

In each of these examples, the couplet-initial consonant is retained while the couplet-medial **j* is lost. The IM reflexes always have a long vowel (whether glottalized or not), and the quality of the vowel, with the apparent exception of ‘offspring’, is the same as that of the initial vowel of the root. The word **saʔji* ‘offspring’ underwent the vowel change *a* > *e* /_*ji* (Josserand 1983:413–14), and therefore also fits the pattern. The data in Table 52 also show that contrastive glottalization is not lost with the loss of the medial consonant. This lends support for the analysis that glottalization is not a feature of the medial consonant (i.e. a glottalized consonant), since it is retained even when the consonant is lost.

While the data in Table 52 illustrated the strong tendency for couplet-medial **j* to be lost in IM, there is not a single case of couplet-initial **j*-loss in contemporary IM words for which Josserand (1983) provides a PM reconstruction, as shown by these examples:

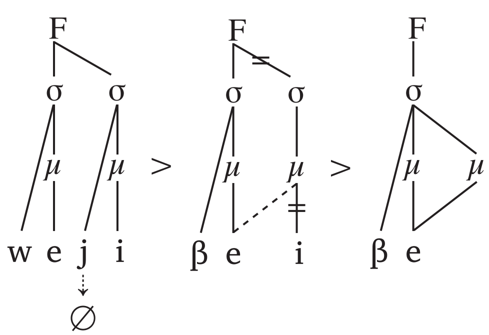
Table 53. No couplet-initial **j* loss (PM data from Josserand 1983:480)

| Gloss | IM | PM | Gloss | IM | PM |
|---|---|---|---|---|---|
| ‘crooked’ | *jakʷà* | **jakʷeʔ* | ‘corn.husk’ | *ɲã́mã́ᴸ* | **jawãʔ* |
| ‘armadillo’ | *jàkʷĩ́* | **jakʷĩʔ* | ‘brother’ | *ɲã́ɲĩ́* | **jeni* |
| ‘hole’ | *jáβí* | **jawi* | ‘wax’ | *ɲṹmã́ᴸ* | **juwẽʔ* |
| ‘squash’ | *jɨkɨ̃̀* | **jɨkɨ̃ʔ* | ‘people’ | *ɲã́jɨβɨ̀* | **jẽ jɨwɨʔ* |
| ‘mountains’ | *jukù* | **jukuʔ* | ‘smoke’ | *ɲṹˀmã́ᴸ* | **juʔwẽ* |
| ‘stone’ | *júúᴸ* | **juuʔ* | ‘salt’ | *ɲɨ̃́ɨ̃́ᴸ* | **jɨ̃ɨ̃ʔ* |
| ‘mouth’ | *juˀù* | **juʔuʔ* | ‘fire’ | *ɲṹˀṹ* | **juʔũ* |

The first column of glosses gives examples of **j* in oral contexts and the second column of glosses gives examples of **j* in nasal contexts. All of the IM forms in both contexts contain a couplet-initial consonantal reflex for **j*.

In summary of this section so far, Macken & Salmons (1997) give numerous examples showing the loss of couplet-medial **x*, **w* and **j* in CM/SM. While only some of the IM cognates of these examples have lost the couplet-medial consonant, many other IM examples show the loss of medial **j*. Following Macken & Salmons, I propose that these data are best understood in terms of prosodic structure. The couplet can be used to describe the location of consonant loss, but provides no motivation for it. If, however, the couplet is recognized as a quantity-sensitive, trochaic foot, the loss of medial consonants makes sense since they occur in the weak syllable of the foot, while the retention or even strengthening (cf. §6.2.2.2) of couplet-initial consonants is expected since they stand at the head and strongest position of the foot. The diachronic derivation is illustrated for **weji* 'heavy' from Table 52 in (243).

(243) Consonant loss: **weji* > *βéè* 'heavy'




The first part of the derivation shows the deletion process targeting the onset of the second syllable of the foot, similar to *d*-deletion in Buttelstedt German (cf. (189) §5.3.2), while the foot-initial glide is retained. To arrive at the contemporary forms which all have a long *e*, a diachronic vowel harmony process is posited that spreads the vowel features associated with the initial mora of the foot to the second mora, delinking the vowel features that were associated there and also its syllable node, as shown in the second part of the derivation. The spreading of vowel features is indicated in the derivation by the dotted line from the initial vowel to the second mora and the double slash on the association line to *i* indicates the deletion of those vowel features. The deletion of the syllable node is shown by a double slash from F to the dependent σ node.

The vowel harmony shown by the data in Table 52 is another indication of the preference for like vowels within the foot, which was noted with respect to the formation of realis/irrealis stems in §6.2.2.1 and will be discussed further in §6.3.3.1. Macken & Salmons (1997:43–44) argue that the loss of foot-medial consonants and vowel harmony reflect the trajectory of sound change toward the specification of a single consonant and vowel per foot—that is, towards a CVː foot template. This tendency is in tension with the equally basic CVCV foot template, and suggests the evolution of the phonology from one that is primarily organized around syllables to one has a primarily foot-based organization.

Medial weakening in trochaic feet leading to the kind of sound changes described above, of course, begin in the synchronic grammar. Synchronic foot-medial weakening was illustrated by the Ibibio data in §5.3.3, and there is evidence of this in IM as well. As mentioned in Chapter 3, there is an observed tendency for some phonemes to have reduced realizations in prosodically weak positions of the word, which we can now identify as foot-medial, and in unfooted syllables preceding and following the foot. The reduction includes varying degrees of shortened duration (when not phrase final), voicing of voiceless consonants, particularly /t/ and /k/, or both voicing and spirantization, particularly of /k/ (→ [ɣ]). The reduction processes are gradient and are greater/more frequent for some speakers than for others.

As an example of the type of lenition described here consider the waveform and spectrogram in Figure 20 of an elicitation of the sentence given in (244).

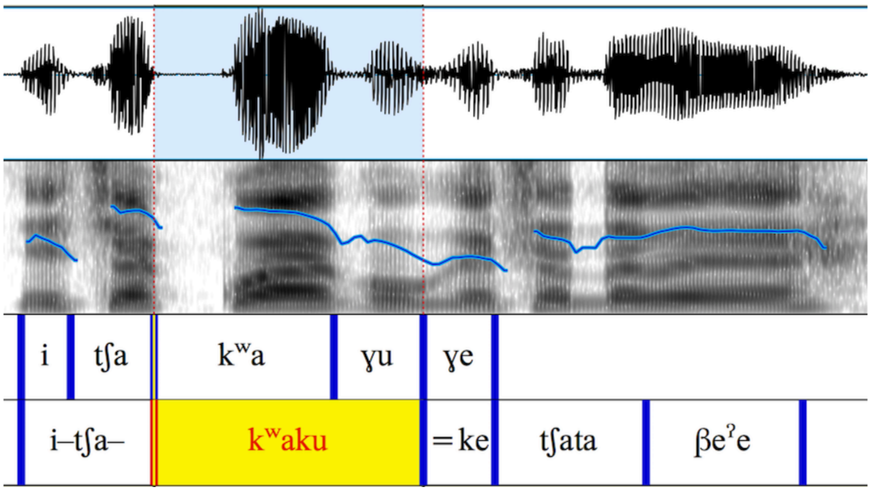



Figure 20. Speaker IMQ: ‘She went (and) cried behind the house.’

(244) *ìtʃá(kʷákù)kē* *tʃátá* *βéˀé*
í–tʃá–ku–akù=kē tʃátá$^{L}$ βeˀè
PFV–go:PFV–IRR–cry=3FEM back house
‘She went (and) cried behind the house.’

The two highlighted syllables between the dotted vertical lines indicate the foot of the PW, with the syllable *kʷa* as the accented head of the foot, easily discernible in the figure for its clear voiceless production of /kʷ/ (the virtual absence of oscillation in the waveform and low energy in the spectrogram during the stop closure) and extra duration. It is preceded by two prefixes and followed by one enclitic. In this example, there is not much reduction in the pre-couplet syllables, although other examples from the same elicitation session have /tʃ/ reduced to [ʃ]. The foot final syllable, *ɣu* (cf. /kù/), however, is voiced and spirantized (as evidenced by the periodic oscillations in the waveform, a light band of energy in the F1 region of the spectrogram and the pitch tracking (blue line) throughout the syllable), while the /k/ of the post-couplet enclitic /kē/ is even more weakened ([ɣ]), as indicated by the greater amplitude in the periodic waveform oscillations, greater intensity (darker) formant bands in the spectrogram, and uninterrupted pitch tracking in the onset of the syllable, which is underlyingly a voiceless velar stop.

Figure 21, which gives the waveform and spectrogram of the clause in (245), shows even more lenition, particularly in the pre-couplet syllables.

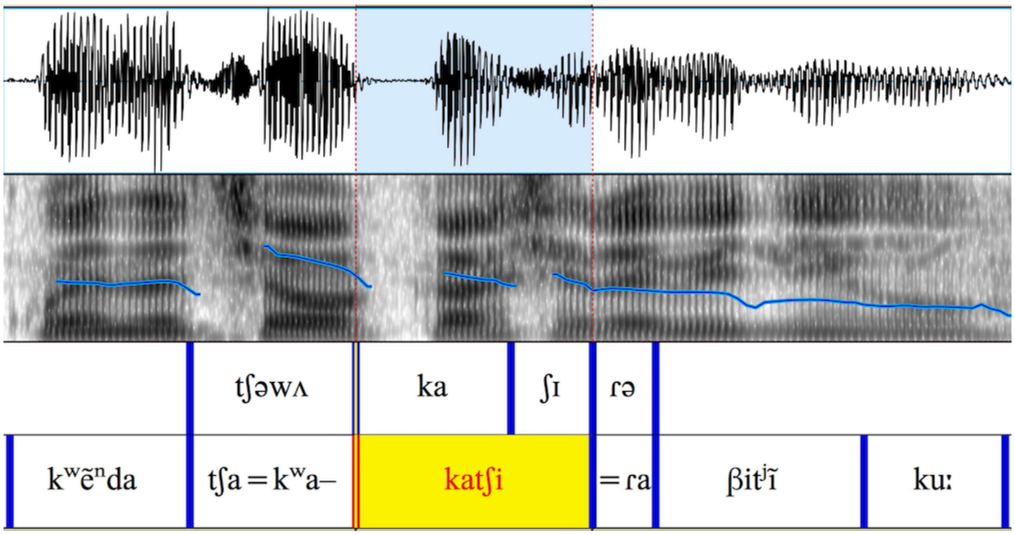



Figure 21. Speaker IMQ ‘(It is) about what he is going to eat now.’

| | | | | |
|---|---|---|---|---|
| (245) | *kʷèⁿdā* | *tʃàkʷá(katʃì)ɾà* | *βitʲĩ̀* | *kuù* |
| | kʷèⁿdā | tʃà–kʷá–ku–atʃì=ɾà | βitʲĩ̀ | ∅ˆkuù |
| | about | already–PROS–IRR–eat=3MASC | today | IPFVˆbe |
| | ‘(It is) about what he is going to eat now.’ | | | |

Here again the disyllabic foot is highlighted. The onset of the head syllable in the foot, /ka/, is a clearly articulated voiceless stop, whereas the foot final /tʃ/ is reduced to [ʃ] with no stop closure, while the onset of the pre-couplet syllable *kʷa–* is reduced to an approximant ([w] is a generous transcription). Notice also the reduction of the vowels in the pre-couplet (/a/ → [ə], /a/ → [ʌ]), foot final (/i/ → [ɪ]) and post-couplet (/a/ → [ə]) syllables. The increased reduction in this token is likely due to the fact that this was a recorded discussion rather than an elicitation of a specific datum and, thus, a less careful speech style. One further thing that should be noted in Figure 21 is that the spectrogram also demonstrates that foot initial consonants can be quite reduced in high frequency words and in utterance final positions, as indicated by the pronunciations of the final two words in the clause. Both *βitʲĩ̀* ‘now, today’ and *kuù* ‘be’ are high frequency words, especially *kuù*. Viewing the waveform and spectrogram at the starting point of each of these words clearly shows that /β/ of *βitʲĩ̀* is quite reduced (there is little decrease in waveform amplitude, spectral intensity or f0 at the beginning of the word), and the /k/ of the utterance final *kuù* is practically an approximant.

While more systematic study and quantification is needed, similar observations of consonant lenition were made during the segmentation of experimental data. In the noun-pronoun experiment (Appendix C), /k/ of third person feminine enclitic pronoun *=kē* (e.g. *tʃɨ́tɨ́=kē* 'her seed') was very frequently reduced to [g] or [ɣ]. Similar reduction also occurred in the foot medial position (e.g. *tʃīkì* 'fist'), though much less often. Lenition was also observed in pre-couplet syllables in the complex noun experiment. The situation with pre-couplet positions is more complex since there may also be strengthening in the initial syllable of the word. For instance, one speaker showed more severe reduction of pre-couplet /k/ in *tʲúkū(ʃɪ̃́ɲɪ̃́ᴸ)* 'fleas/stars', where /k/ was not word initial, than in *kɨtɨ̀(ʃã̀ã́)* 'animal', where it is. While it seems clear that the pre-couplet positions are prosodically weaker than the foot initial position, more study is needed to determine how they should be ordered with respect to the foot medial and enclitic positions.

The kind of lenition described here is consistent with the analysis that the couplet forms a trochaic foot where the initial syllable has greater prominence than the second and therefore its segments are articulated with greater preciseness. The lenition patterns also fit the analysis presented in §6.1 that PWʀᴅs contain only a single foot and that syllables occurring before and after this foot are unfooted and thus also prosodically weak (cf. (218)).

## 6.3 Couplet processes and phonotactics

A primary motivation for positing a prosodic structure is that certain chunks of phonological material function as the domain for the application of phonological rules and phonotactic generalizations (e.g. Selkirk 1986; Nespor & Vogel 2007 [1986]; McCarthy & Prince 1996 [1986]; Inkelas 1989; Rice 1990). The necessity of such a structure becomes even more obvious when the domain in question does not correspond to any existing morphosyntactic unit. The IM couplet is an example of such a structure since it is the domain for numerous phonological processes and phonotactic generalizations, yet does not correspond exactly to the morphological root, stem, word or any other morphosyntactic unit. In this section I will discuss a role of the couplet that goes beyond size/shape concerns that were the subject of the preceding section and look at how the couplet is necessary to describe the domain of contrastive glottalization (§6.3.1), nasalization patterns (§6.3.2), vowel harmony and melodies (§6.3.3.2), the distribution of labial consonants (§6.3.4), epenthetic glottalization (§6.3.5) and tonal phenomena (§6.3.6). All of these patterns which take the couplet as their domain provide evidence that the couplet is a unit to which the IM grammar must refer, and because it is also the domain of stress and has the shape identified for the moraic trochee in the inventory of foot types, this unit should be identified as the foot.

### 6.3.1 Contrastive glottalization

As discussed in Chapter 3, IM has both contrastive glottalization and non-contrastive, epenthetic glottalization. Although the couplet plays an important role in the description of both kinds of glottalization, epenthetic glottalization has different distributional characteristics and will be dealt with separately in §6.3.5. In this section I describe contrastive glottalization, which is found in every Mixtec variety.

Mixtec languages are known for contrastive glottalization in both CVV and CVCV couplets (CVˀV, CVˀCV), as illustrated by the following IM minimal pairs:

(246)

| | CVˀV | | CVV |
|---|---|---|---|
| a. | *βeˀè* ‘house’ | ~ | *βeè* ‘below’ |
| b. | *$^n$daˀà* ‘hand’ | ~ | *$^n$daà* ‘going up’ |
| c. | *ɲ̃ű́ˀű́* ‘fire’ | ~ | *ɲ̃ű́ű́* ‘town’ |
| | **CVˀCV** | | **CVCV** |
| d. | *$^n$dɨ́ˀjɨ̀* ‘pimple’ | ~ | *$^n$dɨ́jɨ̀* ‘corpse’ |
| e. | *jaˀβì* ‘expensive’ | ~ | *jaβì* ‘agave’ |
| f. | *tã́ˀmã́$^L$* ‘ridge’ | ~ | *tã́mã́$^L$* ‘famine’ |

As demonstrated in these examples and in §3.1, contrastive glottalization may occur with any vowel phoneme, but in IM and nearly all other Mixtec varieties, it is only realized couplet medially.[17] Significantly, this type of glottalization is only found in the couplet and never in prefixes or clitics, nor in pre-couplet syllables within a prosodic word. Furthermore, when affixes and clitics are formed through grammaticalization, glottalization is lost as shown by the examples in (247).

(247)

| | | | | | |
|---|---|---|---|---|---|
| a. | *saˀà* | ‘do, make, cause’ | ~ | *sà–* | ‘causative’ |
| b. | *júˀú* | ‘first person singular’ | ~ | *=í* | ‘first person singular’[18] |
| c. | *$^n$dʲúˀú* | ‘first person plural exclusive’ | ~ | *=$^n$dí* | ‘first person plural exclusive’[19] |
| d. | *kʷã́ˀã́* | ‘is/was going’ | ~ | *kʷá–* | ‘prospective, go:motion.away’ |
| e. | *kű́ˀű́* | ‘will/would go’ | ~ | *kú–* | ‘go:motion.away:irrealis’ |
| f. | *tʃã́ˀã́* | ‘go and return’ | ~ | *tʃá–* | ‘round.trip’ |

In each example, the grammaticalized form consists of the CV of the root from which it historically derives, and each of the roots is a synchronic morpheme in the language (see §2.4.2 for further discussion of the prefixes). Significantly, glottalization is never included in the grammaticalized form. The examples in (247d–247f) also show the loss of nasalization, which will be discussed further in §6.3.2.

[17] There are three Mixtec varieties—Ayutla Mixtec (Pankratz & Pike 1967; Josserand 1983), Zacatepec Mixtec (Josserand 1983; Towne 2011) and Southwestern Tlaxiaco Mixtec (McKendry 2013)—where glottalized vowels also occur couplet finally, resulting in couplets with the forms CVCVˀ, CVˀCVˀ, CVˀVˀ and CVVˀ.

[18] Hollenbach (2015:16) reconstructs the form **=ju* for the Proto-Mixtec first person singular enclitic pronoun, which she suggests is plausibly a contraction of the independent first person singular pronoun **juˀvi* (cf. **juˀu* in Josserand 1983:664–668). The form **=ju*, then, would be an intermediate form in the reduction of the full pronoun to the present-day IM clitic form: *=í* < **=ju* < **juˀvi*.

[19] Hollenbach (2015:18) reconstructs the proto form of the independent pronoun as a compound: **$^n$dɨ–* ‘all’ + **juˀβi* ‘first person singular’.

Similarly, when compounds are formed with an initial root having a CVˀV citation form, the initial root is realized as CV and glottalization is lost, as the compounds in (248) show.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (248) | a. | *βèkáà* | 'jail' | cf. *βeˀè* 'house' | + | *káà* | 'metal' |
| | b. | *jùkùˀú* | 'bathroom' | cf. *juˀù* 'mouth' | + | *kúˀú*ᴸ | 'bush' |
| | c. | *túⁿdoˀò* | 'suffering' | cf. *tṹˀũ̀* 'word' | + | *ⁿdoˀò* | 'beat' |

Although the unreduced form is often acceptable, it may be interpreted as a phrase with a more compositional meaning, as in *βeˀèˈkáà* 'a house made of metal' for (248a) rather than 'jail'.[20] Examples (248b) and (248c) show that glottalization is only lost in the initial root of the compound.

Contrastive glottalization has been analyzed in three principal ways in the Mixtec literature: a) as a glottal stop phoneme, b) as a vocalic feature (at the right edge of short vowels or interrupting long vowels) and c) as a floating feature of the root. The glottal stop phoneme approach, which has had many proponents over several decades of Mixtec research (e.g. San Miguel El Grande Mixtec—Pike 1944; Ocotepec Mixtec—Mak 1958; Ayutla Mixtec—Pankratz & Pike 1967; Mixtepec Mixtec—Pike & Ibach 1978; Alacatlazala Mixtec—Zylstra 1980; Atatláhuca Mixtec—Alexander 1980; Chalcatongo Mixtec—Macaulay 1987b), posits the structure in (249) for words like *βeˀè* 'house' and *jaˀβì* 'expensive' (adapted from Macaulay & Salmons 1995:39).

[20] However, my consultants tell me that the unreduced form of (248b) could not be used euphemistically to mean 'bathroom' (i.e. 'the place where you go to relieve yourself'). The full form would be understood as 'the edge of the bush'.

(249) Glottal stop analysis of contrastive glottalization

a. *βe*$^{\text{ʔ}}$*è* ‘house’

$$\begin{array}{cccc} \beta & e & \text{ʔ} & e \\ | & | & | & | \\ C & V & C & V \end{array}$$

b. *ja*$^{\text{ʔ}}$*βì* ‘expensive’

$$\begin{array}{ccccc} j & a & \text{ʔ} & \beta & i \\ | & | & | & | & | \\ C & V & C & C & V \end{array}$$

Under this analysis, these words would have the syllable structures CV.CV and CVC.CV, respectively, adding the CVC syllable type to the inventory, with /ʔ/ as the only phoneme allowed in the coda, but only if it is the first syllable of the couplet (for most varieties of Mixtec).

The vocalic feature analysis of glottalization (Jicaltepec Mixtec—Bradley 1970; Proto-Mixtec—Bradley & Josserand 1982; Josserand 1983; Ayutla Mixtec—Hills 1990; Coatzospan—Gerfen 1996) avoids creating a CVC syllable type with glottals as the only licit coda, since these words would have the structure given in (250) (adapted from Macaulay & Salmons 1995:39), and be parsed into syllables as CVV (or CV.V, if considered disyllabic) and CV.CV, respectively.

(250) Vocalic feature analysis of contrastive glottalization

a. *βe*$^{\text{ʔ}}$*è* ‘house’

$$\begin{array}{ccc} \beta & e^{\text{ʔ}} & e \\ | & | & | \\ C & V & V \end{array}$$

b. *ja*$^{\text{ʔ}}$*βì* ‘expensive’

$$\begin{array}{cccc} j & a^{\text{ʔ}} & \beta & i \\ | & | & | & | \\ C & V & C & V \end{array}$$

This analysis, however, results in a very large vowel inventory, since each of the six IM vowels can be plain, glottalized, nasalized, and five can also be nasalized and glottalized resulting in a vowel inventory of 23 vowel phonemes, which is more than the 19 consonant phonemes posited for the native lexicon. In dialects where glottalization only occurs on stressed syllables, this approach explains the distribution of glottalization as only occurring when it is licensed by stress (e.g. Gerfen 1996); however, there are dialects which are reported to have glottalization in unstressed syllables (Ayutla Mixtec—Pankratz & Pike 1967; Alacatlazala Mixtec—Zylstra 1980:16, 37–38, n. 3).

Macaulay & Salmons' (1995) solution is to propose (for most Mixtec dialects) "a floating glottalic feature as a (facultative) characteristic of the root or 'couplet'" (p. 39). Under this analysis, glottalized roots are marked in the lexicon for a floating glottal feature, [+constricted glottis], which is realized on the surface by a rule that associates it to a vowel slot of the couplet. For most Mixtec varieties this is the leftmost vowel slot, as illustrated in (251) (adapted from Macaulay & Salmons 1995:39).

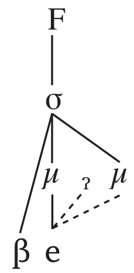
(251) Root feature analysis of contrastive glottalization

a. *βeˀè* 'house' b. *jaˀβì* 'expensive'

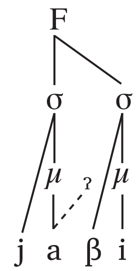

The underlying structure of the "root" or couplet is different from that of the vocalic feature approach (250), in that the glottalic feature exists independently on a different autosegmental tier from the vowel with which it is realized on the surface. The authors propose that this tier is the laryngeal tier, together with voicing, since glottalization in CVCV structures is limited to those with voiced medial consonants (cf. §3.2.2). Thus, the root feature approach to Mixtec glottalization avoids the huge vowel inventory of the vocalic feature approach, since glottalization is not an underlying feature of the vowel, but merely associates to it by rule. It is also able to express the distributional facts of glottalization in a way that does not link it to stress, which makes it more broadly descriptive since there are dialects where it is licensed in unstressed syllables.

Macken & Salmons (1997) adopt the root feature analysis of Macaulay & Salmons (1995), but recognizing that the couplet ≠ morphological root, they claim that glottalization is "best analyzed as a non-segmental phenomenon associated with the couplet or [foot] template" (p. 33). This is the approach I follow in this dissertation. The structures presented in (251) are modified slightly in (252) to show how glottalization in roots bearing this contrastive feature is associated to the vowel that is associated with the first mora of the foot templates.

(252) a. *βeˀè* 'house'




b. *jaˀβì* 'expensive'




Glottalization of the underlying vowel is shown by the dotted line in the representation from ˀ to the vowel associated with the initial mora of the foot. In (252a), the root vowel also spreads to the second mora to fill out the template, but since glottalization is not an underlying feature of this vowel, it does not spread with the vowel.[21] Crucially, the glottalization rule must refer to the foot so that glottalization is inserted at the proper location. Moreover, glottalization cannot be realized in grammatical morphemes (e.g. affixes and clitics) which are not realized in a foot. The foot, therefore, provides the domain for the realization and mapping of glottalization, while the vowel is the glottalization bearing unit, in the same way that tonal melodies are typically the property of (or are mapped to) a larger domain (e.g. the foot, "prosodic stem", etc.), but individual tones are anchored to a smaller constituent (e.g. vowel, mora, syllable) (cf. Hyman & Leben to appear).

Following Macken & Salmons (1997), I consider the loss of glottalization in compounds (248) and grammaticalized morphemes (247) as due to the fact that the resultant form no longer meets the structural requirements for glottalization—that is, it is no longer a prosodic foot. We thus see that reference to the foot is necessary to state the domain which licenses the realization of glottalization as well as the precise location of its realization (the first mora of the foot). Since, as we have seen, the couplet has the shape defined by prosodic theory for the quantity-sensitive, trochaic foot, and since it is a typologically common function of the foot to provide the domain for phonological rules and phonotactic restrictions, I take the fact that the couplet is the constituent which provides the domain for the restriction of glottalization in IM and to which the glottalization

[21] For a similar view of the prosodic structure of (C)VˀV couplets see McKendry (2013:73).

rule must refer for its precise placement as evidence that the couplet should be considered a prosodic foot. The restriction of glottalization to the initial mora of the foot falls out from the fact that this is the strong mora of the foot and therefore capable of licensing the greatest number of contrasts (e.g. Harris 1997). A further consequence of this analysis is that, while there is a surface contrast between glottalized vowels and the other vowel sets described in §3.1, no glottalized vowel phonemes are posited for IM.

### 6.3.2 Nasalization patterns

Marlett (1992) claims that "nasalization in Mixtec [varieties] is an autosegmental morpheme-level feature which links to the right edge of a morpheme and spreads to adjacent sonorants" unless it is blocked by an obstruent, and he notes that in some varieties, even obstruents do not block the spread of nasalization (p. 425–6). In other words, vowels and consonants are not underlyingly nasal, but derive their nasality from the spreading of a floating nasal feature that is part of the underlying representation of some morphemes. This analysis only accounts for the distribution of nasal segments if it is assumed that monomorphemic words always have a couplet shape and that those that are larger than a couplet are multimorphemic (p. 425–6, fn. 2). In this section I will argue that Marlett's analysis is better understood as a description of the historical development of nasalization in IM based on a lack of evidence for synchronic alternation between supposed oral ~ nasal consonant allophones and that it is untenable to analyze various fossilized forms that are larger than a couplet as synchronically analyzable into constituent morphemes in order to explain their nasalization patterns. Instead, I argue that the nasalization rules described by Marlett are responsible for the nasal phonotactic patterns found in contemporary IM, but that the synchronic phonology should include underlyingly nasal vowels and consonants, as well as contextually nasalized vowels. The IM nasal phonotactics are similar to the foot-based distribution of nasal segments in Applecross Gaelic discussed in §5.3.3. Since the couplet forms the domain for IM nasal phonotactics, I consider these patterns to constitute evidence that the couplet should be considered a foot.

All Mixtec languages have contrastive nasalization similar to that which is illustrated by the pairs of IM examples in (253).

| (253) | | **Oral** | | **Nasal** |
|---|---|---|---|---|
| | a. | *jɨkɨ̀* 'bone' | ~ | *jɨkɨ̃̀* 'squash' |
| | b. | *tɨɨ̀* 'tight' | ~ | *tɨ̃ɨ̃̀* 'grab' |
| | c. | *sáˀá^L* 'do/make:IRR' | ~ | *sã́ˀã́^L* 'Spanish' |
| | d. | *ⁿdíjí^L* 'burn' | ~ | *nĩ́ɲĩ́^L* 'blood' |
| | e. | *jɨɨ̀* 'husband' | ~ | *ɲɨ̃ɨ̃̀* 'skin' |
| | f. | *juˀù* 'mouth' | ~ | *ɲũˀũ̀* 'ground' |

In Chapter 3, six nasal vowel phonemes, /ĩ, ẽ, ã, ɨ̃, õ, ũ/, and three nasal stop phonemes, /m, n, ɲ/, were proposed; however, it was also noted that there is a phonotactic restriction that vowels following nasal consonants are nasalized, which neutralizes the contrast between nasal and oral vowels in this context. It is also true, however, that the nasal stops are in complementary distribution with their voiced oral counterparts at the same place of articulation—/β, ⁿd, j/—with the former occurring before nasalized vowels and the latter before oral vowels, as illustrated in Table 54.

Table 54. Complementary distribution of voiced oral and nasal consonants

| | **<u>C</u>V(ˀ)CV** | **CV(ˀ)<u>C</u>V** | **CVː** | **CV(ˀ)V** |
|---|---|---|---|---|
| **m ~ β** | ***β**ítʃĩ̀* 'cold'<br>***m**ĩ́ɲĩ̀* 'pool' | *kãˀ**m**ĩ̀* 'to smoke:IRR'<br>*kaˀ**β**ì* 'read' | ***β**éè* 'heavy'<br>***m**ãã̀* 'emphatic' | ***β**áˀà* 'good'<br>***m**ã́ˀã̀* 'mother' |
| **ⁿd ~ n** | ***ⁿd**áβà* 'wood bar'<br>***n**ã́mã́^L* 'soap' | *ká**ⁿd**á* 'move'<br>*kã**n**ã̀* 'call' | ***ⁿd**aà* 'to rise'<br>***n**ãã̀* 'be lost' | ***ⁿd**aˀà* 'hand'<br>***n**ãˀã̀* 'strapping' |
| **j ~ ɲ** | ***j**úˀβá^L* 'thread'<br>***ɲ**ṹˀmã́^L* 'smoke' | *ká**j**á* 'accumulate'<br>*kã**ɲ**ã̀* 'go out' | ***j**aà* 'tongue'<br>***ɲ**ãã̀* 'dark' | ***j**áˀà* 'pass'<br>***ɲ**ãˀã̀* 'woman' |

The first two columns of the table compare the voiced oral and nasal consonants (in bold) in the first syllable and second syllables of CV(ˀ)CV couplets, respectively, while the third and fourth columns compare them in monosyllabic couplets with plain and glottalized couplets, respectively. When the couplet medial consonant is nasal (column 2), the surrounding vowels are both nasalized regardless of the nasality of the couplet-initial consonant. Similarly, if the medial consonant is a voiced oral consonant, the surrounding vowels are oral except where vowels are phonetically nasalized before a prenasalized consonant, as described in §3.1 (e.g. ***ká**ⁿ**dá*** 'move'). In (C)V(ˀ)CV couplets, if the initial consonant of the couplet is a nasal, all segments in the couplet are nasal; however, if the initial consonant is a voiced oral consonant, the following vowel and medial consonant are always oral, but the final vowel may be nasalized if the medial consonant is voiceless, as in ***βítʃĩ̀*** 'cold' and (253a). In (C)Vː and (C)VˀV couplets, all segments are nasal if the consonant is nasal and oral if it is a voiced oral consonant.

From the data in (253) and Table 54, we can see that the nasalization patterns in IM are more intricate than a simple phonotactic restriction that vowels are nasal following a nasal consonant. In fact, the phonotactic patterns are defined in terms of the same unit that describes the locus of stress, the pervasive structure traditionally referred to as the couplet. The generalizations regarding the distribution of oral and nasal segments within the couplet can be summarized as follows: (In the quasi-examples for each generalization in (254), ***k*** = any voiceless consonant, ***j*** = any voiced consonant, ***ɲ*** = any nasal stop, ***a*** = any oral vowel and ***ã*** = any nasal vowel.)

(254) Phonotactics of nasal segments
- a. There are no oral segments to the right of a nasal segment in the couplet, e.g. ***kakã***, ***kãɲã***, ***ɲãɲã***, but ****kãka****, ****kãkã***, ****ɲãkã***, ****ɲãka***
- b. If the couplet-medial consonant is a nasal, then all couplet vowels will be nasal, e.g. ***kãɲã***, ***ɲãɲã***, but ****jaɲã***, ****kaɲã***, ****kãɲa***
- c. If the couplet-medial consonant is a voiced oral consonant, then all couplet segments will be oral, e.g. ***jaja***, ***kaja***, but ****ɲãjã***, ****ɲaja***, ****kãjã***, ****kãja***

The generalizations in (254) are very robust in IM, though not exceptionless.

Two types of exceptions are couplets with nasalization in the first syllable and oral segments in the second syllable, and couplets with a medial nasal and either an oral vowel or voiced oral consonant in the first syllable. Examples of the first type of exception are given in (255).

| | | | | |
|---|---|---|---|---|
| (255) | a. | *mĩ́ˀ$^{n}$dʲá$^{L}$* | ‘prickly pear fruit’ | cf. **wiˀ$^{n}$deˀ* (Josserand 1983:480) |
| | b. | *ĩ́ᵑgá* | ‘another’ | cf. *ĩĩ̀n* ‘one’, *=ká* ‘more’ |
| | c. | *nã́ã́ kuù ~ nã́kù* | ‘why’ | cf. *nã́ã́* ‘what’, *kuù* ‘be’ |
| | d. | *nãkù* | ‘uncertainty’ | cf. (d) |
| | e. | *nõso ~ nãso* | ‘not’ | |

These examples all violate generalization (254a) by having oral segments to the right of a nasal segment in the couplet, while (255a–b) also violate (254c) since they have nasal segments in the couplet with a medial voiced oral consonant. The first example has a medial prenasalized consonant, which appears to be the source of nasalization of both the onset and vowel of the initial syllable of (255a), but (255b) demonstrates that this type of exception to the nasal phonotactics can also arise from the concatenation of a nasal morpheme to an oral morpheme. It should also be noted that there are other examples with medial prenasalized consonants like *lĩᵑgì* ‘repulsive’ where the vowel of the first syllable is subject to anticipatory phonetic nasalization, as described in §3.2.2. The concatenation of a nasal morpheme to an oral morpheme is also the origin of (255c), and likely the final two examples, as well, all of which are also not lexical morphemes.

All known native exceptions with a couplet-medial nasal and an oral segment in the initial syllable are given in (256).

(256) a. *sjúˀmã̀* ‘Llano Escondido (town)’
b. *kʷíˀnã́$^{L}$* ‘Devil’
c. *$^{L}$lṍmẽ̀* ‘bat’

These examples all violate generalization (254b), since they have a couplet-medial nasal consonant but no nasalization in the first syllable. There also appears to be “free” variation between an oral ~ nasal first vowel in other words with CVˀNV couplets (i.e. with a voiceless initial consonant, glottalization and a medial nasal).[22] This may indicate that vowels in this context are beginning to

[22] For instance, my primary consultant indicated that the word for ‘tortilla cloth’ could be pronounced either *saˀmã̀* or *sãˀmã̀*, and another consultant also did not nasalize the first vowel of *ʃiˀɲã̀* ‘caterpillar’, and pronounced some other CVˀNV words both with and without nasalization on the first vowel. Also, although the predominant pattern for (256a) appears to be with an oral first vowel, my primary consultant gave tokens that have some nasalization on this vowel.

lose their nasalization, perhaps even more so if the initial consonant is a sibilant. Example (256c) also violates the generalization in (254c), since it has a voiced oral consonant in a couplet with nasal segments, and it may also have little or no nasalization on the first vowel, at least for some speakers.

The generalizations in (254) are robust across Mixtec languages, which led Marlett (1992) to propose that individual segments in Mixtec languages are not underlyingly nasal, but derive their nasality by rule from a lexical nasal feature. Morphemes that have nasal segments are marked in the lexicon with an autosegmental nasal feature and the nasalization patterns described in (254) result from the following rules:

(257) Pan-Mixtec nasalization rules (adapted from Marlett 1992:426)
  a. Associate the feature [+nasal] to the right edge of the morpheme
  b. Spread nasalization iteratively from right to left throughout the morpheme until blocked by a voiceless obstruent.

Under this analysis, nasal vowels are all derived from oral vowels, similar to the analysis of glottalized vowels presented in §6.3.1, and each oral ~ nasal consonant pair in Table 54 are allophones of a single phoneme. The blocking effect of obstruents is seen in examples like (253a), where a medial voiceless obstruent permits a nasal vowel to the right, but not to its left in the first syllable (cf. (254a)). Since only voiceless obstruents can block the spread of nasalization, this accounts for the fact that couplets lacking a medial voiceless obstruent are either completely oral (if they have a medial voiced oral consonant, cf. (254c)), or completely nasal (if they have a medial nasal stop, cf. (254b)), apart from the possibility of an initial voiceless obstruent (e.g. (253c)).

