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Topics in Yalálag Zapotec, with Particular Reference to its Phonetic Structures

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TABLE OF CONTENTS

List of Figures vi
List of Tables .... ix.
List of Abbreviations xi

1 Introduction 1
1.1 Outline of the Dissertation 1
1.2 The Yalálag Zapotec Language and its Speakers 3
1.3 Previous studies of Zapotec Languages and Yalálag Zapotec 5

2 Morphology 9
2.1 Introduction to the Spelling System 9
2.2 Noun Morphology 11
2.2.1 Possession 12
2.2.1.1 Inalienable Possession 12
2.2.1.2 Alienable Possession 14
2.2.2 Definitness 18
2.2.2.1 *-n* allomorphy 21
2.2.3 Plural 22
2.3 Verb Morphology 23
2.3.1 Postverbal Affixes 24
2.3.1.1 Plural 24
2.3.1.2 Pronominal Clitics 26
2.3.1.3 Postverbal Suffixes 35
2.3.2 Prefixation 43
2.3.2.1 Aspectual-temporal Prefixes 43
2.3.2.2 Secondary Aspects 47

3 Pronouns and Basic Sentence Structure 50
3.1 Independent Pronouns 50
3.2 Reflexive Pronouns 53
3.2.1 The Domain of Reflexive Coreference 54
3.2.2 Pronoun/reflexive Asymmetries 55
3.3 Reciprocal Pronouns 56
3.3.1 1sg Elision in *lolljto'* Constructions 59
3.4 Basic Sentence Structure 60
3.4.1 Word Order and Word Order Variation 60
3.4.1.1 Preverbal Arguments 61
3.4.1.2 Alternative OVS 63
3.4.2 The Antecedentless Binding Construction 65

4 Vowels, Consonants and Tone **74**
4.1 Preliminaries 74
4.2 Spectral Characteristics of YZ Vowels 75
4.2.1 Data and Methods 76
4.2.2 Vowel quality 77
4.2.2.1 Vowel Quality and the Phonemic Status of Back Vowels in YZ 84
4.2.3 Summary and Discussion of Vowel Qualities 89
4.3 Consonants 92
4.3.1 Plosives 93
4.3.1.1 Voice Onset Time 107
4.3.1.2 On the Devoicing of Stops 110
4.3.2 Sonorants 114
4.3.3 Fricatives 119
4.3.3.1 Devoicing of Fricatives 123
4.3.4 Approximants 125
4.4 Syllable Structure 129
4.4.1 The Internal Structure of the YZ Syllable 130
4.4.2 Consonant Clusters 135
4.4.2.1 Word Initial Clusters 136
4.4.2.2 Word Final Clusters 146
4.4.2.3 Loan Word Phonology and Consonant Clusters in YZ 151
4.5 Tone 156
4.5.1 Tone and Non-modal Phonation 160
4.5.2 YZ Tone and the Typology of Contour Tone Restrictions 165

5 Phonation in Yalálag Zapotec **174**
5.1 Phonation in Zapotecan Languages 174
5.2 Phonetic Characterization of Phonation in YZ 177
5.2.1 Laryngealized Phonation and 'Checked' Syllables 182
5.3 Acoustic Properties of Phonation in YZ 184
5.3.1 Spectral Properties of Phonation in YZ 185
5.3.1.1 Method 186
5.3.1.2 Results and Discussion 189
5.3.2 The Timing of Nonmodal Phonation 199
5.3.2.1 Method 199
5.3.2.2 Results and Discussion 201

6 A palatographic study of Yalálag Zapotec coronals 212
6.1 Method 213
6.2 Results 219
6.2.1 Articulation 219
6.2.2 Acoustics 228
6.2.2.1 Spectral Properties 228
6.2.2.2 Formant Transitions 231
6.2.2.3 Centroid Frequency for Sibilants 240
6.2.2.4 Fricative Duration 242
6.3 Summary and Discussion 243

7 The perception of Tone in Yalálag Zapotec 250
7.1 Introduction 250
7.2 Phonological Preliminaries 251
7.3 Method 252
7.3.1 Materials 252
7.3.2 Subjects 256
7.4 Procedure 257
7.4.1 Identification 257
7.4.2 Discrimination 258
7.5 Hypotheses 259
7.6 Results 260
7.7 Summary and Discussion 271

8 Functional Specialization in Tone Perception: Evidence from Dichotic Listening in Yalálag Zapotec 276
8.1 Introduction 276
8.2 Method 278
8.2.1 Participants and Materials 279
8.3 Dichotic task 279
8.4 Hypotheses 281
8.5 Results 283
8.5.1 Linguistic Stimuli 283
8.5.2 Non-linguistic Stimuli 288
8.6 Summary and Discussion 289
8.7 Concluding Remarks 293

References 303

LIST OF FIGURES

Figure 1. Map of Villa Hidalgo, Yalálag, in Oaxaca, Mexico 4
Figure 2. Modal and laryngealized vowels in YZ 10
Figure 3. Notation of tone in modal and laryngealized vowels 11
Figure 4. YZ verb morphology template 24
Figure 5. YZ pronoun system 51
Figure 6. Mean values and variances of the five modal vowels 79
Figure 7. Mean values of the four laryngealized vowels 81
Figure 8. Spectrograms showing the variation of /o/ 85
Figure 9. Phonemic status of back vowels in YZ 88
Figure 10. Overall mean values of modal and laryngealized vowels. 90
Figure 11. Waveform and spectrogram illustrating the production of /p/ and /b/ word finally 96
Figure 12. Contrast between /k/ and /g/ word initially 99
Figure 13. Spectrograms illustrating differences between /k/ and /kʷ/ 103
Figure 14. Lyman's derivation of vowels followed by glottal stop 105
Figure 15. Waveform and spectrograms illustrating the contrast /p/ and /b/ 108
Figure 16. Mean VOT values of YZ stops 109
Figure 17. Waveform and spectrograms showing the contrast between /t/ and /ð̥/ 111
Figure 18. Aiflow of voiceless and voiced segments in final position 113
Figure 19. Contrast between /nː/ - /n/ in initial position 117
Figure 20. Contrast /lː/ - /l/ in intervocalic position 119
Figure 21. Devoiced sibilant in word initial position 125
Figure 22. Spectrograms showing the contrast between /w/, /b/ and /g/ 128
Figure 23. Spectrograms showing the contrast between /j/ and /ʒ/ 129
Figure 24. Maximum syllabic template 131
Figure 25. Bimoraic syllable structure of stressed syllables in content words 133
Figure 26. Waveform and spectrograms of /stop-stop/ and /stop-sibilant/ clusters 139
Figure 27. Approximant-consonant clusters /wz̥/, /wtʃ/ and /wz̥/ 145
Figure 28. Spectrograms and waveforms for C-χ 150
Figure 29. Adaptation of Spanish in YZ loan words 153
Figure 30. Deletion of unstressed final nucleus 155
Figure 31. Spectrograms and F0 tracks of High, Low and Falling tones. 159
Figure 32. Average values of the tone space for two speakers 160
Figure 33. Pitch tracks illustrating the contrast of Low and High tone in laryngealized vowels 162
Figure 34. Pitch tracks illustrating the contrast between High and Falling tone in creaky vowels 163
Figure 35. F0 track of words illustrating the contrast between Falling and Low tone in laryngealized vowels 164

Figure 36. Gordon's implicational hierarchy of contour tone bearing ability 166
Figure 37. Pitch tracks and spectrograms illustrating the contrast between Falling and Low tone in syllables closed by a sonorant.. 168
Figure 38. High and Falling tone contrast in syllables closed by obstruents................. 170
Figure 39. High and Low tone contrast in vowels followed by a glottal stop 171
Figure 40. Intraspeaker variation of laryngealization in YZ... 180
Figure 41. Contrast between checked, rearticulated and modal vowels 184
Figure 42. Spectrum of modal and laryngealized vowels.. 188
Figure 43. Overall results of the measures H1- H2, H1-A1, and H1-A3 190
Figure 44. Gender differences in phonation type according to the H1-H2, H1-A1 and H1-A3 values 193
Figure 45. Intraspeaker variation in phonation type according to the measures H1-H2, H1-A1 and H1-A3 196
Figure 46. Duration of checked vowels and modal and creaky vowels in open and closed syllables 202
Figure 47. Values for modal, laryngealized and checked vowels according to the measures H1-H2, H1-A1 and H1-A3 at three points in the vowel 205
Figure 48. Rearticulated vowels contrasting High and High-Low tones....................... 209
Figure 49. Arrangement of phonation and tone domains in a laryngealized vowel 210
Figure 50. Static palatography method 215
Figure 51. Classification of articulation based on palatograms.................................... 217
Figure 52. Classification of articulation based on linguograms 218
Figure 53. Sketches illustrating the variability in place of articulation of stops: denti-alveolar/apico-laminal [t̪] and alveolar/apical [t]. 220
Figure 54. Sketches illustrating the articulation of sibilants.. 222
Figure 55. Articulation of affricates.. 224
Figure 56. Sketches illustrating the main variations of /tʃ/ and /dʒ/.............................. 224
Figure 57. Palatograms and linguograms of nasals /nː/ and /n/ 226
Figure 58. Linguograms of the retroflex articulation of the short nasal [ɳ] 227
Figure 59. Palatograms and linguograms of laterals /lː/ and /l/ 228
Figure 60. Spectra of fricatives... 230
Figure 61. Vowel formant and transitions of /a/ following /s, z, ʂ, ʐ, tʃ, dʒ/ 233
Figure 62. Spectrograms illustrating vowel formants and transitions after /s, ʂ, tʃ/. 234
Figure 63. Vowel formant and transitions of /a/ following stops /t, d/ 235
Figure 64. Average vowel formant and transitions of /a/ following nasals /nː, n/ 236
Figure 65. Formant values of /nː/ and /n/ for male speakers 237
Figure 66. Spectrograms for the words /nːàˀà/ 'now' and /nàʔ/ 'hand' 238
Figure 67. Vowel formants and transitions for /a/ following laterals /lː, l/ 239
Figure 68. Centroid frequency for sibilants 241
Figure 69. Average duration of sibilants... 242
Figure 70. Contrast between High, Low and Falling tone... 252
Figure 71. Pitch contours of the resynthesized stimuli 256

Figure 72. Overall identification and discrimination function for the continua (a) H>L, L>H, (b) L>F, F>L and (c)H>F, F>H 263
Figure 73. Identification and discrimination function for the continua (a) H>L, (b) L>F and (c) H>F for subject m8 265
Figure 74. Identification and discrimination functions for the continua (a) H>L, (b) L>F and (c) H>F for subjects f5, f6, f7, f8, m9, m10 and m11 270
Figure 75. Ranges of identification and category pivot shift for H and L tones in the H>L continua. 272
Figure 76. Acoustic properties of unmodified words /já/ 'sweathouse' and /jâ/ 'cane' used as base of the stimuli in the H>F continua. 273
Figure 77. Average frequencies of ear responses 283
Figure 78. Overall reaction times by ear response........ 284
Figure 79. Selective attention 285
Figure 80. Ear advantage and tone........ 285
Figure 81. Intraspeaker variation by tone and ear advantage 286
Figure 82. Selective attention and tone........ 287

LIST OF TABLES

Table 1. Practical orthography for Yalálag Zapotec consonants 10
Table 2. Pronominal clitics attached to a verb stem (regular series) 27
Table 3. *l*-subject clitics 28
Table 4. Animacy hierarchy of clitic order in YZ 31
Table 5. Adverbial suffixes 36
Table 6. Reflexive pronouns 53
Table 7. Reciprocal pronouns 57
Table 8. Contrast between modal and laryngealized vowels 77
Table 9. Mean formant frequencies and standard deviation of modal vowels 80
Table 10. Mean formant frequencies and standard deviation laryngealized vowels 82
Table 11. Free variation between [o] and [u] 85
Table 12. Phonemic contrast between /o/ and /u/ 86
Table 13. Yalálag Zapotec consonants 93
Table 14. Contrast in labial stops; /p/ from Spanish loan words 94
Table 15. Contrast in labial stops: /p/ - /b/ in native words 95
Table 16. Contrasts between /t/ and /d/ 97
Table 17. Contrast between /k/ ~ /g/ in word initial position and clusters 98
Table 18. /k/ in word final position 99
Table 19. Labio-velar /kʷ/ in YZ native words 100
Table 20. YZ labio-velar /kʷ/ in Spanish loans having [ku], [ko] and [xo] 101
Table 21. Stem initial consonant changes marking aspect 102
Table 22. Distribution of [χ], word finally and in clusters 104
Table 23. Free variation of [g] and [χ]. 104
Table 24. /r/ and /m/ in loan words from Spanish 115
Table 25. Long/short nasal contrast 116
Table 26. Place assimilation of short nasals 118
Table 27. Lateral fortis/lenis contrast 118
Table 28. Contrasts among fricatives 120
Table 29. Contrasts between the alveolar sibilants /s/-/z/. 121
Table 30. Laminal post-alveolar sibilants 122
Table 31. Phonetic variation of /ʒ/: [ʒ] ~ [dʒ] 122
Table 32. The contrast /tʃ/-/ʒ/ 123
Table 33. Devoiced fricatives in word final position 124
Table 34. Distribution of approximants /w/ and /j/ 126
Table 35. Causative alternation in verb stems beginning with approximants 127
Table 36. Vowel sequences in a syllable nucleus 132
Table 37. Cosonants in simple onset 134

Table 38. Consonants in simple coda 135
Table 39. Stop initial consonant clusters 137
Table 40. Word initial clusters. C1 is a stop 140
Table 41. Sibilant initial consonant clusters 141
Table 42. Word initial clusters. C1 is a sibilant 142
Table 43. Examples of resonant-C clusters 143
Table 44. Word initial clusters. C1 is a resonant 144
Table 45. Word final clusters 147
Table 46. Examples of consonant clusters in word final position. C1 is a stop 148
Table 47. Examples of consonant clusters in word final position. C1 is a sibilant. 148
Table 48. Examples of word final consonant clusters. C1 is a sonorant 148
Table 49. Correspondences of C-X clusters in YZ with other Zapotec languages and Proto-Zapotec 151
Table 50. Polysyllabic words in Spanish borrowed as monosyllables in YZ 152
Table 51. Trisyllabic words in Spanish borrowed as bisyllables in YZ 154
Table 52. Tone contrasts 157
Table 53. Creaky vowels with different tones 163
Table 54. Level and contour tones in syllables with high sonorous rimes 167
Table 55. Falling tone in syllables closed by obstruents 170
Table 56. Contrast of High and Low tone in syllables closed by a glottal stop 172
Table 57. Phonation contrast between modal and laryngealized voice in YZ 178
Table 58. Checked-rearticulated vowel contrast 182
Table 59. Word-list selected to investigate de contrast between modal, laryngealized phonation and the 'checked' vowel type 187
Table 60. Summary of a post hoc test showing the effects between modal and laryngealized voice plus checked vowel 191
Table 61. Reliability of the measures H1-H2, H1-A1 and H1-A3 as indicators of phonation type 194
Table 62. Range of variation of the three measures H1-H2, H1-A1 and H1-A3 197
Table 63. Contrast between voice type (modal-laryngealized) and checked vowels 200
Table 64. Reliability of duration as indicator of phonation type in open syllables and closed syllables 203
Table 65. Opacity of duration in rearticulated and laryngealized vowels 204
Table 66. Probability values from ANOVA tests at a three time interval 206
Table 67. Typology of tone and non-modal phonation interaction 211
Table 68. Word list for Yalálag Zapotec palatography 214
Table 69. Articulation of stops 220
Table 70. Articulation of fricatives 222
Table 71. Articulation of affricates 223
Table 72. Articulation of sonorants 225
Table 73. Formant values and c-v transitions of fricatives and affricates 233
Table 74. Formant values and c-v transitions of stops, laterals and nasals 240
Table 75. Dichotic pairs of tone and selective attention interaction 287
Table 76. Ear responses and forced conditions for hums 288
Table 77. Ear advantage of dichotic pairs and attention conditions for hums 289

LIST OF ABBREVIATIONS

1	first person
2	second person
3	third person
ANIMAL	animal
CAUS	causative
DET	determiner
DEIC	deictic
DEM	demonstrative
DIM	diminutive
DISTR	distributive
excl	exclusive
FAM	familiar
FL	forced to the left
FR	forced to the right
HAB	habitual
IMP	imperative
INAN	inanimate
incl	inclusive
INF	infinitive
INTENS	intensive
IRR	irrealis
ITER	iterative
L	l-subject
LEA	left ear advantage
NEG	negative
PERF	perfective
pl	plural
POSS	possessive
POT	potential
RFLX	reflexive
RCPR	reciprocal
REA	right ear advantage
RESP	respectful
RFLX	reflexive
sg	singular
STAT	stative
TOP	topic
VOT	voice onset time

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ABSTRACT OF THE DISSERTATION

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This dissertation is primarily intended as a description of the Yalálag Zapotec (YZ) language of Oaxaca, México, with particular reference to its phonetic structures. The first section is an introduction to the Yalálag Zapotec language, its orthography and basic facts of its grammar. Chapter 2 outlines the noun and verb morphology, and Chapter 3 presents a sketch of sentence structure. The second section provides a detailed description of the phonetic structures of the language. Chapter 4 deals with vowels, consonants and tone. The YZ five modal vowels and four laryngealized vowel are described here. The phonetic properties of consonants are also presented, including the phonetic correlates of the fortis-lenis contrast. It is shown that VOT is a reliable parameter for obstruents; the phonetics of obstruent devoicing and consonant clusters are discussed. A description of the three contrastive tones in YZ closes the chapter. YZ data

supports the typology of contour tone restrictions based on the weight of the rime: more sonorous and longer rimes are capable of bearing Falling tone; however, Falling tone can occur in non-sonorous rimes. Chapter 5 offers an analysis of vowel phonation, describing in detail the acoustic properties of modal and laryngealized vowels. The analysis shows that the time course of phonation in YZ is restricted to the edges of the vowel. This pattern suggests that the timing of nonmodal phonation is organized to guarantee the production and perception of multiple phonemic features that could otherwise contradict each other in actual implementation. Chapter 6 presents a palatographic and acoustic study of YZ coronals, denti-alveolars, postalveolars and alveo-palatals. The compression of coronal consonants in a narrow articulatory space allows us to observe the degree of variability in their production. The third section is composed of two chapters devoted to an investigation of the perception of tone in YZ. Chapter 7 investigates whether the perception of tone in YZ is categorical. Chapter 8 presents a dichotic listening experiment concerning the perception of linguistic and non-linguistic pitch in YZ. The results do not support a categorical perception of tone and show a consistent right ear advantage for lexical tone.

1 Introduction

1.1 Outline of the Dissertation

This dissertation is composed of eight chapters divided in three sections. Section I is an introduction to the Yalálag Zapotec (YZ) or *Di'llwrall* language, the orthographic conventions and basic facts of grammar. Chapter 1 gives general information about YZ and its speakers. Chapter 2 describes the noun and verb morphology, and Chapter 3 presents an sketch of the basic sentence structure.

The second section, divided in 3 chapters, provides a detailed description and analysis of the phonetic structures of the language. Chapter 4 deals with vowels, consonants and tone. This chapter examines the quality of the YZ vowel inventory. The modal series is a symmetrical system of five vowels, and the laryngealized series has only four vowels. In both cases the YZ vowels correspond to the dominant systems across languages. The phonetic properties of consonants are also presented in this chapter, including phonetic correlates of what has been labeled as fortis-lenis in other related languages. It is shown that VOT is a reliable parameter in classifying obstruents; several phonetic processes such as devoicing of obstruents and the phonetics implicated in the sequences of consonants is discussed; a section deals with the phonology of loans. A phonetic description of the three contrastive tones in YZ closes the chapter. Remarkably, the three lexical tones can co-occur with non-modal phonation. Data from YZ lends partial support to the typology of contour tone restrictions based on the weight of the rime: more sonorous and longer rimes are capable of bearing Falling tone;

however, Falling tone is for the most part unconstrained, as it occurs in almost any type of rime.

Chapter 5 offers an analysis of vowel phonation, describing in detail the acoustic properties of modal and laryngealized vowels. Non-modal phonation has a great individual, inter-speaker and gender based variability. The description of non-modal phonation shows that the time course of phonation in YZ is restricted to the edges of the vowel. The pattern of YZ offers a parsimonious solution to the contradictory combination of underlying specifications, tone and non-modal phonation, by rearranging the features throughout the vowel, so that every feature is maximally recovered in perception.

Chapter 6 presents a palatographic and acoustic study of YZ coronals, denti-alveolars [t, d, lː, n̪ː, s, z, n, ɾ], postalveolars [s̺, z̺] and alveo-palatals [tʃ, ʒ]. This study provides a detailed phonetic account of these sounds to finally determine the differences that reliably might distinguish between these sounds. The compression of various coronal consonants in a narrow articulatory space allows us to observe the degree of variability in the production of these sounds. The results obtained here are consistent with the view that articulatory variability is allowed in a compressed space as far as its acoustic properties remain constant.

The third section is composed of two chapters investigating the perception of tone in YZ. Chapter 7 addresses fundamental questions about the nature of tone perception in YZ. An experiment was carried out to investigate what is the perception of tone of a series of units changing along the F0 continuum, in particular whether differences in perception correlate with the boundary of a phonemic unit but not within the domain of the phonemic unit. Chapter 8 is a study of a dichotic listening experiment of linguistic and non-linguistic pitch in YZ. The results of this study show a consistent right ear advantage for lexical tone, in contrast with the inconsistent pattern found for non-linguistic pitch stimuli. In addition, the results support the hypothesis that selective attention to pitch stimuli, forcing the attention to one ear, enhances the perception of the attended ear rather than suppressing the intrusions from the non-attended ear. The correlation between the contrastive tones of Yalálag Zapotec and their pattern of lateralization shows better discrimination of High and Falling tones than of Low tone. Other consequences of these findings are discussed.

1.2 The Yalálag Zapotec Language and its Speakers

Yalálag Zapotec is an Oto-Manguean language spoken in Villa Hidalgo (formerly Yalálag), in the Municipality of Villa Alta, Oaxaca, Mexico. According to the Mexican census for the year 2000, there were 2115 people residing in Yalálag (INEGI, 2001). There are Yalaltec settlements in Oaxaca City; Playa Vicente, Veracruz; Mexico City, the US, especially to Los Angeles, CA. However, a number of speakers living outside of Yalálag is undetermined (Cruz Manjarrez, In progress). The language described here represents the speech of Yalálag immigrants as well as people in the town. All the consultants were born and raised in Yalálag. The immigrants have spent an average of 10 years in the US, where they learned Spanish and English. Nevertheless, YZ is their native, first language, which moreover they use on a daily basis in different contexts (at home, with co-workers, or on the phone with family and friends, for example).

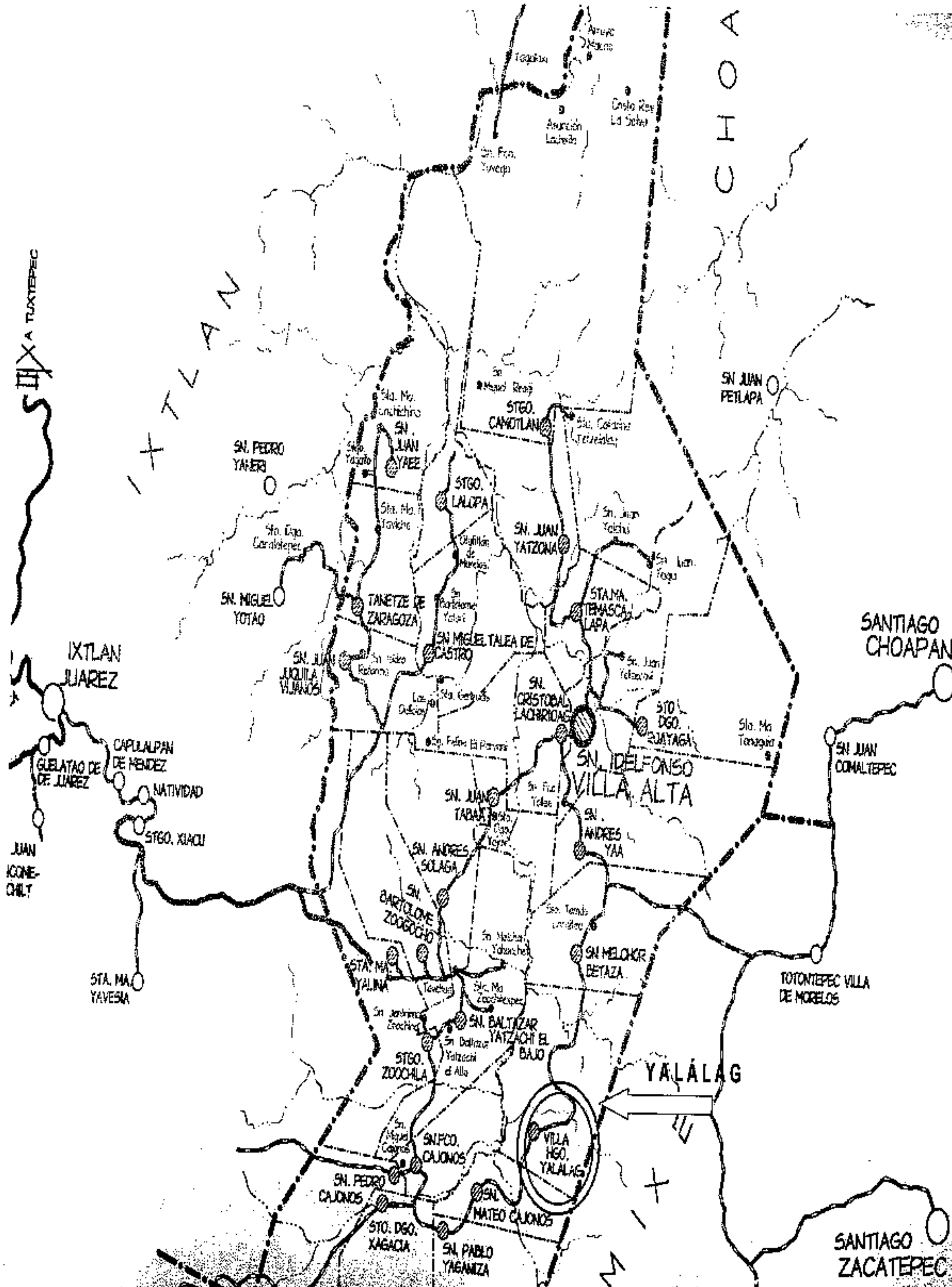


Figure 1. Map of Villa Hidalgo, Yalálag, in Oaxaca, Mexico (adapted from García García *et al.* n.d. [1995])

1.3 Previous studies of Zapotec Languages and Yalálag Zapotec

Zapotec languages have been described as early as the sixtennth century (Cordoua, 1578a; b). There are some other early works from the nineteenth century and the beginning of the twentieth century (Belmar, 1890; Peñafiel, 1880-1894; Pimentel, 1874), which documented vocabularies of Oto-Manguean languages from Oaxaca, and recognize the diversity of Zapotecan languages including Zapotec languages and Chatino (cf. Smith-Stark, 1994 for a summary of the works from that period).

Contemporary studies and literature of Zapotecan languages are not homogeneous. The Ethnologue recognizes 58 different Zapotec languages (Grimes, 2000). From this great variety of languages there are some which have been better described than others. There is a significant number of studies and literacy materials produced by affiliates of the SIL linguistic. Besides the works by SIL there is a number of studies produced by Mexican scholars (Fernández de Miranda, 1995; López Cruz, 1997; Rendón, 1995; Smith-Stark, 1994; 2000). In addition, there are recent studies and dissertations produced in several universities in the US, such as the University of Pittsburg, UC Berkeley and UCSC, and notably the series of publications, thesis and dissertations produced at UCLA, to which this dissertation is added.

With respect to YZ, there are works such as De la Fuente (1949), which only include words in isolation sith accompanying ethnographical information. Molina Cruz has published a vast and important series of poetry and literature in YZ (Molina Cruz, 1995; 1996; 1997a; b; 1998; 2000; 2001; 2003a; b). However, the most important linguistic studies are the works by Newberg (López L., 1990; Newberg, 1983; 1987) and

López and Newberg (1990). Newberg (1983) is an unpublished manuscript dealing with the phonology of the language. The study describes the distribution and allophonic processes of the sound pattern of YZ. Newberg (1987) is about discourse analysis. López and Newberg (1990) is a study about the verbal morphology of YZ, one of the crucial and most complex areas of Zapotec languages. It describes the morphological alternations induced by temporal/aspectual prefixes and by the pronominal clitics, as well as some other adverbial ciltics that can be attached to the verb stem. López and Newberg includes also a list of paradigms and a proposed list of classes based on these paradigms. These works have been very useful and have been frequently taken as a point of reference for my own work. Finally, I wrote a Master's thesis on the fortis-lenis issue (Avelino, 2001), and have published two papers (Avelino, 2003; 2004) presenting preliminary results about topics that are fully developed in the present dissertation. Besides these works, to my knowledge, there is no other linguistic documentation of the YZ language.

YZ is closely related to other languages from the Sierra area. Studies of such related languages include Butler (1976, 1980); Bartholomew (1983); Marks (1976); Nellis and Hollenbach (1980); Nellis and Nellis (1983); Jeager (1983); Leal (1950, 1954); Long (1999). These works are particularly relevant for this disseration as they deal with varieties of Zapotec that, according to my consultants and my own observations, are intelligible with YZ (see also Rendón, 1995). Among these studies, the grammars and dictionaries of Yatzachi Zapotec and Zoogocho Zapotec have been extensively consulted.

I

An introduction to the grammar of Yalálag Zapotec

In this section I will present an introduction to basic facts of the grammar of the YZ language. I tried to write this section without referring to any theoretical framework or assuming a specific formalization. Instead, I tried to provide a descriptively adequate account of YZ. It is aimed thus that any one interested in the topics presented here could use this description. I have included as many examples coming from texts as I could, although elicited data complemented and provided crucial evidence. The section is composed of two chapters. The first one is devoted to the morphology of nouns and verbs, which serves as a necessary prerequisite to understanding the second chapter, which outlines the basic sentence structure of YZ.

There are comparable descriptions of other Zapotec languages closely related to YZ, such as Bartholomew (1983) for Atepec Zapotec, Butler (1980) for Yatzachi el Bajo Zapotec, and Long and Butler (1990) for Zoogocho Zapotec. YZ grammar is in many respects very similar to those of these languages, and, in fact, it seems that speakers of YZ have a good degree of intelligibility with speakers of last two varieties, as well as with most of the languages of the Villa Alta District; however, there are also differences that will be highlighted where necessary. Thus, the description presented in this section could also be taken as a source for comparative studies in Zapotecan languages.

2 Morphology

2.1 Introduction to the Spelling System

In this chapter I will use a practical orthography for YZ (Section II deals with the phonetics on the language in detail). Table 13 shows the letters used to represent the consonants of YZ. Letters on the right of individual cells in italics stand for voiced segments. The letters in parentheses are found mainly in Spanish loanwords. Two allophones have been included in the orthography. The uvular allophone of /g/ is written with the letter *j*. The palato-alveolar /ʒ/ is frequently devoiced. In general, the digraph used for both the voiced and the devoiced forms will be *ll*; however, some speakers feel that the derived allophone should be distinguished in the written form of some words (there are just a handful of such a cases) so it was reasoned that the written form could not be harmed by using a separate digraph *sh* for this allophone.

Table 1. Practical orthography for Yalálag Zapotec consonants								
	Bilabial	Dental	Alveolar	Post-Alveolar	Palato-Alveolar	Velar	Labio - Velar	Glottal
Plosive	p *b*	t *d*				k *g*	kw	’
Affricate					ch			
Nasal	m	nn	n		(ñ)			
Fricative	(f)	s *z*		x *xh*	sh *ll*	j		
Lateral		*l*	*r*					
Trill			(*rr*)					
Approximant					*y*	*w*		

There are nine phonemic vowels in YZ, five vowels with modal phonation and four with laryngealized phonation. The representation of the modal vowels is straightforward. For the laryngealized vowels I will adopt a sequence of a vowel followed by an apostrophe and then another vowel. The series of vowels are presented in Figure 2 below.

Modal: a, e, i, o, u
Laryngalized: a’a, e’e, i’i, o’o

Figure 2. Modal and laryngealized vowels in YZ

The three phonemic tones, High, Low and Falling, will be represented by accents over the vowels (Figure 3). Informal tests with native speakers regarding the legibility of the tone diacritics showed that their use in forms in isolation is helpful for disambiguating pairs contrasting in tone; however, the native speakers found using the tone marks in reading and writing sentences and texts was not helpful; one of the main sources of confusion was changes of tone in stems conditioned by grammatical factors, such as the High tone introduced in the potential aspect or the modification produced by the first person. In most cases, the native speaker reader was guided more by the context than by the orthography. Based on this observation, it was decided not to indicate tone in the present section, except where it was necessary for clarifying potentially ambiguous forms.

v́	v́'v́	high tone
v̀	v̀'v̀	low tone
v̂	v́'v̀	falling tone

Figure 3. Notation of tone in modal and laryngealized vowels

2.2 Noun Morphology

YZ nouns can be simple noun roots or compounds of two nouns. There is also a large class of deverbal nouns derived by means of a prefix that forms abstract nouns. The inflectional noun morphology of YZ is restricted to the expression of possession, number (plural) and definitness. Other categories such as number, gender, dimension and deixis are not expressed in the noun morphology but indicated by separate words (adjectives, numerals, quantifiers and determiners) or expressed in the verb morphology. In this section, I will cover the description of possession and definiteness.

2.2.1 Possession

Like many other Mesoamerican languages, YZ makes a distinction between alienable and inalienable possession. Inalienable possession expresses a relationship that in the YZ culture is viewed as inherent, permanent or intimate, such as the categories of body parts and kinship terms and part-whole relations. Alienable possession, in contrast, expresses a conventional type of possession (Chappell, 1996; Nichols, 1988). YZ is head-initial, thus possessors come after possessed nouns consistently. There are two types of possessive constructions, direct and periphrastic. Direct constructions indicate the possessor with a noun or a pronominal clitic after the possessed noun without any additional marking on it. Periphrastic constructions uses a preposition between the possessed noun and the possessor; this type of construction is only found in alienable possession.

2.2.1.1 Inalienable Possession

The nouns belonging to this class cannot stand alone but are obligatorily possessed. The noun phrase that indicates possessor does not receive any marking. Possessors can be expressed either by the same set of clitics as those indicating person in verb inflection, or by a noun, in which case there is no additional marking on the noun. A number of examples illustrating inalienable possession are given below.

a) Body parts

(1) yichj=a' 'my head'
    head=1sg

(2) yichj=to' 'our heads'
head=1pl.excl

(3) nian Stel-en 'Estela's arm'
arm Estela-DET

(4) raw bidao'-n 'the boy's eye'
eye boy-DET

b) Kinship terms

(5) zan=a' 'my brother'
brother=1sg

(6) xhazw=e' 'his grandson'
grandson=3sg.RESP

(7)	xhazw grandson	Kwse Jose	'Jose's grandson'
(8)	xa' father	Adriana Adriana	'Adriana's father'

Some nouns, including kinship terms and body parts, show variation among speakers as to whether they are considered obligatorily possessed or not; hence, for some speakers, unpossessed noun forms are acceptable (in the sense that speakers can give the unpossessed noun as citation form), while for others, they are not. My younger consultants are more willing to accept the unpossessed forms than the older ones are.

(9) xnà' 'mother' (unpossessed)
(10) xná=o' 'your mother'
mother=2sg

(11) ra' 'name' (unpossessed)
(12) ra'=llo 'our name'
name=1pl.incl

(13) lloa' 'mouth' (unpossessed)
(14) lloa'=be' 'your mouth'
mouth=3sg.FAM

2.2.1.2 Alienable Possession

For nouns which are not alienably possessed, possession is expressed by one of two mechanisms: (i) a prefix *x-* before the stem, and (ii) by the *ke-* preposition, quasi-equivalent to the English preposition 'of' followed by the possessor. It cannot be predicted whether a noun will express possession with the *x-* prefix or with the preposition. Some nouns can use both mechanisms for expressing possession; for others, only one is allowed (see examples in 2.2.1.2.2).

2.2.1.2.1 Posession with *x-*

The function of the prefix *x-* is to indicate that the noun to which it is attached is possessed by the noun following it. In some nouns, prefixation of *x-* causes quite noticeable modifications of the following stem. Three types of phonological changes are documented: a) changes in the voicing of the initial consonant of the stem (voiced to voiceless; however, not all the nouns starting with voiced consonants experience the change); b) deletion of the first consonant of the stem; and c) changes in the whole syllable of the stem. These modifications seem to be a stable feature in the Zapotec languages of the area, as they have also been recorded in Zoogocho Zapotec and Yatzachi el Bajo Zapotec.

a) Changes in the first consonant of the stem from voiced to voiceless.

(15) llen 'blood'
(16) x-chen=a' 'my blood' (*xllena')
POSS-blood=1sg

(17) llin	'work'	
(18) x-chin=a' POSS-work=1sg	'my work'	(**xllina'*)

(19) llit	'bone'	
(20) x-chit=a' POSS-bone=1sg	'my bone'	(**xllita'*)

(21) beb	'trash'	
(22) x-peb=a' POSS-trash=1sg	'my trash'	(**xbeba'*)

(23) be'ch	'louse'	(**xbe'cha'*)
x-pe'ch=a' POSS-louse=1sg	'my louse'	

(24) zu	'fermented beverage (made of pineapple)'	(**xzua'*)
x-su=a' POSS-fermented=1sg	'my fermented beverage'	

(25) zet	'young shoot of a squash vine'	(**xzeta'*)
x-set=a' POSS-shoot.of.squash=1sg	'my young shoot of a squash vine'	

b) Deletion of the stem initial consonant. The replacement of the initial consonant applies only to some of the stems beginning in nasal *n*.

(26) nis			'water'	
(27) x-is POSS-water	be'nn man	ka' pl	'the men's water'	(**xnis*)

(28) no'or	'woman'	
(29) x-o'or=a' POSS-woman=1sg	'my wife'	(**xno'ora'*)

(30) nay	'ear'	
(31) x-ay=a' POSS-ear=1sg	'my ear'	(**xnaya'*)

c) Changes in the stem. The examples involve the semivowel y and, in a unique example, the initial syllable *be'* of the word for 'dog'.

(32) yet		'tortilla'	
(33) chixh	Stel-en	'Estela's tortilla'	(**xyeta'*)
POSS.tortilla	Estela-DET		
(34) ye'n		'dish'	
(35) x-le'n=a'		'my dish'	(**xye'na'*)
POSS-dish=1sg			
(36) be'kw		'dog'	
(37) xi'kw=a'		'my dog'	(**xbe'kwa'*)
POSS.dog=1sg			

2.2.1.2.2 Possession with *ke*

As mentioned earlier, possession of some nouns is expressed with the preposition *ke* 'of' followed by a clitic noun possessor. The words cited below can express possession only with the preposition *ke* and the clitic series. The forms in parenthesis were elicited to test the possibility of possession using *x*-; however, the consultants rejected these forms systematically.

(38) llum			'basket'	
llum		ki=a'	'my basket'	(**xuma'*)
basket		of=1sg		
(39) lle'			'jar'	
lle'	ke	no'or-en	'the woman's jar'	(**xlle'e*)
jar	of	woman-DET		
(40) nisyes			'sweat'	
nisyes	ki=a'		'my sweat'	(**xisyesa'*)
sweat	of=1sg			

(41) ni'ix 'urine'

ni'ix	ke	bidaon'	'the boy's urine'	(*xi'ix*)
urine	of	boy		

2.2.1.2.3 Possession with *x-* and ke

Some nouns can be possessed either by the preposition or the possessive prefix. There is no clear difference in meaning, and out of an appropriate context, both forms are considered equivalent for native speakers. It seems, however, that direct constructions are used primarily to express inalienable relations, while periphrastic constructions indicate ownership or belonging. The sentences below exemplify a comprehensible contrasts in the meaning of the two types of constructions.

(42)

Bi	w-ka'n=o'	be'el	ki=a'.
NEG	PERF-take=2sg	meat	of=1sg

'Don't take my meat.' (the meat belongs to me, but is not from my body)

(43)

Bi	w-ka'n=o'	x-pel=a'.
NEG	PERF-take=2sg	POSS-meat=1sg

'Don't touch my flesh.' (the flesh of my body)

(44)

Go'ot=a'	llen	ki=a'.
IRR.sell=1sg	blood	of=1sg

'I'm going to sell my blood.' (the blood belongs to me, but it comes from an animal)

(45)

Go'ot=a'	x-chen=a'.
IRR.sell=1sg	POSS-blood=1sg

'I'm going to sell my blood.' (my own blood)

In addition, the forms with the prefix *x-* suggest for native speakers a more intimate or permanent type of possessive relation in the sense that a form like (46) can be said of a new grill that Estela just bought; in contrast with (47), that might refer to a grill that has been with Estela for a long time or one that she has received as an inheritance. The rest of the examples illustrate similar contrasts.

(46) llir ke Stel-en 'Estela's grill'
grill of Estela-DET

(47) x-chir Stel-en 'Estela's grill'
POSS-grill Estela-DET

(48) llin ke Stel-en 'Estela's job'
work of Estela-DET

(49) x.in Stel-en 'Estela's job'
POSS.work Estela-DET

(50) yet ki=a' 'my tortilla'
tortilla of=1sg

(51) chi'x=a' 'my tortilla'
POSS.tortilla=1sg

2.2.2 Definitness

The form *–n* indicates that a noun in a sentence is highly individuated; it occurs, for instance, when a noun has been mentioned previously in the discourse or its identity is already known (cf. Butler 1980 and Long 1999 for a similar characterization of a cognate morpheme). The suffix does not appear on pronouns. The examples in (52)-(53) illustrate the contrast of a definite, determined noun and an indefinite, undetermined noun, which is not marked by the *–n* suffix.

(52) B-nit Xheb-en mell-en.
PERF-lose José-DET money-DET
'José lost the money.'

(53) B-nit Xheb-en mell.
PERF-lose José-DET money
'José lost money.'

The determiner *-n* can occur after the plural marker *ka'* (2.2.3). The difference in meaning between forms with plural plus *-n* and those without *-n* is very subtle, and not always easy to understand. In general, the forms with *-n* confirm the that its presence makes reference to already known or previously mentioned entities. The example in (55) can be undesrstood in a context where the phrase *yetgo' ka'n* refers to some particular set of tamales, in contrast with (54), which only mentions a quantity of the tamales without any further implication. The contrast suggests, thus, that *-n* is more like a definite article, regardless of the number of the noun phrase.

(54) Stela b-daw=be' yetgo' ka'.
Estela PERF-eat-3.FAM tamale pl
'Estela ate tamales.'

(55) Stela b-daw=be' yetgo' ka'-n.
Estela PERF-eat-3.FAM tamale pl-DET
'Estela ate those tamales.'

(56) Gare w-xua Gladis libr ka'?
where PERF-put Gladis book pl
'Where did Gladys put books?'

(57) Gare w-xua Gladis libr ka'-n?
where PERF-put Gladis book pl-DET
'Where did Gladis put those books?'

The pairs of sentences below present further evidence about the meaning of *-n*. For example, in (59) the object being questioned, *mell* 'money', is unknown and therefore cannot be definite. Native speakers consider the ungrammaticality of this type of sentences similar to ungrammatical English sentences such as **How much the money did José lose?* It is worth noting that speakers frequently translate proper nouns into Spanish with an article *el* or *la* 'the' (*el José, la Adriana*), which are otherwise, non-standard in the Spanish from Oaxaca; it is likely that this use reflects a Zapotec substrate.

(58)	Garke	mell	b-nit	Xheb-en?
	how.much	money	PERF-lose	José-DET
	'How much money did José lose?'			

(59)	*Garke	mell-en	b-nit	Xheb-en?
	how.much	money-DET	PERF-lose	José-DET
	intended: 'How much money did José lose?'			

(60)	Garke	yetgo'	b-daw	Adriana-n?
	how.many	tamale	PERF-eat	Adriana-DET
	'How many tamales did Adriana eat?'			

(61)	*Garke	yetgo'-n	b-daw	Adriana-n?
	how.many	tamale-DET	PERF-eat	Adriana-DET
	intended: 'How many tamales did Adriana eat?'			

In general, speakers consider a sentence as degraded if a definite noun does not have the –*n* suffix. However, judgments also depend on the pragmatic information given by the particular construction and are subject to individual variation; thus, there are some elicited sentences containing definite nouns which are not –*n* marked but are considered grammatical. Examples of this pattern are shown in (62) and (63); however, sometimes, as shown in (64) and (65), the absence of -*n* degrades the sentence. A noun cannot have –*n* simultaneously with the indefinite *to* 'one', 'a' as illustrated in (66) and (67). Other than these generalizations it is not known yet what governs the appearance of the –*n* suffix in a sentence. Further research on spontaneous speech is needed to clarify this aspect of the grammar of YZ.

(62) B-sa'al be'kw bidao'.
PERF-CAUS:fall dog boy
'The dog made the child fall down.'

(63) B-chew be'kw nada'.
PERF-kick dog 1sg
'The dog kicked me.'

(64) Bidao'-n b-yal=be'.
boy-DET PERF-fall=3sg.FAM
'The boy fell down.'

(65) ?Bidao' b-yal=be'.
boy PERF-fall=3sg.FAM
intended: 'The boy fell down.'

(66) To bidao' b-yal=be'.
one boy PERF-fall=3sg.FAM
'A boy fell down.', 'One boy fell down.'

(67) *To bidao'-n b-yal=be'.
one boy-DET PERF-fall=3sg.FAM
intended: 'A boy fell down.', 'One boy fell down.'

2.2.2.1 *-n* allomorphy

–n has an *–en* allomorph conditioned by the features of the final segment of the preceding stem. When the stem ends in a vowel *–n* is suffixed directly as in (68) and (69); the form *-en* occurs if the stem ends in a consonant as in (70) and (71).

(68) Ll-tas Adriana-n.
HAB-sleep Adriana-DET
'Adriana is sleeping.'

(69) B-zu Ria-n to yaj yichj Adriana.
PERF-put Maria-DET one flower head Adriana
'Maria put a flower in Adriana's head.'

(70) Xheb-en b-zuteks=be' ke waya'.
José-DET PERF-live=3sg.infor of dance
'José lived for dancing.'

(71) B-xhill=e' payas-en bidao' ka'.
PERF-make.laugh=3sg.RESP clown-DET boy pl
'The clown made the children laugh.'

2.2.3 Plural

The plural of nouns in YZ is expressed with the word *ka'* after the noun. Sentences (72)-(82) illustrate the plural *-ka'* in subjects, topics, objects, and possessors (cf. 2.2.1).

(72) B-a-zay be'nne gul ka'.
PERF-ITER-come.back person old pl
'The ancestors came back again.' (Molina, 2001:52)

(73) Tochopse no'or ka' b-titj=gak=e' be'nn bio' ka'.
a.few woman pl PERF-criticize=pl=3.RESP person male pl
'Some women criticized the men.'

(74) B-et be'nn ka' yo' ka' ke Mixh ka'.
PERF-sell person pl house pl of Mixe.people pl
'The men sold the houses to the Mixe people.'

Sentences (75)-(79) show the position of *ka'* in more complex noun phrases. In the cases of possessive noun phrases, the plural marker occurs after the whole possessive phrase, i.e. after the possessor. However, it is perhaps possible that this pattern occurs only when the possessor is pronominal or cannot be pluralized. Note that in (74) the plural marker, *ka'* follows a possessed noun, before a plural possessive phrase. As the examples (76) and (78) show, the plural cannot occur contiguous to the the possessed noun *xhiya* 'key' to which is associated with, instead it appears after the possessors *kia'* and *keto'*, respectively.

(75) B-nit xhiya ki=a' ka'.
PERF-lose key of=1sg pl
'I lost my keys.'

(76) *B-nit xhiya ka' ki=a'.
PERF-lose key pl of=1sg
'I lost my keys.'

(77) Ba b-a-llele xhiya ke=to' ka'
already PERF-ITER-find key of=1pl.EXCL pl
'We already found our keys again.'

(78) *Ba b-a-llele xhiya ka' ke=to'
already PERF-ITER-find key pl of=1pl.EXCL
'We found our keys.'

(79) Wenchnanen bej k=o' ka' ch=il=o' yayel ka'.
because with cloud of=2sg pl HAB-water=2sg cornfield pl
'So that with your clouds, you water the cornfields'

2.3 Verb Morphology

Verb morphology is more complex than noun morphology in YZ. One series of suffixes indicates the number and person, another series conveys information about mode. A series of prefixes indicates temporal/aspectual and modal distinctions. In this section I describe the verb morphology of YZ. First I deal with suffixes and clitics, then verb prefixes. López and Newberg (1990) provide a comprehensive account of the verbal conjugations. I will not attempt to duplicate their work in this section, but only point out particular uses and provide examples of certain aspects that I have recorded in the language.

The general scheme of the YZ verb is given in Figure 4 (cf. López and Newberg (1990) for a similar characterization of YZ verb morphology). The stem can be formed from of a monomorphemic root or a root with an incorporated object. There are a series of optional secondary aspects, which usually express the idea of locative deixis. At the beginning of the verb complex are the aspectual and tense markers, which are obligatory. Imperative is expressed with the same forms that mark perfective aspect. The causative is indicated as changes of features in the first consonant of some verb stems; (for a set of verbs that mark causative in this way see López and Newberg (1990)). A series of optional adverbial clitics occur to the right of the verb stem, after the clitics there is a position for the number of the person, followed by the position for person markers indicating subject and objects.

tense/aspect-(secondary aspect)- { caus.root-(incorporated NP) / stem }-(adverb)-(number)-(person)

Figure 4. YZ verb morphology template

2.3.1 Postverbal Affixes

2.3.1.1 Plural

In verbs, plural is expressed with the clitic *=gak* (*=ak* for some speakers) after the verb stem. Consider the sentences below. In (80) the clitic is not adjacent to the corresponding pronominal clitic *=be'*, '3.FAM', instead, the plural attaches directly to the verb, before the first person subject clitic. The sentences in (81) and (84) show, furthermore, that the sequence of plural plus the person clitics, to which is related to, is ungrammatical.

(80) We'e=gak=a'=be' xhua.
PERF.give=pl=1sg=3.FAM corn
'I gave them corn.'

(81) *We'e=a'=gak=be' xhua.
PERF-give=1sg=pl=3.FAM corn
'I gave them corn.'

(82) W-ej=gak=be' niseye'
PERF-drink=pl=3.FAM atole
'They drank atole.'

(83) B-et=gak=a'=ba'.
PERF-kill=1sg=3.ANIMAL
'I killed the animals.' (López and Newberg,1990:11)

(84) *B-et=a'=gak=ba'.
PERF-kill=1sg=3.ANIMAL
'I killed the animals.'

This pattern was noticed by López and Newberg (1990), who also pointed out that sentences like (85)-(87), containing two or three third persons, are ambiguous, in that the plural can be interpreted or can refer to any or all of the pronouns, i.e. all the three pronouns in the sentence can be interpreted as plurals at the same time.

(85) B-che'=gak=e'=be'.
PERF-take=pl=3.RESP=3.FAM
'He took them' or 'They took him' (López and Newberg,1990:11)

(86) B-go'x=ak=e'=be'=n.
PERF=hand=pl=3.RESP=3.FAM=3.INAN
'He/They handed it/them (inanimate) to him/them' (Newberg *apud* Marlett and Pickett, 2001:4)

(87) B-nab=gak=e'=be'=n.
PERF-ask=pl=3.RESP=3.FAM=3. INAN
'He/They asked him/them for it/them.'

Marlett and Pickett labeled this pattern 'clitic floating', because, assuming that the plural and the pronominal clitic forms a constituent, they claim that the plural 'floats' from the pronoun to a post-verbal position (2001:4). In addition, as Marlett and Pickett observe, only one plural morpheme can occur. The sentences below offer evidence supporting their claim.

(88) *B-nab=gak=e'=gak=be'=n.
PERF-ask=pl=3.RESP=pl=3.FAM=3.INAN
'He/They asked him/them for it/them.'

(89) *B-nab=gak=gak=e'=be'=n.
PERF-ask=pl=3.RESP=pl=3.FAM=3.INAN
'He/They asked him/them for it/them.'

(90) *B-go'x=ak=e'=gak=be'=n.
PERF=hand=pl=3.RESP=pl=3.FAM=3.ANIMAL
'They handed it to them.'