As insightful as this analysis is, there are reasons to reject it as a synchronic analysis for IM nasalization and consider it rather to describe the historical development of nasalization in Mixtec. One key reason is that there is no clear evidence of synchronic alternation between the supposed oral ~ nasal consonant allophones—that is, you never find a situation where a morpheme with say, [β] changes to [m] (or vice versa) when brought into proximity with a nasal similar to the way the English plural morpheme /–z/ alternates to [s] when it is suffixed to a root ending in a voiceless consonant (e.g. *cat–s* [kæts] ~ *dog–s* [dɑgz]).[23] One place that an oral ~ nasal consonant alternation might be expected to show up in IM is when the nasal second person singular enclitic pronoun, =*ũ*, integrates with the couplet (cf. §2.5, §6.2.1); however, nasalization does not trigger an alternation in couplet-medial voiced oral consonants, as shown in these examples:

(258) a. *kaˀβì* ‘to read’
*kaˀβũ* ‘you read’
b. *ká$^{n}$dá* ‘to move’
*kà$^{n}$dȭ* ‘you move’
c. *kajɨ̀* ‘to cough’
*kajũ̀* ‘you cough’

In each pair of examples, the final stem vowel is nasalized when the nasal pronoun coalesces with it, but the medial voiced oral consonant does not alternate to a nasal stop and the resultant form violates couplet nasal phonotactics, since it has a voiced oral consonant in a couplet with a nasal (cf. (254c)). Although there can be nasalization on /β/ in the possessed form of the first example, it is not realized as [m] and clearly contrasts with /m/ in *kãˀmũ̀* ‘owl’. I take the lack of alternation as evidence that the nasalization patterns should be modelled as static phonotactic constraints (cf. Silverman 2000; Gorman 2013), rather than generated by rule.[24]

A second reason to consider the nasalization patterns to be static generalizations is that there are trisyllabic monomorphemic words that do not fit the nasalization rules in (257). Some or all of these trisyllabic words may have been complex at some earlier stage of Mixtec, but are now monomorphemic.[25] These exceptions are of two types, words with an oral pre-couplet syllable and

[23] One kind of alternation that does occur in IM, however, is that /ɲ/ may be realized as [ɲ] or [j̃] in nasal couplets in fast speech.

[24] An Optimality Theoretic analysis, on the other hand, would generate the phonotactic patterns through the language-specific ranking of constraints rather than handling them in the underlying representations (cf. Gerfen 1996); however, Silverman (2000) argues that it is important to distinguish between active and static relations among sounds in order to make predictions that are accurate and testable.

[25] Some of these words are comparable to English *refer* and *prefer*, which are synchronically monomorphemic in English, though they were complex in Latin from which they descended.

a nasal couplet, and words with a nasal pre-couplet syllable and an oral couplet. Exceptions of the first type are given in (259) with the couplet boundaries marked by round brackets.

(259) a. *sá(ɲɨ̃ɨ̃̀)* ‘corncob’
b. *tɨ́(nãnã̀)* ‘tomato’
c. *tɨ̀(nɨ̃́ˀɨ̃́$^{L}$)* ‘twins’
d. *tɨ̀(ɲɨ̃́ˀɨ̃́$^{L}$)* ‘skunk’
e. *tú(mãˀã̀)* ‘racoon’

Marlett (1992) considered the domain of nasalization to be the morpheme and therefore the initial vowel in these examples should be nasalized since there is no obstruent to block the leftward spread of nasalization, but it is not. To be fair, Marlett’s (1992) analysis did not consider morphemes larger than a couplet because he considered them to be “almost invariably clearly not monomorphemic” (p. 426, fn. 2); however, languages change and monomorphemic words such as these provide evidence either that the nasalization patterns are static generalizations or that the domain of application is the couplet not the morpheme, or both, a point I will return to below.

Examples which have nasals in the pre-couplet syllable and no nasalization in the couplet are given in (260).

(260) a. *ɲã́(jɨβɨ̀)* ‘people’
b. *ɲã̀(jɨ́βɨ́$^{L}$)* ‘world’
c. *nɨ̃̀(jɨˀɨ̀)* ‘raw’
d. *mã̀(tʃiì)* ‘vulture’
e. *mã́($^{n}$doò)* ‘turtle’
f. *mã́(jɨ́ɨ́)* ‘cicada’

Since these words are synchronically monomorphemic, if nasalization spreads leftward from the right edge of the morpheme, there should be no oral segments to the right of nasal segments. Furthermore, nasalization in the pre-couplet syllables cannot be attributed to the purported nasalization rules since these syllables are not morphemes.

The examples in (259) and (260) show that the nasalization patterns, which probably at some point in Mixtec history were derived by rule, have now been lexicalized and should be considered static phonotactic patterns. Moreover, these data also show that the domain of nasal phonotactics in IM is the couplet, since the patterns of nasalization are adequately described in these larger words if they are stated in terms of the couplet, as in (254)—that is, the nasal phonotactics hold over the couplet portion of the word, and the nasality of the pre-couplet syllable neither affects the couplet nasalization patterns nor is affected by them. Presently I will show that even at the stage of the language when the nasalization patterns would have been rule-based, the domain of nasalization was the couplet and not simply the morpheme, but first I turn to the question of how much vowel nasalization should be included in underlying forms.

Nasal vowels in words which have no nasal consonants clearly must be considered underlyingly nasal if we do not adopt Marlett's (1992) lexical nasal feature analysis. Examples of underlying forms for words like these are given in (261).

(261) a. 'squash' /jɨ̀kɨ̃̀/ → *jɨkɨ̃̀*
b. 'delicious' /ásɨ̃́$^{L}$/ → *ásɨ̃́*$^{L}$

By the same token, (C)V(ˀ)V words with a nasal vowel and no nasal consonant are also represented with underlying nasal vowels:

(262) a. 'to grab' /tɨ̃̀/ → *tɨ̃ɨ̃̀*
b. 'one' /ĩ̀/ → *ĩĩ̀*
c. 'Spanish' /sã́ˀ$^{L}$/ → *sã́ˀã́*$^{L}$
d. 'five' /ṹˀ/ → *ṹˀṹ*

When these roots lengthen the underlyingly short vowel to fulfill the requirement that words/roots are minimally a foot (cf. §6.2.1), it is a nasal vowel which spreads to the second mora of the couplet. The nasal "spreading" in (C)V(ˀ)V couplets, then, is simply a consequence of the augmentation that occurs to meet the prosodic requirements.

As already mentioned, vowels are predictably nasal following nasal stops and I propose to treat these vowels as underlyingly oral and to be phonologically nasalized by nasal spreading from the preceding nasal. Unlike the situation with nasal consonants, there is evidence of an oral ~ nasal vowel alternation. One context where this occurs is when the oral perfective prefix, *í–*, is preceded by the negative proclitic, *ɲã́ᴸ*＝, as shown in (263).

(263) a. *ɲã́ĩ́(tʃíkā)* *ĩ́ɲĩ́*
ɲáᴸ＝í–tʃìkà ĩɲĩ
NEG=PFV–walk:REAL inner.being
'did not think'

b. *ɲã́ĩ́(kētà)*
ɲáᴸ＝í–kètà
NEG=PFV–go.out
'did not go out'

The vowel of at least the perfective prefix must be considered underlyingly oral due to its oral realization in non-nasal contexts (e.g. *í–satà* 'bought'), however, both the vowel of the proclitic and the perfective prefix are nasalized on the surface because they follow the nasal consonant, /ɲ/. Another context showing an oral ~ nasal vowel alternation is when the first person singular enclitic pronoun, ＝*í*, is integrated into the couplet of monomoraic roots:

(264) a. *tṹˀĩ́*
tũˀ＝í
word=1SG
'my word'

b. *ʃã́ˀĩ̀*
ʃã́ˀᴸ＝í
lard=1SG
'my lard'

c. *kúˀì*
kúˀᴸ＝í
bush=1SG
'my bush'

d. *ⁿdàˀī*
ⁿdàˀ=í
hand=1SG
'my hand'

If the couplet is nasal, the pronoun vowel is nasal (264a–264b), but if the couplet is oral, the pronoun vowel is oral (264c–264d). The fact that the oral pronoun is nasalized in nasal couplets is significant because, as discussed in §6.2.1, the pronoun does not coalesce with the root vowel (i.e. take on the vowel height of the final root) vowel in (C)V(ˀ)V couplets like it does in (C)V(ˀ)CV couplets (e.g. *tʃátá*ᴸ 'back' + *=í* '1SG' → *tʃátè* 'my back', **tʃátì*), it simply fills the final slot of the couplet since there is no vowel there for it to coalesce with. This being the case, the nasalization of the pronoun vowel is modelled as the result of progressive assimilation from the preceding nasal vowel (i.e. the root vowel).[26] Based on the evidence of the alternations in (263) and (264), therefore, I treat vowels next to nasals as underlyingly oral and nasalized by spreading from the preceding vowel:

(265) 'brother' /ɲáɲí/ → *ɲá̃ɲí̃*

Couplets with two nasal consonants, then, are represented with underlyingly oral vowels.

The final context to consider for vowel nasalization is following a voiceless consonant and preceding a nasal consonant (e.g. *kãˀmı̃̀* 'to smoke:IRR'). These vowels are obviously not nasalized by progressive vowel nasalization, and they generally only occur in the initial syllable of couplets with a medial nasal (i.e. (C)V̲(ˀ)NV).[27] I therefore treat the initial vowel in (C)V̲(ˀ)NV couplets as underlyingly nasal, as shown in (266).

---

[26] The nasalization of the first person singular pronoun in nasal (C)V(ˀ)V couplets could also be considered evidence for a lexical nasal feature which is realized within the couplet of the word—that is, the pronoun vowel is nasalized because it is integrated into the couplet of a root that is marked with the nasal feature; however, this evidence does not seem compelling enough to overturn the reasons outlined above for rejecting the lexical nasal feature analysis as a synchronic analysis.

[27] There are a few exceptions in my data like *kãnã̀kaβà* 'to fall', which could be taken to be compounds consisting of two couplets, and it should also be noted that there can be phonetic anticipatory nasalization in oral prefixes like *kʷá–* 'prospective' preceding a nasal prefix like *nã̀–* 'repetitive' (e.g. *kʷá–nā–kúˀβá* 'going to repay'.

(266) a. ‘to smoke:IRR’ /kã^ʔmi/ → *kã^ʔmȉ̃*
b. ‘inner being’ /ı̃́ɲí/ → *ı̃́ɲı̃́*

These data, together with (261) and (262) show that the distribution of underlyingly nasal vowels is restricted to couplets. This is similar to DiCanio’s (2008:70–1) analysis of nasalization in the Mixtecan language, Itunyoso Trique (Mexico), except that in that language underlying nasal vowels are restricted to the final syllable. Interestingly, it is the final syllable in Trique that bears stress and is obligatorily bimoraic.

To summarize this section so far, IM has three nasal stop phonemes, /m, n, ɲ/, and underlyingly nasal vowels of each of vowel quality within the couplet when there are no nasal stops preceding them (e.g. /jɨ̀kɨ̏/ → *jɨkɨ̏̃* ‘squash’, /tɨ̏/ → *tɨ̃ɨ̏̃* ‘to grab’, /kã^ʔmi/ → *kã^ʔmȉ̃* ‘to smoke’). Vowels are also contextually nasalized by a progressive nasalization process from a neighbouring nasal segment (e.g /ɲáɲí/‘→’*ɲã́ɲı̃́*, tũ^ʔ = í → *tṹ^ʔı̃́* ‘my word’). There is also phonetic anticipatory nasalization of vowels preceding prenasalized consonants (e.g. /ka^nda^H/ → *kã́^ndá* ‘to move’). Due to the historical development of nasalization from an autosegmental feature of particular morphemes and rules of nasal harmony, the distribution of nasal segments and the nasal spreading rules are governed by the couplet—that is, the patterns of nasal segments (cf. (254)) are described in terms of the couplet not the synchronic morpheme, and progressive phonological nasalization does not appear to cross couplet boundaries.

I now turn to consider data showing that even at the stage of the language when Mixtec nasalization was rule-based, the couplet and not simply the morpheme was the domain of application. In §6.2.2.1 I described a class of verbs that have fossilized irrealis and realis stems formed with a root plus the mood prefixes *ku–* ‘IRR’ and *tʃi–* ‘REAL’. Some of the etymological roots of these stems were monomoraic and therefore unable to form a couplet without some form of augmentation. The roots which had a CV shape simply combined with the mood prefixes in order to form a couplet rather than following the usual strategy in the language of lengthening the root vowel (cf. §6.2.1). What is significant with respect to nasalization is that when the oral prefixes formed a couplet with nasal roots, the entire couplet except the initial obstruent was nasal, as shown in Table 55, where the second column gives a hypothesized etymological root based on Marlett's (1992) nasal harmony analysis, and the third and fourth columns give the contemporary irrealis and realis stems, respectively.[29]

Table 55. Irrealis/realis stems with nasal CV roots

| **Gloss** | **Root** | **Irrealis** | **Realis** |
|---|---|---|---|
| 'hear' | *jiᴺ | *kũ•ɲĩ̀* | *tʃĩ•ɲĩ̀* |
| 'run' | *nuᴺ | *kũ•nũ̀* | *tʃĩ•nũ̀* |

On the other hand, when the prefixes formed stems with oral roots, the couplet was oral:

Table 56. Irrealis/realis stems with oral CV roots

| **Root** | **Gloss** | **Irrealis** | **Realis** |
|---|---|---|---|
| *tʲì | 'bathe' | ˈ*ku•tʲì* | ˈ*tʃi•tʲì* |
| *tù | 'clear land' | ˈ*ku•tù* | ˈ*tʃi•tù* |
| *tò | 'know' | ˈ*ko•tò* | ˈ*tʃi•tò* |

Furthermore, when stems were formed with CVCV roots, the prefix was outside the couplet and thus the prefix vowel did not nasalize even if the couplet was nasal, as shown in (267).

(267) a. *kù(nãɲĩ̀)*
kù•nàɲì
be.named:IRR
'Be named!'

b. *ītʃí(nã́ɲĩ̀)ɾà*
í–tʃì•nàɲì = ɾà
PFV–be.named:REAL=3MASC
'he was named'

[29] The etymological roots given in Table 55 and Table 56 are not based on comparative data and are not meant to represent PM forms. My point here is not how they should be represented, but that when they are nasal(ized), the nasal feature spreads to the oral prefix.

This also appears to have happened with *tĩ̀ɲĩ́* 'rat', which is completely nasalized even though it is historically derived from an oral animal classifier, *tɨ–* and a nasal root **jĩ*ˀ (cf. **tɨjĩʔ*; Josserand 1983:480). Yet when the classifier is inside an oral couplet, as in *tɨ́kà* 'grasshopper', or outside a nasalized couplet, as in *tɨ(ɲĩ́ˀĩ́ᴸ)* 'skunk', it is oral. These data argue that the domain of lexical nasalization was the couplet and not simply the morpheme; however, given the predominant pattern for roots to be realized as couplets, the typical couplet is monomorphemic.

Another interesting fact about nasalization is that, similar to glottalization (§6.3.1), nasalization is often lost when nasal morphemes are grammaticalized as prefixes, as in *kʷã́ˀã́* 'go:PROG' > *kʷá–* 'PROS, MOT.AW.PR', *kṹˀṹ* 'go:IRR' > *kú–* 'MOT.AW.IRR' and *tʃã́ˀã́* 'go:RNT' > *tʃá–* 'RNT' (cf. §2.4.2). To this list could be added the fossilized wood classifier prefix, *tu–*, from the final syllable of *jutũ̀* 'tree', which is usually not nasalized (though it sometimes is for a couple of my consultants). Though the data are not plentiful and more study is needed, it also appears that inherently nasal vowels in CVˀV couplets are lost (as well as glottalization) when they are the initial root in a compound, as in abstract nouns formed with /tṹˀ/ 'word', e.g. *tú(mã́ɲĩ́ᴸ)* 'favour', *tú(ⁿdoˀò)* 'suffering' (although the second example can have some phonetic nasalization due to the following prenasalized stop). Nasal consonants, on the other hand, do not lose their nasalization when grammaticalized—*nṹṹᴸ* 'face' > *nṹᴸ=* 'locative'—nor when they form compounds—*ɲãˀã̀* 'woman' ~ *ɲã̀(sìˀī)* 'wife'. Similar facts in Ixpantepec Mixtec led Carroll (2015) to suggest that vowel nasalization is a "stress-dependent property" which may be lost lost due to destressing. I suggest, rather, that vowel denasalization be interpreted as evidence that underlyingly nasal vowels are restricted to the couplet, as discussed above, and therefore when these roots are not realized in the couplet, underlying vowel nasalization is lost.

It should be noted, however, that enclitics do not lose their nasalization through the grammaticalization process in IM as in these examples:

(268) a. =*tũ* ‘WOOD’ cf. *jutũ̀* ‘tree’
b. =*ũ* ‘2SG’ cf. **kɨʔᴺ* ‘2SG’ (Hollenbach 2015:10)
c. =*ɲã̀* ‘3.FEM.POL’ cf. *ɲãʔã̀* ‘woman’

These data show that the generalization that underlyingly nasalized vowels only occur in couplets must be qualified to include enclitics. The nasal phonotactics of couplet are patterns of (historic) nasalization that take the foot as their domain. This type of nasalization is normally lost in grammaticalization, but not in the case of enclitics perhaps due to the position of enclitics at the end of the PWRD where the nasalization is proposed to have originated.

In summary, in this section we have seen that IM has robust nasalization patterns (cf. (254)) that take the couplet as their domain. The couplet is also the only domain where underlying nasal vowels are posited, and there is evidence that when these vowels are realized outside the couplet their nasalization is lost. Underlying (C)V(ʔ) roots with nasal vowels surface with a long nasal vowel as a result of the lengthening of the underlying vowel that occurs in order to fulfill the bimoraic minimal word/root requirements. The monomorphemic trisyllabic words given in (259) and (260) are exceptions to Marlett’s (1992) nasalization rules, which are morpheme-based rather than couplet-based. The final two syllables/moras of these words—that is, the couplet—are the domain of the nasal phonotactics, while the initial syllable is excluded, even though the couplet no longer corresponds to any synchronic morphosyntactic structure (root, stem, morpheme, etc.). Further evidence for the couplet and not simply the morpheme as the domain of nasalization comes from fossilized word formation processes which show that when couplet-sized stems were formed with oral prefixes and nasal roots, the result was a couplet with the same nasalization patterns as those that were monomorphemic. In other words, nasalization spread throughout the couplet. On the other hand, the prefixes remain oral in stems formed with oral roots, or with the prefixes outside a nasal couplet. Recognizing the special status in the grammar of the final couplet of the lexical word provides the unit needed for the description of the nasal phonotactics and many other patterns in IM. Since the couplet is the locus of stress in IM, a prototypical role of the foot, and since the couplet has the shape defined by prosodic theory for the quantity-sensitive, trochaic foot, and since it is a typological property of the foot to provide the domain for phonological rules and phonotactic restrictions, I take the fact that the couplet provides the domain for nasal phonotactic patterns in IM to be evidence that the couplet should be considered a foot.

### 6.3.3 Distribution of vowels

Another piece of evidence that Macken & Salmons (1997) give for the existence of a prosodic foot template in Mixtec is that there are particular vowel distribution patterns and restrictions that are peculiar to the couplet. They report that CM and SM show "a broad diachronic tendency towards vowel harmony," (p. 52) by which they mean identical vowels, especially in CV(ˀ)V couplets, as well as other vowel co-occurrence restrictions within the couplet.[30] Similar vowel distribution patterns are also found in IM, though with some differences, and the fact that the domain of these patterns is the couplet provides yet another example of a phonotactic restriction that takes the couplet as its domain, and thus further evidence that the descriptive unit "couplet" fulfills the typologically common role of the foot in providing the domain for phonotactic generalizations. I begin in §6.3.3.1 by addressing the specific harmony processes noted by Macken & Salmons and show that IM has the same or similar diachronic vowel harmony processes. Following that, in §6.3.3.2, I address other vowel pattern restrictions within the couplet mentioned by Macken & Salmons and compare them to those found in IM.

#### 6.3.3.1 Vowel harmony

Macken & Salmons (1997) give evidence from CM that vowels within the couplet show a broad tendency towards absolute vowel harmony—that is, sound changes that result in a single vowel quality associated with both moras of the couplet. The fact that the couplet serves as the domain for this diachronic tendency/phonotactic constraint constitutes evidence for considering

[30] Josserand (1983) also reports a number of "vowel harmony" processes common throughout the Mixteca.

it a prosodic constituent. In this section I will show that the IM data also provide evidence that the vowels within couplets have been harmonized when compared to data provided by Macken & Salmons, as well as to other data from Josserand's (1983) Proto-Mixtec reconstructions.

Macken & Salmons (1997) present data showing the strong tendency for harmony in couplets with /ɨ/ and /i/, usually resolved in favour of /ɨ/. They argue that CM has made a number of diachronic innovations compared to the neighbouring dialect of SM which result in vowel harmony, including "a categorical, bidirectional harmony rule in Chalcatongo" (p. 53) whereby C*ɨ*C*i* and C*i*C*ɨ* templates become C*ɨ*C*ɨ* (and occasionally C*i*C*i*). Interestingly, where corresponding forms in IM exist they also have identical vowels, as can be seen in Table 57, which shows rightward harmony, and Table 58, which shows leftward harmony (SM & CM data from Macken & Salmons (1997:53)).

Table 57. Rightward i ~ ɨ vowel harmony

| | **CɨCi →** **SM** | **CɨCɨ** **CM** | **CɨCɨ** **IM** |
|---|---|---|---|
| 'blood' | *(nɨñì)* | *(nɨñɨ)* | *(nɨ̃́ɲɨ̃́$^{L}$)* |
| 'corncob' | *(nɨñi)* | *(nɨ́ñɨ́)* | *(nɨ̃ɲɨ̃̀)* |
| 'rat' | *(tɨñí)* | *(tɨñɨ), (tiñí)* | *(tɨ̃̀ɲɨ̃́)* |
| 'to play tricks on' | *sá(ndɨží)* | *sá–(ndɨžɨ)* | — |
| 'jug' | *(kɨ̀ži)* | *(kɨžɨ)* | *(kɨ́jɨ́)* |
| 'to grind one's teeth' | *(kɨʔñi)* | *(kɨʔñɨ)* | — |
| 'to scorch' | *(sɨžì)* | *(sɨ́žɨ́)* | — |
| 'pimple' | *(ndɨʔži)* | *(ndɨʔžɨ)* | *($^{n}$dɨ́ˀjɨ̀)* |
| 'corpse' | *(ndɨ̀ži)* | *(ndɨžɨ)* | *($^{n}$dɨ́jɨ̀)* |

Table 58. Leftward i ~ ɨ vowel harmony

| | **CiCɨ →** **SM** | **CɨCɨ** **CM** | **CɨCɨ** **IM** |
|---|---|---|---|
| 'to curl' | *(čiŋgɨ)* | *(čɨ̃ŋgɨ̃), (čĩŋgĩ)* | — |
| 'sand' | *(ñɨ̀tɨ́)* | *(ñɨtɨ̀)* | *ɲɨ̃̀(jɨtɨ̀)*[31] |

[31] One consutant pronounced this word [ɲɨ̃tɨ] and [ɲũɨtɨ].

| | CiCɨ → | CɨCɨ | CɨCɨ |
|---|---|---|---|
| | **SM** | **CM** | **IM** |
| 'candle' | *(žitɨ)* | *(žɨtɨ)* | *(jɨtɨ̀)* 'pitchpine' |

In both tables, the SM form in the second column has different vowels in the two vowel positions of the couplet—*ɨ-i* in Table 57 and *i-ɨ* in Table 58—while the CM and IM forms in the next two columns both have identical vowels—*ɨ-ɨ*. It should be noted that a couple of the forms have PM reconstructions and these are reconstructed with **ɨ* in both vowel slots of the couplet: **nɨjɨʔ* 'blood', **tɨjɨ̃ʔ* 'rat' and **$^{n}$dɨʔjɨ* 'pimple' (Josserand 1983:479–80). Nevertheless, it is reasonable to question whether these reconstructions should have identical vowels given that the SM forms have /i/ instead of /ɨ/, and that, according to Josserand (1983:300), **ɨ* merged with **i* in all environments in most modern varieties of Mixtec, while /ɨ/ reflexes of **i* are rare. Notice also that the SM form *ɲ̃ìtɨ́* 'sand' appears to be a contraction of a longer form that is found in IM. Consequently, if SM *ɲĩ* was originally a pre-couplet syllable like it is in IM, this example may not be an instance of the couplet-initial *i* harmonizing with the couplet final *ɨ* in CM and IM; however, it is also possible that the form was contracted in CM and SM and then harmonized in CM once it was within the couplet. These examples provide evidence of a diachronic process of vowel harmony within the couplet particularly in CM and IM. The data also suggest that harmonizing the second couplet vowel with the initial vowel is the more frequently attested sound change.

Other examples of harmony in IM compared to corresponding PM words from Josserand (1983) are given in Table 59.

Table 59. Other vowel harmony examples compared to PM (Josserand 1983:479–80)

| **Gloss** | **PM** | **IM** | **Direction** | **V Process** |
|---|---|---|---|---|
| 'cockroach' | **tɨ teʔjaʔ* | *tɨ̀(ˈtʲéˀlé$^{L}$)* | right | a → e |
| 'foam' | **tɨ ijũ* | *(tɨ̃́ɲɨ̃́$^{L}$)* | right | u → ɨ |
| 'cut' | **kàʔndè* | *(káˀ$^{n}$dʲá)* | right | e → a |
| 'crooked' | **jakʷeʔ* | *(jakʷà)* | right | e → a |
| 'chachalaca' | **laxẽʔ* | *($^{L}$látʃã̀)* | right | e → a |
| 'whisky' | **$^{n}$disɨ* | *($^{n}$díʃí)* | left | ɨ → i |

Although there appears to have been considerable vowel harmony in PM, these examples show that the process of harmonization has continued so that PM words with different vowels have been harmonized in IM. Significantly, the vowel preceding the couplet in *tɨ̀(ˈtʲéˀléᴸ)* is not harmonized. Again, the data suggest that a tendency to preserve the initial vowel of the template and copy it to the second vowel slot is evident.

Another diachronic contributor to vowel harmony has been the loss of the template medial consonant, which has already been discussed in §6.2.2.3. In Table 60 I repeat the data from that section showing that medial consonant loss in IM as compared with corresponding PM forms in Josserand (1983) has resulted in vowel harmony (PM data from Josserand 1983:479–80).[32]

Table 60. Vowel harmony resulting from couplet-medial consonant loss

| Gloss | IM | PM | Lost C | Final V | Direction |
|---|---|---|---|---|---|
| 'heavy' | *(βéè)* | **weji* | **j* | **i* | right |
| 'house' | *(βeˀè* | **weʔji* | **j* | **i* | right |
| 'sickness' | *(kʷéˀéᴸ)* | **kʷeʔji* | **j* | **i* | right |
| 'offspring' | *(séˀè)* | **saʔji* | **j* | **i* | ? |
| 'slowly' | *(kʷèē)* | **kʷeje* | **j* | **e* | ? |
| 'see' | *(ⁿdʲeˀè)* | **ⁿdeʔja* | **j* | **a* | right |
| 'be afraid' | *(júˀú)* | **juʔwi* | **w* | **i* | right |

As can be seen, the lost medial consonant is almost always a glide, the glide is usually **j*, the final vowel is usually **i* and harmonization almost always preserves the couplet initial vowel and spreads it to the couplet final position, as was shown in (243). Clearly, this process contributed to the present-day situation in IM where all but three CV(ˀ)V couplets known to me have a long vowel associated with both moras of the couplet.

Other significant IM data involving the loss of the medial consonant comes from the loss of /β/, the IM reflex of **w*, as shown by the data in (269), which are repeated from Table 50.

[32] A couple other possible examples of harmony from couplet-medial consonant loss whose diachronic derivations are less clear are *tʃáˈʃèˀé* 'armpit' (< **leʔjiʔ*) and *ⁿdáá* 'true' (< **ⁿdixe*).

(269) Vowel harmony from couplet-medial **w* loss

| | | | | |
|---|---|---|---|---|
| a. | *(kuβì)* ~ *(kuù)* | ‘be’ | cf. **kúwí* | (Dürr 1987:53) |
| b. | *(suβì)* ~ *(suù)* | ‘affirmative’ | | |
| c. | *(tuβi)* ~ *(tuù)* | ‘appear’ | | |
| d. | *(úβí)* ~ *(úú)* | ‘two’ | cf. **uwi* | (Josserand 1983:480) |
| e. | *(jùˀū)* | ‘be afraid’ | cf. **juʔwi* | (Josserand 1983:480) |
| f. | *(kúú)* | ‘die:IRR’ | cf. *kuβi* | Coatzospan Mixtec (Gerfen 1996:48) |

Examples (269a–d) show synchronic free variation between forms with and without the medial consonant, while the last two examples (269e–f) are always pronounced without the medial consonant. These data are consistent with the hypothesis that when the couplet-medial consonant is lost, the vowel from the first syllable lengthened to fill the bimoraic couplet, as per the analysis in §6.2.2.3. Alternatively, a vowel assimilation process which takes the couplet as its domain could be posited.[33]

Macken & Salmons (1997) give several examples of a process whereby CVV words with different vowels in SM developed identical vowels in CM. However, as can be seen in Table 61, the cognate words in IM all have a medial consonant and no vowel harmony (SM & CM data from Macken & Salmons 1997:53).

Table 61. Examples with no medial C loss in IM and no V Harmony

| **Gloss** | **SM** | **CM** | **PM** | **IM** |
|---|---|---|---|---|
| ‘there’ | *(yṹã)* | *(wã́ã)* | **juku ã* | *(jukʷã̀)* |
| ‘his’ | *(yũ̀ã́)* | *(wãã́)* | | _---- |
| ‘comal’ | *(xío)* | *(šiò) > (šoò)* | **xijoˀ* | *(tʃíjóᴸ)* |

Josserand (1983:480) reconstructs ‘there’ and ‘comal’ with medial consonants (**juku ã* and **xijoˀ*, respectively), so it seems safe to assume that at least these two words had a medial consonant at an earlier stage. Apparently dialects like SM have a higher tolerance for different vowels in the couplet when the medial consonant is lost than dialects like CM and IM.

[33] For instance, it could be posited that /i/ assimilates [+round] from /β/ and since [+round] vowels are always [+back] in IM, the vowel is also realized with this feature and therefore realized as /u/.

An important generalization that emerges from the consideration of vowel harmony relates to the asymmetrical distribution of the vowels at the extremes of the vowel space (/i, a, u/) with respect to the vowels more internal to the vowel space (/e, ɨ, o/). The asymmetry in Mixtec was first recognized by Pike (1947:168ff) in his study of SM. He named the vowels outer and inner triangle vowels, respectively, and observed that the outer triangle vowels have less combinatorial restriction within the couplet than the inner triangle set. The combinatorics of outer and inner triangle vowels will be discussed further in §6.3.3.2, but the basic asymmetry between the two sets of vowels can also be seen in their relative frequencies in Table 62, which gives the frequency of each vowel by couplet type and position within the couplet from the database of 1088 native IM stems of various sizes.

Table 62. Vowel distribution by couplet type/position

| | **Disyllabic** | | **Monosyllabic** | | | |
|---|---|---|---|---|---|---|
| | **V1** | **V2** | **Vː** | **VˀV** | **Total** | |
| **/a/** | 289 | 225 | 70 | 70 | **654** | **(36%)** |
| **/i/** | 156 | 179 | 23 | 17 | **375** | **(21%)** |
| **/u/** | 142 | 137 | 37 | 32 | **348** | **(19%)** |
| **/ɨ/** | 78 | 102 | 24 | 15 | **219** | **(12%)** |
| **/o/** | 53 | 77 | 21 | 21 | **172** | **(9%)** |
| **/e/** | 5 | 3 | 17 | 18 | **43** | **(2%)** |
| | **723** | **723** | **192** | **173** | **1811** | **(100%)** |

The first two columns give the counts of each vowel in the first and second vowel position in (C)VC(ˀ)V couplets, respectively, while the third and fourth columns give the number of occurrences of each vowel in monosyllabic couplets with long vowels and glottalized long vowels, respectively. The sum of all occurrences for each vowel is given in the final column together with the percentage of the total number of vowels. As can be seen, the outer triangle vowels (the first three rows of the table) occur with considerably greater frequency that the inner triangle vowels. The properties of these two groups of vowels will be discussed further in the next section, but here it is important to note that the distributional asymmetry is also evident in vowel harmony patterns within the couplet. While both groups of vowels display vowel harmony, inner triangle vowels nearly always do so. The only non-identical combination of inner triangle vowels in a couplet in my data are two words with the vowel pattern *o-e* (*tʃokʷe* 'Chatino person' and *ᴸlómȅ* 'bat'). In other words, vowel harmony is nearly categorical for couplets with only inner triangle vowels in IM, as has been noted for several other Mixtec varieties (SM—Pike 1947; CM—Macaulay 1996; Macken & Salmons 1997; Ixpantepec Mixtec—Carroll 2015).

The vowel frequency data in Table 62 can also be used to show that the diachronic tendency towards vowel harmony within the couplet has resulted in a significantly greater number of words with couplets having like-vowels than would be predicted by chance, as Carroll (2015:63–7) has done for Ixpantepec Mixtec. Since monosyllabic couplets almost always have a single vowel quality in the couplet, a point I address in the next section, I focus here on disyllabic couplets. Following Carroll (2015), I calculate the probability of vowel harmony for each vowel based on the observed relative frequency of the vowel in each syllable of the couplet (n = 723 disyllabic couplets). The probability of identical vowels in both syllables of the couplet is the relative frequency of the vowel in the first vowel position—P(V1)—multiplied by the relative frequency of the vowel in the second vowel position—P(V2)—as shown in (270).

(270) Probability that V1 and V2 of a couplet are identical
P(V1 and V2) = P(V1) * P(V2)

The frequencies of each vowel in disyllabic couplets from Table 62 are repeated in the first two columns of Table 63 followed by a column with the frequency of vowel harmony. The next two columns give the relative frequency of the vowel in each syllable of a disyllabic couplet (= probability of that vowel occurring in that syllable position) and the sixth column gives the expected probability of harmony using the formula in (270). The next column (in bold) gives the relative frequency of vowel harmony for each vowel (= observed the observed harmony in column 3 divided by n = 723). The exact binomial test was used to evaluate whether the relative incidence of harmony for each vowel is significantly greater than the expected probability of harmony and the p-value resulting from this test is given in the final column. As can be seen, the relative frequency of harmony is significantly greater than the expected frequency for all vowel qualities ($p < .001$ for the first five vowel qualities and $p = 0.021$ for the sixth); furthermore, the overall relative frequency of harmony (0.487) is also significantly greater ($p < .001$) than the overall expected frequency of harmony (0.238), a result which parallels the findings of Carroll (2015:66), who reports the relative frequency of harmony in oral disyllabic couplets in Ixpantepec Mixtec to be 0.51 and to be highly statistically significant ($n = 236$, $p = .000$).

Table 63. The probability of vowel harmony in disyllabic couplets for each vowel quality

| | **Frequency** | | | **Relative frequency** | | | | |
|---|---|---|---|---|---|---|---|---|
| | **V1** | **V2** | **Harmony** | **P(V1)** | **P(V2)** | **P(V1)*P(V2)** | **Harmony** | **p-value** |
| **a** | 289 | 225 | 121 | 0.400 | 0.311 | 0.124 | **0.167** | p < .001 |
| **i** | 156 | 179 | 62 | 0.216 | 0.248 | 0.053 | **0.086** | p < .001 |
| **u** | 142 | 137 | 47 | 0.196 | 0.189 | 0.037 | **0.065** | p < .001 |
| **ɨ** | 78 | 102 | 73 | 0.108 | 0.141 | 0.015 | **0.101** | p < .001 |
| **o** | 53 | 77 | 48 | 0.073 | 0.107 | 0.008 | **0.066** | p < .001 |
| **e** | 5 | 3 | 1 | 0.007 | 0.004 | 0.000 | **0.001** | p = .021 |
| **Sums:** | **723** | **723** | **352** | **1.0** | **1.0** | **0.238** | **0.487** | p < .001 |

In this section I have shown that the domain for diachronic processes resulting in vowel harmony and for the synchronic description of these patterns is the bimoraic couplet. Since the couplet has the shape identified in prosodic theory as the moraic trochee (cf. §6.1) and since it is a common typological function of the foot to provide the domain for processes and phonotactic generalizations, I take the facts of vowel harmony as additional evidence that the couplet should be identified as a prosodic foot. Whether words are larger than a foot, as in ***tɨ̀(tʲéˀléᴸ)*** ‘cockroach’, or not, the diachronic harmonizing processes only target the foot, producing a single vowel quality on both moras whether the foot has a disyllabic or monosyllabic form. The IM data show harmonization across a medial consonant in (C)V(ˀ)CV couplets, and also where medial consonants have deleted and a CV(ˀ)V couplet with a single vowel quality has resulted. In all of these processes, the pattern of vowel spreading (or assimilation) is predominantly from the strong initial position of the foot to the weaker (final) one, and thus constitutes additional evidence for trochaic foot structure. In this section, I have also shown that the overall result of these processes is that the number of IM words with vowel harmony in the foot is much greater than what is predicted by chance. The form of the foot also plays a role in that vowel harmony is nearly categorical in monosyllabic (C)V(ˀ)V feet. As I have already mentioned in §6.2.2.3, this fact demonstrates the strong constraint in IM against having different vowels in feet lacking a medial consonant and lends support for the analysis in §6.2.1 that these radicals/roots are underlyingly monomoraic and are lengthened in order to fill out the foot template. One other foot-based generalization discussed in this section is that, with only two exceptions, feet having only inner triangle vowels will invariably have absolute vowel harmony.

6.3.3.2 Vowel patterns

Besides the tendency toward identical vowels, there are other combinatorial restrictions on vowels within the couplet. As was discussed in the preceding section, Pike (1947) noted that SM vowels divide into two groups based on their combinatorial possibilities within the couplet; outer triangle vowels—that is, the peripheral vowels, /i, a, u/—combine relatively freely, whereas inner triangle vowels—that is, the non-peripheral vowels, /e, ɨ, o/—are restricted in their distribution within the couplet. Building on the work of Macaulay (1996:29–32), Macken & Salmons (1997) note similar vowel restrictions in CM, also reporting the free co-occurrence of outer triangle vowels, but also note that only three combinations of outer and inner triangle vowels occur with any frequency in CM—namely, the outer-inner pattern *i–o* and two inner-outer patterns *e–u* and *ɨ–u*. This they take as evidence for restrictions on the two vowel slots of the couplet to either have identical vowel quality (i.e. vowel harmony) or to be sequenced V1[-round]-V2[+round] and V1[-back]-V2[+back].

The IM data concur with the general findings of Pike (1947) and Macken & Salmons (1997), though with differences in the specific vowel patterns. The IM patterns for disyllabic and monosyllabic couplets are given in Table 64.

Table 64. Vowel patterns in (C)V(ˀ)CV and (C)V(ˀ)V couplets

| | **Disyllabic Couplets** | | | | | | | **Monosyllabic** |
|---|---|---|---|---|---|---|---|---|
| | **(C)_C*i*** | **(C)_C*a*** | **(C)_C*u*** | **(C)_C*e*** | **(C)_C*ɨ*** | **(C)_C*o*** | **Total** | **ˈ(C)_ː(ˀ)** |
| **/i/** | **62** | 39 | 26 | 0 | 0 | 29 | **156** | **40** |
| **/a/** | 76 | **121** | 63 | 0 | 29 | 0 | **289** | **140** |
| **/u/** | 38 | 57 | **47** | 0 | 0 | 0 | **142** | **69** |
| **/e/** | 0 | 3 | 1 | **1** | 0 | 0 | **5** | **35** |
| **/ɨ/** | 0 | 5 | 0 | 0 | **73** | 0 | **78** | **39** |
| **/o/** | 3 | 0 | 0 | 2 | 0 | **48** | **53** | **42** |
| | **179** | **225** | **137** | **3** | **102** | **77** | **723** | **365** |

The number in each cell of the columns pertaining to disyllabic couplets is the count of couplets from the database of 1088 stems which have the vowel quality of the vowel in the row header in the initial syllable of the couplet (i.e. filling the empty slot in the column header frame) and the vowel quality indicated in the column header in the second syllable of the couplet. The actual form of the initial vowel may be any of variant forms given in Chapter 3 for vowel phonemes—plain, nasalized, glottalized or nasalized & glottalized—and the form of the final vowel may be plain or nasalized, but not glottalized, as discussed in §6.3.1.[34] The counts in bold font on the diagonal of the table are the number of items where the couplets have the same vowel quality in both syllables. The totals given in the final disyllabic column are the total number of couplets where the vowel in the row header appears as V1 in the couplet, while the totals at the bottom of each column indicate the total number of couplets where the vowel in the column header appears as V2 in the couplet. (These numbers correspond to those given for disyllabic couplets in Table 62.) It should be noted that the disyllabic figures include ***ʃɨ́ú***$^{L}$ 'abdomen' and ***tʃáˀṹ*** 'fifteen', which lack a medial consonant, but which pattern with disyllabic couplets in having different vowels. The final column of the table gives the count of couplets having long vowels with each vowel quality. These long vowels also may be either plain, nasalized, glottalized or nasalized & glottalized.[35] The counts in this column combine the counts of CVː and CVˀV couplets in Table 62.

[34] It should be noted, however, that there are no instances of glottalized & nasalized /o/.
[35] See footnote 34 in chapter 6.

The relatively unrestricted combination of outer triangle vowels with each other can be seen by the robust counts in the unshaded cells in the disyllabic data, although they still show a strong preference for like-vowels with 43% (230/529) showing vowel harmony. Couplets with two outer triangle vowels account for 529 (73%) of the 723 disyllabic couplets, and to these can be added the 249 instances of these vowels in (C)V(ˀ)V couplets from the first three rows of the last column, bringing the total couplets with an outer-outer vowel pattern to 778 (72%) of 1088 stems.

Combinations of two inner triangle vowels in a couplet, on the other hand, although the second most frequently attested type of disyllabic combination at 124 (17%), are nearly categorically restricted to sequences of like vowels, as shown by the darkly shaded cells in the lower right quadrant of Table 64. To these can be added 116 (C)V(ˀ)V couplets with inner triangle vowels bringing the total number of couplets in the database with an inner-inner vowel combination to 240 (22%).

Next along the cline of preference in vowel combinatorics within the couplet come mixed combinations of outer and inner vowels. Inner-outer patterns are the most frequent mixed pattern attested (cf. the lightly shaded cells in the upper right quadrant of Table 64), but are restricted to only two combinations—*i-o* and *a-ɨ*—each attested in a fair number of words. There are 58 couplets with inner-outer vowel patterns which amounts to 8% of disyllabic stems and only 5% of all stems. The other mixed pattern, outer-inner, has four weakly attested patterns— *ɨ-a*, *e-a*, *o-i* and *e-u*—shown in the lightly shaded cells in the lower left quadrant of Table 64. These patterns total only 12 couplets which is 2% of disyllabic stems and 1% of the stems in the database; this pattern also does not occur in (C)V(ˀ)V couplets.

The vowel patterns in terms of outer and inner vowel triangle combination types are summarized and exemplified for disyllabic couplets in Tables 65 and 66, where the different types of vowel patterns are ordered by overall frequency from left (most frequent) to right (least frequent). Monosyllabic couplet patterns are not shown since they always have identical vowel quality on both moras.

Table 65. Disyllabic couplet vowel patterns with all outer or inner triangle vowels

| Outer-Outer | Example | Count | Inner-Inner | Example | Count |
|---|---|---|---|---|---|
| *i-i* | *títʃî* ‘stomach’ | 62 | *e-e* | *tɨ̀(tʲéˀléᴸ)* ‘cockroach’ | 1 |
| *i-u* | *ítú* ‘cornplant’ | 26 | *ɨ-ɨ* | *kɨtɨ̀* ‘animal’ | 73 |
| *i-a* | *ítá* ‘flower’ | 39 | *o-o* | *sokò* ‘well’ | 48 |
| *u-u* | *tútú* ‘paper’ | 47 | *o-e* | *ᴸlómè* ‘bat’ | 2 |
| *u-i* | *ⁿdutʲì* ‘beans’ | 38 | | | |
| *u-a* | *jútʲà* ‘river’ | 57 | | | |
| *a-a* | *tʲákà* ‘fish’ | 121 | | | |
| *a-i* | *kátʲíᴸ* ‘cotton’ | 76 | | | |
| *a-u* | *tʃátú* ‘pants’ | 63 | | | |
| | | **529 (73%)** | | | **124 (17%)** |

Table 66. Disyllabic couplet mixed vowel patterns

| Outer-Inner | Example | Count | Inner-Outer | Example | Count |
|---|---|---|---|---|---|
| *i-o* | *tʃítò* ‘bed’ | 29 | *ɨ-a* | *jɨkà* ‘delicate’ | 5 |
| *a-ɨ* | *lajɨ̀* ‘clear’ | 29 | *e-a* | *ketà* ‘go out’ | 3 |
| | | | *o-i* | *tʃoˀlì* ‘navel’ | 3 |
| | | | *e-u* | *sá(lérú)* ‘heron’ | 1 |
| | | **58 (8%)** | | | **12 (2%)** |

The first column of each dataset gives the vowel combinations for the vowel pattern type in the column header—outer-outer, inner-inner, outer-inner and inner-outer. The next column of the dataset gives examples of the patterns and the third column gives the count of couplets having the particular vowel pattern, which is totalled at the bottom with its percentage of the total number of disyllabic couplets.

The frequencies of the different combinations of vowel types support the following cline of preference in vowel combinatorics within the couplet from most to least preferred:

(271) Cline of preference in vowel combinatorics
outer-outer > inner-inner > outer-inner > inner-outer

It can also be seen, however, that the frequency of pattern type does not correspond entirely with restrictions on the number of patterns of the type. For instance, although outer-outer patterns are by far the most frequently attested and also show no restriction on their combinatorial possibilities, the inner-outer pattern type has the next most different patterns, having five out of nine possible vowel patterns, but each pattern is very poorly attested, only amounting to 2% of the total number of couplets. By the same token, inner-inner patterns, which have one less pattern than the inner-outer type, have more than twice the number of attestations, but are almost completely restricted to like vowel combinations. The strong generalizations that can be made regarding couplet vowel pattern restrictions are that (a) outer-outer combinations are strongly preferred and are unrestricted, although there is still a significant bias towards like-vowel combinations; (b) inner-inner are basically restricted to like-vowel combinations; and (c) combinations which mix vowel types (inner-outer or outer-inner) are dispreferred, especially inner-outer combinations.

In terms of the findings of Macken & Salmons (1997) (cf. Macaulay 1996:30–32), the IM data show that only the outer-inner pattern *i–o* [-back, +back] identified for CM is well attested, while the *e–u* pattern occurs only once and *ɨ–u* not at all. If the poorly attested inner-outer patterns are disregarded, the IM data also show support for the general preference identified in CM for couplets with mixed inner and outer triangle vowels to be sequenced [-back, +back] (cf. the *i-o* pattern) or have the same backness specification (cf. the *a-ɨ* pattern); however, in light of the OCP [labial] and OCP [coronal] constraints that were introduced in the discussion of consonants in §3.2, for IM the more significant generalizations in terms of feature co-occurrence within the couplet are that neither labial vowels (/u, o/) nor front vowels /i, e/ co-occur in couplets. In other words, couplets with identical front vowels, like *títʃì* 'stomach' and *tɨ̀ˈtʲéˀléᴸ* 'cockroach', or identical back vowels, like *tɨ́tɨ́* 'paper' and *sokò* 'well' are acceptable, but not **tɨtʃe/tetʃi* or **tuto/totu* since they mix inner and outer vowels with the same front or back specification.

It is important to note that the generalizations about IM couplet vowel patterns are not true of other two-syllable combinations in lexical words except in compounds composed of more than one couplet (e.g. ***kɨtɨ̀ˈʃã̀ã́*** ‘animal’ < ***kɨtɨ̀*** ‘animal’ + ***ʃã́ã́ᴸ*** ‘fierce’). This is demonstrated for the quasi-couplet combination consisting of a pre-couplet and a couplet initial syllable in Table 67, where the couplet is indicated having round brackets and the quasi-couplet is underlined.

Table 67. Couplet vowel patterns violated in quasi-couplet

| Pattern type | Pattern | Example |
|---|---|---|
| **Inner-inner** | *ɨ-o* | ***síkɨ́(sóˀò)*** ‘earring’ |
| | *ɨ-e* | ***tɨ̀(tʃéˀléᴸ)*** ‘cockroach’ |
| **Inner-outer** | *ɨ-i* | ***tɨ̀(ʃíɲĩ́)*** ‘ridgepole’ |
| | *o-u* | ***tʲó(ɲṹṹ)*** ‘town name’ |
| | *o-a* | ***kóó(jáˀⁿdí) ~ kó(jáˀⁿdʲí)*** ‘rainbow’ |
| | *o-ɨ* | ***jò(jɨkɨ̃̀) ~ joˀò(jɨkɨ̃̀)*** ‘squash vine’ |
| | *e-i* | ***βè(tʲĩɲũ̀)*** ‘government office’ |
| **Outer-inner** | *i-ɨ* | ***ʃî(kɨ̂jɨ́ᴸ) ~ (ʃkɨ́jɨ́ᴸ)*** ‘blister’ |
| | *i-e* | ***ʃî(kẽˀẽ̀) ~ (ʃkẽˀẽ̀)*** ‘fly’ |
| | *u-ɨ* | ***tù(tɨtɨ̀)*** ‘zapolote tree’ |
| | *u-e* | ***tʃú(βeˀè)*** ‘inside the house’ |
| | *u-o* | ***tú(ⁿdoˀò)*** ‘suffering’ |
| | *a-o* | ***mã̀(ⁿdoò)*** ‘turtle’ |
| | *a-e* | ***sá(léɾú)*** ‘heron’ |

Each of these vowel patterns is unattested in actual couplets (cf. Tables 65 and 66), and represent violations of the restrictions for each pattern type, not to mention violations in the placement of glottalization and nasal phonotactics, which are discussed in §6.3.1 and §6.3.2, respectively. Furthermore, the constraint against couplets with two non-identical back vowels are violated by the patterns *o-u* and *u-o*, while the patterns *e-i* and *i-e* violate the prohibition against couplets with non-identical front vowels.

The data presented in this section show that the couplet plays an important organizational role in the language by providing a unit of structure within which vowel patterns are defined and realized. Since the couplet does not have a one-to-one correspondence with any morphosyntactic unit, its form has the properties of the moraic trochee and it is a typologically common role of the foot to provide the domain for phonotactic generalizations, I take the facts of IM couplet vowel patterns as evidence that the couplet should be considered a foot.

### 6.3.4 Distribution of labial consonants

Another phonotactic generalization that takes the couplet as its domain is what I have called OCP Labial. In §3.2, I showed that the effects of the constraint are evident in syllables which, with only a few exceptions in the native phonology, are prohibited from having labial onsets and labial vowels (e.g. **βu*); however, the effects of the constraint extend beyond the syllable. IM also has a prohibition against two consecutive syllables having consonants with the labial feature if the two syllables lie within the couplet. This phonotactic generalization affects all consonants with the labial feature including, whether oral or nasal, including secondary articulation and the two marginal labial phonemes: /β/, /kʷ/, /p/, /ᵐb/, /m/. Thus, there are no IM words of the form **βaβi*. This restriction does not, however, apply to other two-syllable sequences, which I call a quasi-couplet, as can be seen in these examples, where the couplet is marked with round brackets and the quasi-couplet is underlined:

(272) a. *<u>mã́(β</u>àtú)*
máᴸ–βátú
NEG.OPT–fit
'will not fit'

b. *<u>mà(kʷã́ˀ</u>nṹ)*
máᴸ–kʷaˀnù
NEG.OPT–grow:IRR
'will not grow'

c. *<u>kʷàkʷá</u>(tʲĩ̀ɲũ̀)*
kʷá–kʷá–tʲiɲù
PROS–MOT.AW.PR–work
'going to go work'

The pairs of onset consonants in the underlined syllables (*m–β*, *m–kʷ*, *kʷ–kʷ*) are not possible inside the couplet, yet as shown by the data in these examples, the prohibition does not hold over pairs of syllables that include syllables outside the couplet.

Longacre (1955:47) and Silverman (1993) have identified this as a constraint that is common to the entire Mixtecan family. DiCanio (2008:49) also reports a very similar constraint for the Mixtecan languages Itunyoso Trique and Chicahuaxtla Trique, but in those languages it is described as a restriction of one labial consonant per word (or more specifically, roots; DiCanio p.c.). Both languages are also reported to prohibit labial consonants from co-occurring with labial vowels in a syllable.

Once again we see that the exact domain within which the OCP Labial constraint holds is the same domain that has been shown to be the domain of glottalization, nasalization, vowel distribution restrictions and medial weakening—that is, the couplet, which we have also come to see has just the shape dictated by prosodic theory for the moraic trochee. Since it is also a cross-linguistic function of the foot to provide the domain for phonotactic generalizations, I therefore consider the fact that this bimoraic unit provides the domain for the OCP Labial constraint as further evidence that the couplet should be considered a foot.

### 6.3.5 Epenthetic glottalization

It has long been observed, although not widely discussed, that besides contrastive glottalization, Mixtec languages also have glottalization in the initial position of words that would otherwise be considered vowel initial (e.g. *ĩ́nã́* [ˀĩ́nã́] ‘dog’). Although some early researchers have analyzed this (as well as couplet-medial glottalization) as a glottal stop phoneme (e.g. Pike 1944), Josserand (1983:227) rightly observes, “the glottal element seems to be an automatic feature of word initial vowels, and is probably a feature of all Mixtec varieties, whether it is reported or described or not,” and considers that a glottal stop phoneme analysis “would be an obfuscation, which hinders more useful generalizations” (p. 227). She furthermore raises another interesting issue about initial glottalization that until recently has not been addressed in the literature. She noted that certain dialects have a glottal between the animal classifier and the word for 'dog', *tiˀina*, which in other varieties is *tina* or *ina* (cf. Dürr 1987:43). The glottal, she claimed, could either be interpreted as retention of the glottal of the vowel initial word for 'dog' (*ina*), or a retention of the final glottal on the classifier, *tiˀ* (in *tina* the glottal is lost due to reduction). The second interpretation can be ruled out immediately as a general solution since the phenomenon is actually much more widespread than just the word for 'dog', as can be seen by the following IM data (a phonetic transcription is given in square brackets which includes "initial" glottalization; in larger words, the couplet is demarcated with round brackets):

(273) a. *úˀβí* [ˀuˀβi]
'hurting'

b. *tàúˀβí* [ta(ˀuˀβi)]
'become hurt'

c. *íkùúˀβí* [ku(ˀuˀβi)]
í–kù–úˀβí
PFV–be–hurting
'he was hurting'

d. *ìtʲī* [ˀitʲi]
'dry'

e. *nàìtʲí* [nã(ˀitʲi)]
nà–ìtʲī
REP–dry
'be drying'

f. *ijà* [ˀija]
'sour'

g. *tùkʷáijà* [tukʷa(ˀija)]
tùkʷáᴸ–ìjā
orange–sour
'lime'

In these examples, the roots *úˀβí*, *ìtʲī* and *ijà* are all vowel initial, but are (usually) pronounced with initial glottalization which they retain in a variety of morphological contexts, as illustrated by complex examples with these roots.

A prosodic analysis for this phenomena is suggested by Carroll (2015), who addresses the issue in Ixpantepec Mixtec. Citing data similar to that in (273), he proposes that glottals are epenthesized at the initial boundary of the stress foot. Additionally, Carroll provides data showing that glottal epenthesis marks the initial boundary of the prosodic word. This is also found in IM as illustrated by these examples:

| | | | | |
|---|---|---|---|---|
| (274) | a. | *ìtʲã́ã́* | [ˀi(tʲãã)] | ‘tomorrow’ |
| | b. | *à$^n$dɨβɨ̀* | [ˀa($^n$dɨβɨ)] | ‘sky’ |
| | c. | *à$^n$dʲajà* | [ˀa($^n$dʲaja)] | ‘hell’ |

Here the initial vowel is not part of the couplet, or as Carroll calls it, the stress foot, nevertheless they are pronounced with initial glottalization. Since, as we also have noted, the boundary of the stress foot may or may not coincide with a root or word boundary, Carroll observes, “The stressed foot usually coincides with a bimoraic root, but the evidence shows that it is the prosodic domains and not the morphology that determines the distribution of epenthesis” (p. 112). He therefore concludes that glottal epenthesis marks both the initial boundary of the prosodic word and the stress foot.

The IM facts support Carroll’s (2015) analysis, although hard and fast conclusions are difficult to make because of the great variation in the realization of glottalization, and the fact that many times the acoustic properties are very subtle, as was noted in §3.1 with respect to contrastive glottalization and is thoroughly investigated by Gerfen & Baker (2005) for Coatzospan Mixtec. There are, however, many tokens where it is robustly attested, perhaps more so at the couplet/foot boundary (e.g. (273)), than the prosodic word boundary (e.g. (274)). A very clear example of foot initial epenthetic glottalization can be seen at the middle arrow in the waveform and spectrogram in Figure 22 (a). In this example, there is a dip in intensity (yellow line) and, more importantly, irregular glottal pulses (vertical striations in the spectrogram) resulting in the inability of the pitch tracker to accurately track the pitch (blue line), all characteristics of glottalization (creaky phonation) (Gordon & Ladefoged 2001). Curiously, the acoustic indications for couplet/foot medial (contrastive) glottalization (see the right arrow) are rather weak, since the decrease in pitch and intensity would be present with the production of the medial /β/ anyway, and there is no sign of irregularity in the glottal pulses. Notice, too, that there is even less indication of epenthetic glottalization on the initial vowel of the PWRD (left arrow). The opposite situation is shown in (b), where the signs of contrastive glottalization (right arrow) are fairly robust, while those of couplet/foot initial (epenthetic) glottalization (middle arrow) are limited to dips in f0 and intensity. Epenthetic glottalization at the beginning of the PWRD (left arrow), however, is slightly more obvious in this token. In the final plot (c), only the word initial (left arrow) glottalization is robust, while indications of couplet/foot initial (epenthetic) glottalization and the couplet/foot medial (contrastive) glottalization are both weak.

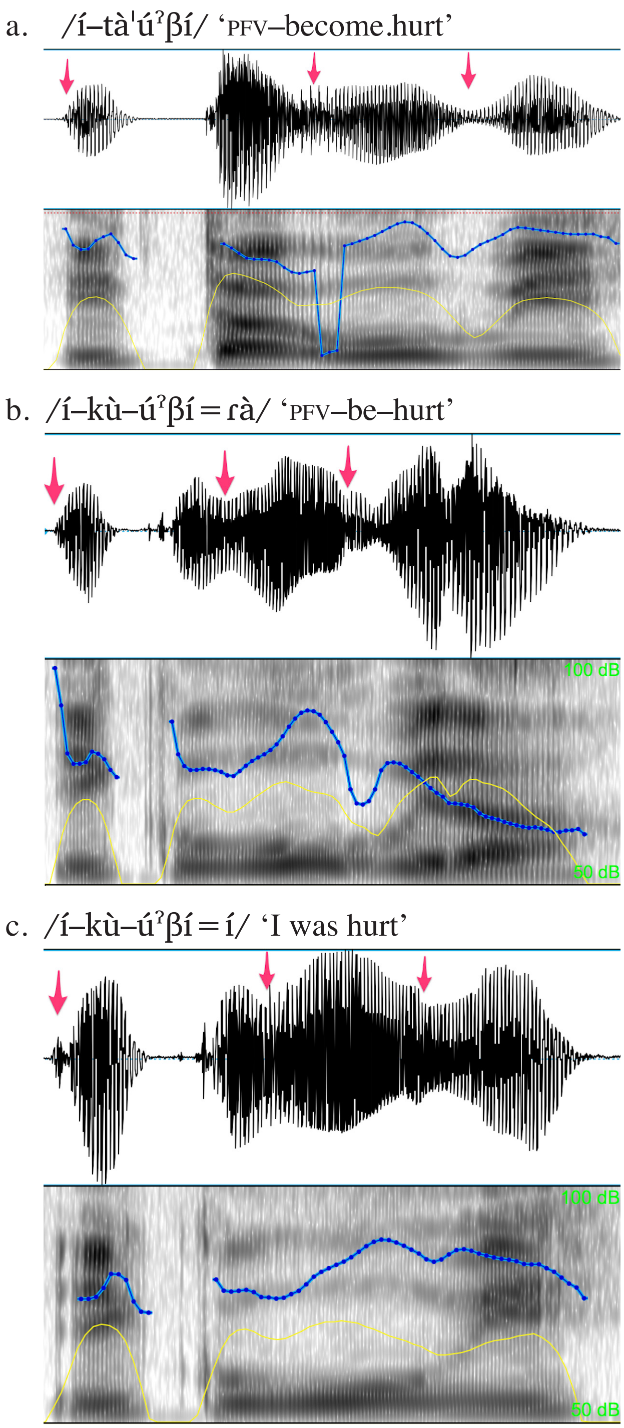



Figure 22. Waveforms and spectrograms of epenthetic and contrastive glottalization in productions by MQM

Despite the great variation in the realization of epenthetic glottalization, it appears to be a fairly robust phenomenon at the beginning of the PWRD and the couplet/stress foot. What is not as clear, however, is whether it applies to separate vowel hiatus between prefixes/proclitics in examples like these:

(275) a. *tʃàí(tʃatʃì)ɾà*
tʃà–í–tʃatʃì = ɾà
already–PFV–eat:REAL=3MASC
'he already ate'

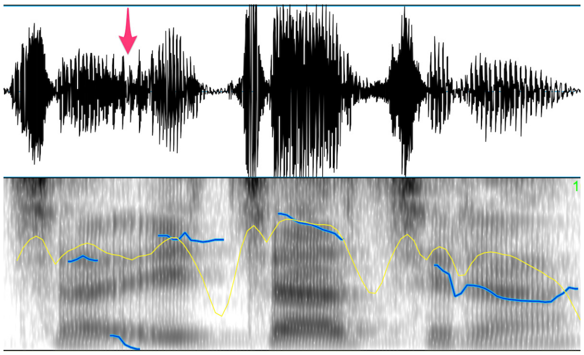
b. *ɲã̋íkṹɲĩ̋ ĩ̋ɲĩ̋ɾà*
ɲã̋ᴸ = í–kṹɲí = ɾà íɲí = ɾà
NEG=PFV–feel inner.being=3MASC
'he did not think'

According to Carroll (2015) there should not be glottal epenthesis at the *a–i* hiatus in either of these situations, since they do not occur at the boundary of either the stress foot or the PWRD. While often (even usually) there is little or no indication of epenthetic glottalization in these contexts in the IM data, there are some clearly glottalized tokens in my data, as can be seen in Figure 23. In both figures, epenthetic glottalization is clearly seen at the vowel hiatus in the pre-stress foot syllables (indicted by arrows), where there are vertical striations in the spectrogram and irregular cycles visible in the waveform such that the pitch tracker fails to produce an accurate pitch track and there is a concomitant dip in intensity.[37]

Carroll (2015) also reports that glottal epenthesis does not occur before vowel initial enclitics, which fuse with the root. This is also true in IM. The vowel hiatus which is created by including vowel initial enclitics into the foot (e.g. *kóó*ᴸ 'snake' + *=í* '1SG' → *kóì* 'my snake'; see Table 39 for more examples) does not result in epenthetic glottalization, nor does it occur in the one CVV word with different vowels, *ʃíú*ᴸ 'abdomen', nor, of course, in CVː words.

[37] A second instance of epenthetic glottalization, before the vowel initial root, *ĩ̋ɲĩ̋*, can also be seen at the large dip in f0 and intensity in the right half of the spectrogram.

a. tʃà–í–tʃatʃì = ɾà ‘already–PFV–eat=3M’



b. ɲá = í–kúɲí íɲí = ɾà ‘NEG–PFV–want inner.being=3M’

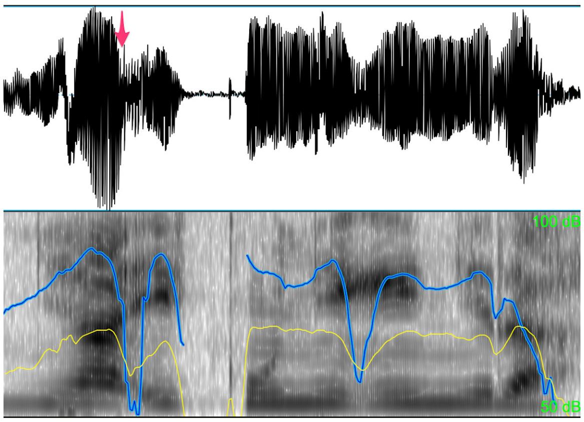



Figure 23. Glottal epenthesis a. between two prefixes (speaker MQM), and b. between a proclitic and a prefix (speaker AHM)

To conclude this discussion, epenthetic glottalization is robustly attested in IM at the initial boundary of vowel initial couplets, which Carroll (2015) rightly recognizes as the boundary of the stress foot, as well as at the initial boundary of the PWRD (though perhaps slightly less robustly). It definitely does not occur before vowel initial enclitics, which are integrated into the foot, nor between vowels within the foot (excluding roots with contrastive glottalization, of course). It apparently occasionally does occur in sequences of pre-couplet vowels, but is not robustly attested in this prosodic position and deserves further study before making a firm decision. These facts lead me to conclude, with Carroll (2015), that glottal epenthesis is prosodically driven, although it may be necessary to revise his formulation to say that it occurs before all vowel initial morphemes preceding the foot in addition to marking the initial boundary of vowel initial feet and PWRDs.

Since the initial foot boundary which is marked by glottal epenthesis coincides with the unit which traditional Mixtecan studies have called the couplet, I take prosodically driven glottal epenthesis as further evidence that the couplet should be called the foot. The prohibition of glottal epenthesis to resolve vowel hiatus within the foot serves as further evidence for the special status of the stress foot as a phonological domain in the IM grammar, which also serves as the domain for numerous other phonological patterns described in this chapter.

### 6.3.6 Tonal phenomena

A tonal melody is a cohesive pattern of tones that is part of the signifier of a lexical item (Leben 1973; 1978; Snider 1999; 2017; Hyman 2001; 2006; 2011a). In Chapter 4 I described the possible tonal melodies for IM roots and how they are realized on couplets. In this section I will argue that the fact that the couplet provides the domain for the realization of these tonal melodies and the consequences that fall out from this fact provide evidence that the couplet should be considered a foot.

In order to appreciate the profound influence of the couplet on the tonal phonology of IM let us first consider an example of tonal melodies from a language with considerably different properties from IM. The following data demonstrate the stem melodies of the Bantu language Kukuya (Congo) as they are realized when followed by another stem:

Table 68. Tonal melodies in Kukuya (data from Hyman 1987:313–4)[38]

| Melody | Mapping | Example | Gloss |
|---|---|---|---|
| **/L/** | L | *(kì).bà* | ‘grasshopper-killer’ |
| | LL | *(kì).bàà* | ‘jealousy’ |
| | L-L | *(kì).bàlà* | ‘to build’ |
| | LL-L | *(kì).bààlà* | ‘to cleave’ |
| | L-L-L | *(kì).bàlàgà* | ‘to change route’ |
| | | | |
| **/H/** | H | *(mà).bá* | ‘oil palms’ |

[38] The data is transcribed as in Hyman (1987:313–4) except for *(.ndÉ).pàlî* ‘he goes out’, which follows Paulian (1975:132).

| Melody | Mapping | Example | Gloss |
|---|---|---|---|
| | HH | *(mà).báá* | 'cheeks' |
| | H-H | *(mà).bágá* | 'show knives' |
| | HH-H | *(mà).báámá* | 'liana' |
| | H-H-H | *(lì).bálágá* | 'fence' |
| **/LH/** | ⟨LH⟩ | *(mÚ).sǎ* | 'weaving knot' |
| | LH | *(mÚ).sàá* | 'seed necklace' |
| | L-H | *(mÚ).sàmí* | 'conversation' |
| | LL-H | *.sààbí* | 'roofing' |
| | L-L-H | *.m$^w$àrəgí* | 'younger brother' |
| **/HL/** | ⟨HL⟩ | *(kì).kâ* | 'to pick' |
| | HL | *(kì).káà* | 'to grill' |
| | H-L | *(kì).kárà* | 'paralytic' |
| | HL-L | *(kì).káàrà* | 'to be just right' |
| | H-L-L | *(kì).káràgà* | 'to be entangled' |
| **/LHL/** | ⟨LHL⟩ | *(.ndÉ).bvi̋* | 'he falls' |
| | LHL | *(.ndÉ).kàây* | 'he loses weight' |
| | L-HL | *(.ndÉ).pàlî* | 'he goes out' |
| | LH-L | *(.ndÉ).bàámì* | 'he wakes up' |
| | L-H-L | *(.ndÉ).kàlə́gì* | 'he turns around' |

The header of each row gives the underlying tonal melody of the stem for each group of examples. A schematic representation of the tonal mapping in terms of L (= low tone) and H (= high tone) of the melody onto stems of various sizes is given in the first column where syllable breaks are marked with "-" and tonal glides are enclosed in angle brackets ("⟨⟩"). In the examples, the beginning of a stem is indicated by " . " and irrelevant prefixal material is placed in round brackets. As described by Hyman (1987), there are exactly five underlying stem melodies, each of which are expanded or contracted as needed to fit the shape of the stem, which can have one of five different shapes—CV, CVV, CVCV, CVVCV and CVCVCV—where each V represents a TBU. In other words, the domain to which the tonal melody is mapped is the stem regardless of its size/shape. Tonal melodies are analyzed as underlyingly unassociated and are mapped to TBUs by Goldsmith's (1976) association conventions plus one additional rule. These properties—a fixed set of melodies or tone patterns, underlyingly unassociated and mapped to the TBUs of stems of various sizes by rules—make Kukuya a canonical example of a language with tonal melodies.

In contrast, consider the IM noun melodies in Tables 69 and 70 (repeated from Chapter 4).

Table 69. Majority tonal melodies of noun couplets

| | **CVCV** | **CVˀCV** | **CV:** | **CVˀV** | **Count** |
|---|---|---|---|---|---|
| **/L/** | *tʃikì* ‘fist’ | *koˀlò* ‘turkey’ | *ɲɨ̀ɨ̀* ‘skin’ | *ɲũˀũ̀* ‘earth’ | 82 (28.0%) |
| **/H/** | *tʃɨ́tɨ́* ‘seed’ | *kúˀβá* ‘amount’ | *ɲṹṹ* ‘town’ | *ɲṹˀṹ* ‘fire’ | 57 (19.5%) |
| **/H$^L$/** | *tʃɨ́tɨ́*$^L$ ‘knee’ | *ɲṹˀmã́*$^L$ ‘smoke’ | *ɲɨ́ɨ́*$^L$ ‘salt’ | *ʃṹˀṹ*$^L$ ‘money’ | 89 (30.4%) |
| **/HL/** | *tʃɨ́tʲɨ̀* ‘canal’ | $^n$*dɨ́ˀjɨ̀* ‘pimple’ | *sɨ̂* ‘saliva’ | *nṹˀũ̀* ‘tooth’ | 46 (15.7%) |
| | | | | **Total:** | **274 (94%)** |

Table 70. Minority tonal melodies of noun couplets

| | **CVCV** | **CVˀCV** | **CV:** | **CVˀV** | **Count** |
|---|---|---|---|---|---|
| **/$^L$HL/** | $^L$*tʃókò* ‘opossum’ | $^L$*lɨ́ˀjɨ̀* ‘chick’ | $^L$*pɨ̂* ‘turkey hen’ | | 10 (3.4%) |
| **/$^L$H/** | *jàkʷɨ́* ‘armadillo’ | *lùˀlú* ‘foal’ | | | 5 (1.7%) |
| **/L$^H$/** | $^n$*dɨ̀βɨ̄* ‘chicken’ | | *ɲũ̀ũ̄* ‘night’ | | 4 (1.4%) |
| | | | | **Total:** | **19 (6%)** |

As discussed in §4.1, all bimoraic noun roots, which can be equated morphologically to the Kukuya stems, have one of these seven tonal melodies, which are exemplified above on every possible couplet shape. Even fossilized trimoraic radicals have the same underlying tone patterns on the couplet portion of the word. With some minor differences, though significantly different distributions, the same melodies are found on adjective (§4.2.1) and verb roots (§4.2.2).) Aside from the fact that IM tonal melodies have unpredictable floating tones which require the melodies to be underlyingly associated to the root, another property that immediately sets IM apart from Kukuya (and other prototypical tone melody languages) is that a single TBU in Kukuya may host multiple tones, even the largest melody, /LHL/, consisting of three tones;[39] IM, on the other hand, only allows a single tone per TBU. An even more significant difference in terms of this discussion, however, is the variable nature of the Kukuya stem, which can have from one to three TBUs. IM is very different in this respect in that the domain for the realization of the tonal melody is a very strictly prescribed invariable shape, the bimoraic couplet, which has only two basic forms, (C)VCV and (C)Vː, both of which have exactly two TBUs. This has a templatic effect on IM tonal melodies ensuring that they are always realized in more or less the same way. For instance, whereas the Kukuya /HL/ melody has the realizations, ⟨HL⟩, HL, H-L, HL-L, H-L-L, the IM /HL/ melody, by contrast, is just HL (for CVː couplets) or H-L (for CVCV couplets). Thus, while the concept of "tonal melody" is not as dramatically demonstrated in IM as in Kukuya, the data nevertheless demonstrate that there are a limited number of root melodies and that these map to a specific domain—the couplet—even though the mapping is lexicalized, and the couplet templatically regulates the realization of the tonal melodies to just two associated tones.

It might also be supposed that the existence of floating tones in IM is another consequence of only having two TBUs to map melodies to and not allowing multiple tones per TBU. This would be an oversimplification, however, since it is not clear, for instance, that there are too many tones for the number of TBUs in melodies like /$H^L$/, which I represent autosegmentally as a single H feature associated with both TBUs of the couplet, in keeping with the OCP (Leben 1973; Goldsmith 1976), and a floating L at the right edge, while /HL/, which has the same number of tonal features, has no floating tone. Under the analysis I propose, then, there are actually fewer underlyingly associated tones in the /H/, /$H^L$/, /$^L H$/, /L/ and /$L^H$/ melodies than there are TBUs in the couplet domain to which they associate. This can be seen by comparing the realization of these melodies on couplets and monomoraic grammatical morphemes as shown in Table 71.

[39] Note that an analysis based only on the tone patterns found on monosyllabic stems would predict 125 (5 x 5 x 5) possible tone patterns on stems with three TBUs; however, only the same five melodies are actually attested (cf. Snider 1999; 2017; Hyman 2011a).

Table 71. Comparing tonal melodies on grammatical morphemes and couplets

| Melody | Monomoraic form | Couplet form |
|---|---|---|
| **/H/** | =*ⁿdí* 'first person plural exclusive' | *ⁿdʲúˀú* 'first person plural exclusive' |
| **/H$^{L}$/** | *nṹ$^{L}$*= 'locative' | *nṹṹ$^{L}$* 'face' |
| **/L/** | =*jò* 'first person plural inclusive' | *joò* 'first person plural inclusive' |
| **/L$^{H}$/** | =*kē* 'third person feminine' | *jòˀō* 'second person singular' |
| **/HL/** | ---- | *tṹˀũ̀* 'word' |
| **/$^{L}$HL/** | ---- | *$^{L}$lóˀò* 'small' |
| **/$^{L}$H/** | ---- | *jàkʷĩ́* 'armadillo' |

Some monomoraic grammatical morphemes have a clitic form, given in the first column, and a related word with a couplet form, given in the second column. (The word *jòˀō* 'second person singular' does not correspond to the third person feminine enclitic and is only given to illustrate the /L$^{H}$/ melody on a couplet.) As these data illustrate, some melodies do show templatic expansion to fit the bimoraic couplet domain similar to the expansion of Kukuya melodies, although this has been lexicalized so that floating tones are kept at the edge of the domain—that is, some melodies have a form which is realized on a morpheme consisting of a single TBU and an expanded form for a couplet: /H/ → [H] ~ [HH], /H$^{L}$/ → [H$^{L}$] ~ [HH$^{L}$], /L/ → [L] ~ [∅L] and /L$^{H}$/ → [M] ~ [LM]. Other melodies—/HL/, /$^{L}$HL/, /$^{L}$H/—which require two TBUs for their realization are not possible on grammatical morphemes.

My first argument from the tonal phonology that the couplet should be considered a foot, then, is that it is the bimoraic domain to which the root melodies are mapped, and my second argument lies in the way the couplet templatically imposes an invariable shape on the realization of tonal melodies. Since it is a typologically common role of the foot to both provide the domain for the realization of phonological patterns and for this domain to function as a template in many languages (cf. §5.3.2), and since the couplet is also the domain of stress assignment and has the properties of a moraic trochee (cf. §6.1), I therefore take these tonal properties of the couplet as evidence that the couplet should be considered a foot.