(91) *B-go'x=ak=e'=be'=gak=n.
PERF=hand=pl=3.RESP=pl=3.FAM=3.ANIMAL
'They handed them to him.'

2.3.1.2 Pronominal Clitics

The verb clitics indicating person are the same series of clitics indicating the possessor of nouns. First person plural includes both inclusive *-llo'* and exclusive *-to* forms. The third person is further divided into three major categories: human, animal, inanimate; the first subcategory is also subdivided between formal and familiar. Table 2 below shows the series of clitics on the habitual form of the verb 'to fall', *llbix-*, illustrating a verb stem closed by a consonant. In such environment the clitics are attached without further segmental changes of the stem.

Table 2. Pronominal clitics attached to a verb stem (regular series)

Base		Singular		Plural	
				Inclusive	Exclusive
	1	=a'		=llo'	=to'
	2	=o'		=le'	
llbix- 'falls'		=e'	formal	=gak=e'	
	3	=be'	familiar	=gak=be'	
		=ba'	animal	=gak=ba'	
		=n	inanimate	=gak=en	

2.3.1.2.1 *l*-Subjects

There is another series of clitics used to indicate that the subject of the predicate is an experiencer argument. I will call these informally *l*-subject clitics. However, it should be noted that not all the verbs that might be considered as having experiencer subjects are marked with this series. According to the study of verb conjugation by López and Newberg, "These forms can only be used to express the subject of the verb but not the complement" (1990:8) (my translations henceforth). As evident from Table 3, illustrating the pattern with the verb *wallén* 'to want', the *l*-subject clitics are formally differentiated from the regular series in that the forms that begin with a vowel in the regular series in Table 2, correspond to *lV'* forms in the *l*-subject series, whereas verbs that begin with a consonant in the regular series correspond to *eCV'* forms in *l*-subject series. Comparable clitics have also been described for Zoogocho Zapotec and Yatzachi Zapotec.

Table 3. *l*-subject clitics

Base		Singular	Plural	
			Inclusive	Exclusive
llen- 'want'	1	=la'	=ello'	=eto'
	2	=lo'	=ele'	
	3	=le'	=gak=le'	
		=ebe'	=gak=ebe'	
		=eba'	=gak=eba'	
		=en	=gak=len	

My data agrees with López and Newberg's description; examples in addition to those presented in their study are given in the examples below. The examples below are habitual forms that can be combined with the clitic series to form a complete verb complex. Other verbs include *llen-* 'wants', *llre'-* 'sees', *llya-* 'falls', *llajti-* 'bumps into (someone)', *lldeb-* 'misses (someone)' and *llak-* 'feels'. Independent nouns (with exception of pronouns, similar to the one introduced in 2.2.1) can also function as subjects after the verb. It is unknown at this point whether there are additional syntactic properties peculiar to these class of verbs. This is an area that deserves further research.

(92) Ll-yen=la' lue'. 'I listen to you.'
HAB-listen-1sg.L 2sg

(93) *Ll-yen=a' lue'. intended: 'I listen to you.'
HAB-listen-1sg 2sg

(94) Ll-aban=eto' Benito Juárez. 'We admire Benito Juárez.'
HAB-admire=1pl.excl.L Benito Juárez

(95) *Ll-aban=to' Benito Juárez. intended: 'We admire Benito Juárez.'
HAB-admire=1pl.excl Benito Juárez

2.3.1.2.2 Person Marking in the Verb Complex

The arguments of the predicate can be expressed solely with the series of pronominal clitics. This holds true for both intransitive and transitive verbs. In the case of ditransitive verbs, although it is possible to get three clitics attached to the verb, as in (101) and (102). However, it is common that only two arguments, the subject and the direct object, are encoded in that way, while the indirect object is expressed by an independent noun phrase, usually a pronoun or a noun as in (103).

i. Intransitive

(96) Kat ll-ejdinla=be' waya' ka'
when HAB-remember=3sg.FAM dance pl

ll-az=do=be' lakscha ll-yukyal=be'. (*José el danzante*)
HAB-stand.up=INTENS=3sg.FAM though HAB-stumble=3sg.FAM
'When he remembers the dances, stands up, but he stumbles.'

(97) Yo'ite=llo' b-lla'=llo'
all=1pl.incl PERF- be.angry=1pl.incl
'All of us were angry.'

(98) Ll-achayra'=o'
HAB-suffer=2sg
'You are suffering.'

ii. Transitive

(99) B-a-yilj=o'=e'.
PERF-ITER-look.for=2sg=3sg.RESP
'You used to look for him.'

(100) Awa', ll-sed=a'=be' Di'llwrall.
yes HAB-study=1sg=3sg.FAM Zapotec
'Yes, I'm teaching him Zapotec.'

iii. Ditransitive

(101) B-nab=a'=be'=n.
PERF-ask=1sg=3sg.FAM=3sg. INAN
'I asked him for it.'

(102) B-ran=o'=be'=ba'.
PERF-steal=2sg=3sg.FAM=3sg.ANIMAL
'You stole it (animal) from him.'

(103) W-un=a'=n lebe'.
IRR-give=1sg=3sg.INAN 3sg.FAM
'I will give it to him.'

2.3.1.2.3 Clitic Pronouns and Animacy Hierarchy

In addition to the lexical semantic information conveyed by the subclassification of the third persons, the entire set of pronouns participates in an animacy hierarchy that is reflected.in a number of constraints governing the relative order of pronominal clitics (see also López and Newberg 1990). Let us consider first the canonical order of clitics in YZ. As with independent NP's, the clitics in YZ follow the VSO order. that is to say in the verb complex the subject comes first and then the object, V=S=O. Sentences (104) - (107) illustrate the stringent basic order of clitics in transitive verbs, i.e., no V=O=S is allowed.

(104) B-et=te=o'=ba'. V=S=O
PERF-kill-ASSERTIVE.TE=2sg=3sg.ANIMAL
'You killed the animal.'

(105) *B-et=te=ba'=o'. *V=O= S
PERF-kill-ASSERTIVE.TE=3sg.ANIMAL=2sg
intended: 'You killed the animal.'

(106) Ll-ut=be'=ba'. V=S=O
HAB-kill=3.FAM=3.ANIMAL
'He is killing an animal.'

(107) *Ll-ut=ba'=be'. *V=O= S
HAB-kill=3.ANIMAL=3.FAM
intended: 'He is killing an animal.'

However, the clitic order V=S=O in the verb complex cannot be maintained if the animacy properties of the object outrank those of the subject according to the scale represented in Table 4.

Table 4. Animacy hierarchy of clitic order in YZ

		Third						
First -a'		formal	>	familiar	>	animal	>	inanimate
	>	-e'		-be'		-ba'		-n
Second -o'								

The table sums up the following pattern: When the two participants in an event expressed by a transitive verb are marked by the forms in the Table 4, both clitics can be attached to the verb if the subject corresponds with a form that is to the left of the form representing the object, i.e. when the subject outranks the object on the scale. An object of a higher hierarchy cannot follow a subject of a lower or the same hierarchy.

First and second person are in the same cell in Table 4. That means that the speech act participants cannot both be expressed as pronominal clitics. Examples (108) *V=1=2 and (109) *V=2=1, illustrate this pattern.

(108) * Bi ll-re'=la'=o'.
NEG HAB-see=1sg=2sg
intended: 'I don't see you'

(109) * Bi ll-re'=lo'=a'.
NEG HAB-see=2sg=1sg
intended: 'You don't see me'

Therefore, first and second pronominal clitics do not occur in the verb complex as the subject and object of the transitive sentence, =a' and =o' (and the *l*-marked variants) indicate only subjects. Only one of them can be encoded as a subject clitic, whereas a first or second person object is expressed as an independent pronoun (110) and (111).

(110) Bi ll-re'=la' lue' V=1 2
NEG HAB-see-1sg 2sg
'I don't see you'

(111) Bi ll-re'=o' nada'. V=2 1
NEG HAB-see-2sg 1sg
'You don't see me.'

Let us consider now particular instances of the proposed hierarchy of clitic order in YZ. When the participants are either first or second persons, plus a third person, the subject and object can be expressed as verb clitics as long as the third person is the object of the sentence as shown in (112), (114) and (116); otherwise the sentence becomes ungrammatical as shown in (113), (115) and (117).

(112) Nada' w-e'w=a'=n. V=1=3
1sg PERF-buy=1sg=3sg.INAN
'I bought it'

(113) *B-naw=ba'=a'. *V=3=1
PERF-follow=3sg.ANIMAL=1sg
intended: 'It (animal) followed me.'

(114) Ll-sed=la'=be' Di'llwrall. V=1=3
HAB-teach=1sg.L=3sg.FAM Zapotec
'I'm teaching him Zapotec.'

(115) *Ll-sed=be'=la' Di'llwrall. *V=3=1
HAB-teach=3sg.FAM-1sg.L Zapotec
intended: 'He is teaching me Zapotec.'

(116) Bixhchén b-et=te=o'=ba'? V=3=2
why PERF-kill=INTENSE=2sg=3sg.ANIMAL
"Why did you kill it (animal)?"

(117) *B-et=te=ba'=o'. *V=3=2
PERF-kill-ASSERTIVE.TE=3sg.ANIMAL=2sg
intended: 'The animal killed you.

When the participants are two third persons, both can be expressed as verb clitics only if the object is lower in the hierarchy (to the right in the table) than the subject. A third person familiar *-be'* cannot outrank a third formal *-e'* in the clitic order hierarchy as demonstrated by the contrast between (118) and (119); a third inanimate clitic *-n* cannot outrank a third familiar *-be'* (123); a third animal *-ba'* or inanimate *-n* cannot outrank a third familiar *-be'* (126); and a third inanimate *-n* cannot outrank a third animal *-ba'* (128). A sentence where a third person object outranks the subject in the animacy hierarchy can be formed by expressing the object as an independent pronoun. Examples (120), (122), (125) and (127) illustrate this pattern. In addition, note that an independent pronoun object is always acceptable, even when the clitic would be allowed.

(118) W-kwell=e'=be'. V=3.RESP=3.FAM
IRR-CAUS.cry=3sg.RESP=3sg.FAM
He will make him cry.'

(119) *W-kwell=be'=e'. *V=3.FAM=3.RESP
IRR-CAUS.cry=3sg.FAM=3sg.RESP
intended: 'He will make him cry.'

(120) W-kwell=e' lebe'. V=3.RESP 3.FAM
IRR-CAUS.cry=3sg.RESP 3sg.FAM
'He will make him cry.'

(121) B-et=be'=n. V=3.FAM=3.INAN
PERF-grind=3sg.FAM-3sg.INAN
'He ground it.'

(122) B-et=be' len. V=3.FAM 3.INAN
PERF-grind=3sg.FAM 3sg.INAN
'He ground it.'

(123) *B-et=en=be'. *V=3.FAM=3.INAN
PERF-grind=3sg.INAN=3sg.FAM
intended: 'It ground him.'

(124) B-chew=be'=ba'. V=3.FAM=3.ANIMAL
PERF-kick=3sg.FAM=3sg.ANIMAL
'He kicked it (animal).'

(125) B-chew=be' leba' V=3.FAM 3.ANIMAL
PERF-kick=3sg.FAM 3sg.ANIMAL
intended: 'He kicked it (animal).'

(126) *B-dinn=ba'=be' *V=3.ANIMAL=3.FAM
PERF-bite=3sg.ANIMAL=3sg.FAM
intended: 'It (animal) bit him.'

(127) B-dinn=ba' lebe' V=3.ANIMAL 3.FAM
PERF-bite=3sg.ANIMAL 3sg.FAM
'It (animal) bit him.'

(128) *B-chochj=en=ba' *V=3.INAN=3.ANIMAL
PERF-hit=3sg.INAN=3sg.ANIMAL
intended: 'It hit it (animal).'

(129) B-chochj=en leba' *V=3.INAN=3.ANIMAL
PERF-hit=3sg.INAN 3sg.FAM
'It hit it (animal).'

Furthermore, a verb cannot bear two pronominal clitics if the two third persons have the same position in the hierarchy. In this case the object must be expressed as an independent pronoun.

(130) *Ll-ne'=be'=be'. *V=3sg.familiar=3sg.FAM
HAB-speak=3sg.FAM=3sg.FAM
intended: 'He is speaking to him.'

(131) Ll-ne'=be' lebe'. *V=3sg.FAM 3sg.FAM
HAB-speak=3sg.FAM 3sg.FAM
'He is speaking to him.'

(132) *B-dinn=ba'=ba' *V=3.ANIMAL=3.ANIMAL
PERF-bite-3sg.ANIMAL-3sg.ANIMAL
intended: 'It (animal) bit it (animal).'

(133) B-dinn=ba' leba' *V=3.ANIMAL 3.ANIMAL
PERF-bite=3sg.ANIMAL=3sg.FAM
intended: 'It (animal) bit it (animal).'

2.3.1.3 Postverbal Suffixes

A series of post-verbal suffixes can be attached to the verb stem. These forms are ordered after the verb root and before the pronominal clitics. Some of these forms are related to the speaker's evaluation of the particular event, or further specify the manner or degree in which the particular event is realized, i.e. they are adverbs. Descriptions of closely related languages (Butler, 1980; Long and Cruz, 1999; López and Newberg, 1990; Nellis and Nellis, 1983) list an abundant collection of these forms; Table 5 lists those forms found to date in YZ for which I can give an appropriate description. The grammar and meaning of these elements is still under study and I will not present a full account of them. Instead I will offer the basic information about their use and distribution within the verb complex.

Table 5. Adverbial suffixes

suffix	Meaning
–te	complete assertion
–s	partial assertion
–do	intensive
–ses	apathetic
–chach	incremental
–lolj	"a lot of water"

One interesting property of some of these affixes is that they encode different degrees of veridicality. The first two morphemes in the table, which I am glossing 'ASSERTIVE -*te*' and 'ASSERTIVE -*s*', express different degrees of assertion, ranging from complete certainty to an intermediate estimation, in contrast with unmarked sentences which simply offer a neutral evaluation of the event. These morphemes cannot co-occur.

2.3.1.3.1 Assertive –*te*

It has been very difficult to capture the meaning of the morpheme -*te* in YZ. Butler says about the cognate -*te* in Yatzachi el Bajo Zapotec "It is impossible to specify the exact meaning of the suffix -*te*" (1980:165). However, it is adequate to say that –*te* conveys the meaning that the speaker is positive about the statement reported. The examples below illustrate a contrast between sentences with the assertive, which would not allow any possible doubt of the truth of the assertion versus unmarked sentences, which simply offer an uncommitted report (in the examples -*te* becomes -*ti* before [a]).

(134) Awa, ll-sed=la'=be' Di'llwrall.
yes HAB-teach=1sg.L=3sg.FAM Zapotec
'Yes, I am teaching him Zapotec.'

(135) Awa, Il-sed=ti=a'=be' Di'llwrall.
yes HAB-teach=ASSERT.T=1sg=3sg.FAM Zapotec
'Yes, certainly I am teaching him Zapotec.'

(136) Zeyaj=ba'
STAT.go=3sg.ANIMAL
'The animal is already gone.'

(137) Zeyaj=te=ba'
STAT.go=ASSERT.T=3sg.ANIMAL
'The animal is already gone, for sure.'

(138) B-ayed=be' neje.
PERF-come.back =3sg.FAM yesterday
'He came back yesterday.'

(139) B-ayed=te=be' neje.
PERF-come.back.ASSERT.T=3sg.FAM yesterday
'He certainly came back yesterday.'

2.3.1.3.2 Assertive *–s*

The assertive suffix *–s* indicates that the speaker provides a strong degree of certainty about the event, but may not be absolutely confident of it. The series of sentences below show that the speaker has a certain conviction about the reported event in sentences with *–s*, which nevertheless does not necessarily amount to absolute certainty. However, the degree of confidence in these sentences is higher than in sentences lacking the morpheme. The first pair of examples, coming from texts, illustrates how the contrast is exploited in spontaneous speech. In (140) the speaker did not use the *–s* morpheme, given that he was referring to someone else's belief, which he wanted to contradict in (141); more certainty about the event is expressed in the sentence by using *–s*.

(140) Segun lebe' bi b-lleb=e'.
according 3sg NEG PERF-scare=3sg.RESP
'According to him, he did not get scared.'

(141) Pero konka ll-ak=la' b-lleb=s=e'.
but somehow HAB-think=1sg.L PERF-scare-ASSERT.S-3sg.RESP
'But somehow I think he really got scared.'

(142) B-lleb=a'.
PERF-scare=1sg
'I got scared.'

(143) B-lleb=s=a'.
PERF-scare=ASSERT.S=1sg
'I certainly got scared.'

(144) B-lleb=o'.
PERF-scare=2sg
'You got scared.'

(145) B-lleb=s=o'.
PERF-scare=ASSERT.S=2sg
'You certainly got scared.'

The morphemes *-te* and *-s* can occur under similar circumstances. There are, however, some contexts, such as in negative statements, where the occurrence of *-te* is not acceptable. Consider the examples below.

(146) Bill g-aw=a' 'I'm not going to eat.'
NEG IRR-eat=1sg

(147) Bill g-aw=s=a' 'I'm certainly not going to eat.'
NEG IRR-eat=ASSERT.S=1sg

(148) *Bill g-aw=ti=a' intended: 'I'm certainly not going to eat.'
NEG IRR-eat=ASSERT.T=1sg

(149) Bill ll-sed=a' 'I don't study.'
NEG HAB-study=1sg

(150) Bill ll-sed=s=a' 'I certainly don't study.'
NEG HAB-study=ASSERT.S=1sg

(151) *Bill ll-sed=ti=a' intended: 'I certainly don't study.'
NEG HAB-study=ASSERT.T=1sg

2.3.1.3.3 Intensive *–do*

The suffix *–do* indicates that the action expressed by the verb is accomplished in an intense manner. Accordingly, the translations lay emphasis on the adverbial modification of the verb. The intuition of native speakers is that the meaning associated with this morpheme entails urgency orintensity. At any rate, *–do* emphasize the intensity of the event. Thus, for instance the pairs below were volunteered by a native speaker who furthermore explained that the contrast is based solely on the impulsive manner of accomplishing the verb.

(152) Ll-azulla=be'.
HAB-stand.up=3sg.FAM
'He stands up.'

(153) Ll-azulla=do=be'.
HAB-stand.up=INTENS=3sg.FAM
'He stands up suddenly.'

(154) G-aw=a'.
PERF-eat=1sg
'I eat.'

(155) G-aw=do=a'
PERF-eat=INTENS=1sg
'I ate compulsively.'

(156) Jesj=do
IMP.take.a.shower=INTENS
'Go take a shower (immediately).'

(157) Beche b-xhu' le b-lloj=do=be' yo'.
a.while.ago PERF-trembled then PERF-go.out-INTENS-3sg.FAM house
"A while ago there was an earthquake and he run out of the house.'

The intensive *-do* precedes the assertive *-te.*

(158) Ja-tas=do=be'.
PERF.GO.DEIC-sleep=INTENS=3sg.fam
'He went to sleep (somewhere else) quickly.'

(159) Ja-tas=te=be'.
PERF.GO.DEIC-sleep=ASSERTIVE.T=3sg.FAM
'He certainly went to sleep (somewhere else).'

(160) Ja-tas=do=te=be'.
PERF.GO.DEIC-sleep=INTENS=ASSERTIVE.T=3sg.FAM
'He certainly went to sleep (somewhere else) quickly.'

(161) *Ja-tas=te=do=be'.
PERF.GO.DEIC-sleep=ASSERTIVE.T=INTENSE=3sg.FAM
intended : 'He certainly went to sleep (somewhere else) quickly.'

2.3.1.3.4 Apathetic *-ses*

The main meaning associated with this form the action performed is accomplished without any particular interest, or concern. Nonetheless, it is also found in forms like the examples in (164) that convey a meaning of imperfection.

(162) Ll-ao=ses=be'.
HAB-eat=APATHETIC.SES=3sg.FAM
'He is eating unwillingly.'

(163) Yinn=ses=be'.
HAB.bite=APATHETIC.SES=3g.FAM
'He bites unwillingly.'

(164) B-chej=ses=be'=n.
IMP-tie=APATHETIC.SES=3sg.FAM=3sg.INAN
'He tied it loosely.

2.3.1.3.5 Carelessly *–chach*

This form is used to mean that the event is accomplished in an unordered fashion, without consideration, carelessly. López and Newberg gloss this suffix as 'repeatedly'; I failed to obtain that meaning for this morpheme. My main consultant said that the form could be used in a derogatory way too.

(165) B-zannj=en.
IMP-squeeze=3sg.INAN
'Squeeze it!'

(166) B-zannj-chach=en.
IMP-squeeze-CHACH=3sg.INAN
'Squeeze it incompletely!'

(167) Ll-ao-chach=be'.
HAB-eat-CHACH=3sg.FAM
'He is eating carelessly.'

(168) Ll-ne'-chach=be'.
HAB-speak-CHACH=3sg.FAM
'He is speaking irresponsibly.'

(169) Xhi't-chach=be'.
HAB.jump-CHACH=3sg.FAM
'He is jumping crazily.'

This affix is closer to the stem relative to other adverbial affixes in the verb complex. Consider the contrast in the pair below where *-chach* follows the verb stem before *-do*. This pattern suggest that *-chach* might be analyzed as a secondary root (Munro p.c.).

(170) Ll-asj-chach=do=be'
HAB-take.a.shower-CHACH=INTENS-3sg.FAM
'He is taking a shower messily.'

(171) *Ll-asj=do-chach=be'.
HAB-take.a.shower-CHACH=3sg.FAM
intended: 'He is taking a shower messily.'

It seems that the possibility of using *-chach* depends also on the meaning of the verb. It is not clear, though, what is the common denominator of the class of verbs that can or cannot select *-chach*; for instance, it cannot be used in combination with the verb *wased* 'to study', or with some other verbs of action such as *wata'* 'to move' or *waka'* 'to walk'.

2.3.1.3.6 Water Abundance *-lulj*

Some of the adverbvials have a very specialized meaning. This is the case of *-lulj*; the form implies the abundance of water. Note that *lulj* is not an independent word and cannot occur other than attached to the verb. It is likely that *lulj* is also a secondary root.

(172) J-esj-lulj
IMP-take.a.shower-LULJ
'Take a shower! (with a lot of water).'

(173) B-zu-lulj=en nis.
IMP-put-LULJ=3sg.INAN water
'Put a lot of water on it!'

(174) W-ej-lulj=be' nis.
PERF-drink- LULJ=3sg.FAM water
'He swallowed a lot of water.'

(175) B-dib=lulj nnil-en
IMP-wash=LULJ corn.softened.with.lime.water.for.tortillas-DET
'Go wash the nixtamal with lots of water!'

(176) Ll-ayak=lulj=be'.
HAB-sweat=LULJ=3sg.FAM
'He is sweating a lot.'

2.3.2 Prefixation

2.3.2.1 Aspectual-temporal Prefixes

In general, Zapotec languages present a rich and complex system of prefixes. The most important series are the aspectual prefixes. In most Zapotec languages time reference is encoded by a series of morphemes that do not necessarily anchor to the time of the speech act, but refer mainly to the internal temporal structure of that event. Time reference is further specified with adverbs. Thus, YZ does not primarily encode tense, but rather aspectual properties. Verbs in YZ are obligatorily inflected for aspect. In addition, there is an infinitive form, marked with *w*- or *wa*-, for most verbs. Infinitives are neutral with respect to aspect and do not convey any temporal information. Imperatives are formed with the same forms marking perfective. I will differentiate both meanings in the glosses, even though they are expressed formally with the same morpheme.

Aspectual markers and infinitive	
Aspect	Gloss
ll-	habitual
b-	perfective/imperative
n-	stative
w-	irrealis
a-	iterative
w-	infinitive

2.3.2.1.1 Habitual *ll-*

The habitual *ll*- normally expresses the maintenance of an event over time. This morpheme occurs in currently ongoing events, i.e. events that coincide with the speech act, which corresponds to the present tense in other languages. The examples below show different instances of the habitual *ll*- referring to slightly different situations over time.

The first two examples (177) and (178) express present tense; the latter shows that the affix may be used in several different ways in ones sentence. The first instance of the habitual in *llenla'* 'I listen' coincides with the speech act, so it means present tense; the second instance in *llnabo'* denotes a continuing action, which is glossed accordingly with the progressive 'asking'; then, the last occurrence in *llnab* refers to a past habitual action. Sentences (179) and (180) show that even though the events took place in the past, the aspect marker in the matrix clause is habitual. Lastly, sentence (181) shows that the habitual can be used to refer to an event that would continue in the future.

a) Habitual referring to present time

(177)	Dios	dao'	ki=a'	ll-ej=la'	be'.
	god	DIM	of=1sg	HAB-need=1sg	air.

'My dear God, I need air.' ('Tierra querida':18)

(178)	LL-en=la'	be	chi'w=o'	ll-nab=o'	
	HAB-listen.to=1sg.L	echo	POSS.voice=2sg	HAB-ask.for=2sg	

nada'	kada	ll-nab	x-na'	"Xi'nna'	bi	ch-aj=o'!"
1sg	like	HAB-ask.for	POSS-mother.1sg	POSS.son.1sg	NEG	IRR-go=2sg

'I listen the echo of your voice asking me like my mother used to ask "my son don't go!"' ('Tierra querida':18)

b) Habitual referring to past time

(179)	Bixha	ka	na-nak=a'	bidao',	bi	ll-en=la'
	then	when	STAT-be=1sg	boy	NEG	HAB-want-=1sg.L

cha'a	li'ix.
IRR.go.1sg	field.

'Once up on a time when I was a boy, I did not want to go to the field.' (José andaba en el campo:1)

(180)	Le	b-lleb=a'	wencha'	lull	dao'	zen
	then	PERF-be.scared=1sg	if	lizard	DIM	just

o kat	ll-en=la'	zill.
or when	HAB-listen=1sg.L	noise.

(José andaba en el campo:1)

'Then I was scared if there was a just a little lizard, or if I heard noise.'

c) Habitual referring to future time

(181) Bi n-xhi=a' cha ll-ele=llo' mexkwel.
NEG STAT-doubt=1sg that HAB-find=1pl.excl teacher
'I doubt that we will find the teacher.'

2.3.2.1.2 Perfective *b-*

Many events in the past take the perfective affix to indicate that the action has been completed. There are three different alternants of the perfective: *b-* (182)-(183), *w-* (184)-(185), and *g-* (186)-(187).

(182) Le b-rell=ti=a'
then PERF-wait=ASSERT.T=1sg
'Then, I waited.'

(183) B-dichj tak=a'
PERF-break hand=1sg
'I broke my hand.'

(184) No'or ka' w-e'o=gak=e' chonn rboz.
woman pl PERF-buy=pl=3.RESP three shawl
'The women bought three shawls.'

(185) Bi w-uk?
what PERF-happen
'What happened?'

(186) W-kra'll Stel-en g-au=do chixh=be'.
PERF-want Estela-DET IRR-eat=INTENSE POSS.tortilla.=3sg.FAM
'Estela wanted to eat her tortilla quickly.'

(187) G-ulall=a' ke x-sir ki=a'.
PERF-forget=1sg of POSS.lunch of=1sg
'I forgot my lunch.'

2.3.2.1.3 Stative *n-*

López and Newberg include a stative *n-* category in their study, defined as a "static condition, which is used as background for actions expressed in other tenses" (:6). The cognate form has been considered as a neutral aspect in other Zapotec languages (Munro, 2002b). I will not attempt a definite analysis here, but since the meaning of the prefix *n-* is mainly associated with stativity, I will follow the traditional terminology. The examples below show the use of *n-* and show the stative forms contrast with cognate adjectives. For instance, in in (188) there is a predicative adjective, which requires a copula *da*. The distinction among adjectives, statives and neutral aspect in YZ is not well understood yet.

(188) De to xa=a' da gul.
HAB.have one POSS.shirt=1sg be old
'I have shirt that is old.'

(189) Ba n-gul to xa=a'.
already STAT-old one POSS.shirt-1sg
'My shirt is already old.'

(190) Ba n-gul-be'.
already STAT-old-3sg.FAM
'He is already old.'

(191) nis lla'
water tepid
'tepid water'

(192) n-lla' nis?
STAT-tepid water
'Is the water tepid?'

2.3.2.2 Secondary Aspects

2.3.2.2.1 Displacement Deictics

Previous accounts of Zapotec languages usually describe a series of secondary aspects, which further specify the manner in which the event or state is realized. Most of the northern Zapotec languages, YZ included, describe a series of "displacement aspects" (aspectos de desplazamiento) which refer to whether the event is realized towards or away from the speaker (Bartholomew, 1983; Butler, 1980; Long C., 1999a; López L., 1990). López and Newberg define movement away from the speaker as "when the subject of the verb is moving away from the person who is talking or the person who he is talking to" and the movement toward the speaker as "when the subject of the verb comes to the person who is talking or to the person who he is talking to" (1990:7). López and Newberg point out that the affixes are derived from the verbs *chejllo* 'go' and *yedllo* 'to come', accordingly; as the function of these forms is to ground the event in space with reference to the speaker, I will consider to be sptial deictics (Fillmore, 1997). I will gloss these morphemes as GO.DEIC and COME.DEIC. I have recorded instances of such aspects. Below are examples of their use.

(193) Ja-til Stel-en yeto.
PERF.GO.DEIC-fight Estela-DET once.again
'Estela went to fight once again.'

(194) B-ad-til Stel-en yeto
PERF-COME.DEIC-fight Estela-DET once.again
'Estela came to fight once again.'

(195) Ja-tas=be'.
PERF.GO.DEIC -sleep=3sg.FAM
'He went to sleep' (somewhere else)

(196) B-ad-tas=be'.
PERF-GO.DEIC-sleep=3sg.FAM
'He came to sleep.'

(197) Se'e b-ad-wya=be' nada'.
quick PERF-COME.DEIC-see=3sg.FAM 1sg
'He came to see me quickly.'

(198) Se'e ja-wya=be' nada'.
quick PERF.GO.DEIC-see=3sg.FAM 1sg
'He went to see me quickly.'

(199) Cha-bagat=ba' li'ixe
IRR.GO.DEIC-die=3sg.animal field
'It (animal) will go to die in the field.'

2.3.2.2.2 Iterative *a*–

Another secondary aspect is the iterative. The affix follows the primary aspectual markers and goes before the verb stem. The iterative indicates that a single completed event is iterated in time, either continuosly or discontinously, i.e. the iterative does not necesarily entail a typical continuous meaning; accordingly, one of the glosses of the iterative frequently voluntered by my consultant is repeating the verb; thus, for instance, examples can also be translated as (201) and (203)'He was studying and studying.' or 'I was carrying logs and carrying logs'.

(200) B-sed=be'
PER-study=3sg.FAM
'He studied.'

(201) B-a-sed=be'.
PERF-ITER-study=3sg.FAM
'He was studying.', 'He was studying and studying.'

(202) B-iw=a' way.
PERF-carry=1sg log

'I carried logs.'

(203) B-a-iw=a' way.
PERF- ITER-carry=1sg log
'I carried logs.', 'I was carrying logs and carrying logs.'

3 Pronouns and Basic Sentence Structure

3.1 Independent Pronouns

Zapotec languages have a very complex system of personal pronouns (Marlett, 1993; Munro, 2002a) including differences in deixis, number, animacy, and special forms for different degrees of formality. YZ has thirteen independent pronouns as schematized in Figure 5. These pronouns are phonologically independent or unbounded words. They can occur in isolation (as answers to questions, for instance), and may indicate either (topicalized) subject or objects. The inclusive/exclusive distinction appears in the first person plural expressed by *llo'* and *neto'*, respectively. *Llo'* includes only speaker and hearers, while *neto'* includes also persons who do not participate in the speech act. The second person has only a singular/plural distinction, *lue'* and *le'e*, respectively. The third person is the more elaborated in YZ, with a three-way distinction based on the animacy properties of the referents: human, animal and inanimate. The pronouns corresponding to humans are further divided according to the level of familiarity with the speaker: *Le'* is the respectful pronoun, it used mainly to refer to older people and adults who are not intimate with the speaker and deserve a respectful treatment; *lebe'* is used to refer to young people, children, and adults who have a close relationship with the speaker, so that they can be addressed informally or familiarly. There is a unique form for animals, *leba'*, and inanimates, *len*. In other Zapotec languages (e.g. Munro and Lopez 1999) the pronouns have been analyzed as having a 'base' and a suffix indicating person. Third person forms can be further analyzed having a plural morpheme *-gak-* (or *-ak-*) (cf. 2.3.1.1) intervening between the base of the base *le-*, and a pronominal suffix, which gives information about the specific class.

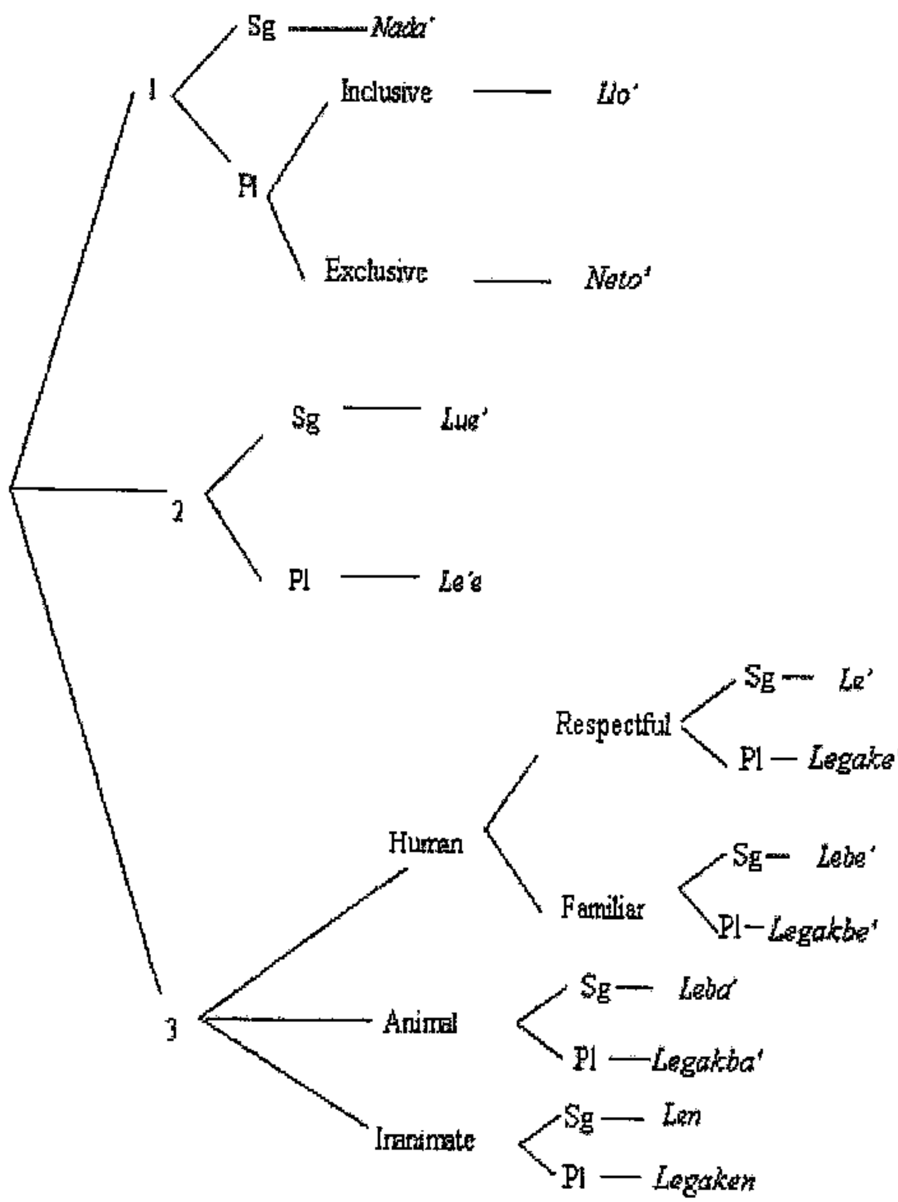


Figure 5. YZ pronoun system

Postverbal subjects cannot be expressed by independent pronouns. Thus, by extension, unlike sentences where subject and object noun phrases are non-pronominal (e.g. common and proper nouns), the canonical VSO word order is ungrammatical if the subject and object are expressed by independent pronouns. Consider the contrast between pronominal and non-pronominal arguments illustrated in the examples below.

(204) Ll-a-jdirj Pinn na' Xheb-en V Noun
HAB-ITER-look.for Rufina DEM José-DET
'Rufina is looking for José.'

(205) *Ll-a-jdirj nada' lue'. *V Pronoun Pronoun
HAB-ITER-look.for 1sg 2sg
intended: 'I am looking for you.'

(206) B-chew Pinn na' Xheb-en V Noun Noun
PERF-kick Rufina DEM José-DET
'Rufina kicked José.'

(207)

(208) *B-chew nada' lue'. *V Pronoun Pronoun
PERF-kick 1sg 2sg
intended: 'I kicked you.'

However, a topic noun phrase can be expressed with independent pronouns before the verb. In this case, a TOPV=S O structure might describe better the fact that the subject is obligatorily marked in the verb (more about the description of these facts is elaborated in the section corresponding to word order). Notice that examples as those in (209)-(211), obtained from elicitation sessions, are satisfactorily accepted by all of the consultants.

(209) Nada' ll-a-jdirj=a' lue'.
1sg HAB-ITER-look.for-1sg 2sg
'I am looking for you.'

(210) Lue' ll-a-jdirj=e' nada'.
2sg HAB- ITER -look.for-2sg 1sg
'You are looking for me.'

(211) Leba' b-nis=ba' nada'.
3sg.ANIMAL PERF-scratch-3sg.ANIMAL 1sg
'It (an animal) scratched me.'

3.2 Reflexive Pronouns

Reflexive pronouns are expressed by the base *kwin* and the pronominal clitic expressing person attached to it. This clitic is the same as the forms indicating subject or possessor. Table 6 summarizes the formation of reflexive pronouns.

Table 6. Reflexive pronouns

Reflexive Base	Person Clitics			
Singular			Plural	
			Inclusive	Exclusive
kwin	1	=a'	=llo'	=to'
	2	=o'	=le'	
	3	=e'	=gak=e'	
		=be'	=gak=be'	
		=ba'	=gak=ba'	
		=n	=gak=en	

The series of examples below illustrate the difference between reflexives and independent pronouns. In contrast with independent pronouns, only reflexives can be coreferential with an antecedent noun; accordingly (213) and (217) are ungramatical. Sentences (215) and (219) are grammatical only if the the pronoun is not bound. Unlike some other Zapotec languages (Quiegolani Zapotec and San Lucas Quiaviní Zapotec, among others) YZ does not allow repetition of a proper name to show coreference. Consider sentences (214) and (218).

(212) B-a-re' be'nn-en$_k$ kwin=e'$_k$ lo' yajwa'n.
PERF-ITER-see person-DET RFLX-3sg.RESP in mirror
'That man repeatedly saw himself in the mirror.'

(213) *B-a-re' be'nn-en$_k$ le'e$_k$ lo' yajwa'n.
PERF-ITER-see person-DET 3sg.RESP in mirror
'That man repeatedly saw himself in the mirror.'

(214) *B-a-re' Stel-en$_k$ Stel-en$_k$ lo' yajwa'n.
PERF-ITER-see Estela-DET Estela-DET in mirror
'That man repeatedly saw himself in the mirror.'

(215) B-a-re' be'nn-en$_j$ le'e$_k$ lo' yajwa'n.
PERF-ITER-see person-DET 3sg.RESP in mirror
'That man repeatedly saw him in the mirror.'

(216) B-a-chew bidao'$_k$ kwin=be'$_k$
PERF-ITER-kick boy RFLX-3sg.infor
'The boy repeatedly kicked himself.'

(217) *B-a-chew bidao'$_k$ lebe'$_k$
PERF-ITER-kick boy 3sg.FAM
'The boy repeatedly kicked himself.'

(218) *B-a-chew bidao'$_k$ bidao'$_k$
PERF-ITER-kick boy boy
'The boy repeatedly kicked himself.'

(219) B-a-chew bidao'$_j$ lebe'$_k$.
PERF-ITER-kick boy 3sg.FAM
'The boy repeatedly kicked him.'

3.2.1 The Domain of Reflexive Coreference

Sentences below further illustrate more complex cases of reflexive constructions. These sentences present an empirical challenge for the simplest assumption that having an antecedent noun as potential coreferent with the reflexive is a necessary and sufficient condition to produce grammatical sentences. Sentence in (220) shows that in YZ the independent pronoun can be coreferential with the subject of the matrix verb, while that in (221) shows that the reflexive cannot.

(220) Be'nn biew-on$_k$ ll-ake=le' cha b-re'
person male-DET HAB-think=3sg.RESP.L that PERF-see

no'or-en le'e $_k$.
woman-DET 3sg.RESP
'The man thinks that the woman saw him.'

(221) *Be'nn biew-on'$_k$ ll-ake=le' cha bre'
person male-DET HAB-think-3sg.RESP.L that PERF-see

no'or-en kwin=e'$_k$.
woman-DET RFLX-3sg.RESP
'The man $_k$ thinks that the woman saw him $_k$.'

In fact, the only grammatical interpretation of a sentence like (222) is one in which the antecedent is the immediately preceding noun *no'oren*'the woman'. This example indicates that the domain of coreference for reflexives is the clause that contains the reflexive and the noun phrase antecedent, i.e. in YZ reflexivization is clause-bounded.

(222) Be'nn biew-n ll-ake=le' cha bre'
person male-DET HAB-think=3sg.RESP.L that PERF-see

no'or-én$_k$ kwin=e'$_k$.
woman-DET RFLX=3sg.RESP
'The man thinks that the woman saw herself.'

3.2.2 Pronoun/reflexive Asymmetries

YZ departs from other languages in which some prepositions license pronouns to be coreferential with the antecedent NP, just like reflexives do. Consider the YZ sentences of the English type 'My brother saw a deer close to him/himself' below. The example in (224) shows the construction first volunteered by my consultants to express this type of sentence. The preposition *kwit* 'by' has a third person object, agreeing with the features of the coreferent noun phrase. The contrast indicated by the subscripts *k/*h* means that the only possible reference is with the antecedent NP *bibicha'* 'my brother'.

(223)	B-re'	bibicha	to	blli'nyixh.	
	PERF-see	brother	one	deer	
	'My brother saw a deer.'				

(224)	B-re'	bibicha $_{k}$	to	blli'nyixh	kwit=be' $_{k/*h}$.
	PERF-see	brother	one	deer	by=3sg.FAM
	'My brother saw a deer close to him.'				

If the reference is intended to a non-antecedent NP, then an independent pronoun is used instead, as in (225). Crucially, the independent pronoun cannot refer to the antecedent NP. Furthermore, (226) shows that the reflexive pronoun, *kwinbe'*, 'himself' is prohibited from making reference to the antecedent subject NP, *bibicha* 'my brother'.

(225)	B-re'	bibicha $_{k}$	to	blli'nyixh	kwit	lebe' $_{*k/h}$.
	PERF-see	brother	one	deer	by	3sg.FAM
	'My brother $_{k}$ saw a deer close to him $_{*k/h}$.'					

(226)	B-re'	bibicha $_{k}$	to	blli'nyixh	kwit	kwin=be' $_{*k/*h}$.
	PERF-see	brother	one	deer	by	RFLX=3sg.FAM.
	intended: 'My brother $_{k}$ saw a deer close to himself $_{*k}$.'					

3.3 Reciprocal Pronouns

Reciprocal pronouns are expressed by the base *lollj-* followed by the plural suffix, and then, the corresponding clitic. Reciprocals convey an intrinsic notion of plurality;

hence, as first and second persons have especial forms to express plural, all the third person reciprocal pronouns take the plural morpheme. Table 7 summarizes the formation of reciprocal pronouns in YZ.

Table 7. Reciprocal pronouns

Reciprocal Base		Person Clitics	
		Plural	
		Inclusive	Exclusive
	1	=llo'	=to'
	2	=le'	
lollj-	3	=ak=e' =ak=be' =ak=ba' =ak=en	

Like reflexive pronouns, reciprocals have to be coreferential with a subject noun phrase, trivially, with the NP's in a construction denoting events that describe a mutual action. A third person reciprocal pronoun should agree with the class of the noun referent. Examples of the use of reciprocal pronouns are given in sentences (227) to (232).

(227) Bi ll-oya'l til lojll=to'.
NEG HAB-should IRR.argue RECPR=1pl.excl
'We should not argue with each other.'

(228) Bi ll-oya'l til lollj=le'.
NEG HAB-should IRR.argue RECPR-2pl
'You should not argue with each other.'

(229) Be'nn ka' b-dis=gak=e' yell-liu lollj=gak=e'.
person pl PERF-divide=pl=3.RESP land RECPR=pl=3.RESP
'The men divided the land among themselves.'

(230) Bibicha ka' b-ala'a=gak=be' mell lollj=gak=be'.
brother pl PERF- split=pl=3.FAM money RECPR=pl=3=FAM
'My brothers divided the money among themselves.'

(231) Bayix ka' ll-a'=gak=s=ba'
animal pl HAB-bite=pl=ASSERTIVE.S=3S.ANIMAL

lollj=gak=ba'.
RECPR=pl=3.ANIMAL
'Those animals are just biting each other.'

(232) Yaj ka' ll-dil lollj=gak=en.
rock pl HAB-pile.up RECPR=pl=3.INAN
'The rocks pile up against each other.'

The reciprocal base never occurs bare in the sentence. Always there should be a pronominal clitic attached to it, or before an independent noun.

(233) *Bill n-llie' Xhuana-n nen Bed-en lollj.
NEG STAT-love Juana-DET and Pedro-DET RECPR
'Juana and Pedro do not love each other any more.'

(234) *Xhuanan nen nada' bill ll-ne-to' lollj.
Juana-DET and 1sg NEG HAB-speak-1pl.excl RECPR
'Juana and I do not speak to each other any more.'

(235) B-dis yell-liu lollj be'nn ka'.
PERF-divide land RECPR person pl
'The men divided the land among themselves.'

(236) B-a-ban lollj be'nn ka'.
PERF-ITER-steal RECPR person pl
'The stole each other.'

Reciprocals follow the antecedent noun phrase, regardless of the word order, either V-S-Reciprocal or S-V-Reciprocal.

(237) Che'el Yirma-n nen Stel-en lollj=gak=be'.
IRR.hug Irma-DET and Estela-DET RCPR=pl=3.FAM
'Irma and Estela are going to hug each other.'

(238) *Che'el lollj=gak=be' Yirma-n nen Stel-en.
IRR.hug RCPR=pl=3.ANIM Irma-DET and Estela-DET
intended: 'Irma and Estela are going to hug each other.'

(239) Bill n-llie' Xhuana-n nen Bed-en lollj=gak=be'.
NEG STAT-love Juana-DET and Pedro-DET RCPR=pl=3.ANIM
'Juana and Pedro do not love each other anymore.'

(240) *Bill n-llie' lollj=gak=be' Xhuana-n nen Bed-en.
NEG love RCPR=pl=3.ANIM Juana-DET and Pedro-DET
'Juana and Pedro do not love each other anymore.'

(241) Xhuana-n nen nada' bill ll-ne lollj=to'.
Juana-DET and 1sg NEG HAB-speak RCPR-1pl.excl
'Juana and I do not speak each other any more.'

(242) *Lollj-to' Xhuana-n nen nada' bill ll-ne.
RCPR-1pl.excl Juana-DET and 1sg NEG HAB-speak
'Juana and I do not speak each other any more.'

(243) Be'nn ke barr ka' ll-aya'l w-zénáy
person of neighborhood pl HAB-should INF-listen

ke lollj=gak=e'.
of RCPR=pl=3.RESP

(244) *Loll=gak=e' be'nn ke barr ka'
RCPR=pl=3.RESP person of neighborhood pl

ll-aya'l w-zenay ke.
HAB-should INF-listen of
'People from the barrios should listen to each other.'

3.3.1 1sg Elision in *lolljto'* Constructions

Not infrequently when the first plural exclusive subject occurs as one of the NP's involved in a reciprocal construction of the type "me and NP", the first person singular pronoun *nada'* can be omitted, such that the second term of the conjunct expression appears as the only independent NP in the sentence. The sentences below illustrate this construction. In example (245) the pronoun *nada'* and the proper noun *Xhuanan* form the conjunct, which is referred to in the reciprocal. In sentence (246) one member of the conjunct, the pronoun, has been dispensed with; however, the sentence is grammatical and equivalent to that in (245). According to the native consultants the first person in (248) can be inferred from the resumptive pronominal clitic and it does not trigger further ambiguities.

(245)	Nada'	nen	Xhuana-n	bill	ll-ne	lollj=to'.
	1sg	and	Juana-DET	NEG	HAB-speak	RECPR=1sg.excl

'Me and Juana do not speak each other any more.'

(246)	Bill	ll-ne	lollj=to'	nen	Xhuana-n.
	NEG	HAB-speak	RECPR=1sg.excl	and	Juana-DET

'Me and Juana do not speak each other any more.'

(247)	Xhuana-n	nen	nada'	dil	lollj=to'.
	Juana-DET	and	Isg	HAB.fight	RECPR=1sg.excl

'Juana and I fight.'

(248)	Dill	lollj=to'	nen	Xhuana-n.
	HAB.fight	RECIPR=1sg.excl	and	Juana-DET

'Juana and I fight.'

3.4 Basic Sentence Structure

3.4.1 Word Order and Word Order Variation

In the pragmatically unmarked word order of YZ sentences the verb comes first in the sentence and the subject must follow the verb. In sentences with transitive verbs the object must follow the subject if both arguments are expressed as full noun phrases. This word order is absolutely strict, so that any change in the relative order of postverbal subject-object will produce ungrammatical constructions (or a different interpretation). The examples below illustrate the basic word order in YZ. Sentences (250) and (252) are ungrammatical since their respective subject noun phrases have scrambled from their original position. Furthermore, sentences (250) and (252) demonstrate that the VOS order is never allowed, since their only grammatical interpretations are, respectively, 'John killed the snake' and 'Pedro kicked Juan', with a VSO interpretation.

(249) B-et bel-en Xhua.
PERF-kill snake-DET John
'The snake killed John.'

(250) *B-et Xhua bel-en.
PERF-kill John snake-DET
intended: 'The snake killed John.' means only 'John killed the snake'

(251) B-chew Xhua Bed-en.
PERF-kick Juan Pedro-DET
'Juan kicked Pedro.'

(252) *B-chew Bed-en Xhua.
PERF-kick Pedro-DET Juan
intended: 'Juan kicked Pedro.' means only 'Pedro kicked John'

3.4.1.1 Preverbal Arguments

Early studies pointed out that crosslinguistically there is a tendency for verb initial languages to have an alternate word order in which the subject occurs in a preverbal position (Greenberg 1963, Keenan 1971). This order, moreover, typically conveys pragmatic information identifying the fronted noun phrase as an emphasized constituent. Let us consider a realated phenomenon exemplified in the sentence in (253). The NP *Xhuan* 'Juan', appears in preverbal position. This operation conveys the meaning of specifying that it was a specific individual, *Xhuan*, who performed the action expressed in the verb. These type of sentences are obtained as a natural answer to a question such as 'Who did the snake kill?'. Hence, I will assume the question-answer congruity of these type of constructions to be a diagnostic of what has been identified in the literature as 'focus' (see Buring 1999 and Rooth 1996 for a definition of topic and focus). Although an analysis of the intonational properties of topic/focus constructions of YZ will not be investigated here, I only note that there seems to be an intonational phrase boundary between the NP moved and the rest of the sentence. The boundary is indicated by a prosodic prominence of these constituents, such as a greater length, and a high pitch accent on the preverbal NP (the underlined constituents in the examples); that NP could be also followed by a pause, although that is not always observed.

There are concurrent morphosyntactic correlates of constructions with preverbal arguments. If the noun phrase preceding the verb (informally 'topic' or 'topicalized subject' herein after) makes reference to the subject, then, the subject is expreseed by an obligatory clitic pronoun marker attached to the verb. In the examples below, the coreference between the fronted NP and the clitic is indicated by the subindex ($_k$). Consider the paradigm given below. Sentence (254) contrasts with (253) in that, although it also has a preverbal NP, the absence of the clitic causes the sentence to be ungrammatical, thus, thepostverbal subject is obligatory. Sentence (255) further shows that the clitic and the NP cannot co-occur in post-verbal position. It is only when the topic NP occurs in preverbal position that the clitic is attached to the verb. In consequence, a more precise description of the word order in (253) should include a small S attached to the verb stem, TOP V=S O. A similar contrast is given in sentences (256)-(258).