Recognizing the couplet as the domain of stress and, therefore, a foot also makes sense of another related tonal property of couplets which is that they license a fuller range of tonal melodies than both affixes and clitics due to their bimoraic structure. While seven melodies are found on couplets, only L, H, and $H^{L}$ are found on prefixes (cf. Table 2 in Chapter 2), only L and $H^{L}$ on proclitics and L, H and $L^{H}$ on enclitics (cf. Table 6 in Chapter 2). Missing on grammatical morphemes of any type are the melodies /HL/, /$^{L}$HL/ and /$^{L}$H/ (→ LH), all of which are realized on the surface with two different tones in couplets.[40] These facts mirror the situation in related Trique languages. For instance, both Copala Trique (Hollenbach 1984) and Itunyoso Trique (DiCanio 2008) are described as having the maximum number of tonal contrasts in the final syllable and a smaller set of tonal contrasts in other syllables. Significantly, it is the final syllable that bears stress in those languages.

As the domain of root melody association, the couplet is also the domain of various restrictions on both the distribution of tones and their realization, similar to the way it is the domain for phonotactics in the non-tonal phonology. IM has a dispreference for L on the initial TBU of the couplet. As discussed at length in §4.1.5, L initial melodies are very rare in native IM nouns (only 3% in my sample), and most of these words are hypothesized to have derived from a L toned animal classifier prefix/suprafix. L initial melodies are only posited in the underlying melody of one verb (§4.2.2), since other LH and LM verb forms are imperfective and are derived with a L suprafix. Although L initial melodies are much more frequent in adjectives, it is hypothesized that these were likely historically derived by a L suprafix. There is good reason, then, to believe that couplet initial Ls come from outside the couplet, either synchronically or diachronically. It is possible to view the dispreference as resulting from a cross-linguistic avoidance of L on prosodic heads (de Lacy 1999; 2002), which in the case of IM is the leftmost mora of the foot; however, it may just be the phonologization of a phonetic tendency for L to fall over the course of the couplet when there is no contrast between LL and ML (DiCanio p.c.).

[40] It should be noted, however, that the vocative tonal suprafix (cf. §2.4.1) has the /HL/ melody.

Another couplet-related distributional restriction is that /L/ is realized differently in the two positions of the couplet. As was noted in §4.1.1, when L does occur in the couplet initial position (cf. (279) and (280)), it is realized with a low level pitch whereas template finally it is realized as a low falling tone (cf. the mean pitch contours presented in Figure 5). While it may be tempting to simply consider the two different realizations of L as two different tones this conclusion is untenable, first, because the tones are in complementary distribution, and second, because of the similarity between words with a lexical LH melody, like *màⁿgú* 'mango' and LH derived by FLA in the N-N associative construction that was illustrated by the plot in Figure 9, in §4.1.3.

The most significant phonotactic constraint on tone is *LL, which bans consecutive L tones within the couplet, as described in Chapter 4. This constraint is a specific example of a broad cross-linguistic generalization known as the Obligatory Contour Principle (OCP; Leben 1973; Goldsmith 1976), which bans sequences of like features. A ban on adjacent L tones has also been described for SM (Tranel 1995a:2; 1995b:300; cf. Pike 1944:124; 1948:57, 79), Peñoles Mixtec (Daly & Hyman 2007:166) and Southeastern Nochixtlán Mixtec (SE) (McKendry 2013:305–306). The *LL constraint plays an active role in the tonal phonology by blocking processes that would spread L (LTS) or associate a floating L (FLA) to a couplet which already has an associated L, whether in imperfective verb inflection, phrasal tonology or in the fossilized forms of words derived historically with the wood classifier prefix. For instance, L may optionally spread from a noun with the /L/ melody to a following noun with the /H/ or /H$^{L}$/ melodies in a NP, as shown by the data in (276), repeated from (131).

(276) a. *nɨ̃ɲɨ̃̀ ɲã̀ɲɨ̃́*
nɨ̀ɲɨ̀ ɲáɲí
corncob brother
'brother's corncob'

b. *nɨ̃ɲɨ̃̀ nɨ̃̀ɲɨ̃́*
nɨ̀ɲɨ̀ nɨ́ɲɨ́$^{L}$
corncob blood
'blood's corncob'

However, LTS does not apply to a following noun in the same context if it has the /HL/ melody:

(277) *nɨ̃ɲɨ̃̀* *mĩ́ɲĩ̀*
nɨ̀ɲɨ̀ míɲì
corncob pool
'pool's corncob'

The surface form of the HL noun, *míɲì* does not change to LL, **mìɲì*, since this would violate *LL by juxtaposing two separate Ls inside a couplet.

Similarly, FLA will not associate a floating L with a HL couplet, whether the floating L is morphological (e.g. the imperfective suprafix) or lexical (e.g. /ᴸHL/, /Hᴸ + HL/). I will illustrate this with an example from verb inflection. As described in §2.4.2 and §4.2.2, the IM imperfective morpheme is a L tonal suprafix, which associates to the verb couplet by FLA; however, when the couplet already has a L, as in the /HL/ verb *kíkũ̀* 'sew', FLA is blocked since the L of the imperfective cannot associate to the base and a ∅ allomorph is selected instead, as shown in (278a).

(278) a. *kíkũ̀*
∅⌒kíkũ̀
IPFV⌒sew
'is sewing'

b. *kìkĩ́*
ᴸ⌒kíkũ̀ = í
IPFV⌒sew=1SG
'I am sewing'

However, when the final TBU of the couplet is changed to H through coalescence with the first person singular pronoun, as shown in (278b), the L suprafix is selected and FLA applies resulting in a LH surface melody.

It is also tempting to consider the lack of LL as a surface melody in IM couplets (a gap also noted in the surface inventory of couplet melodies of SM and SE) to be a consequence of *LL; however, representing /L/ as *single* L feature associated with both moras of the couplet (cf. (97))

is not an OCP violation. Still, while /H/ and /Hᴸ/ couplets are permitted to surface with H on both TBUs of the couplet, this is apparently not permitted for /L/. Recall from §4.1.2 that the surface realization of the /L/ melody is [∅L], which is modelled as derived from an underlying L linked to both couplet TBUs and a process (ILD) delinking L from the initial couplet TBU, as in /ⁿdùtʲà/ 'water' → *ⁿdutʲà* (cf. (98)). This process is blocked, however, if the final TBU is modified through coalescence with the first person singular pronoun, as in *ⁿdùtʲē* 'my water', where the final couplet TBU is changed to M and L is not deleted from the initial TBU.

It should be noted, on the other hand, that the restriction on consecutive L TBUs within the couplet is not found in quasi-couplets consisting of the pre-couplet syllable and the initial couplet syllable (underlined) as shown by these examples:

(279) a. *pè(ɾùú)* 'watermelon'
b. *ɲȉ(ʃȉjō)* 'palm belt'
c. *jù(kùˀúᴸ)* 'bathroom'

Consecutive L tones are also permitted in sequences of two pre-couplet syllables:

(280) a. *nȁ̃nȁ̃(tʃàű̃)*
nà–nà–tʃá = ũ
OPT–REP–arrive=2SG
'when you arrive'

b. *sàⁿdù(βìʃí̋)*
sà–ⁿdù–βíʃí̋
CAUS–INCH–heated
'causing to be heated'

Similarly, consecutive L tones are also possible at the other end of the prosodic word:

(281) a. *(βeˀè)ɾà*
βèˀ = ɾà
house=3MASC
'his house'

b. *(ⁿdutʲà)ɾà*
ⁿdùtʲà = ɾà
water=3MASC
'his water'

In these examples, L toned enclitics are shown to follow /L/ roots. Despite the fact that ILD occurs in /L/ couplets but consecutive L TBUs are permitted in quasi-couplets, ILD is bettered considered to be a consequence of the dispreference for L on the stressed mora of the couplet discussed above, rather than a consequence of the *LL constraint.

Tonal processes themselves also provide support for the couplet as a tonal domain, but in a way that is different from the segmental evidence. Whereas the segmental evidence consists mostly of phonological patterns that take the couplet as the domain, all tonal processes, except ILD, operate across couplet boundaries rather than within the couplet, as shown by the descriptions of the tonal processes in Table 72.

Table 72. IM tonal processes

| **Process** | **Description** |
|---|---|
| **LTS** | L spreads from /L/ *across a couplet boundary* to a H TBU in a following couplet subject to *LL (cf. (132), (107)) |
| **FLA** | Associates a floating L *across a couplet boundary* to a H TBU in a following enclitic (cf. (104)) or couplet subject to *LL (cf. (109)) |
| **LRS** | *l*-register spreads from a floating L *across a couplet boundary* to a following /HL/ couplet (cf. (147)), or from /L/ to a following H enclitic (cf. (149), (150)) |
| **HTS** | Spreads H *across a couplet boundary* to a L TBU in a following enclitic (cf. (114)) or couplet (cf. (117)) |
| **ILD** | L linked to both moras *within a couplet* is delinked from the initial mora (cf. (98)) |

Here it is important to remember Leben's (2003:136) comments concerning tonal domains: "The significance of tonal domains, in a nutshell, is that different things happen *across* them than happen *within* them" (emphasis mine). In IM, tonal processes generally occur *across* the boundary of the couplet domain rather than within it. For instance, neither LTS nor LRS apply from L to H within a LH couplet. Similarly, HTS does not apply from H to L within a couplet. Since floating tones are never found couplet internally, FLA is not even possible within the couplet except when it applies iteratively. In §4.1.3, it was noted that in a N-N construction with the melody combination /H$^{L}$/ + /H/, FLA can replace the entire melody of the /H/ noun with L (rather than just the first TBU), resulting in a [∅L] couplet. This was represented autosegmentally in (111) as iterative association of the floating L feature to each TBU of the couplet followed by delinking L from the initial couplet TBU by ILD. Once FLA has applied across a couplet domain, then, it can optionally iterate within the couplet domain.

HTS is another process that iteratively spreads through the couplet. In §4.1.3, HTS was described as obligatorily applying from a /H$^{L}$/ couplet to a following L pronoun, but this process also optionally applies from a /H$^{L}$/ couplet to a following /L/ couplet in the N-N construction, in which case it spreads iteratively to both TBUs of the couplet, as was shown in (115) and (117). The fact that HTS must apply to both TBUs if it is to apply at all provides evidence for the couplet as a domain. The evidence is somewhat weakened, however, by the fact that if a /L/ enclitic is added—/H$^{L}$/-/L/=/L/ (cf. (118))—H will also spread to the /L/ enclitic. In other words, the enclitic also appears to be included in the spreading domain. Another interpretation, however, as noted in §4.1.3, is that there is a phrasal HTS rule that spreads H from one /H$^{L}$/ couplet to a following /L/ couplet (i.e. within the PPH), and there is another HTS rule that spreads H within the PWRD to a following /L/ enclitic.

There is, however, a tonal process that requires the couplet both in the formulation of the rule and as the domain of application, which has not yet been discussed. H Dissimilation is a process that delinks the H of a LH sequence before another H if the LH sequence is within the couplet, as illustrated by the data in (282).

(282) a. ***(kùtʃi)$^{n}$dí***
$^{L}$kútʃí = $^{n}$dí
pig=1PL.EXCL
'our pig'

b. *(jà**kʷĩ**)ⁿdí*
ᴸjákʷĩ́ = ⁿdí
armadillo=2PL.EXCL
'our armadillo'

c. *(lùˀ**lu**)ⁿdí*
ᴸlúˀlú = ⁿdí
foal=1PL.EXCL
'our foal'

Each of the roots in the examples has the /ᴸH/ melody and is realized as LH in isolation (and other contexts), however, when followed by the H toned second person exclusive pronoun the H tone of the second couplet TBU (in bold) is realized at a pitch intermediate between L and H. I follow Paster & Beam de Azcona (2005), who describe the same phenomena in Yucunany Mixtec, in analyzing the process formally as delinking the couplet H of the LH=H sequence, resulting in a toneless mora, as indicated by the lack of tone marking on these TBUs in the examples.

Crucially, H Dissimilation does not occur in the following examples because the LH sequence does not occur within the couplet:

(283) a. *rà(ⁿdʲíˀí)* 'child'
b. *ɲã̀(jíβíᴸ)* 'people'
c. *tì(kátʲíᴸ)* 'blanket'
d. *rà(ⁿdʲíˀí) = ⁿdí* 'our child'

In each example, the L on the initial TBU belongs to a pre-couplet syllable, while the following H belongs to the couplet, so no H Dissimilation occurs. Example (283d), shows that even if the couplet melody is considered to be linked to a single H (as the /H/ couplet melody is formalized) and thus forms a LH sequence together with the pre-couplet L, the addition of the H toned first person plural exclusive pronoun still does not trigger H Dissimilation of the couplet H.

I formalize H Dissimilation as follows:

(284)

H Dissimilation

```
   L   H   H
   |   ǂ   |
[[(μ   μ)] μ ]
```

As shown, the domain of the rule is the extended PWRD (cf. (220)), but the LH sequence outputted from the Lexical Phonology crucially must be within the couplet/foot, while the H which triggers the deletion of the couplet H must follow it within the extended PWRD. Following Morén & Zsiga (2006:134–5), I assume that toneless TBUs "are phonetically mapped to the neutral/default pitch range", which in this case, where the toneless TBU lies between L and H TBUs, amounts to an interpolation between the preceding L and following H (cf. Pierrehumbert 1980; Liberman & Pierrehumbert 1984; Pierrehumbert & Beckman 1988). This analysis is well suited to the phonetic realization of the toneless TBU in Figure 24, which gives the average pitch contour of four male speakers and two female speakers producing eight repetitions each of ***(kùtʃi)$^{n}$dí*** 'our pig' (282a) ($^{L}$H=H '1PL.EXCL') and ***(kùtʃí)ɾà*** 'his pig' ($^{L}$H=L '3MASC') from the N-Pron production experiment (Appendix C). The effect of the deleted H of $^{L}$H=H '1PL.EXCL' is clearly seen by the middish pitch of the second TBU of this f0 contour as compared to the pitch of its final TBU and to the corresponding (second) TBU of $^{L}$H=L '3.MASC', since this construction with a L pronoun does not undergo H Dissimilation. Aside from whatever cognitive or perceptual factors might motivate dissimilation (Ohala 1981; Alderete 2003), H Dissimilation serves the purpose of reducing articulatory effort, as is evident in the name "Gradient Smoothing" used by Hinton et al. (1991) and Paster & Beam de Azcona (2005) for the same process in Chalcatongo Mixtec and Yucunany Mixtec, respectively. Reducing H between L and H allows for the pitch change to be accomplished over a greater amount of time, thus reducing the effort; however, this process is clearly governed by prosodic structure and not by articulatory pressures alone.[41]

In summary, I have shown the couplet to be the domain of association for root tonal melodies and have explored the templatic effects this has on the realization of tonal melodies. I have also

[41] Another language with prosodically governed H dissimilation is Bambara. Leben (2002; 2003) reports that LH alternates with L before H, but, as in IM, only when LH is contained within what he calls a tonal foot.

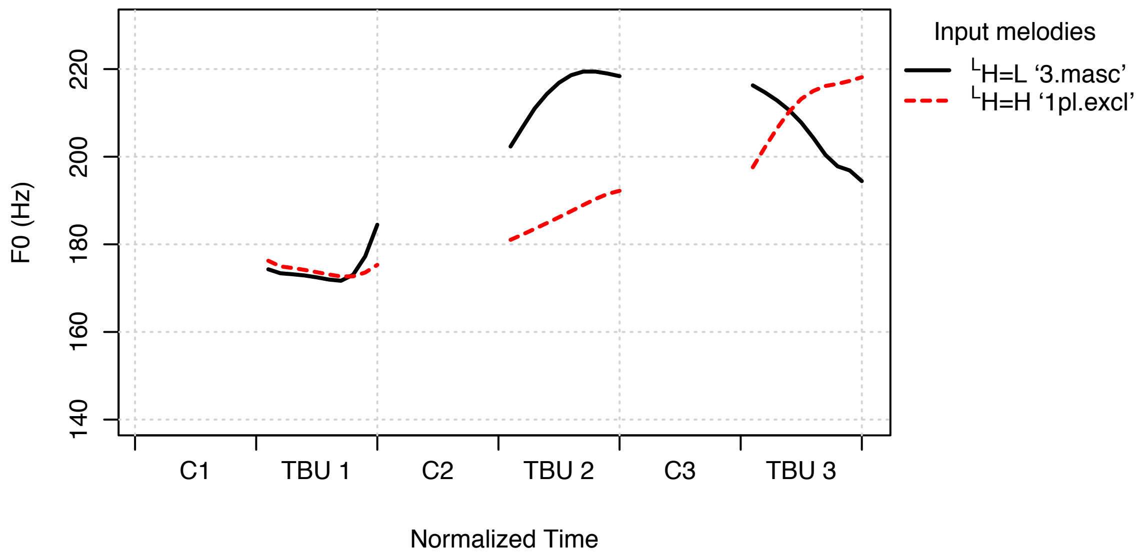



Figure 24. Mean pitch contours of /ᴸH/ + / = ⁿdí/ '1PL.EXCL' and /ᴸH/ + / = rà/ '3MASC'; dotted vertical line = syllable boundary

described various restrictions on the distribution and realization of tones that take the couplet as their domain including *LL, the dispreference of L on the initial couplet TBU and the different realizations of L in the different couplet positions. The *LL constraint was also shown to block the application of tonal processes that would spread or associate L to couplets already having an underlying L. Aside from being subject to the *LL, constraint, the main couplet generalization from tonal processes themselves is that they almost exclusively occur across couplet boundaries, rather than within them; however, iterative FLA and HTS both take the couplet as the domain within which they iterate. Furthermore, the H Dissimilation process only affects LH sequences which are contained within the foot. All of these patterns which take the couplet as their domain provide evidence that the couplet is a unit to which the IM grammar must refer, and because it is also the domain of stress and has the shape identified for the moraic trochee in the inventory of foot types, this unit should be identified as the foot. Further evidence for the foot status of the couplet related to its status as the domain of stress assignment is the fact that the couplet licenses the greatest number of tonal contrasts, and also that it shows a dispreference for L on its initial TBU, which could instantiate the cross-linguistic dispreference for L on prosodic heads.

## 6.4 Prosodically conditioned L raising

This section discusses a tonal process that I refer to as L Raising, which has not yet been described. Like most other tonal processes, the structural description of this process also makes reference to phonological material across a couplet boundary; however, it is conditioned by prosodic structure in a way that is unparalleled by other tonal processes. L Raising raises the L of a HLH sequence, but only when the L is not in a prominent position. This means that the process not only affects couplet final Ls, but also unfooted pre-couplet Ls, while Ls in the couplet initial TBU are not raised.

The examples in (285) illustrate a context where L in the second couplet position of a /HL/ couplet is raised when followed by the H toned first person exclusive pronoun, *=ⁿdí*.

(285) a. *(tʃít**ò**)ⁿdí* [¯ – ¯]
tʃítò = ⁿdí
bed=1PL.EXCL
'our bed'

b. *(ⁿdɨ́ˀj**ɨ̀**)ⁿdí* [¯ – ¯]
ⁿdɨ́ˀjɨ̀ = ⁿdí
pimple=1PL.EXCL
'our pimple'

c. *(ká**à**)ⁿdí* [¯ – ¯]
kâ = ⁿdí
metal=1PL.EXCL
'our metal'

d. *(ⁿdóˀ**ò**)ⁿdí* [¯ – ¯]
ⁿdôˀ = ⁿdí
adobe=1PL.EXCL
'our adobe'

As can be seen by the middle tone bar in the schematic pitch representations, the final L of the couplet is raised, and further, the final tone bar, representing the tone of the pronoun, is not lowered, showing that LRS does not apply, as it does obligatorily when H pronouns are preceded by /L/

couplets (cf. (285), in §4.1.6). Since the realization of L Raising is gradient and appears to be sensitive to speech rate, I represent it formally as the delinking of L between the two Hs (hence, the lack of a tone mark above the second couplet vowel (in bold) in the surface form). A formal representation of the derivation of /HL/ + '1PE' is given in (286).

(286) Couplet final L Raising

$$\begin{array}{ccc} \multicolumn{3}{c}{\underline{\text{L Raising}}} \\ \text{H} & \text{L} & \text{H} \\ | & \nmid & | \\ (\mu & \mu\,) & \mu \end{array}$$

Crucial to the statement of the rule are the couplet boundaries, which are marked with round brackets. It is the L of the second TBU of the couplet that is delinked, and this bleeds LRS that would otherwise apply to the pronoun (cf. (148), (149)). I assume that the surface pitch of the toneless TBU, while lacking a phonological pitch target, is "phonetically mapped to the neutral/default pitch range" (Morén & Zsiga 2006:134–5) between the two high pitch targets on the neighbouring TBUs.[42]

The phonetic realization of L Raising can be seen in the plot of the mean pitch contour of eight repetitions of (285a) by each of two female and four male speakers from the N-Pron production experiment (Appendix C) given in Figure 25. The f0 contour of this item is represented by HL=H '1PL.EXCL' in the plot, which has the output tones H∅=H, and is compared to the f0 contour of HL=L '3.MASC' (*tʃítò=ɾà* 'his bed'), with the output tones HL=L, and L=H '1PL.EXCL' (*tʃíkì=$^{n}$dī* 'his fist'), which has the output tones ∅L=M (the H pronoun being lowered by LRS; cf. (148)). The pitch of the "raised L" (=∅) in the second TBU of HL=H '1PL.EXCL' is clearly higher

[42] The gradience and apparent sensitivity of L Raising to speech rate suggest that the process is phonetic, however, the application of the process bleeds LRS, which would presumably apply from the final L of /HL/ to the following H pronoun as it does from /L/ couplets to H pronouns, suggesting that the process is phonological. The autosegmental account offered here attempts to capture both the gradient nature of the process (i.e. a toneless TBU that is assigned its target by phonetic implementation) and its phonological nature (i.e. the fact that L has been deleted and therefore can no longer spread), but this may not be entirely satisfactory to all. L Raising provides a good example to support Kiparsky's (1985:94) observation that "the distinction between postlexical phonological and phonetic processes is by no means clear-cut," and that gradient processes form a cline.

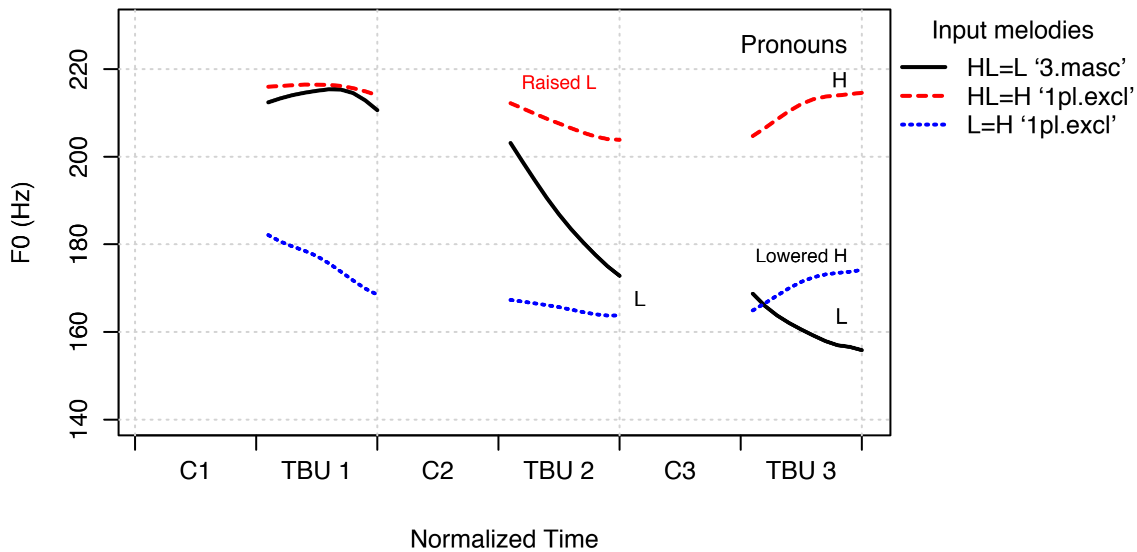



Figure 25. Mean pitch contours of /HL/ + /H/ ‘1PL.EXCL’, /HL/ + /L/ ‘3.MASC’ and /L/ + /H/ ‘1PL.EXCL’; dotted vertical line = syllable boundary

than the pitch of the second TBU of the other f0 contours, which have a L tone.[43] Comparison of the pronoun tones (the third TBU of each f0 contour) also shows that the H pronoun in HL=H ‘1PL.EXCL’ is not lowered like it is in L=H ‘1PL.EXCL’.

What is significant about L Raising from the standpoint of prosodic structure is that it does not occur when the couplet melody is LH—that is, where the L is in the strong position of the couplet. This tonal configuration is found in N-N constructions, such as those in (287), where the initial word in the constructions ends in H, and the second word has the LH melody.

(287) a. *ɲa̋ɲi̋* *màᵑgú*
ɲáɲí ᴸmáᵑgú
brother mango
‘mango’s brother’

[43] Here it is important to remember that no HTS occurs to the underlying L TBU, since if it did, a continuous (more or less flat) high pitch contour over the three TBUs would be expected. The dip in the pitch is due to the fact that this TBU is phonetically mapped to the neutral/default pitch range, as mentioned above.

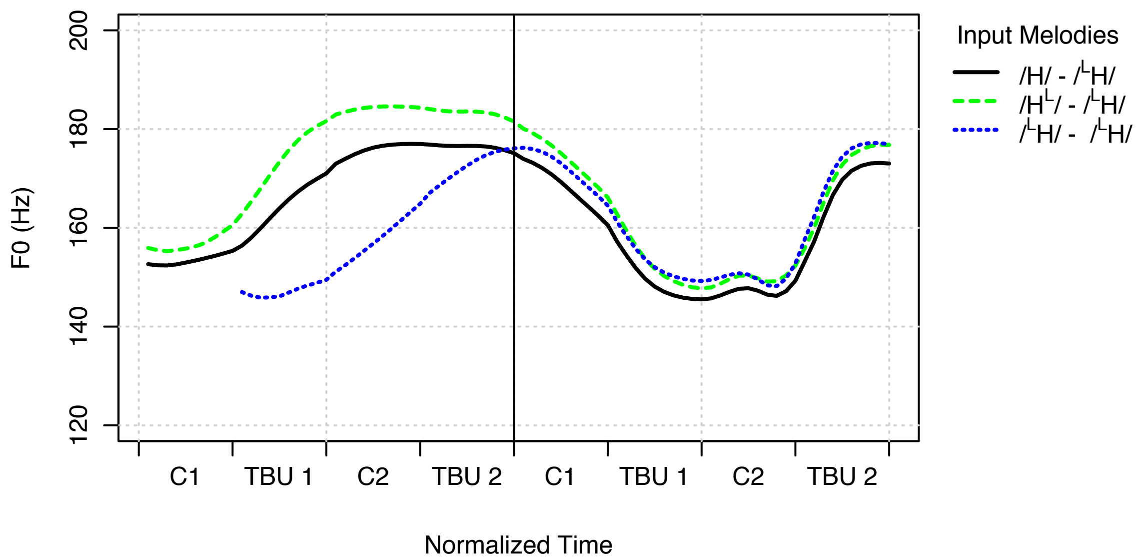



Figure 26. Mean pitch contour of /H/+ /$^{L}$H/, /H$^{L}$/ + /$^{L}$H/ and /$^{L}$H/ + /$^{L}$H/ in the N-N construction; dotted vertical line = syllable boundary, solid vertical line = word boundary

b. *nɨ̋ɲɨ̋* *màᵑgú*
nɨ́ɲɨ́$^{L}$ $^{L}$máᵑgú
blood mango
'mango's blood'

c. *ȁmấ* *màᵑgú*
$^{L}$ámá $^{L}$máᵑgú
heart mango
'mango's heart'

This creates a HLH sequence; however, the couplet initial L does not undergo the L Raising process. This can be seen in the phonetic realization of these examples given in Figure 26, where they are given the melody labels, H-$^{L}$H (287a), H$^{L}$-$^{L}$H (287b) and $^{L}$H-$^{L}$H (287c). The low pitch of the third TBU of each f0 contour in the plot compared to the high pitch of the TBUs on either side clearly shows the lack of L Raising of the L in the strong position of the couplet.

It might be argued that L Raising does not apply in examples like (287) because it does not apply across prosodic word boundaries, but this is not so, as the N-N construction examples in (288) show.

(288) a. *mĩ́ɲĩ ɲã́ɲĩ́*
míɲì ɲáɲí
pool brother
'brother's pool'

b. *mĩ́ɲĩ nɨ̃́ɲɨ̃́*
míɲì nɨ́ɲɨ́ᴸ
pool blood
'blood's pool'

c. *mĩ́nũ mĩ́ɲĩ̀*
mínù míɲì
epazote.herb pool
'pool's epazote herb'

In each of these examples, the initial word in the phrase has the /HL/ melody and the following word begins with H, creating a HLH sequence. Since the L in the first word is in the weak position of the couplet it is delinked and surfaces as toneless. The phonetic realization of these examples is shown by the plot in Figure 27, where they are labeled HL-H (288a), HL-Hᴸ (288b) and HL-HL (288c), and are compared with the f0 contour of the HL-ᴸH phrase, ***mĩ́ɲĩ̀ màᵑgú*** 'mango's pool', which does not have L Raising since the second word in the phrase begins with L rather than H. Observing the pitch at the offset of the initial /HL/ in each f0 contour of the plot (at the solid vertical line), L is clearly raised in each f0 contour except that of HL-ᴸH. In the f0 contour of HL-H, it may also be that, besides L Raising, the /H/ melody is also somewhat lowered, although the initial HL is lower also.

In addition to targeting couplet final Ls, L Raising also applies to a pre-couplet L if the couplet melody begins with H and this word is preceded by a word ending in H, as illustrated by these examples:

(289) a. *màᵑgú* ***ɾa(ⁿdíˀí)*** [_ ¯ – ¯ ¯]
ᴸmáᵑgú ɾà(ⁿdʲíˀ
mango child
'the child's mango'

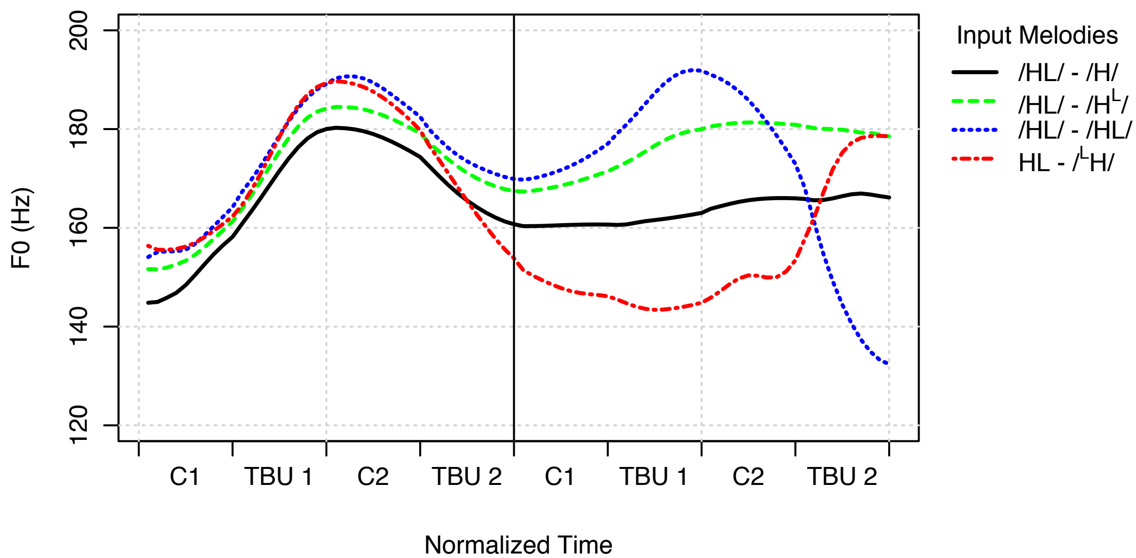



Figure 27. Mean pitch contour of /HL/ + /H/, /HL/ + /H$^{L}$/, /HL/ + /HL/ and /HL/ + /$^{L}$H/ in the N-N construction; dotted vertical lines = syllable boundary, solid vertical line = word boundary

b. *tʃátú* ***tɨ****(nɨ́ˀɨ́)* [¯ ¯ – ¯ ¯]
tʃátú tɨ̀(nɨ$^{ʔL}$
pants twins
'twins's pants'

c. *kúˀβá* ***tʲi****(káà)* [¯ ¯ – ¯ ↘]
kúˀβá tʲì(kâ
measurement knife
'knife's measurement'

In each example, the initial word in the phrase ends in H and the second words have the melodies L(HH) (289a), L(HH$^{L}$) (289b) and L(HL) (289c). The initial TBU of the trimoraic word (the third tone bar in the schematic pitch representation) is raised between two Hs. The average pitch contours of *ɾàⁿdʲíˀí* and *tɨnɨ́ˀɨ́$^{L}$* pronounced by speaker MQM in H_H and L_L carrier sentences in the Large Noun production experiment (Appendix D) are given in Figure 28. Only the pitch of the target word is given in the plot. Bearing in mind that the initial TBU of each item was preceded by a word ending in a H or L depending on the carrier sentence, it is evident that the pre-couplet syllable (i.e. the pitch of the first TBU) of the words preceded by H have a raised pitch in comparison to the

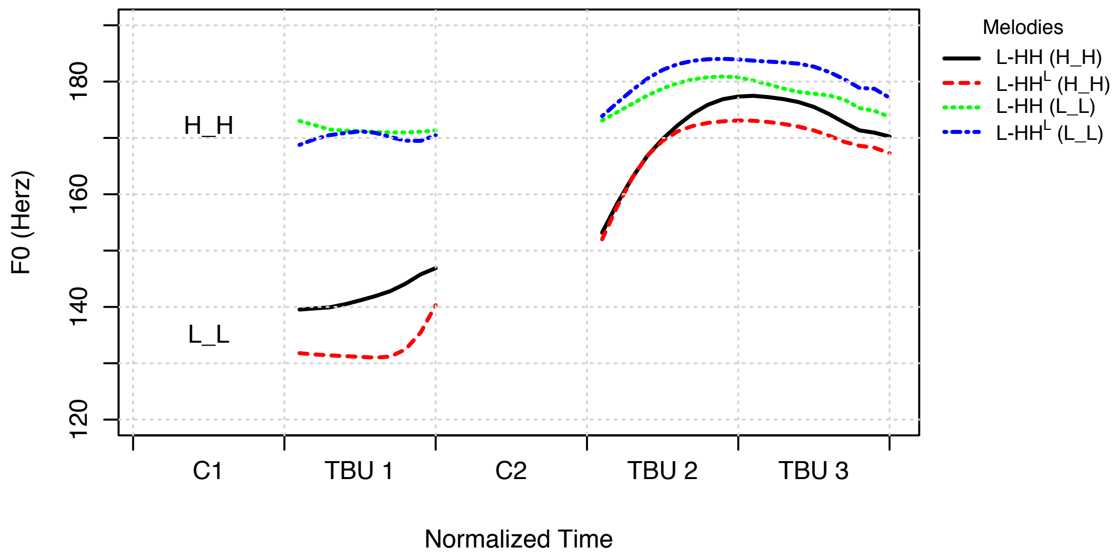



Figure 28. Mean pitch contours of /L-H/ and /L-H$^L$/ complex nouns by speaker MQM in a H_H and L_L carrier sentences

same words preceded by L. It should also be noted that L Raising does not occur in this context if the preceding word has the /H$^L$/ melody, presumably due to the floating L.

The autosegmental derivation of pre-couplet L Raising is given in (290).

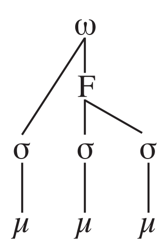
(290) Pre-couplet L Raising

<u>L Raising</u>
H L H
| ǂ |
μ ) μ ( μ

Critical to this derivation are the couplet boundaries. Unlike the couplet final L Raising, shown in (286), two couplet boundaries are needed to define the environment, a fact that will be discussed further below.

L raising in a HLH sequence is a typologically common process. Viewed from an articulatory perspective, L is raised between Hs in order to reduce articulatory effort by minimizing the tonal ups and downs (Hyman 1978:261; Hyman & VanBik 2004; Cahill 2008; Chen 2010).[44] In IM, however, this constraint does not apply across the board, since Ls in stressed syllables do not undergo the process when surrounded by Hs. In other words, L Raising occurs in prosodically weak positions in the PWRD.[45] Thus, L Raising offers only indirect support for the couplet as a prosodic constituent; it is compatible with the overall prosodic structure argued for in this dissertation, of which the couplet (= foot) is an integral part, but does not single out the couplet as the domain for the process. In order to appreciate the contribution of L Raising to the thesis, it is important to consider these data in light of what it means to say that L belongs to a stressed or unstressed TBU. As discussed in §5.3.1, word stress is defined in in terms of hierarchical prominence relations within the prosodic word that result from parsing the string of phonemes into feet and feet into PWRDs, not as a feature associated with a particular vowel or syllable. In this conception of stress, the prominence of a TBU or mora derives from its position within the overall prosodic structure. The most prominent TBU is the one that is the head of the most prominent foot in the PWRD. In IM, where only a single foot is constructed per PWRD, not only does the non-head mora of the foot lack prominence, but so do unfooted pre-couplet syllables, as illustrated in (291).

(291)




As shown, the initial mora of the foot is the most prominent of the PWRD, while the final mora is a dependent within the foot, and word initial mora is a dependent of the PWRD node. Viewed

[44] See Cahill (2008:7) for examples and references cited in support of the hypothesis that HLH is a dispreferred sequence.

[45] Since L Raising targets pre-couplet Ls as well as Ls in the weak position of the couplet, the simplest way to state the rule would be to say that an unstressed L is delinked/deleted between two Hs: L [-stress] → ∅ / H_H. A rule like this makes no overt reference to the couplet. However, there are good reasons for why stress is considered to fall out from prosodic structure and not to be the property of individual syllables (e.g. Hayes 1995, Ch. 3).

in this light, the facts of L Raising are entirely consistent with the prosodic structure in (291). L Raising occurs when L is surrounded by H tones and is not associated with the head of the foot—that is, when the L is associated to the weak mora of the foot or to an unfooted pre-foot mora. Thus, L Raising provides support not only for the foot, but also for how the foot fits into the PWRD, the next level up in the prosodic hierarchy. The deletion of L in non-prominent positions, then, falls in line with a host of evidence reported in other sections of the dissertation that targets tend to be reduced or eliminated in these positions: deletion (or labialization) of pre-foot vowels (§6.2.2.1, §6.2.2.2), the diachronic loss of foot-medial consonants (§6.2.2.3), synchronic reduction of (primarily) obstruents in pre- and post-foot positions, as well as foot-medially (§6.2.2.3) and the diachronic loss of contrastive glottalization in the final syllable of the foot and restriction of this feature to the head of the foot (§6.3.1).

## 6.5 The foot in loanword adaptation

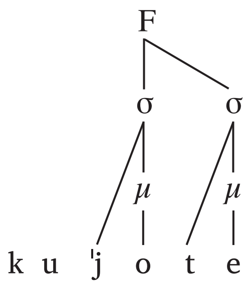
The adaptation of loanwords into a language can provide valuable insights into the nature of the phonological system into which the word is borrowed (e.g. Hyman 1970; Holden 1976; Kang 2011). In §5.3.2 we saw that the foot can play an important templatic role in the adaptation of foreign words into Cantonese (Silverman 1992) and Fijian (Kenstowicz 2007), and in §6.1 we saw that the couplet as the unit of stress assignment in IM should be identified as a bimoraic, trochaic foot from the typology of stress systems (e.g. Hayes 1995). In this section I show that a structure with the same properties—that is, a foot consisting of either two light syllables or one heavy (C)Vː syllable—is active in the adaptation of Spanish loanwords in IM. A strong constraint maintaining correspondence between the stressed syllable in the source word and the adapted word, and the strategies used to repair situations where the mapping of the stressed syllable to the foot template would violate foot structure confirm the essential link between stress and a trochaic foot in IM phonology.

In the vast majority of adaptations the stressed syllable in the adaptation corresponds to the stressed syllable in the Spanish source, as illustrated by the examples in (292).

| | | | | | |
|---|---|---|---|---|---|
| (292) | a. | *kù.(ˈjò.té)* | ‘coyote’ | cf. *coyote* | [ko.ˈjo.te] |
| | b. | *(ˈɲẽ̀ɾ.kú)* | ‘Wednesday’ | cf. *miércoles* | [ˈmʲeɾ.ko.les] |
| | c. | *(ˈlá.mĩ̀).nã̀* | ‘corrugated roofing’ | cf. *lámina* | [ˈla.mi.na] |

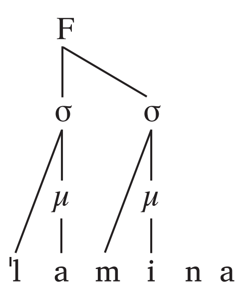
Much of the time, as in each of these examples, mapping the source structure to the IM disyllabic foot template is accomplished trivially. This is shown for example (292a) in (293).

(293)




Since *coyote* has penultimate stress, the stressed penult can map to the head of the foot and its ultimate syllable to the final syllable of the foot resulting in a proper trochaic stress foot. The Spanish source of (292b) actually has antepenultimate stress, but here the entire form is truncated to fit the foot template while maintaining correspondence between the stressed syllables. Finally, in the case of (292c), where the Spanish source also has antepenultimate stress, the string is similarly parsed into a trochaic stress foot with the stressed syllable mapping to the head of the foot template, but with one syllable (*na*) leftover, as shown in (294).

(294)




Since, like native enclitics, the final syllable does not affect the placement of stress, I consider this leftover syllable to be extrametrical and associated directly to the prosodic word, as described in

§6.1. This is similar to the situation in !Xóõ reported by Downing (2010:395; citing Traill 1985), where Afrikaans ***koppie*** 'cup' is adapted as ***(kóo)pì*** with the initial vowel lengthened to form a bimoraic foot, whereas ***lorrie*** 'lorry' is adapted as ***(nòli)*** with a short vowel. The difference is that ***pi*** is interpreted phonologically as a suffix, since the language does not allow foot medial stops (e.g. **(kópi)*), but since foot medial sonorants are allowed, the adaptation of ***lorrie*** does not require vowel lengthening.

Even though mapping to the foot is accomplished more or less trivially in these examples, they show three important properties of the IM foot. The first is its intimate connection with stress, since the stressed syllables in the Spanish sources and their adaptations always correspond. The second property is the trochaic prominence pattern, since the stressed syllable in the source maps to the initial (head) syllable of the foot. The third property observed is the truncation of the trisyllabic, *miércoles* down to foot size (*ˈɲȅr.kú*) (292b), similar to the Cantonese truncation of English loanwords discussed in §5.3.2. Although loanwords are not always truncated (e.g. (292a, c)), and an exhaustive treatment of the subject will not be attempted here, it is not difficult to recognize in the adaptation of *miércoles* the templatic role played by the foot in IM both as a minimal word/root (§6.2.1) and as a canonical word referenced in diachronic processes (§6.2).

So far we have seen that Spanish words with penultimate and antepenultimate stress map to the IM foot template in a straightforward manner. This is not the case, however, with Spanish words having final stress, and it is the adaptation of these words that provides the strongest evidence for the vital connection of the foot to stress in IM. I will focus on the adaptation of these words for the rest of the section.

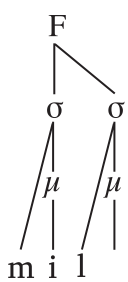
In Spanish, words with final stress often end in a consonant and this is true of the Spanish source of all of the loanwords considered here. These words are problematic because of the strong constraint in IM that the stressed syllable in the adaptation correspond to the stressed syllable in the source, the inviolable constraint that stress be realized in a bimoraic foot, as well as the fact that consonants cannot be moraic in Mixtec, nor are closed syllables permissible. This general situation in loanword adaptation is repaired in one of three ways—two of which allow the stressed syllables in the input and output to correspond, and one which does not—but all of which result in a proper stress foot in the loanword.

The first repair strategy is to delete the final consonant and lengthen the vowel of the stressed syllable, as in the examples in (295).

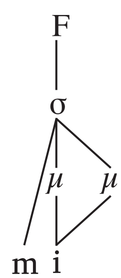
| (295) | **Source** | **Gloss** | **Adaptation** | **Gloss** |
|---|---|---|---|---|
| a. | *mil* [ˈmil] | 'thousand' | *(ˈmĩ̀ĩ́)* | 'thousand' |
| b. | *Dios* [ˈdʲos] | 'God' | *(ˈ$^{n}$dʲòó)* | 'God' |
| c. | *corral* [ko.ˈral] | 'corral' | *ku.(ˈɾàá)* | 'corral' |
| d. | *reloj* [re.ˈlox] | 'clock' | *rè.(ˈlòó)* | 'clock' |
| e. | *Miguel* [mi.ˈgel] | 'Michael' | *mĩ̀.(ˈgèé)* | 'Michael' |
| f. | *Simón* [si.ˈmon] | 'Simon' | *ʃĩ.(ˈmõ̀ṍ)* | 'Simon' |

The final consonant in each of these examples cannot fill the second mora of the foot template, as shown in (296a) for the adaptation of *mil* 'thousand' (295a).

(296) a.




b.



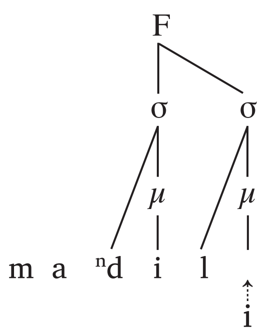

What happens instead, is that the consonant is deleted and the vowel of the stressed syllable is mapped to both moras of the monosyllabic foot template resulting in a long vowel, as shown in (296b). In this adaptation strategy, we see both the importance in the grammar of making sure that the stressed syllable in the adapted form corresponds to the stressed syllable in the source word, and that stress must be realized in a bimoraic foot. Given that there is only a single, short vowel in the input of these loanwords, and lengthening does not occur in words that are adapted with a disyllabic stress foot (e.g. (293)), the most straightforward analysis is that the short vowel is lengthened to meet the prosodic demands of the receptor language. Thus, this pattern of vowel lengthening provides further support for the analysis of native (C)V(ˀ)V couplets presented in 6.2.1 as underlyingly monomoraic /(C)V(ˀ)/ and lengthened to fill out the foot template.

If the Spanish source is monosyllabic, as in (295a-b), then the deletion and vowel lengthening strategy appears to be the only adaptation strategy employed; however, if the source word has more than one syllable, then a second option to maintain correspondence between the stressed syllables is to keep the final consonant and epenthesize a vowel for the second mora of the template, as in the examples in (297).

| (297) | **Source** | **Gloss** | **Adaptation** | **Gloss** |
|---|---|---|---|---|
| a. | *mandil* [man.ˈdil] | ‘apron’ | *mà.(ˈ$^{n}$dì.lí)* | ‘apron’ |
| b. | *Miguel* [mi.ˈgel] | ‘Michael’ | *(ˈjè.lí), mì.(ˈjè.lí)* | ‘Michael’ |
| c. | *Carasol* [ka.ɾa.ˈsol] | ‘Carasol’ | *kà.ɾà.(ˈsò.lā)*[46] | ‘Carasol’ |

This strategy adopts the disyllabic foot template for the adapted word, as illustrated in (298) for *mandil* (297a).

(298)




Interestingly, ***Miguel*** (297b) can also be adapted by this strategy (cf. (295e)). Although there is insufficient data to make firm generalizations about the epenthetic vowel, these few data suggest that it must be an outer triangle vowel (cf. §6.3.3.2), and perhaps that if the stressed vowel in the source is [+front], then the epenthetic vowel is /i/ and elsewhere /a/ (the least marked vowel

[46] I am uncertain of the tone of this word.

in the system). This adaptation strategy appears to be much less frequently employed than the lengthening strategy.

The third strategy used to adapt Spanish source words with final stress into IM is to delete the final consonant and map the final two syllables of the word to the disyllabic foot template (216a), with the result that stress is shifted one syllable left of what it was in the source word, as in the examples in (299).

| (299) | | Source | Gloss | Adaptation | Gloss |
|---|---|---|---|---|---|
| | a. | *azul* [a.ˈsul] | ‘blue’ | *(ˈà.sū)* | ‘blue’ |
| | b. | *cotón* [ko.ˈton] | ‘cotton’ | *(ˈkò.tō̃)* | ‘shirt’ |
| | c. | *Miguel* [mi.ˈgel] | ‘Michael’ | *(ˈmí.gè)* | ‘Michael’ |
| | d. | *Simón* [si.ˈmon] | ‘Simon’ | *(ˈʃí.mũ̀)* | ‘Simon’ |

Notice that *Miguel* (299c) may also be adapted using this strategy (cf. (295e) and (297b)), as well as *Simon* (299d) (cf. (295f)). The two forms of *Simon* refer to different persons, suggesting that sometimes alternate strategies may be used to achieve contrast. The significance of these data are that they show that, while the correspondence between the stressed syllable in the input and output may be violated, the realization of stress in a trochaic foot is obligatory.[47]

The role of the foot in IM loanword adaptation is very similar to what we saw in Fijian adaptations of English loanwords in §5.3.2. That language also assigns stress to a bimoraic trochee aligned to the right edge of the word and attempts a close correspondence between the stressed syllable in the adaptation and the stressed syllable in the source word. English words with final stress create a situation requiring repair since it is not possible to form a bimoraic foot and maintain correspondence between the stressed syllables in the source and adapted forms just like Spanish words with final stress do in IM. In both languages the mismatch between the input structure and

[47] It should be noted that stress shift also occurs in two Spanish loanwords with antepenultimate stress (*ˈn̥ⁿdʲí.kó*$^L$ ‘syndic’ < *síndico* [ˈsin.di.ko], *mà.ˈkí.ná*$^L$ ‘machine’ < *máquina* [ˈma.ki.na]) and two with penultimate stress (*ˈtrà.ᵑgā* < *tranquera* [tɾaŋ.ˈke.ɾa], *ˈkù.tʃí* ‘pig’ < *cochino* [ko.ˈtʃi.no]) in my corpus. In all of these adaptations stress is realized in a disyllabic foot consisting of the final two syllables of the adapted form, taking into account the truncation down to foot size of all of the examples except *màˈkíná*$^L$. In the case of *ˈn̥ⁿdʲí.kó*$^L$, since truncation has resulted in the fusion of the stressed syllable in the source word with the following syllable (which is stressed in the adaptation), it could be argued that no stress shift has occurred.

prosodic structure is repaired by two strategies that maintain correspondence between the stressed syllable of the source and the stressed syllable in the adapted forms—that is, either by dropping the final consonant and lengthening the final vowel to create a monosyllabic foot, or by keeping the final consonant and epenthesizing a vowel to create a disyllabic foot. A third strategy, which maintains foot structure but not the correspondence of stressed syllables is also used in both languages. This strategy simply maps the final two syllables onto the disyllabic foot template, resulting in an adapted word which has the stressed syllable shifted one syllable from its location in the source word. What all three adaptation strategies have in common is that they demonstrate the essential connection of stress and the foot in these languages through the obligatory requirement that stress be realized in a trochaic foot aligned with the right edge of the grammatical word. In the first two strategies (lengthening and epenthesis), correspondence between the stressed syllable of the source and the stressed syllable in the adapted forms is maintained at the cost of augmenting the existing structure. In the third strategy, even though correspondence of the stressed syllables is violated, both the bimoraic shape and the trochaic prominence requirements are upheld. These strategies show the templatic function of the foot in triggering structural changes (vowel lengthening, epenthesis and stress shift) to ensure a proper stress foot even when word minimality is not an issue. They also highlight the fact that either form of the foot is acceptable, especially, in the case of IM, the Spanish words that are adapted by multiple strategies.

Chapter 7

# Conclusion

The descriptive term "couplet" has been ubiquitous in the descriptions of most Mixtec varieties; however, exactly what this structure is in terms of the structure of the word has not been satisfactorily explained, nor has the pervasiveness of the couplet in the synchronic and diachronic phonology been adequately explored in the past. This dissertation has shown that the couplet should be identified as a foot from prosodic hierarchy theory, because it has the structural properties of the foot and fulfills the typologically common functions of the foot. In §6.1 the couplet was shown to fulfill the prototypical function of the foot as the constituent to which stress is assigned in IM, and to have all of the structural properties of the foot: it is a constituent intermediate between the syllable and the PWRD, and the basic couplet forms (11) match the foot templates of the moraic trochee (184b), having a binary structure that is quantity-sensitive and left headed, comprising either two light syllables ((C)V(ˀ)CV) or one heavy (bimoraic) syllable ((C)V(ˀ)V). In §6.2 it was demonstrated that the couplet plays a templatic role in both the synchronic and diachronic phonology. Since the couplet was shown to have the structural properties of the foot and to function in the prototypical role of stress assignment in IM (cf. §6.1), the templatic function of the couplet was taken as further evidence that it should be identified as a foot.

Synchronically, couplets with the form (C)V(ˀ)V (e.g. *kóó*ᴸ 'snake', *kóˀó*ᴸ 'dish') were shown in §6.2.1 to be underlyingly /(C)V(ˀ)/ (e.g. /kóᴸ/, /kóˀᴸ/) and augmented through vowel lengthening when they are the stressed couplet of the word. Crucially, when these couplets are combined with the first and second person singular enclitic pronouns (*=í*, *=ũ̃*), no augmentation occurs, and thus the pronouns do not coalesce with the final couplet vowel as they do in disyllabic couplets. Rather, the pronouns—which consist of a single vowel—simply fill the second mora of the monosyllabic foot template (e.g. *kóì* 'my snake', *kóű̃*ᴸ 'your snake', *kóˀĩ̀* 'my dish', *kóˀű̃*ᴸ 'your dish'). We thus see that the couplet functions as a minimal word template to trigger augmentation of prosodically deficient forms just as the foot serves as the minimal word template in languages like Lardil (cf. §5.3.2). As it turns out in IM, the foot is, more specifically, the minimal morphological root template, since prefixes and enclitics are not allowed to fill out the foot template like they are, for instance, in Fijian (cf. (194)). The grammar of IM therefore contains constraints that map the root to the foot, aligning the left edge of the root with the left edge of the foot, and the couplet as a minimal word template falls out from the fact that all words in IM consist minimally of a root. Given this close relationship between the foot and the root, it is not surprising that most Mixtecanists have been content to refer to the couplet simply as the root, for in most cases they are, in fact, coextensive. Nevertheless, there are good descriptive and conceptual reasons to maintain their distinctness.

The analysis that long vowels are underlyingly short is contrary to Carroll's (2015) analysis of long vowels in Ixpantepec Mixtec. He analyzes these vowels as underlyingly long in order to provide two TBUs for the tonal melodies of the root. However, this analysis fails to account for the lack of vowel coalescence in (C)V(ˀ)V couplets or for their predictable distribution in the stressed couplet (§6.2.1). The restriction of a single tone per TBU, on the other hand, is analyzed as a surface constraint in this dissertation, and not holding over underlying forms. The underlying form of a root with the /HL/ melody like *káà* 'metal', for instance, is /kâ/, with both tones associated with the only underlying root vowel; however, the surface form of this root is augmented through vowel lengthening when prosodic structure is assigned in the Lexical Phonology, which provides a second TBU for the realization of the tonal melody.

The templatic influence of the couplet is also demonstrated in diachronic processes that created couplet-sized structures (§6.2.2). For instance, in the formation of realis and irrealis stems at an earlier stage of the language (cf. §6.2.2.1), subminimal CV roots combined with mood prefixes (*tʃì–* and *kù–*, respectively) to produce a stem matching the disyllabic couplet form (e.g. *tʃì•tʲì* 'bathe:REAL', *ku•tʲ*ì 'bathe:IRR')—a form of template satisfaction different from the vowel lengthening described above that was particular to this morphological context. Interestingly, bimoraic

VCV roots also resulted in CVCV couplets through the deletion of the prefix vowel (e.g. ***tʃ•isò*** 'carry:REAL', ***k•isò*** 'carry:IRR') or, in the case of the irrealis prefix, the labialization of the prefix vowel (e.g. *kʷ•ãɲũ* 'step on:IRR'). Both the augmentation of subminimal CV roots by including the prefix into the couplet and the truncation of prefix + VCV roots find a unified explanation in a disyllabic couplet template, since both result in a bimoraic foot. By contrast, the prefix vowel is never deleted when it can be mapped to the foot template without creating either a trimoraic form or a monosyllabic couplet with two different vowels, and roots which already had a CVCV shape were neither augmented nor truncated, since the roots already had the ideal CVCV shape. The imposition of a particular shape on a morphological structure is a typologically common functions of the foot and constitutes evidence that the couplet should be identified as a foot.

The tendency to reduce multisyllabic constructions to couplet form was noted by Josserand (1983:460) as one of the most important processes in the historical development of Mixtecan languages, and it is also seen in IM data in places other than realis/irrealis stems. In §6.2.2.2 it was shown that, similar to what was reported by Macken & Salmons (1997) for CM, vowel syncope in the pre-couplet syllables has created consonant clusters at the onset of the couplet that are unattested within the couplet and, in most cases, has reduced these words to a couplet-sized structure. It was argued that the location of these consonant clusters is not predicted in an analysis based solely on syllables since the clusters occur in the onset of the first couplet syllable and not the second; however, if the couplet is a trochaic foot the location of the clusters makes good sense, since the initial syllable of the trochaic foot is the most prominent and expected to host the greatest number of phonological contrasts (e.g. Macken 1996; Macken & Salmons 1997; Harris 1997; Dresher & van der Hulst 1998). Furthermore, the syllables preceding the foot in IM are considered to be unfooted and therefore also prosodically weak, giving rise to the tendency for vowel deletion in this context. In these data, as with the truncation observed in realis/irrealis stems, the function of the couplet clearly parallels the function of the foot as a diachronic template in languages like Old Saxon, for instance, where the theme vowel of i-stems was lost if it was not footed with the stem, and retained if it was (cf. §5.3.2).

The couplet similarly has functioned templatically in the diachronic phonology to define the site of consonant deletion. IM reflexes of PM $*w$ (> $\beta$) and $*j$ (> $j$) have tended to be lost in the couplet medial position but not in the couplet initial position. Again, these facts find a simple explanation if the couplet is considered a trochaic foot which acts as a template for sound change. Since the second syllable of the foot is weak, this is precisely the location where one might expect consonant lenition and loss. On the other hand, retention in the initial syllable is expected since this is the most prominent syllable of the trochaic foot. These facts are similar to the diachronic process of d-deletion in Buttelstedt German, which is also described in terms of a trochaic foot template by Smith & Ussishkin (2015) (cf. §5.3.2).

The most pervasive typological role of the foot outside of stress assignment is its role in providing the domain for phonological processes and phonotactic generalizations (e.g. Nespor & Vogel 2007 [1986]). Since the couplet has the theoretical properties of the moraic trochee and functions in the prototypical role of the foot in stress assignment, I take the fact that it also provides the domain for numerous phonotactic constraints, as well as a few phonological processes, as further evidence that the couplet should be identified as a foot. Phonotactic patterns that take the couplet as their domain include distributional restrictions on patterns of nasal segments (§6.3.2), vowels (§6.3.3), labial consonants (§6.3.4) and various tonal phenomena (§6.3.6). With respect to the latter, the couplet was shown to be the domain within which a restricted set of root tonal melodies are realized, as well as the domain which licenses the greatest number of tonal melodies. Further, the *LL constraint bans consecutive L tones from occurring within the couplet, there is a dispreference for L on the couplet initial TBU and L has different allotones occurring on the initial and final TBUs of the couplet.

Phonological processes which take the couplet as their domain are contrastive glottalization (cf. §6.3.1), consonant lenition ($t \rightarrow d$, $tʃ \rightarrow ʃ$, $k \rightarrow ɣ$) (cf. §6.2.2.3), epenthetic glottalization (§6.3.5) and L Raising (§6.4). Of these, only the first is restricted to the couplet. The other processes all occur in other prosodically weak positions, which include both the final syllable of the couplet as well as unfooted pre- and post-couplet syllables; their implications for prosodic structure are considered below. Contrastive glottalization is a feature of roots that is only licensed on the first mora of the couplet and is lost when roots are not realized in couplet form (i.e. in compounds). While the couplet is referenced in the description of tonal processes (ILD, LTS, FLA, LRS, HTS, H Dissimilation), nearly all tonal processes are found to occur *across* couplet boundaries rather than *within* them. This also can be considered as evidence for the unit status of the couplet since, as Leben (2003:136) points out, a significant characteristic of tonal domains is that "different things happen across them than happen within them." The H Dissimilation process, however, also has a condition that uniquely targets the couplet: the first H of a LHH sequence dissimilates (i.e. deletes) across a couplet boundary, but only if the LH sequence is *within a couplet*. In addition, the FLA process may optionally iterate within the domain of the couplet. HTS also iterates within the couplet but includes post-couplet enclitics and therefore does not uniquely target the couplet.

The final type of evidence for the foot comes from Spanish loanwords (§6.5). The adaptation of source words with final stress provides a convincing demonstration of the integral connection of stress with the foot in IM, its bimoraic form and trochaic prominence pattern. In these adaptations, the stressed final syllable is usually augmented so that stress can be realized both on the corresponding syllable in the adapted form and in a trochaic foot. This is accomplished either through deleting the final consonant of the Spanish word and lengthening the vowel to create a heavy syllable (the most common strategy) or through epenthesizing a vowel after the final consonant, creating a disyllabic foot. A third strategy deletes the final consonant and shifts stress one syllable to the left. All of the strategies highlight the fact that stress in IM must be realized in a bimoraic, trochaic foot, which can either be a single heavy syllable or two light syllables aligned with the right edge of the root/minimal prosodic word. The vowel augmentation strategy also provides support for the analysis of (C)V($^{ʔ}$)V couplets as having underlyingly short vowels which are lengthened on the surface to satisfy the foot template since the vowels in the Spanish source words are short, but are lengthened to fill the foot template during adaptation.

The picture that emerges from the findings of this dissertation is that prosodic structure plays a large role in the grammar of IM. The focus of this study has been on the foot and the findings summarized above are all ways in which it manifests itself in the phonology, and the end result of the couplet = foot analysis advanced is a coherent explanation for a disparate set of phonological patterns encompassing synchronic and the diachronic dimensions of the phonology. Since the foot exists within a hierarchy of units, descriptions of the units below and immediately above it have also been necessary. The smallest unit—the mora—has a key role in the phonology since the quantity-sensitive foot is defined over moras, rather than syllables—that is, the foot comprises either two light syllables or one heavy syllable, but always has two moras. Closed syllables are prohibited in the native phonology, thus only vowels are moraic; a short vowel has a single mora and a long vowel has two. It was also shown in §4.1.1, that the mora rather than the syllable is the TBU, since feet have exactly two TBUs whether they are disyllabic or monosyllabic (i.e. because they are bimoraic) and bear the same set of root tonal melodies.

Despite the fact that the foot and the TBU are defined by the mora, the syllable still plays a limited role in the phonology by providing the domain for the OCP labial and OCP coronal constraints, as described in §3.3. The IM data do, however, support the claim of Macken & Salmons (1997) that Mixtec languages are evolving away from a syllable orientation towards a foot orientation. The definition of the foot and TBU in terms of the mora can be taken as evidence for this analysis. More convincing evidence comes from patterns that limit phonological specifications within the foot such as those discussed by Macken & Salmons for CM. Such patterns in IM include the restriction of contrastive glottalization to a single instance in the foot (§6.3.1), evidence from nasal phonotactic patterns for the spreading of a single nasal feature throughout the foot (§6.3.2), the reduction of vowel contrasts within the foot through vowel harmony processes (§6.3.3.1) and the loss of medial consonants (§6.2.2.3).

Moving to the level above the foot in the prosodic hierarchy, I have shown that, while many prosodic words consist of a single foot, especially nouns and adjectives which lack inflection, larger

PWRDs are also found as a result of word formation processes, inflection and cliticization, as well as some that are synchronically monomorphemic, fossilized forms (§2.4; §6.2.1). The criterial property of the phonological word is a single primary stress which falls on the head mora of the foot, and the location of the prosodic head does not change with the addition of phonological material preceding or enclitics following the foot. Thus, a single foot forms the obligatory nucleus of the PWRD. All syllables preceding and following the foot are claimed to be unfooted and attach directly to the PWRD for their phonological realization, as shown in (220). The phonological patterns described above that exclusively target the foot provide evidence for positing a single, bounded foot, and the violation of the Exhaustivity constraint (178a) in connecting other syllables directly to the PWRD, rather than parsing them into feet. Other evidence that is consistent with this analysis comes from several reduction processes that target weak pre-foot syllables. In the formation of realis/irrealis stems (cf. §6.2.2.1), the vowel of the etymological mood prefix was truncated (or reduced to a glide in some cases with *kù–* 'irrealis') when it combined with vowel initial roots and could not be included within the foot. Similarly, it was shown that various consonant clusters have developed when unfooted pre-foot vowels are syncopated (cf. §6.2.2.2). These clusters are found mostly at the left foot boundary, and sometimes at the left PWRD boundary, but never foot internally. As such, the clusters constitute a form of strengthening of both the PWRD and foot boundaries. Consonants in unfooted syllables before and following the foot also tend to undergo lenition (cf. §6.2.2.3), in addition to consonants in the foot medial position, providing evidence for the prosodic weakness of these positions. This is also seen in the tonal process L Raising (cf. §6.4), in which L is raised between two Hs when it is in the prosodically weak final TBU of the foot, or in a pre-foot TBU. Finally, epenthetic glottalization was found to strengthen not only vowel initial foot boundaries, but also vowel initial PWRD boundaries, which provides support for a PWRD category that is superordinate to the foot.

While the evidence presented in this dissertation argues conclusively that the couplet should be identified as a foot set within a hierarchy of prosodic units, there is, of course, still much more to be said. This study opens the door to numerous avenues of further study that will increase our understanding of the extensive influence of the foot in IM and other Mixtec varieties. One obvious avenue that needs exploration is instrumental study of the phonetic manifestation of stress in IM words of various sizes, including compounds, and how word stress is related to phrase or sentence stress and intonation. Such studies would shed light on whether or not there is acoustic evidence for secondary stress. Other instrumental studies that would contribute to the results presented in this dissertation are more rigorous investigations of consonant lenition and epenthetic glottalization and their relation to prosodic structure.

Another avenue for further research is the study of the PWRD, within which the foot is realized. The instrumental studies described above should provide a better grasp of the acoustic nature of the PWRD and how the foot relates to it. In addition, a more complete understanding of the phonological patterns of the PWRD, particularly those that are unique to it, would provide a fuller picture of word level prosodic structure in IM and how the foot fits into it.

One final avenue for further study that I will mention here is to expand the investigation of the role of the foot in loanword adaptation, particularly to examine examples of truncation down to foot-sized words. Related to this is the study of IM hypocoristics, most of which derive from Spanish names, and have not been dealt with extensively in this dissertation.

Having summarized the evidence that the couplet should be identified as a foot and the directions for future research, I close by considering whether identifying the couplet as a foot is not simply a terminological preference without substance or merely a desire to update an older term with an equivalent contemporary one. On the contrary, I believe there are real advantages to adopting the term “foot”. First, consider that “couplet” communicates very little on its own about the nature of the constituent whereas the term “foot” clearly conveys the phonological nature of this unit. It, moreover, signifies that it is a unit occupying a specific spot within the prosodic hierarchy, that it has very specific properties—a headed, binary structure composed of moras and syllables, and is a constituent of the higher prosodic unit PWRD (cf. (213))—and that it is expected to fulfill at least some of the typologically common functions of the foot given in (214).

Furthermore, identifying the couplet as a specific kind of foot—a moraic trochee—immediately explains the two basic forms of the couplet—that is, two light syllables or one heavy syllable. It also implies an inherent strong-weak prominence relation within the unit and that it is a constituent in a hierarchical arrangement of other prosodic structures which also have prominence relations. It is the prominence relations of the prosodic structure that provide the motivation for many of the specific phonological patterns that are attributed to the couplet such as the deletion/glide formation of pre-couplet vowels, which are unfooted and therefore prosodically weak (§6.2.2.1), the deletion of weak couplet medial consonants but not initial ones (§6.2.2.3), the limitation of contrastive glottalization to the strong (initial) mora of the couplet and the fact that it is not licensed in reduced, monomoraic forms (§6.3.1), marking and strengthening the initial boundary of vowel initial feet with epenthetic glottalization (§6.3.5), diachronic vowel harmony patterns that are predominantly left to right, from the strong mora to the weak one (§6.3.3.1), a constraint against L on the head mora which can be seen as instantiating a crosslinguistic preference for higher tones on positions of metrical prominence (e.g. de Lacy 2002) (§6.3.6), and L raising in weak prosodic positions but not on the head of the foot (§6.4).

Identifying the couplet as a foot also avoids the ambiguity that is present in many Mixtec descriptions about whether it is a morphological or a phonological structure, yet it also anticipates a close relationship to morphological structure, since a close but non-isomorphic relationship of prosodic structure with morphosyntactic structure is part of the theory of prosodic phonology, as discussed in §5.4 (e.g. Selkirk 1980a; 1986; 2011; Nespor & Vogel 2007 [1986]; Booij & Lieber 1993; Booij 1999). In IM and probably all Mixtec languages, the basic relationship of the foot to morphosyntactic structure is one of alignment with the morphological root, although, as expected, these constituents are non-isomorphic in the various ways that have been elaborated. The very restricted phonological form of Mixtec roots, then, is due to the relationship that exists between the root and the foot. Recognizing the distinctness of the morphological and prosodic units (and the hierarchies they belong to) is important conceptually and methodologically since, in Halliday's

(1961:268) words, "different *kinds* of abstractions are involved" (emphasis in the original), and failure to analyze the units of the different hierarchies ("levels") separately before relating them to each other "results in a failure to account for them fully at any level." Separating the different kinds of units, for instance, enables us to describe fossilized items in the IM lexicon where morphological boundaries have become obscured and reinterpreted as prosodic boundaries. It should also make it easier for Mixtecanists to recognize and more fully explore the influence of the foot in the grammar of other Mixtec varieties and particularly of its relationship to morphological structure. As noted in Macken & Salmons (1997) and demonstrated in this study, recognition that the couplet is a foot provides a unified explanation for a variety of diverse patterns encompassing both the synchronic and diachronic dimensions of the phonology.

From the preceding discussion it is obvious that identifying the couplet as a foot also allows us to situate this unit in a broader typological context, making it easier for the typologist to identify commonalities and differences of the IM foot with constituents in other languages that meet the definition of a foot. Furthermore, the formulation of the definition of "foot" in this study and its application to IM can stimulate discussion about which aspects of the definition are criterialand how it can be profitably applied to the couplet in other Mixtec varieties, as well as to other related and unrelated languages. This dissertation thus forms part of the dialogue necessary to develop consistent, well-defined terminology for making valid crosslinguistic comparisons, which is essential to linguistics as a scientific discipline (cf. Beck 2016).

It goes with out saying, then, that the findings of this dissertation speak to the importance of the foot as an analytical construct even where stress is not iterative (rhythmic), contra those who say otherwise (e.g. Prince 1983; Selkirk 1984; Gordon 2002; Samuels 2009). The fact that the same bimoraic unit that defines the locus of stress assignment is also implicated in the description of the various synchronic and diachronic patterns enumerated above suggests, as recently argued by Bennett (2012), that the foot must be considered to have a more general role in the phonological organization of languages beyond its prototypical role in stress assignment. I contend that one can profitably use a term like "foot" that is well-defined with respect to its structural properties and functions as an analytical device in the description of a specific language as well as a term for crosslinguistic comparison without saying that the foot is a universal, abstract category that is "instantiated" in individual languages. Rather, as Beck (2016) points out, saying that some terms are "portable" in this respect

> is simply a statement that there are things that languages do similarly for a variety of reasons rooted in communicative needs, cognition, cultural convergences, and other factors that combine with the physics and physiology of speech and hearing to shape the design space of human languages — and that there are terms that can be usefully and informatively applied to the description of these things in many (but not necessarily all) specific languages. (p. 398)

He goes on to point out that considering that some clearly defined terms can serve as both language-particular descriptive terms as well as for cross-linguistic comparison is no more controversial than what biologists do when they compare the "eye" of one animal to that of another: saying that humans and octopi both have eyes is not to say these structures instantiate an abstract, universal "eye" category, nor that they are exactly the same. Identifying structures that meet the well-formulated definition of a unit, however, does form the basis of fruitful comparison and useful discussions about what it means to say that something is an eye—or a foot. This dissertation accomplishes the first step in this process by identifying the couplet as a structure meeting the definition of a foot. This puts IM and other Mixtec languages in a position to participate in the comparative task in the days to come.

# REFERENCES


Alderete, John. 2003. Phonological processes: Dissimilation. *International encyclopedia of linguistics,* ed. by William J. Frawley, 2nd Edition. 323–324. Oxford: Oxford University Press.

Alexander, Ruth Mary. 1980. *Gramática mixteca de Atatlahuca.* (Gramáticas de Lenguas Indígenas de México Núm. 2.) Mexico: Instituto Lingüístico de Verano.

Anderson, John Mathieson & Colin J. Ewen. 1987. *Principles of Dependency Phonology.* Cambridge: Cambridge University Press.

Anderson, Stephen R. 2005. *Aspects of the theory of clitics.* New York: Oxford University Press.

Aranovich, Raul. 1994. The tone system of Acatlán Mixtec and some exceptions to the OCP. *Linguistic Notes from La Jolla* 17. 3–26.

Aston, John A.D., Jeng-Min Chiou & Jonathan P. Evans. 2010. Linguistic pitch analysis using functional principal component mixed effect models. *Journal of the Royal Statistical Society: Series C (Applied Statistics)* 59(2). 297–317.

Bao, Zhiming. 1999. *The structure of tone.* Oxford: Oxford University Press.

Bates, Douglas, Martin Mächler, Ben Bolker & Steve Walker. 2015. Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software* 67. 1–48.

Beck, David. 1997. Theme, Rheme, and Communicative Structure in Lushootseed and Bella Coola. *Recent Trends in Meaning-Text Theory,* ed. by Leo Wanner, 93–135. Amsterdam/Philadelphia: John Benjamins Publishing Company.

Beck, David. 2002. *The typology of parts of speech systems: The markedness of adjectives.* New York: Routledge.

Beck, David. 2011. Lexical, quasi-inflectional, and inflectional compounding in Upper Necaxa Totonac. *Multi-verb constructions: A view from the Americas,* ed. by Alexandra Aikhenvald & Pieter Muysken, 63–106. Leiden: Brill.

Beck, David. 2016. Some language-particular terms are comparative concepts. *Linguistic Typology* 20(2). 395–402.

Beckman, Jill N. 1986. *Stress and Non-Stress Accent.* Dordrecht, The Netherlands: De Gruyter Mouton.

Bennett, Ryan Thomas. 2012. *Foot-conditioned phonotactics and prosodic constituency.* University of California Santa Cruz dissertation.

Bickford, J. Albert & Marlett, Stephen A. 1988. The semantics and morphology of Mixtec mood and aspect. *Work Papers of the Summer Institute of Linguistics, University of North Dakota* 32. 1–39.

Boersma, Paul & David Weenink. 2016. *Praat: Doing phonetics by computer v.6.0.20.* Online: www.praat.org.

Booij, Geert E. 1988. Review of Prosodic Phonology. *Journal of Linguistics* 24(2). 515–25.

Booij, Geert E. 1996. Cliticization as prosodic integration: The case of Dutch. *The Linguistic Review* 13(3–4). 219–242.

Booij, Geert E. 1999. The role of the prosodic word in phonotactic generalizations. *Studies on the Phonological Word,* ed. by T.Allan Hall & Ursula Kleinhenz, 47–72. Amsterdam: Benjamins.

Booij, Geert E. & Rochelle Lieber. 1993. On the simultaneity of morphological and prosodic structure. *Phonetics and Phonology 4: Studies in Lexical Phonology,* ed. by Sharon Hargus & Ellen M. Kaisse, 23–44. San Diego: Academic Press.