(253)	Xhua-n$_k$	b-chew=be'$_k$	Bed-en.	TOP[V= S]O
	Juan-DET	PERF-kick=3.FAM	Pedro-DET	
	'<u>Juan</u> kicked Pedro.'			

(254) *Xhua-n b-chew Bed-en. * TOPVO
Juan-DET PERF-kick Pedro-DET
intended: 'Juan kicked Pedro.'

(255) *B-chew=be'$_k$ Xhua-n$_k$ Bed-en. *[V= S]TOPO
PERF-kick=3.FAM Juan-DET Pedro-DET
intended: 'Juan kicked Pedro.'

(256) Xhid-en b-nis=ba' nada'. TOP[V= S]O
cat-DET PERF-scratch=3sg.ANIMAL 1sg
'The cat scratched me.'

(257) *Xhid-en b-nis nada'. * TOPVO
cat-DET PERF-scratch=3sg.ANIMAL 1sg
intended: 'The cat scratched me.'

(258) *B-nis=ba' xhid-en nada'. *[V= S] TOP O
PERF-scratch cat-DET 1sg
'The cat scratched me.'

3.4.1.2 Alternative OVS

Besides sentences involving preverbal NP's coreferent with the subject, there is also an alternative OVS order. Note, though, that preverbal objects are not common. Nevertheless, it is possible to elicit grammatical constructions with objects preceding the verb. Likewise, in these cases the meaning of the sentence has a strong emphasis on the preverbal object (underlined). A preverbal object, in addition, can be marked with a demonstrative *-nan*; the phrase cannot occur bare (260) or just with a determiner (261).

(259) Xhua-nan b-et bel-en. OVS
Juan-DEM PERF-kill snake-DET
'The snake killed Juan.'

(260) *Xhua b-et bel-en. OVS
Juan PERF-kill snake-DET
intended: 'The snake killed Juan.'

(261) *Xhua-n b-et bel-en. OVS
Juan-DET PERF-kill snake-DET
intended: 'The snake killed Juan.'

Sentences like (262), in which the subject is non-pronominal (an independent NP) and the object is expressed by a clitic, are ungrammatical (*VS=O). In these cases, the object can be an independent pronoun (263).

(262) *B-a-chew Kwse-n=ba'.
PERF-ITER-kick Jose-DET=3sg.ANIMAL
'José repeatedly kicked an animal.'

(263) B-a-chew Kwse-n leba'.
PERF-ITER-kick Jose-DET 3sg.ANIMAL
'José repeatedly kicked an animal.'

Hence, in contrast with constructions in which preverbal topics are coreferential with clitic subjects, a fronted object cannot have a pronominal clitic in object position.

(264) *Bed-nan b-chew Xhua-n=be'. *OVS=O
Pedro-DEM PERF-kick Juan-DET=3sg.FAM
intended: 'Juan kicked Pedro.'

(265) *Xhua-nan b-et bel-en=be'. *OVS=O
Juan-DEM PERF-kill snake-DET=3sg.FAM
intended: 'The snake kill Juan.'

Nevertheless, a fronted object can be coreferential with an object expressed as an independent pronoun.

(266) Bed-nan b-chew Xhua-n lebe'. TOP-O VSO(pron)
Pedro-DEM PERF-kick Juan-DET 3sg.FAM
intended: 'Juan kicked Pedro.'

(267) Xhua-nan b-et bel-en lebe'. TOP-O VSO(pron)
Juan-DEM PERF-kill snake-DET 3sg.FAM
intended: 'The snake kill Juan.'

There are no cases of preverbal subject and object in a single sentence; all SOV and OSV forms are regarded by native speakers as ungrammatical. Note, in addition, that the animacy hierarchy described in 2.3.1.2.3 is restricted to pronominal clitics as shown by example (268) and (271).

(268)	B-nis	xhid-en	Adriana-n.	VSO
	PERF-cratch	cat-DET	Adriana-DET	
	'The cat scratched Adriana.'			
(269)	*Xhid-en	Adriana-n	b-nis=ba'.	*SO[V=S]
	cat-DET	Adriana-DET	PERF-scratch-3sg.ANIMAL	
	intended: 'The cat scratched Adriana.'			
(270)	*Adriana-n	xhid-en	b-nis'.	*OSV
	Adriana-DET	cat-DET	PERF-scratch	
	intended: 'The cat scratched me.'			
(271)	B-cheb	chjes-en	bidao'-n.	VSO
	PERF-scare	opossum-DET	boy-DET	
	'The oposum scared the boy.'			
(272)	*Chjes-en	bidao'-n	b-cheb	*SOV
	opossum-DET	boy-DET	PERF-scare	
	intended: 'The oposum scared the boy.'			
(273)	*Bidao'-n	chjes-en	b-cheb	*OSV
	boy-DET	opossum-DET	PERF-scare	
	intended: 'The oposum scared the boy.'			

3.4.2 The Antecedentless Binding Construction

YZ has another very unusual construction, illustrated in sentences (274) and (275).

(274)	B-a-chew	xhi'kw	Kwse-n.
	PERF-ITER-kick	POSS.dog	José-DET
	'José repeatedly kicked his (own) dog'		

(275) B-dib x-la'all=e'.
PERF-wash POSS-cloth=3sg.RESP
'She washed her clothes'

The construction is observed in cases involving sentences with transitive verbs with possessed objects, such that the possessor and the subject are coreferential. The oddity of the construction illustrated above is the apparent absence of an overt syntactic subject, which otherwise is required in all YZ sentences. Compare these sentences with the regular transitive sentences below. In (277) the subject and the possessor of the object are not necessarily coreferential.

(276) B-chew bidao' xhi'kw Stel-en
PERF-kick boy dog Estela-DET
'The boy kicked the Estela's dog.'

(277) B-dib Stel-en x-la'all=e'.
PERF-wash Estela-DET POSS-cloth=3sg.RESP
'Estela$_k$ washed her$_{h/k}$ clothes'

The sentences in (274) and (275) show that the subject is omitted, although it seems to be necessary to serve as antecedent to the possessor of the object. Informally, and with no reference to any theoretical perspective, I will call this the Antecedentless Binding Construction (ABC). Although the construction is typologically atypical, it has been found in most of the major branches of Zapotecan languages, with the exception of Valley Zapotec and Isthmus Zapotec (Black, 1996; 2000; Butler, 1976; Foreman, In progress (2004); Pride, 1965; Sonnenschein, In progress (2004)), and there is evidence of it in Colonial Zapotec (Avelino *et al.* 2004).

Unlike the situation in some other Zapotec languages from the Sierra Norte area (e.g. Macuiltianguis Zapotec, as described by Foreman (in progress, 2004), in YZ the presence of an overt possessive clitic degrades the sentence significatively (278); in contrast, the ABC is perfectly grammatical (279).

(278) */? B-chew=be' xhi'kw=be'
PERF-kick=3sg.FAM POSS.dog=3sg.FAM
'He$_k$ kicked his$_k$ dog.'

(279) B-chew xhi'kw=be'
PERF-kick POSS.dog=3sg.FAM
'He$_k$ kicked his$_k$ dog.'

Butler described a special case of ABC, the "reflexive of possession" construction for Yatzachi Zapotec: "Reflexive constructions in Zapotec are similar [to those in Spanish], however, they don't take two pronouns. The Zapotec construction uses only one reflexive pronoun to indicate both, the person who performs the action and the direct complement...There are other constructions in which the person to whom the complement of the verb belongs to is simultaneously the person who performs the action" (1980:293). The sentences from YZ below illustrate the ABC where the possessed object is the reflexive base. In (280) the possessor is a pronominal clitic, whereas in (281) it is a noun.

(280) B-a-re' kwin=be'.
PERF- ITER -see RFLX=3sg.FAM
'He repeatedly saw himself.'

(281) B-a-re' kwin be'nn-en
PERF-ITER-see RFLX man-DET
'The man repeatedly saw himself.'

As in many other Zapotec languages noun incorporation is attested also in YZ. A common type is body part incorporation, for example *wyo'raw* 'to get used to' is composed of the verb *wyo'* 'put in, introduce' and *raw* 'face, eye'. An appealing hypothesis, thus, is to treat the ABC as a case of incorporation, so that it is a subject—not a possessor—that surfaces in these constructions. However, there is evidence indicating that this is not the case. Let us consider the evidence provided by some of the adverbs described earlier in 2.3.1.3 . The intense adverbial clitic *=do* can be attached to the verb stem before of the markers of subject as illustrated in sentence (282). In (283) the suffix is the last element of the verb stem before the possessed object. This sentence demonstrates that the verb and the possessed object do not form a constituent, and, therefore, it is not a case of incorporation. Moreover, sentence (284) shows that it is not possible to incorporate the noun *xhi'kw* 'dog' into the verb before the adverb *=do*.

(282) B-a-chew=do=a' xhi'kw Kwsen.
PERF-ITER-kick=INTENS=1sg POSS.dog Jose
'I repeatedly kicked Jose's dog hard.'

(283) B-a-chew=do xhi'kw Kwsen.
PERF-ITER-kick=INTENS POSS.dog Jose
'Jose repeatedly kicked his (own) dog hard.'

(284) *B-a-chew=xhi'kw=do Kwsen.
PERF-ITER-kick-dog=INTENS Jose
intended: 'Jose repeatedly kicked his (own) dog hard.'

Now, consider sentences (285) and (286). Theses examples show that different structures can intervene between the verb stem and the possessed object; in these examples, a complex coordinated structure comes between the verb and the possessed object, which strongly indicates the implausibility of an incorporation analysis.

(285) B-a-chew to xhid na' nente xhi'kw Kwsen.
PERF-ITER-kick one cat and also POSS.dog Jose
'Jose repeatedly kicked a cat and his (own) dog too.'

(286) G-aw chixh=e' nente yetgo' k=e'.
IRR-eat POSS.tortilla=3sg.RESP and tamale of=3sg.RESP
'She will eat her tortilla and her tamale'.

As discussed in 3.4.1.1 there are morphosyntactic correlates of constructions with preverbal topics. Consider the sentence in (287) (repeated from (253)), showing a clitic pronoun marker coreferential with the preverbal NP attached to the verb.

(287) Xhua-n_k b-chew=be'$_k$ Bed-en.
Juan-DET PERF-kick=3.FAM Pedro-DET
'Juan kicked Pedro.'

The otherwise stringent condition of having a resumptive clitic concurrent with a fronted topic is dispensed with when the possessor of the object and the subject are coreferential. Sentences (288) and (289) illustrate this case for reflexives and possessed nouns. The sentences are highly degraded or ungrammatical if the clitic is attached, as shown in (290) and (291). As in VSO sentences, in those with preverbal subjects, the intense *=do* occurs at the end of the verb and before the object (292)-(293).

(288) Xhuan b-chew kwin=be'.
Juan PERF-kick self-3sg.informal
'Juan kicked himself.'

(289) Bidao'-n b-chew xhi'kw=be'.
boy-DET PERF-kick POSS.dog=3sg.FAM
'The boy kicked his (own) dog.'

(290) *Xhuan b-chew=be' kwin=be'.
Juan PERF-kick=3sg.FAM self=3sg.informal
'Juan kicked himself.'

(291) *Bidao'-n b-chew=be' xhi'kw=be'.
boy-DET PERF-kick3sg.FAM POSS.dog=3sg.FAM
'The boy kicked his (own) dog.'

(292) Xhuan b-chew=do kwin=be'.
Juan PERF-kick=INTENS self=3sg.informal
'Juan kicked himself hard.'

(293) Bidao'-n b-chew=do xhi'kw=be'.
boy-DET PERF-kick=INTENS POSS.dog=3sg.FAM
'The boy kicked his (own) dog hard.'

Further arguments supporting the ABC come from the evidence provided by quantifiers. In general, quantifiers precede the noun (294)-(298).

(294) yo'ite be'nn 'all the people'
all person

(295) to no'or 'a woman', 'one woman'
one woman

(296) chop wej bidao' ka' 'every two boys'
two DISTR boy pl

(297) Gaw yo'ite no'or ka' yet ka'.
IRR.eat all woman pl tortilla pl
'All the women will eat the tortillas.'

(298) Ll-ap bidao' ka' chop xhi'l=gak=be'.
HAB-watch.over boy PL two sheep=pl=3.FAM
'The boys are watching over their two sheep.'

There is a preference to interpret the subject and the possessor of the object as coreferential when the subject is quantified. Disjoint reference is available; however, it is disprefered.

(299) G-aw yo'ite no'or ka' chixh=gak=e'.
IRR-eat all woman pl POSS.tortilla=pl=3.RESP
'All the woman$_k$ will eat their$_{k/h}$ tortillas.'

(300) Ll-ap ga'ay bidao' ka' chop xhi'l=gakbe'.
HAB-watch.over five boy PL two sheep=pl=3.FAM
'Five boys$_k$ are watching over their$_{k/h}$ two sheep.'

Sentences (301) and (302) show that a quantified noun phrase can function as the possessor of the object in the ABC. As expected, it is interpreted as the subject of the sentence.

(301) Gaw chixh yo'ite no'or ka'.
IRR.eat POSS.tortilla all woman pl
'All the woman will eat their tortillas.'

(302) Ll-ap chop xhi'l ke ga'ay bidao' ka' .
HAB-watch.over two sheep of five boy PL
'Five boys are watching over their two sheeps.'

Let us consider a more complex pattern. First, consider the general properties of quantifiers illustrated in sentences (303) and (304). The sentences are ungrammatical if the quantifiers *yo'ite* 'all' and *ga'ay* 'five' occur without the noun head.

(303) *Gaw yo'ite chixh=gak=e'.
IRR.eat all POSS.tortilla=pl=3sg.RESP
intended: 'They all will eat their tortillas.'

(304) *Ll-ap ga'ay chop xhi'l=gak=be'.
HAB-watch.over five two sheep=pl=3.FAM
intended: 'Five (familiar persons) are watching over their two sheep.'

However, the sentences become grammatical if the pronominal clitics occur on the quantifier.

(305) Gaw yo'ite=gak=e' chixh=gak=e'.
IRR.eat all=pl=3.RESP POSS.tortilla=pl=3.RESP
'They all will eat their tortillas.'

(306) Ll-ap ga'ay=gak=be' chop xhi'l=gak=be'.
HAB-watch.over five=pl=3.FAM two sheep=pl=3.FAM
'Five (familiar persons) are watching over their two sheep.'

Now, consider the sentences in (307) and (308). These forms show the regular pattern of ABC's described so far: The possessor has the quantifier with the pronominal clitics, is interepreted as the subject of the whole sentence. Note, in addition, that the quantifiers cannot occur after the object, as intended in (309) and (311), because they will produce the VOS order, just as it occurs in sentences where the possessor is an independent noun phrase (310). These sentences suggest, again, that the visible pronominal features occuring in the ABC correspond to the possessor and not to the subject of the sentence.

(307)	G-aw	chixh	yo'ite=gak=e'
	IRR-eat	POSS.tortilla	all=pl=3.RESP
	'They all will eat their tortillas.'		

(308)	Ll-ap	chop	xhi'l	ke	ga'ay=gak=be'
	HAB-watch.over	two	sheep	of	five=pl=3.FAM
	'Five (familiar persons) are watching over their two sheep.'				

(309)	*G-aw	chixh=gak=e'	yo'ite=gak=e'
	IRR-eat	POSS.tortilla=pl=3.RESP	all=pl=3.RESP
	'They all will eat their tortillas.'		

(310)	*B-chew	xhi'kw=be'	bidao'-n.
	PERF-kick	POSS.dog=3.FAM	boy-det
	'The boy kicked his dog.'		

(311)	*Ll-ap	chop	xhi'l=gak=be'	ga'ay=gak=be'
	HAB-watch.over	two	sheep=pl=3.FAM	five=pl=3.FAM
	'Five (familiar persons) are watching over their two sheep.'			

II

The Phonetic Structures of Yalálag Zapotec

4 Vowels, Consonants and Tone

4.1 Preliminaries

In its native vocabulary Yalálag Zapotec has 21 consonants and 9 vowels, five modal vowels and four vowels produced with laryngealized phonation. The goal of this chapter is to provide a description of the phonetic structures of YZ vowels, consonants and tone. YZ is of particular interest in several respects. Descriptions of closely related languages differ with respect to the status of back vowels, whether there are two back vowels /u/ and /o/. Unlike other Zapotec languages I propose that the vowel system of YZ is asymmetrical in the sense that it has two back modal vowels and only one back vowel in the laryngealized series. The consonants of YZ also present uncommon properties among languages. Against typological predictions (Greenberg, 1978), in YZ the labiovelar approximant can occur as the first member of an onset cluster /wC/, but the sequence cannot be separated in two syllables so that /w/ could be analyzed as a vowel. Previous descriptions of many Zapotec languages have included a series of 'checked' vowels described as a vowel followed by a glottal stop. In contrast with these studies, including my own previous account (Avelino, 2001), I analyze the glottal stop [ʔ] as a consonantal segment. I will discuss the arguments supporting this account later in this chapter. In the next sections I present a phonetic account of the Yalálag sound pattern. I describe first vowels, then consonants, and after that, I present a description of tone. There is no comparable acoustic account of any Zapotec language, it is hoped that this work will contribute to initiate a series of similar studies in the large and diverse family of Zapotec languages.

4.2 Spectral Characteristics of YZ Vowels

Accounts of Zapotec languages, Yalálag Zapotec included, have described a contrast between modal, checked and rearticulated vowels (Jones, 1977; López Cruz, 1997; Lyman, 1977; Nellis, 1980; Newberg, 1983; Pickett, 1998). While the descriptions of previous studies are suggestive of laryngeal actions as the base of the contrast, little has been investigated about the quality of the vowels.

YZ has nine vowels, the series of modal vowels /a, e, i, o, u/, plus a series of four vowels characterized by a contrastive use of laryngealized voice /aˀa, eˀe, iˀi, oˀo/. These vowels will be phonemically represented by a superscripted glottal stop, however, in my analysis is not a phonemic unit and it should be differentiated from the phonemic glottal stop /ʔ/. I will discuss how I deal with sequences of vowels in section 4.3.4. The phonemic representation intends to capture the traditional use of the 'rearticulated' vowel type (vˀv) mentioned in previous studies, although this is only one of the possible realizations of the contrastive laryngeal phonation type. The phonetic narrow transcription of vowels with this phonation type includes also creakiness through most of the segment (v̰:). A comprehensive account of YZ phonation will be presented in Chapter 5.

In principle, the properties of the sound source should not affect the acoustic properties contributed by the vocal tract configuration (Fant, 1960). Thus, even if the contrast between the two series of vowels is based on differentiated glottal activity, it is predicted that the two series of modal and laryngealized vowels will have similar acoustic resonance properties. However, there is also evidence showing that vowels with non-modal phonation present a formant structure dissimilar to that of modal vowels (Pongweni, 1983). Likewise, it has been argued that in languages where there is an extra feature distinguishing series of vowels (for instance, duration), a consistent difference in vowel quality might enhance the primary contrast based on vowel length (McDonough, 1993). Hence, a reasonable hypothesis would be that in YZ a systematic difference in vowel quality provides an enhancing cue to the phonemic contrast based on phonation. At any rate, the phonetic description of the YZ vowel qualities provided in this chapter will instruct us about whether there are differences in vowel quality associated with phonation type.

4.2.1 Data and Methods

A set of recordings was made from eight native speakers of YZ, five male and three female in Villa Hidalgo, Yalálag, Mexico (m2, m4, m13, m14, m15, f3, f4, f9). Their ages were between 30 and 50's. They were asked to repeat a list of words that illustrated the phonemic contrast in the three vowel series. To control the effect of consonant place of articulation on the vowel formants, the series of words elicited started with a coronal consonant preceding the target vowel. The words were repeated in isolation. A list with words illustrating the contrast is given in Table 8. The complete list of words used for the acoustic analysis of vowels is given in appendix 1. Data were sampled at 22050 Hz. Measurements of the three first formants were made using LPC analysis assisted displays of the spectrograms (10 and 12 coefficients were used for female and male speakers, respectively) from the middle, steady portion of the vowel with the PCQuirer software (Tehrani, 2000). Formant charts were prepared with PlotFormant software (Tehrani, 2003). The results are based on a total of 910 vowel tokens. Statistical analyses were made with SPSS software (10.05).

Table 8. Contrast between modal and laryngealized vowels

Modal		Laryngealized	
l:a	'hot'	la$^{?}$al	'up'
za	'beans'	za$^{?}$a	'baby corn'
le	'then'	le$^{?}$e	'he'
ze	'each'	ze$^{?}$e	'wall'
li	'truth'	di$^{?}$ide	'spotted'
zi	'odor'	zi$^{?}$i	'heavy'
lo	'root'	no$^{?}$ol	'woman'
to	'one'	wado$^{?}$os	'to put upside down'
zu	'fermented beverage'	--	

4.2.2 Vowel quality

Modal vowels. In general, the quality of modal vowels in YZ resembles the distribution of most five vowels systems cross-linguistically (Disner, 1983; Maddieson, 1984; Schwartz, 1997a; b). Figure 6 shows acoustic vowel diagrams based on the mean formant frequencies along with ellipses that describe the dispersion of the five modal vowels of the male and female YZ speakers. It is well known that the frequencies of the first two formants correlate well with the vowel qualities of height and backness (Fant, 1960; Ladefoged, 1996a; Stevens, 1998). This and the following figures will show the values of F1 on the ordinate and those of F2' on the abscissa. F2' was used to give a closer representation of the perceptual dimension of backness, and it was calculated according to Fant's (1973) formula F2' = F2 + 0.05 (F3-F2) F2-F1/F3-F1. Data were plotted in separate charts for male and female speakers. Overall, the plot of mean values reveals higher values of the vowel formants for females than males. The plot of mean values for the two groups shows a typical instance of a so-called 'triangular' five-vowel system with two front and two back vowels and one central low vowel. The mean values are sufficiently distinct from each other, but it is apparent from the chart that the vowels are not equidistant from each other. Thus, on a Bark scale, the space between /a/ and /e/ or /o/ is greater than the one between /i/ and /e/ or /u/ and /o/. An interesting point is that there is no uniform tendency regarding the range occupied by each vowel in any of the two groups. In female speech the chart reveals some extent of variance of front and back vowels in the F1 dimension, which is reflected in the scope of their ellipses. In male speech, in contrast, the dispersion of front or back vowels is greater in the F2' dimension than that of females, as the plots show that there is only partial overlap between front and back vowels of both groups. It is interesting to note that the center points of /e/ and /o/ fall very close to the border of the ellipses of /i/ and /u/, respectively. The wide dispersion of back vowels is consistent with the impressionistic observation that the actual realization of /u/ and /o/ is very similar in the speech of some speakers; likewise, the relative widespread distribution of the two vowels might contribute to explain the source of the free variation found in some words discussed further in section 4.2.2.1.

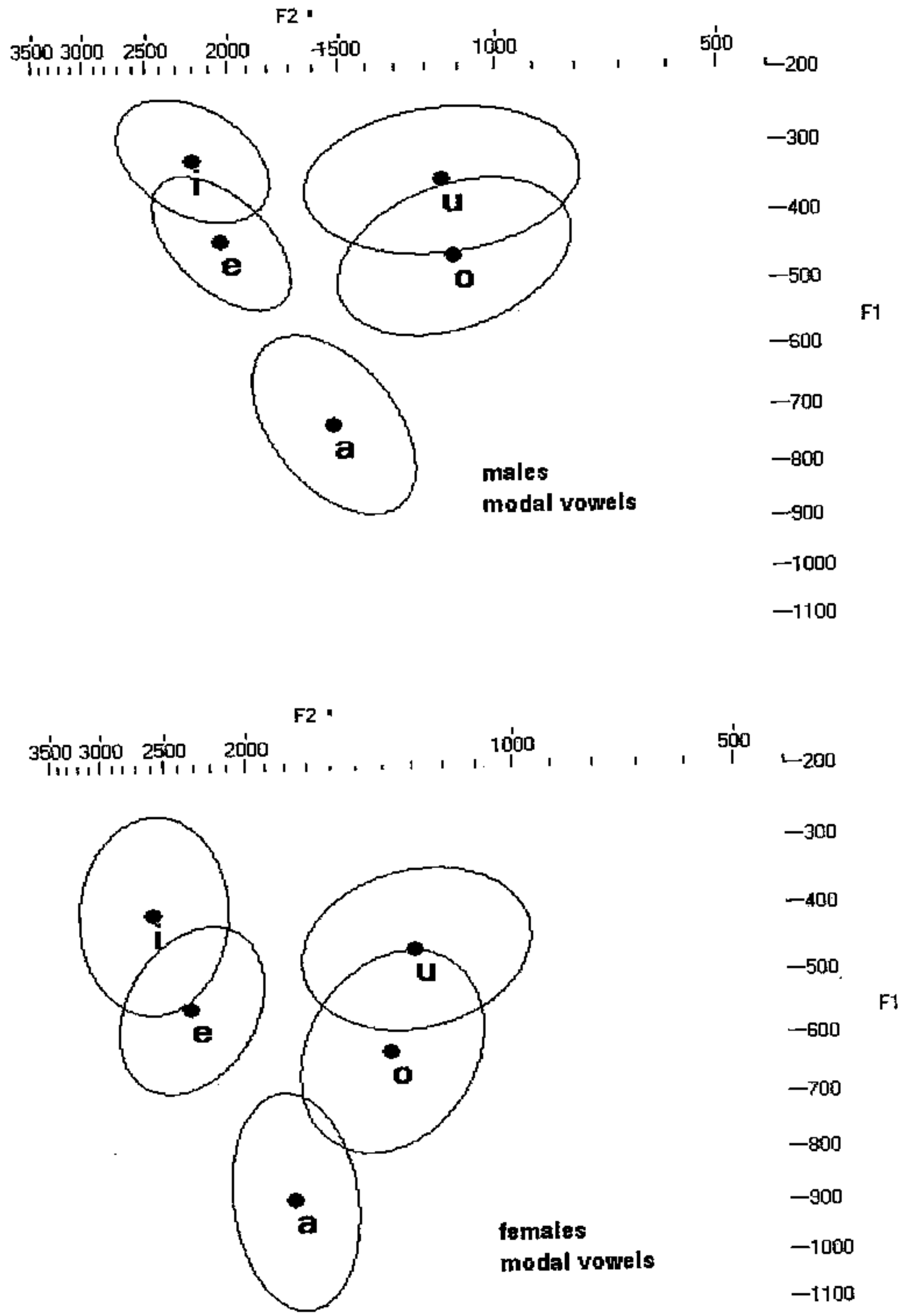


Figure 6. Mean values and variances of the five modal vowels for male and female YZ speakers

As shown in the chart, vowels in the back region have higher values along the F1 parameter indicating that they were lower vowels than the corresponding front vowels. Table 9 summarizes the mean values and standard deviation of the vowels of the two groups. The values in the table show what is conspicuous in Figure 6, that there is a greater dispersion along the F1 dimension for the front and back vowels for females than males.

Table 9. Mean formant frequencies and standard deviation (in parentheses) of the modal vowels of male and female speakers of YZ

	a		e		i		o		u	
	male	female	male	female	male	female	male	female	male	female
F1	728 (77)	871 (101)	440 (50)	545 (76)	322 (44)	407 (74)	464 (58)	625 (84)	353 (53)	462 (63)
F2'	1539 (162)	1778 (158)	2047 (184)	2256 (196)	2210 (221)	2598 (265)	1128 (176)	1389 (167)	1167 (211)	1304 (196)
F3	2535 (143)	2622 (393)	2646 (135)	2666 (224)	2819 (226)	2996 (189)	2421 (256)	2778 (371)	2400 (242)	2707 (367)

Laryngealized vowels. In general, the mean values of most laryngealized vowels are well distributed, and, as expected, they did not differ significantly from the modal series. As illustrated in Figure 7, the most prominent characteristic of laryngealized vowels is a tendency to centralize the back vowel /o^{ʔ}o/ toward areas that phonetically are similar to close-mid vowels [ʊ] or [ɵ]. Another difference between the laryngealized vowels is that the three female subjects have a greater dispersion along the F1 dimension than the five male subjects. Regarding the vowel space of front vowels /i^{ʔ}i/ and /e^{ʔ}e/, the two groups show different distributions. For males, the plots show that the average values are well separated, and only minor portions of the two vowels intersect. In contrast, for females, the plots reveal a greater overlap. The specific values of the data for the two groups are presented in Table 10.

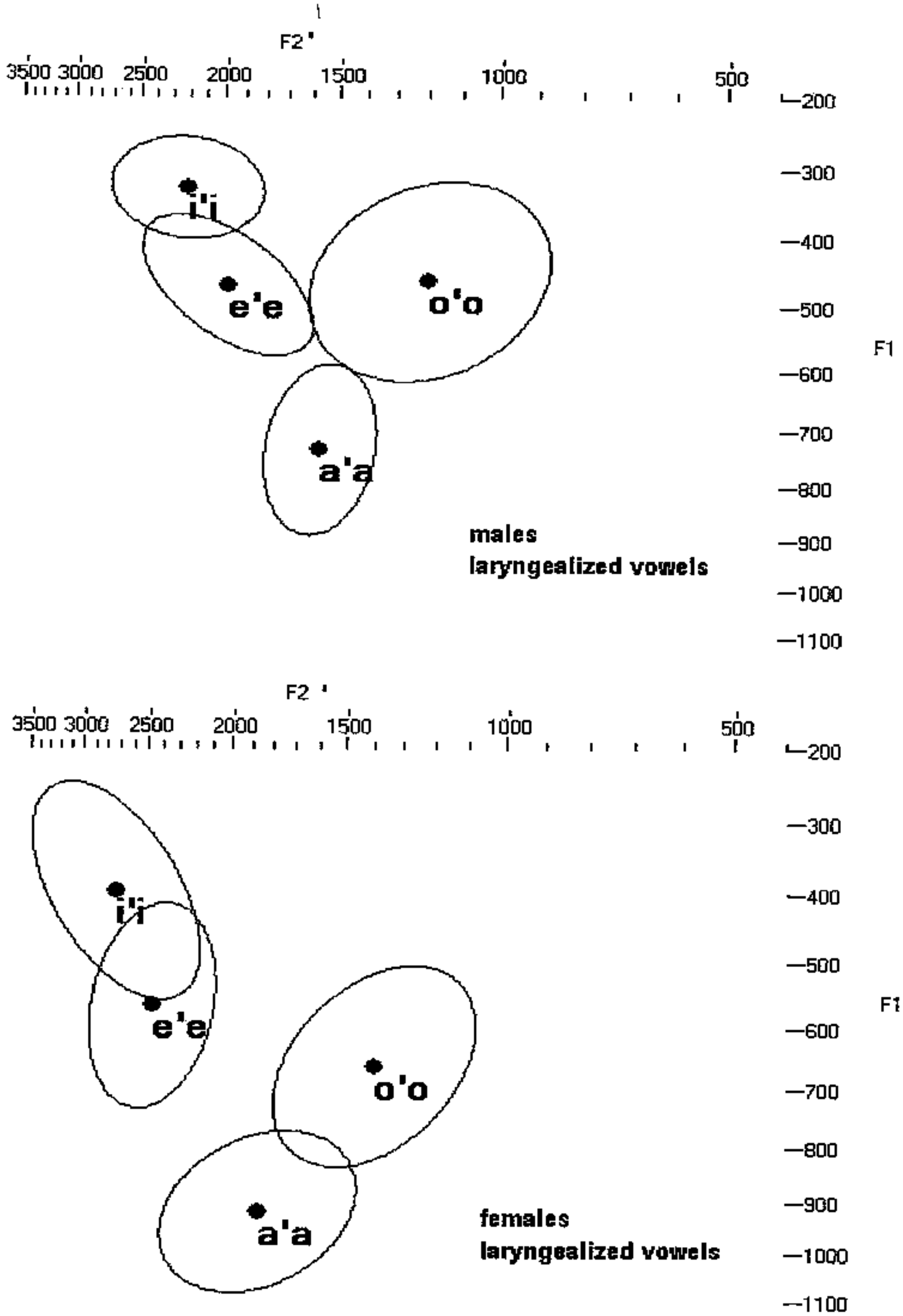


Figure 7. Mean values of the four laryngealized vowels for male and female YZ speakers

Table 10. Mean formant frequencies and standard deviation (in parentheses) of the laryngealized vowels of male and female speakers of YZ

	$a^{?}a$		$e^{?}e$		$i^{?}i$		$o^{?}o$	
	male	female	male	female	male	female	male	female
F1	734 (72)	919 (79)	470 (53)	568 (81)	327 (37)	399 (79)	465 (76)	663 (82)
F2'	1574 (109)	1880 (242)	2001 (214)	2481 (222)	2224 (221)	2755 (329)	1210 (181)	1405 (185)
F3	2549 (142)	2931 (283)	2583 (121)	3101 (471)	2833 (207)	2988 (348)	2480 (211)	2738 (324)

The preceding characterization of the phonetic space of YZ vowels assumed the well-known correlation between vowel formants (F1 and F2') and tongue height and backness. However, a dimension not separately accounted for in the previous description is the configuration of the lips, in that F2' values reflect both backness and rounding. In this regard, it is important to notice that rounding is not particularly prominent in the actual production of YZ back vowels. Thus, very often (especially in casual speech), YZ native speakers pronounce the back modal vowels /o/ and /u/ more like the back unrounded vowels [ɤ] and [ɯ], and the laryngealized /o$^{?}$o/ is similarly pronounced as [ɤ$^{?}$ɤ]. This observation might partially explain the formant frequency values observed before. It is known that rounding produces the effect of lowering the F2 values, so the relatively higher values of the YZ back vowels are consistent with the typological tendency, and are also comparable to data from languages that have a phonemic contrast between round and unround back vowels (cf., for instance, Thai, as described by Abramson 1962).

The most conspicuous asymmetry of YZ vowels is the lack of a phonemic high back vowel in the laryngealized series. Maddieson (1984) has suggested that in uneven systems like YZ the lack of a high back vowel could be compensated for a rising of the mid back vowel at higher values than the corresponding of the mid front vowel. The data obtained for YZ do not confirm this prediction. On the one hand, although the data for male subjects shows that the mean F1 value of /o^{ʔ}o/ was slightly lower, indicating a higher vowel than that of /e^{ʔ}e/, the difference was non-significant. On the other hand, the data for female subjects showed that the mean F1 of /e^{ʔ}e/ is indeed lower than that of /o^{ʔ}o/.

Another potential indication of compensation of the back space of the laryngealized vowel series could be found in the relative wide dispersion of /o^{ʔ}o/, as indicated by the ellipses in Figure 6 and Figure 7. Such a distribution might suggest that the vowel is occupying the high back empty space of the vocal quadrilateral. However, this hypothesis should also be rejected. As the modal series is symmetrical, it was expected that the presence of /u/ would constrain the dispersion of /o/. However, the data revealed that the modal vowel /o/ shows a comparable variance to that of /o^{ʔ}o/. Therefore, the distribution of /o^{ʔ}o/ cannot be explained solely by the lack of high back vowel; instead, the data indicates that the mid vowels in the two series, modal and laryngealized have a very similar pattern of wide dispersion in the back space. Furthermore, it should be also noticed that the dispersion observed for /o^{ʔ}o/ does not expand to the entire high back space available; i.e., the space of laryngeal vowels remains skewed even though there is no other vowel filling in the high back area.

4.2.2.1 Vowel Quality and the Phonemic Status of Back Vowels in YZ

The phonemic status of back vowels in Zapotec languages of the Sierra region differs across dialects; some descriptions refer to a five vowel system with two back vowels /o/ and /u/ (Bartholomew, 1983; Butler, 1980; Long, 1999), while others report a four vowel system with only one back vowel, /o/ (Nellis, 1980), as it has been also proposed for YZ, which varies between [o] and [u] (cf. Newberg 1983; López and Newberg 1990). Indeed, my own previous analysis (Avelino 2001) claimed a four vowel system /a, e, i, o/. Here, I would like to reconsider the issue and propose a different hypothesis: that there is a contrast between two phonemic categories, /o/ and /u/, that divides the back vowel space. Nevertheless, for some items it is also possible to observe free alternation between [o] and [u]. Moreover, I propose that the distinction between two back vowels is maintained only in modal vowels but absent in laryngealized vowels, i.e. the vowel system has just one laryngealized back vowel, /o^{ʔ}o/. In the rest of this section, I elaborate on this proposal.

In a great number of YZ words, certainly, there is free variation between [o] and [u]. Table 11 presents examples of this pattern, and the spectrogram in Figure 8 shows the realization of /tó/ 'one' pronounced as [o] and [u] by two male speakers. The values of the F1 and F2 show the typical values for the two vowels en each case.

Table 11. Free variation between [o] and [u]	
tó ~ tú	'one'
dó ~ dú	'rope'
tʃôd ~ tʃûd	'hawk'
góbé ~ gúbé	'broom'
gòz ~ gùz	'sow'

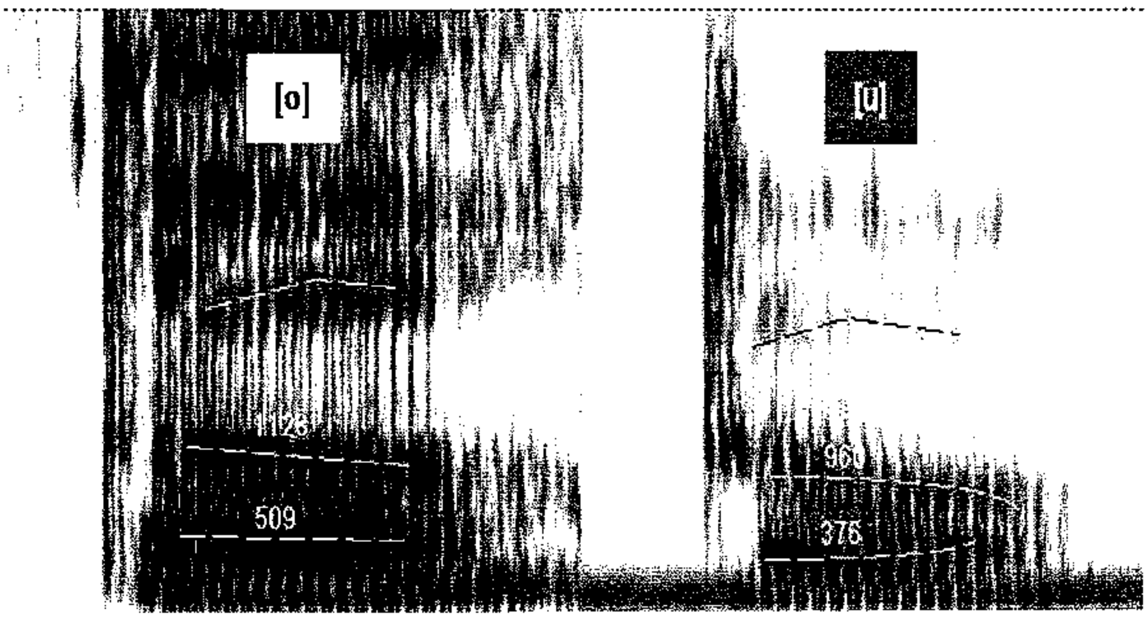


Figure 8. Spectrograms showing the variation of /tó/ 'one' in the speech of two males (m2 and m15). The spectrogram to the left shows typical formant values of [o], while the one to the right shows those of [u].

In contrast, for many other words free variation between /u/ and /o/ is not possible, so that for most of the words, the alternation pronounced with [u] renders unacceptable forms. Some examples showing the contrast are given in Table 12 below.

Table 12. Phonemic contrast between /o/ and /u/	
bsû ~ *bsô	'adobe'
gúl ~ *gól	'old'
bʒón ~ *bʒún	'cereus'
bʒòχ ~ *bʒùχ	'mute'
lóʔ ~ *lúʔ	'stomach'
bròχ ~ *brùχ	'cave, hole'

I suggest that the phonological status of back vowels in YZ ranges from a continuum going from the free alternation of the two phonetic variants, [o] and [u], to the contrast between two separate phonemes. On one side of the continuum there is absolute free variation with no preference for either of the two vowels shown by the speakers. López and Newberg (1983) and Newberg (1990) have suggested that the choice of one or the other vowel varies from speaker to speaker. My own impression, substantiated by my consultants, is that younger people are prone to pronounce [u], while [o] is found in more conservative speech. In any case, it seems that the alternation cannot be attributed to any phonological rule. In an intermediate step of the continuum there are instances of words for which speakers prefer to use one of the two phonetic values and regard the opposite production as atypical. This is, for instance, the case of the alternation between *tó ~ tú* for the word 'one' or *dó ~ dú* for 'rope'. Interestingly, speakers differ in terms of which pronunciation they prefer; some prefer [o], whereas others favor [u]. Finally, in the extreme point of the continuum there is the contrast between /u/ and /o/. I will consider as an indication of contrast the fact that in some cases the alternation produces unacceptable forms to the native speakers; note, however, that minimal pairs have not been found.

There is a problem relating to the distribution of the three steps along the continuum in the lexicon of YZ. In a corpus of 954 words, 166 contained a back vowel. The complete set was presented to my main consultant to evaluate whether their vowels could be pronounced with free variation, with a preferred pronunciation or with phonemic contrast. Although the assessment is limited to one consultant, the responses obtained may be indicative of the general YZ pattern. Overall, the possibility of free variation was 67%, from this total; there was a greater preference for an [o] pronunciation (39%), over [u] (28%). Words showing a contrast between the back vowels accounted for 33% of the corpus, in which the contrast /u/ ~ */o/ represented 14% and /o/ ~ */u/ 19%. The figures suggest that the ratio of the different possibilities represented in the lexicon of the language is skewed, with the free variation as the more frequent option and the phonemic contrast as the more limited.

In general, the frequency of laryngealized vowels is less than that of modals vowels. This dissimilarity is observed in the low frequency of /oˀo/. Within the same corpus, only 28 words had a back laryngealized vowel. It is interesting to note that even in this rather reduced number of words there were two patterns with respect to the possible pronunciation of the vowels. Only 11 of these words were consistently pronounced with [oˀo], with a pronunciation [uˀu] rejected; the rest, 17 cases, showed free variation between [oˀo] ~ [uˀu], with a strong tendency to prefer the [oˀo] variant. Figure 9 sums up the phonemic status of back vowels in YZ. The major split is between phonemic and non-phonemic alternations. The figure shows separate patterns for modal and laryngealized vowels. For modal vowels the wider base of the triangle represents the more common case of free variation, while the narrower section corresponds to the less frequent phonemic contrast. Phonemic split within the back space is limited to the modal series, whereas for laryngealized vowels a phonemic contrast has not been attested; accordingly, the figure represents only the more frequent case of free variation and the more limited one of preferring certain words pronounced with one vowel or the other.

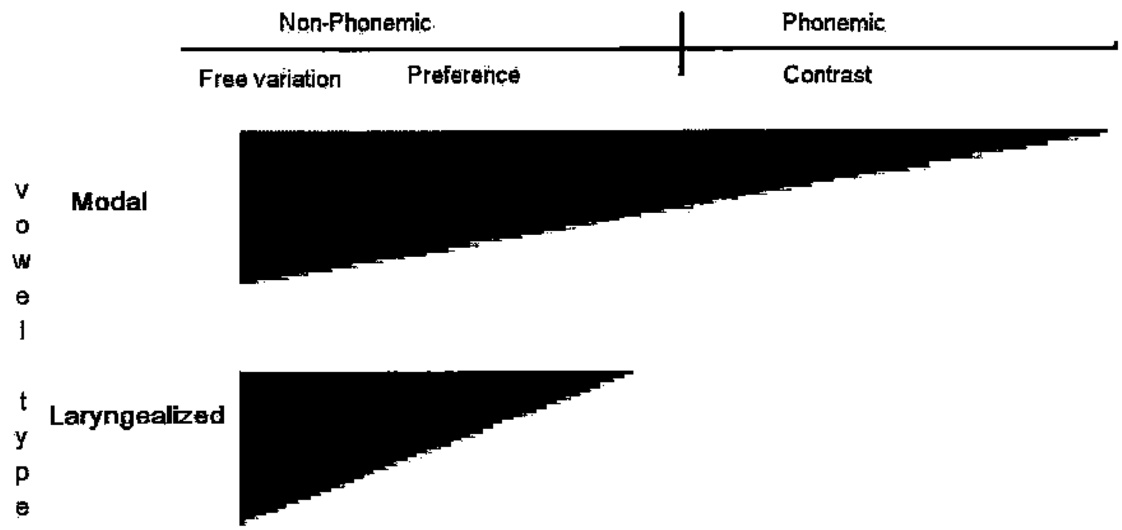


Figure 9. Phonemic status of back vowels in YZ

Without considering the possible influences of Spanish on YZ (as all the speakers I worked with are fluent bilinguals in both YZ and Spanish), one plausible conjecture explaining the YZ pattern is that the vowel system of YZ (and by extension similar Zapotec languages from the Sierra area) is a four-vowel system that is in the course of splitting the back space into two phonemes. The relatively late emergence of a new phoneme could explain its limited occurrence in the lexicon, as well as the absence of a contrast in the laryngealized vowel series. However, this proposal goes against historical grounds as the available studies of Proto-Zapotec reconstruct no fewer than five vowels /*a, *e, *i, *o, *u/ according to Fernández de Miranda (1995) and /*a, *e, *i, *o, *u, *ɨ, *A, *O/ according to Suárez (1973). Another possible speculation, more in the line with these proposals of reconstruction, is that YZ has a five vowel system in the process of merging the contrast in back vowels. However, this view has to assume that complete fusion has already taken place in the laryngealized series. A full study of the reconstruction and development of YZ vowels is beyond the scope of the present dissertation; nonetheless, the description and discussion presented here might be considered as the basis for further research on the reconstruction of Zapotec languages.

4.2.3 Summary and Discussion of Vowel Qualities

The goal of this section was to provide an acoustic description of YZ vowels. Considering all the evidence together, the distribution of vowels in the plots and the phonemic status of back vowels support the proposal that the inventory of YZ has five modal vowels and four laryngealized vowels. The front and low vowels resemble the typical qualities of cardinal vowels /i/, /e/ and /a/; however, the back vowels are better described as back, not quite high as the cardinals /o/ and /u/, and without a consistent lip rounding, which can explain their wide distribution along the F2 dimension. Figure 10 summarizes the acoustic properties of YZ vowels. The circles represent vowels produced by the female speakers, while the triangles connected by dotted lines represent vowels produced by the male speakers. Dark symbols represent laryngealized vowels, whereas white ones represent modal vowels. One of the obvious points shown in the figure is the difference in vowel quality of females and males. In general, the vowels of the three females have more dispersed values along the F1 dimension than the vowels of the five males. In this regard, the data from YZ is illustrative of the correlation between vocal tract size and formant values. As the plots show, females, who typically have smaller vocal tract dimensions, presented greater absolute formant frequencies than males, who typically have larger ones (Fant, 1973; 1975).

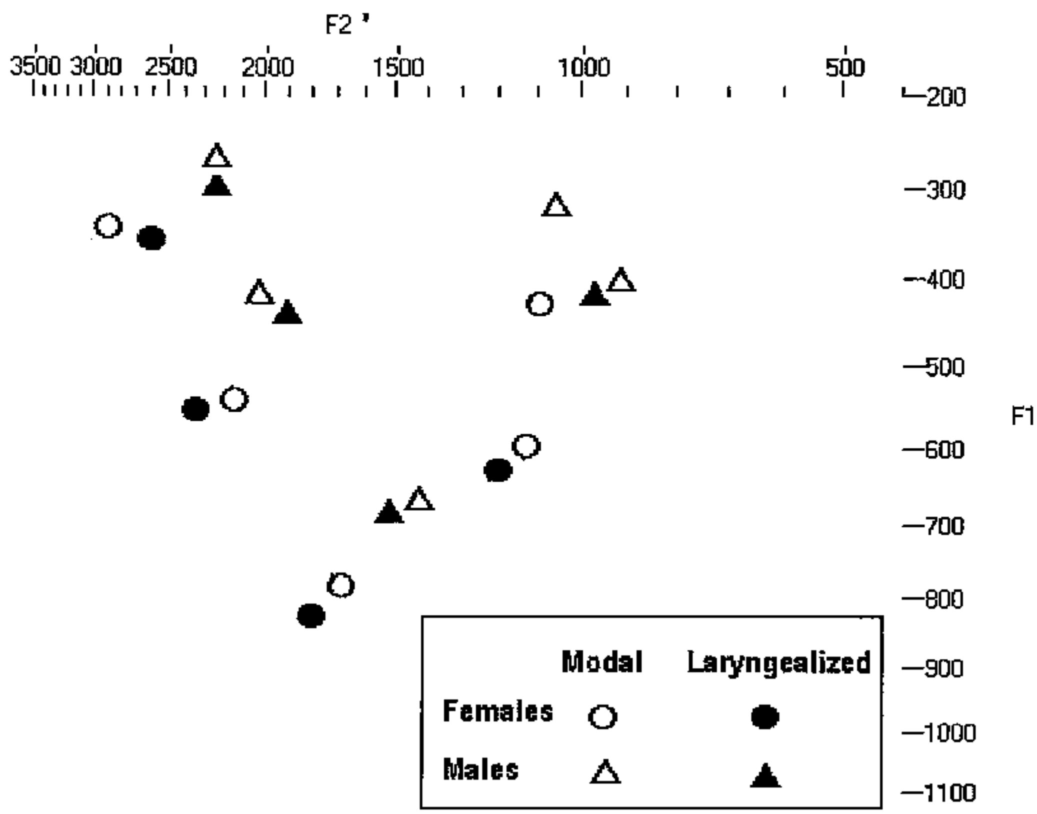


Figure 10. Overall mean values of modal and laryngealized vowels of male and female subjects.

Another feature that might distinguish the pattern of each group was the greater overlap in the vowel dispersion of the vowels of the females compared to that of the males. As shown in the more detailed plots in Figure 6 and Figure 7, the pairs of front and back modal vowels of females intersected each other more than those of males. It should be recalled, though, that the variance of the vowels and the eventual overlap between ellipses could likewise be due to anatomical considerations (differences in individual head and vocal tract size). Regarding the differences between modal and laryngealized vowels, the data show that there is a tendency for the modal vowels to be more closed (and more centralized in females) than their laryngealized counterparts as may be seen in the chart. However, an analysis of variance was conducted and the effect of vowel type was non-significant (a conservative comparison, Tamhane's T2, test was used). This result supports the observation that the mean values of each pair of modal and laryngealized vowels essentially occupy the same position in the vowel space. Thus, the pattern portrayed in the chart lends support to a basic hypothesis of vowel dispersion, which maintains that vowels are dispersed in the phonetic space so that the auditory differences among the vowels are maximized; however, the relative wide variance of the vowels does not guarantee an optimal auditory contrast. In connection with this point, one other observation that deserves comment is the fact that back vowels are articulated without a prominent protrusion of the lips. It has been noted in the literature that the difference between front and back vowels makes use of lip configuration to maximize the distinction, so that back vowels are rounded and front vowels are unrounded (Liljencrants, 1972). Thus, the tendency of YZ back vowels to be centralized on a formant chart can also be due in part to the effects of a relatively unrounded, unprotruded configuration of the lips.

Finally, the findings outlined above suggest a number of potential studies that might follow up the research initiated here. For instance, regarding the alternations of back vowels, it would be highly desirable to elicit more speakers' judgments about what words show contrastive alternation, free variation or a preferential pronunciation. Perceptual studies might investigate more accurately the status of vowels in YZ. After all, the definition of vowels in the acoustic space (F1-F2) has been associated with a perceptual function; we would be interested in learning how YZ listeners in fact perceive the formant frequencies of vowels.

4.3 Consonants

In the following sections I will present the description of the YZ consonants. I deal first with the temporal aspects of consonants, especially those connected to voicing, then turn to the description of place and manner and later I describe the possibilities of consonant sequencing found in YZ.

The inventory of Yalálag Zapotec consonants is shown in Table 13 below. Yalálag Zapotec has 25 consonants, including sounds from loan words, represented with symbols between parentheses. Voiceless consonants appear to the left of cells, voiced to the right in italics.