Booij, Geert & Jerzy Rubach. 1984. Morphological and prosodic domains in Lexical Phonology. *Phonology Yearbook* 1. 1–27.

Bradley, C. Henry & Barbara E. Hollenbach (eds.). 1988–1992. *Studies in the syntax of Mixtecan languages.* 1–4. Dallas, TX: Summer Institute of Linguistics.

Bradley, C. Henry. 1968. A Method for Determining Dialectal Boundaries and Relationships. *América Indígena* 28. 751–760.

Bradley, C. Henry. 1977. Toward a definition of the Mixtec languages. Summer Institute of Lingustics, ms.

Bradley, C. Henry. 1970. *A Linguistic Sketch of Jicaltepec Mixtec.* Norman, Oklahoma: Summer Institute of Linguistics.

Bradley, C. Henry & Kathryn J. Josserand. 1982. El protomixteco y sus descendientes. *Anales de Antropología* 19. 279-343.

Brown, J.C. 2002. The phonetics of Mixtec glottalization. *Santa Barbara papers in linguistics: Procedings from the fifth workshop on American indigenous languages,* ed. by Jeanie Castillo, 13, 3–9. Santa Barbara: Department of Linguistics University of California, Santa Barbara.

Brugman, Hennie & Albert Russel. 2004. Annotating Multi-media/Multi-modal Resources with ELAN. ed. by M. T. Lino, M. F. Xavier, F. Ferreira, R. Costa, & R. Silva. *Proceedings of the Fourth International Conference on Language Resources and Evaluation (LREC 2004).* 2065–2068. Paris: European Language Resources Association.

Cahill, Mike. 2008. *More universals of tone.* (SIL Electronic Working Papers.) Online: http://www.sil.org/resources/publications/entry/7816.

Campbell, Lyle. 2000. *American Indian languages.* Oxford: Oxford University Press.

Carroll, Lucien Serapio. 2015. *Ixpantepec Nieves Mixtec Word Prosody.* University of California, San Diego dissertation.

Castillo García, Rey. 2007. Descripción fonológica, segmental, y tonal del Mixteco de Yoloxóchitl, Guerrero. México, D.F. Centro de Investigaciones y Estudios Superiores en Antropología Social master's thesis.

Chen, Matthew Y. 2000. *Tone Sandhi: Patterns Across Chinese Dialects.* Cambridge University Press.

Chen, Tsung-Ying. 2010. Some remarks on Contour Tone Units. *Journal of East Asian Linguistics* 19(2). 103-35.

Chomsky, Noam & Morris Halle. 1968. *The sound pattern of English.* New York: Harper & Row.

Clark, Lawrence E. 1977. Linguistic Acculturation in Sayula Popoluca. *International Journal of American Linguistics* 43(2). 128–138.

Clements, George N. 1990. The role of the sonority cycle in core syllabification. *Papers in laboratory phonology I: Between the grammar and the physics of speech,* ed. by John Kingston & Mary Beckman, 283–333. Cambridge, UK: Cambridge University Press.

Clements, G. N. & K. C. Ford. 1979. Kikuyu tone shift and its synchronic consequences. *Linguistic inquiry* 10. 179-210.

Comrie, Bernard. 1976. *Aspect: An Introduction to the study of verbal aspect and related problems.* Cambridge University Press.

Connell, Bruce & D. Robert Ladd. 1990. Aspects of Pitch Realisation in Yoruba. *Phonology* 7. 1-29.

Crowhurst, Megan Jane. 1991. *Minimality and foot structure in metrical phonology and prosodic morphology.* University of Arizona dissertation.

Dahl, Osten. 1985. *Tense and aspect systems.* Oxford: Blackwell.

Daly, John P. 1978. Notes on Diuxi Mixtec tone. *Work Papers of the Summer Institute of Linguistics,* ed. by John P. Daly, 22, 98–113. Grand Forks: University of North Dakota.

Daly, John P. & Larry M. Hyman. 2007. On the representation of tone in Peñoles Mixtec. *International Journal of American Linguistics* 73. 165–207.

de Lacy, Paul. 1999. Tone and prominence. University of Massachusetts, ms. Online: http://roa.rutgers.edu/article/view/343.

de Lacy, Paul. 2002. The interaction of tone and stress in Optimality Theory. *Phonology* 19. 1.

León Pasquel, María de Lourdes de. 1988. *Noun and numeral classifiers in Mixtec and Tzotzil: A referential view.* University of Sussex dissertation.

DiCanio, Christian T. 2008. *The Phonetics and Phonology of San Martin Itunyoso Trique.* University of California, Berkeley dissertation.

DiCanio, Christian T. 2016. Abstract and concrete tonal classes in Itunyoso Triqui person morphology. *Tone and Inflection: New facts and new perspectives,* ed. by Enrique Palancar & Jean Léo Léonard, 227–268. Berlin & Boston: Mouton de Gruyter.

DiCanio, Christian, Hosung Nam, Douglas H. Whalen, H. Timothy Bunnell, Jonathan D. Amith & Rey Castillo García. 2013. Using automatic alignment to analyze endangered language data: Testing the viability of untrained alignment. *The Journal of the Acoustical Society of America* 134(3). 2235–2246.

DiCanio, Christian T., Jonathan Amith & Rey Castillo García. 2014. The phonetics of moraic alignment in Yoloxóchitl Mixtec. 4th International Symposium on Tonal Aspects of Languages (May 13-16, 2014). Nijmegen, The Netherlands.

DiCanio, Christian T., Joshua Benn & Rey Castillo García. 2018. The phonetics of information structure in Yoloxóchitl Mixtec. *Journal of Phonetics* 68. 50-68.

Dixon, R. M. W. 1977. Where have all the adjectives gone? *Studies in Language* 1. 19–80.

Dixon, R. M. W. 2006. Adjective classes in typological perspective. *Adjective Classes: A Cross-Linguistic Typology,* ed. by Robert M. W Dixon & Alexandra Y. Aikhenvald, 1–49. Oxford University Press.

Downing, Laura J. 1988. Tonology of noun-modifier phrases in Jita. *Studies in the Linguistic Sciences* 18(1). 25–60.

Downing, Laura J. 1990. *Problems in Jita tonology.* University of Illinois at Urbana-Champaign dissertation.

Downing, Laura J. 2010. Accent in African languages. *A Survey of Word Accentual Patterns in the Languages of the World,* ed. by Ellen van Zanten, Rob Goedemans & Harry van der Hulst, 381–427. Berlin: De Gruyter Mouton.

Dresher, B. Elan & Harry van der Hulst. 1998. Head–dependent asymmetries in phonology: Complexity and visibility. *Phonology* 15(3). 317–352.

Dryer, Matthew S. 1997. On the six-way word order typology. *Studies in language.* 21(1). 69–103.

Duanmu, San. 1994. Against Contour Tone Units. *Linguistic Inquiry* 25(4). 555-608.

Duanmu, San. 2016. *A Theory of Phonological Features.* Oxford University Press.

Dürr, Michael. 1987. A Preliminary reconstruction of the Proto-Mixtec tonal system. *Indiana: Contributions to the Ethnology and Archaeology, Linguistics, Social Anthropology, and History of Indigenous Latin America* 11. 19–60.

Dyk, Anne & Betty Stoudt. 1965. *Vocabulario mixteco de San Miguel el Grande.* (Vocabularios Indígenas Núm. 12.) México, D.F.: Instituto Lingüístico de Verano, A.C.

Egland, Steven. 1978. *La inteligibilidad interdialectal en México: Resultados de algunos sondeos.* México, D.F: Instituto Lingüístico de Verano.

Filemaker, Inc. 2012. *Bento v4.1.2.* Filemaker, Inc.

Fox, Anthony. 2000. *Prosodic features and prosodic structure: The phonology of suprasegmentals.* Oxford: Oxford University Press.

Gandour, J., S. Potisuk & S. Dechongkit. 1994. Tonal coarticulation in Thai. *Journal of Phonetics* 22. 477-92.

Gerfen, Chip. 1996. *Topics in the phonology and phonetics of Coatzospan Mixtec.* University of Arizona dissertation.

Gerfen, Chip & Kirk Baker. 2005. The production and perception of laryngealized vowels in Coatzospan Mixtec. *Journal of Phonetics* 33(3). 311-34.

Goldsmith, John A. 1976. *Autosegmental phonology.* Massachusetts Institute of Technology dissertation.

Goldsmith, John A. 1990. *Autosegmental and metrical phonology.* Cambridge, MA: Blackwell.

Gordon, Matthew. 2002. A factorial typology of quantity-insensitive stress. *Natural Language & Linguistic Theory* 20(3). 491–552.

Gordon, Matthew & Peter Ladefoged. 2001. Phonation types: A cross-linguistic overview. *Journal of Phonetics* 29(4). 383–406.

Gorman, Kyle. 2013. *Generative phonotactics.* University of Pennsylvania dissertation.

Halle, Morris. 1990. Respecting metrical structure. *Natural Language & Linguistic Theory* 8(2). 149–176.

Halle, Morris & Jean-Roger Vergnaud. 1987. *An Essay on Stress.* Cambrdige, MA: MIT Press.

Halliday, Michael Alexander Kirkwood. 1961. Categories of the theory of grammar. *Word* 17(3). 241–292.

Hammond, Michael Theodore. 1984. *Constraining Metrical Theory: A Modular Theory of Rhythm and Destressing.* University of California, Los Angeles dissertation.

Harris, John. 1997. Licensing inheritance: An integrated theory of neutralisation. *Phonology* 14(3). 315–370.

Harris, John. 2004. Release the captive coda: The foot as a domain of phonetic interpretation. *Phonetic Interpretation* (Papers in Laboratory Phonology), ed. by John Local, Richard Ogden & R. A. M. Temple, 103–129. Cambridge: Cambridge University Press.

Harris, John & Eno-Abasi Urua. 2001. Lenition degrades information: Consonant allophony in Ibibio. *Speech, Hearing and Language: Work in progress* 13. 72–105.

Harris, Larry & Mary Harris. 2006. Nuyoo Mixtec phonology. SIL International, ms.

Hayes, Bruce. 1980. *A metrical theory of stress rules.* Cambridge, MA: Massachusetts Institute of Technology dissertation.

Hayes, Bruce. 1985. Iambic and trochaic rhythm in stress rules. *Annual Meeting of the Berkeley Linguistics Society,* 11, 429–446. Berkeley: University of California.

Hayes, Bruce. 1987. A revised parametric metrical theory. ed. by J. McDonough & B. Plunkett. *Proceedings of NELS 17.* 274–189. Amherst, MA: GLSA.

Hayes, Bruce. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20(2). 253–306.

Hayes, Bruce. 1995. *Metrical Stress Theory: Principles and Case Studies.* Chicago: University of Chicago Press.

Hills, Robert A. 1990. A Syntactic Sketch of Ayutla Mixtec. *Studies in the syntax of Mixtecan languages,* ed. by C.H. Bradley & B.E. Hollenbach, 1–260. The Summer Institute of Linguistics and The University of Texas at Arlington.

Hinton, Leanne, Gene Buckley, Marv Kramer & Michael Meacham. 1991. Preliminary analysis of Chalcatongo Mixtec tone. *Papers from the American Indian Languages Conference, University of California, Santa Cruz, July and August 1991,* ed. by James E. Redden, 147-55. Carbondale: Southern Illinois University.

Hockett, Charles Francis. 1955. *A manual of phonology.* Baltimore: Waverly Press.

Holden, Kyril. 1976. Assimilation Rates of Borrowings and Phonological Productivity. *Language* 52(1). 131–147.

Holland, William R. 1959. Dialect Variations of the Mixtec and Cuicatec Areas of Oaxaca, Mexico. *Anthropological Linguistics* 1(18). 25–31.

Hollenbach, Barbara E. 1984. *The phonology and morphology of tone and laryngeals in Copala Trique.* University of Arizona dissertation.

Hollenbach, Barbara E. 1995. Semantic and syntactic extensions of body-part terms in Mixtecan: The case of 'face' and 'foot'. *International Journal of American Linguistics* 62(2). 168–190.

Hollenbach, Barbara E. 2003. The historical source of an irregular Mixtec tone-sandhi pattern. *Language and life: Essays in memory of Kenneth L. Pike,* ed. by Mary Ruth Wise, Thomas N. Headland & Ruth M. Brend, 533-50. Dallas: SIL International and University of Texas at Arlington.

Hollenbach, Barbara E. 2015. A preliminary reconstruction of Mixtec pronouns. SIL International, ms.

Hollenbach, Elena Erickson de. 2004. Los tonos del mixteco de Magdalena Peñasco. SIL International, ms. Online: http://www-01.sil.org/mexico/mixteca/magdalena-penyasco/G030-TonosMixtecoMP-xtm.htm.

Holsinger, David. 2000. *Lenition in Germanic: Prosodic templates in sound change.* University of Wisconsin Madison dissertation.

Holsinger, David. 2001. Weak position constraints: The role of prosodic templates in contrast distribution. *Zentrum für Allgemeine Sprachwissenschaft Papers in Linguistics,* ed. by Ewald Lang, Marzena Rochon, Kerstin Schwabe & Oliver Teuber, 19, 91–118. Berlin: Humboldt Universität.

Holsinger, David. 2008. Germanic prosody and consonantal strength. *Lenition and Fortition,* ed. by Joaquim Brandão de Carvalho, Tobias Scheer & Philippe Ségéral, 273–300. Berlin: Mouton De Gruyter.

Hombert, Jean-Marie. 1976. Noun classes and tone in Ngie. *Studies in Bantu Tonology,* ed. by Larry M. Hyman, 3, 3–21. Southern California Occasional Papers In Linguistics.

Hunter, Georgia G. & Eunice V Pike. 1969. The phonology and tone sandhi of Molinos Mixtec. *Linguistics* 7(47). 24-40.

Hyman, Larry M. 1970. The role of borrowing in the justification of phonological grammars. *Studies in African linguistics* 1(1). 1–48.

Hyman, Larry M. 1975. *Phonology: Theory and Analysis.* Holt McDougal.

Hyman, Larry M. 1978. Historical tonology. *Tone: A Linguistic Survey,* ed. by Victoria Fromkin, 257–269. New York: Academic Press.

Hyman, Larry M. 1985. *A thoery of phonological weight.* Dordrecht: Foris Publications.

Hyman, Larry M. 1987. Prosodic domains in Kukuya. *Natural Language & Linguistic Theory* 5(3). 311–333.

Hyman, Larry M. 1993. Register tones and tonal geometry. *The phonology of tone: The representation of tonal register,* ed. by Keith L Snider & Harry van der Hulst, 75–108. New York: Mouton De Gruyter.

Hyman, Larry M. 2001. Tone systems. *Language typology and language universals: An international Handbook,* ed. by M. Haspelmath, 1, 1367–1380. Mouton De Gruyter.

Hyman, Larry M. 2006. Word-prosodic typology. *Phonology* 23(2). 225-57.

Hyman, Larry M. 2007a. Kuki-Thaadow: An African tone system in Southeast Asia. University of California, Berkeley, ms. Online: http://www.linguistics.berkeley.edu/phonlab/annual_report/documents/2007/Hyman_KT_Tone_PL_Annual.pdf.

Hyman, Larry M. 2007b. Universals of tone rules: 30 years later. *Tones and tunes: Typological studies in word and sentence prosody,* ed. by Thomas Riad & Carlos Gussenhoven, 1, 1–34. Berlin: Mouton de Gruyter.

Hyman, Larry M. 2011a. Tone: Is it different? *The handbook of phonological theory,* ed. by John A Goldsmith & Jason Riggle, 2nd edition Edition. 197–239. Oxford: Blackwell.

Hyman, Larry M. 2011b. Does Gokana really have no syllables? Or: What's so great about being universal? *Phonology* 28(1). 55–85.

Hyman, Larry M. 2014. How to study a tone language. *Language Documentation & Conservation* 8. 525–562.

Hyman, Larry M. & William R. Leben. to appear. Word prosody II: Tone systems. *The Oxford handbook of prosody,* ed. by Carlos Gussenhoven & Aoju Chen, Oxford: Oxford University Press.

Hyman, L. M & R. G. Schuh. 1974. Universals of tone rules: Evidence from West Africa. *Linguistic Inquiry* 5(1). 81–115.

Hyman, Larry M. & Kenneth VanBik. 2004. Directional rule application and output problems in Hakha Lai tone. *Language and Linguistics* 5(4). 821–861.

Idsardi, William. 1991. Stress in Interior Salish. *Papers from the Twenty-seventh Regional Meeting, Chicago Linguistic Society,* 246–60. University of Chicago: Chicago Linguistic Society.

Instituto Nacional de las Lenguas Indígenas. 2008. Catálogo de las lenguas indígenas nacionales: Variantes lingüísticas de México con sus autodenominaciones y referencias geoestadísticas. Mexico: INALI. Online: http://www.inali.gob.mx/clin-inali/.

Instituto Nacional de Estadística y Geografía. 2010. Conteo de población y vivienda 2010. Instituto Nacional de Estadística y Geografía. Online: http://www.inegi.org.mx.

Inkelas, Sharon. 1989. *Prosodic constituency in the lexicon.* Stanford University dissertation.

Inkelas, Sharon & Draga Zed. 1990. Introduction. *The phonology-syntax connection,* ed. by Sharon Inkelas & Draga Zec, xiii–xv. University of Chicago Press.

Itô, Junko. 1986. *Syllable Theory in Prosodic Phonology.* University of Massachusetts Amherst dissertation.

Itô, Junko & Armin Mester. 2003 [1992]. Weak layering and word binarity. *A new century of Pphonology and phonological theory: A festschrift for Professor Shosuke Haraguchi on the occasion of his sixtieth birthday,* ed. by Takeru Honma, Masao Okazaki, Toshiyuki Tabata & Shin-ichi Tanaka, 26–65. Tokyo: Kaitakusha.

Itô, Junko & Armin Mester. 2007. Prosodic adjunction in Japanese compounds. *Formal approaches to Japanese linguistics,* ed. by Yoichi Miyamoto & Masao Ochi, 4, 97–111. Cambridge, MA: MITWPL.

Itô, Junko & Armin Mester. 2009a. The extended prosodic word. *Phonological domains: Universals and deviations,* ed. by Janet Grijzenhout & Baris Kabak, 135–194. Berlin: De Gruyter Mouton.

Itô, Junko & Armin Mester. 2009b. The onset of the prosodic word. *Phonological argumentation: Essays on evidence and motivation,* ed. by Steve Parker, 227–260. London: Equinox Publishing Ltd.

Itô, Junko & Armin Mester. 2013. Prosodic subcategories in Japanese. *Lingua* 124. 20–40.

Johnson, Audrey F. 1988. A Syntactic Sketch of Jamiltepec Mixtec. *Studies in the syntax of Mixtecan languages,* ed. by C.H. Bradley & B.E. Hollenbach, 11–150. The Summer Institute of Linguistics and The University of Texas at Arlington.

Johnson, Audrey F. & Sharon C. Stark. n.d. San Juan Colorado Phonology. SIL, ms.

Josserand, J. Kathryn. 1983. *Mixtec dialect history.* Tulane University dissertation.

Kager, René. 1989. *A metrical theory of stress and destressing in English and Dutch.* Dordrecht: Foris Publications.

Kager, René. 1993. Alternatives to the iambic-trochaic law. *Natural Language & Linguistic Theory* 11(3). 381–432.

Kager, René. 1995. The metrical theory of word stress. *The handbook of phonological theory,* ed. by John A. Goldsmith, 367–402. Cambridge, MA; Oxford, UK: Blackwell Publishers.

Kager, René. 1999. *Optimality theory.* Cambridge, U.K. & New York: Cambridge University Press.

Kager, René. 2007. Feet and metrical stress. *The Cambridge handbook of phonology,* ed. by Paul de Lacy, 195–227. Cambridge: Cambridge University Press.

Kang, Yoonjung. 2011. Loanword phonology. *The Blackwell companion to phonology,* ed. by Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume & Keren Rice, 4, 2258–2282. Wiley-Blackwell.

Kaufman, Terrence. 2006. Oto-Mangean Languages. *Encyclopedia of language & linguistics,* ed. by Keith Brown, 2nd edition Edition. 118-24. Oxford: Elsevier.

Kaufman, Terrence & John Justeson. 2009. Historical linguistics and Pre-Columbian Mesoamerica. *Ancient Mesoamerica* 20(2). 221-31.

Kenstowicz, Michael J. 1993. Evidence for metrical constituency. *The view from building 20: Essays in linguistics in honor of Sylvain Bromberger,* ed. by Kenneth L. Hale, Samuel Jay Keyser & Sylvain Bromberger, 257–273. MIT Press.

Kenstowicz, Michael J. 2007. Salience and similarity in loanword adaptation: a case study from Fijian. *Language Sciences* 29(2). 316–340.

Kiparsky, P. 1979. Metrical structure assignment is cyclic. *Linguistic Inquiry* 10(3). 421–441.

Kiparsky, P. 1982. Lexical phonology and morphology. *Linguistics in the morning calm,* ed. by I. S. Yang, 3–91. Seoul: Hanshin Publishing Co.

Kiparsky, P. 1985. Some consequences of lexical phonology. *Phonology Yearbook* 2. 85–138.

Kumagai, Gakuji. 2016. Recursive feet and hidden phonology: The case of Fijian. ed. by Hiroki Nomoto, Takuya Miyauchi & Asako Shiohara. *AFLA23: The Proceedings of the 23rd Meeting of the Austronesian Formal Linguistics Association.* 123–137. Canberra, Australia: Asia-Pacific Linguistics.

Kuznetsova, Alexandra, Per Bruun Brockhoff & Rune Haubo Bojesen Christensen. 2016. *lmerTest: Tests in Linear Mixed Effects Models [Computer program].* (R package version 2.0-33.) Online: https://CRAN.R-project.org/package=lmerTest.

Ladd, D. Robert. 1986. Intonational phrasing: The case for recursive prosodic structure. *Phonology Yearbook* 3. 311–340.

Ladd, D. Robert. 2008. *Intonational phonology.* 2nd edition Edition. (Cambridge studies in linguistics, 79.) Cambridge University Press.

Ladd, D. Robert. 2014. *Simultaneous structure in phonology.* Oxford; New York: Oxford University Press.

Ladefoged, Peter. 2003. *Phonetic data analysis: An introduction to fieldwork and instrumental techniques.* Blackwell.

Laniran, Yetunde Ọlabisi. 1992. *Intonation in tone languages: The phonetic implementation of tones in Yoruba.* New York: Cornell University dissertation.

Laniran, Y. O. & G. N. Clements. 2003. Downstep and high raising: Interacting factors in Yoruba tone production. *Journal of Phonetics* 31. 203-50.

Leben, William Ronald. 1973. *Suprasegmental phonology.* Massachusetts Institute of Technology dissertation.

Leben, William Ronald. 1978. The representation of tone. *Tone: A Linguistic Survey,* ed. by Victoria A. Fromkin, 177–219. New York: Academic Press.

Leben, William Ronald. 2002. Tonal feet. *Typology of African prosodic systems* (Bielefeld Occasional Papers in Typology 1), ed. by Ulrike Gut & Dafydd Gibbon, 27–40. Universität Bielefeld.

Leben, William Ronald. 2003. Tonal Feet as Tonal Domains. *Linguistic typology and representation of African languages* (Trends in African Linguistics 5), ed. by John M. Mugane, 129–138. Trenton, NJ: African World Press, Inc.

Lehiste, Ilse. 1970. *Suprasegmentals.* Cambridge, MA: MIT Press.

Liberman, Mark Yoffe. 1975. *The intonational system of English.* Massachusetts Institute of Technology dissertation.

Liberman, Mark & Janet Pierhumbert. 1984. Intonational invariance under changes in pitch range and length. *Language sound structure,* ed. by M. Arnoff & R. Oerhle, 157–233. Cambridge, MA: MIT Press.

Liberman, Mark & Alan Prince. 1977. On stress and linguistic rhythm. *Linguistic inquiry* 8(2). 249-336.

Longacre, Robert E. 1955. *Proto-Mixtecan.* University of Pennsylvania dissertation.

Macaulay, M. 1987a. Cliticization and the morphosyntax of Mixtec. *IJAL* 53. 119–135.

Macaulay, M. 1987b. *Morphology and cliticization in Chalcatongo Mixtec.* University of California, Berkeley dissertation.

Macaulay, M. 1990. Negation and mood in Mixtec: Evidence from Chalcatongo. *Anthropological Linguistics* 32(3/4). 211–227.

Macaulay, M. 1996. *A grammar of Chalcatongo Mixtec.* (University of California Publications in Linguistics 127.) Berkeley: University of California Press.

Macaulay, Monica & Joseph C. Salmons. 1995. The Phonology of glottalization in Mixtec. *International Journal of American Linguistics* 61(1). 38–61.

Macken, Marlys A. 1996. Prosodic Constraints on features. ed. by Barbara Bernhardt, John Gilbert, and David Ingram. *Proceedings of the UBC international conference on phonological acquisition.* 159–172. Somerville, MA: Cascadilla Press.

Macken, Marlys A. & Joseph C. Salmons. 1997. Prosodic templates in sound change. *Diachronica* 14(1). 31–66.

Maddieson, Ian. 1984. *Patterns of Sounds.* Cambridge: Cambridge University Press.

Mak, Cornelia. 1950. A unique tone perturbation in Mixteco. *International Journal of American Linguistics* 16(2). 82-86.

Mak, Cornelia. 1953. A comparison of two Mixtec tonemic systems. *International Journal of American Linguistics* 19(2). 85-100.

Mak, Cornelia. 1958. The tonal system of a third Mixtec dialect. *International Journal of American Linguistics* 24(1). 61-70.

Mak, Cornelia & Robert Longacre. 1960. Proto-Mixtec phonology. *International Journal of American Linguistics* 26(1). 23-40. Online: http://www.jstor.org/stable/1263729.

Marlett, Stephen A. 1992. Nasalization in Mixtec languages. *International Journal of American Linguistics* 58. 425–435.

Martínez-Paricio, Violeta. 2013. *An exploration of minimal and maximal metrical feet.* University of Tromsø dissertation.

Max Planck Institute for Psycholinguistics. 2017. *ELAN Linguistic Annotator v4.6.2.* Nijmegen, The Netherlands: Max Planck Institute for Psycholinguistics. Online: http://tla.mpi.nl/tools/tla-tools/elan/.

McCarthy, John J. & Alan Prince. 1996 [1986]. Prosodic morphology 1986. Rutgers University Center for Cognitive Science, ms. Online: http://works.bepress.com/john_j_mccarthy/54/.

McCarthy, John J. & Alan Prince. 1990a. Foot and word in prosodic morphology: The Arabic broken plural. *Natural Language & Linguistic Theory* 8(2). 209–283.

McCarthy, John J. & Alan Prince. 1990b. Prosodic morphology and templatic morphology. *Perspectives on Arabic linguistics: Papers from the second symposium,* ed. by M. Eid & John McCarthy, 1–54. Amsterdam: Benjamins.

McCarthy, John J. & Alan Prince. 1993. Generalized alignment. *Yearbook of Morphology 1993,* ed. by Geert Booij & Jaap Marle, 79–153. Dordrecht: Kluwer.

McCarthy, John J. & Alan Prince. 1995. Prosodic morphology. *The handbook of phonological theory,* ed. by John Goldsmith, 318–366. Cambridge, MA: Blackwell Publishers.

McCawley, James D. 1978. What is a tone language. *Tone: A linguistic survey,* ed. by Victoria A. Fromkin, 113–131. New York: Academic Press, Inc.

McKendry, Inga. 2013. *Tonal association, prominence and prosodic structure in South-eastern Nochixtlán Mixtec.* University of Edinburgh dissertation.

Mel′čuk, Igor. 2001. *Communicative organization in natural language: The semantic-communicative structure of sentences.* Amsterdam & Philadelphia: J. Benjamins.

Mel′čuk, Igor. 2006. *Aspects of the theory of morphology.* Berlin: Mouton de Gruyter.

Merrifield, William R. 1992. Concerning Otomanguean verbs of motion. *Language in context: Essays for Robert E. Longacre* (Publications in Linguistics 107), ed. by Shin Ja J. Hwang & William R. Merrifield, 475–497. Dallas: Summer Institute of Linguistics and University of Texas at Arlington.

Mohanan, K. P. 1982. *Lexical phonology.* Massachusetts Institute of Technology dissertation.

Morén, Bruce & Elizabeth Zsiga. 2006. The lexical and post-lexical phonology of Thai tones. *Natural Language & Linguistic Theory* 24(1). 113–78.

Murray, Robert W. & Theo Vennemann. 1983. Sound change and syllable structure in Germanic phonology. *Language* 59(3). 514–528.

Nespor, Marina. 1991. The phonology of clitic groups. *Clitic doubling and clitic groups,* ed. by Lars Hellan & Henk van Riemsdijk, 5, 67–90. ESF-Eurotyp Working Papers.

Nespor, Marina & Irene Vogel. 2007 [1986]. *Prosodic phonology.* 2nd Edition. (Studies in Generative Grammar 28.) Berlin & New York: Walter de Gruyter.

Nordell, Norman. 1984. Spanish loan words via Aztec. *SIL-Mexico Workpapers,* V, 9–23. Summer Institute of Linguistics.

North, J. & Shields, J. 1977. Silacayoapan mixtec phonology. *Studies in Otomanguean phonology,* ed. by William R. Merrifield, 21–33. Dallas: Summer Institute of Linguistics and The University of Texas at Arlington.

Ohala, John J. 1974. Experimental historical phonology. *Historical linguistics,* ed. by John M. Anderson & Charles Jones, 2, 353–387. Amsterdam: North-Holland.

Ohala, John J. 1981. The listener as a source of sound change. ed. by Carrie S. Masek, Roberta A. Hendrick & Mary Frances Miller. *Papers from the parasession on language and behavior (Chicago Linguistics Society.* 178–203. Chicago: Chicago Linguistics Society.

Oostendorp, Marc van. 2013. σ strikes back: A defense of headedness and constituency in phonology. *The Linguistic Review* 30(2). 347–371.

Overholt, E. 1961. The tonemic system of Guerrero Mixteco. *A William Cameron Townsend en el vigésimoquinto aniversario del Instituto Lingüístico de Verano,* ed. by Ben Elson & Juan Comas, 597–626. México, D.F.

Pankratz, L. & E. V. Pike. 1967. Phonology and morphotonemics of Ayutla Mixtec. *International Journal of American Linguistics* 33(4). 287-99.

Paster, Mary E. 2006. *Phonological conditions on affixation.* University of California, Berkeley dissertation.

Paster, Mary & R. B de Azcona. 2005. A phonological sketch of the Yucunany dialect of Mixtepec Mixtec. ed. by Lea Harper and Carmen Jany. *Proceedings of the Seventh Annual Workshop on American Indigenous Languages.* 61–76. UC Santa Barbara.

Paulian, Christiane. 1975. *Le Kukuya: Langue teke du Congo: Phonologie, classes nominales.* Paris: S.E.L.A.F.

Penner, Kevin L. 2014. Adjectives in Ixtayutla Mixtec. University of Alberta, ms.

Pensinger, Brenda J. 1974. *Diccionario mixteco-español, español-mixteco: Mixteco del este de Jamiltepec, pueblo de Chayuco.* (Vocabularios Indígenas Núm. 18.) México, D.F.: Instituto Lingüístico de Verano.

Pierrehumbert, Janet Breckenridge. 1980. *The phonology and phonetics of English intonation.* Massachusetts Institute of Technology dissertation.

Pierrehumbert, Janet & Jill Beckman. 1988. *Japanese tone structure.* 15. (Linguistic inquiry monographs.) Cambridge, MA: MIT Press.

Pike, Eunice V. & Cowan, John H. 1967. Huajuapan Mixtec phonology and morphophonemics. *Anthropological Linguistics* 9. 1–15.

Pike, E. V. & T. Ibach. 1978. The phonology of the Mixtepec dialect of Mixtec. *Linguistic and literary studies in honor of Archibald A. Hill,* ed. by Mohammed Jazayery, Edgar C. Polomé & Werner Winter, 2, 271–285. The Hague: Mouton De Gruyter.

Pike, Eunice V. & Joy Oram. 1976. Stress and tone in the phonology of Diuxi Mixtec. *Phonetica* 33(5). 321-33.

Pike, E. V. & P. Small. 1974. Downstepping terrace tone in Coatzospan Mixtec. *Advances in Tagmemics,* ed. by Ruth M. Brend, 105–134. North-Holland: New York.

Pike, Eunice V. & K. Wistrand. 1974. Step-up terrace tone in Acatlán Mixtec (Mexico). *Advances in tagmemics,* ed. by Ruth M. Brend, 81-104. New York: North-Holland.

Pike, Kenneth L. 1944. Analysis of a Mixteco text. *International Journal of American Linguistics* 10(4). 113-38.

Pike, Kenneth L. 1945. Tone puns in Mixteco. *International Journal of American Linguistics* 11(3). 129-39.

Pike, Kenneth L. 1947. Grammatical prerequisites to phonemic analysis. *Word* 3. 155-72.

Pike, Kenneth L. 1948. *Tone languages: A technique for determining the number and type of pitch contrasts in a language, with studies in tonemic substitution and fusion.* Ann Arbor, Michigan: University of Michigan Press.

Pike, Kenneth L. 1967. *Language in relation to a unified theory of the structure of human behavior.* The Hague; Paris: Mouton & Co.

Pike, Kenneth L. 1970. *Tagmemic and matrix linguistics applied to selected African languages.* Norman, Oklahoma: Summer Institute of Linguistics of the University of Oklahoma Norman.

Prince, Alan. 1976. Applying stress. University of Massachusetts Amherst, ms.

Prince, Alan. 1983. Relating to the grid. *Linguistic Inquiry* 14(1). 19–100.

Prince, Alan. 1985. Improving tree theory. *Proceedings of the Eleventh Annual Meeting of the Berkeley Linguistics Society,* 11, 471–490. Berkeley, CA: Berkeley Linguistics Society.

Prince, Alan. 1991 [1990]. Quantitative Consequences of Rhythmic Organization. *Papers from the 26th Regional Meeting of the Chicago Linguistic Society,* ed. by Michael Ziolowski, Manuela Noske & Karen Deaton, 355–398. Chicago: Chicago Linguistic Society.

Pulleyblank, Douglas. 1986. *Tone in Lexical Phonology.* Dordrecht: Reidel.

R Core Team. 2017. R: A language and environment for statistical computing. Online: http://www.R-project.org.

Rensch, Calvin R. 1976. *Comparative Otomanguean phonology.* Bloomington: Indiana University Publications.

Rensch, Calvin R. 1977. Classification of the Otomanguean languages and the position of Tlapanec. *Two studies in Middle American comparative linguistics,* 53–108. Dallas, TX: Summer Institute of Linguistics/University of Texas at Arlington.

Rice, Keren. 1990. Prosodic constituency in Hare (Athapaskan): Evidence for the foot. *Lingua* 82(2). 201–245.

Samuels, Bridget D. 2009. *The structure of phonological theory.* Harvard University dissertation.

Selkirk, Elisabeth O. 1980a. *On prosodic structure and its relation to syntactic structure.* Bloomington, Indiana: Indiana University Linguistics Club.

Selkirk, Elisabeth O. 1980b. The role of prosodic categories in English word stress. *Linguistic Inquiry* 11(3). 563-605.

Selkirk, Elisabeth O. 1980c. Prosodic domains in phonology: Sanskrit revisited. *Juncture,* ed. by Mark Aronoff & Mary-Louise Kean, 107–129. Saratoga, CA: Anma Libri.

Selkirk, Elisabeth O. 1981. On the nature of phonological representation. *Advances in Psychology,* ed. by Terry Myers, John Laver & John Anderson, 7, 379-88. North-Holland.

Selkirk, Elisabeth O. 1984. *Phonology and syntax: The relation between sound and structure.* Cambridge, Mass. & London: MIT Press.

Selkirk, Elisabeth O. 1986. On derived domains in sentence phonology. *Phonology* 3(1). 371–405.

Selkirk, Elisabeth O. 1996. The prosodic structure of function words. *Signal to syntax: Bootstrapping from speech to grammar in early acquisition,* ed. by James L. Morgan & Katherine Demuth, 187–214. Lawrence Erlbaum.

Selkirk, Elisabeth O. 2011. The syntax-phonology interface. *The handbook of phonological theory,* ed. by John Goldsmith, Jason Riggle & Alan Yu, 2nd edition Edition. 563–623. Oxford: Wiley-Blackwell.

SIL International. 2017. *Fieldworks language explorer v8.39.* SIL International. Online: https://software.sil.org/fieldworks/.

SIL International. 2015. *Phonology assistant v3.62.* SIL International. Online: https://software.sil.org/phonologyassistant/.

Silverman, Daniel. 1992. Multiple scansions in loanword phonology: Evidence from Cantonese. *Phonology* 9(2). 289–328.

Silverman, Daniel. 1993. Labiality in Mixtecan — A unified treatment. *UCLA occasional papers in linguistics, No. 13,* ed. by Daniel Silverman, 109–123. Los Angeles: Linguistics Department, UCLA.

Silverman, Daniel. 1995. *Phasing and recoverability.* University of California Los Angeles dissertation.

Silverman, Daniel. 1997. Laryngeal complexity in Otomanguean vowels. *Phonology* 14(2). 235–261.

Silverman, Daniel. 2000. Dynamic versus static constraints in English truncation. *Proceedings of the 19th West Coast Conference on Formal Linguistics,* 466–478. Somerville, MA: Cascadilla. Online: http://www.seedyroad.com/academics/WCCFL19.pdf.

Simons, Gary F. & Charles D. Fennig. 2018. *Ethnologue: Languages of the world.* Twenty-first Edition. Dallas, Texas: SIL International. Online: http://www.ethnologue.com.

Simpson, Andrew Kingsbury. 2009. *The origin and development of nonconcatenative morphology.* University of California, Berkeley dissertation.

Smith, Laura Catharine. 2004. *Cross-level interactions in West Germanic phonology and morphology.* University of Wisconsin Madison dissertation.

Smith, Laura Catharine. 2007. The resilience of prosodic templates in the history of West Germanic. *Historical linguistics 2005,* ed. by Joseph C. Salmons & Shannon Dubenion-Smith, 351–366. Amsterdam & Philadelphia: John Benjamins Pub. Co.

Smith, Laura Catharine. 2009. Dialect variation and the Dutch diminutive: The role of prosodic templates. *Historical linguistics 2007: Selected papers from the 18th international conference on historical linguistics, Montreal, 6-11 August 2007,* ed. by Etleva Vocaj, Fernande Dupuis & Monique Dufresne, 37–46. Amsterdam: John Benjamins Publishing Co.

Smith, Laura Catharine & Adam Ussishkin. 2015. The role of prosodic templates in diachrony. *The oxford handbook of historical phonology,* ed. by Patrick Honeybone & Joseph C. Salmons, 262–285. Oxford: Oxford University Press.

Snider, Keith L. 1990. Tonal Upstep in Krachi: Evidence for a register tier. *Language* 66. 3.

Snider, Keith L. 1998. Phonetic realisation of downstep in Bimoba. *Phonology* 15. 1.

Snider, Keith L. 1999. *The geometry and features of tone.* Dallas: Summer Institute of Linguistics.

Snider, Keith L. 2014. On establishing tonal contrast. *Language Documentation & Conservation* 8. 707–737. Online: http://hdl.handle.net/10125/24622.

Snider, Keith L. 2017. *Tone analysis for field linguists.* Dallas: Summer Institute of Linguistics, Academic Publications.

Stark, Donald S. 1947. Mixteco: Complex phonemes. *Aboriginal linguistics* 1(1). 10–15.

Stark, Sharon C., Audrey P. Johnson & Benita González de Gúzmon. 2003. *Diccionario básico del mixteco de Xochapa, Guerrero.* Instituto Lingüístico de Verano. Online: http://www-01.sil.org/acpub/repository/P004-DiccXochapa-xta.pdf.

Suárez, Jorge A. 1983. *The Mesoamerican Indian Languages.* Cambridge University Press.

Ternes, Elmar. 1973. *The phonemic analysis of Scottish Gaelic: Based on the dialect of Applecross, Ross-shire.* (Forum Phoneticum, 1.) Hamburg: Helmut Buske.

Thomas, Elaine. 1974. Engenni. *Ten Nigerian tone systems,* ed. by John Bendor-Samuel, 4, 13–26. Dallas and Arlington: Summer Institute of Linguistics and University of Texas Press.

Towne, Douglas. 2011. *Gramática popular del tacuate (mixteco) de Santa María Zacatepec, Oaxaca.* (Serie de gramáticas de lenguas indígenas de México Núm. 12.) Instituto Lingüístico de Verano.

Traill, Anthony. 1985. *Phonetic and phonological studies of Xoo Bushman.* Johannesburg, South Africa: University of the Witwatersrand dissertation.

Tranel, Bernard. 1995a. Rules vs. constraints: A case study. Current trends in phonology: Models and methods, June 19-21. Royaumont, France.

Tranel, Bernard. 1995b. On the status of universal association conventions: Evidence from Mixteco. *Proceedings of the Berkeley Linguistics Society,* ed. by J. Ahlers, L. Bilmes, J. Guenter & J. Namkung, 21, 299-312.

van der Hulst, Harry & Norval Smith. 1982. Prosodic domains and opaque segments in autosegmental theory. *The structure of phonological representations (Part II),* ed. by Harry van Der Hulst & Norval Smith, 311–336. Dordrecht: Foris.

Vaysman, Olga. 2009. *Segmental alternations and metrical theory.* Massachusetts Institute of Technology dissertation.

Vennemann, Theo. 1988. *Preference laws for syllable structure and the explanation of sound change with special reference to German, Germanic, Italian, and Latin.* New York: Walter de Gruyter.

Vihman, Marilyn May & Tamar Keren-Portnoy. 2013. Introduction: The emergence of phonology: Whole-word approaches, cross-linguistic evidence. *The emergence of phonology: Whole-word approaches and cross-linguistic evidence,* ed. by Marilyn May Vihman & Tamar Keren-Portnoy, 1–14. Cambridge University Press.

Williams, John L. 1996. Tezoatlan Mixtec motion and arrival verbs. *International Journal of American Linguistics* 62(3). 289–305.

Wilkinson, Karina. 1988. Prosodic structure and Lardil phonology. *Linguistic Inquiry* 19(2). 325–334.

Xu, Yi. 2013. ProsodyPro—A tool for large-scale systematic prosody analysis. *Proceedings of tools and resources for the analysis of speech prosody (TRASP 2013), Aix-en-Provence, France. 7-10.* 7–10. Online: http://www.phon.ucl.ac.uk/home/yi/ProsodyPro/.

Xu, Yi. 2001. Sources of tonal variations in connected speech. *Journal of Chinese Linguistics* 17. 1–31. Online: http://www.phon.ucl.ac.uk/home/yi/sources.html.

Xu, Yi. 1999. Effects of tone and focus on the formation and alignment of f0 contours. *Journal of Phonetics* 27(1). 55-105.

Xu, Yi. 1997. Contextual tonal variations in Mandarin. *Journal of Phonetics* 25. 61-84.

Xu, Yi. 1993. *Contextual tonal variation in Mandarin Chinese.* University of Connecticut dissertation.

Xu, Y. & Q. Emily Wang. 2001. Pitch targets and their realization: Evidence from Mandarin Chinese. *Speech communication* 33(4). 319-37.

Zec, Draga. 1989. *Sonority constraints on prosodic structure.* Stanford University dissertation.

Zylstra, Carol F. 1980. Phonology and morphophonemics of the Mixtec of Alacatlazala, Guerrero. *SIL Mexico Workpapers* 4. 15–42.

Zylstra, Carol F. 1991. A syntactic sketch Of Alacatlatzala Mixtec. *Studies in the syntax of Mixtecan languages,* ed. by C.H. Bradley & B.E. Hollenbach, 1–178. The Summer Institute of Linguistics and The University of Texas at Arlington.

Appendix A

# The Single Word production experiment

This appendix describes the method employed in the Single Word production experiment. This experiment examines single words pronounced in isolation with the primary goal of investigating the general acoustic properties of IM vowels (cf. §3.1) and tonal melodies (cf. Chapter 4). The main part of the experiment, consisting of 108 words, was conducted in 2011; the second part, consisting of 12 additional words, was conducted in 2012.

## A.1 Subjects

The main experiment had nine participants, four female speakers and five male speakers, ranging in age from 19 to 34. All were native speakers of IM, living in the municipality of Santiago Ixtayutla (Oaxaca, Mexico). In 2012, 12 more items were added to the experiment using the same participants except that a 56 year old male was substituted for a 27 year old male from the 2011 study, and an 18 year old female participant was added.

## A.2 Materials

The main experiment had 108 stimuli. In keeping with the goal of providing a description of the general acoustic properties of IM vowels, the stimuli for the experiment included each of the six IM vowel phonemes (cf. §3.1)—/i, e, a, ɨ, o, u/—in a variety of contexts, including the initial and final syllables of CVCV couplets, the initial syllable of VCV couplets, in CVV couplets and in CVˀV couplets. Stimuli were chosen that had each vowel in the initial (stressed) and second (unstressed) vowel positions in CVCV couplets following both the coronal consonant /t/ and the dorsal consonant /k/, where native words could be found. In addition, stimuli were also chosen that had each vowel in the initial position of VCV couplets. The CVCV contexts are illustrated with stimuli from the experiment in Table 73 for the stressed syllable and Table 74 for the unstressed syllable. A word with /e/ following /t/ was not found so a word with an initial /$^{n}$d/ was used instead. The gap for /e/ in the second syllable following /t/ is an oversight in the experiment design. Examples of VCV stimuli are given in Table 75.

Table 73. Stimuli with stressed short vowels preceded by /t/ and /k/ in CVCV couplets

| **Vowel** | **ˈ*t*_CV** | | **ˈ*k*_CV** | |
|---|---|---|---|---|
| /**i**/ | ˈ*títʃî* | ‘stomach’ | ˈ*kítʃî* | ‘to come:IRR’ |
| /**e**/ | ˈ$^{n}$*dèkū* | ‘Douglas’ | ˈ*ketà* | ‘to go out’ |
| /**a**/ | ˈ*táká* | ‘nest’ | ˈ*katà* | ‘itch’ |
| /**ɨ**/ | ˈ*tɨ́kà* | ‘grasshopper’ | ˈ*kɨtɨ̀* | ‘animal’ |
| /**o**/ | ˈ*tókò* | ‘crotch’ | ˈ*kotò* | ‘to know:IRR’ |
| /**u**/ | ˈ*tukù* | ‘also’ | ˈ*kútú* | ‘to be full:IRR’ |

Table 74. Stimuli with unstressed short vowels preceded by /t/ and /k/ in CVCV couplets

| **Vowel** | **ˈCV*t*_** | | **ˈCV*k*_** | |
|---|---|---|---|---|
| /**i**/ | ˈ*ítí* | ‘cornfield=1S’ | ˈ*tʃikì* | ‘fist’ |
| /**e**/ | | | ˈ*tɨ́ké* | ‘grasshopper’ |
| /**a**/ | ˈ*katà* | ‘itchy’ | ˈ*táká* | ‘nest’ |
| /**ɨ**/ | ˈ*kɨtɨ̀* | ‘animal’ | ˈ$^{n}$*dikɨ̀* | ‘horn’ |
| /**o**/ | ˈ*kotò* | ‘to know:IRR’ | ˈ*tokò* | ‘crotch’ |
| /**u**/ | ˈ*kútú* | ‘to be full:IRR’ | ˈ*tukù* | ‘also’ |

The stimuli also included plain and glottalized long vowels—CVV and CV$^{ʔ}$V couplets, respectively (cf. §3.1, §6.2.1). These stimuli were preceded by an onset consonant of either /t/, /$t^{j}$/ or /k/, where examples words could be found, as shown in Table 75, which also includes examples of VCV stimuli.

Table 75. Stimuli with long vowels (plain and glottalized) and VCV couplets

| **Vowel** | **ˈCVV** | | **ˈCVˀV** | | **ˈ_CV** | |
|---|---|---|---|---|---|---|
| **/i/** | *ˈtʲii̇̀* | ‘to get wet’ | *ˈtʲiˀì* | ‘to put in’ | *ˈítú* | ‘corn.field’ |
| **/e/** | *naˈkeè* | ‘to pull back’ | *ˈkeˀè* | ‘to touch:REAL’ | *ˈèkū* | ‘Regulo’ |
| **/a/** | *ˈkáà* | ‘metal’ | *ˈkàˀā* | ‘inexpensive’ | *ˈàkú* | ‘Marcos’ |
| **/ɨ/** | *ˈtɨɨ̀* | ‘tight’ | *ˈtɨˀɨ̀* | ‘bump’ | *ˈɨ̀tɨ̄* | ‘short’ |
| **/o/** | *ˈkóó* | ‘snake’ | *ˈkóˀó$^L$* | ‘bowl’ | *ˈókó* | ‘twenty’ |
| **/u/** | *ˈkúú* | ‘die:irr’ | *ˈkúˀú$^L$* | ‘brush’ | *ˈútù* | ‘buddy’ |

With respect to tone, at least one example of CVCV and CVV couplets with each tonal melody found on noun couplets (/L/, /H/, /H$^L$/, /HL/, /$^L$HL/, /$^L$H/, /L$^H$/) (cf. §4.1) was represented in the wordlist. All melodies except the /$^L$HL/ melody were also represented by a CVˀV couplet. Only the /H/, /H$^L$/, /HL/ and /$^L$HL/ melodies were represented by a (C)VˀCV couplet. Examples of stimuli representing each melody are presented in Table 76 by couplet type. The lack of CVˀV stimuli with the /$^L$HL/ melody is due to a gap in the data; however, the lack of (C)VˀCV stimuli with the /L/, /$^L$H/ and /L$^H$/ melodies are an oversight in the experimental design.

Table 76. Stimuli representing each tonal melody by couplet type

| | **CVCV** | **CVV** | **CVˀV** | **(C)VˀCV** |
|---|---|---|---|---|
| **/L/** | *tʃikì* ‘fist’ | *ⁿdoò* ‘to be clean’ | *koˀò* ‘wide opening’ | |
| **/H/** | *tʃítɨ́* ‘seed’ | *ɲṹṹ* ‘town’ | *ɲṹˀṹ* ‘fire’ | *úˀβí* ‘hurt’ |
| **/H$^L$/** | *tʃítɨ́$^L$* ‘knee’ | *ⁿdóó$^L$* ‘sugar cane’ | *kóˀó$^L$* ‘bowl’ | *ɲṹˀmã́$^L$* ‘smoke’ |
| **/HL/** | *tɨ́kà* ‘grasshopper’ | *ⁿdóò* ‘to remain’ | *ⁿdóˀò* ‘adobe’ | *ⁿdɨ́ˀjɨ̀* ‘pimple’ |
| **/$^L$HL/** | *$^L$tʃókò* ‘opossum’ | *$^L$pîi* ‘turkey hen’ | | *$^L$lɨ́ˀjɨ̀* ‘chick’ |
| **/$^L$H/** | *kùtʃí* ‘pig’ | *ⁿdʲòó* ‘god’ | *kòˀó* ‘let’s go’ | |
| **/L$^H$/** | *kòtȭ* ‘shirt’ | *ɲũ̀ũ̄* ‘night’ | *kàˀā* ‘inexpensive’ | |

The stimuli for this experiment also included a number of minimal tone sets (i.e. sets of words with identical segments but contrastive tonal melodies), which are given in (300).

(300) Minimal tone sets

a. /L/ *tʃikì* ‘fist’
/H$^{L}$/ *tʃíkí*$^{L}$ ‘hill’
b. /H/ *tʃɨ́tɨ́* ‘seed’
/H$^{L}$/ *tʃɨ́tɨ́*$^{L}$ ‘knee’
c. /L/ *isà* ‘immature corn’
/H/ *ísá* ‘loom’
/L$^{H}$/ *ìsā* ‘day after tomorrow’
d. /L/ *koˀò* ‘wide opening’
/H$^{L}$/ *kóˀó* ‘bowl’
/$^{L}$H/ *kòˀó* ‘let’s go’
e. /H$^{L}$/ *$^{n}$dɨ́βɨ́*$^{L}$ ‘egg’
/L$^{H}$/ *$^{n}$dɨ̀βɨ̄* ‘chicken’
f. /L/ *$^{n}$doò* ‘clean’
/H$^{L}$/ *$^{n}$dóó*$^{L}$ ‘sugar cane’
/HL/ *$^{n}$dóò* ‘to remain’
g. /H$^{L}$/ *$^{n}$dóˀó*$^{L}$ ‘woven basket’
/HL/ *$^{n}$dóˀò* ‘adobe’
h. /H/ *ɲṹṹ* ‘town’
/L$^{H}$/ *ɲũ̀ũ̄* ‘night’
i. /L/ *ɲũˀũ̀* ‘ground’
/H/ *ɲṹˀṹ* ‘fire’
/HL/ *ɲṹˀũ̀* ‘mountain spirit’
j. /L/ *sukũ̀* ‘to stick’
/H$^{L}$/ *súkṹ*$^{L}$ ‘throat, neck’
/L$^{H}$/ *sùkũ̄* ‘tall’
k. /H/ *tʲókó* ‘wasp’
/HL/ *tʲókò* ‘ant’
l. /HL/ *βíʃì* ‘grey hair’
/$^{L}$HL/ *$^{L}$βíʃì* ‘squirrel’
m. /L/ *jaβì* ‘agave’
/H/ *jáβí* ‘hole?'

A number of minimal glottalization sets (i.e. words which differed minimally by the presence or absence of contrastive vowel glottalization, cf. §6.3.1) were also included, and are shown in (301).

(301) Minimal glottalization sets

| | **Plain** | **Glottalized** |
|---|---|---|
| a. | *káà* ‘metal’ | *kàˀā* ‘inexpensive’ |
| b. | *nã̀keè* ‘to stretch’ | *keˀè* ‘to touch’ |
| c. | *kóó*$^{L}$ ‘snake’ | *kóˀó*$^{L}$ ‘bowl’ |
| d. | *kúú* ‘die:IRR’ | *kúˀú*$^{L}$ ‘brush’ |
| e. | $^{n}$*daà* ‘going up’ | $^{n}$*daˀà* ‘hand’ |
| f. | $^{n}$*dɨ́ɟɨ̀* ‘corpse’ | $^{n}$*dɨ́ˀɟɨ̀* ‘pimple’ |
| g. | $^{n}$*dóò* ‘to remain’ | $^{n}$*dóˀò* ‘adobe’ |
| | $^{n}$*dóó*$^{L}$ ‘sugar cane’ | $^{n}$*dóˀó* ‘woven basket’ |
| h. | *ɲṹmã́*$^{L}$ ‘wax’ | *ɲṹˀmã́*$^{L}$ ‘smoke’ |
| i. | *ɲṹṹ* ‘town’ | *ɲṹˀṹ* ‘fire’ |
| j. | *tɨɨ̀* ‘tight’ | *tɨˀɨ̀* ‘protrusion’ |
| k. | *tʲiì* ‘to get wet’ | *tʲiˀì* ‘to put in’ |
| l. | *úβí* ‘two’ | *úˀβí* ‘hurt’ |
| m. | *βeè* ‘below’ | *βeˀè* ‘house’ |

The stimuli were arranged in a semi-random manner. Items in minimally contrasting tone or glottalization sets were separated in the list by at least two items (and usually more) to reduce pressure for subjects to exaggerate contrasts. Each item in the list consisted of an item number, the Spanish gloss of the item (to ensure that speakers understood which word was required) and the item in IM orthography.[1] Tone is not currently marked in the IM orthography and therefore was not marked in the wordlist. The entire wordlist from the main (2011) part of the experiment written in IPA is provided in §A.5.

The second part of the experiment consisted of the twelve additional (C)VCV words given in (302).

(302)
a. *àʃū* ‘garlic’
b. *tʃítò* ‘bed’
c. *mĩ́ɲĩ̀* ‘pool’
d. *ɲã́ɲã́* ‘brother’
e. *nɨ̃ɲɨ̃̀* ‘corncob’
f. *mũ̀lī* ‘stew’
g. *tútú* ‘paper’

[1] Spanish is the language of wider communication in the area.

h. *kúká*$^{L}$ ‘comb’
i. *ĩ́nã́* ‘dog’
j. *sokò* ‘well’
k. *ɲũnũ̀* ‘netbag’
l. *nɨ̃́ɲɨ̃́*$^{L}$ ‘blood’

The recordings of these stimuli were made over a seven day period in 2012; each participant was recorded in a single session.

## A.3 Procedures

Subjects familiarized themselves with the wordlist on their own and with other participants and were given help understanding which Mixtec words corresponded to the Spanish glosses as needed. During the experiment subjects did not have access to the sheet with the stimuli, however. Instead, following the suggestion of Ladefoged (2003:23), the subjects were prompted by a (Mixtec) assistant using the Spanish gloss of the stimuli in order to elicit more natural speech than reading off a list. If the subject was unsure of the proper Mixtec response, the target item was not spoken in Mixtec, instead, she was guided to the correct response in other ways to avoid priming her pronunciation. The wordlist was elicited all the way through in order six times for each participant; however, in a few cases, items were recorded out of order and occasionally additional repetitions were elicited if the author judged that a pronunciation was disfluent in some way or if there was a disturbance. Only six fluent repetitions were chosen for analysis.

Recording was done in the field in a makeshift recording “tent” set up inside a building with mattresses standing vertically to form two walls of a cubical with a blanket over top of them. Subjects sat in this “tent” facing the mattresses in order to dissipate the sound and reduce reverberation. The experiment was paused when loud outside noises might interfere (e.g. roosters crowing, thunder). The author held a Shure SM58 unidirectional microphone close to the corner of the subject’s mouth during productions. Digital recordings were made by the author using a Marantz PMD660 solid state recorder at a sampling frequency of 44.1 kHz in the WAVE file format. All stimuli for each subject were recorded in a single session. All recordings for the main experiment were accomplished in a six day period.

## A.4 Measurements

Raw sound files were transferred to the author's computer where they were annotated by hand using Yi Xu's ProsodyPro v4.3 script (Xu 2013) for Praat (Boersma & Weenink 2016). Segment boundaries were marked by visual inspection of the waveform, spectrogram and formant tracks. Besides automatically creating annotation windows for the next stimuli and saving the annotations to files, the main advantage of using the ProsodyPro script is that it can also automatically extract many acoustic measurements from annotated intervals created by the user (for a list see Xu (2013)), some of which are time-normalized. The most important measurement for the purpose of this study is time-normalized f0 extracted from the vowel portion of the syllable, since this was used to display the canonical pitch contours of words in isolation (cf. §4.1.1). The script time-normalizes the f0 data by taking an equal number of samples from each annotated interval and at the same relative locations within the intervals (e.g. 10%, 20%, 30%, etc.). This procedure allows for averaging across multiple repetitions of the same item and across multiple speakers' productions of the same item. The text files containing acoustic measurements were imported into R (R Core Team 2017), where the f0 data points for each stimuli were averaged across repetitions and speakers and plotted using R scripts created by the author. It should be noted that, due to time constraints, only a small number of the stimuli in this production experiment were annotated for analysis. The mean pitch contours presented in this dissertation were created from all and only the 2011 male speakers.

## A.5 Main experiment stimuli

The following table gives the 108 stimuli for the main part of the Single Word production experiment recorded in 2011:

Table 77. Stimuli for the 2011 Single-Word production experiment

| Item No. | IM | English |
|---|---|---|
| 1 | $^{n}$*dóˀò* | ‘adobe’ |
| 2 | *isà* | ‘immature corn’ |
| 3 | *tukù* | ‘also’ |
| 4 | *kɨtɨ̀* | ‘animal, horse’ |
| 5 | *tʲókò* | ‘ant’ |
| 6 | *jàkʷĩ́* | ‘armadillo’ |
| 7 | *tʃɨ́tɨ̀* | ‘my knee’ |
| 8 | *lèē* | ‘baby’ |
| 9 | $^{L}$*lṍmè* | ‘bat’ |
| 10 | *kútú* | ‘to be full:IRR’ |
| 11 | $^{n}$*dóò* | ‘to remain’ |
| 12 | *βeè* | ‘below’ |
| 13 | *βìjā* | *belt* |
| 14 | *kóˀó*$^{L}$ | ‘bowl’ |
| 15 | *kúˀú*$^{L}$ | ‘brush’ |
| 16 | *útù* | ‘buddy’ |
| 17 | $^{n}$*dóó*$^{L}$ | ‘sugar cane’ |
| 18 | $^{L}$*βílù* | ‘cat’ |
| 19 | *jaβì* | ‘agave’ |
| 20 | $^{L}$*látʃã̀* | ‘chachalaca (bird)’ |
| 21 | $^{L}$*lɨ́ˀjɨ̀* | chick |
| 22 | $^{n}$doò | ‘to become clean’ |
| 23 | *kítʃì* | ‘to come:IRR’ |
| 24 | *ketà* | ‘to go out’ |
| 25 | *ítú* | ‘cornfield’ |
| 26 | $^{n}$*dɨ́jɨ̀* | ‘corpse’ |
| 27 | *tɨ́ké* | ‘my grasshopper’ |
| 28 | *ʃõ̀ᵑgí* | ‘cricket’ |
| 29 | *tokò* | ‘crotch’ |
| 30 | *ìsā* | ‘day after tomorrow’ |
| 31 | *kúú* | ‘die:IRR’ |
| 32 | $^{n}$*dèkū* | ‘Douglas’ |
| 33 | *ɲũˀũ̀* | ‘ground’ |

| Item No. | IM | English |
|---|---|---|
| 34 | $^{n}$*dɨ̀βɨ̄* | ‘egg’ |
| 35 | *mĩ́nũ̀* | ‘epazote herb’ |
| 36 | *ɲṹ*$^{ʔ}$*ṹ* | ‘fire’ |
| 37 | *tʃikì* | ‘fist’ |
| 38 | *t*$^{j}$*iì* | ‘to become wet’ |
| 39 | $^{n}$*d*$^{j}$*òó* | ‘god’ |
| 40 | *mã̀*$^{ŋ}$*gí* | ‘my mango’ |
| 41 | $^{n}$*daà* | ‘to go up’ |
| 42 | *ùβá* | ‘grape’ |
| 43 | *tɨ́kà* | ‘grasshopper’ |
| 44 | *βíʃì* | ‘grey hair’ |
| 45 | $^{n}$*da*$^{ʔ}$*à* | ‘hand’ |
| 46 | *toò* | ‘handspan’ |
| 47 | *ã̀mã́* | ‘heart’ |
| 48 | $^{n}$*dɨ́βɨ́*$^{L}$ | ‘chicken’ |
| 49 | *tʃíkí*$^{L}$ | ‘hill’ |
| 50 | *mũ̀sū* | ‘hired hand’ |
| 51 | *jáβí* | ‘hole’ |
| 52 | *ìsē* | ‘my immature corn’ |
| 53 | $^{n}$*dɨkɨ̀* | ‘horn’ |
| 54 | *βe*$^{ʔ}$*è* | ‘house’ |
| 55 | *ú*$^{ʔ}$*βí* | ‘hurt’ |
| 56 | *kà*$^{ʔ}$*ā* | ‘inexpensive’ |
| 57 | *ĩ́ɲĩ́* | ‘inner being’ |
| 58 | *katà* | ‘itchy’ |
| 59 | *tʃɨ́tɨ́*$^{L}$ | ‘knee’ |
| 60 | *kotò* | ‘know:IRR’ |
| 61 | $^{n}$*díʃí* | ‘whisky’ |
| 62 | *kò*$^{ʔ}$*ó* | ‘let’s go’ |
| 63 | $^{L}$*láβà* | ‘lizard’ |
| 64 | *ísá* | ‘loom’ |
| 65 | *mã̀*$^{ŋ}$*gú* | ‘mango’ |
| 66 | *àkú* | ‘Mark’ |
| 67 | *pã̀ɲũ̄* | ‘men’s belt’ |
| 68 | *tàtá* | ‘mestizo’ |
| 69 | *káà* | ‘metal’ |
| 70 | $^{n}$*dɨ̀βí* | ‘my chicken’ |
| 71 | *táká* | ‘nest’ |
| 72 | *ɲũ̀ũ̄* | ‘night’ |
| 73 | *kókó* | ‘notch’ |
| 74 | $^{L}$*tʃókò* | ‘opossum’ |

| Item No. | IM | English |
|---|---|---|
| 75 | *kùtʃí* | ‘pig’ |
| 76 | *$^{n}$dɨ́ˀjɨ̀* | ‘pimple’ |
| 77 | *tɨˀɨ̀* | ‘protrusion’ |
| 78 | *$^{L}$úʃũ̀* | ‘puppy’ |
| 79 | *t$^{j}$iˀì* | ‘to put in’ |
| 80 | *$^{L}$léʃù* | ‘rabbit’ |
| 81 | *èkú* | ‘Regulo’ |
| 82 | *sɨ̂* | ‘saliva’ |
| 83 | *súkṹ$^{L}$* | ‘throat’ |
| 84 | *tʃɨ́tɨ́* | ‘seed’ |
| 85 | *kòtȭ* | ‘shirt’ |
| 86 | *ɨ̀tɨ̄* | ‘short’ |
| 87 | *pàlā* | ‘shovel’ |
| 88 | *ɲṹˀmã́$^{L}$* | ‘smoke’ |
| 89 | *kóó$^{L}$* | ‘snake’ |
| 90 | *$^{L}$βíʃî* | ‘squirrel’ |
| 91 | *sukũ̀* | ‘to stick’ |
| 92 | *títʃî* | ‘stomach’ |
| 93 | *nã̀keè* | ‘to stretch’ |
| 94 | *òɾā* | ‘sun’ |
| 95 | *sùkũ̄* | ‘tall’ |
| 96 | *tɨɨ̀* | ‘tight’ |
| 97 | *keˀè* | ‘to touch’ |
| 98 | *ɲṹṹ* | ‘town’ |
| 99 | *ítí* | ‘my cornfield’ |
| 100 | *$^{L}$pîî* | ‘turkey hen’ |
| 101 | *ókó* | ‘twenty’ |
| 102 | *úβí* | ‘two’ |
| 103 | *ɲṹˀũ̀* | ‘mountain spirit’ |
| 104 | *t$^{j}$ókó* | ‘wasp’ |
| 105 | *ɲṹmã́$^{L}$* | ‘wax’ |
| 106 | *koˀò* | ‘wide opening’ |
| 107 | *$^{n}$dáβà* | ‘wood bar’ |
| 108 | *$^{n}$dóˀó$^{L}$* | ‘woven mat’ |

Appendix B

# The N-N production experiment

This appendix describes the method employed in the 2012 N-N production experiment. This experiment examines each combination of the seven underlying tonal melodies found on noun couplets (cf. §4.1) in N-N associative constructions (cf. §2.3) pronounced in isolation. The primary purpose of the study is to investigate the kinds of tonal alternations that occur when words are combined in phrases.

## B.1 Subjects

The N-N experiment was conducted with nine participants, four female and five male, ranging in age from 18 to 57, not including one of the female participant's data that was discarded because she had a cold. All were native speakers of IM, living in the municipality of Santiago Ixtayutla (Oaxaca, Mexico), and all but two subjects in this study had participated in the 2011 Single Word study.

## B.2 Materials

The materials used in this experiment consisted of 88 IM N-N associative constructions consisting of two disyllabic noun couplets with voiced onsets and having every combination of the seven underlying tone melodies found on noun couplets. Of these, only 49—one exemplar of each pairwise combination of the seven noun melodies—were chosen for analysis and only these will be discussed here. It should be noted that 49 additional N-N stimuli having similar phonological characteristics except that the noun couplets had *voiceless* onsets were also slated for inclusion in this study; however, due to time constraints, these were only recorded with three speakers. These data were not processed further and will not be discussed here.

Although words with exactly the same segmental makeup allow for the best melody comparisons, this was not possible since there are no minimal noun sets showing all tonal contrasts and it was necessary to limit the stimuli to actual Mixtec words (i.e. no nonce words) in order to ensure accurate production of pitch contours. The intended phonological structure of each word in the phrase was NVNV (i.e. with nasal onsets) to allow for an uninterrupted pitch contour throughout the entire word, as well as relatively straightforward segmentation (cf. Xu 1997); however, due to the lack of NVNV words in the smaller melody classes, in some cases other voiced consonants had to be used ([l], [β], [$^{n}$d], [$^{ŋ}$g]), and in the LH-LH combination, the structure was VNV-NVNV with the first noun lacking an onset..

A complete list of the representative words for each melody is given in Table 78.

Table 78. Representative words for each tonal melody

| **Melody** | **Exemplar 1** | **Exemplar 2** |
|---|---|---|
| **HH** | *ɲã́ɲĩ́* ‘brother’ | |
| **HH**$^{L}$ | *nɨ̃́ɲɨ̃́*$^{L}$ ‘blood’ | $^{n}$*dɨ́βɨ́*$^{L}$ ‘egg’ |
| **HL** | *mĩ́ɲĩ̀* ‘pool’ | *mĩ́nũ̀* ‘epazote’ |
| $^{L}$**HL** | $^{L}$*lṍmẽ̀* ‘bat’ | $^{L}$*láβà* ‘lizard’ |
| **L** | *nɨ̃ɲɨ̃̀* ‘corncob’ | *ɲũnũ̀* ‘net’ |
| **L**$^{H}$ | *mũlì*$^{H}$ ‘mole’ | $^{n}$*dɨβɨ̀*$^{H}$ ‘chicken’ |
| **LH** | *mã̀*$^{ŋ}$*gú* ‘mango’ | *ã̀mã́* ‘heart’ |

Where a second word is given for a melody, this word was used in the construction where both words had that particular melody. For instance, for the /HL-HL/ combination, *mĩ́nũ̀ mĩ́ɲĩ̀* ‘pool’s epazote’ was used rather than *mĩ́ɲĩ̀ mĩ́ɲĩ̀* ‘pool’s pool’. The list of the associative constructions that constituted the stimuli for the experiment is given in §B.5. The stimuli were ordered so that the second melody in the construction was kept constant and the first melody varied. It was assumed that following a logical order like this would make it easier for the subjects to respond to the prompts, since most of the time the following stimulus would not be entirely new.

## B.3 Procedures

Subjects were given a sheet with the stimuli written in Mixtec and Spanish and were allowed to familiarize themselves with the list on their own and were given help understanding the Mixtec where needed. The Mixtec orthography did not include tone markings. During the experiment subjects did not have access to the sheet with the stimuli. Instead, the subjects were prompted by the author using the Spanish gloss of the stimuli (Spanish is the language of wider communication in the area) in order to elicit more natural speech than reading off a list (cf. Ladefoged 2003:23). If the subject was unsure of the proper Mixtec response, the target item was not spoken in Mixtec, instead, she was guided to the correct response in other ways to avoid priming her pronunciation. Each item on the list was elicited eight times consecutively in order to make it easier for the subject to respond and cause the experiment to flow more quickly (cf. Gerfen 1996:41). However, additional repetitions were elicited if the author judged that a pronunciation was not fluent in some way. Only eight fluent repetitions were chosen for analysis.

Recording was done in the field in a makeshift recording "tent" as described in Appendix A.3. The experiment was paused when loud outside noises might interfere (e.g. roosters crowing, thunder). Subjects held a Shure SM58 unidirectional microphone close to the corner of their mouth during productions. Digital recordings were made by the author using a Marantz PMD660 solid state recorder at a sampling frequency of 44.1 kHz in the WAVE file format. All stimuli for each subject were recorded in a single session except for one, whose first session was stopped because of thunder. This subject completed her recordings in a second session the following day.

## B.4 Measurements

Raw sound files were transferred to the author's computer where they were annotated by hand using Yi Xu's ProsodyPro v4.3 script (Xu 2013) for Praat (Boersma & Weenink 2016). Segment boundaries were marked by visual inspection of the waveform, spectrogram and formant tracks. The ProsodyPro script handled the logistics of creating, saving and editing annotation files, and when the annotations were completed, it was also used to extract acoustic measurements from the labeled intervals in the Praat TextGrid files. Since the stimuli had onsets with a high degree of sonority, both the onset and the vowel of each syllable were labeled (in separate intervals) and therefore included in the measurements. ProsodyPro extracts many acoustic measurements (for a list see Xu (2013)), but the most important for the purposes of this study is time-normalized f0, since this is used to display the canonical pitch contours of the constructions. Time-normalization is accomplished in the script by taking ten equidistant samples from each labeled interval. This procedure allows for averaging across multiple repetitions of the same item and across multiple speakers' productions of the same item. The text files containing acoustic measurements were imported into R (R Core Team 2017), where the f0 data points for each stimuli were averaged across repetitions and speakers and plotted using R scripts created by the author. It should be noted that, due to time constraints, only the male data from this experiment have been completely processed and are used in this dissertation.