Table 13. Yalálag Zapotec consonants								
	Bilabial	Dental	Alveolar	Post-Alveolar	Palato-Alveolar	Velar	Labio - Velar	Glottal
Plosive	p *b*	t *d*				k *g*	kʷ	ʔ
Affricate					t͡ʃ			
Nasal	(m)	n̪:	n					
Fricative	(f)	s *z*		ʂ *ʐ*	ʃ *ʒ*	(x)		
Lateral		*l̪:*	*l*					
Trill			*(r)*					
Approximant					*j*	*w*		

In contrast with previous descriptions of Zapotec languages, YZ included, (Newberg, 1983) the present account differs from previous approaches in several ways. I did not find evidence for a fortis-lenis contrast in consonants (4.3.1.1); rather the results indicate that the main difference is based on durational properties. In obstruents, the main contrast is based on voice onset timing and closure duration, whereas in sonorants the contrast is between long and short segments. The main differences from my own previous description is that in the present study (Avelino 2001), I include a labio-velar consonant and a glottal stop as phonemes.

4.3.1 Plosives

In Yalálag Zapotec plosives contrast in six places of articulation: labial, dental, palatal, velar, labio-velar and glottal. My analysis diverges from descriptions of closely related Zapotec languages mainly in that I do not consider a uvular place of articulation as phonemic, but as a variant of velar. I will discuss the details of this approach further below.

Labials. In general, labial consonants are defective in Otomanguean languages. Labials are so rare in the native phonology of languages of the family that Rensch (1976) has proposed that Proto-Otomanguean lacked labials. According to him, contemporary labials are assumed to derive from $*k^w$. Likewise, in Zapotec languages native labials sounds are rare, especially word initially and in root initial position. The scarcity of Yalálag Zapotec words with /p/ is consistent with the historical observations. Table 14 presents examples of contrast between labial stops in word initial position where most of the instances are loans from Spanish.

Table 14. Contrast in labial stops; /p/ from Spanish loan words

pít	'thread'	from Spanish *pita*
bît	'epazote plant'	
pêl	'Ofelia'	from Spanish *Ofelia* (proper name)
bêl:	'fish'	
pâp	'potato'	from Spanish *papa*
bà	'tomb'	

Nevertheless, in other environments there are few instances of native words, which have /p/, as shown below.

Table 15. Contrast in labial stops: /p/ - /b/ in native words

wàtúpén	'to daub'
wàdúbén	'to wrap'
ʒàχpéʔ	'thin rain'
ʒàzχbéʔ	'he takes a shower'
ʒàpàʔ	'I comb my hair'
ʒàbàn	'young'
wàtʃip	'to cut (fruit)'
wàtʃáb	'to offer'

Among the most noticeable properties of /p/ (and stops in general) is that there is no evident aspiration in the release, although in word final position there is a slight audible release. Another salient property of labial stops concerns their stricture. In normal speech (normal rate, non-careful style) /p/ is realized with a complete closure, whereas /b/ alternates between a stop and fricative [β] articulation, regardless of rate and speech style. Figure 11 show representative tokens of the realization of /p/ and /b/ word finally. The waveform corresponding to /p/ shows a longer closure duration (200 ms) followed by a perceptible release; in contrast, /b/ does not show a closure interval, but is realized as a fricative.

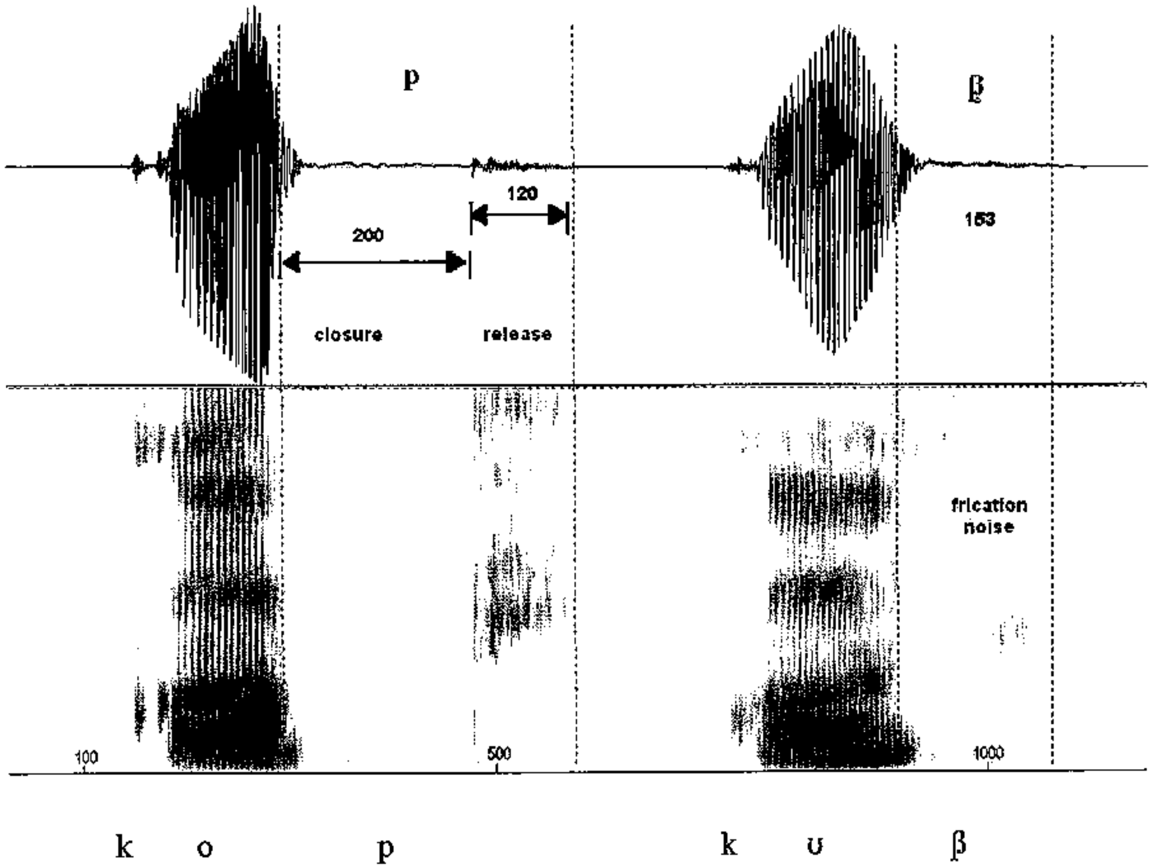


Figure 11. Waveform and spectrogram illustrating the total occlusion and posterior release of /p/ in contrast with the fricative realization of /b/ in the words *kóp* 'cup' and *kúb* 'new' in the speech of a male speaker (m2).

Denti-alveolars. There are two denti-alveolar stops in YZ, /t/ and /d/. In spite of the fact that Table 13 shows a contrast between dentals and alveolars for other phonemes, this distinction in place of articulation is non-phonemic for stops. The dental-alveolar contrast is restricted to sonorants and is a concomitant feature of the phonemic contrast in length; in other words, long nasals and laterals are dental, while their short counterparts are alveolar. Thus, consonants /t/ and /d/ are typically dentals [t̪], [d̪]; however, that specification does not preclude the possibility of variation in place of articulation. Indeed, there is a great deal of individual variation in the production of dentals, as it will be further discussed in Chapter 3 . This fact is captured in Table 13 by placing /t/ and /d/ under the dental column in the table, but in a cell, which also includes alveolar. Hence, a typical /t/ is often laminal, while /d/ varies from dental to alveolar, and, when alveolar, tends to be apical. Table 16 shows examples of contrast between /t/ and /d/, using a narrow phonetic transcription.

There is a great range of variation regarding the stricture of /d/; very often it is realized as fricative [ð], although it can be pronounced as stop, as well. Although the fricative realization tends to occur more often in word final and intervocalic positions, it is not infrequent to find it word initially.

Table 16. Contrasts between /t/ and /d/

/t/		/d/	
[tè]	'gray'	[dè] ~ [ðè]	'ashes'
[tó]	'one'	[dó] ~ [ðó]	'rope'
[túpén]	'daub'	[ˈdúβéŋ] ~ [ˈðúβéŋ]	'enfolded'
[tàsbéʔ]	'he has slept'	[ˈdasbéʔ] ~ [ðasˈbéʔ]	'he is just hanging around'
[sété]	'quickly'	[ˈzêdè] ~ [ˈzêð̥è]	'it takes a lot of time'
		[ˈbáˀàðèʔ] ~ [ˈbáˀàðèʔ]	'tumpline'
[ʒǐt]	'egg'	[zi̢ð̥] ~ [zi̢ð]	'cat'
[ɟĩt]	'squash'	[ɟĩð̥] ~ [ɟĩð]	'leather'
[zêt]	'squash sprout'	[zéˀèð] ~ [zéˀèd]	'salty'

Velar. There are two velar stops in YZ, /k/ and /g/. Newberg describes the irregular distribution of /g/: "/g/ does not occur in word-medial or word-final position in monomorphemic words" (1983:2). Indeed, my own data show that [g] is limited to word initial position and a handful of consonant clusters, further only occurring before [a] and [o]. In these environments [g] contrasts with [k], as illustrated in Table 17. In addition, unlike /g/, /k/ also occurs in final position in a small number of words, as shown in Table 18, below.

Table 17.The contrast between /k/ ~ /g/ is limited to word initial position and clusters

kàʔ	'no'
gáˀá	'basket'
kát	'when?'
gátʃ	'blond'
kólbéz̥	'cricket'
gô	'sweet potato'
kónè	'with'
gòn	'muddy'
jètgóʔ	'tamale'

Table 18. /k/ in word final position

tâk	'hand'
zâk	'value'
ʂpák	'band'
wàk	'old'

Like the rest of the plosives, the voiced velar is often produced as a fricative [ɣ]. Figure 12 shows typical examples of the contrast between the two velars word initially with the words [kàˀà] 'no' and [gáˀá] 'basket' As evident from the figure, /k/ shows a clear burst before the vowel, whereas /g/ has instead fricative noise through the whole duration of the segment, indicating thus an incomplete closure.

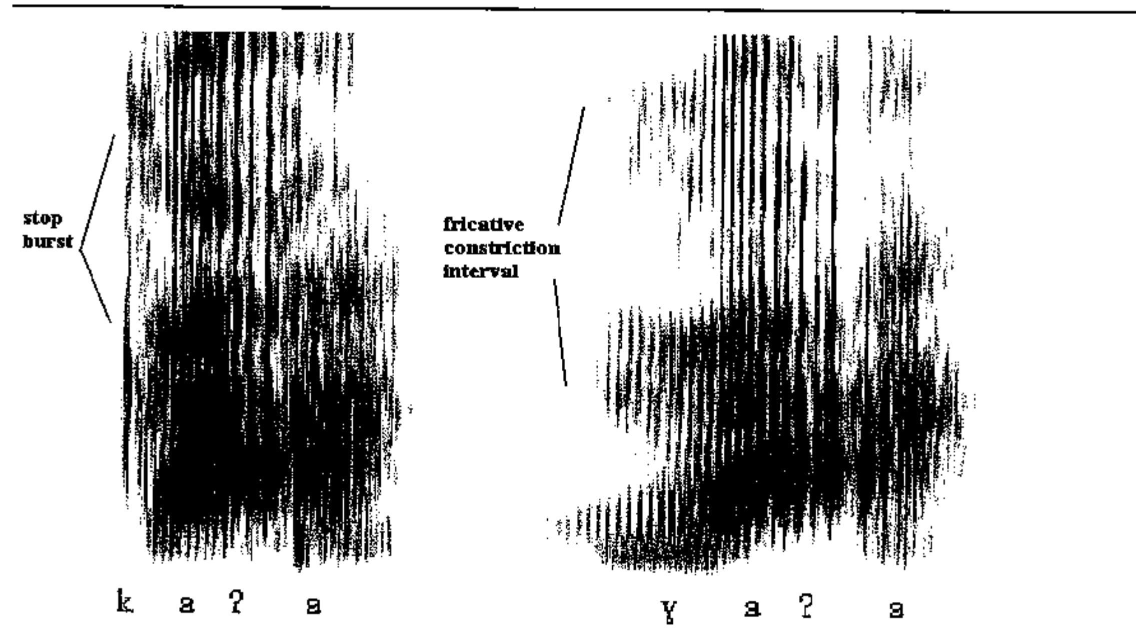


Figure 12. Contrast between /k/ and /g/ word initially in the speech of male speaker (5). Voiced velar is realized as fricative (almost approximant) [ɣ].

Labialized velar. There is a phonemic /k^w/ in YZ. Its distribution is parallel to that of /k/, except that it does not appear before round vowels. Table 19 shows the examples of /k^w/ in word initial and final positions.

Table 19. Labio-velar /k^w/ in YZ native words

#_	k^wáw	'to have sexual intercourse'
	k^wek	'to put'
	k^win	'self'
	k^wì	'besides'
_#	lák^w	'bark (of a tree)'
	lék^w	'rooster'
	wàtʃék^w	'crush (a thing)'

A distributional argument in favor of the phonemic status of /k^w/ comes from the fact that in stem initial position /w/ does not form a cluster with any other preceding consonant. Thus, the sequence of three gestures {consonant - k - w} would be the only case of a triconsonant cluster with /w/ as the as third member. However, if /k^w/ is considered as a single segment, such C-k^w sequences follow the very frequent pattern of two consonant clusters.

Loan words from Spanish have provided a source of labio-velar segments in contemporary YZ. Spanish sequences of /k/ followed by unstressed /u/ and /o/ (especially in word initial or final position) are typically incorporated into YZ as /k^w/. Thus, the Spanish round vowel has been reanalyzed as a secondary articulation of the velar, producing a single complex segment. Table 20 includes some examples of YZ labio-velars derived from Spanish sequences of velar before back a vowel both [ko] and [ku], but also [xo]. Additionally, Spanish sequences of velar before the diphthong /we/ have also been incorporated in YZ as /k^w/.

Table 20. YZ labio-velar /k^w/ in Spanish loans having [ku], [ko] and [xo]

#_	k^wét	'fireworks' *from Spanish* [kwete]
	k^wsé	'José' *from Spanish* [xose]
	k^weɾp	'body' *from Spanish* [kwerpo]
_#	mâŋk^w	'mango' *from Spanish* [maŋgo]
	mjêɾk^w	'Wednesday' *from Spanish* [mjeɾkoles]
	ẑik^w	'Francisco' *from Spanish* [fransisko]
C_	ʂk^wêl	'school' *from Spanish* [eskwela]

Additional phonological evidence supports the phonemic status of the labio-velar in YZ. One group of verbs presents an alternation in the initial consonant of the stem from voiced to voiceless to indicate a change in aspect, from Habitual to Potential. Examples illustrating this alternation are shown in Table 21. In a subset of these verbs, a form with labial consonant stem initially, /b/, in the Habitual alternates with the labio-velar /k^w/ in the Potential aspect, instead of the expected /p/. This might be taken as evidence that /k^w/ is the phonemic voiceless counterpart of /b/, as the domain of the consonant change is restricted to the first consonant of the stem. Therefore, considering /k^w/ as a single segment in the phonemic inventory of YZ is justified.

Table 21. Stem initial consonant changes marking aspect

Habitual	Potential	Gloss
ʒ-dit	tit	' itches'
ʒ-ʒoʔn	tʃoʔn	'throws out'
ʒ-beχ	k^wej	'takes out'
ʒ-beʒ	k^weʒ	'cries'

Figure 13 shows spectrograms illustrating the contrast between plain velar and labialized velar in YZ with the pair /káʔ/ 'like' and /k^wà/ 'dough'. The most prominent acoustic property of /k^w/, compared to /k/ is, of course, produced by the rounding of the lips in the release of the primary velar articulation. The formant transitions of the vowel following the plain velar correspond to the archetypal cases with the second and third formants coming together (around 2160 Hz). In contrast, the main acoustic effect of the labial gesture of /k^w/ is observed in the prominent lowering of onset of the second formant in the following vowel. In this particular example, the second formant frequency at the onset is about 798 Hz.

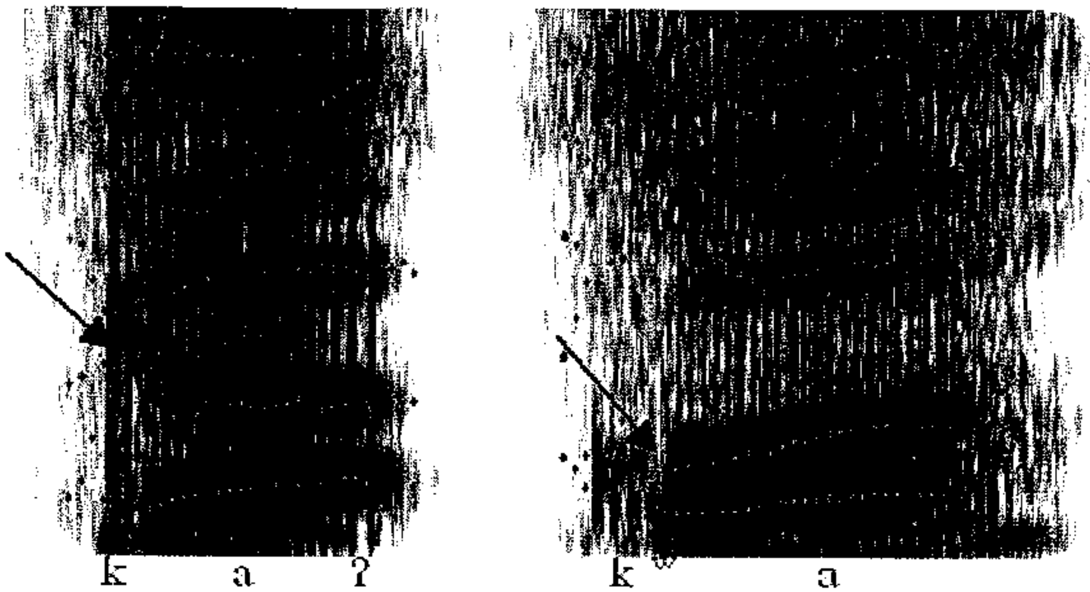


Figure 13. Spectrograms illustrating differences between plain velar and labialized velar in the words *káʔ* 'like' and k^w*à* 'dough' (speaker m2). The main acoustic effect of labialization is lowering F2 at the vowel after the consonant release.

There is a uvular fricative [χ] in YZ. This sound has been interpreted as phonemic unit in previous descriptions of YZ (Newberg, 1983) and studies of neighboring Zapotec languages that have the sound as well (Nellis, 1980). Nevertheless, a closer inspection of its distribution suggests that the YZ uvular is an allophone of /g/. Table 22 illustrates the distribution of [χ], which occurs predominantly in word final position and in clusters, while /g/ occurs mainly word initially and in a some cases in consonant clusters. The few instances where [χ] appears in word initial position are in sequences of consonants where the uvular is the first member of the cluster.

Table 22. Distribution of [χ], word finally and in clusters

_#	[bèχ]	'well'
	[bêχ]	'cloud'
	[nèχ]	'yesterday'
	[wèχ]	'plow'
	[wá'tʃàlχ]	'to chat'
	[wá'títχ]	'to criticize'
	[jáχ]	'flower'
C_V	[tít'χòn]	'owl'
	[bèʒ'χè]	'chicken'
	['bérχè]	'star'
#_	[χsíw]	'onion'
	[χtúré]	'huajinijuil (baby corn)'

There is additional evidence indicating the non-phonemic status of [χ]. In some words, speakers freely alternate between [g] and [χ], as shown in Table 23. Those examples rule out a relation of complementary distribution and further support the non-contrastiveness of [g] and [χ]. Therefore, I will consider the YZ uvular not to be phonemic, but an allophone of /g/. If this analysis is correct, it may have consequences for the analysis of other Zapotec languages, especially those closely related languages where a uvular has been analyzed as phonemic.

Table 23. Free variation of [g] and [χ].

gazχ ~ χazχ	'black'
wagàʔ ~ waχàʔ	'to serve'
gáˀá ~ χáˀá	'basket"

Glottal stop. The status of glottal stop is, perhaps, one of the most controversial issues in the phonology of Zapotec languages. As introduced at the beginning of section 4.2.2, most authors consider the phonetic gesture of total occlusion in the larynx to be part of a a series of phonemic vowels, the so-called 'checked' vowels. Jones and Knudson (1977), for instance, propose that checked vowels contrast phonemically with plain vowels and and are in complementary distribution with laryngealized vowels. Other studies such as in Lyman and Lyman (1977) derive the sequence vowel glottal stop from an underlying laryngeal vowel by a series of rules presented in Figure 14. According to this proposal a laryngeal vowel will surface as a stressed vowel followed by a glottal stop if a following vowel (v_2) has a different quality than the laryngeal one (v_1); otherwise the laryngeal vowels surfaces as a sequence $\acute{v}_1ʔv_1$, where the vowels are of the same quality

$$\underset{\sim}{v} \rightarrow \begin{cases} \acute{v}_1ʔ \;/\; \_\; v_2 \\ \acute{v}_1ʔv_1 \end{cases}$$

Figure 14. Lyman's derivation of vowels followed by glottal stop

Some other proposals for languages closely related to YZ consider a contrast between checked and laryngealized vowels based on distributional properties; Thus, Nellis and Hollenbach (1980) describe for Cajonos Zapotec, that checked vowels occur only in open syllables, laryngealized vowels can occur in open and closed syllables.

The present analysis of YZ differs from the previous studies in several aspects. On basic descriptive grounds, I showed in section 4.4.1 that any consonant can appear as the single segment in coda position; later in 4.4.2.2 I will show that consonant clusters are restricted to sequences of C-χ. Glottal stop conforms to these patterns; for instance, as any other consonant in YZ, /ʔ/ can appear as the single coda of the syllable, and it can form clusters with the uvular allophone of /g/, e.g. *wchè'j* 'to tie'. Therefore, *strictu sensu* the distributional evidence ruling out the glottal stop as a phonemic unit cannot be taken as the definitive argument, at least in YZ.

Newberg (1983) considers only the opposition between plain-glottalized in vowels; he analyzes YZ checked and laryngealized surface forms as allophones conditioned by tone and stress. Checked vowels occur before pause and in mid or mid Falling tones; laryngealized forms occur in any other position but final, and it can bear any tone. However, he points out "in utterance-final position glottalized vowels are phonetically laryngealized" (:13) if they occur with High, High-Falling or Low tones.

My own anlayses of YZ differ as well from the description offered by Newberg. First, as it will be shown later in section 4.5 the acoustic anlayses have found only three phonemic tones, High, Low and Falling, the results are significantly consistent and reliable across and within speakers. Second, I have not found differences in the phonetic implementation to which Newberg attributes the allophonic rule, namely utterance-final and pause. In my description, vowels followed by glottal stop and laryngealized vowels appear in both environments before pause and utterance final position, as well as in citation forms.

My view on the glottal stop vs checked issue is essentially that it is a segment with a defective distribution. Languages with segments of defective distribution are not at all unknown in the languages of the world (e.g. Spanish distribution of rhotics; nasals as the only segment found in coda in Kru, Tewa and Tura, as referred in Gordon (2002)); likewise, in many languages certain segments are restricted to appear just in postvocalic coda, e.g. nasals, and this does not constitute acceptable evidence to propose for instance a 'nasal checked vowel'. Therefore, I propose that unlike other consonants of the YZ system, the glottal stop is absolutely banned from appearing as a syllable onset. In YZ there are a few phonemic vowel initial words. Some speakers will pronounce these words as onsetless syllables; whereas others will insert an epenthetic [g]; in many languages the glottal stop functions as the default epenthetic consonant, however, in YZ it cannot occur even in this context. All the idiosyncratic properties of this consonant follow from that restriction. The confinement of glottal stop to appear in coda is a consequence of that more stringent constraint.

4.3.1.1 Voice Onset Time

A number of studies have proposed that the contrast along the VOT parameter does not constitute a constrastive phonological feature in several Zapotec languages. These analyses argue, instead, in favor of a 'fortis/lenis' contrast that includes in a single natural class both plosives and sonorants (Jaeger, 1983; Jones, 1977; Nellis, 1980; Newberg, 1983). Against these approaches I have shown elsewhere that for YZ the VOT parameter is, indeed, a reliable parameter in characterizing plosives (Avelino 2001). I concluded that "fortis" stops are unaspirated voiceless, whereas "lenis" are voiced. Hence, in contrast with previous descriptive studies of other Zapotecan languages, as well as Jaeger's instrumental study of Yatee Zapotec, the results obtained in YZ indicate that the difference is well defined and consistent along the VOT dimension. In this section I expand the study in Avelino (2001) by including data from two additional adult speakers, one male and one female, for a total of seven speakers (m2, m4, m5, m6, f3, f4, f9).

VOT was measured from the point of release of the stop to the onset of voicing of F2 and higher formants in the following vowel as seen in a wideband spectrogram and supplemented with observation of the waveform. Figure 15 shows audio and spectrograms of the minimal pair /pít/ 'thread'- /b̃ìt/ 'epazote plant' illustrating the contrast in voicing. It is apparent from the figure there is no activity at all during the closure of the unaspirated [p], i.e. it shows zero VOT, while the voiced [b] shows a voice bar during the closure, which amounts a long negative VOT of 150 ms in this particular token.

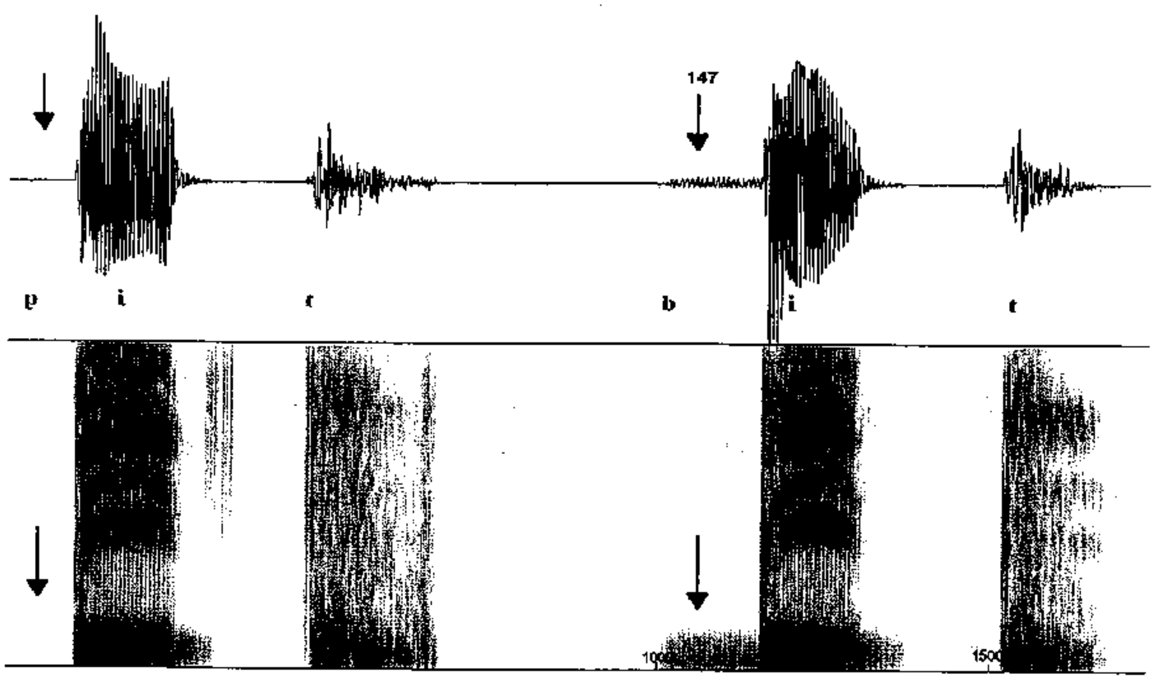


Figure 15. Waveform and spectrograms illustrating the contrast between voiceless and voiced segments with the words /pít/ 'thread'- /b̃ìt/ 'epazote plant' of speaker m6.

Results of the VOT values pooled over seven speakers in all contexts are summarized in Figure 16 below.

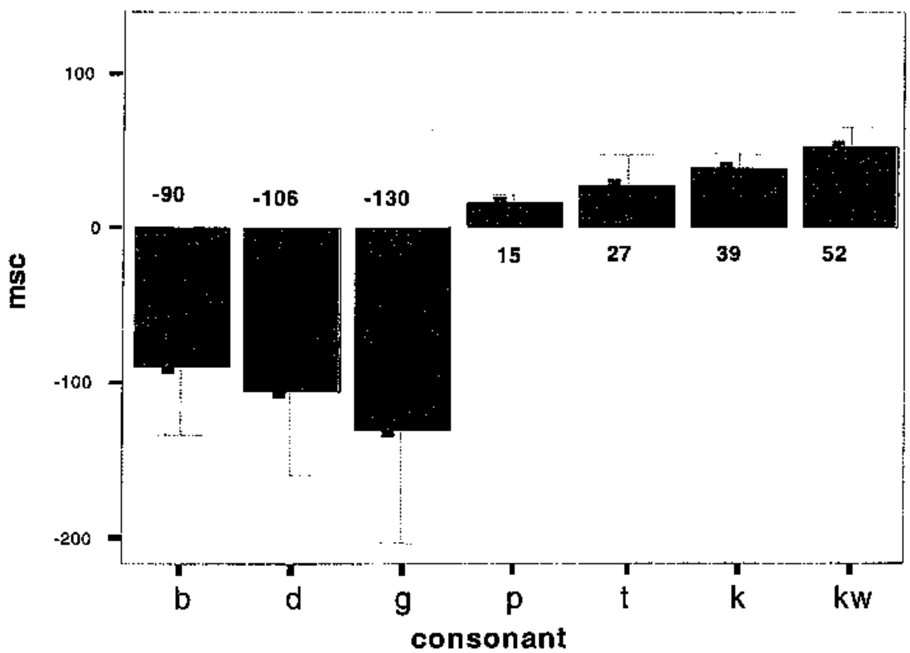


Figure 16. Mean VOT values of YZ stops. Bars represent standard deviations

This figure shows that in YZ there is a clear difference between voiceless and voiced stops. The large negative VOT values of the voiced segments are particularly noticeable —/b/ -90 ms, /d/ -106 ms and /g/ -103 ms— in contrast with the short positive lag of the voiceless /p/, /t/, /k/ and /k^w/ (15 ms, 27 ms and 39 ms and 52 ms, respectively). In contrast with the crosslinguistic tendencies that VOT of /b, d, g/ becomes increasingly less negative, the data showed long values for the voiced velar. However, this fact is explained as a result of the manner of articulation, as velars are often pronounced as fricatives. At any rate, these findings constitute robust evidence that YZ stops contrast primarily along the VOT parameter.

4.3.1.2 On the Devoicing of Stops

The difference between voiceless and voiced stops was, for the most part, generally consistent; nevertheless, in word final position it was not always easy to determine the voicing of obstruents. A great number of languages present restrictions regarding the occurrence of final stops; among other constraints there is a common pattern that limits the final stops to voiceless segments, so it is frequent to find descriptions of phonological rules that devoice underlying voiced segments. Devoicing of voiced stops in YZ was also noticed by Newberg (1983) and has been repeatedly reported in other Zapotec languages (Jaeger 1983; Nellis 1980, among others). Again, the results obtained in the present study confirmed my previous findings showing that the final devoicing of voiced segments in YZ is not an absolute phonological rule, but a phonetic rule, which produces gradient and variable differences. That is to say, a 'devoiced' stop is still different from its underlying voiceless counterpart. Figure 17 shows the waveforms and spectrograms of the words /btʃit/ 'rainbow', and /bʒid/ 'kiss', exhibiting a case of contrast between voiceless and devoiced segments. Indeed, looking at the voicing properties the spectrograms the last segment of the word for 'kiss' does not display a significant amount of voicing, so that [d̥] could be potentially confounded with [t].

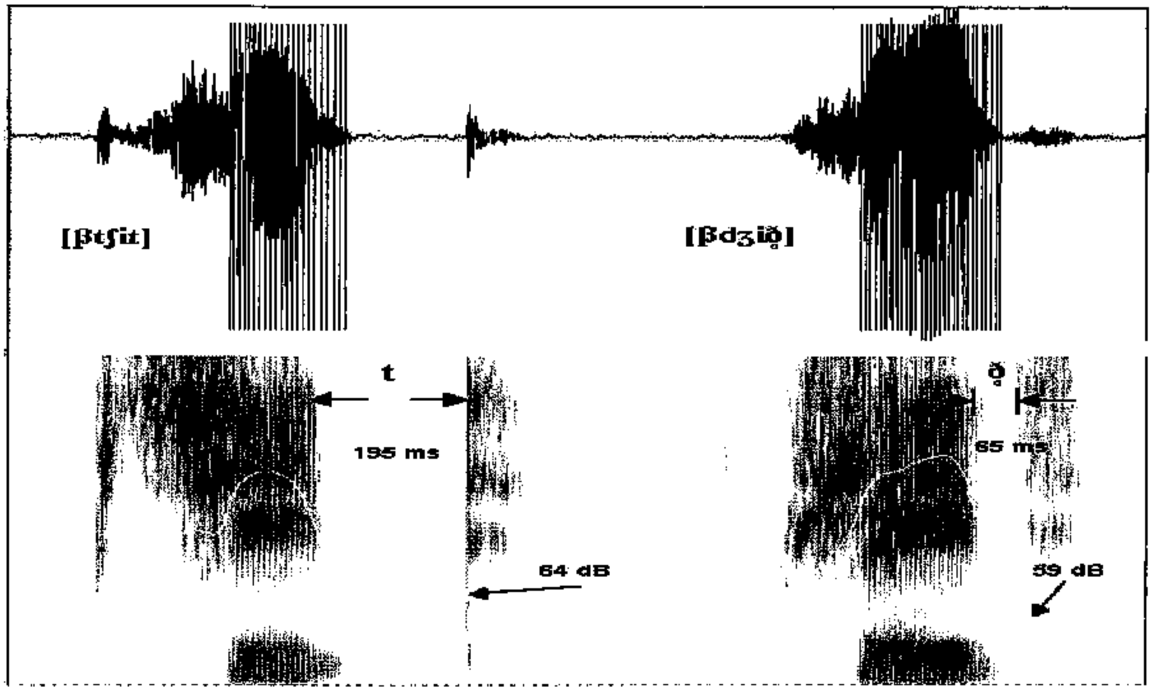


Figure 17. Waveform and spectrograms of the words *btʃit* 'rainbow' and *bʒid* 'kiss' showing the contrast between voiceless and devoiced segments in word final position (m2). Closure duration of voiceless /t/ is longer than that of devoiced /ð̥/(195 ms and 65 ms, respectively).

However, voiceless and devoiced segments were still well distinguished from each other. One of the most consistent differences was shown in the closure duration. The mean values showed that the closure duration of voiceless stops is larger than that of voiced sounds (158 ms and 89 ms, respectively). This is consistent with the overall results obtained for closure duration, as one factor ANOVA comparison showed that this difference was highly significant ($F(1, 292) = 70.575, p = .001$). The evidence shows that YZ stops agree with the well-established cross-linguistic tendency to have a longer closure duration in voiceless than voiced stops (Fischer-Jørgensen, 1968; Ladefoged, 1996b; Lisker, 1957; Löfqvist, 1976; Maddieson, 1985).

Other properties of the release were also significant in differentiating voiceless and voiced stops. In general, voiceless segments were produced with a clear closure, burst and release, in contrast with the voiced ones, which were often produced as fricatives. This property of the closure explains the unusual VOT pattern of /b, d, g/ described before. This difference naturally causes a greater energy in the release of the voiceless sounds than in the voiced ones. The intensity curve in Figure 17 illustrates this observation. The release of [t] has stronger energy in the release than in the release of [ð̥] (70 dB and 55 dB, respectively), although the overall intensity of the vowel before [ð̥] is greater than [t].

A further source of evidence concerning the difference between voiceless and devoiced stops in YZ comes by comparing airflow present in the release of these segments. The air speed varies directly with the quantity of flow.

A basic condition for vocal fold vibration is a transglottal pressure maintained for a certain period, so that the volume of air in the lungs flows through the glottis. Therefore, we would predict that in voiceless sounds, when the vocal folds are abducted, the column of air will flow more rapidly than in voiced sounds where the vocal folds are adducted producing a greater final release. In fact, this is what seems to occur in YZ. Consider the illustration in Figure 18. It shows the airflow of the same utterances presented in the spectrograms above. The record does not show calibration, and I have not performed any quantitative analysis of the aerodynamics of these sounds. The purpose of the figure here is to advance a qualitative description of the subtle phonetic differences of a contrastive feature that in some analyses could have been regarded as phonemically neutralized.

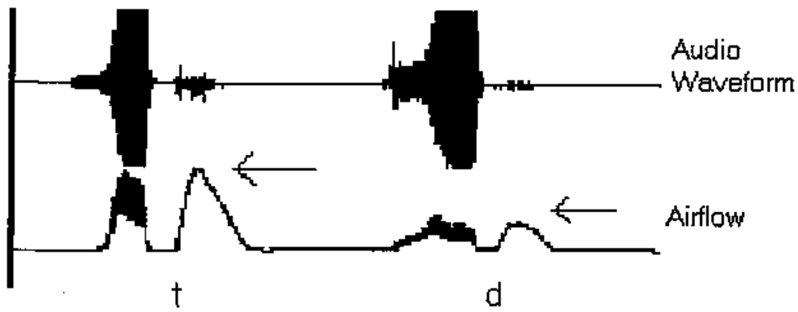


Figure 18. Aiflow of voiceless and voiced segments in final position. The arrows point out the highest peak reached by each one of the segments (m2).

After a period of closure following the vowel, both words complete the release. The arrows indicate the highest levels of airflow present in [t] and [d̥], respectively. As expected, it is clear from the figure that the release of the voiceless segment has a greater volume than that in the devoiced one.

The voicing pattern of YZ final voiced stops, and perhaps of some other Zapotec languages, can be explained by looking at the two main mechanisms of "devoicing" used in language (Ladefoged and Maddieson 1996; Maddieson 1997; Stevens 1998): "active" devoicing occurs when the glottis opens so wide that the vocal folds no longer vibrate, while "passive" devoicing takes place when the configuration of the vocal folds is such that they could vibrate, but the pressure below the glottis is insufficient for inducing voicing. As Ladefoged and Maddieson indicate, these different mechanisms produce a conflict between an articulatory and an acoustic definition "for some linguists, voicelessness invariably implies an open glottis, whereas for others it means absence of vibration" (1996:49). The data analyzed suggests that the final devoicing observed in YZ is an instance of passive devoicing. A period of voicing in the onset of the closure suggests that the vocal folds are adducted when the stop is articulated, but then the transglottal air pressure drops, suspending the vocal fold vibration. In this case, YZ agrees with recent analysis of final devoicing in some other languages such as Germanic (Kohler, 1980) (Jessen, 1998) or Polish (Slowiaczek, 1985; Slowiaczek, 1989), for instance. Summarizing, I suggest that the lack of vocal fold vibration does not produce an absolute neutralization of the contrasting segments, but there are sub-phonemic differences, namely release and closure duration, which can be perceived by the YZ native listeners/speakers.

4.3.2 Sonorants

In this section I introduce the general phonetic characterization and distributional pattern of YZ sonorants, while in Chapter 3 I will present a detailed articulatory and acoustic account of the coronal sonorants. As mentioned before, there are proposals maintaining a fortis/lenis contrast in the consonantal system of Zapotec languages, including the sonorants. However, in my previous study of YZ (Avelino 2001), I found that the contrast in length was highly significant. Thus, the traditionally labeled fortis sonorants are significantly longer than their lenis counterparts. Furthermore, as part of the arguments supporting the fortis/lenis contrast, it has been claimed (for other languages) that a vowel before a lenis sonorant is longer than a vowel before a fortis sonorant, while my previous study also found that in YZ such correlation is non-significant. I will describe the phonetic properties of these sounds further in this section.

Yalálag Zapotec has six sonorants, /m, n̤:, n, l̤:, l, r/. The labial nasal and the trill do not contrast in length. These two sounds are found mostly in Spanish loan words, and they are pronounced roughly as in Spanish. In fact, these sounds are also rare in other Zapotec languages, and they are not even reconstructed for Proto-Otomanguean (Rensch 1976). The labial occurs with higher frequency than the trill, and in a greater variety of environments, namely in word initial position and in clusters. The only apparent examples of /m/ in native words recorded so far are *mádà* 'someone who does not walk on the right track', *máṣá?* 'snail', *mérás* 'pretty' and *májàl* 'someone who stumbles'.

Table 24. /r/ and /m/ in loan words from Spanish

/r/	ròs	'pink'	from Sp. *rosa*
	rũĩn	'selfish'	from Sp. *ruin*
/m/	màɾs	'March'	from Sp. *marzo*
	mièɾ	'Miguel'	from Sp. *Miguel*
	míʐ	'Mixe, person of Mixe origin'	from Sp. *mixe*
	nò'βiémbɾ	'November'	from Sp. *noviembre*
	dmíó	'Sunday'	from Sp. *domingo*

Although the most important contrast among the other sonorants is in length, there are concurrent phonetic properties and phonological processes that reflect the underlying specification of these segments. First, as specified in Table 13, /n:/ and /l:/ are dental, while /n/ and /l/ are pronounced as alveolars. Second, in word final position, /n̤:/ preserves its coronal place of articulation, but /n/ is articulated as velar [ŋ].

The articulation of /l:/ and /n:/ is with the tip of the tongue up and the posterior upper teeth; however, occasionally it is produced as interdental, especially in slow, careful speech. For /l:/ the lateral escape of air seems to occur for both sides, although this is just an impressionistic observation. In general, the perceived quality of the YZ /l:/ is similar to the Spanish /l/. In contrast, /l/ and /n/ are articulated with the tip of the tongue up and on the alveolar ridge, making the contact in a fast movement; these sounds are notably short, especially in intervocalic position. Indeed, they could be described as nasal and oral alveolar taps. My consultants agree in regarding these sounds as closer to the Spanish tap, and in fact they often write words containing these sounds (even the nasal) with the *r* letter of Spanish. A detailed account of the articulatory properties of these sounds will be presented in Chapter 3.

Yalálag Zapotec nasals contrast for length in all three environments, word initially, medially and in word final position. Some pairs illustrating the contrast of YZ nasals are listed in Table 25 below.

Table 25. Long/short nasal contrast

n:àˀà	'now'	nàʔ		'hand'
bĭn:	'seeds'	bîn	[bîŋ]	'vein'
bʒĭn:	'foam'	ʒèn	[ʒèŋ]	'blood'
zi̯ˀìn:	'son'		zi̯ˀìn	'nose'
tón:	'high'	tón	[tóŋ]	'there will be hunger'
bèn:	'Give it to me!'	bèn	[bèŋ]	'Do it!'

The contrast in length between /n:/ and /n/ is even quite perceptible word initially. The spectrograms in Figure 19 illustrate a typical contrast of length in nasals with the words /n:à^{ʔ}à/ 'now' and /nàʔ/ 'hand'. /n:/ is about 35% longer than /n/.

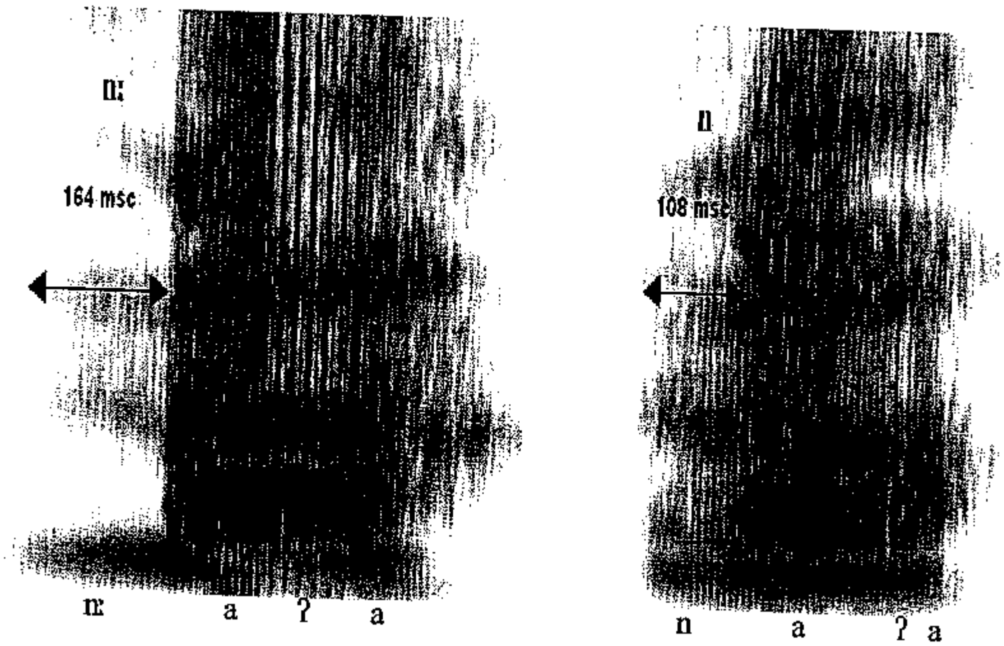


Figure 19. Contrast between /n:/ - /n/ in initial position in the speech of speaker m2

In word final position the contrast /n:/ - /n/ is more difficult to perceive. In this environment the further specification of place preserves the identity of the two phonemes. In addition, a stem ending in a long nasal does not undergo assimilation in place when a morpheme attaches to the stem; in contrast, a stem ending in a short nasal assimilates to the place of articulation of the following consonant (cf. Newberg 1983 for a similar rule). Table 26 shows this process with the suffix *-beʔ* 'third person, familiar' attached to verb stems ending in nasals.

Table 26. Place assimilation of short nasals

bén:-àʔ [bén:àʔ] 'I gave (something)'	bén:béʔ [bén:béʔ] 'he gave (something)'
bén-àʔ [bénàʔ] 'I make (something)'	bém-béʔ [bémbéʔ] 'he makes (something)'

Table 27 shows examples of the contrast of /l:/ and /l/ in word initial, medial and final position. As it is clear from the spectrograms in Figure 20, /l:/ is longer than /l/, a difference that was highly significant in all the environments (Avelino 2001).

Table 27. Lateral fortis/lenis contrast

l:		l	
l:á	'hot'	lâ	'name'
l:âw	'monkey'	làw	'eye'
l:éʔé	'he'	léʔ	'you' (Pl.)
bèl:é	'snake'	béˀèʔlé	'meat'
gúl:	'soft'	gúl	'old'
jéˀél	'banana'	jéʔlè	'huarache' (type of traditional sandal)

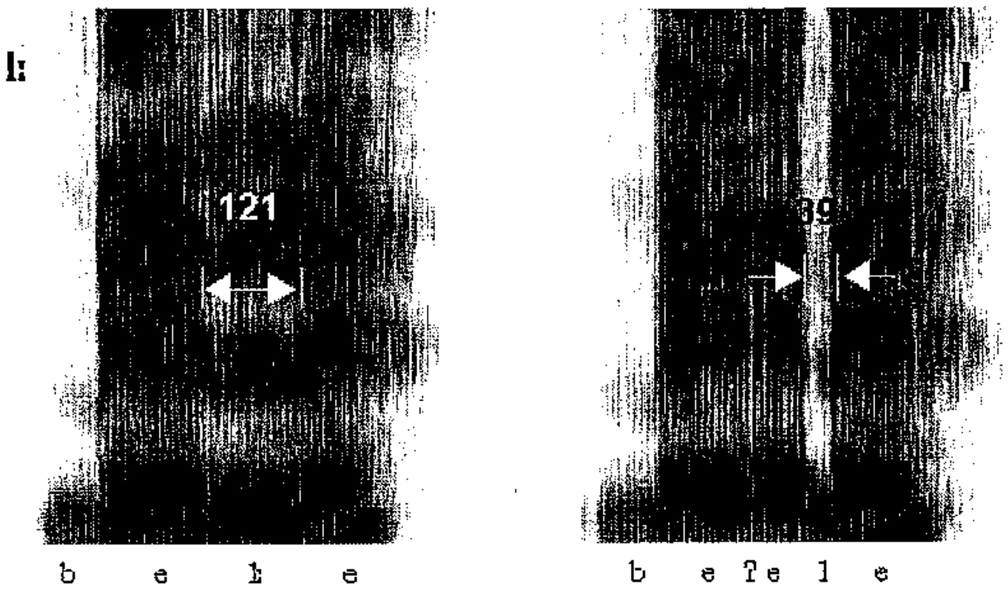


Figure 20. Contrast /l:/ - /l/ in intervocalic position. The figure illustrates the words bèl:é 'snake' and béˀèléʔ 'meat' in the speech of a male speaker (m2). Arrows indicate the duration of the two segments, 121 and 39 ms, respectively.

4.3.3 Fricatives

Yalálag Zapotec presents a triple-way contrast between alveolar, retroflex and palato-alveolar place of articulation only in fricatives /s, z, ʂ, ʐ, ʒ/. As mentioned earlier, [f] and [x] only occur in a few words borrowed from Spanish. However, not all the Spanish words with these sounds are borrowed unchanged into YZ. In many loan words, [f] is replaced by [p]: e.g. [pêl] from *Sp. Ofelia*, [pêm] from *Sp. Eufemia*. In contrast, Spanish words containing [x] normally do not change when borrowed into YZ; however, there are differences in the adaptation to YZ. The most common is that [x] can be also pronounced as a back velar, very close to the YZ [χ] allophone of /g/: e.g. [xùeβ] ~

[χùeβ] 'Thursday', from *Sp. jueves*; [xùl] ~ [χùl] 'July' from *Sp. julio.* Table 28 shows examples of contrasts among native fricatives in YZ.

Table 28. Contrasts among fricatives

wàˈsáʔ 'to massage'	záʔ 'ear of maize'	s̺á 'father'	z̺à 'there was'	ʒáʔ 'tepid'
sȋt 'Mexico'	zȋt 'far'	s̺íʔt 'he is going to jump'	z̺íd 'cat'	ʒí 'quiet'
wàˈsòʒ 'to get drunk'	wàˈzôχ 'to write'	wàˈs̺òs̺ 'to toast'	wàˈz̺òb 'to shake out the grain'	wáʔˈʒòʔ 'you are nursing'
wàˈsèd 'to learn, study'	wàˈzèd 'to bother'	wàˈs̺è 'to begin'	ˈz̺ébé 'José'	wâˈʒè 'memela' (type of small tortilla)

Alveolar fricatives contrast in all environments. The alveolar fricatives /s, z/ are articulated either with the tip of the tongue behind the lower front teeth, so that the blade of the tongue makes the constriction with the roof of the mouth just behind the alveolar ridge or with the tip of the tongue up, so that the constriction is made on the alveolar ridge. The difference is non-phonemic; nonetheless, it is of phonetic interest to record that YZ presents the two possible articulations for /s/ and /z/. More details on the articulatory properties are given in Chapter 3. Examples of contrast between /s/ and /z/ in different contexts are presented in Table 29 below.

Table 29. Contrasts between the alveolar sibilants /s/ - /z/.

ˈsété	'quickly'
ˈzêtè	'squash sprout'
sȋt	'Mexico'
zǐ	'odor'
wàˈsèd	'to study'
wàˈzèd	'to bother'
wàˈsòʒ	'to get drunk'
wàˈzôχ	'to write'
bsià	'eagle'
bziáʔ	'I bought'
nȉs	'water'
nêz	'road'

By the label 'retroflex' I indicate a post-alveolar articulation in the realization of /ʂ/ and /ʐ/. However, the prototypical retroflex gesture of curling the tongue and articulating with the sub-apical part of the tongue is only one of the variants observed for these sounds. Based only on impressionistic observation, Yalálag Zapotec retroflex sounds may also articulated as laminals with the body of the tongue slightly retracted and making a great length of constriction behind the alveolar ridge. Yalálag Zapotec retroflexes are thus more similar to the apical O'odham-Pima post-alveolar fricatives described by Dart (1991) and Avelino and Kim (2003) or to the Chinese 'flat post-alveolar sibilants' described by Ladefoged and Maddieson (1996:153), than to the retroflex sounds described for Indo-Aryan languages (Ladefoged, 1983b). In Chapter 3 I will present results of a palatographic study concluding the status of YZ retroflexes sibilants. In the meantime, I will adopt the term and the definition of 'laminal post-alveolar' for this type of sound in YZ, as originally proposed by Ladefoged and Maddieson (1996) and Ladefoged (1997).

Table 30. Laminal post-alveolar sibilants

ʂ̻án	'boss'
ʐ̻án	'base, bottom'
ʂ̻ón	'eight'
ʐ̻ón	'Zapotec'

Phonemically there is only one palato-alveolar fricative, /ʒ/. Like the laminal post-alveolar, the palato-alveolar has a wider length of constriction; however, it is pronounced even further back in the mouth. The tongue apex is down, as in the alveolar sounds, so that the contact is made chiefly with the front of the tongue body. /ʒ/ is sometimes pronounced as a weak affricate [dʒ]; however, the difference is non-contrastive. Newberg (1983) reports that this fricative/affricate variation is associated with the age of the speaker: old people alternate between [dʒ] and [ʒ], whereas young speakers have only /ʒ/. My own observation is that any speaker, regardless of age, uses both pronunciations.

Table 31. Phonetic variation of /ʒ/: [ʒ] ~ [dʒ]

/ʒèn/	[ʒèŋ] ~ [dʒèŋ]	'blood'
/bʒónè/	[bʒónè] ~ [bdʒónè]	'pitaya' (cactus fruit)
/bʐ̻î'ʒéʔ/	[bʐ̻î'ʒé] ~ [bʐ̻î'dʒé]	'the badger'

Second, /ʒ/ and /tʃ/ occur in the same environments.

Table 32. The contrast /tʃ/ - /ʒ/

tʃàʔ	'pan'
ʒà	'day'
tʃòa	'forty'
ʒòáʔ	'my mouth'
tʃi	'ten'
ʒĭt	'egg'
btʃit	'rainbow'
bʒít	'dandruff'
btʃèkʷ	'low'
bʒèʔ	'ant'
jítʃˈχéʔ	'his head'
bèʒˈχé	'chicken'
wàtʃàtʃ	'to discuss, to argue'
wàˈsòʒ	'to get drunk'

4.3.3.1 Devoicing of Fricatives

One of the processes often mentioned in the literature on Zapotec languages is the devoicing of fricatives (Nellis 1980). I have recorded phonetically voiceless realizations of fricative sounds which are underlyingly voiced, that is to say, /z, ʐ, ʒ/ are pronounced either as partially devoiced or completely voiceless sounds, especially, but not only, in word final position) [z̥ ~ s, ʐ̥ ~ ʂ, ʒ̊ ~ ʃ].

Table 33. Devoiced fricatives in word final position		
/ři̥ʒ/	[řiʒ̊]	'house'
/wàtʃĭʒ/	[wàtʃĭʃ]	'to get fat'
/wèʒ/	[wèʒ̊]	'to cry'
/wâʒ/	[wâ̰ʒ̊]	'memela' (type of small tortilla)

As additional evidence, it should be pointed out that native speakers still judge all these fricatives to be the voiced sounds. For instance, two of the consultants who are able to write in Zapotec keep the symbol *ll*—which in our practical orthography represents /ʒ/—regardless of whether the actual phonetic realization is either [ʒ̊] or [ʃ]. Also, in careful, slow speech speakers tend to pronounce the voiced allophone. Figure 21 shows a spectrogram of /ʒil/ 'grill' illustrating a devoiced fricative in word initial position. As evident from the figure there is no voicing at all during the production of the segment (the bars at the bottom of the figure come from background noise; note that the same bars are present at the beginning and end of the utterance); just before the beginning of the vowel voicing is initiated; nevertheless this is an underlying voiced consonant /ʒ/ realized here as devoiced [ʒ̊].

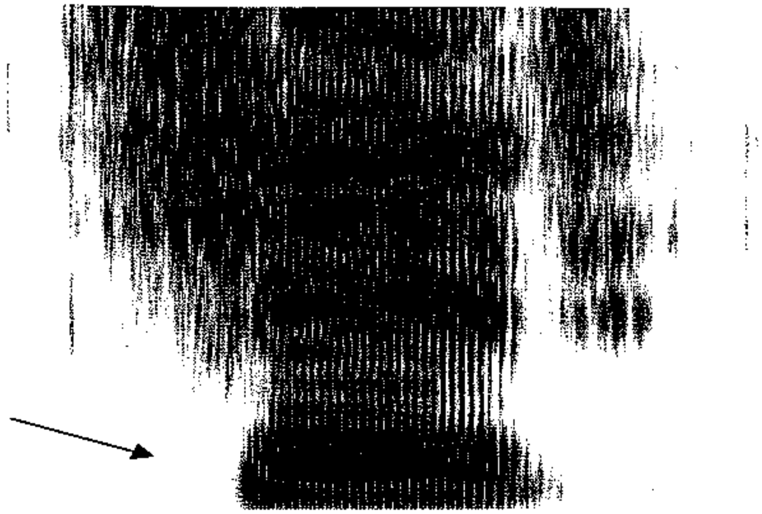


Figure 21. Devoiced sibilant in word initial position in the speech of speaker (m2). The arrow points to the absence of voicing. The bars at the bottom of the spectrogram are background noise.

4.3.4 Approximants

In the present section I will restrict the class of approximants to the non-lateral approximants, as I discussed laterals in the section devoted to sonorants. There are two approximants in YZ, /w/ and /j/. Table 34 shows examples of these sounds word initially. I adopt a phonological (phonotactic) definition of this class as non-syllabic vocoid segments. In descriptive phonetic terms, YZ approximants can be characterized similarly to the vowels /i/ and /u/, except that the oral constriction is narrower for the aproximants; still, the constriction is not narrow enough to produce turbulent airflow, i.e. a fricative sound. This definition is explicitly reminiscent of that of Pike (1943) with respect to the phonotactic definition and that of Ladefoged (1971) with respect to the phonetic characterization. That is to say, YZ approximants are considered consonants, since they present similar phonological properties of unambiguous consonants. First, in YZ there is a prevalent tendency to avoid onsetless syllables. Table 34 shows that approximants, like other consonants, can appear as onsets of syllables Clearly, an analysis of approximants as consonantal onsets has advantages over an approach that render onsetless syllables, which are otherwise banned in the grammar of YZ.

Table 34. Approximants /w/ and /j/ appear in the same environments as consonants

	w		j
wâ	'mature'	já	'clear'
wéʔé	'wound'	jàʔ	'tender'
wî	'orange'	jâj	'tree'
bàwîʒ	'noon'	wâjàʔ	'dance'
wẫlew	'to twist'	nâj	'ear'
wátʃêw	'to kick'	láj	'teeth'
mîw	'friend'	wáj	'firewoods'

Second, a number of morphological processes make use of phonological changes in the features of the verb stem initial consonant. One of these processes is causativization. In general, if the consonant of the stem is a voiced stop or a short sonorant, causative derivation turns the consonant into voiceless stop or long sonorant. Table 35 shows the causative alternation in verb stems starting with approximants. The examples show that the causative alternant of the initial palatal approximant /j/ is the affricate palatal /tʃ/.

Table 35. Causative alternation in verb stems beginning with approximants

Gloss	Infinitive	Causative
'enter'	wajoʔ	watʃoʔ
'go up'	wajep	watʃep
'slender'	walaz	wal:az
'ask'	wanab	wan:ab
'burn'	wazey	wasey

The labial-velar approximant /w/ is well differentiated from /g/ and /b/, even when the latter sounds are produced phonetically as fricatives. Figure 22 presents spectrograms of the words /wâ/ 'mature', /bà/ 'grave' and /gà/ 'nine' exemplifying the crucial properties of the contrast. One of the most noticeable differences between the three consonants is the effect on the formants of the following vowel. For /w/, the first and second formants show an important lowering (746 and 414 Hz, respectively) at the vowel onset. In contrast, the formant transitions for /b/ show a less dramatic lowering in F1 and F2, 606 and 1270 Hz, respectively. This seems to indicate that /w/ differs from the fricative allophone of /b/ in that the tongue is bunched back in the mouth, a gesture that would correlate with the F3 values of the approximant. Likewise, /g/ does not show an F1 lowering of a comparable magnitude to that of /w/, (449 HZ), and the F2 and F3 come together describing the typical trajectory for velars (1688 and 2404 Hz, respectively), which is the property that better distinguishes the velar from the two other sounds. In addition to the differences in the locus of vowel trajectories, one of the most noticeable properties of approximants is the 'slow' transitions from and into the vowel;

this is a very well know phenomenon of approximants crosslinguistically and can be clearly observed in the examples.

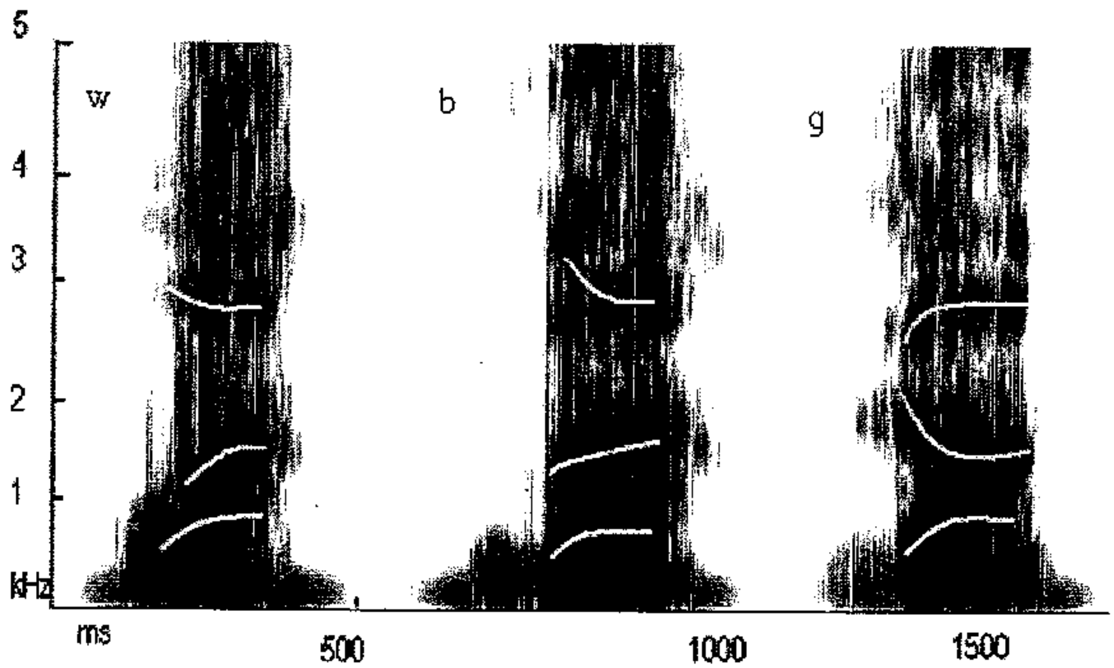


Figure 22. Spectrograms showing the contrast between /w/, /b/ and /g/ in the words wâ 'mature', bà 'grave' and gà 'nine' spoken by speaker (m2).

The palatal approximant /j/ is also notably different from the fricative palatal /ʒ/. As illustrated by the spectrograms in Figure 23, the approximant does not show the great amount of random energy at high frequencies that is characteristic of sibilants. Instead, /j/ presents no traces of prominent friction in the formant structure. Otherwise, both the fricative and the approximant share similar properties of place of articulation, as revealed by the formant structure of the adjacent vowel.

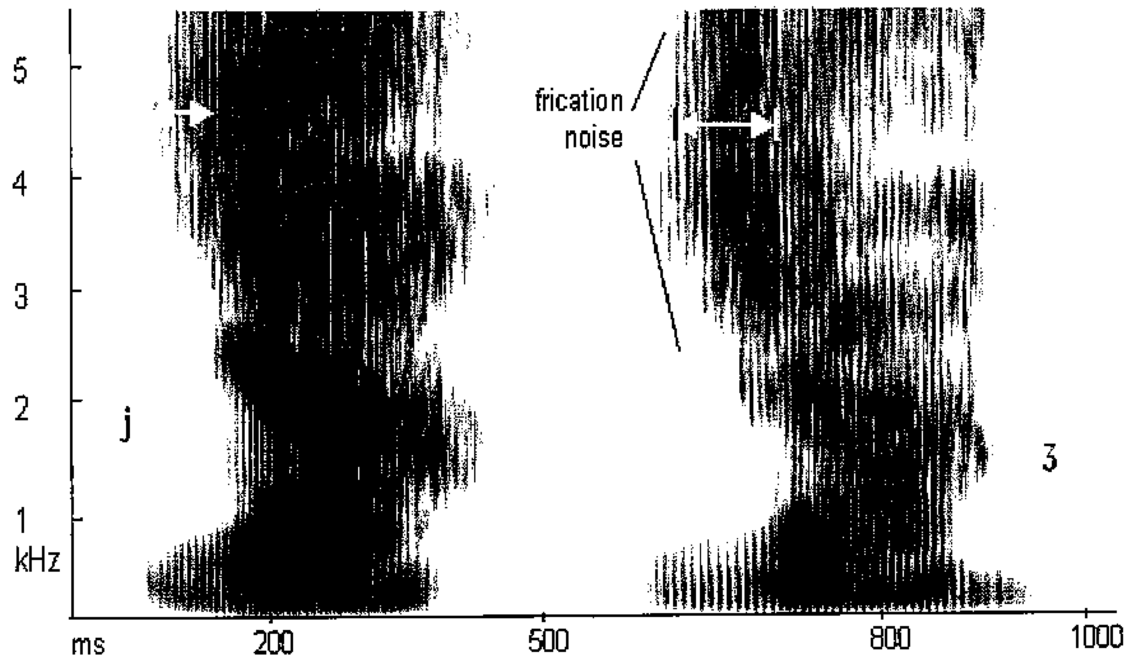


Figure 23. Spectrograms showing the contrast between /j/ and /ʒ/ in the words /jâ/ 'cane' and /ʒà/ 'day' spoken by speaker (m2). Arrows point out the greater amount of fricative noise of /ʒ/ compared to that of /j/.

4.4 Syllable Structure

As in many other aspects of the phonology of Zapotec languages, the syllable structure differs radically from language to language. The historical development of individual languages has produced a large array of consonant clusters in some languages, whereas in others the restrictions on consonant sequences result in simpler syllables. For instance, Southern Zapotec languages tend to have CV syllables whereas many languages of the Valley tolerate complex sequences of consonants. Thus, Isthmus Zapotec tolerates consonant clusters (Marlett, 1987); on the contrary, Atepec Zapotec, a language from the Sierra area, has simpler clusters than in YZ (Nellis, 1983). The diversity of sound patterns in Zapotecan languages is vast enough to take with caution any categorical generalizations about syllable structure associated with geographical areas.

In the next sections I will describe the configuration of syllables in YZ, then discuss the possibilities of consonant sequencing within a syllable observed in YZ. I will show that consonant clusters crucially depend on the feasibility of phonetic implementation of their members. I will argue that some of the clusters have a clear historical origin: deletion of a final vowel in morphologically complex forms has produced some of the current clusters. Finally, I will discuss how the adaptation of loan words into YZ accords with the description of the syllable presented and how these processes produce some other contemporary consonant clusters.

4.4.1 The Internal Structure of the YZ Syllable

YZ allows complex syllables. In the native vocabulary, the maximum syllabic template tolerates two consonants in the onset and two consonants in the coda, yet some loan words and native words deviate from this general pattern: some of these words can have up to three consonants (*noviembr* 'November', *chintr go'oye* 'dove', while only loan words and exclamations can dispense with an onset (*or* 'hour', *Adrianan* 'Adriana', *awa'* 'yeah'). Yet these atypical cases can be listed and will not be considered in the discussion henceforward. The maximum expansion of the YZ syllable array is given in Figure 24 below.

(C)CV(V)(C)(C)

Figure 24. Maximum syllabic template

Nucleus. The nucleus can be filled with any of the vowels from the modal or laryngealized series. The sequences of vowels in what can be considered a single syllable include /ao, eo, oa, ua/. It is a general convention that the two elements of a diphthong correspond to a single syllable, with neither of them being regarded as the non-syllabic part; in this section I will adopt the approximants /j/ and /w/ instead of alternative transcriptions using non syllabic symbols [i̯] and [u̯] in sequences with vowels. Thus, a word like /jâj/ 'tree, log' could, in principle, be transcribed also as [ja̰i̯], nonetheless, I will systematically use the symbols for approximants in the phonetic transcription (and the corresponding characters, *y* and *w* in the practical orthography). The list of vowel sequences in Table 36 below is exhaustive, based on a corpus of 942 words. Two words, duaʔ 'maguey' and duaʒjin 'pineapple' do not conform to the generalization. Descriptively it is difficult to decide whether there are one or two syllable peaks in the sequence [ua]. Furthermore, as there are no recorded instances of dw, a cogent proposal could be to permit this marginal vowel sequence. In addition, it should be noted that etymologically the two words are related and come from the disyllabic form *doba? (Fernández de Miranda, 1995); this further piece of evidence might support the vowel sequence in these words, as they come from two independent syllables.

Table 36. Vowel sequences in a syllable nucleus	
bàó?	'charcoal'
dàó?	DIMINUTIVE
bràò?	'zapotilla fruit'
dábráò	'good'
bzáó?	'purple'
tàó?	'ancestor'
tʃóà	'forty'
dúá?	'maguey'
dúáʒĵin	'pineapple'
bèò?	'month', 'moon'
gwèó?	'young'
jèó?	'Santiago'
jéò	'all'

Some data suggest that the the permissible weight of the nucleus in the stressed syllable of content words (particularly, those in root and stems) is two moras. First, the vowel sequences just mentioned are restricted to vowels with modal phonation, as no sequences of two laryngealized vowels have been recorded. In Chapter 5 I present quantitative evidence regarding the durational properties of non-modal vowels; I will include here only the relevant data and refer to that chapter for a thorough discussion of this matter. Modal and laryngealized vowels in open syllables are significantly longer than tautosyllabic sequences of modal or laryngealized vowels followed by a voiceless stop, which in turn are consistently as long as vowels followed by glottal stop (mean values of 116 and 120 ms, respectively). In simple terms, the phonetic data suggest a syllable configuration as in Figure 25. That account implies, on the one hand, that the glottal stop follows the same pattern as any other consonant in this position, and, therefore, the 'checked' vowel type is not supported as a different class; on the other, it also indicates that modal and laryngealized vowels pattern alike with respect to their duration properties.

μ μ]σ
VC
V :

Figure 25. Bimoraic syllable structure of stressed syllables in content words. VC subsumes Vʔ together with V + voiceless stops; Vː includes both modal, laryngealized vowels and diphthongs [vˀv, v, vv̯].

Onset and coda. Only t the glottal stopcannot occur as the single onset of a syllable. Some examples are given in Table 37 below. Phonotactic restrictions about the possible consonant-vowel sequences word initially have already been discussed in section 4.3.

Table 37. Cosonants in simple onset

YZ	gloss
pích	'dove'
bîch	'grasshopper'
ták	'hand'
dách	'empty'
kà'	'no'
gá	'where'
kwì	'besides'
chà'	'pan'
llà	'day'
sît	'Mexico'
zît	'far'
xán	'boss'
xhán	'tail'
màxá'	'snail'
nnàdá'	'I'
nèn	'and'
lá	'hot'
râ	'name'
wí	'orange'
yâ	'cane'

Any consonant can appear as the single segment in coda position. As discussed earlier in section 4.3.1, the allophone [χ] of /g/ occurs in the coda (only one exception *pûrg*, coming from the Spanish word *purga* 'purge'has been recorded with a final [g]).Glottal stop is licensed to occur only in coda. Some examples of segments in coda are given in Table 38 below.

Table 38. Consonants in simple coda

YZ	gloss
gòp	'humid'
kúb	'new'
wxít	'to spill'
wàchìd	'to squeeze'
chtak	'bundle'
llòj	'sediment'
wàchékw	'to crush'
wàkwàch	'to hide'
wàchìll	'to get fat'
nìs	'water'
nêz	'road'
xhîx	'sweet, candy'
yùxh	'sand'
llúm	'basket'
bènn	'Give it to me'
bèn	'Do it'
bêl	'fish'
llîr	'griddle'
jsíw	'onion'
bày	'handkerchief'

4.4.2 Consonant Clusters

Consonant clusters entail a complex concatenation of gestures and acoustic information. Often, conflicting phonetic conditions arise as result of the concatenation of dissimilar segments, causing a number of articulatory and acoustic modifications of the members of the cluster. The subtle phonetic account of the specific ways of realizing consonant clusters in YZ is not only interesting from a descriptive phonetic point of view, in that it may help us to understand the phonological pattern of sounds in this language, but it is also of interest from a typological perspective; as the mechanisms to deal with sequence of consonants might well vary one language to another, we might want to know in detail what are the patterns of YZ.

The phonotactics of YZ allow a considerable range of possible consonant clusters. As it will be shown later, most of the YZ consonant clusters occur in word initial position, but also word final and medial clusters have been recorded. A great number and variety of these are derived from morphological processes. Thus, word initial sequences are very common because of the affixation of aspectual markers such as *b*- PERFECTIVE, *ʒ*- HABITUAL, and the *w*- INFINITIVE, or possession *ʂ*-, just to mention the most common ones; however, some of them have been also observed in stems, so they must be specified lexically. In what follows I will describe some of the most relevant properties of consonant clusters in YZ.

4.4.2.1 Word Initial Clusters

Table 39 presents representative examples of the consonant clusters beginning with stops (including the affricate) found in YZ. Some of the word initial clusters are found only in loanwords; this is the case, among others, of the sequences *pn* and *dm*. Other clusters are found only in certain domains (for example *chd, chll, chn* have been attested only in numerals); however, these cases can be explained as the product of morphological concatenation, with the base *chi* 'ten' preceding a digit. In any event, these sequences are well established in the phonology of YZ, although restricted to a closed set of words.

Table 39. Stop initial consonant clusters. Zapotec forms are given in both orthography and phonetic transcription.

Zapotec		gloss
pnet	[pnêt]	'blow with the clossed fist' *from Sp. puñetazo*
pner	[pnêɾ]	'brown sugar' *from Sp. panela*
btás	[βtás]	'sleep' (PERF)
bdínj	[βðínχ]	'edge of a cliff'
bchît	[βtʃît]	'rainbow'
bchèkw	[βtʃèkʷ]	'low'
bllòj	[βʒòχ] ~ [bʒòχ]	'mute'
bgá	[βgá]	'collar'
byà'	[βjàʔ] ~ [bjàʔ]	'fly'
bsyà	[βsjà] ~ [βsjà]	'eagle'
bzao'	[βzaoʔ] ~ [βzaoʔ]	'purple'
bxhîll	[βʐ̂iʒ] ~ [βʐ̂iʒ]	'badger'
blòj	[blòχ]	'hole'
txhòz	[tʐòz]	'bundle'
tlâs	[trâs]	'peach'
dmíw	[ðmíw]	'Sunday' *from Sp. domingo*
kwá	[kʷá]	'dough'
gwèó'	[gwèóʔ]	'young'
chták	[tʃták]	'bundle'
chdá'	[tʃdáʔ]	'fourteen'
chjês	[tʃχês]	'possum'
chllìn	[tʃʒìn]	'twelve'
chnèj	[tʃnèχ]	'eleven'
chlás	[tʃlás]	'never'

Although these clusters are phonotactically permissible, a number of modifications occur in the pronunciation of the individual members of the sequence. For reasons that will be apparent later, sequences of the type /b-stop/ are of particular interest. Let us consider the cluster in the word *btás* 'sleep' (PERF); very often, if not always, /b/ is not realized as a stop, but pronounced instead as fricative [β]. This modification, one might conjecture, allows the realization of both segments in the cluster, and particularly the effective realization of the underlying stop. There are various advantages to the fricative pronunciation in this particular context. On one hand, the incomplete closure provides the aerodynamic conditions for sustaining the voicing (Ladefoged, 1967); on the other, a complete closure of /b/ would render a poorly perceptible segment, since the cues for a stop are given mainly in the release. On the contrary, in the fricative, the cues for place are present through the segment itself. it seems, then, that the allophonic process attested in YZ provides the setting for an undemanding production and, perhaps, a robust perception of the segments. Furthermore, this remark is consequent with the alternations observed in the sequences of the type /b-sibilant/ or /b-approximant/, where the first consonant can be pronounced either as a stop or a fricative; the pattern is not very surprising if it is assumed that the release of /b/ can be projected into the fricative.

The contrast between consonant clusters of /b-stop/ and /b-fricative/ is illustrated in Figure 26 with the spectrograms and waveforms for the words *btás* 'sleep' (PERF) and *bllè'* 'ant'. Let us examine first the sequence /b-stop/. The release of /b/ starts around 140 ms, followed by an increasing section of noise of 135 ms until the beginning of /t/ (its closure it is not visible). Let us now turn to the sequence of /b/ followed by a fricative. In this example, /b/ is well defined as a stop; the waveform shows a clear period of voicing, then a robust burst around 1000 ms (better observed in the spectrogram), followed by a release that lasts approximately 47 ms. The following segment, /ʒ/, starts right after the release of /b/. Immediatly after the release of /b/ it is possible to observe the beginning of /ʒ/, indicated by the increase of noise at high frequencies.

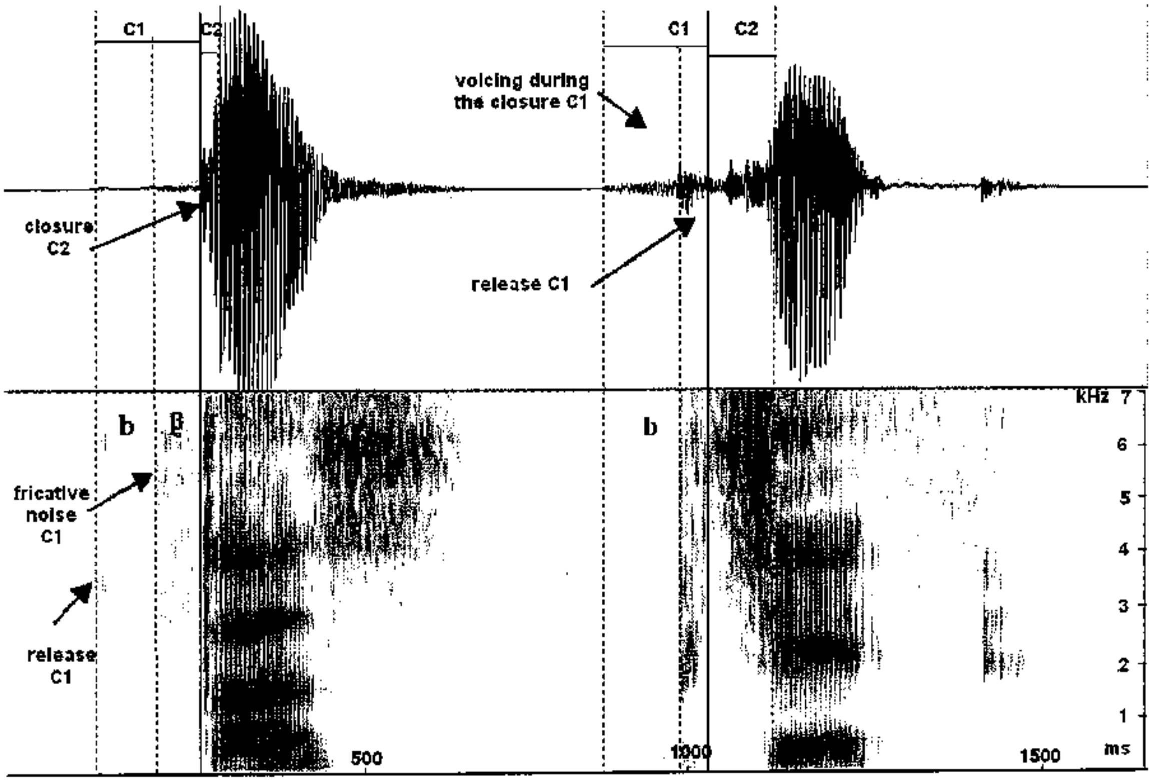


Figure 26. Waveform and spectrogram of the words *btás* 'sleep' and *bllè'* 'ant' illustrating /stop-stop/ and /stop-sibilant/ clusters. In the word to the left, C1 is produced as a fricative, in the word to the right, it can be pronounced as a stop. From speaker (m6).

Table 40 summarizes the clusters in word initial position where C1 is a stop. Clusters in parentheses have been found only in borrowings. In this and subsequent tables I include the two symbols /g/ and /χ/ when necessary to give a better idea of their distribution.

Table 40. Word initial clusters. C1 is a stop

	t	d	χ	s	z	t͡ʃ	ʒ	ʐ	nː	l	w	j	m
p									(pnː)				
b	bt	bd		bs	bz	bt͡ʃ	bʒ	bʐ		bl		bj	
t								tʐ	tnː	(tl)			
d													(dm)
k										(kl)			
g											gw		
kʷ				kʷs									
t͡ʃ	t͡ʃt	t͡ʃd	t͡ʃχ				t͡ʃʒ		t͡ʃnː	t͡ʃl			

Another type of frequent initial cluster involves a sibilant as the first member of the sequence. This kind of cluster is very common across languages, particularly the sequences of sibilant-stop. What is remarkable in YZ is the possibility of combining two sibilants, which, moreover, may disagree in important features, such as voicing. Examples of every combination of sibilant-consonant sequences found in YZ are presented in Table 41.

Table 41. Sibilant initial consonant clusters

Zapotec		gloss
stor	[stôl]	'Isadora'
skin	[skíŋ]	'corner *from Sp. esquina*
sya	[sjá]	'cry'
zban	[zbáŋ]	'ugly'
zdú'	[zdúʔ]	'shame'
zla'	[zl:áʔ]	'bitter'
znà'	[znàʔ]	'salty'
zyòá	[zjòá]	'cacao'
llbîx	[ʒbîʂ]	'falls down' (HAB)
lltás	[ʒtas]	'sleeps' (HAB)
llká'	[ʒkáʔ]	'takes away (HAB)
llkwêll	[ʒkʷêʒ]	'plays' (HAB)
llgà'p	[ʒgàʔp]	'makes tortillas' (HAB)
llsà'	[ʒsàʔ]	'rubs' (HAB)
llzèd	[ʒzêd]	'irritates' (HAB)
llcháb	[ʒtʃáb]	'offers' (HAB)
llxhónj	[ʒʐónχ]	'runs' (HAB)
llxónnj	[ʒʂón:χ]	'wrinkles' (HAB)
llnnàb	[ʒn:àb]	'asks' (HAB)
llní'	[ʒníʔ]	'puts (something inside) (HAB)
lllùà'	[ʒl:ùàʔ]	'sweeps' (HAB)
lllá'á	[ʒláʔá]	'sharpens' (HAB)
llwè'	[ʒwèʔ]	'gives' (HAB)
llyát	[ʒját]	'regrets' (HAB)
xpák	[ʂpák]	'scarf'
xbèn	[ʂbèŋ]	'finger'
xtáò'	[ʂtáòʔ]	'ancestors'
xkùll	[ʂkùʒ]	'nape of the neck' (POSS)
xkwêl	[ʂkʷêʒ]	'school' *from Sp. escuela*
xsíré'	[ʂsíréʔ]	'lunch'
xchèn	[ʂtʃèn]	'blood' (POSS)
xnà	[ʂnà]	'red'
xnnà'	[ʂnà:ʔ]	'mother' (POSS)
jtúré'	[χtúréʔ]	'huajuinijuil' (species of plant)

jsîw	[χsîw]	'onion'
jchò'y	[χt͡ʃòʔj]	'weevil'

Table 42 summarizes the permissible combinations of sibilant-consonant word initially.

Table 42. Word initial clusters where the initial segment is a sibilant

	p	**b**	**t**	**d**	**k**	**g**	**kʷ**	**s**	**z**	**t͡ʃ**	**ʂ**	**ʐ**	**nː**	**n**	**lː**	**l**	**w**	**j**
s			(st)		(sk)							sʐ						sj
z		zb		zd									znː		zlː			zj
ʒ	ʒp	ʒb	ʒt	ʒd	ʒk	ʒg	ʒkʷ	ʒs	ʒz	ʒt͡ʃ	ʒʂ	ʒʐ	ʒnː	ʒn	ʒlː	ʒl	ʒw	ʒj
ʂ	ʂp	ʂb	ʂt		ʂk	ʂg	(ʂkʷ)	ʂs		ʂt͡ʃ			ʂnː				ʂw	
ʐ	ʐp	ʐb	ʐt		ʐkʷ			ʐs		ʐt͡ʃ			ʐnː					
χ			χt					χs		χt͡ʃ								

It is evident from the table that /ʒ/ and /ʂ/ form clusters with a wide variety of segments. This is facilitated, in part, by the fact that *ll-* and *xh-* are morpheme markers, which may be prefixed to virtually any stem.

Another class of consonant clusters has an initial resonant. Words exemplifying all the combinations of initial clusters are presented in Table 43 below.

Table 43. Word initial clusters where the initial segment is a resonant

	Zapotec	gloss
mchét	[mtʃét]	'hatchet' from Sp *machete*
nnbás	[n:bás]	'seed'
nngúl	[n:gúl]	'old'
nnzà'n	[n:zàʔn]	'complete'
nnlá	[n:lá]	'be hot' (STAT)
lbà"	[l:bàʔ]	'twining plant'
lsí'ìn	[l:sîʔĩn]	'wrist'
lnín	[l:n:ín]	'party'
lmét	[l:mét]	'bottle'
wté'é	[wtéʔé]	'to pass' (INF)
wdìl	[wdĩl]	'to fight' (INF)
wklè	[wklè]	'to help' (INF)
wsà'	[wsàʔ]	'to drive' (POT)
wzí'	[wzîʔ]	'to buy' (INF)
wchúj	[wtʃúχ]	'to crush' (INF)
wllè'n	[wʒèʔn]	'to bend over' (INF)
wxá'	[wʂáʔ]	'to scatter seeds' (INF)
wxhèn	[wʐèŋ]	'to chase' (INF)
wnès	[wn:ès]	'to put' (something in the middle of something else.) (INF)
wnì'	[wnìʔ]	'to put (something inside) (INF)
wlè'	[wl:èʔ]	'to break' (INF)
wlìz	[wlĩz]	'to put (something small inside something else) (INF)
wyón	[wjóŋ]	'sixty'
rbôz	[rbôz]	'shawl' *from Sp rebozo*
rsâr	[rsâr]	'rosary' *from Sp rosario*

It is evident that a large number of combinations are formed with the approximant /w/, which is the infinitive marker that is prefixed to many verb stems. Likewise, many instances of n:-C sequences are also heteromorphemic, formed with the prefix *n-* STATIVE and consonant initial stems. Table 44 summarizes the instances of initial consonant sequences recorded.

Table 44. Word initial clusters where the initial segment is a resonant

	b	**t**	**d**	**k**	**g**	**s**	**z**	**t͡ʃ**	**ʒ**	**ʂ**	**ʐ**	**nː**	**lː**	**l**	**j**	**m**
m								(mt͡ʃ)								
nː	nːb				nːg		nz							nːl		
lː	lːb					lːs								lːnː		lːm
w		wt	wd	wk		ws	wz	wt͡ʃ	wʒ	wx	wʐ	wnː	wlː	wl	wj	
r	(ɾb)					(ɾs)										

A question necesarily arises regarding the status of /w/, i.e. whether the /wC/ clusters are indeed sequences of two consonants or if they can be separated in two syllables, with /w/ better analyzed as /u/. The concern is well grounded typologically, as Greenberg's survey found that approximants (semivowels) cannot be separated from the syllable nucleus by stops (1965). It is important to mention that there are no syllabic sonorants in YZ, and that, as stated earlier, the cases of vowel initial words are extremely rare. Furthermore, a large number of the approximant-consonant sequences come from morphological concatenation, e.g. from the morpheme marking infinitive forms *w-* prefixed to verb stems. The prefix appears as a plain consonant before vowel initial stems. When the verb stem begins with a vowel, the approximant is realized as a very short gesture, without independent (secondary) stress. Native speakers cannot parse it as a separate syllable, i.e. the native syllabification takes the consonant cluster wC as the onset of the syllable. Figure 27 shows waveforms and spectrograms of words illustrating the w-C clusters, with the words /wzôχ/ 'to write', /wtʃâb/ 'to offer' and /wẓônχ/ 'to run'.

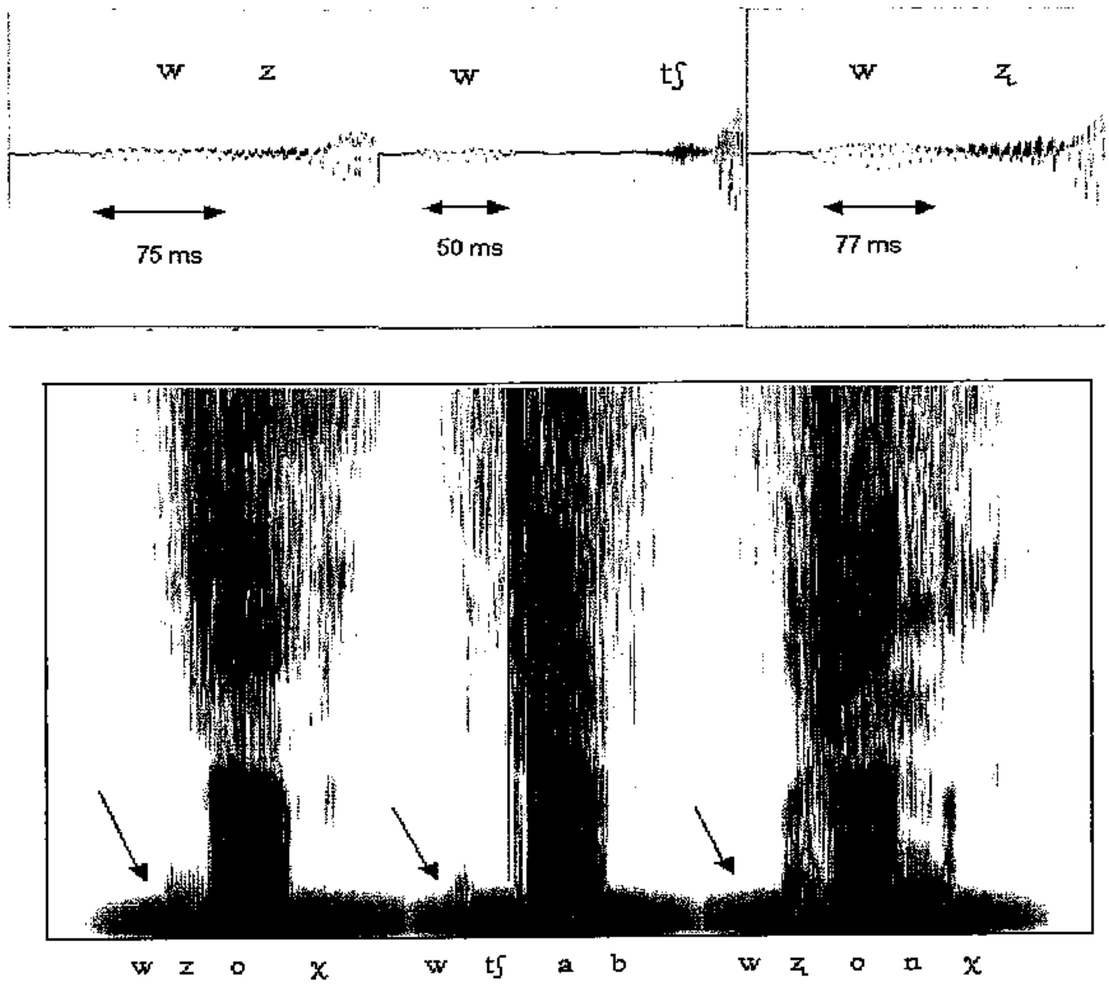


Figure 27. Approximant-consonant clusters *wẓ*, *wtʃ and wẓ*. The upper panel shows the short duration and low amplitude of /w/. From speaker (m2).

The lower panel shows complete spectrograms of the three words; these particular recordings have a fair amount of background noise so that the low frequencies of the utterance where the traces of /w/ could have been observed better are lost. However, the upper panels show waveforms of slices corresponding to the approximant followed by a consonant and a few cycles of the vowel onset of every word. These figures reveal the short duration and low amplitude of the approximant, properties that have been proposed as characteristic difference of this class of sounds in contrast with the cognate vowels (analogous to the English words *woos* and *ooze,* for instance) (Stevens, 1998). Moreover, since there seems not to be an underlying sequence with vowel initial and consonant elsewhere in the language, it is reasonable to assume that the approximant -consonant sequence is a true initial cluster.

4.4.2.2 Word Final Clusters

Crosslinguistically, there is a tendency to reduce the number and type of consonant clusters permitted in word final position with respect to those allowed in word initial position (Greenberg 1963). This asymmetry is also attested in YZ. In fact, as evident from Table 45, the only native types consonant clusters in final position (except, maybe, the case of /ntʃ/) are the one that has the uvular /χ/ as its second member, and the one that has glottal stop as its first member.

Table 45. Word final clusters

	b	t	d	k	χ	s	t͡ʃ	r
p					pχ	(ps)		(pr)
b			(bd)					(mbr)
t					tχ			(ntr)
s		(st)						
z					zχ			
t͡ʃ					t͡ʃχ			
ʒ					ʒχ			
ʂ					ʂχ			
ʐ					ʐχ			
n̪ː					nːχ		nːt͡ʃ	
n		(nt)		(nk)	nχ			
l̪ː					lːχ	(lːs)		
l					lχ			
r		(ɾt)		(ɾk)	(ɾχ)	(ɾs)		(ɾn)
m	(mbr)							
ʔ								

The series of tables below present examples of word final clusters in YZ. Table 46 shows instances where the first member of the cluster is a stop, Table 47 shows cases where it is a sibilant and lastly, Table 48 shows words where the initial member is a sonorant.

Table 46. Examples of consonant clusters in word final position. C1 is a stop (or affricate).

Zapotec		gloss
bdînj	[βðinχ]	'edge of a cliff'
yâpj	[jâpχ]	'chayote' (type of squash)
lâps	[lâps]	'pencil' *from Sp. lápiz*
sípr	[sípɾ]	'Cipriano' *from Sp.Cipriano*
sâbd	[sâβð]	'Saturday' *from Sp. sábado*
sèptyêmbr	[sèptjêmbɾ]	'September' *from Sp.* septiembre
chíntr gó'òyé	[tʃíntɾ góʔòjé]	'dove'
zìtj	[zìtχ]	'deep'
beèchj	[bètʃχ]	'crow'
xha'y	[z̨aʔj]	'cheek'
bè'ch	[bèʔtʃ]	'louse
we't	[wèʔt]	'to sell'
wrà'b	[wràʔb]	'to count (numbers)'
wachè'z	[watʃèʔz]	'to split'
wà's	[wàʔs]	'to chew'
wche'j	[wtʃéʔχ]	'to tie'
wlle'n	[wʒéʔn]	'to bend over'

Table 47. Examples of consonant clusters in word final position. C1 is a sibilant, C2 is χ.

Zapotec		gloss
gôst	[gôst]	'August' *from Sp. agosto*
wàzj	[wàzχ]	'to take a bath'
yîxj	[jîʂχ]	'net'
waxhúxhj	[waz̨úzχ]	'to cut'

Table 48. Examples of word final consonant clusters. C1 is a sonorant

Zapotec		gloss
waxhónnj	[waz̨ónχ]	'to flee'
waxhónj	[waxhónχ]	'to run'
wènch	[wèntʃ]	'what for'
wachàrj	[watʃàɾχ]	'to chat'
bôls	[bôls]	'purse' *from Sp. bolsa*
yá'rârj	[jáʔlâlχ]	'Yalálag'

mârt	[mâʀt]	'Tuesday' *from Sp. martes*
sárk	[sáʀk]	'sugar' *from Sp. azúcar*
púrg	[púʀg]	'purge' *from Sp. purga*
kwadêrn	[kwadêʀn]	'notebook' *from Sp. cuaderno*
márs	[máʀs]	'March' from *Sp. marzo*

Illustrative waveforms and spectrograms of C-uvular consonant clusters are presented in Figure 28. The spectrograms show a robust frication and relatively long duration of the uvular (112, 122 and 92 ms, respectively). One property that may characterize the fricative uvular is the greater energy in the low frequency range; in the spectrograms the lower arrow points out to frequencies around 1500 Hz and the upper one to frequencies close to 3000 Hz; however, since the uvular does not contrast with velar in this context, it remains uncertain whether the energy distribution of /χ/ would be different than that of a velar, espcially at the lower range. The figure illustrate also a common property of C-uvular consonant clusters: there is a lag between the consonant preceding the uvular (indicated by a line on top of the spectrograms). It is likely that this lag reflects the timing employed by the articulatory maneuver of the tongue retracting towards the back of the mouth.

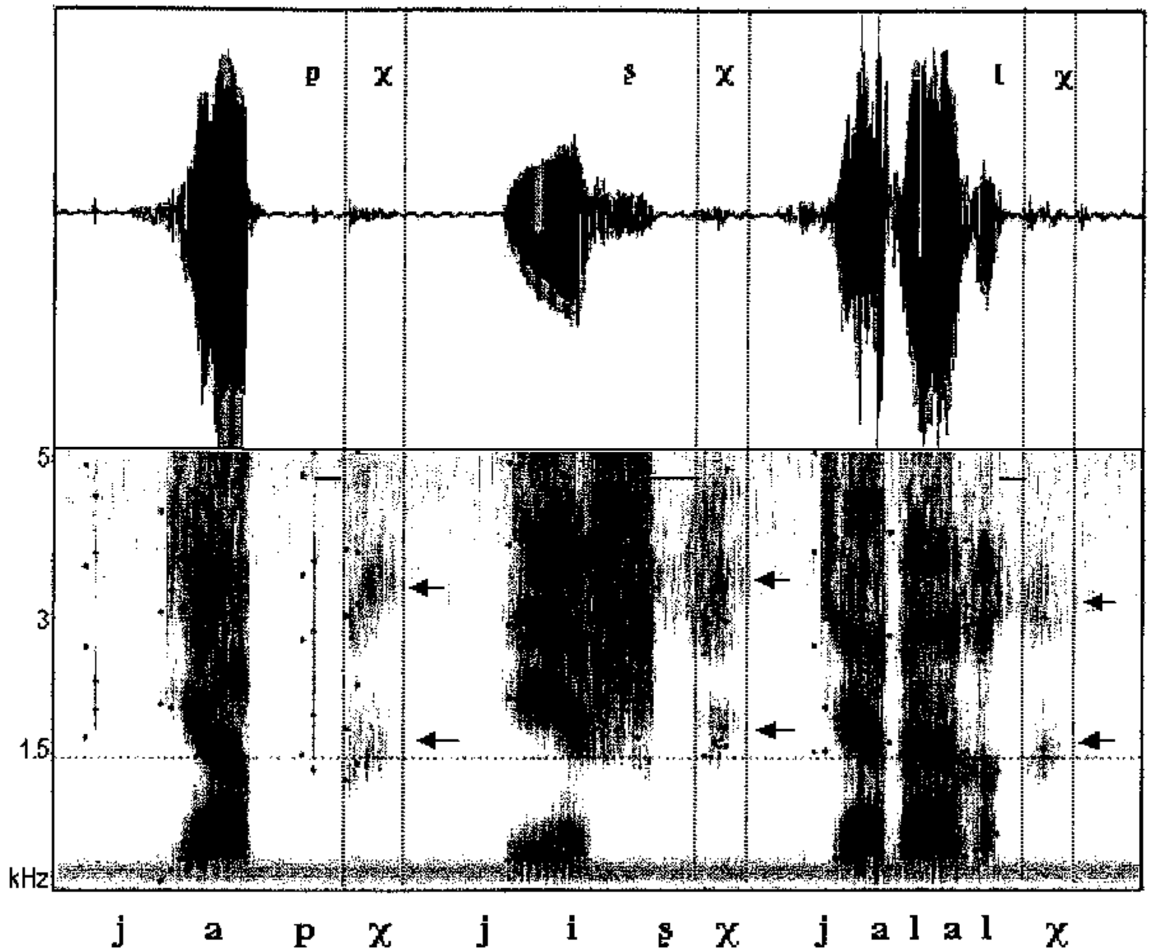


Figure 28. Spectrograms and waveforms for C-χ word finally in /jâpχ/ 'chayote' (green squash covered with spines), /jiʂχ/ 'net' and /jáʔlâlχ/ 'Yalálag'. There is greater energy in the low frequency range, at around 1500 Hz. From speaker (m2).

Earlier in this chapter, it was proposed that [χ] was an allophone of /g/. Historical evidence regarding these consonant clusters lends support to that hypothesis. Most of the words in contemporary YZ displaying the consonant-uvular final series are derived from morphologically complex words in the Proto-Zapotec. Table 49 presents representative examples of the correspondences of YZ consonant cluster C-χ with other Zapotec languages and Proto-Zapotec. Take the word *bètʃχ* 'crow', for instance; in other Zapotec languages the word is derived from two parts, bekkia (Atepec Zapotec), boikiR (Rincon Zapotec), and biaʔ-kiʔ (Mitla and Isthmus Zapotec); so that the corresponding proposed protoform is *beki-RV(data from Fernández de Miranda 1995:162). Hence, the historical explanation would suggest that vowel deletion of the second syllable in the compound left the velar stop consonant in the coda of the initial member of the compound. This reasonably could be considered the origin of the YZ uvular observed in some of the contemporary final clusters

Table 49. Correspondences of C-X clusters in YZ with other Zapotec languages and Proto-Zapotec

	YZ	Proto-Z	Atepec	Rincon	Mitla	Isthmus
'crow'	[bètʃχ]	*beki-RV	bekkia	boikiR	biaʔ-kiʔ	
'bathe'	[wázχ]	*gazV-RV		ru-gazR-aʔ	wahz	ru-gaze
'run'	[waxhónχ]	*žoʔoNV-RV	ru-žunR-aʔ		žuN	žoʔoñeʔ

4.4.2.3 Loan Word Phonology and Consonant Clusters in YZ

It is well known that the phonology of borrowed words reveals interesting facts about the phonology of the receiving language. People from Yalálag has been in contact with Spanish speakers for more than five centuries; sociolinguistic factors disfavouring the use of YZ are reflected in various aspects of the language and particularly in the great number of Spanish borrowed words. Depending on various factors (such as how long the word has been in the language, i.e. recent or old loans) the borrowings are usually transformed and adjusted to fit the pattern of YZ. In this section I will describe what I consider the most prominent processes observed in the adaptation of Spanish borrowings to YZ.

There is a tendency in YZ (and perhaps in all Otomanguean) to prefer monosyllabic roots, and to some extent, monosyllabic words. In YZ this trend can be observed in the pattern of adaptation of Spanish words. Among other modifications to the YZ phonology, many loanwords which in Spanish contain more than one syllable, are borrowed as monosyllables. In many cases, the adapted words are the source of the consonant clusters described in the preceding section. The tables below show the adaptation of Spanish words of one, two and three syllables.

Table 50. Polysyllabic words in Spanish borrowed as monosyllables in YZ

Spanish borrowing		YZ adaptation
σ		σ
buey [bwej]	'ox'	bè'ʒ
Juan [xwan]	'Juan'	[ʂ̥úà]
ˈσ σ		σ
burro [ˈburo]	'donkey'	búr
cuerpo [ˈkweɾpo]	'body'	kʷérp
lápiz [ˈlapis]	'pencil'	lâps
libro [ˈlibro]	'book'	lîbr
Irma [ˈiɾma]	'Irma'	jîɾm
mesa [ˈmesa]	'table'	mês
medio [ˈmedjo]	'medio' (currency)	mêʒ
σˈσ		σ
Miguel [miˈgel]	'Miguel'	mjèɾ
color [koˈloɾ]	'color'	klóɾ
σˈσ σ		σ
Estela [esˈtela]	'Stela'	stél
domingo [doˈmiŋgo]	'Sunday'	dmíw
Eufemia [ewˈfemja]	'Eufemia'	pêm
esquina [esˈkina]	'corner'	skíŋ
enero [eˈneɾo]	'January'	néɾ

Ignacio [ix'nasjo]	'Ignacio'	nás
amigo [a'migo]	'friend'	mîw

All the cases in this table are borrowed as one syllable words in YZ. The major generalization is that a borrowed word in YZ will take the stressed syllable of the Spanish word as the locus of the borrowing. Thus, regardless of the two possible stress patterns in bisyllabic Spanish words—with initial or final stress—without exception the stressed syllable corresponds to the YZ borrowed word. Let us represent informally the correspondence relation in Figure 29 (c_0 any means number of consonants from zero to *n*) The figure depicts the Spanish-YZ stress correspondence as the most important function in the phonology of borrowed words, such that any stressed syllable in Spanish maps into the single syllable in YZ. Then subsidiary processes adapt the arrangement of particular segments.