## B.5 Stimuli

The following table gives the stimuli from the 2012 N-N production experiment:

Table 79. Stimuli from the N-N production experiment

| | N1 Melody | N2 Melody | N1 | N2 | Gloss |
|---|---|---|---|---|---|
| 1. | /H/ | /H/ | *ɲa̋ɲi̋* | *ɲa̋ɲi̋* | 'brother's brother' |
| 2. | /H$^{L}$/ | /H/ | *nɨ̋ɲɨ̋$^{L}$* | *ɲa̋ɲi̋* | 'brother's blood' |
| 3. | /HL/ | /H/ | *mi̋ɲȉ* | *ɲa̋ɲi̋* | 'brother's pool' |

| | N1 Melody | N2 Melody | N1 | N2 | Gloss |
|---|---|---|---|---|---|
| 4. | /ᴸHL/ | /H/ | *ᴸlɔ̋mɛ̏* | *ɲɑ̋ɲí̋* | 'brother's bat' |
| 5. | /L/ | /H/ | *nɨ̃ɲɨ̏* | *ɲɑ̋ɲí̋* | 'brother's corn' |
| 6. | /Lᴴ/ | /H/ | *mʉ̏lī* | *ɲɑ̋ɲí̋* | 'brother's mole' |
| 7. | /ᴸH/ | /H/ | *mɑ̏ᵑgú* | *ɲɑ̋ɲí̋* | 'brother's mango' |
| 8. | /H/ | /Hᴸ/ | *ɲɑ̋ɲí̋* | *nɨ̋ɲɨ̋ᴸ* | 'blood brother' |
| 9. | /Hᴸ/ | /Hᴸ/ | *nɨ̋ɲɨ̋ᴸ* | *ⁿdɨ́βɨ́ᴸ* | 'egg's blood' |
| 10. | /HL/ | /Hᴸ/ | *mɨ̋ɲɨ̏* | *nɨ̋ɲɨ̋ᴸ* | 'pool of blood' |
| 11. | /ᴸHL/ | /Hᴸ/ | *ᴸlɔ̋mɛ̏* | *nɨ̋ɲɨ̋ᴸ* | 'blood's bat' |
| 12. | /L/ | /Hv/ | *nɨ̃ɲɨ̏* | *nɨ̋ɲɨ̋ᴸ* | 'blood's corn' |
| 13. | /Lᴴ/ | /Hᴸ/ | *mʉ̏lī* | *nɨ̋ɲɨ̋ᴸ* | 'mole made with blood' |
| 14. | /ᴸH/ | /Hᴸ/ | *mɑ̏ᵑgú* | *nɨ̋ɲɨ̋ᴸ* | 'blood's mango' |
| 15. | /H/ | /HL/ | *ɲɑ̋ɲí̋* | *mɨ̋ɲɨ̏* | 'pool's brother' |
| 16. | /Hᴸ/ | /HL/ | *nɨ̋ɲɨ̋ᴸ* | *mɨ̋ɲɨ̏* | 'pool's blood' |
| 17. | /HL/ | /HL/ | *mɨ̋nʉ̏* | *mɨ̋ɲɨ̏* | 'pool's epazote' |
| 18. | /L/ | /HL/ | *nɨ̃ɲɨ̏* | *mɨ̋ɲɨ̏* | 'pool's blood' |
| 19. | /Lᴴ/ | /HL/ | *mʉ̏lī* | *mɨ̋ɲɨ̏* | 'pool's mole' |
| 20. | /ᴸHL/ | /HL/ | *ᴸlɔ̋mɛ̏* | *mɨ̋ɲɨ̏* | 'pool's bat' |
| 21. | /ᴸH/ | /HL/ | *mɑ̏ᵑgú* | *mɨ̋ɲɨ̏* | 'pool's mango' |
| 22. | /H/ | /ᴸHL/ | *ɲɑ̋ɲí̋* | *ᴸlɔ̋mɛ̏* | 'bat's brother' |
| 23. | /Hᴸ/ | /ᴸHL/ | *nɨ̋ɲɨ̋ᴸ* | *ᴸlɔ̋mɛ̏* | 'bat's blood' |
| 24. | /HL/ | /ᴸHL/ | *mɨ̋ɲɨ̏* | *ᴸlɔ̋mɛ̏* | 'bat's pool' |
| 25. | /ᴸHL/ | /ᴸHL/ | *ᴸlɔ̋mɛ̏* | *ᴸláβà* | 'lizard's bat' |
| 26. | /L/ | /ᴸHL/ | *nɨ̃ɲɨ̏* | *ᴸlɔ̋mɛ̏* | 'bat's corn' |
| 27. | /ᴸH/ | /ᴸHL/ | *mɑ̏ᵑgú* | *ᴸlɔ̋mɛ̏* | 'bat's mango' |
| 28. | /Lᴴ/ | /ᴸHL/ | *mʉ̏lī* | *ᴸlɔ̋mɛ̏* | 'mole made of bat' |
| 29. | /H/ | /L/ | *ɲɑ̋ɲí̋* | *nɨ̃ɲɨ̏* | 'corn's brother' |
| 30. | /Hᴸ/ | /L/ | *nɨ̋ɲɨ̋ᴸ* | *nɨ̃ɲɨ̏* | 'corn's blood' |
| 31. | /HL/ | /L/ | *mɨ̋ɲɨ̏* | *nɨ̃ɲɨ̏* | 'corn's pool' |
| 32. | /ᴸHL/ | /L/ | *ᴸlɔ̋mɛ̏* | *nɨ̃ɲɨ̏* | 'corn's bat' |
| 33. | /L/ | /L/ | *nɨ̃ɲɨ̏* | *ɲʉ̃nʉ̏* | 'netbag's corn' |
| 34. | /Lᴴ/ | /L/ | *mʉ̏lī* | *nɨ̃ɲɨ̏* | 'mole made of corn' |
| 35. | /ᴸH/ | /L/ | *mɑ̏ᵑgú* | *nɨ̃ɲɨ̏* | 'corn's mango' |
| 36. | /ᴸH/ | /ᴸH/ | *ɑ̏mɑ̋* | *mɑ̏ᵑgú* | 'mango's heart' |
| 37. | /H/ | /ᴸH/ | *ɲɑ̋ɲí̋* | *mɑ̏ᵑgú* | 'mango's brother' |
| 38. | /Hᴸ/ | /ᴸH/ | *nɨ̋ɲɨ̋ᴸ* | *mɑ̏ᵑgú* | 'mango's blood' |
| 39. | /HL/ | /ᴸH/ | *mɨ̋ɲɨ̏* | *mɑ̏ᵑgú* | 'mango's pool' |
| 40. | /ᴸHL/ | /ᴸH/ | *ᴸlɔ̋mɛ̏* | *mɑ̏ᵑgú* | 'mango's bat' |
| 41. | /L/ | /ᴸH/ | *nɨ̃ɲɨ̏* | *mɑ̏ᵑgú* | 'mango's corn' |
| 42. | /Lᴴ/ | /ᴸH/ | *mʉ̏lī* | *mɑ̏ᵑgú* | 'mole made with mangos' |

| | N1 Melody | N2 Melody | N1 | N2 | Gloss |
|---|---|---|---|---|---|
| 43. | /H/ | /L$^{H}$/ | *ɲã́ɲĩ́* | *mũ̀lī* | 'mole's brother' |
| 44. | /H$^{L}$/ | /L$^{H}$/ | *nɨ̃́ɲɨ̃́*$^{L}$ | *mũ̀lī* | 'mole's blood' |
| 45. | /HL/ | /L$^{H}$/ | *mĩ́ɲĩ̀* | *mũ̀lī* | 'mole's pool' |
| 46. | /$^{L}$HL/ | /L$^{H}$/ | $^{L}$*lṍmẽ̀* | *mũ̀lī* | 'mole's bat' |
| 47. | /L/ | /L$^{H}$/ | *nɨ̃ɲɨ̃̀* | *mũ̀lī* | 'mole's corn' |
| 48. | /L$^{H}$/ | /L$^{H}$/ | *mũ̀lī* | $^{n}$*dɨ̀βɨ̄* | 'mole made of chicken' |
| 49. | /$^{L}$H/ | /L$^{H}$/ | *mã̀*$^{ŋ}$*gú* | *mũ̀lī* | 'mole's mango' |

Appendix C

# The N-Pron production experiment

This appendix describes the method for the N-Pron production experiment. The purpose of this experiment is to examine the tonal realization of nouns with each underlying tonal melody combined with enclitic pronouns having each possible tonal melody and CV structure. The main part of the experiment was carried out in 2014, and was supplemented in 2016 with additional items.

## C.1 Subjects

The main N-Pron experiment was conducted in 2014 with six participants, two female speakers and four male speakers, ranging in age from 25 to 37. All were native speakers of IM, living in the municipality of Santiago Ixtayutla (Oaxaca, Mexico) and had participated in earlier studies. In 2016, 14 stimuli (discussed below) were added using the same participants.

## C.2 Materials

The stimuli used in this experiment consisted of an exemplar for each of the seven underlying tonal melodies found in nouns (cf. §4.1) plus each noun exemplar combined with each of five pronouns representing all of the possible enclitic pronoun melodies and CV structures. A complete list of the noun exemplars of each melody is given in (303).

(303) Exemplars of each noun tonal melody

| Melody | Exemplars |
|---|---|
| **/H/** | *tʃítí* 'seed' |
| **/H$^{L}$/** | *tʃítí$^{L}$* 'knee' |
| **/HL/** | *tʃítò* 'bed' |
| **/$^{L}$HL/** | *$^{L}$tʃókò* 'opossum' |
| **/L/** | *tʃikì* 'fist' |
| **/$^{L}$H/** | *kùtʃí* 'pig' |
| **/L$^{H}$/** | *kotȭ* 'shirt' |

The five pronouns with which the nouns were combined are given in (304).

(304) Exemplars of each enclitic pronoun tonal melody

| Melody | Exemplars |
|---|---|
| **/L/** | =*ɾà* 'third person masculine singular' (3SG.MASC) |
| **/L$^{H}$/** | =*kē* 'third person feminine singular' (3SG.FEM) |
| **/H/** | =*$^{n}$dí* 'first person plural exclusive' (1PL.EXCL) |
| **/H/** | =*í* 'first person singular' (1SG) |
| **toneless** | =*ũ* 'second person singular' (2SG) |

There were thus a total of 42 stimuli — 7 nouns x 6 contexts (bare noun, N + 3SG.MASC, N + 3FEM, N + 1PL.EXCL, N + 1SG, N + 2SG).

Exemplar nouns were restricted to disyllabic roots having a CVCV structure and containing only voiceless onsets in order to make the stimuli as similar to each other as possible and to facilitate segmentation. Although words with exactly the same segmental makeup allow for the best melody comparisons, this was not possible since there are no minimal noun sets showing all tonal contrasts and it was considered necessary to limit the stimuli to actual Mixtec words (i.e. no nonce words) in order to ensure accurate production of pitch contours.

A clitic pronoun may be added to the end of a noun to indicate the possessor of the noun (cf. §2.5). Enclitic pronouns do not fulfill the bimoraic minimal word template and therefore "lean" on the preceding word for their pronunciation. Fewer tonal melodies are found on enclitics than on lexical words. The first person plural exclusive and first person singular pronouns are of particular interest because they both have a H tone, which is the target of some interesting tonal alternations, and because the processes by which the pronouns combine with the root are different: the first person plural exclusive pronoun, *=ndí*, adds a CV syllable to the end of the noun root, whereas the first person singular pronoun, *=í*, which lacks an onset, coalesces with the final vowel of a preceding CVCV root and replaces its tone. This is significant because it allows us to compare the effect of the pronoun tone both when it replaces part of the root melody, in the case of the N=*í* '1SG' construction, and when it is concatenated to the root melody, in the case of the N=*ⁿdí* '1PL.EXCL' construction. The vowel initial *=ũ̃* '2SG' also coalesces with the final vowel of preceding CVCV roots. Its inclusion in this experiment is to demonstrate that it results in no change in the root melody and should be analyzed as toneless, as well as to explore whether other acoustic properties, such as duration, are affected by its coalescence with the root.

Each of the stimuli were embedded in the carrier phrase given in (305) in order to observe the target items in a non-utterance final context.

(305) *kʷáⁿdʲeˀètʃì* ___ *βitʲĩ̀*
kʷá–ⁿdʲeˀè=tʃì ___ βitʲĩ̀
PROS–see=3GNRL ____ today
'They will see ____ today.'

In the carrier sentence, the target word is the direct object and is immediately preceded by a pronominal subject enclitic with the /L/ melody (*=tʃì* 'third person general' and followed by an adverbial with the /L/ melody (*βitʲĩ̀* 'today').

The original experiment in 2014 contained 28 stimuli consisting of each noun in (303) combined with the the first four pronouns in (304)—that is, combined with the third person masculine, third person feminine, first person plural exclusive and first person singular enclitic pronouns. The stimuli were ordered so that all stimuli for each noun combined with each pronoun were together in the list, as can be seen in the complete list of stimuli given in Appendix C.5. It was assumed that following a logical order like this would make it easier for the subjects to respond to the prompts since most of the time the following stimulus was not entirely new (i.e. that the noun portion of the stimuli was the same and only the pronoun changed until all contexts had been recorded for that particular noun before moving on to the next noun in the list).

The original experiment was supplemented with 14 additional stimuli in 2016. These consisted of each bare noun in (303) and the combination of each noun with the toneless second person singular enclitic pronoun. These were embedded in the same carrier sentence and ordered according to the same scheme as the original experiment, as shown by the complete list given in Appendix C.6.

## C.3 Procedures

Before the experiment it was explained to the subjects how each of the stimuli would be given within the carrier sentence and they were given a sheet with the stimuli in the carrier sentence written in Mixtec and Spanish. The Mixtec orthography did not include tone markings. They were allowed to familiarized themselves with the list on their own and were given help understanding the Mixtec where needed. Subjects did not have access to the sheet with the stimuli during the experiment. Instead, the subjects were prompted by the author using the Spanish gloss of the target item (Spanish is the language of wider communication in the area), and the subjects responded in Mixtec with the target item appropriately embedded in the carrier sentence. This procedure was followed in order to elicit more natural speech than reading off a list (cf. Ladefoged 2003:23). If the subject was unsure of the proper Mixtec response, the target item was not spoken in Mixtec, instead, she was guided to the correct response in other ways to avoid priming her pronunciation. Each item on the list was elicited eight times consecutively in order to make it easier for the subject to respond and cause the experiment to flow more quickly (cf. Gerfen 1996:41). However, additional repetitions were elicited if the author judged that a pronunciation was not fluent in some way (e.g. hesitation, voice "cracking"), or if an external disruption occurred (e.g. rooster crowing, dog barking). Only eight fluent repetitions were chosen for analysis.

Recording was done in the field so a makeshift recording "studio" was created inside a building as described in A.3. The experiment was paused when loud outside noises might interfere (e.g. roosters crowing, thunder). Subjects held a Shure SM58 unidirectional microphone close to their mouth during productions. Digital recordings were made by the author using a Marantz PMD660 solid state recorder at a sampling frequency of 44.1 kHz in the WAVE file format. All stimuli for each part of the experiment were recorded in a single session for each subject.

As described above, the experiment was supplemented with 16 stimuli in 2016. The same procedures were used in each part of the experiment, with the exception that in 2016 the subjects were prompted with the Spanish translation of the entire carrier phrase including the target item, rather than just the gloss of the target item, as in the original experiment.

## C.4 Measurements

Raw sound files were transferred to the author's computer where they were annotated by hand using Yi Xu's ProsodyPro v6.1.4 beta script (Xu 2013) for Praat (Boersma & Weenink 2016). The segment boundaries for the vowel portion of each syllable were marked by visual inspection of the waveform, spectrogram and formant tracks and were given a label. The ProsodyPro script handled the logistics of creating, saving and editing annotation files, and when the annotations were completed, it was also used to extract acoustic measurements from the labeled (vowel) intervals in the Praat TextGrid files.

ProsodyPro extracts many acoustic measurements (for a list see Xu (2013)), but the most important for the purposes of this study is time-normalized f0, since this is used to display the canonical pitch contours of the constructions. Time-normalization is accomplished in the script by taking ten equidistant samples from each labeled interval. This procedure allows for averaging across multiple repetitions of the same item for each speaker and across multiple speakers' productions of the same item. The non-beta ProsodyPro v5.6.1 script was used to perform averaging item repetitions for each speaker and across all speakers. Averages are calculated by the script by first converting f0 values to logarithms, calculating the average of the logarithmic values and then converting the averages back to Hertz values for plotting. The text files containing the averaged f0 measurements of each item for each speaker and the averaged f0 measurements of each item by all speakers were imported into R (R Core Team 2017) for visualization and analysis using scripts written by the author.

## C.5 Main experiment stimuli (2014)

The stimuli for the main N-Pron experiment conducted in 2014 are given (in bold) in (306), embedded in the carrier sentence.

(306) a.

| | | |
|---|---|---|
| kʷáⁿdʲeˀètʃì | **tʃɨ́tɨ́ɾà** | βitʲĩ̀ |
| kʷá–ⁿdʲeʔè = tʃì | tʃɨ́tɨ́ = ɾà | βitʲĩ̀ |
| PROS–see=3.GNRL | seed=3SG.MASC | today |

‘They are going to see his seed today.’

b.

| | | |
|---|---|---|
| kʷáⁿdʲeˀètʃì | **tʃɨ́tɨ́kè** | βitʲĩ̀ |
| kʷá–ⁿdʲeʔè = tʃì | tʃɨ́tɨ́ = kèᴴ | βitʲĩ̀ |
| PROS–see=3.GNRL | seed=3.FEM | today |

‘They are going to see her seed today.

c.

| | | |
|---|---|---|
| kʷáⁿdʲeˀètʃì | **tʃɨ́tɨ́ⁿdí** | βitʲĩ̀ |
| kʷá–ⁿdʲeʔè = tʃì | tʃɨ́tɨ́ = ⁿdí | βitʲĩ̀ |
| PROS–see=3.GNRL | seed=1PL.EXCL | today |

‘They are going to see our (ex) seed today.’

d.

| | | |
|---|---|---|
| kʷáⁿdʲeˀètʃì | **tʃɨ́tí** | βitʲĩ̀ |
| kʷá–ⁿdʲeʔè = tʃì | tʃɨ́tɨ́ = í | βitʲĩ̀ |
| PROS–see=3.GNRL | seed=1SG | today |

‘They are going to see my seed today.’

e. kʷáⁿdʲeˀètʃì **tʃɨ́tɨɾá** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{L}$ = ɾà βitʲĩ̀
PROS–see=3.GNRL knee=3SG.MASC today
'They are going to see his knee today.'

f. kʷáⁿdʲeˀètʃì **tʃɨ́tɨ́kè** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{L}$ = kè$^{H}$ βitʲĩ̀
PROS–see=3.GNRL knee=3.FEM today
'They are going to see her knee today.'

g. kʷáⁿdʲeˀètʃì **tʃɨ́tɨ́ⁿdì** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{L}$ = ⁿdí βitʲĩ̀
PROS–see=3.GNRL knee=1PL.EXCL today
'They are going to see our (ex) knees today.'

h. kʷáⁿdʲeˀètʃì **tʃɨ́tì** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{L}$ = í βitʲĩ̀
PROS–see=3.GNRL knee=1SG today
'They are going to see my knee today.'

i. kʷáⁿdʲeˀètʃì **tʃítòɾà** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò = ɾà βitʲĩ̀
PROS–see=3.GNRL bed=3SG.MASC today
'They are going to see his bed today.'

j. kʷáⁿdʲeˀètʃì **tʃítòkē** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò = kè$^{H}$ βitʲĩ̀
PROS–see=3.GNRL bed=3.FEM today
'They are going to see her bed today.'

k. kʷáⁿdʲeˀètʃì **tʃítōⁿdí** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò = ⁿdí βitʲĩ̀
PROS–see=3.GNRL bed=1PL.EXCL today
'They are going to see our (ex) bed today.'

l. kʷáⁿdʲeˀètʃì **tʃíté** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò = é βitʲĩ̀
PROS–see=3.GNRL bed=1SG today
'They are going to see my bed today.'

m. kʷáⁿdʲeˀètʃì **tʃókòɾà** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì ᴸtʃókò = ɾà βitʲĩ̀
PROS–see=3.GNRL opossum=3SG.MASC today
‘They are going to see his opossum today.’

n. kʷáⁿdʲeˀètʃì **tʃókòkē** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì ᴸtʃókò = kèᴴ βitʲĩ̀
PROS–see=3.GNRL opossum=3.FEM today
‘They are going to see her opossum today.’

o. kʷáⁿdʲeˀètʃì **tʃókōⁿdí** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì ᴸtʃókò = ⁿdí βitʲĩ̀
PROS–see=3.GNRL opossum=1PL.EXCL today
‘They are going to see our (ex) opossum today.’

p. kʷáⁿdʲeˀètʃì **chòké** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì ᴸtʃókò = é βitʲĩ̀
PROS–see=3.GNRL opossum=1SG today
‘They are going to see my opossum today.’

q. kʷáⁿdʲeˀètʃì **tʃikìɾà** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃikì = ɾà βitʲĩ̀
PROS–see=3.GNRL fist=3SG.MASC today
‘They are going to see his fist today.’

r. kʷáⁿdʲeˀètʃì **tʃikìkē** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃikì = kèᴴ βitʲĩ̀
prosp–see=3.GNRL fist=3SG.FEM today
‘They are going to see her fist today.’

s. kʷáⁿdʲeˀètʃì **tʃikìⁿdī** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃikì = ⁿdí βitʲĩ̀
PROS–see=3.GNRL fist=1PL.EXCL today
‘They are going to see our (ex) fists today.’

t. kʷáⁿdʲeˀètʃì **tʃikī** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃikì = í βitʲĩ̀
PROS–see=3.GNRL fist=1SG today
‘They are going to see my fist today.’

u. kʷáⁿdʲeˀètʃì **kùtʃíɾà** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kùtʃí = ɾà βitʲȉ
PROS–see=3.GNRL pig=3SG.MASC today
'They are going to see his pig today.'

v. kʷáⁿdʲeˀètʃì **kùtʃíkē** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kùtʃí = kèᴴ βitʲȉ
PROS–see=3.GNRL pig=3.FEM today
'They are going to see her pig today.'

w. kʷáⁿdʲeˀètʃì **kùtʃīⁿdí** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kùtʃí = ⁿdí βitʲȉ
PROS–see=3.GNRL pig=1PL.EXCL today
'They are going to see our (ex) pig today.'

x. kʷáⁿdʲeˀètʃì **kùtʃí** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kùtʃí = í βitʲȉ
PROS–see=3.GNRL pig=1SG today
'They are going to see my pig today.'

y. kʷáⁿdʲeˀètʃì **kòtȭɾà** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kòtȍᴴ = ɾà βitʲȉ
PROS–see=3.GNRL shirt=3SG.MASC today
'They are going to see his shirt today.'

z. kʷáⁿdʲeˀètʃì **kòtȭkē** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kòtȍᴴ = kèᴴ βitʲȉ
PROS–see=3.GNRL shirt=3.FEM today
'They are going to see her shirt today.'

aa. kʷáⁿdʲeˀètʃì **kòtȭⁿdí** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kòtȍᴴ = ⁿdí βitʲȉ
PROS–see=3.GNRL shirt=1PL.EXCL today
'They are going to see our (ex) shirts today.'

ab. kʷáⁿdʲeˀètʃì **kòtḗ** βitʲȉ
kʷá–ⁿdʲeʔè = tʃì kòtȍᴴ = é βitʲȉ
PROS–see=3.GNRL shirt=1SG today
'They are going to see my shirt today.'

## C.6 Supplemental stimuli (2016)

The stimuli for the 2016 supplement to the N-Pron production experiment are given (in bold), embedded in the carrier sentence in (307).

(307) a. kʷáⁿdʲeˀètʃì **tʃɨ́tɨ́** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́ βitʲĩ̀
PROS–see=3.GNRL seed today
'They are going to see seed today.'

b. kʷáⁿdʲeˀètʃì **tʃɨ́tű̃** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́ = ũ βitʲĩ̀
PROS–see=3.GNRL seed=2SG today
'They are going to see your seed today.'

c. kʷáⁿdʲeˀètʃì **tʃɨ́tɨ́** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{\text{L}}$ βitʲĩ̀
PROS–see=3.GNRL knee today
'They are going to see knees today.'

d. kʷáⁿdʲeˀètʃì **tʃɨ́tű̃** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃɨ́tɨ́$^{\text{L}}$ = ũ βitʲĩ̀
PROS–see=3.GNRL knee=2SG today
'They are going to see your knee today.'

e. kʷáⁿdʲeˀètʃì **tʃítò** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò βitʲĩ̀
PROS–see=3.GNRL bed today
'They are going to see beds today.'

f. kʷáⁿdʲeˀètʃì **tʃítȍ̃** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì tʃítò = ũ βitʲĩ̀
PROS–see=3.GNRL bed=2SG today
'They are going to see your bed today.'

g. kʷáⁿdʲeˀètʃì **tʃókò** βitʲĩ̀
kʷá–ⁿdʲeʔè = tʃì $^{\text{L}}$tʃókò βitʲĩ̀
PROS–see=3.GNRL opossum today
'They are going to see opossums today.'

h. kʷá$^{n}$dʲeˀètʃì **tʃókȍ** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì $^{L}$tʃókò = ũ βitʲĩ̏
PROS–see=3.GNRL opossum=2SG today
'They are going to see your opossum today.'

i. kʷá$^{n}$dʲeˀètʃì **tʃikì** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì tʃikì βitʲĩ̏
PROS–see=3.GNRL fist today
'They are going to see fists today.'

j. kʷá$^{n}$dʲeˀètʃì **tʃikũ̏** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì tʃikì = ũ βitʲĩ̏
PROS–see=3.GNRL fist=2SG today
'They are going to see your fist today.'

k. kʷá$^{n}$dʲeˀètʃì **kùtʃí** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì kùtʃí βitʲĩ̏
PROS–see=3.GNRL pig today
'They are going to see pigs today.'

l. kʷá$^{n}$dʲeˀètʃì **kùtʃũ̋** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì kùtʃí = ũ βitʲĩ̏
PROS–see=3.GNRL pig=2SG today
'They are going to see your pig today.'

m. kʷá$^{n}$dʲeˀètʃì **kòtõ̏** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì kòtõ̏$^{H}$ βitʲĩ̏
PROS–see=3.GNRL shirt today
'They are going to see shirts today.'

n. kʷá$^{n}$dʲeˀètʃì **kòtõ̏** βitʲĩ̏
kʷá–$^{n}$dʲeʔè = tʃì kòtõ̏$^{H}$ = ũ βitʲĩ̏
PROS–see=3.GNRL shirt=2SG today
'They are going to see your shirt today.'

Appendix D

# The Large Noun production experiment

This appendix describes the method employed in the Large Noun production experiment. The purpose of this experiment is to examine nouns that are larger than a couplet having various tonal melodies in isolation and in carrier sentences with two different tonal configurations.

## D.1 Subjects

The Large Noun experiment was conducted in 2015 with four participants, two female speakers and two male speakers, ranging in age from 26 to 33. All were native speakers of Ixtayutla Mixtec and were living in the municipality of Santiago Ixtayutla (Oaxaca, Mexico), and all had participated in previous production experiments with the author.

## D.2 Materials

The primary materials for the experiment are the 29 three mora nouns given in Table 80, which represent all of the 13 known surface melodies for nouns of this size. Where possible, stimuli with CVCV, CVV and CVˀV couplet structures were included for each melody, however, this not possible for many of the melodies. Given that nouns of this size are much less frequent than couplet-sized nouns, it was not possible to find stimuli that were highly comparable in terms of their segmental makeup or that had onsets that were easy to segment. Most, if not all, of these words have a complex diachronic history, many being fossilized forms that were derived with one of the old classifier prefixes (cf. §2.4.1). Some of the words, however, are clearly composed of identifiable, synchronic morphemes. What is known of the composition, historical and synchronic, is provided in the complete list of stimuli for this experiment in D.5.

Table 80. Trimoraic nouns by tonal melody and couplet type

| Melody | CVCV | CVV | CVˀV |
|---|---|---|---|
| L-LH | *tù(tàtá)* 'cultivated trees' | *pè(rùú)* 'watermelon' | |
| L-LH$^L$ | | | *jù(kùˀú$^L$)* 'bathroom' |
| L-LM | *ɲɨ̃̀(ʃijō)* 'woven belt' | *tù(tʃīī)* 'rifle' | *ɲã̀(sɨ̀ˀɨ̄)* 'wife' |
| L-HH | | | *ɾà(ⁿdʲíˀí)* 'children' |
| L-HH$^L$ | *tɨ̀(ʃɨ̃́ɲɨ̃́$^L$)* 'ridge pole' | *tùkʷáá$^L$* 'orange' | *tɨ̀(ɲɨ̃́ˀɨ̃́$^L$)* 'twins' |
| | | *tɨ̀(ⁿdáá$^L$)* 'gunny sack' | |
| L-HL | *tù(tʃítò)* 'ditch reed' | *tù(ʃíì)* 'rod of discipline' | |
| L-∅L | *tù(tɨtɨ̀)* 'tololote tree' | *mã(tʃiì)* 'vulture' | *tɨ̀(kaˀà)* 'coconut' |
| H-LH | | | |
| H-LH$^L$ | *nṹ(sòkó$^L$)* 'shoulder' | | *tʃá(ʃèˀṹ)* 'your armpit' |
| H-HL | | *ɲṹ(kʷíì)* 'fox' | |
| H$^L$-HL | *nṹ(ⁿdúβà)* 'Oaxaca' | *jú(káà)* 'sharpening stone' | |
| H-∅L | *tɨ́(nãmã̀)* 'tomato' | *ɾá(jɨɨ̀)* 'man' | *tú(ⁿdoˀò)* 'suffering' |
| | *tɨ́(kiʃɨ̀)* 'heron' | | |
| H-HH | *sá(lérú)* 'heron' | *mã́(jɨ́ɨ́)* 'cicada' | *tʃí(tóˀó)* 'owner' |

The experiment also included 9 four-mora nouns. Nouns of this size are not nearly as frequent and no attempt was made to exhaustively represent melodies or couplet structures. These stimuli are the last nine items in the list of all 38 stimuli, which are given in Appendix D.5 in the order they were presented in the experiment.

In order to get a better understanding of the effects of surrounding tones on the various tonal melodies, each of the stimuli were produced in the following four contexts:

(308) Contexts for the Large Noun production experiment
  a. Isolation
  b. In a carrier phrase bounded by H tones (H_H)
  c. In a carrier sentence bounded by L tones (L_L)
  d. Combined with the first person singular pronoun (=*ɨ́*) in the L_L carrier sentence

The carrier sentences are given in (309).

(309) Carrier sentences for the Large Noun production experiment

a. H_H
*íⁿdʲeʔè ɲáɲí* ___ *kíjaβà*
í–ⁿdʲeˀè ɲáɲí = í ___ kíjaβà
PFV–see brother=1SG ____ last.year
'My brother saw ____ last year.'

b. L_L
*íⁿdʲeʔètʃì* ___ *ɲùũ*
í–ⁿdʲeˀè = tʃì ___ ɲuù$^{H}$
PFV–see=3GNRL _____ night
'They saw _____ in the night.'

In each of the carrier sentences the target word is the direct object and is immediately preceded by a nominal or pronominal subject with the desired context tone and followed by an adverbial beginning with the same context tone. The final context (308d) is a possessive construction where each of the stimuli are combined with the first person singular enclitic pronoun (= *í*) and produced in the L_L carrier sentence (309b). As described in §2.5, the pronoun, which comprises a single vowel and its tone, either coalesces with the final vowel of the couplet if it has the structure (C)V(ˀ)CV (e.g. /tɨ́nàmà/ 'tomato' + / = í/ '1SG' → *tɨ́nàmẽ*) or fills the final vowel position of (C)V(ˀ)V couplets (e.g. /tùʃî/ 'rod of discipline' + / = í/ '1SG' → *tùʃìí*). In both cases, however, the pronoun tone (after tonal processes have applied) replaces the final couplet tone, which causes some interesting tonal alternations in some tonal melodies.

## D.3 Procedures

Before the experiment it was explained to the subjects how each of the stimuli would be given within the carrier sentence and they were given a sheet with the stimuli in the carrier sentence written in Mixtec and Spanish. The Mixtec orthography did not include tone markings. They were allowed to familiarize themselves with the list on their own and were given help understanding the Mixtec where needed. Subjects did not have access to the sheet with the stimuli during the experiment. Instead, the subjects were prompted by the author using the Spanish gloss of the target item (Spanish is the language of wider communication in the area), and the subjects responded in

Mixtec with the target item appropriately embedded in the carrier sentence. This procedure was followed in order to elicit more natural speech than reading off a list (cf. Ladefoged 2003:23). If the subject was unsure of the proper Mixtec response, the target item was not spoken in Mixtec, instead, she was guided to the correct response in other ways to avoid priming her pronunciation. Each item on the list was elicited eight times consecutively in order to make it easier for the subject to respond and cause the experiment to flow more quickly (cf. Gerfen 1996:41). However, additional repetitions were elicited if the author judged that a pronunciation was not fluent in some way (e.g. hesitation, voice "cracking"), or if an external disruption occurred (e.g. rooster crowing, dog barking). Only eight fluent repetitions were chosen for analysis.

Recording was done in the field so a makeshift recording "studio" was created inside a building as described in A.3. The experiment was paused when loud outside noises might interfere (e.g. roosters crowing, thunder). Subjects held a Shure SM58 unidirectional microphone close to their mouth during productions. Digital recordings were made by the author using a Marantz PMD660 solid state recorder at a sampling frequency of 44.1 kHz in the WAVE file format. All stimuli for each part of the experiment were recorded in a single session for each subject.

The order of items given in §D.5 was followed except that the second column of the wordlist (items 20–38) was overlooked for the isolation context for subject AHM and was recorded later in the session. Subjects recorded the wordlist in all four contexts in a single session, but took one or more breaks while another subject was recorded. It should also be noted that all tokens of a wordlist item for two speakers were accidentally omitted in the original experiment, but these were added approximately a year later by the same subjects.

## D.4 Measurements

Raw sound files were transferred to the author's computer where they were annotated by hand using Yi Xu's ProsodyPro v6.1.4 beta script (Xu 2013) for Praat (Boersma & Weenink 2016). The segment boundaries for the vowel portion of each syllable were marked by visual inspection of the waveform, spectrogram and formant tracks and were given a label. The ProsodyPro script handled the logistics of creating, saving and editing annotation files, and when the annotations were completed, it was also used to extract acoustic measurements from the labeled (vowel) intervals in the Praat TextGrid files.

ProsodyPro extracts many acoustic measurements (for a list see Xu (2013)), but the most important for the purposes of this study is time-normalized f0, since this is used to display the canonical pitch contours of the stimuli. Time-normalization is accomplished in the script by taking ten equidistant samples from each labeled interval. This procedure allows for averaging across multiple repetitions of the same item for each speaker and across multiple speakers' productions of the same item. It should be noted that due to time constraints, the data from this experiment has not been completely analyzed. One male speaker's data for the isolation, L_L and H_H contexts has been processed in ProsodyPro and the averaged f0 data for each item imported into R (R Core Team 2017) for visualization and analysis using scripts written by the author. The averaging of multiple repetitions of each item for the isolation context was accomplished using the ProsodyPro v6.1.4 beta script, however, due to data handling limitations of the beta script, the non-beta v5.6.1 script was used for averaging the item repetitions for the L_L and H_H contexts. Averages are calculated by the script by first converting f0 values to logarithms, calculating the average of the logarithmic values and then converting the averages back to Hertz values for plotting.

## D.5 Stimuli

The following table gives the list of stimuli for the production study of three and four-mora nouns in the order they were elicited. These were produced by subjects in the contexts given in (308).

Table 81. Wordlist for the Large Noun production study (2015)

| No. | Mixtec | Gloss | Comment |
|---|---|---|---|
| 1. | *tùˈtɨtɨ̀* | ‘tololote tree’ | *tù–* ‘WOOD’ + ? |
| 2. | *ɲìˈʃĩjō* | ‘palm belt’ | |
| 3. | *sáˈlérú* | ‘heron’ | |
| 4. | *tùˈtàtá* | ‘cultivated trees’ | *tù–* ‘WOOD’ + *tátá* ‘descendants’ |
| 5. | *tùˈtʃítò* | ‘ditch reed’ | *tù–* ‘WOOD’ + *tʃítò* ‘bed’ |
| 6. | *tɨ̀ˈʃĩ́ɲĩ́*$^{L}$ | ‘ridge pole’ | *tɨ–* ‘RND’ + *ʃíɲí*$^{L}$ ‘head’ |
| 7. | *tɨ́nãnã̏* | ‘tomato’ | *tɨ̀–* ‘RND’ + ? |
| 8. | *tɨ᷄ˈkiʃĩ̏* | ‘moth’ | *tɨ̀–* ‘ANML’ + *kiʃĩ̏* ‘glue’ |
| 9. | *nũ̋ˈsòkó/nũ̋ˈsokò* | ‘shoulder’ | *nũ̋ũ̋*$^{L}$ ‘face’ + *sókó* ‘arm’ |
| 10. | *nũ̋ˈ*$^{n}$*duβà* | ‘Oaxaca City’ | *nũ̋ũ̋*$^{L}$ ‘face’ + $^{n}$*dúβá* ‘guaje fruit’ |
| 11. | *tɨ́sɨ́kɨ́* | ‘hair bauble’ | *tɨ̀–* ‘RND’ + ? |
| 12. | *tɨ̀ˈkaˀà* | ‘coconut’ | *tɨ̀–* ‘RND’ + ? |
| 13. | *ɲã̏ˈsɨ̀ˀɨ̄* | ‘wife’ | *ɲãˀã̏* ‘woman’ + *sɨ̀ˀɨ̄* ‘female’ |
| 14. | *jùˈkùˀú*$^{L}$ | ‘bathroom’ | *juˀù* ‘mouth’ + *kúˀú*$^{L}$ ‘bush’ |
| 15. | *ɾàˈ*$^{n}$*dʲíˀí* | ‘children’ | *ɾà=* ‘3MASC’ + $^{n}$*dʲíˀí* ‘small’ |
| 16. | *tɨ̀ˈnɨ̋ˀɨ̋*$^{L}$ | ‘twins’ | |
| 17. | *túˈ*$^{n}$*doˀò* | ‘suffering’ | *tũ̋ˀũ̏* ‘word’ + $^{n}$*doˀò* ‘beat’ |
| 18. | *tʃáˈʃèˀũ̋* | ‘your armpit’ | *tʃá*$^{L}$*=* ‘COMP’ + ? + *=ũ* ‘2SG’ |
| 19. | *tʃí᷄ˈtóˀó* | ‘owner’ | |
| 20. | *màˈtʃĩì* | ‘vulture’ | |
| 21. | *tùˈtʃĩī* | ‘rifle’ | *tù–* ‘WOOD’ + ? |
| 22. | *pèˈɾùú* | ‘watermelon’ | |
| 23. | *tùˈʃĩî* | ‘rod of discipline’ | *tù–* ‘WOOD’ + *ʃĩî* ‘tough’ |
| 24. | *tùˈkʷáá*$^{L}$ | ‘orange’ | *tù–* ‘WOOD’ + ? |
| 25. | *tɨ̀ˈ*$^{n}$*dáá*$^{L}$ | ‘gunny sack’ | *tɨ̀–* ?‘ANML’ + $^{n}$*dáá*$^{L}$ ‘agave fibre’ |
| 26. | *ɾáˈjɨ̀ɨ* | ‘man’ | *ɾà=* ‘3MASC’ + *jɨ̀ɨ* ‘male mate’ |
| 27. | *ɲũ̋ˈkʷĩì* | ‘fox’ | |
| 28. | *júˈkāà* | ‘sharpening stone’ | *júú*$^{L}$ ‘rock’ + *káà* ‘metal’ |
| 29. | *máˈjɨ́ɨ́* | ‘cicada’ | |
| 30. | $^{n}$*dutʲàˈɲũˀũ̏* | ‘ocean’ | $^{n}$*dutʲà* ‘water’ + *ɲũˀũ̏* ‘ground’ |
| 31. | $^{n}$*dutʲàˈβítʃĩ̏* | ‘soft drink’ | $^{n}$*dutʲà* ‘water’ + *βítʃĩ̏* ‘cold’ |
| 32. | *tʲĩ̋ɲũ̋ˈɲũ̋ũ̋* | ‘town work’ | *tʲĩɲũ̏* ‘work’ + *ɲũ̋ũ̋* ‘town’ |
| 33. | *kɨtɨ̀ˈʃã̏ã̋* | ‘animal’ | *kɨtɨ̀* ‘animal’ + *ʃã̋ã̋*$^{L}$ ‘fierce’ |
| 34. | *tʃátáˈjúkú*$^{L}$ | ‘Las Trojes (town)’ | *tʃátá*$^{L}$ ‘back’ + *jukù* ‘mountains’ |
| 35. | *tùkʷáˈijà* | ‘lime’ | *tùkʷáá*$^{L}$ ‘orange tree’ + *ijà* ‘sour’ |
| 36. | *tùkʷáˈjuù* | ‘guava’ | *tùkʷáá*$^{L}$ ‘orange tree’ + *júú*$^{L}$ ‘rock’ |
| 37. | *tʲúkuʃĩ́ɲĩ́*$^{L}$ | ‘fleas/stars’ | *tʲúkũ̏* ‘fly’ + *ʃíɲí*$^{L}$ ‘head’ |
| 38. | *sáβí᷄tátʲí*$^{L}$ | ‘rain storm’ | *sáβí*$^{L}$ ‘rain’ + *tátʲí*$^{L}$ ‘wind’ |