	Spanish	YZ	
	σ σ́ σ	σ́	
a)	$c_0\acute{v}$ c_0v	c_0v	Unstressed nucleus deletion
	bu ro	búr	
	lapis	lâps	
b)	c_0v $c_0\acute{v}$	c_0v	
	mi gel	mjêr	Glide formation

Figure 29. Adaptation of Spanish in YZ loan words

The rest of the adaptation depends on a number of factors, including the segments in the original Spanish word and the restrictions in the YZ native phonology. The simplest cases involve only vowel deletion of the unstressed vowels in Spanish; this is clearest in cases cv́cv words, such as [ˈburo] 'donkey' which is adapted as [búr] , but cases as ˈlapis > laps 'pencil', where the final consonant is preserved, suggest that only the nucleus of the unstressed syllable is deleted. Other words, however, change the features of the unstressed nucleus instead of deleting it; this is the case of words such as the Spanish [miˈɣel], in which the unstressed [i] is turned into a glide [j] to comply with the rigorous phonotactic constraints of YZ, requiring monosyllables.

At this point, it is interesting to note that, often, adapted words violate general patterns of the language. As discussed earlier, many of the consonant clusters of the language are only attested in loan words; for instance, there is no native YZ word ending in *-rm*, or *-br*, yet these sequences are tolerated in borrowed words such as *lǐbr* and *fǐrm*.

Not all the borrowings are reduced to one syllable in YZ, though; thus, several cases of trisyllabic Spanish words are borrowed in YZ as bisyllables. Table 51 presents some representative examples.

Table 51. Trisyllabic words in Spanish borrowed as bisyllables in YZ

Spanish borrowing		YZ adaptation
σˈσσ		σˈσ
caballo [kaˈβaʒo]	'horse'	kàˈβâʒ
cuñada [kuˈɲada]	'sister in law'	kuˈɲâda, kuˈɲàd
fandango [fanˈdaŋgo]	'party'	panˈdâŋkʷ
paraje [paˈraxe]	'place'	paˈrâk
septiembre [sepˈtjembre]	'Septemebr'	sepˈtjêmbr
octubre [okˈtubre]	'October'	okˈtûbr
noviembre [noˈβjembre]	'November'	noˈβjêmbr
conejo [koˈnexo]	'rabbit'	kùˈnêkʷ
ˈσσσ		σˈσ
pálido [ˈpaliðo]	'tepid'	paɾˈʒîð

In the first set, of Spanish words with penultimate stress the final nucleus is the target of deletion, rather than the nucleus of the initial syllble; that is to say, deletion of unstressed nuclei targets first the final edge of the word. A deletion pattern cvcv́cv > ccv́cv, as in the hypothetical form [ˈkbaʒo], which has deleted the first syllable, has not been attested. To follow the style of the preceding description, let us refer to this pattern, final deletion in Figure 30.

	Spanish	YZ	
a)	σ σ́ σ c_0V $c_0\acute{V}$ c_0V ka βa ʒo	σ σ́ c_0V $c_0\acute{V}$ ka βaʒ ~ *kβaʒo ~ *kβaʒ	Final deletion
b)	σ́ σ σ $c_0\acute{V}$ c_0V c_0V pá li do	σ σ cv $c_0\acute{V}$ pàr jíð ~ *pàldó ~ páld	

Figure 30. Deletion of unstressed final nucleus. Spanish trisyllabic words are incorporated into YZ by deleting the nuclei of the right most unstressed syllable.

Thus, the cvcv́ pattern, on the one hand, complies with that of many YZ native words; on the other, one might conjecture that the adaptation to the YZ phonology should not be that stringent that the identity of the borrowed word would be lost; that is to say, words as [kaˈbaʒo] are adapted in YZ with two syllables instead of one, as the possible *βaʒ, because if the borrowed word is modified to satisfy totally the YZ preference for monosyllables, that word would be confounded with words in the native vocabulary.

In sum, YZ takes the stressed syllable of the loanword as the locus for the adaptation. The Spanish word will be preferably adopted as a monosyllable, regardless of the number of syllable in the original form. The phonology of loan word adaptation reflects the predominant phonological pattern of monosyllabic themes in the lexicon of YZ. The case (b) *pàrjĩǒ* is still problematic. The stress in Spanish is in the initial syllable, thus it would be expected to have a form such as *pal*in YZ. There are no other instances of loan words with a similar number of syllables and stress pattern; one alternative is that the word comes from a different Spanish word.

4.5 Tone

The contrastive use of tone is so consistent in the Otomanguean family that is has been considered to be a genetic feature (Rensch 1976; Suárez 1983). However, the phonological patterns and tonal inventories across languages in the family are very diverse. Suárez has mentioned "the smallest number is naturally two, the largest, in register systems is five" (1983:51). For Zapotec languages, most descriptions acknowledge two level tones and at least one contour (Bartholomew, 1983; Leal, 1950; López Cruz, 1997; Marks, 1976; Pickett, 1967; Speck, 1984). Although most studies of Zapotecan languages describe tonal contrast in the lexicon the grammatical information encoded by tone is not as important as in other Otomanguean languages (Chinantec, Amuzgo, Pame, among others), where the only indication of certain grammatical distinctions is based on pitch (Chatino (Pride, 1963) is an exception here).

Yalálag Zapotec has three tone heights: High, Low and Falling. Two factors indicate the phonemic status of the three tones, and especially that of the contour tone.

First, none can be derived from one of the other two in the lexicon; and second, the three tones are the maximum of tone heights found in the tone system. Nevertheless, it is important to mention that contour tones—Falling and Rising— and tone adjustments, such as upstep and downstep, might arise as the result of morphological and intonational processes. I will limit the present description to lexical tones in the forthcoming sections. The contrast of tones in lexemes has beeen found mainly in content words; however, several affixes are associated to some feature specifying tone, e.g. first person singular -*a'* seems to be associated to Falling tone, and third person (respectful form) -*e'* seems to be related to High tone. Nonetheless, in the current state of the research it is uncertain whether non-content words can bear contrastive tone on their own. This area deserves further investigation. In this section I will confine the discussion to the phenomenon in content words. Table 52 shows examples of tonal contrasts in YZ.

Table 52. Tone contrasts

High		Low		Falling	
já	'sweathouse'	jà	'bell'	jâ	'cane'
zú	'stand up'	zù	'fermented beverage'	zû	'to fly'
ʒén	'smoke'	ʒèn	'blood'		
bʒín:	'mule'	bʒìn:	'foam'		
jáʔ	'hill'	jàʔ	'square'		
jítʃ	'griddle'	jìtʃ	'paper'		
káʔ	'like'	kàʔ	'no'		
		bèl:	'snake'	bêl:	'fish'
		zá	'fat'	zâ	'bean'
		jèz	'corn'	jéˀèz	'pot'
		làw	'eye'	l:âw	'monkey'
zéʔ	'to come'			zéˀè	'wall'

Figure 31 shows F0 tracks illustrating a paradigmatic triple contrast of tone with the words /já/ 'sweathouse', /jà/ 'bell' and /jâ/ 'cane' in the speech of a male speaker. The frequencies of the High tone in the word for /já/ 'sweathouse' are relatively stable around 160 Hz through the vowel. Many High tone words are realized phonetically with a slight rising tone, just like in the examples shown in the figure; however, there is no contrast between the level and the rising realizations of High tone. The word /jà/ 'bell' exemplifying a Low tone is also a level register, in this example the frequencies are steady at 122 Hz; many Low tone words show a small lowering towards the end, but not as prominent, nor consistent as the underlying Falling tone, illustrated with the word /jâ/ 'cane', which shows a large excursion going from the frequencies of the High tone to frequencies close to the Low tone (162-131 Hz).

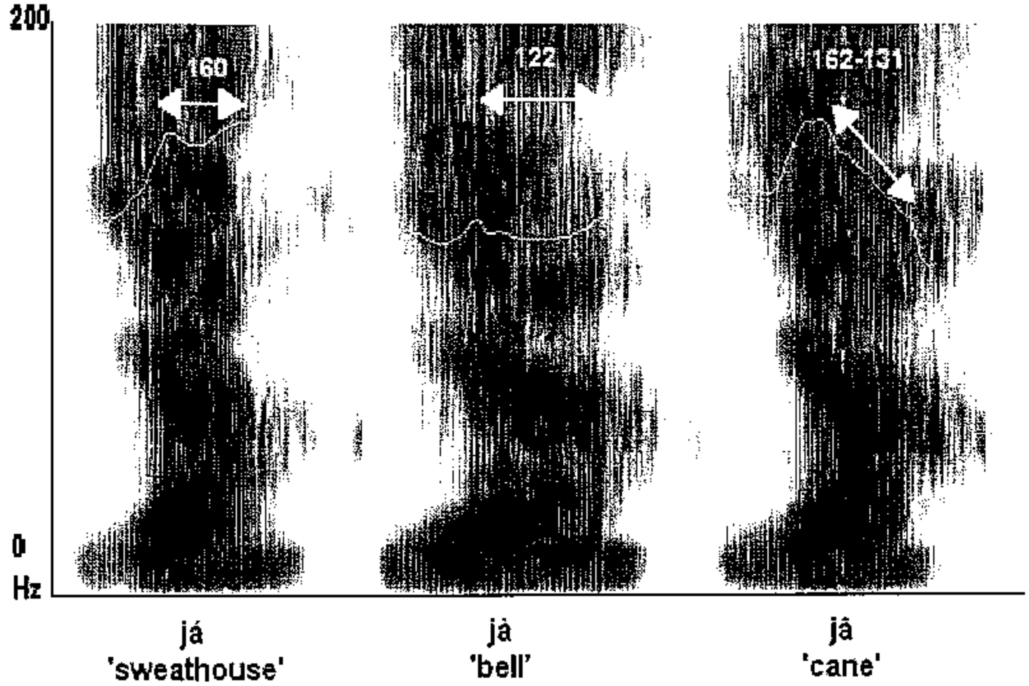


Figure 31. Spectrograms with superimposed F0 tracks of High, Low and Falling tones in YZ. Arrows show the steady values of the f0 through the vowel. From speaker (m2).

These examples are an adequate illustration of the overall shape of the tones in YZ. Figure 32 shows averaged contours of the three tones in 272 tokens, from two speakers, one female and one male. F0 was taken at three points in the vowel, initial, mid and final. The female speaker high register reaches 270 Hz, while the male voice corresponds to the expected normal range of male speakers. In spite of the relative differences between the two subjects, the figure reveals a remarkably similar distribution of the tones in their respective tonal space. The figure shows the minor allophonic variations of the level tones already mentioned; for the female speaker there is a small lowering of the High and Low tones; whereas for the male speaker the High tone raises, and the Low tone falls towards the end. Falling tone is characterized by a prominent slope that occupies the whole range of the tonal space, i.e. it starts at frequencies closer to those of High tone and falls down until reaching the ranges of Low tone; the average down excursion of the Falling tone is about Δ35 Hz for the female and Δ24 Hz for the male. The results were consistent and there were no statistically significant differences within tone category.

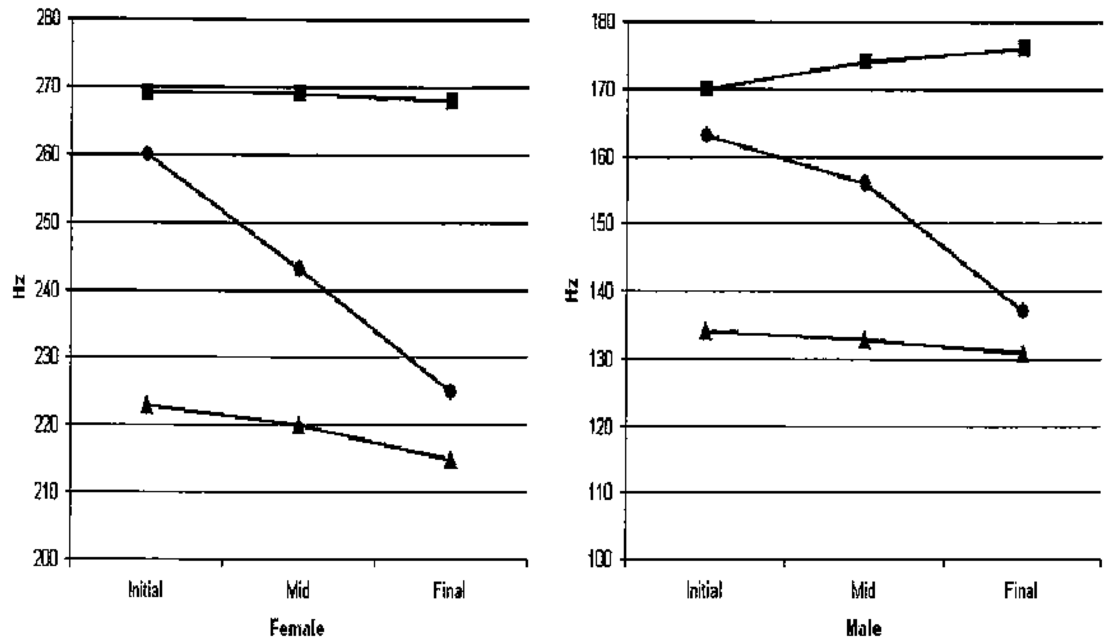


Figure 32. Average values of the tone space for two speakers, female (f3) and male (m2)

4.5.1 Tone and Non-modal Phonation

It is common in languages with non-modal phonation to have restrictions on the type of tones that can be simultaneously with the non-modal voice. In YZ, the three tones contrast in both modal and creaky vowels. Figure 33 shows spectrograms and superimposed pitch tracks of a minimal pair illustrating the contrast of High and Low tone in creaky vowels, with the words /bàˀà/ 'animal' and /báˀá/ 'smooth' in the speech of a male speaker. The spectrograms of the two words show typical 'rearticulated' realizations of creaky vowels. This implementation of creakiness in YZ is characterized by dividing the vowel in three portions: a modal vowel, followed by a section of irregular glottal pulses and low frequencies, which precedes a final short section of more regular vibration (in Chapter 3 I discuss the properties of voice quality in detail). The pitch track corresponding to the first word /bàˀà/ shows F0 values around the Low tone threshold of the modal voice for this speaker (134 Hz). Then, in the middle section of the vowel the values drop off dramatically at about 68 Hz. Finally, the values at the end of the vowels are spurious calculations of the system based on the high rate of vibration of four short pulses at the very end of the utterance that are not considered to constitute a genuine part of the vowel. The contrast with the F0 of the next word /báˀá/ is manifest. Both ends of the vowel have similar peak values, around 178 Hz, which is in the upper range of High tone for this speaker. The F0 track of words like these corresponds well with the auditory impression, i.e. they sound like Low and High tone words, respectively.

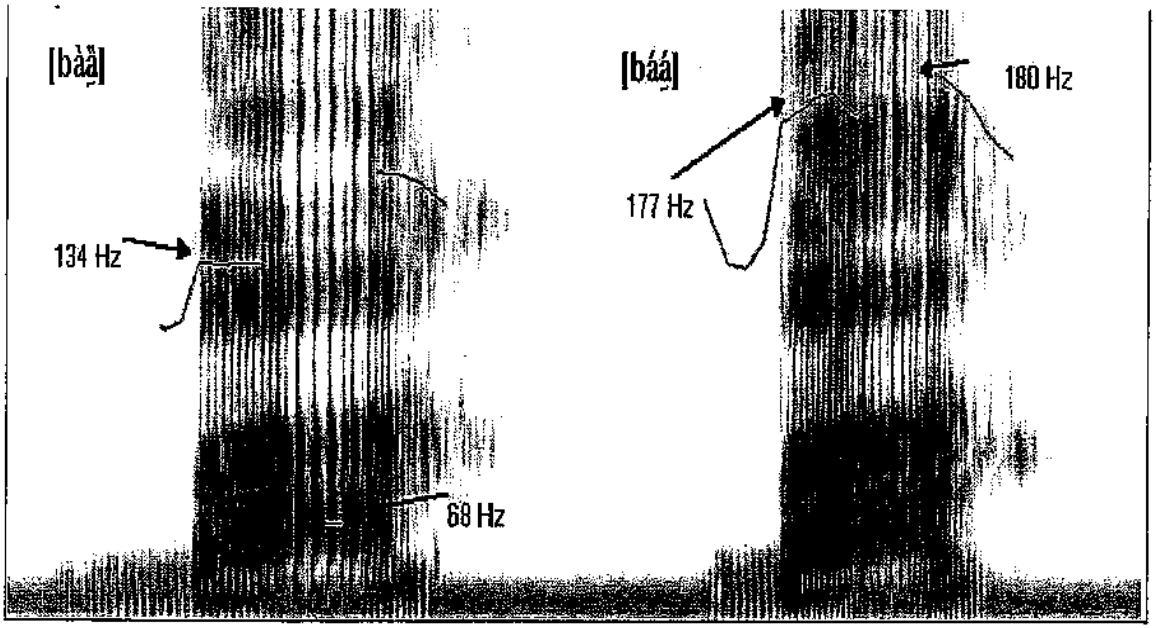


Figure 33. Pitch tracks of the words /bà$^{?}$à/ 'animal' and /bá$^{?}$á/ 'smooth' in the speech of a male speaker (m2), illustrating the contrast of Low and High tone in laryngealized vowels.

As mentioned earlier, the main characteristic of Falling tone is the prominent slope from high to low frequencies through the syllable nucleus. In modal syllables the fall is continuous, while in vowels with creaky voice the Falling tone is distributed in two parts: the first part of the nucleus bears high pitch, and the second bears low pitch. Figure 34 illustrates the realization of Falling tone in creaky vowels and the contrast with High tone words. The word /dé$^{?}$é/ exemplifies a High tone word; although there are small variations in the F0 track, these are due to the irregular vocal fold vibration typical of creaky voice; in spite of this fact, the values are relatively stable at around 170 Hz (with a deviation of ± 4 Hz). The word /zé$^{?}$è / illustrating the Falling tone, has a peak at 168 Hz, which falls down evenly until reaching 115 Hz; it should be noticed that this value corresponds to the end of the more creaky portion of the nucleus, after this point, the values rise up to 143 Hz, in the last section of the vowel. In any case, this value is still lower than the initial and in the range of the lower limit of Falling tones. The excursion fron the High tone to the lower value in the last portion of the vowel is about Δ 25 Hz, a magnitude that coincides with the results about the perception of Falling tone reported in Chapter 5.

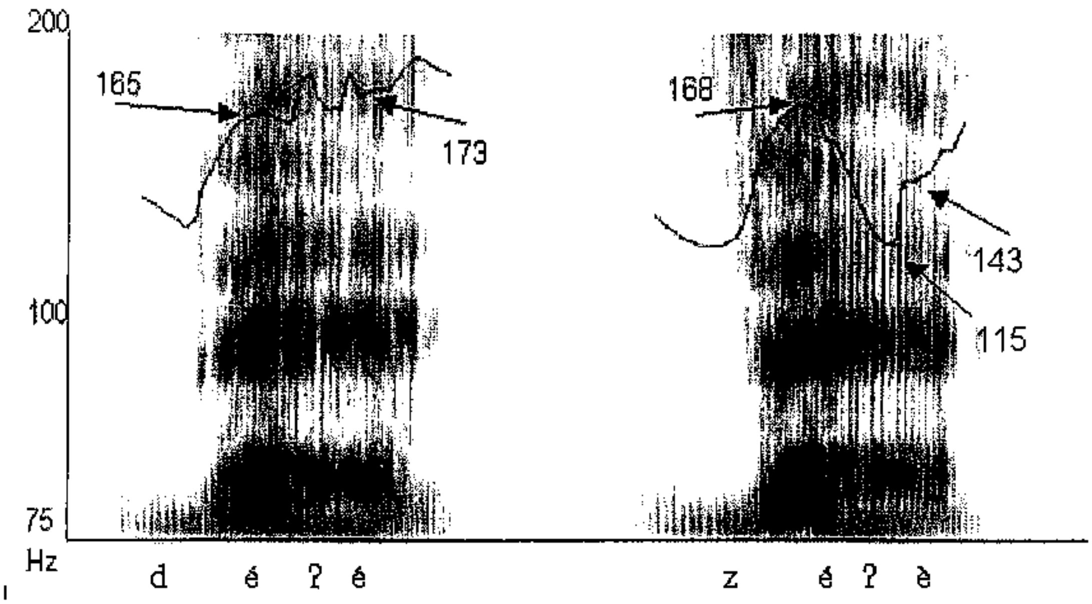


Figure 34. Pitch track of the word /déˀé/ 'lie down' and /zéˀè/ 'wall' illustrating the contrast between High and Falling tone in creaky vowels. Speaker (m2).

Table 53 shows examples of the occurrence of different tone patterns in creaky vowels.

Table 53. Creaky vowels with different tones

High		Falling		Low	
lːéˀé	'he, she'	léˀè	'his name'	lːèˀèˈbèʔ	'his belly'
ʒéˀé	'excrement'	tʃéˀè	'last night'		
wéˀé	'wound'			wèˀè	'to carry on'
jíˀíʂe	'avocado'	wazíˀìʒ	'to laugh'		

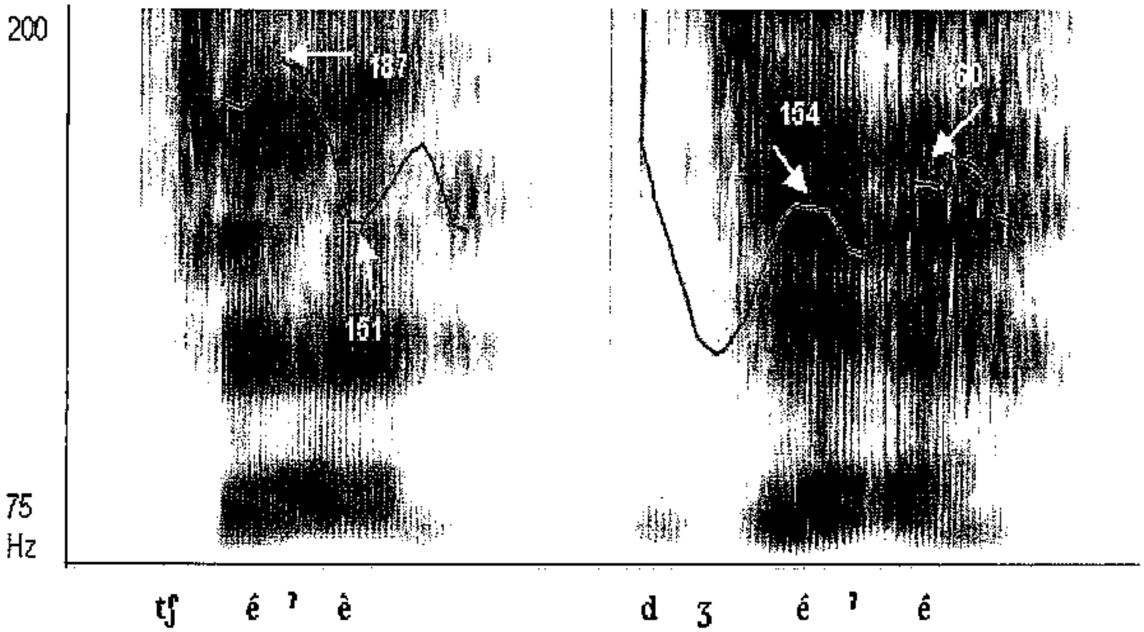


Figure 35. F0 track of the words /tʃéˀè/ 'last night' and /ʒéˀé/ 'excrement' illustrating the contrast between Falling and Low tone in creaky vowels. Speaker (m2).

As already noted in the previous figures, F0 in creaky vowels is, in general, uneven, i.e. there are frequent variations of the F0 contour in the course of the vowel; this is explainable, in part, if we consider the acoustic properties of creaky phonation in YZ. Vowels pronounced with creaky voice are often divided in three portions, the first and last sections being more modal than the middle. Nonetheless, the pitch periods of these two extreme portions are very short and have irregular interval periods, at least not as regular as those of modal vowels. As shown in the series of previous figures, the middle portions presents the most irregular F0 values (often showing pitch doubling), whereas the steady contours are obtained at the edges of the vowel. Because of this considerable source of variance in the production of tone, it seems that the most important factor for implementing tone, especially, in creaky vowels, is the maintenance of a 'tone ra around a central, prototypical value in the speaker's range. This is also consistent with conclusions of Chapter 5, which investigated the perception of tone, in particular, the results regarding the thresholds of tone identification. It was shown, for instance, that listeners could identify High and Falling tones within a range of 15 and 25 Hz, with respect to the values of prototypical High and Falling tones. Thus, taking this into consideration, one might conjecture that a speaker has a wide enough span to implement a given tone and it will be perceived as such by the listener, regardless its very common instability; it is thus not surprising that the tones of creaky vowels showed such a great deal of variation . After all, one might propose that if the actual production of tones effectively corresponds to a perceptual target, then some degree of variation might be tolerated.

4.5.2 YZ Tone and the Typology of Contour Tone Restrictions

Two previous studies have shown that, across languages, contour tones in syllables closed by obstruents are typologically uncommon (Gordon, 2001a; Zhang, 2001), concluding that contour tones are more likely to occur in syllables whose rimes have greater duration. Gordon has proposed an implication scale where the rime best suited to bear a contour tone is a long vowel, followed by a syllable with a sonorous rime, i.e. a rime formed by a short vowel and a sonorant in coda; third in the hierarchy is a syllable closed by an obstruent, and with the least probable carrier of contour tone, a short vowel. I summarize Gordon's proposal in Figure 36.

$$V: \quad > \quad VN \quad > \quad VO \quad > \quad \breve{V}$$

Figure 36. Gordon's implicational hierarchy of contour tone bearing ability

Overall, the YZ pattern follows the predictions made by the hierarchy; as illustrated in the previous section, the three phonemic tones contrast in open syllables with long vowels; it will be shown soon after that syllables ending in sonorants or obstruents are also able to carry all three tones. Hence, it seems that the place of YZ in the implicational scales exploits almost the full range of possibilities, leaving aside only the extreme endpoint of the scale, i.e. short vowels in open syllables are banned from being carriers of Falling tones in YZ. However, such a restriction might be a consequence of a more general constraint stipulating that no content word has an stressed open syllable with a short vowel. Thus, it seems that the occurrence of Falling tone depends, at least partially, on prosodic conditions, such that only the syllable of a word with primary stress is able to bear the contour. The YZ tone pattern is unconstrained regarding the ability of realizing Falling tones in every syllable that is licensed to contrast tone.

The previous section documented the three way contrast in syllables with long vowels. In addition, syllables with a more sonorous segment in the rime, i.e. syllables with a sonorant in coda, are also carriers of Falling tone. Some representative examples of this pattern are given in Table 54 below.

Table 54. Level and contour tones in syllables with high sonorous rimes			
Level tone		Contour tone	
bȅl:	'snake'	bêl:	'fish'
bʒȉn:	'foam'	bzîn:	'mule'
zị́ˀín	'son'	zị́ˀìn	'nose'
bȉn:	'seed'	bîn:	'vein'
jéˀél	'banana'	jéˀèl	'baby corn'
zị̌ˀìl	'cotton'	zị́ˀìl	'sheep'
làw	'eye'	l:âw	'monkey'

Figure 37 presents the F0 track and spectrograms of a paradigmatic example (observed in many other Zapotec languages) contrasting the Low tone word /bȅl:/ 'snake' with the Falling tone in the word /bêl:/ 'fish'. The figure shows the section of interest corresponding to the lateral coda in both words. Let us now see first the properties of the Low tone word, on the left side of the panel. The figure shows an F0 starting with a normal frequency for this tone at about 137 Hz in the speech of my main consultant; the values remain relatively stable with small variations through the vowel, and continue constant during the portion corresponding to /l:/; the final lowering to 117 Hz occurs at the very end of the utterance, were the sound is almost lost, as reflected also in the corresponding faint formant structure in the upper panel. Let us now turn to the Falling tone word. The Falling tone starts at the upper limit of the High tone in the speech of this subject, about 170 Hz; from that point there is a downslope through the end of the vowel, reaching an excursion of 20 Hz, which is close to the average value for the slope of Falling tones on modal vowels. Even though there is no minimal pair such that the contrast between level and Falling tone is restricted to the coda, it seems that the Falling tone exploits the sonority properties of the sonorant to follow the downward trajectory initiated in the nucleus, so that the end of the whole contour reaches the low range limits of the speaker's register.

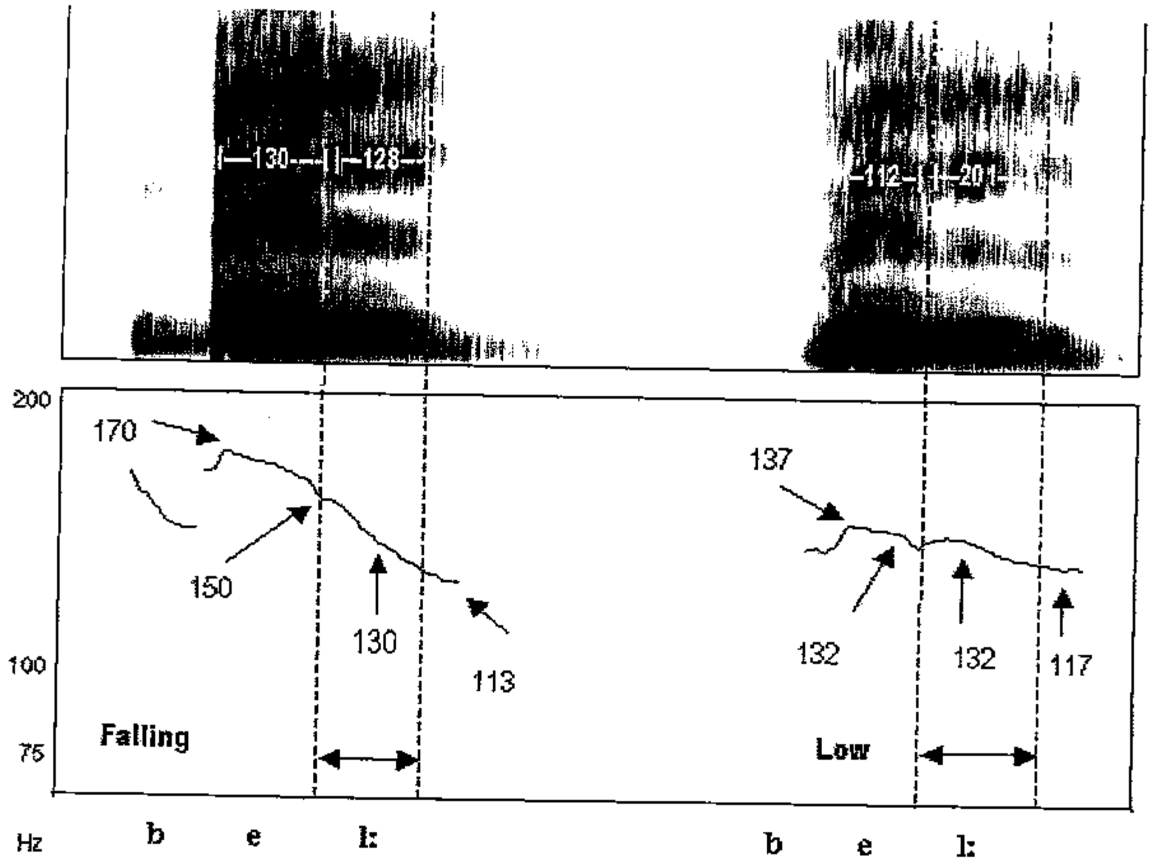


Figure 37. Pitch track and spectrograms of speaker m2 illustrating the contrast between Falling and Low tone in syllables closed by a sonorant.

Gordon's survey showed that syllables closed by obstruents are among the less likely carriers of contour tones. He proposed that the short time of the vocalic nucleus and the unfavorable acoustic properties of obstruents for voicing do not provide the necessary acoustic setting for the realization of a contour tone. In contrast with this crosslinguistic tendency, some data from YZ seems to indicate that the contrast between level tones and the Falling tone is also present in syllables closed by obstruents, including most voiceless consonants. In other words, preliminary data suggest that Falling tone in YZ is unrestricted. Let us start looking at Figure 38, which shows examples of High and Falling tone contrast in syllables ending in /t/, with the words *dit* 'itchiness' and *pît* 'thread'. The High tone word is consistent with the previous description of High tone; it is a level tone, in the range about 165 Hz through the vowel. The Falling tone is also coherent with the previous discussion; the F0 starts at essentially the same value as for High tone (164 Hz) and thereafter presents a steady downslant until reaching the typical values of Low tone (130 Hz). The crucial observation, of course, is that the Falling tone is produced in spite of the short duration of the vowel. Obviously, the rime of this type of words in YZ does not possess the acoustic properties that would assist an optimal realization of the Falling tone, as it happens in many other languages.

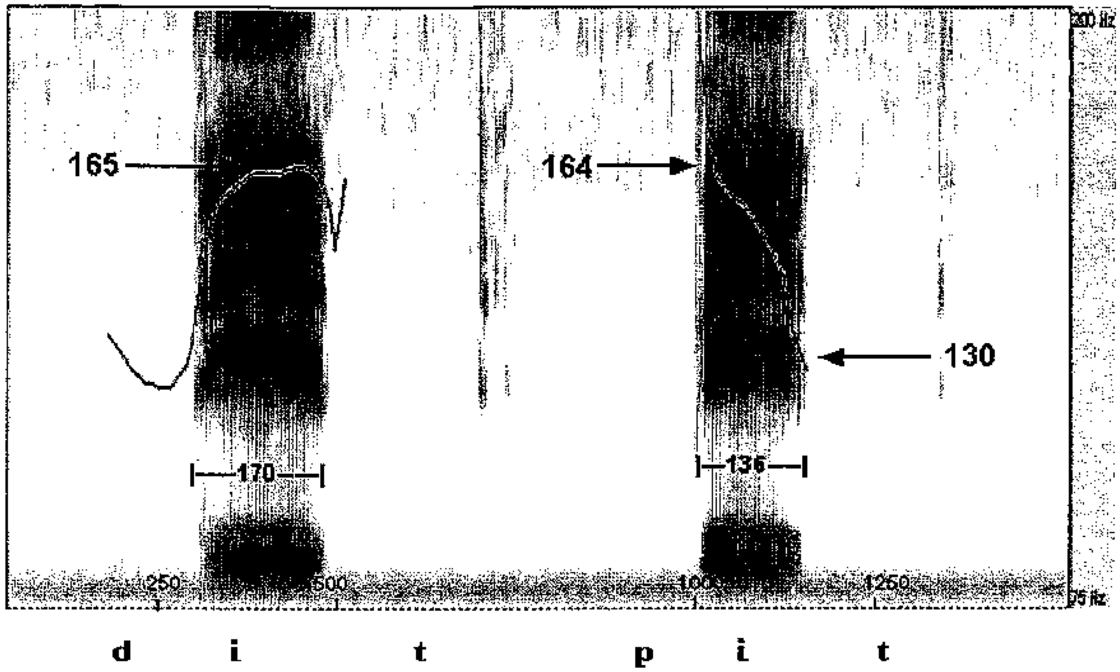


Figure 38. High and Falling tone contrast in syllables closed by obstruents in the speech of speaker m2. The word *dít* 'itchness' to the right shows a steady level High tone, whereas the word *pît* to the left shows a clear Falling tone.

The pattern of Falling tone in closed syllable has been found in a variety of rime types, including codas with both voiced and voiceless obstruents and fricatives. Table 55 gives some examples.

Table 55. Falling tone in syllables closed by obstruents

YZ	gloss
pît	'thread'
ɓît	'epazote plant'
ɓîd	'bedbug'
zêd	'salty'
pâp	'potato'
bêb	'trash'
tʃχɛ̰̂ˑs	'possum'
nːbâs	'seed'
ẓị̂ṣ	'sweet'
bêχ	'cloud'

The only apparent restriction of contour tones occurs in syllables closed by a glottal stop. In this context, High and Low tones contrast. Figure 39 shows a minimal pair with the words *yá'* 'hill' and *yà'* 'plaza'. Three arrows point out the initial, mid and final F0 values for each word. The contrast is evident; note, in addition, that both tones are consistent with the overall shape of the tones described for this speaker the previous section: the High tone word presents a slight rising, while the Low tone shows a small lowering towards the end of the word. As an additional observation, the spectrograms in these examples show no indication of the irregular pulses characteristic of creaky voice, even in the Low tone word, which often is perceived with some degree of laryngealization.

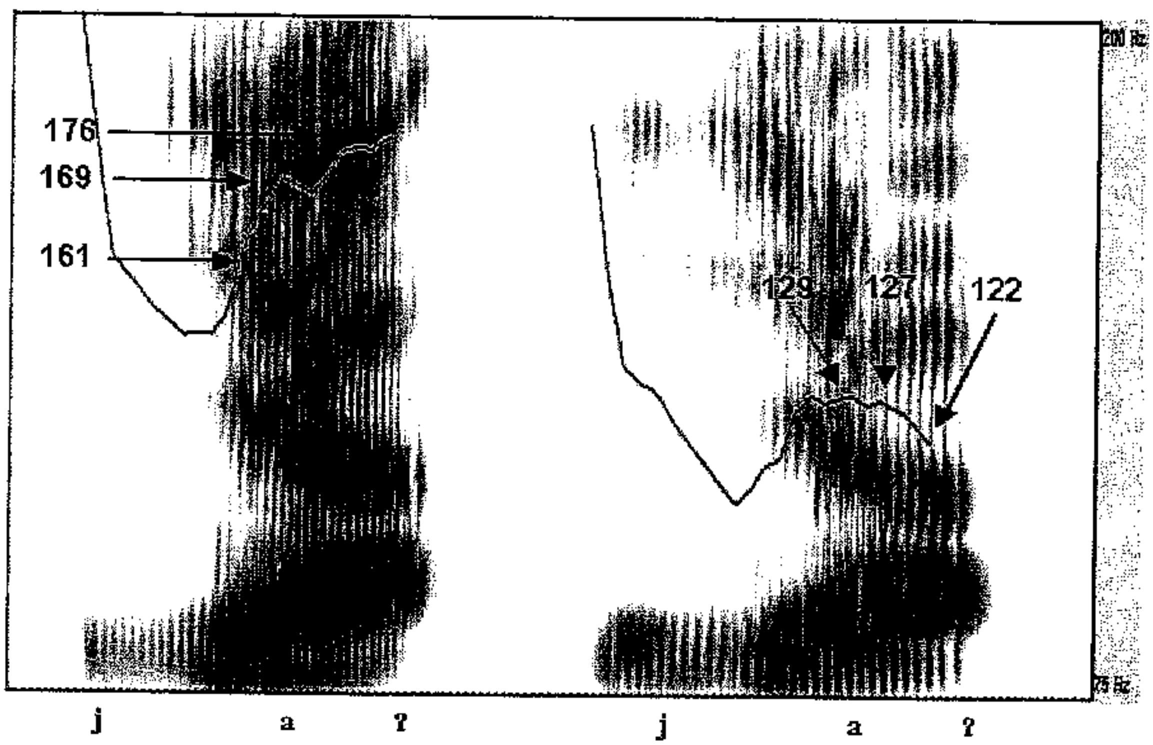


Figure 39. High and Low tone contrast in vowels followed by a glottal stop. Falling tone is not allowed in this context. Speaker m2

Some examples showing the contrast between High and Low tone in syllables closed by glottal stop are given in Table 56.

Table 56. Contrast of High and Low tone in syllables closed by a glottal stop

High		Low	
káʔ	'like, thus'	kàʔ	'no'
bjáʔ	'mole'	bjàʔ	'fly'
wtʃáʔ	'to change (one's) clothes'	tʃàʔ	'pan'
wtʃóʔ	'to cough'	ẓòʔ	'earthquake'

The data from YZ lends partial support to the typology of contour tone restrictions based on the weight of the rime, in the sense that it follows the expectations that more sonorous and longer rimes are capable of bearing Falling tone; however, the data shows that a Falling tone is for the most part unconstrained, as it occurs in almost any type of rime (i.e. closed by sonorants, obstruents) with the exception of the glottal stop. The restriction on contour tones observed in YZ cannot be taken as an exception or counterexample to Gordon's proposal. His thesis is concerned with a theory of the prosodic restrictions on tonal patterns, so the YZ pattern thus would would constitute, if anything, a segmental restriction or probably as an influence of consonant types on tone, a phenomenon which has been documented in the past (Hombert, 1978). The observation extends beyond YZ. A not insignificant number of languages have been described with a similar pattern to the one in YZ (e.g. several languages in Gordon's survey (Andoka, Karen, Lahu and Ocaina) are described having a glottal stop as the only coda, or with glottal stop as one of the few segments permitted in the coda (Tewa). The particular problem in YZ is why syllables closed by obstruents, particularly voiceless stops are better suited to bear Falling tone than the glottal stop. I would like to offer as a conjecture to this pattern. From the results reported in Hombert (1978) it is known that a glottal stops produces a rising of F0 on the preceding vowel. Furthermore, a series of experiments on perception lead Hombert to conclude that even small effects of the glottal stop on the pitch of the vowels can be perceived by the listener. The short duration of vowels followed by a glottal stop and the high sensitivity of the perturbations on the pitch induced by glottal stop could support a conjecture that Falling tones in YZ are not attested before a glottal stop because the influece of the segment would render a flatter pitch, which may be consfused with a High level tone. However, perceptual studies are necessary to further explore this possibility.

5 Phonation in Yalálag Zapotec

5.1 Phonation in Zapotecan Languages

One of the most remarkable features of Otomanguean languages is the use of contrastive laryngeal activity in vowels (Blankenship, 2002; Gordon, 2001b; Kirk, 1993; Pike, 1947; Silverman, 1997; Silverman, 1995). Specifically, the description of many Zapotecan languages (Long C., 1999b; Long, 1999; Lyman, 1977; Munro, 1999; Newberg, 1983) suggests that the languages of the family may have at least three contrastive voice types including, modal, breathy and creaky voices. The investigation of phonation in the languages of the Otomanguean family has been limited and no phonetic research has been done on the phonation of YZ or any other Sierra Zapotec language. In the present section I will present an acoustic characterization of the phonation types of YZ vowels. However, before treating the facts in YZ, I will summarize previous literature describing properties associated with phonation in other Zapotec languages.

Although from previous descriptions we can recognize the phenomenon of nonmodal phonation in Zapotecan languages, there are few studies addressing the phonetic description of the laryngeal complexity of Zapotec vowels. Notable exceptions, that will be discussed throughout the paper, are the recent studies of Esposito (2002) and Gordon and Ladefoged (2002), which provide acoustic accounts of phonation in two Valley Zapotec languages. Several other studies of Zapotec languages mention properties that seem to be related to phonation. Not infrequently, these studies refer to syllable types rather than to the activity of the vocal folds, but the information provided allows one to deduce contrastive use of laryngeal features. The most common allusion found in the literature is to a three way distinction between plain, 'checked' and 'rearticulated' syllable types. Many descriptions seem to characterize checked vowels as modal vowels followed by a glottal stop, whereas the rearticulated type makes reference to a sequence of two vowels with an intervening glottal stop (Nellis and Hollenbach 1980 for Cajonos, Lyman and Lyman 1977 for Choapan Zapotec, Long and Cruz 1999 for Zoogocho Zapotec, Bartholomew 1983 for Atepec Zapotec, López Cruz 1997 for San Pablo Guilá Zapotec, among others). Some other studies provide more elaborated accounts making explicit reference to a classification based on phonation. For instance, Munro and Lopez *et al.* (1999) describe for San Lucas Quiaviní Zapotec a four way contrast which includes modal, breathy, checked and creaky vowels. Checked vowels are described as vowels followed by a glottal stop. One of the striking facts described for SLQZ is that a single complex syllable can allow up to three different phonations, so it "may contain up to three individual vowels, each with its own phonation" (Munro and Lopez *et al.*, 1999:3). In addition, according to Munro and Lopez *et al.* (and personal communication of Munro) tone is a function of the vowel phonation types. Thus, independent breathy vowels have Low tone and independent checked and modal vowels have High tone. Creaky vowels have Low tone although they never appear alone but only as part of a Falling tone sequence, and never have High tone.

In her study of phonation in Santa Ana del Valle Zapotec, Esposito (2002) found a three-way contrast in modal, breathy and creaky vowels, but no difference between "checked" and modal phonation. In the case of creaky vowels it was found that creakiness was limited to the end of the vowel; however, other cases did not show a special phonation, but had a Falling tone as the only associated characteristic. Breathy vowels showed a decrease in higher frequency energies or noise at the end of the vowel. Furthermore, there was a correlation between phonation and tone patterns, where modal vowels were produced with High or High rising tone, whereas breathy and creaky vowels had a Falling tone.

Gordon and Ladefoged (2001) further explored the acoustic correlates of phonation in SLQZ. For breathy voice they found a reduced intensity and increased noisiness as the most relevant properties, while creaky voice was signaled by less frequent and very irregular pitch periods. For both types of phonation there was a progressive increase in the respective nonmodal phonation to the end of the vowel. However, they also found individual variation in the degree of implementing nonmodal phonation; thus, one speaker, for instance, maintained creaky voice throughout the entire vowel, instead of producing creakiness at the end of the vowel as another speaker did.

In sum, previous descriptions of Zapotec languages robustly point out the use of contrastive nonmodal phonation. The minimum contrast includes the modal and the phonation associated to the so-called rearticulated type, whereas the greatest includes a four way contrast between modal, breathy, rearticulated and checked types, in addition to modal voice. Although acoustic studies have confirmed the use of nonmodal phonation in Zapotecan languages, it is still not clear from the literature whether the checked type should be considered as a legitimate phonation type or just as a sequence of a vowel followed by a glottal stop. Hence, in order to clarify the status of checked vowels in YZ, it will be treated in the phonetic analyses as a separate category. In the light of this review, in the forthcoming sections, I will address the subject of phonation in YZ.

5.2 Phonetic Characterization of Phonation in YZ

All spoken languages make use of the laryngeal activity to produce a source of acoustic energy which is subsequently modified (filtered) by actions and configurations of the vocal apparatus (Fant 1960; Stevens 1998). Several scholars coincide in defining phonation as the function of the laryngeal system to transform the airstream into audible sound (Ladefoged, 1983a; Ladefoged, 1996b; Ladefoged, 1987; Laver, 1980; Ní Chasaide, 1997). Despite the fact that there is is a general wisdom about what is the realm of phonation, recently several authors have warned about the confusions and misinterpretations originated by the multiple and, occasionally, inconsistent terms coming from different research fields (phonetics, speech pathology, engineering, etc.) used to describe the mode of vibration of the vocal folds when producing linguistic sounds (Gerrat and Kreiman 2001, Ladefoged and Maddieson 1996, Laver 1980). So, for instance, labels such as creaky voice, vocal fry, laryngealization, glottalization and irregular voicing, among others, have been used to refer to the sound produced when the vocal folds are vibrating anteriorly but with the arytenoid cartilages pressed together. Clearly, this is a major problem to the objective study of human voice. In an effort to capture the diversity of phonation types found across languages Ladefoged (1971, 1983) has suggested that phonation can be considered a continuum whose common denominator is the degree of aperture between the arytenoid cartilages. The continuum ranges from voiceless sounds, where the cartilages are completely separated (as in typical voiceless sounds) through breathy voice, to modal, until reaching the laryngeal setting where the cartilages show a total closure. Other proposals, such as that of Hirose (1997), develop a more elaborated system of parameters that can account for the variety of phonation types, which includes the adduction/abduction mechanisms of the vocal folds; the extent of stiffness, thickness and length of the focal folds; the supraglottal constrictions; and the elevation of the entire larynx. Even though proposals like Hirose's are close to the reality of the configuration and activity of the vocal apparatus, Ladefoged's continuum, supplemented with studies of the acoustic correlates of phonation types (Hanson and Stevens 2001, Stevens 1998), provides a suitable and operational framework to investigate phonation in YZ.

YZ presents a contrast between modal and laryngealized phonation. The list in Table 57 shows typical examples of the contrast. I use the convention introduced earlier to represent laryngealized vowels by a superindexed glottal stop between two vowel symbols.

Table 57. Phonation contrast between modal and laryngealized voice in YZ

Tone	Phonation Type			
	Modal		Creaky	
High	zé	'each'	zéˀé	'wall'
	jín	'a chest of clothes'	jíˀîn	'chilli'
Low	bà	'tomb'	bà̰ˀà̰	'animal'
	gà	'nine'	gàˀà̰	'basket'
	jìtʃ	'paper'	jḭ̀tʃ	'hair'
Falling	bê	'echoe'	béˀè	'in the morning'
	zît	'far'	zíˀì	'heavy'

The production of creaky vowels in YZ is subject to a great deal of variation within and across speakers. Thus, although a categorical contrast in the continuum of phonation of YZ is made only between modal and creaky phonations, the implementation of the underlying specification of creakiness is open to a wide range of allophonic variation. The spectrograms and waveforms in Figure 40 show representative examples of the various ways of implementing creakiness in YZ. The examples illustrate the vowel of the word /n:à^{ʔ}à/ 'now' produced by four female speakers. Each panel shows sections of the waveform to the right of the spectrograms that presents a detailed view of individual pulses. Each section illustrates three different laryngeal settings produced during the course of the vowel. The interval between individual pulses is indicated by arrows. The wave forms are taken from the points indicated by small arrows in the spectrograms. As is evident in the first panel, corresponding to speaker f4, there are three gestures in what is considered a single phonemic unit: a modal vowel followed by a complete closure of the glottis followed then by a vowel of reduced amplitude. This figure represents the archetype of a 'rearticulated' vowel, which has been often described in previous literature. The second speaker (f3) shows also three laryngeal settings through the vowel. The first part illustrates a typical modal vowel followed by four aperiodic, long cycles and then a new segment of sustained periodicity and decreased amplitude pulses. This panel contrasts with the next one, of speaker f1, which exemplifies a modal vowel followed by a longer fragment where the waveform is quite irregular. This section is then followed by a shorter segment of more periodic pulses, indicated as an extrashort vowel in the spectrogram. Finally, the last panel (f2) shows a vowel with three sections of periodic pulses, which nevertheless give the auditory impression of a single vowel with vocal fry throughout.

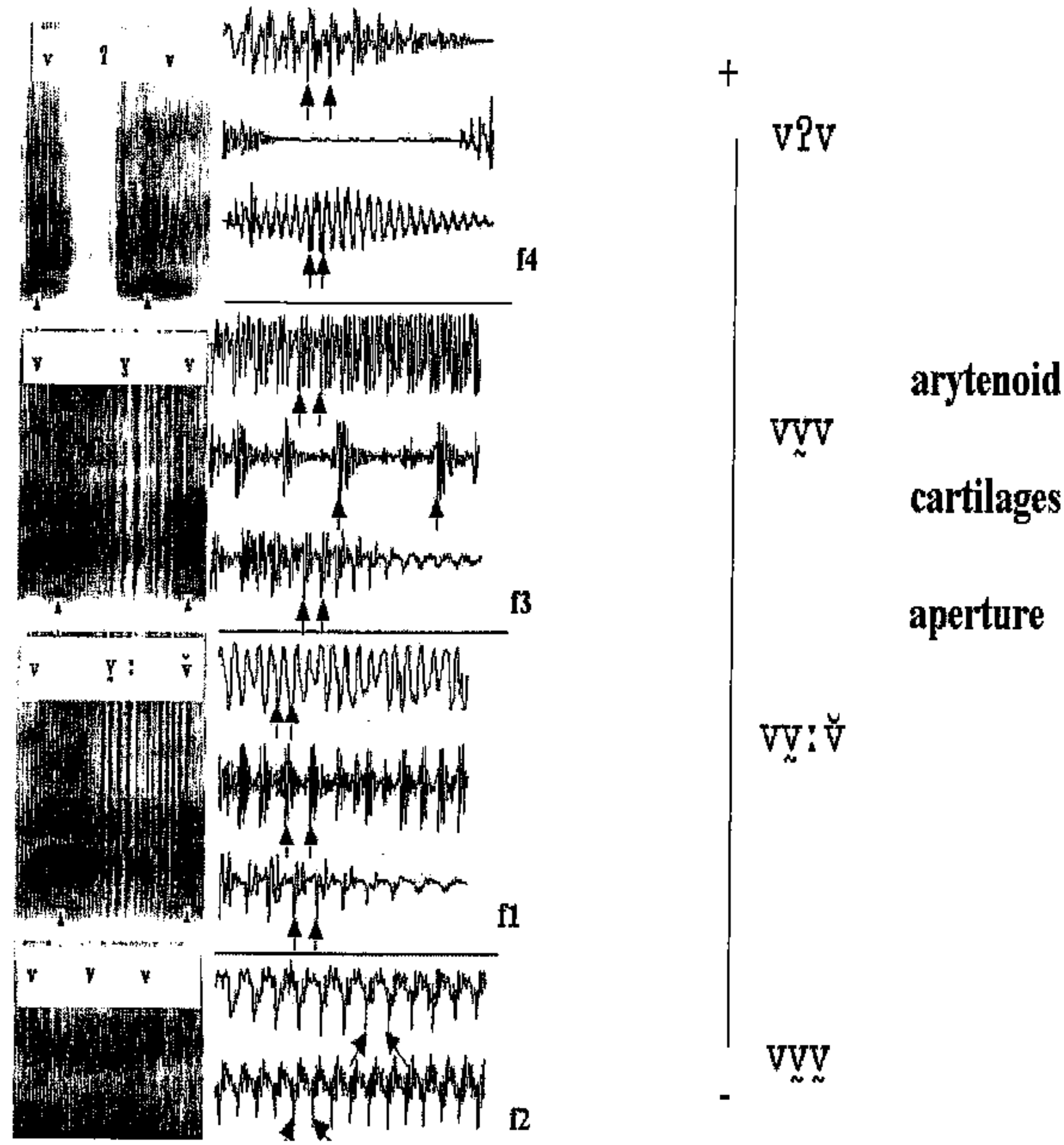


Figure 40. Intraspeaker variation of laryngealization in YZ

The wide variation shown in the implementation of laryngealization in YZ is reminiscent of the observation of Ladefoged and Maddieson (1996) that across languages glottal stops are often implemented as pressed voice on adjacent segments instead of a total glottal closure; however, it seems that the pattern just described for YZ is an instance of the opposite case in which the phonemic creaky phonation of a vocalic segment can be realized as a complete glottal closure like one of the allophonic alternatives. In any case, the typology should include both patterns, glottal stop implemented as creaky phonation and underlying creaky phonation realized as glottal stop.

Regardless of the intraspeaker variation shown in Figure 40, a generalization emerges: all of the examples present a sequence of at least two laryngeal settings. In the typical case there is first a section of regular and sustained periodicity followed by a region of instability. In this region the vocal folds vibrate at irregular interval pulses of reduced intensity and lowered fundamental frequency. It is likely that the irregularity is due to a tight adduction of the vocal folds that still allows some amount of voicing. Then, the vocalic gesture ends with a short portion of more steady vibration. In the light of the evidence revealing the diverse manifestations of creaky phonation, following the term that Ladefoged used for similar phenomena in Chadic languages (Ladefoged, 1971), I will employ the term laryngealized to refer to the YZ phonological contrast to distinguish vowels produced with contrastive non-modal phonation from modal vowels. Laryngealized vowels can be phonetically implemented either as rearticulated vowels or vowel with creaky phonation. As often the articulatory and auditory properties of the contrastive non-modal phonation type in YZ do not occur simultaneously (i.e. sometimes, there are perceived creaky vowels which are not rearticulated, and rearticulated vowels which are not perceived nor produced with creaky voice) the use of the two terms in the rest of the chapter aims to reflect the complex nature and specific instantiation of non-modal phonation in YZ (cf. Blankenship 2002 for a similar discussion on the terminology of non-modal phonation in Mazatec) A caveat is needed, though. The use of the term laryngealized to refer to the contrastive non-modal phonation should not be confused with subsequent discussion about allophonic creaky properties of other vowels due to the contiguity of a glottal stop. In the former case it refers to a contrastive feature, in the other, it refers to an assimilatory sub-phonemic process. At any rate, the use of the two terms in every case will be clear enough to make it unambiguous.

5.2.1 Laryngealized Phonation and 'Checked' Syllables

As noted earlier in this section, it is unclear that 'checked' vowels constitute a contrastive phonation type. In this section, I elaborate on the properties of checked vowels and their comparison with creaky vowels.

The following pairs in Table 58 give examples of the contrast between rearticulated and checked vowels. Notice that neither type is associated with a specific tone.

Table 58. Checked-rearticulated vowel contrast

gáʔá	'basket'	gáˀà	'green'
jéʔ	'daily'	ʒéʔé	'excrement'
bèʔ	'air, wind'	béˀè	'in the morning'
zíʔ	'pain'	zíˀì	'heavy'

In contrast with the typical rearticulated vowel where a glottal stop intervenes between the two vocalic gestures, [v ˀ v̆], a checked vowel lacks the final vowel of reduced duration and intensity. In fact, the impressionistic observation is that checked vowels are followed by a complete glottal closure [vʔ] which cuts off any vowel-like sound. It is worthmentioning that laryngealized phonation is also usually perceived in checked vowels, although it is uncertain if with the same quality as laryngealized vowels. A phonetic quantitative analysis about the phonation properties of checked vowels will be provided later in section 5.3.1.2. In any event, as a working hypothesis, I assume that the creaky quality of checked vowels is an allophonic process due to the proximity of the adjacent glottal stop.

The contrast between modal, checked and rearticulated vowels is illustrated by the spectrograms in Figure 41. The vertical arrows indicate the point where a major laryngeal change occurs in checked and rearticulated vowels. The spectrogram of the word *gáˀà* 'green' illustrates a representative rearticulated vowel type. First, there is a modal vowel spectrum, then, there is a transition signaling a different glottal activity followed by a more modal phase. In the spectrogram corresponding to the checked vowel, the steady vocalic component is followed by a sudden cessation of the vowel formants indicating a complete closure of the vocal folds, (i.e. a glottal stop). Both checked and rearticulated vowels contrast with the modal example, which shows a steady spectrum throughout the duration of the vowel. It should be noticed that several tokens of checked and modal vowels, as in the figure, presented a slight breathiness towards the very end of the vowel. In the figure, duration of the vocalic segments is marked by angles below the spectrograms. It can be seen that the duration of the checked vowel is very similar to the first section of the rearticulated vowel (for the particular tokens illustrated, 86 and 101 ms, respectively). Findings about the duration of the three vowel types will be presented in section 5.3.2.

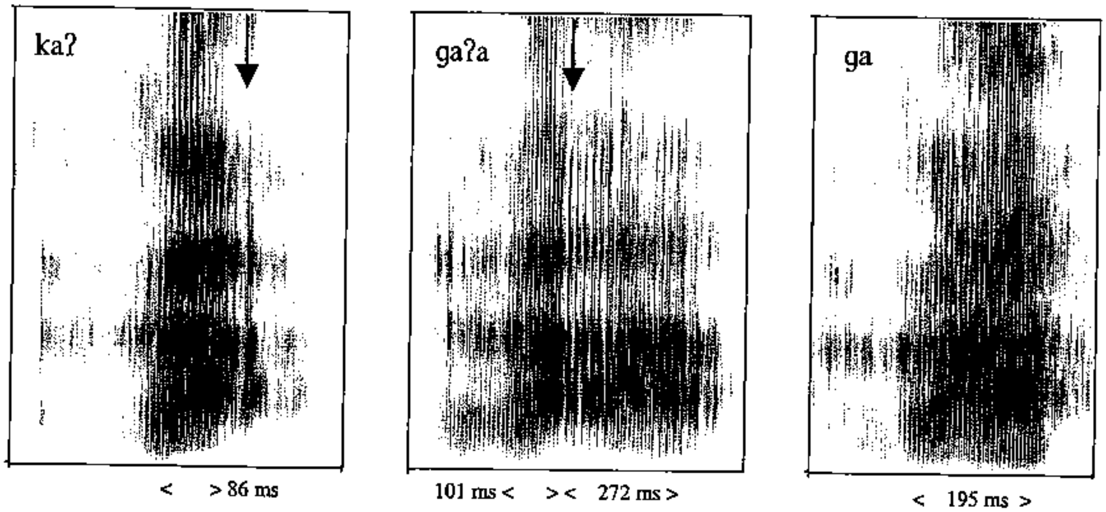


Figure 41. Contrast between checked, rearticulated and modal vowels /kàʔ/ 'no', /gáˀà/ 'green' and /gà/ 'nine', respectively, produced by speaker m2.

In addition, at this point it is worth mentioning that native speakers regard rearticulated vowels as one syllable regardless of the specific pronunciation illustrated earlier, i.e. as a vowel interrupted by a glottal constriction in the middle, or as a entirely creaky vowel. This intuition can be taken as further evidence in favor of rearticulated vowels as a single unit, rather than a sequence of independent vowels.

5.3 Acoustic Properties of Phonation in YZ

Gordon and Ladefoged (2001) summarize a number of phonetic properties that distinguish different phonation types across languages. Among the relevant properties the authors include spectral tilt, fundamental frequency, periodicity, intensity, formant frequencies, duration and airflow. In this section I will report the acoustic correlates of phonation types in YZ as revealed by the results of instrumental analysis of spectral tilt, duration, f0 and formant frequencies.

5.3.1 Spectral Properties of Phonation in YZ

Previous researchers have claimed that spectral tilt, "the degree to which intensity drops off as frequency increases" (Gordon and Ladefoged 2001: 397), is a reliable indicator of the degree of abruptness or gradualness of vocal fold closure (Hanson *et al.* 2001, Stevens 1999). Among several measures of spectral slope, it has been proposed that the measure of the relative amplitude of the two first harmonics, *H*1-*H*2 —or the corrected measure *H*1*-*H*2* proposed by Hanson 1997—is an indicator of open quotient (the ratio of the time that the folds are open to the duration of a complete cycle of vibration) (Hanson, 2001; Holmberg, 1995; Ladefoged, 1983a). Other measures reported in the literature, in addition to *H*1-*H*2, include the amplitude difference between the first harmonic and the highest amplitude in the vicinity of the first, second and third formants (*H* 1-*A*1, *H* 1-*A*2 and *H* 1-*A*3, respectively). In this section I present the results of spectral analysis of *H* 1- *H* 2, *H* 1-*A*1 and *H*1-*A*3, which have been used successfully in analyses of languages where nonmodal phonation is contrastive (Blankenship, 2002; Esposito, 2003; Gordon, 2001b; Kirk, 1993; Ladefoged, 1987).

5.3.1.1 Method

5.3.1.1.1 Data Acquisition and Speakers

The YZ data are based on the speech of 6 adults (3 female, 3 male; f1, f2, f3, m1, m2, m7) ages ranging from 14 to 60s. Data for four speakers were collected in Oaxaca, México, and data from two speakers were recorded in Los Angeles, CA, where they moved about 15 years ago. The subjects spoke mainly Zapotec when they lived in their hometown Yalálag. The speakers claim that later, even in Oaxaca City or in the US, they still speak Zapotec on a daily basis.

Consultants were instructed to read and repeat the list of six monosyllabic words shown in Table 59 that illustrated the contrast among the two phonation types, modal and laryngealized, [a], [aˀa̰], plus a vowel followed by a glottal stop (the checked vowel type) [aʔ]. The words containing a vowel-glottal stop sequence were included to investigate whether they show properties that allow us to consider them as a separate phonation type. Each word was repeated five times; for greater consistency of prosodic effects, the first and last words were not considered in the analyses. Utterances were recorded on an analog audiotape. In order to obtain as much as possible acoustic signal from the glottal source a cardioid microphone (Shure SP19L) was set at 10 cm in front of the speaker. Four of the consultants were recorded in their homes and two were recorded in the sound booth at the UCLA Phonetics Laboratory. The quality of the recordings analyzed was equally satisfactory and reliable enough for the purposes of this study. Words were pronounced in a carrier sentence *cho wne __ tapse* 'let us go to say __ four times'. This sentence was selected because it does not include nonmodal phonation that may affect the target word. Tokens were digitized at a sampling rate of 22050 Hz. Analyses were made with PcQuirer software (Tehrani, 2000). A Fast Fourier Transform (FFT) was calculated over a 26 ms window at three points within a vowel: 25%, 50% and 75% from the beginning of the vowel.

Table 59. Word-list selected to investigate de contrast between modal, laryngealized phonation and the 'checked' vowel type

Modal	Laryngealized	Checked
zá 'fat'	gáˀa̰ 'green'	dàʔ 'mat'
ʒà 'day'	nːàˀà 'now'	lːàʔ 'Oaxaca'

5.3.1.1.2 Measurements

Three measures were selected to investigate the spectral properties of YZ vowels, *H*1-*H* 2, *H* 1-*A*1 and *H*1-*A*3. Both measurements, H1-A2 and H1-A3, provide values of spectral slope, which is correlated with the degree of abruptness of the vocal fold closure. However, because an increase in spectral slope is magnified at high frequencies, only *H*1-*A*3 was selected in this study. The spectra in Figure 42 illustrates representative shapes of modal and laryngealized vowels. The spectra were taken from the middle of each of the vowels. The arrows indicate the intensity values of interest considered for the measurements, first and second harmonics, *H*1, *H* 2, the harmonics with the highest intensity in the first and third formants, *A*1, *A*3.

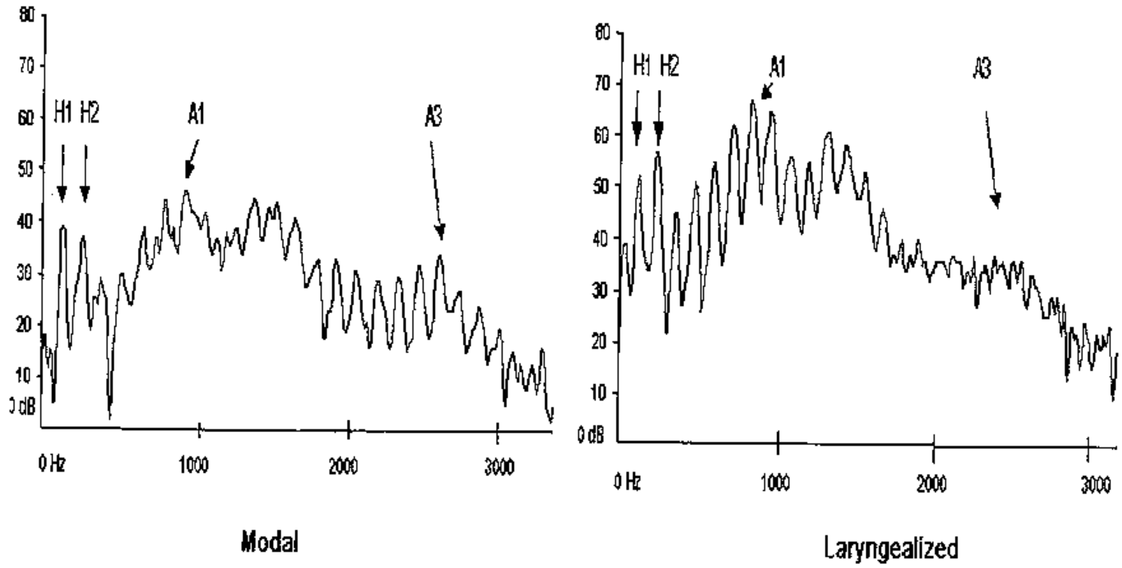


Figure 42. Spectrum of modal and laryngealized vowels. The acoustic parameters indicated are the amplitudes of the first harmonic (H1), second harmonic (H2), first formant (A1), and third formant (A3).

An abrupt adduction of the vocal folds is characteristic of creaky phonation. According to Stevens (1998) a configuration of the vocal folds tight together will cause two major effects on the spectrum. On the one hand, it will produce a greater amplitude of the spectrum at high frequencies compared to that of modal voice, and, on the other, it will produce smaller amplitudes at low frequencies. Thus, for instance, in creaky phonation it is expected that the energy of the second harmonic will be higher than that of the first harmonic compared to the spectrum of modal phonation where the magnitude of the first harmonic is higher than that of the second. Hence, with this considerations in mind I will proceed to present the results obtained.

5.3.1.2 Results and Discussion

5.3.1.2.1 Overall Results

Figure 43 displays the mean values of all 3 time points during all 3 iterations for all 6 speakers of the three measures, *H*1-*H* 2, *H* 1-*A*1, and *H*1-*A*3, for the two types of phonation plus the checked type. Overall, the means of the three measures give the impression that vowels with creaky phonation and checked vowels form a class in contrast to modal vowels. The difference between *H*1-*H*2 in checked (zero dB) and creaky vowels (-2.1 dB) contrasts with that shown by modal vowels, which have a more steeply positive slope of 2.7 dB. That pattern is consistent with previous findings demonstrating that the magnitude of creaky phonation is small or negative, whereas modal (and breathy) show a greater magnitude (Hanson *et al.* 2001). The results of *H*1-*A*1 show negative values for all the three vowels investigated, indicating a greater magnitude of *A*1. However, further differences should be noticed. The figure shows a greater difference between the amplitudes of checked and creaky vowels (-13.9 and -10 dB) than modal vowels which have the smallest difference (-3.7 dB); a pattern that also agrees with the expected tendencies for creaky and modal phonation. Finally, the spectral tilt (positive) found in the *H*1-*A*3 measure shows the expected greater magnitude for modal phonation (14.4 dB), as the gradual adduction of the vocal folds would excite frequencies close to f0. The next greater difference is that of creaky vowels (8 dB) and then the checked one with the smallest amount of differential energy (4.47 dB). Such a result also confirms the pattern anticipated by Stevens (1998): as the vocal folds vibrate abruptly when they are compressed together they produce excitation of high frequencies.

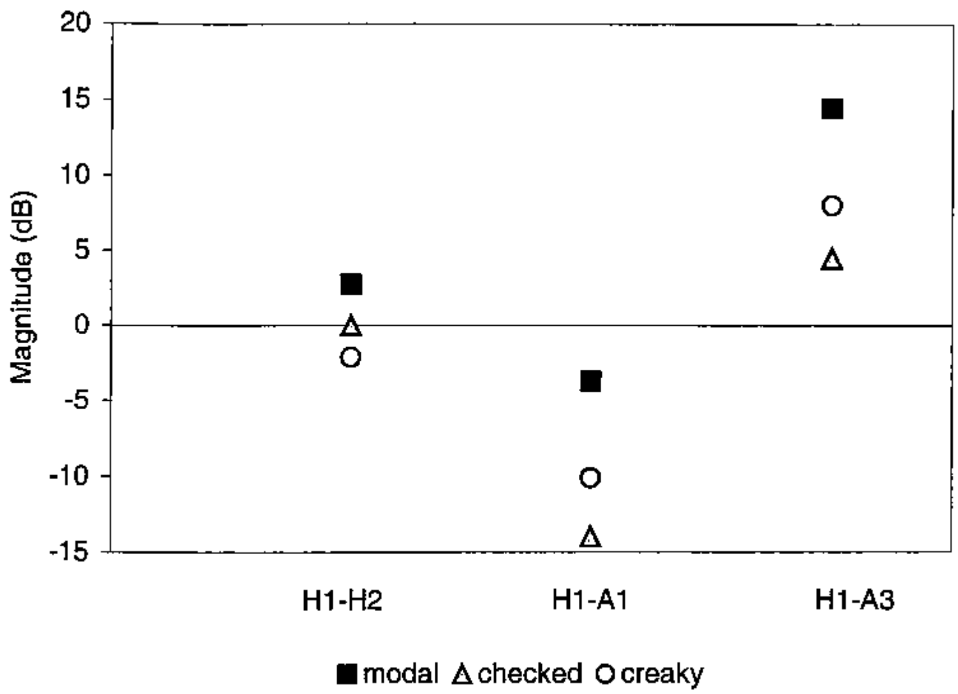


Figure 43. Overall results of the measures H1- H 2, H 1-A1, and H1-A3, for the two types of phonation plus the checked type.

The results of an analysis of variance (ANOVA) testing the effect of vowel phonation in the three measures showed a consistent positive effect: *H*1-*H*2 ($F(2, 324) = 10.716, p = .001$), *H*1-*A*1 ($F(2, 324) = 28.144, p = .001$), *H*1-*A3* ($F(2, 324) = 30.928, p = .001$). A Bonferroni pairwise *post hoc* comparison (selected because it adjusts the level of significance for the fact that multiple comparisons are made in a small number of pairs) summarized in Table 60, further details significant relations among phonation types. A significant effect between the three types of vowels measured was confirmed. Thus, the results partially support the contrast between creaky and checked vowels, as the only non significant value (indicator of similarity) was found only in the *H*1-*H*2 measure. Non-significant values appear shaded in the table.

Table 60. Summary of a post hoc test of the three measures showing the effects between modal and laryngealized voice plus checked vowel

Measure	Factor	Bonferroni *post hoc* test
H1-H2	modal-creaky	p = .001
	modal-checked	p = .028
	creaky-checked	p = .138
H1-A1	modal- creaky	p = .001
	modal-checked	p = .001
	creaky –checked	p = .013
H1-A3	modal- creaky	p = .001
	modal-checked	p = .001
	creaky –checked	p = .017

5.3.1.2.2 Gender Differences in Phonation

Several studies have noticed a difference of phonation based on the speaker's gender in languages where nonmodal phonation is noncontrastive. Multiple factors may contribute to gender differences in phonation, (anatomical, stylistic, et cetera). The extent of gender variation in a language which makes a phonological contrast between modal and nonmodal phonation, as YZ does, can inform us about the nature and manner of the mechanisms employed in controlling voice. For instance, we can learn about this variation comparing the gender-based allophonic use of nonmodal phonation with that found in languages where nonmodal phonation signals phonological contrasts. How does this variation arise? How is this variation different from the one found between male and female speakers in a language where phonation is phonemic? In general, the studies report higher rates of glottalization in females than males in languages like English and Swedish (Dillet *et al.* 1996, Byrd 1994 and Huber 1988, respectively, as summarized in Redi *et al.* 2001). Redi *et al.* (2001), themselves, found divided evidence showing that, in English, female professional speakers glottalize more often than males, but for a group of nonprofessional male speakers glottalize more than females did. Likewise, Esposito (2003) found that the apparent gender distinction of phonation might differ according to the measure used. She found a difference for female (one subject) as opposed to male (two subjects) Zapotec voices in the parameter $H1$-$H2$, but $H1$-$A3$ was a successful measure of both breathy and creaky phonations only for the male speakers. However, with only three speakers the differences might be those of individuals rather than gender differences.

In this section I report the findings of the differences in phonation based on the gender of the YZ subjects. Figure 44 summarizes the overall results. There are clear differences between the speech of females and males in the three measures observed. The main trend is a steeper positive spectral slope for female voices, whereas men show the opposite trend toward steeper negative spectral tilt. Likewise, there is a consistent difference between females and males in the $H1$-$H2$ measure. Thus, while females have positive values for all three phonation types, males show negative values. This pattern suggests that, overall the vowels of females have a more modal voicing than those of males, who, instead, present more properties of creaky phonation. Thus, in contrast with previous studies, the results suggest that in YZ male subjects tend to creak more than females. This is consistent with other studies, which have found that women voices tend to be more breathy (Hanson 1997 for English; Henton and Blandon 1985 for English and Japanese; Klatt and Klatt 1990 for English). It is worthmentioning that a similar tendency has been also noticed in a Zapotec language from the Valley area (San Lucas Quiaviní) by Gordon and Ladefoged (2001), in which females have breathier vowels than male speakers. More research is needed to understand the gender-based differences of phonation in Zapotecan languages.

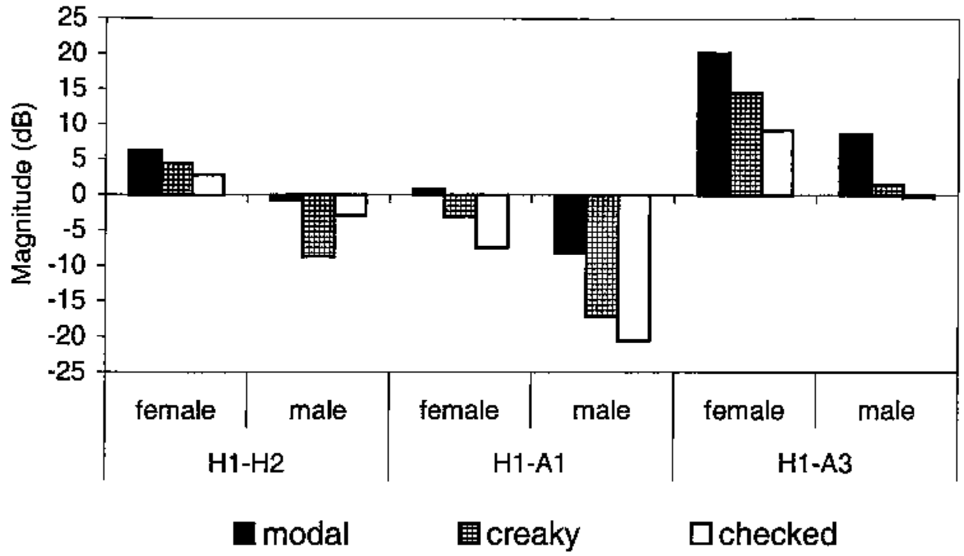


Figure 44. Gender differences in phonation type according to the H1-H2, H1-A1 and H1-A3 values

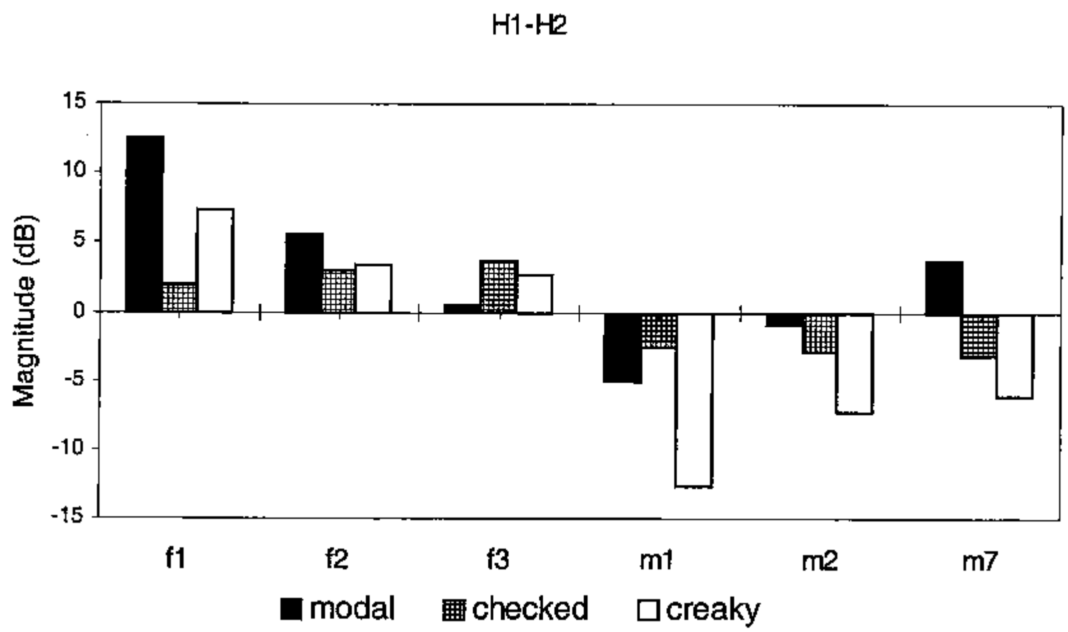
A one-way ANOVA showed that the effect of the three measurements and the phonation type was significant for both groups, female and male speakers: for females in *H*1-*H*2, (F(2, 162) = 3.425) *p*. = .035; in *H*1-*A*1 (F(2, 162) = 10.069) *p*. = .001; in *H*1-*A*3 (F(2, 162) = 32.187) *p*. = .001; whereas for males *H*1-*H*2, (F(2, 162) = 28.874) *p*. = .001; in *H*1-*A*1 (F(2, 162) = 53.097) *p*. = .001; in *H*1-*A*3 (F(2, 162) = 19.437) *p*. = .001. As the overall ANOVA has shown significance across the three measures, a Bonferroni pairwise *post hoc* test was performed to reveal further differences among specific means. For females, only modal and checked vowels pattern together according to the *H*1-*H*2 magnitude (*p* = .029), in contrast with males who showed significant effects only for the pairs creaky-checked and modal-creaky (both *p* = .001), but not for modal-checked. The test on the *H*1-*A*1 measure showed that for females, only the means of modal and checked vowels are significantly different (p = .001), in contrast with males, who showed significant values for all the three pairs, modal-checked (p = .001), creaky-checked (p = .021) and modal-creaky (p = .001). Finally, in the *H*1-*A*3 measure in females, there was a significant effect for the three pairs of vowel types (for the three of them p = .001). The same measure for males only excluded the pair creaky-checked as significant. Table 61 summarizes these results informally. Some measures are more reliable as indicators of nonmodal phonation than others. It is clear that differentiation of phonation is less consistent for females than for males. For females the most reliable indicator of nonmodal phonation is *H*1-*A*3, given that the difference between modal and creaky is not distinguished in *H*1-*H*2 and *H*1-*A*1 That pattern contrasts notably with the male speech for which all measures distiguished modal form creaky vowels, wehreas only *H*1-*A*1 distinguished all the three categories investigated.

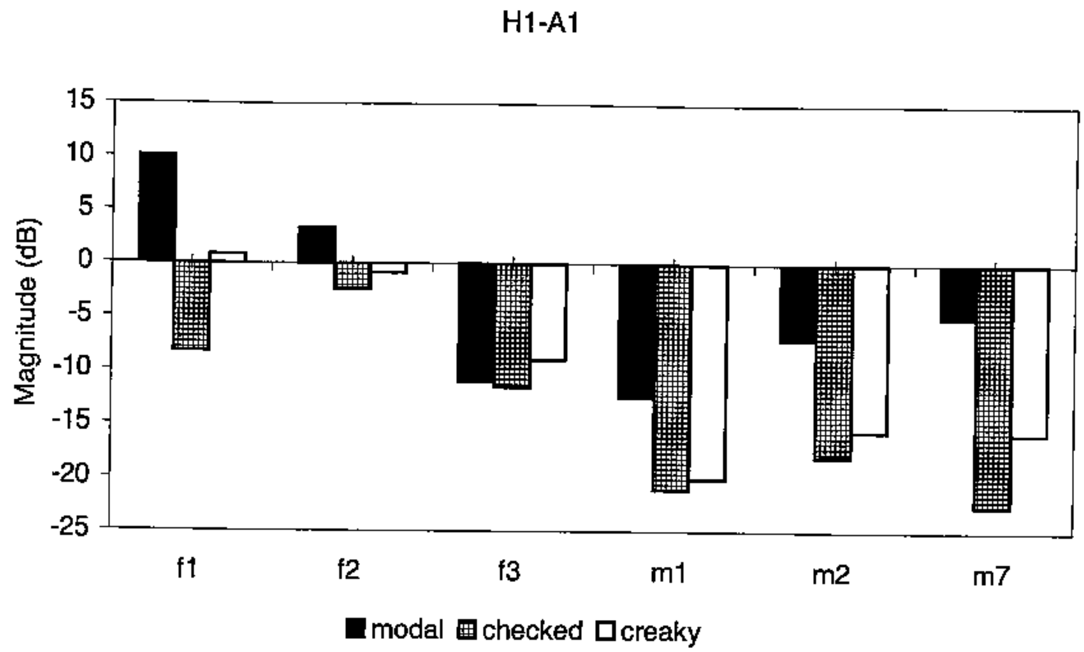
Table 61. Reliability of the measures H1-H2, H1-A1 and H1-A3 as indicators of phonation type in female and male speakers. Shaded cells show non-significant values based on a Bonferroni post hoc test

	Females		Males	
*H*1-*H*2	modal-creaky	non-sig.	modal-creaky	sig.
	modal-checked	sig.	modal-checked	non-sig.
	creaky-checked	non-sig.	creaky-checked	sig.
*H*1-A1	modal-creaky	non-sig.	modal-creaky	sig.
	modal-checked	sig.	modal-checked	sig.
	creaky-checked	non-sig.	creaky-checked	sig.
*H*1-A3	modal-creaky	sig.	modal-creaky	sig.
	modal-checked	sig.	modal-checked	sig.
	creaky-checked	sig.	creaky-checked	non-sig.

5.3.1.2.3 Individual Variation in Phonation

Previous studies in languages in which vowel phonation is a contrastive feature and in languages where it is allophonic have reported a great extent of intraspeaker variation (Hanson *et al.* 2001; Redi and Shattuck-Hufnagel 2001). Considering the results presented in previous sections it is worthwhile to explore the pattern of each speaker independently. Figure 45 shows the difference in the three measures $H1$-$H2$, $H1$-$A1$ and $H1$-$A3$ for individual subjects, females (f) and males (m), separately.





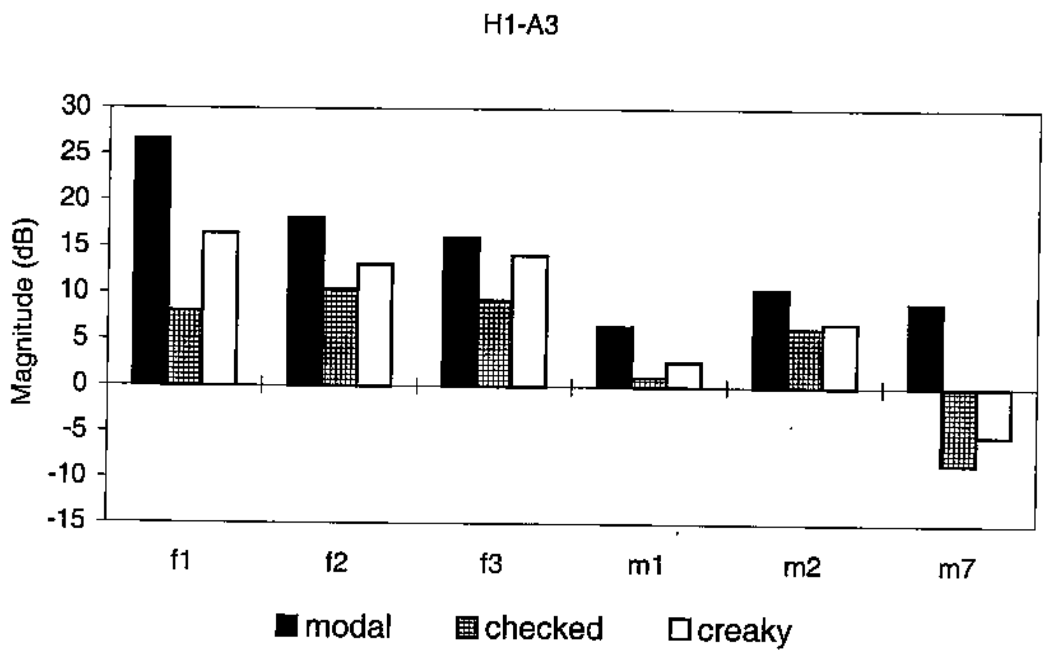


Figure 45. Intraspeaker variation in phonation type according to the measures H1-H2, H1-A1 and H1-A3

A rather obvious remark is that values of the three parameters investigated vary greatly across speakers, both in the absolute magnitude and in the ranges of each specific measure, summarized in Table 62.

Table 62. Range of variation of the three measures H1-H2, H1-A1 and H1-A3 in the three vowel types for both female and male speakers

		Modal	Checked	Creaky
H1-H2	female	12 dB	2 dB	4 dB
	male	8 dB	.6 dB (negative)	6 dB (negative)
H1-A1	female	20 dB	4 dB	10 dB
	male	7 dB (negative)	4 dB (negative)	5 dB (negative)
H1-A3	female	10 dB	2 dB	3 dB
	male	4 dB	dB	11 dB

Nonetheless, regular patterns emerge. The first general tendency across speakers is that modal voice is associated with a greater magnitude of *H*1 with respect to *H*2 and creaky voice with a smaller *H*1-*H*2 magnitude. The range for female speakers is about 12 dB, which roughly corresponds to 50% in open quotient; the range in male sepakers is about 8.7 dB, corresponding to 35% of open quotient (after Stevens and Hanson 1995). However, that trend is inconsistent for one subject *f3,* who shows a smaller *H*1-*H*2 difference in modal voice; it is also inconsistent for subject *m1*, who shows a greater negative slope in modal voice (-5 dB) than for checked vowels (-2.6 dB). Hence, the results may reflect the correlation hypothesized by Hanson *et al.* (2001) that as the amplitude of *H*1 increases in relation to the amplitudes of higher harmonics, an increase in open quotient could be expected. The second overall tendency concerns the values obtained in the difference *H*1-*A*1. In general, the figure reveals a major trend to negative values indicating a prominent first formant peak for most speakers, with greater magnitude for checked vowels, followed by creaky and modal vowels (in spite of this, the trend is reversed in two subjects *f1* and *f2*). The greater negative slope of checked vowels was observed consistently across speakers. Gordon and Ladefoged (2001) found in another Zapotec language that $A1$ is greater than $H1$. Thus, the pattern observed in YZ yielded unexpected results; it indicates that the checked vowel type (assumed by hypothesis to be a sequence of modal vowel followed by glottal stop) is more creaky than the underlying vowels with creaky voicing. As it will be further discussed shortly, this finding can be explained by two factors; on one hand, the shorter duration of checked vowels makes them more vulnerable to allophonic creakiness due to the proximity to the glottal stop, and, on the other, as shown in section 5.2, vowels with underlying creaky phonation have a longer duration, and frequently allocate the creakiness at the end of the vowel. Hence, it is not implausible that in rearticulated vowels the overall $H1$-$A1$ values obtained could conceal the component of the vowel produced with modal phonation, as it will be discussed later. The third overall tendency concerns the results of $H1$-$A3$. The figure reveals a wide variation of spectral tilt among speakers, with greater ranges for females than males in modal voicing, in contrast with the greatest ranges for males in checked and laryngealized vowels. For this measure as well, modal vowels are reliably associated across speakers with a greater positive slope, and checked vowels, with smaller slopes. In essence, the results indicate that checked vowels have more energy dispersed in higher frequencies, so that $A3$ tends to have greater values in modal or laryngealized vowels. The results for modal vowels suggest the same type of relation mentioned already: in modal phonation the energy is concentrated in low frequencies, so, $H1$ obtains greater amplitudes than the peaks of higher frequencies.

5.3.2 The Timing of Nonmodal Phonation

Several studies have drawn the attention to the fact that in languages where nonmodal phonation is contrastive in vowels, the relevant laryngeal configuration lasts longer and displays acoustic properties that clearly differentiate them from modal voice, than in languages where nonmodal phonation is non-phonemic. Particularly relevant for this study, instances of such a languages are Otomanguean languages (Blankenship 2002; Silverman *et al.* 1995). As previous research has shown the relevance of timing in the implementation of nonmodal phonation, I will investigate the question in the upcoming section.

5.3.2.1 Method

5.3.2.1.1 Data Acquisition and Speakers

Data are based on the speech of 8 adults (4 female, 4 male) ages ranging from 18 to the 50's. All but one of the speakers' data were analyzed in the preceding analysis of phonation. Additional data from one female and two males were included. As in the previous study, data for four speakers were collected in Oaxaca, México and data from the other four were recorded in Los Angeles. All of the subjects have YZ as their native, first language and speak the language on a daily basis. Consultants were instructed to read and repeat a list (appendix 2) of words that illustrated the contrast among the three series of vowels modal /a, e, i, o , u/, laryngealized /aˀa, eˀe, iˀi, oˀo/ and checked /aʔ, eʔ, iʔ, oʔ, uʔ/. Table 63 includes illustrative words of the contrast investigated, the complete list is contained in appendix 2. Three repetitions of each word were recorded, yielding a total of 927 tokens. Tokens were digitized at a sampling rate of 22050 Hz. Acoustic analyses were made with Praat.

Table 63. Contrast between voice type (modal-laryngealized) and checked vowels

modal		laryngealized		checked	
gà	'nine'	gáˀà	'green'	kàʔ	'no'
l:á	'hot'	báˀá	'polished'	l:àʔ	'Oaxaca'
lè	'many'	tʃéˀè	'last night'	ʒèʔ	'jar'
ʒǐ	'tranquil'	zíˀí	'heavy'	zíʔ	'pain'
gô	'sweet potato'	z̨óʔòz	'branch'	lóʔ	'inside'
zú	'fermented beverage'	-		tʃúʔ	'flu'

5.3.2.1.2 Measurements

Duration. Measurements of vowel duration were made from the spectrograms of each token. For a subset of laryngealized vowels which clearly had two vocalic portions (vˀv), duration of the two sections was measured based on visual inspection of individual spectrograms, assisted by waveform observation. If the vowel did not exhibit conspicuous changes in the spectrogram, it was considered as only one vocalic gesture.

Spectral tilt. The measures discussed in the previous section, $H1$-H 2, H 1-$A1$ and $H1$-A 3, were taken at three points in the vowel in order to investigate whether the phonation properties was sustained through the entire duration of the vowel or just confined to certain portions of it. A Fast Fourier Transform (FFT) was calculated over a 26 ms window at three points within a vowel, 25%, 50% and 75% from the beginning of the vowel.

5.3.2.2 Results and Discussion

Duration. Overall, the results show that modal and laryngealized vowels are consistently longer than checked vowels (average durations of 151 ms, 150 ms and 120 ms, respectively). The same trend holds for all the speakers but one (*f* 3). A one way ANOVA confirmed the reliability of the result ($F(2, 927) = 36.799$) *p*. 001. In order to probe the working hypothesis that checked vowels are essentially modal vowels followed by glottal stops, the duration of modal vowels followed by voiceless stop consonants (modal-C) was compared to that of checked vowels. It was expected that the duration of the vowels would be approximately the same, i.e. both types would be equally shorter than modal and laryngealized vowels. Figure 46 summarizes the results. As evident from the graphs, modal vowels in closed syllables and checked vowels are the shortest of the series (116 and 120 ms, respectively), followed by laryngealized vowels (in closed and open syllables, 140 ms and 155 ms, respectively), whereas modal vowels in open syllables are the longest of the series (176 ms).

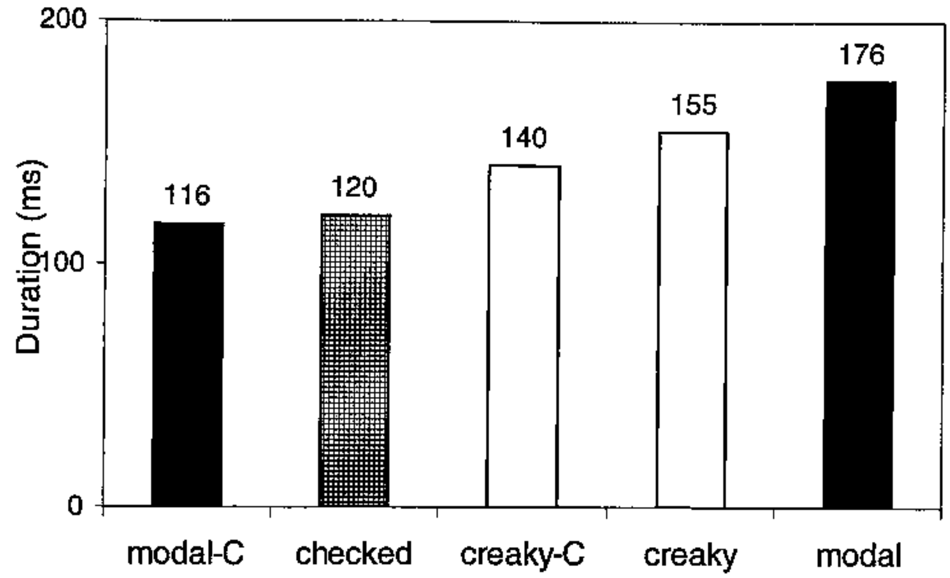


Figure 46. Duration of checked vowels and modal and creaky vowels in open and closed syllables

As results of a one-way ANOVA confirmed a consistent effect of duration on the five different vowel categories ($F(2, 927) = 36.799$), $p. = .001$, further analyses were performed to know details of the differences among specific means. A Bonferroni *post hoc* test confirmed that duration of modal vowels in open syllables was significantly different from the rest of the series. The interaction between checked vowels and creaky vowels followed by stop was non significant. Similarly, vowels followed by a consonant coda also form a separate class (modal-C vs. creaky-C gives $p. = 1.000$, and modal-C vs checked, $p.=1.000$). On the contrary, creaky vowels did not differed with the context (creaky-C vs. creaky in open syllable renders $p. = .496$). Comparable tendencies were found across gender and speaker variables. Table 64 summarizes the probability values obtained by the *post hoc* test.

Table 64. Reliability of duration as indicator of phonation type in open syllables and closed syllables. Cells show observed significance level based on a Bonferroni *post hoc* test.

	modal	checked	creaky	modal-C	creaky-C
modal		*p.* = .001	*p.* = .002	*p.* = .001	*p.* = .001
checked	*p.* = .001		*p.* = .001	*p.* = 1.000	*p.* = .034
creaky	*p.* = .002	*p.* = .001		*p.* = .008	*p.* = .496
modal-C	*p.* = .001	*p.* = 1.000	*p.* = .008		*p.* = 1.000
creaky-C	*p.* = .001	*p.* = .034	*p.* = .496	*p.* = 1.000	

In sum, the results confirm the previous impressionistic observation that modal vowels in a syllable closed by a voiceless stop and checked vowels are equally short, and it is also consistent with similar previous descriptions of other Zapotec languages (Briggs, 1961; Pickett, 1967; Swadesh, 1949). The results also indicate that duration represents a consistent concomitant cue to phonation only in open syllables, where the context does not produce any variation in the vowel duration.

As the results suggest that vowels in closed syllables have similar duration, it is plausible to propose that they are differentiated by their intrinsic phonation properties; thus, duration does not constitute a reliable cue for category in this particular context. However, there are two allophonic processes that make the contrast between modal and laryngealized vowels opaque. Table 65 schematizes the two processes in the form of phonological rules and corresponding phonetic narrow transcription of the outputs. On one hand, modal vowels preceding a glottal stop show allophonic creakiness spreading to the vowel making them similar to phonemic laryngealized vowels. On the other hand, an underlying laryngealized vowel in a syllable closed by a consonant is shortened, so that it may be confounded with a checked vowel. Nevertheless, as the results showed, creaky vowels followed by a consonant were significantly longer than checked vowels (although not as long as in open syllables). This difference is captured in the narrow transcription by the sub-phonemic lengthening of one mora in the output of creaky vowels followed by a consonant. Thus, it is suggested that duration is an enhancing feature that contributes to preserve the difference between modal and creaky voice even in contexts where the difference could be minimized.

Table 65. Opacity of duration in rearticulated and laryngealized vowels

Phonological rule		Phonetic outcome (narrow transcription)
Allophonic creakiness	v → v̰ / _ ʔ(C)	v̰̆ ʔ (C)
Preconsonantal shortening	vˀv → v̰ˀ / _ C	v̰ˑˀ C

Spectral tilt.

Figure 47 summarizes the results of the three measures taken at three points in the vowel, 25%, 50% and 75%. A rather obvious result is that for modal vowels there is a tendency to increase the magnitude through the vowel in all the three different measures. Equally prominent is the fact that modal vowels have the greatest magnitude of the three vowel types in all the three points of the vowel, under the three measures (*H*1-*H*2, *H*1-*A*1 and *H*1-*A*3). This tendency contrasts with that of creaky and checked vowels, which seems not to exhibit homogeneous pattern across the measures: In *H*1-*H*2 the values of the checked and creaky type vary minimally along the duration of the vowel (-0.9, 0.5, 0.4 dB and -1.9, -2.4, -2.0 dB, respectively). As for *H*1-*A*1, the results show a tendency for a negative slope, indicating that the intensity values of the first formant were consistently higher than those of f0 (excepting for the 0.9 dB of modal phonation at 75% of the vowel). Regarding the magnitudes of the difference between *H*1-*A*1, the results indicate that there is a global spectral slope increase as the values of high frequencies were subtracted from the intensity values of the first harmonic. In constrast, the difference of *H*1-*A*3 shows a positive slope, indicating that the amplitude of the higher frequencies was for the most part smaller than that of f0.

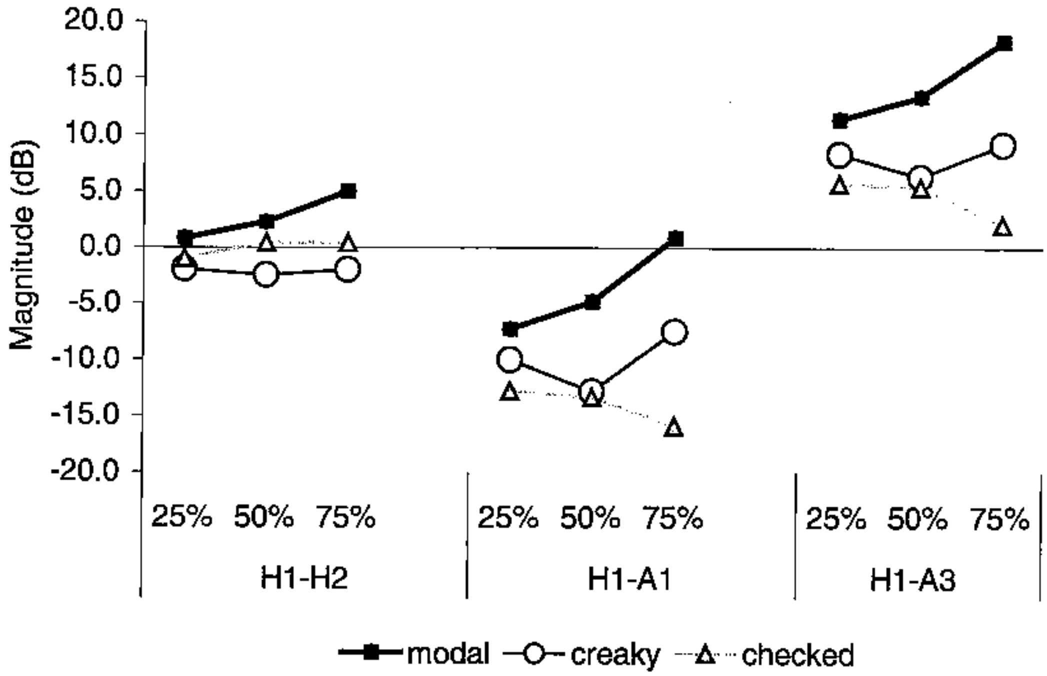


Figure 47. Values for modal, laryngealized and checked vowels according to the measures H1-H2, H1-A1 and H1-A3 at three points in the vowel

The results of a multivariate one factor ANOVA (phonation type x three orthogonal measures) confirmed the general trend already described above. The probability values obtained are summarized in Table 66 below. The tests revealed that all the mean values of the three measures were significantly different at any point in the vowel, except for the measure *H*1-*H*2 at 25%.

Table 66. Probability values from ANOVA tests at each time interval

	25%	50%	75%
H1-H2	F(2, 108) = 1.309) p. = 0.274	F(2, 108) =3.876) p. = 0.024	(F(2, 108) = 6.451) p. = 0.001
H1-A1	(F(2, 108) = 3.355) p. = 0.039	(F(2, 108) = 8.829) p. = 0.001	(F(2, 108) = 20.76) p. = 0.001
H1-A3	(F(2, 108) = 3.592 p. = 0.031	(F(2, 108) =7.846) p. = 0.001	(F(2, 108) =26.21) p. = 0.001

Detailed results are revealed by a pairwise *post hoc* comparison (Bonferroni). Investigating the measure*H*1-*H*2, the results confirmed a null effect among the three vowel categories at the first quarter of the vowel (25%); in the middle of the vowel, a significant difference was found only between modal and creaky phonation ($F(2, 108) = 3.877$, $p. = .02$); at 75% of the vowel, a significant effect was found between modal and creaky phonation ($F(2, 108) = 6.451$, $p. = .002$) and a nonsignificant trend (*p*. is greater than .05 and less than or equal to .08) was found between modal and checked vowels ($F(2, 108) = 1.310$, $p. = .068$).

The *post hoc* test of the measure *H*1-*A*1 showed intriguing results. At the first quarter of the vowel, a significant difference was found only between modal and checked vowels ($p. = .033$); in the middle of the vowel the difference was significant between modal and checked vowels ($p. = .001$), and between modal and rearticulated vowels ($p. = .002$); and finally, in the last quarter of the vowel all the three types were different, modal/checked ($p. = .033$), modal/rearticulated ($p. = .005$) and rearticulated/checked ($p. = .005$). Thus, the results indicate that checked vowels are consistently different from modals throughout the vowel, and different from rearticulated in the last half of the vowel. This finding is in principle unexpected, since it was believed that checked vowels were essentially modal vowels followed by glottal stop. Nevertheless, the results are consistent with the characterization of rearticulated vowels portrayed earlier. In essence, the results confirm the characterization of rearticulated vowels as a complex of three components: The first component has similar properties to modal vowels; then, a second component introduces a laryngeal adjustment, which ranges from a tight adduction to the complete closure of the vocal folds. This component corresponds to the values obtained in the middle of the vowel where the results indicate strong properties of creakiness; then, the last component of the rearticulated vowel goes back to a modal configuration. At this point (75%) the results showed the corresponding values of modal voice in sharp contrast with the values of the checked vowel, which in turn, presents increased properties of creaky voice. In simple terms, it means that a checked vowel becomes creakier as the vocal folds snap shut to produce the glottal stop, whereas a rearticulated vowel implements the creakier component flanked by two modal portions.

This description was further confirmed with the results for a subset of rearticulated vowels that presented only two observable portions, the intial component with properties of modal voice followed by one with properties of creaky voice. It was found that the first component was longer than the second one (99 ms vs 79 ms average, respectively). Thus, the result suggests that it is enough to realize creakiness in the last 45% of the vowel to recover the underlying feature specifying phonation type.

The overall findings are consistent with recent studies addressing the issue of the timing of nonmodal phonation. Blankenship's (2002) and Gordon and Ladefoged's

(2001) have observed that nonmodal properties often do not persist through the entire vowel. According to these authors the separation of modal and nonmodal phonation may reflect conflicting perceptual demands. Along these lines, Silverman (1995) has suggested that the sequential realization of phonological features that could obscure each other in perception if implemented simultaneously is a strategy that ensures the perceptual recoverability of the features in question. Hence, analogous to the Mazatec case analyzed by Blankenship and Silverman, it appears that the timing of nonmodal phonation in YZ is organized to guarantee the production and perception of multiple phonemic features that could otherwise contradict each other in actual implementation: tone and phonation. The production of creakiness entails a low frequency and irregular vibration, properties that conflict with a stable pitch, especially at high frequencies. In simple terms, it seems sensible to suggest that a High tone in a creaky vowel imposes considerable demands in production and perception. Although, as in many other languages it is frequent to find voice qualities associated with different tones (Huffman, 1987; Jianfen, 1989; Ladefoged, 1973), in YZ laryngealized voice often is associated with Low tone. Nevertheless, laryngealized vowels with High tone are also part of the lexical possibilities of the language; thus, YZ appears to show that F0 and phonation are independently controllable parameters, a possibility that is not frequently documented in the literature. Figure 48 shows spectrograms with superimposed pitch contours of the words lé^{ʔ}é 'he, she' and bé^{ʔ}è 'belly' contrasting High and Low tones in the second component of rearticulated vowels. The pair illustrates that phonation and f0 are orthogonal dimensions, as the contrast is realized in a section of the vowel with creaky characteristics.

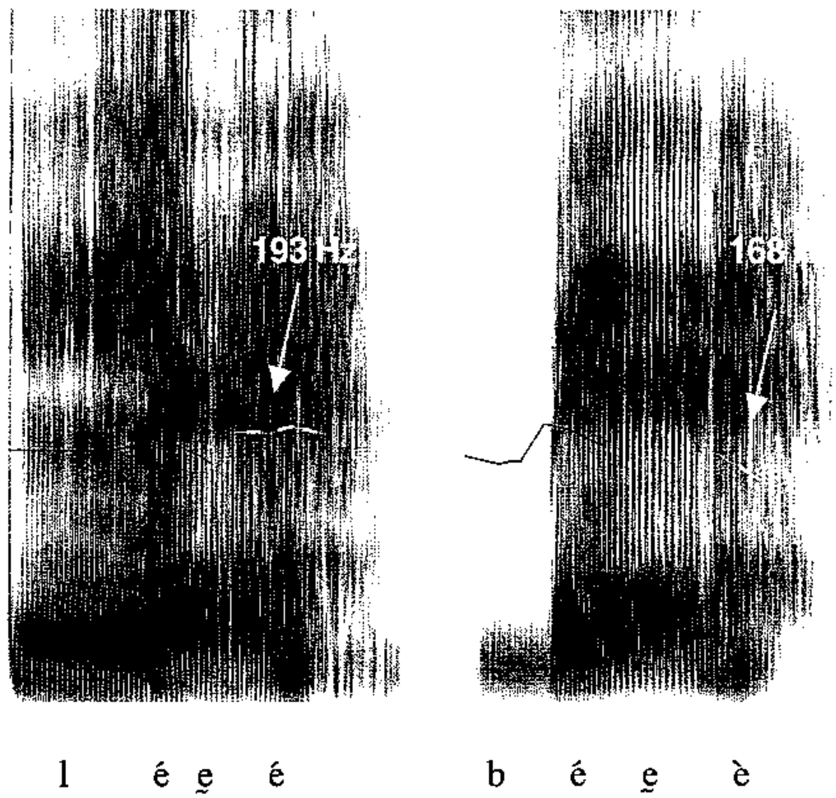


Figure 48. Rearticulated vowels contrasting High and High-Low tones in the words léˀé 'he, she' and béˀè 'belly'. A pitch track has been superimposed to the spectrogram. An arrow points to the portion of the vowel that bears the frequency indicated.

Both spectrograms show the typical three-component timing of rearticulated vowels described earlier. What is noteworthy of the pattern illustrated by this pair is that the final portion of the vowel is not just a phonetic accessory of rearticulated vowels, but it has a critical function in the contrast of tone. By realizing nonmodal phonation in the middle of the vowel, the begining and end frequencies of the tone, which are the most relevant landmarks for the perception of pitch (House 1990), remain aligned to the edges of the vowel. The more regular voice quality observed at the edges of the vowel provides a clear auditory setting and sets the necessary acoustic conditions for the realization of steady frequencies. Hence, I would like to suggest that the pattern of YZ offers a parsimonious solution to the contradictory combination of underlying specifications by rearranging the features throughout the vowel, so that every feature is maximally recovered in perception. The discussion is summarized by the scheme in Figure 49. The tone domain is aligned to the ends of the vowel; the domain of voice quality is represented as the middle component of the vowel. Duration is not included in the scheme, as it is not a phonemic feature of YZ, nevertheless it has been shown that it might contribute to enhance the contrast between rearticulated and checked vowels.

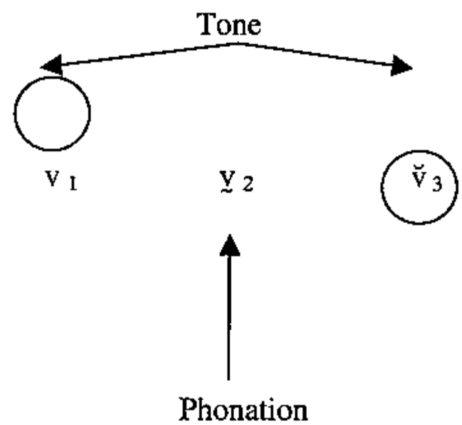


Figure 49. Arrangement of phonation and tone domains in a rearticulated vowel

Finally, I close by identifying one prediction based in the typology of the interaction between tone and non-modal phonation proposed by Silverman. There is a type of languages, such as Chinantec, where non-modal phonation occurs at the beginning of the vowel; other type of languages, such as Mazatec, restricts non-modal phonation at the end of the vowel; the third type of languages, such as Zapotec, constrain non-modal phonation to the middle of the vowel. However, we can predict that in a language where the two properties are contrastive, the same non-modal phonation cannot occur at both edges of an otherwise modal vowel. This arrangement would provide the most adverse articulatory settings and the perceptual conditions for the realization of tone.

Table 67. Typology of tone and non-modal phonation interaction

	Vowel		
I. Chinantec			
II. Mazatec			
III. Pame, Zapotec Trique			
IV. *			

6 A palatographic study of Yalálag Zapotec coronals

Previous sections described the basic phonetic properties of YZ sounds. YZ presents rich inventory of coronal consonants. The sounds in this group include dentals [t, d, l̪ː, n̪ː], alveolars [s, z, n, ɾ], postalveolars [ʂ, ʐ] and alveo-palatals [tʃ, ʒ]. Although the dental-alveolar distinction is non-phonemic, it seems to be quite systematic in sonorants, so that it could be considered as an enhancing feature that importantly contributes to differentiate the contrast between /lː, nː/ and /l, n/, which is primarily based on duration. Typologically the contrast observed in YZ coronals is rather unusual, especially with respect to sibilant fricatives. From the UPSID corpus less than 5% of the languages (17) include a voiceless retroflex sibilant, and only three languages have voiced retroflex sibilants. In addition, YZ also deviates from the cross-linguistic tendency avoiding "voiced and voiceless pairs of fricatives at the same place of articulation" (Maddieson 1984:52). Since the inventory of YZ coronals is relatively uncommon across languages, and there is no previous phonetic description of the language, the primary goal of this section is to provide a detailed description of the articulatory and acoustics properties of the YZ sounds involved in this contrast. Such an account will further allow us to examine what are the parameters that are in use to reliably distinguish between these sounds.

Previous descriptions of YZ and other Zapotec languages of the area (Newberg 1983; Nellis and Hollenbach 1980) claimed that the contrast between the fricatives /s/ and /ʂ, ʐ/ and /tʃ, ʒ/ corresponds to a difference between dental, retroflex and palatal sounds. However, these studies, of general character, lack the precise description about how the retroflex sounds are articulated. In general, the term 'retroflex' describes an articulation made with the inferior part of the tongue by curling the tip. Nevertheless, the label has been used for quite different articulatory gestures across languages (Ladefoged and Maddieson 1996). In an earlier section, as well as in previous work (Avelino 2001), I pointed out that the articulation of /s̺/ and /z̺/ sounds might not be well described as a gesture of curling the tongue tip. However, in that earlier study I could not offer the detailed articulatory and acoustic analyses presented here are aimed at informing us about phonetic properties of YZ coronals and postalveolar sibilants, in particular.

6.1 Method

Data collection and subjects. The corpus investigated consisted of the twelve words listed in Table 68, containing the target segments in a /CV/ context (where V is a low vowel). Subjects were asked to repeat each word five times. The materials were collected in fieldwork in Oaxaca, Mexico, and in Los Angeles, CA. Three female and three male native speakers of YZ, ranging from 14 to 60 years of age participated in this study. Audio data were recorded using digital audiotapes and digitized at a 22,050 Hz sampling rate. Video data were recorded on a digital camera and transferred to a computer.

Table 68. Word list for Yalálag Zapotec palatography

[l:àʔ]	'Oaxaca'
[lâ]	'name'
[n:àˀà]	'now'
[nàʔ]	'hand'
[s̺á]	'father'
[z̺â]	'clothes'
[tʃàʔ]	'pan'
[ʒà]	'day'
[tâʔ]	'I will walk'
[dàʔ]	'mat'
[sàˀà]	'I walk'
[zá]	'fat'

Articulatory data acquisition. The method of static palatography (Anderson, 2000; Dart, 1993; Ladefoged, 2003) was adopted to record articulatory data. To obtain palatographic data, the tongue of a speaker was coated with a colored substance (an innocuous mixture of charcoal and olive oil) so that when the sound being studied was articulated, there was an imprint of the articulation on the roof of the mouth. This imprint was reflected in a mirror and captured as a video image. In linguograms, the process was reversed. The roof of the mouth was coated, and the imprint on the tongue reflecting the location of linguo-palatal contact was recorded as a video image. In order to relate palatographic/linguographic images to the actual articulation, a life-size dental impression was made of each speaker's palate and cast in plaster. Figure 50 shows illustrations of the palatography method.

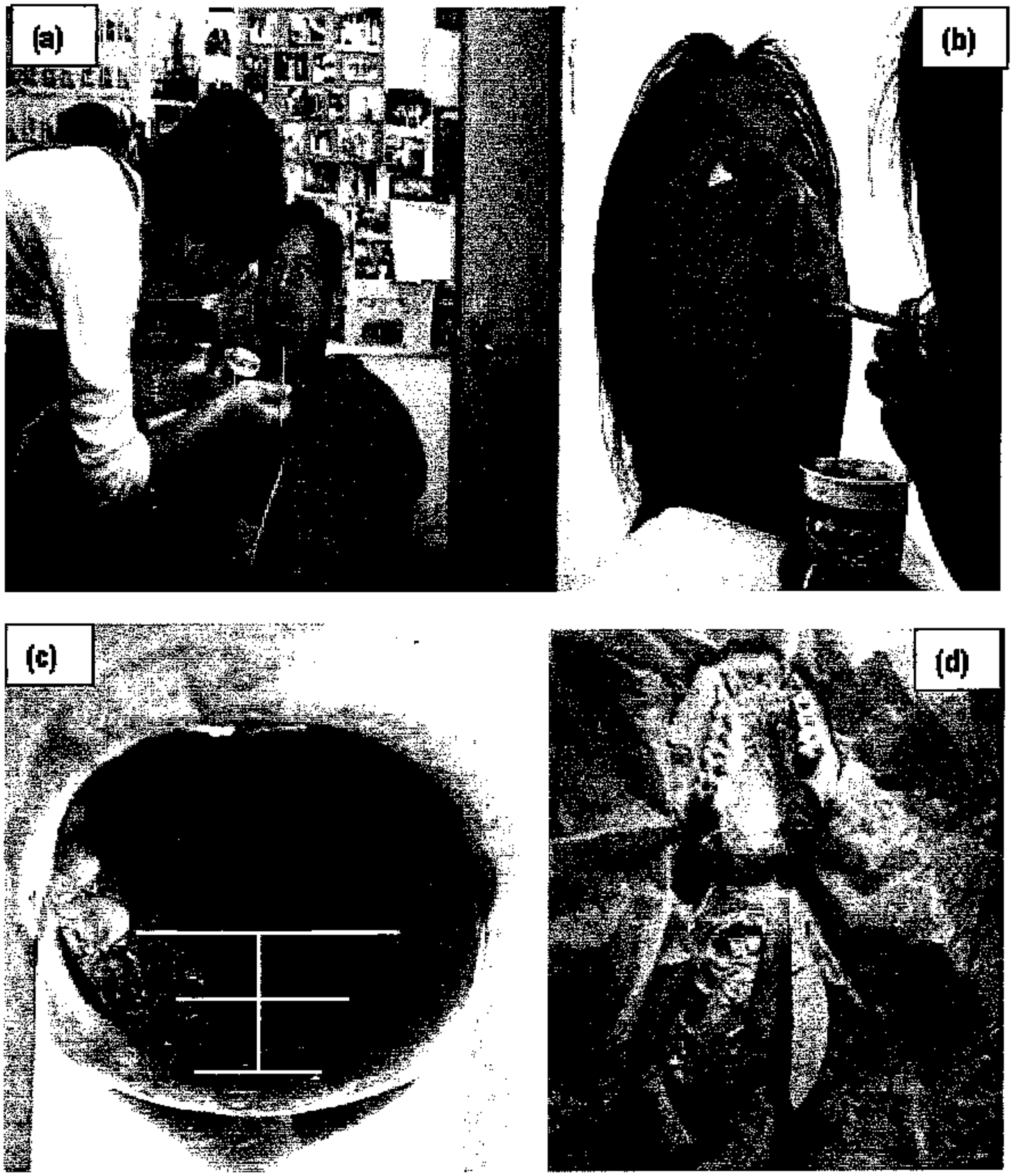


Figure 50. Static palatography method. The pictures in the upper panel show coating the speaker's tongue (a), and palate (b) with a mixture of charcoal and olive oil. The pictures in the lower panel show a life-size dental impression of speaker's palate (d), and a palatogram with reference lines to associate the images to the the actual articulation.

For each still frame, measurements from the vertical and horizontal axes were calibrated according to the measurements of the casts for each speaker. For palatograms, data were classified as post-alveolar, palatal, alveolar, denti-alveolar and dental according to the measurements and visual inspection of the images compared to the plaster casts. Figure 51 shows a sample palatogram of the five categories. For linguograms, no measurements were made; as previous studies have pointed out (Anderson 2000), the contact made with the tongue is extremely variable and depends on the way that a speaker holds the tongue in a particular instance. Instead, data were classified as apical, laminal, sub-laminal and apico-laminal according to visual inspection of the images. Figure 52 shows typical examples of the four categories. The classification was supplemented with remarks on the shape and length of the contact that potentially could relate to acoustic consequences, and, therefore, function as cues to the listener to differentiate and discriminate coronal sounds.

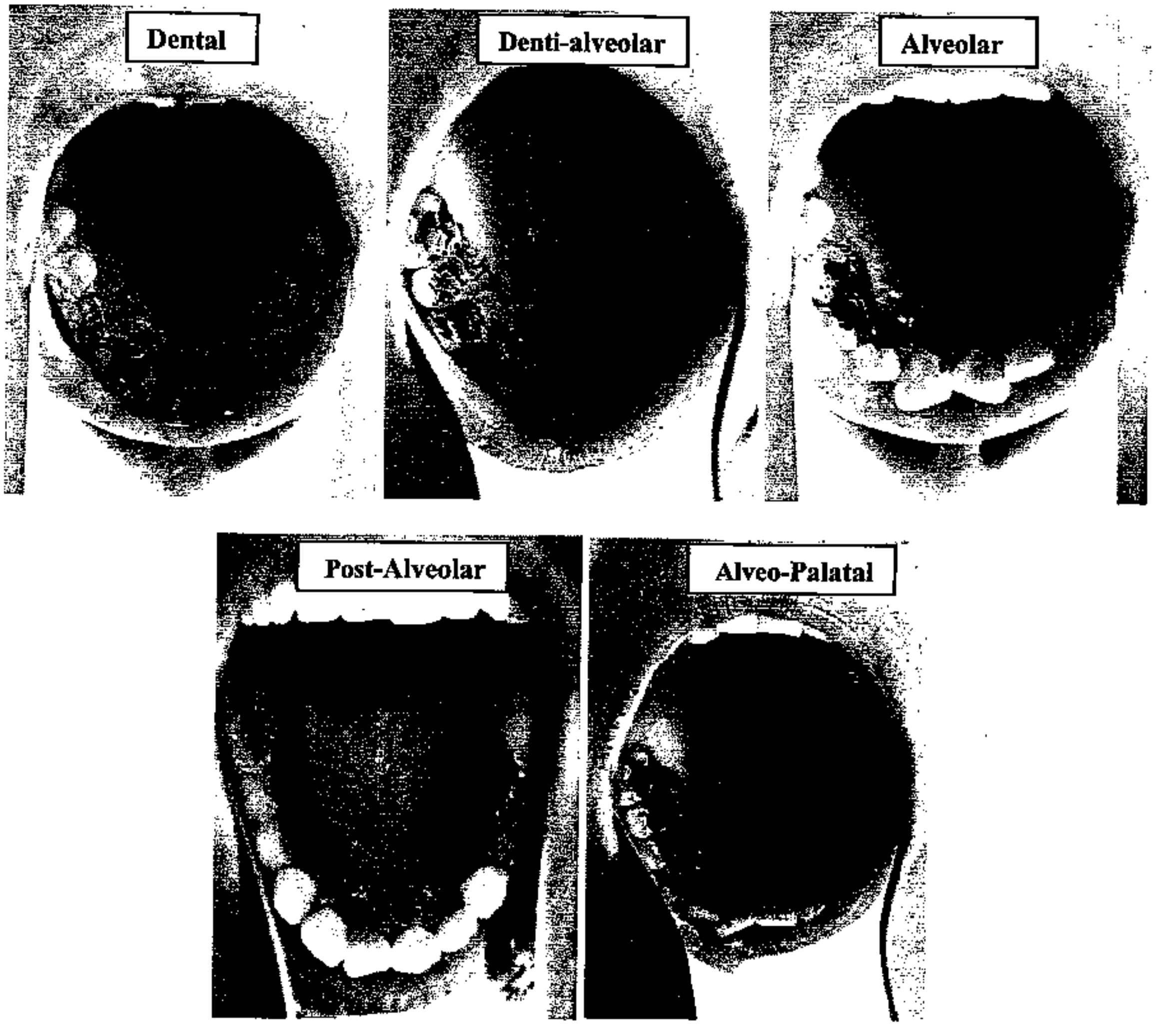


Figure 51. Classification of articulation based on palatograms

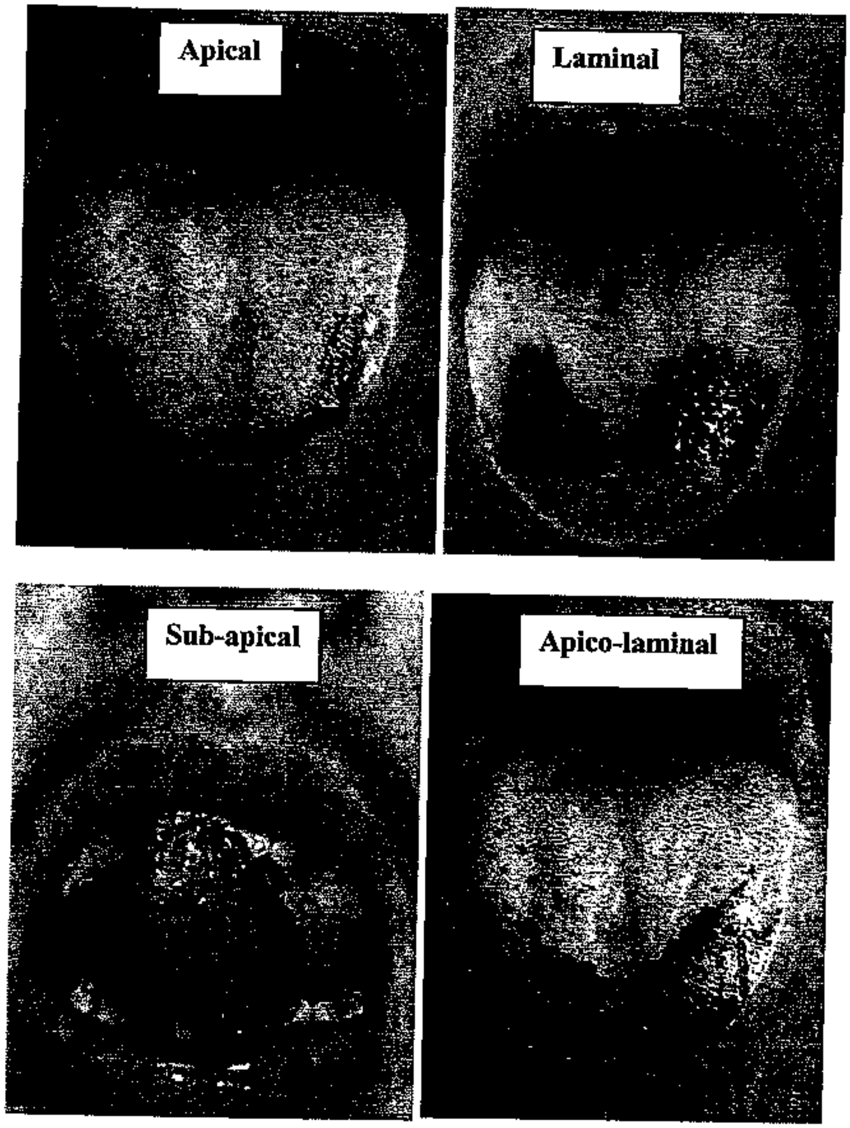


Figure 52. Classification of articulation based on linguograms

Acoustic data acquisition. Several measurements were obtained to perform acoustic analyses. Formant transitions, the centroid frequency and spectra of fricatives and affricates and the duration of fricatives were measured. Formant values (F1, F2, F3, F4) of the following steady state (midpoint) of vowel were obtained to infer the effect of the preceding consonant. Formant transitions were calculated as the difference between the onset of the following vowel and the vowel midpoint. The centroid frequency for fricatives were obtained from FFT spectra computed over a 25 ms window in a frequency range of 1000 Hz to 10000 Hz. Spectral properties were obtained from FFT spectra using a 1024 point frame, which amounted to 46 ms window.

6.2 Results

6.2.1 Articulation

Stops. The results regarding the production of stops are summarized in Table 69. With respect to the place of constriction, /t/ and /d/ were articulated mainly as dental or denti-alveolar although one speaker produced an alveolar constriction. Regarding the portion of the tongue involved in the articulation the results showed a majority of laminal (including apico-laminal) articulations. It is important to point out, however, that regardless of the variety of places of articulation observed, the precise articulation of both /t/ and /d/ was homogeneous within speakers, i.e. each speaker realized both sounds either as dentals, denti-alveolars or alveolars respectively. The section of the tongue used in articulating the sound was also, in general, consistent for both sounds, except for speaker f3 who pronounced /t/ as laminal and /d/ as apical. In Figure 53 palatographic and linguographic data are integrated in the sketches of the saggital plane illustrating the variability of place of articulation ranging from alveolar/apico-laminal [t̪] to alveolar/apical [t].

Table 69. Articulation of stops							
		f1	f2	f3	m1	m2	m3
/t/	palatogram	denti-alveolar	dental	alveolar	dental	dental	denti-alveolar
	linguogram	laminal	apico-laminal	laminal	apico-laminal	laminal	apical
/d/	palatogram	denti-alveolar	dental	alveolar	dental	dental	denti-alveolar
	linguogram	laminal	laminal	apical (rim)	apical	apico-laminal (v-shape)	apical

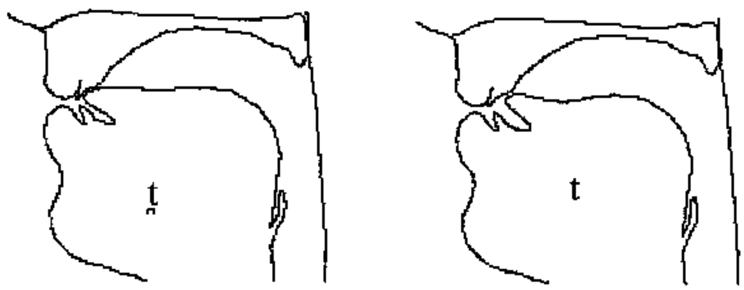


Figure 53. Sketches illustrating the variability in place of articulation of stops: denti-alveolar/apico-laminal [t̪] and alveolar/apical [t].

Fricatives. The difference between fricatives was quite reliable. As the status of post-alveolars was unsettled with respect to whether they were retracted sounds or retroflex sounds properly speaking, special attention was given to the articulation of these sounds during the data acquisition session. /s/ and /z/ fluctuated between dental, denti-alveolar or alveolar, but always were produced with the blade of the tongue. /ʂ/ and /ʐ/ were consistently realized in the post-alveolar region, and with the tip of the tongue. Only one speaker (m3) produced imprints of retroflex articulations, curling the tongue tip, however, it was observed in the recording session that while speakers f1, f3, m1 and m3 may articulate retroflex sounds as well, as will be shown shortly, there was also evidence of a retroflex imprint for speaker m3 in sonorants. In addition, the channel width was consistently wider for /ʂ/ and /ʐ/ than for /s/ and /z/. A number of tokens did not show a channel width due to the fact that speakers repeated the word and, eventually, the channel width traces where covered. The results will be indicated in the table as non available (n/a). A summary of the articulatory properties of fricatives is shown in Table 70, and a sketch of the articulation is given in Figure 54. The upper panel illustrates what may correspond to the articulation of /s/, a constriction between the the front teeth and alveolar ridge articulated with the tip and blade portion of the tongue. The lower panels show the two variants found for post-alveolars. The left panel shows the most common type, which is made with the upper part of the tongue tip, whereas the one to the right shows the typical subapical retroflex. I will follow the representation proposed by Ladefoged and Maddieson (1996) where the symbol [ṣ] (not authorized by the IPA), represents the first type of post-alveolar and [ʂ] is reserved for the second sound.

Table 70. Articulation of fricatives. Chanel width in mm.

		f1	f2	f3	m1	m2	m3
/s/	palatogram	denti-alveolar (5)	denti-alveolar (n/a)	alveolar (3)	dental (4)	alveolar (n/a)	alveolar (7)
	linguogram	apico-laminal	laminal	laminal	laminal	laminal	laminal
/z/	palatogram	denti-alveolar (3)	denti-alveolar (n/a)	denti-alveolar (6)	denti-alveolar (6)	alveolar (n/a)	(missing)
	linguogram	apico-laminal	laminal	laminal	laminal	laminal (v-shape)	laminal
/ʂ/	palatogram	post-alveolar (7)	post-alveolar (n/a)	post-alveolar (5)	post-alveolar (8)	post-alveolar (8)	post-alveolar (8)
	linguogram	apical	apical	apical	apical	apical	apical
/ʐ/	palatogram	post-alveolar (4)	alveolar (n/a)	(missing)	post-alveolar (7)	post-alveolar (8)	post-alveolar (4)
	linguogram	apical	apical	apical	apical	apical	apical

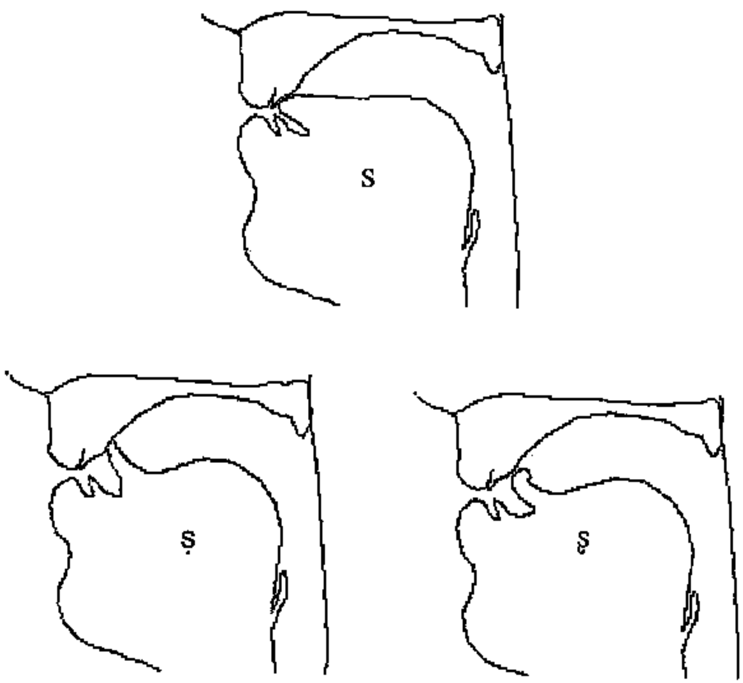


Figure 54. Sketches illustrating the articulation of sibilants. The lower panels illustrate the two variants found in the articulation of post-alveolar sounds: [ṣ] represents a retracted apical articulation, while [ʂ] is kept for the traditional retroflex category.

Affricates. Both affricates were produced mostly as laminal. However, the imprints reflect differences regarding the particular shape and the extent of the back of tongue that was used to make the contact. The imprints suggest a range going from the alveopalatal [tʃ] to a more posterior articulation close to a palatal [ç]. For instance, Figure 55 shows the imprints of speaker f1 who made a consistent contact with the blade, although the constriction includes an important posterior section, especially the sides of the dorsum. The figure exemplifies a typical articulation with wide length contact on the sides. Most of speakers articulated both affricates with a lengthy contact in the front-back axis ranging from the alveolar ridge through the hard palate, however, other speakers did not present a visible alveolar contact. Both affricates were implemented mostly with a analogous long contact of the tongue, which was accordingly labeled as lamino-dorsal. A summary of affricate articulations is presented in Table 71. The main variations of affricates [tʃ] and [dʒ] are illustrated in Figure 56 below.

Table 71. Articulation of affricates. Channel width in mm.

		f1	f2	f3	m1	m2	m3
/dʒ/	palatogram	post-alveolar (3)	alveo-palatal (3)	palatal (6)	palatal (5)	palatal (3)	alveo-palatal (n/a)
	linguogram	lamino-dorsal (sides)	laminal (wings)	laminal (sides)	laminal	laminal	laminal
/tʃ/	palatogram	alveo-palatal (n/a)	alveo-palatal (n/a)	palatal (n/a)	denti-alveolar –palatal (n/a)	alveo-palatal (n/a)	alveo-palatal (n/a)
	linguogram	lamino-dorsal	laminal	laminal (sides)	apico-dorsal (v-shape)	laminal	laminal (sides)

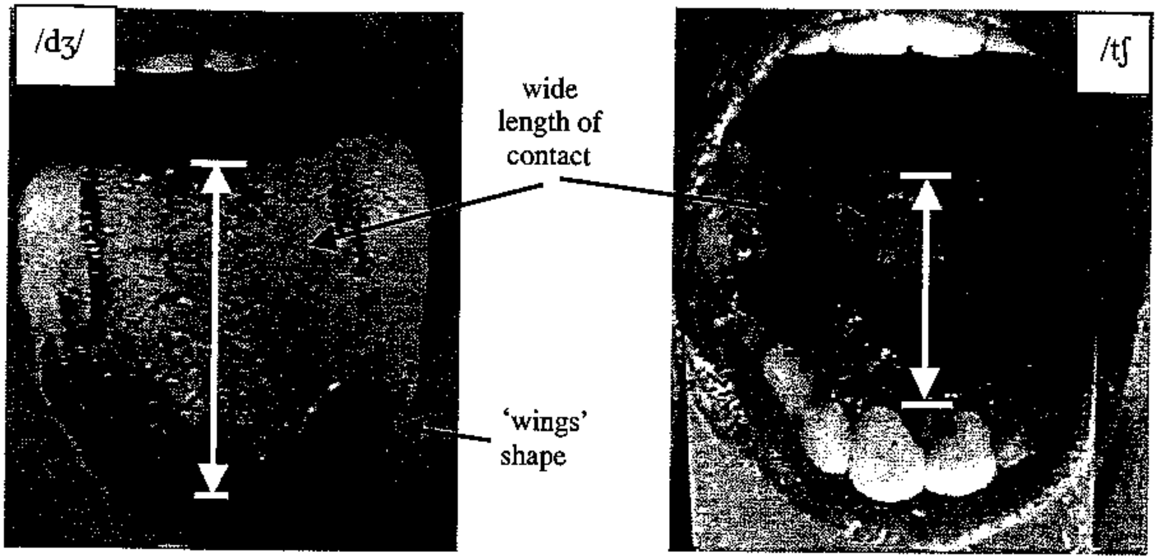


Figure 55. Articulation of affricates. (speaker f1)

Figure 56. Sketches illustrating the main variations of /tʃ/ and /dʒ/. The left panel illustrates an articulation including alveolar contact, whereas the right panel shows an articulation with the tongue apex down.

Sonorants. Table 72 shows the summary of the articulation of sonorants. It was confirmed that /n:/ was produced mainly as dental, whereas /n/ was pronounced by the majority of speakers as alveolar. It is worth mentioning that only one speaker (*m3*) pronounced the short nasal /n/ with the undertip of the tongue, whereas the rest of the speakers made the contact with the apex. Figure 57 illustrates further details of the articulation of nasals. The palatograms in the upper panels illustrate the contrast between the denti-alveolar articulation of /nː/ and the alveolar constriction of /n/. The lower panels show a typical laminal articulation of the long /nː/ and the apical articulation of /n/.

Table 72. Articulation of sonorants

		f1	f2	f3	m1	m2	m3
/nː/	palatogram	denti-alveolar	denti-alveolar	dental	dental	dental	alveolar
	linguogram	laminal	laminal	apical	apical	apical	apical
/n/	palatogram	alveolar	dental	alveolar	denti-alveolar	alveolar	alveolar
	linguogram	laminal	laminal	apical (sides)	apical	laminal	sub-apical
/lː/	palatogram	alveolar	dental	alveolar	denti-alveolar	alveolar	denti-alveolar
	linguogram	apico-laminal	apical	apical	apical	apical	apical
/l/	palatogram	alveolar	alveolar	denti-alveolar	dental	alveolar	alveolar
	linguogram	apical	apical	apical	apical	apical	apical

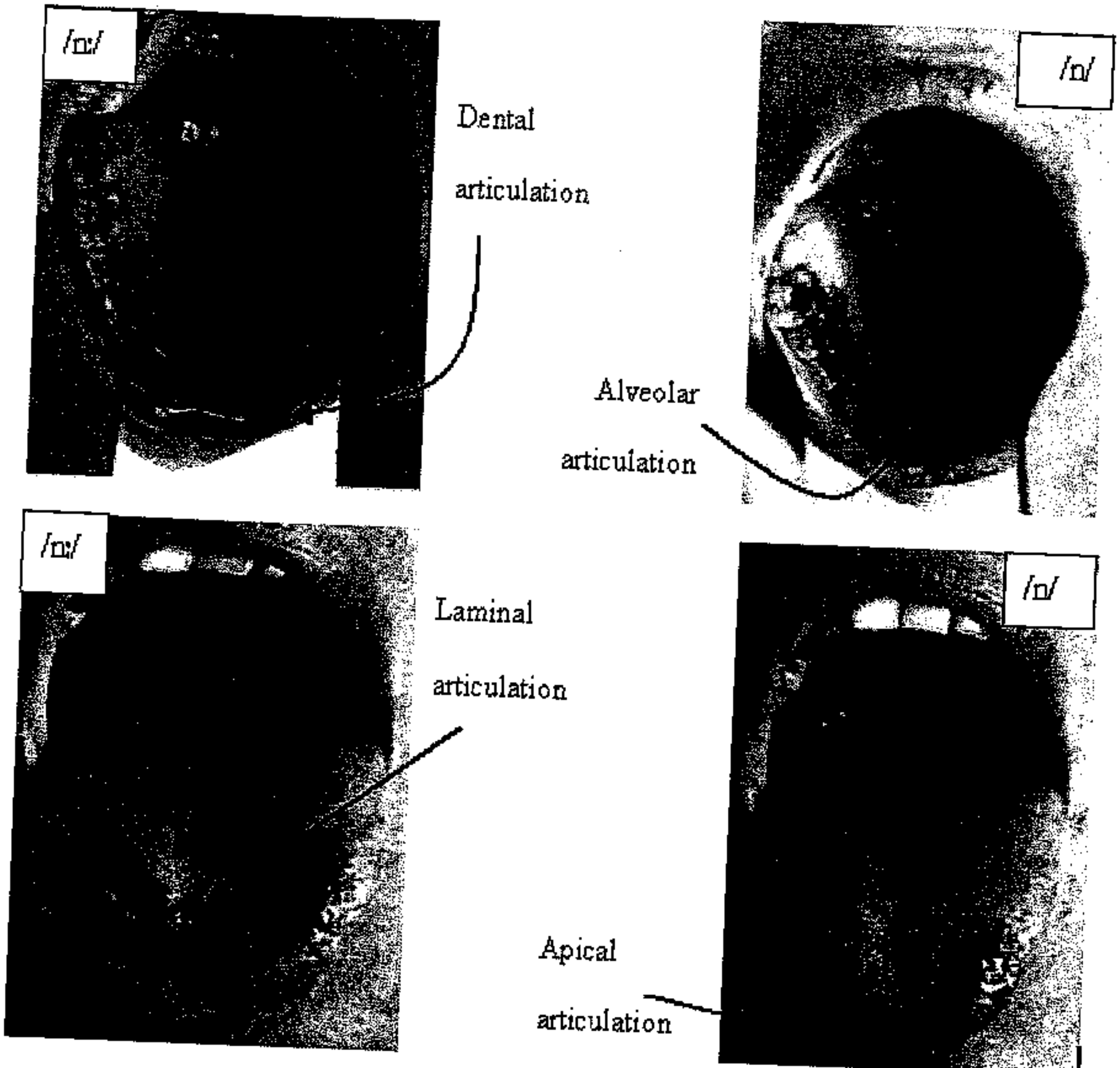


Figure 57. Palatograms and linguograms of nasals /nː/ and /n/ (speaker f1). The long nasal was articulated as denti-alveolar, while the short one was articulated as alveolar.

Figure 58 show two linguograms of the retroflex articulation of speaker *m3*. The leftmost image demonstrates that the upper front of the tongue did not play a meaningful role in the constriction; in contrast, in the image to the right, the underneath of the tongue reveals that the main contact employed in this sound is made with the underside of the tongue tip.

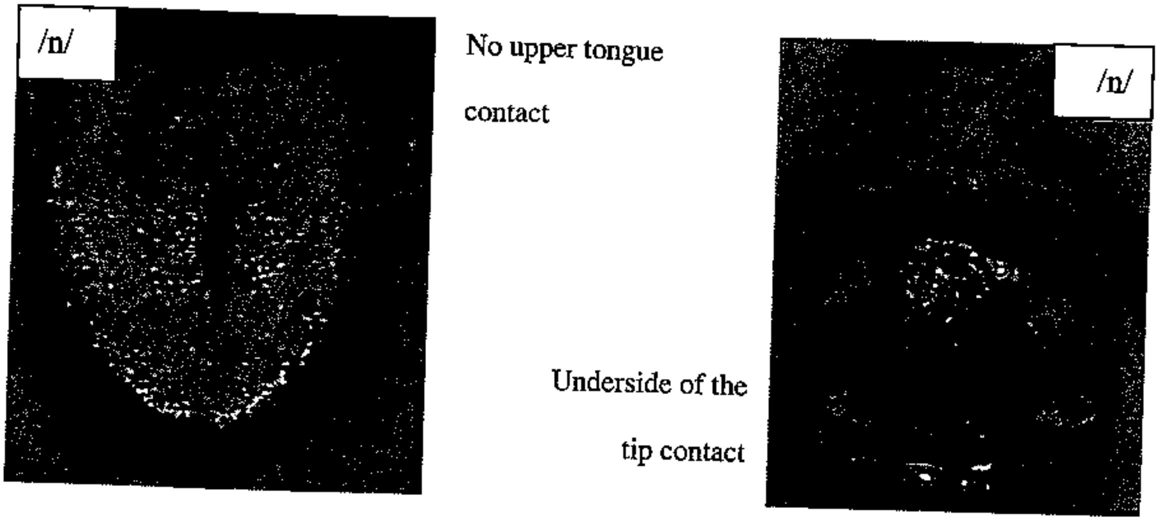


Figure 58. Linguograms of the retroflex articulation of the short nasal [ɳ] found in speaker m3

Laterals. Data showed that both lateral /lː/ and /l/ were consistently pronounced with the tip of the tongue. In contrast, they showed more variation regarding the place of articulation; the results showed that both were produced either as dental or alveolars, a very common property of these class of sounds (Ladefoged, 1977). Nevertheless, it is interesting to note that /l/ was more likely to be articulated in the alveolar ridge area, whereas /lː/ showed a wider area of constriction also including contact with the front teeth. Figure 59 shows representative examples of the articulation of laterals.

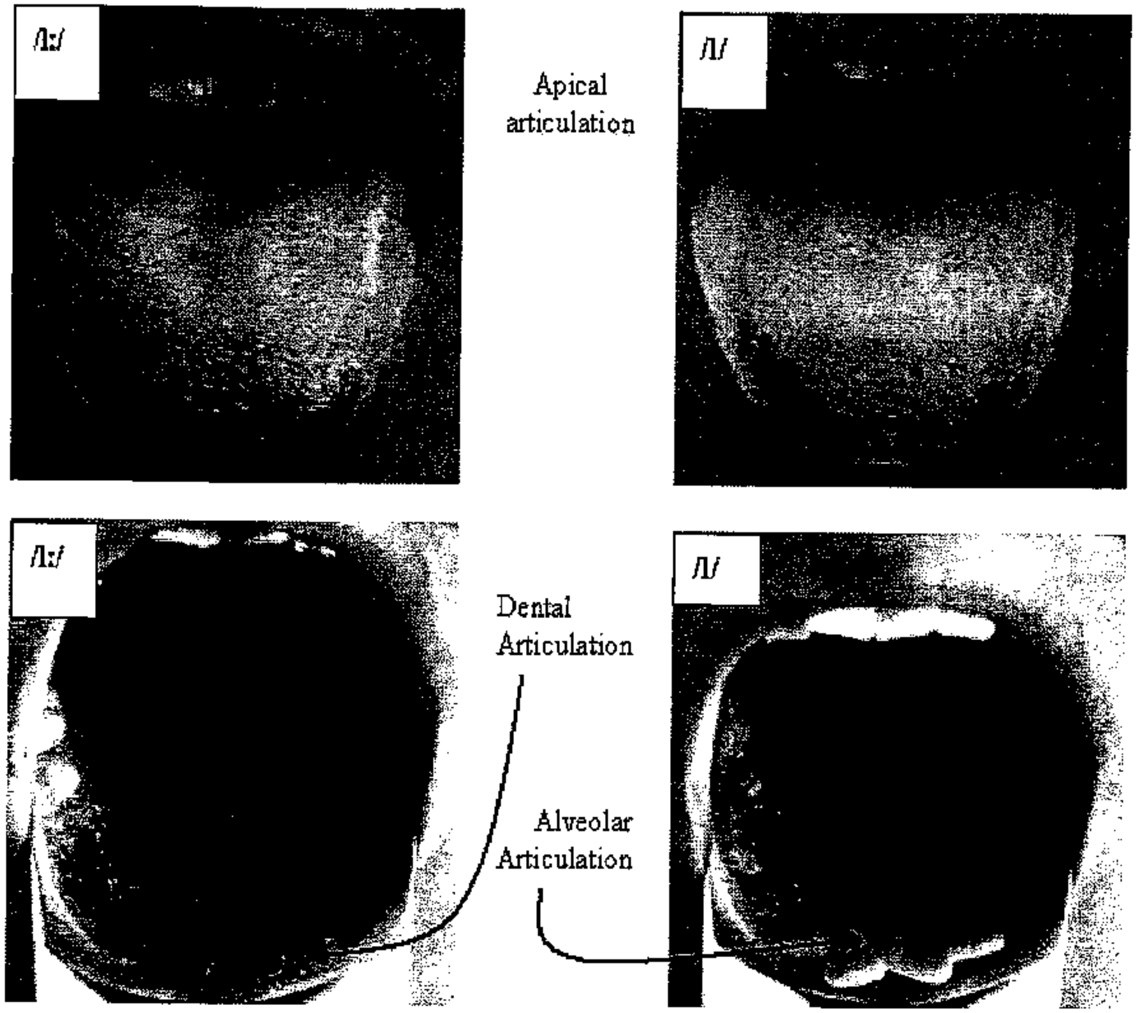


Figure 59. Palatograms and linguograms of laterals /l:/ and /l/ of speaker f2. Both sounds were consistently articulated as apicals.

6.2.2 Acoustics

6.2.2.1 Spectral Properties

Overall the spectra of fricatives reliably distinguish among the three places of articulations, dental, post-alveolar and alveo-palatal.

shows the speaker's average spectra of the six sounds analyzed. As shown in the first two panels, /s/ and /z/ had the greatest amount of energy at high frequencies, consistently between 7000 and 10000 Hz (although one speaker, m2, showed an early peak at 5000 Hz). In contrast, the spectrum for /ʂ/ and /ʐ/ showed a sharp rising and falling of amplitude around 2500 Hz, after which there was a systematic downward slope. Finally, affricates /tʃ/ and /dʒ/ showed the greatest amount of amplitude between 3500 and 4500 Hz. The amplitude dropped off at higher frequencies. In contrast with the post-alveolars, affricates sustained high amplitudes longer. The results were consistent for both female and male speakers.

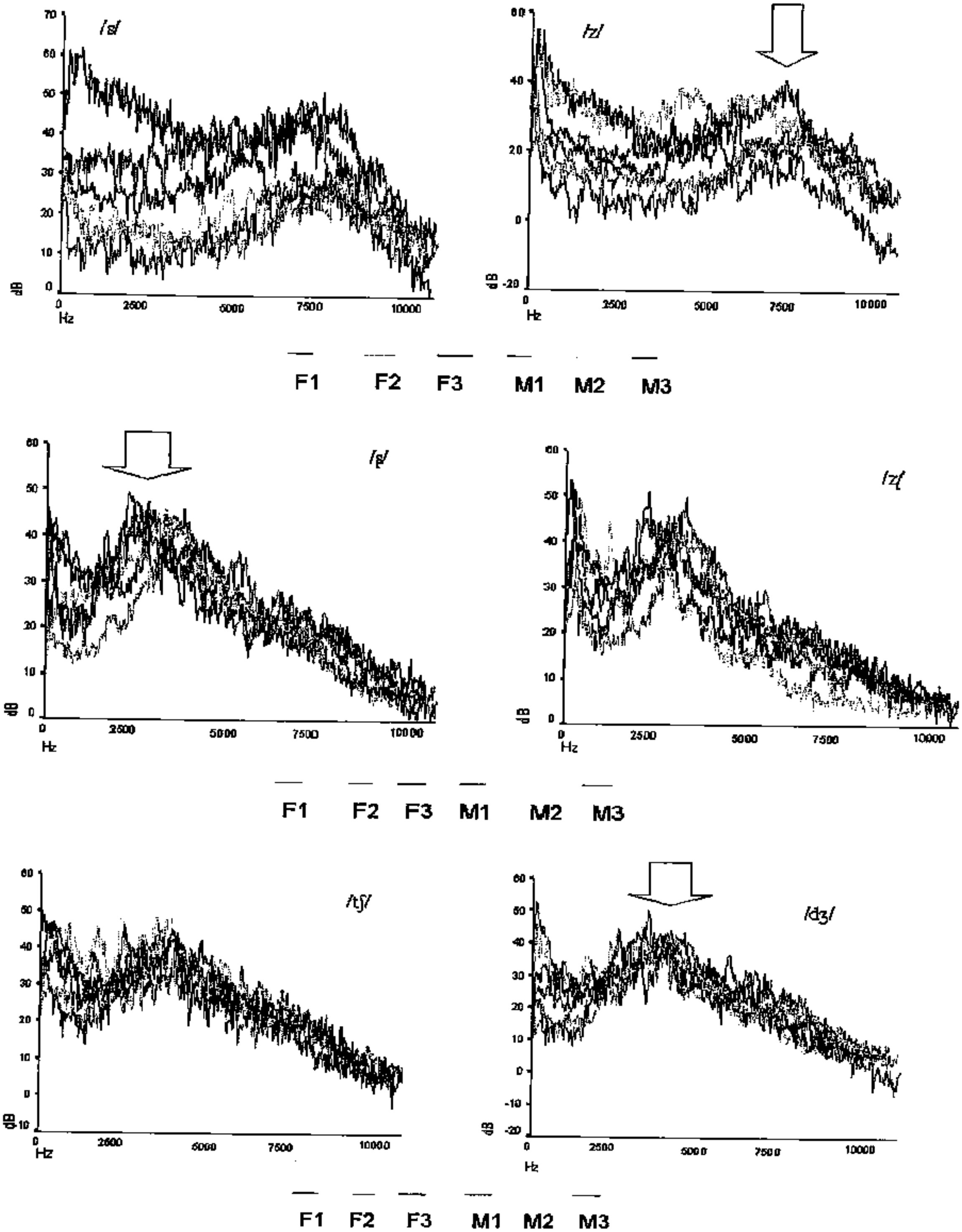


Figure 60. Spectra of fricatives. Lines show the average of five repetitions by six speakers.

As an interim conclusion of this section it has been shown that the spectral properties of YZ sibilants maintain a robust correlation between the place of articulation and the energy distribution of fricatives, thus, confirming, previous theoretical investigations (Fant 1960; Shadle 1991; Stevens 1998) and consistent with cross linguistic evidence (Avelino and Kim 2003; Dart 1991; Gordon *et al.* 2002) showing a correlation between the constriction in the front-back dimension and the peaks of energy displayed: The shorter the front cavity, the higher the peaks of energy at high frequencies.

6.2.2.2 Formant Transitions

Formant values for the first four formants of the vowel /a/ following the twelve YZ coronal sounds were calculated, as it is known that different tract configurations produce characteristic spectral patterns, so that the transitions of the formants in a CV sequence will reveal the place of articulation of the preceding consonant (Delattre, 1955; Fant, 1960; Stevens, 1998; Sussman, 1991). Thus, these measurements allow us to observe possible effects of the consonants of interest on the vowel, and to determine acoustic correlations of the articulation data documented in the previous section.

Fricatives. The results of an ANOVA (position x consonant) showed that formants at steady portions of the vowel did not differ according to the articulatory differences of the preceding sibilants /s, z, ʂ, ʐ, tʃ, ʒ/. A Bonferroni *post hoc* test showed that the only significant differences were found in F1 between /ʒ/ and /ʐ/ (661-775 Hz) $p = .023$ and between /ʒ/ and /z/ (661-789 Hz) $p = .006$. Nevertheless, it is possible to observe general trends differentiating among the consonants in this class. On one hand, in the voiceless series there seems to be a tendency for /ʂ/ to induce higher formant values in the middle vowel than those following /s/ and /tʃ/, except for F2, which showed a hierarchy /tʃ/ > /ʂ/ > /s/. On the other hand, in the voiced series, /ʐ/ consistently correlated with the lowest formant values of the following vowel, whereas vowels following /ʒ/ had the highest F3 and F2, while those after /z/ were higher than the rest in F4 values. Hence, the results failed to show a major pattern differentiating dental and post-alveolar sounds, mainly due to the fact that voiceless and voiced fricatives showed opposite tendencies. However, palatals correlated consistently with the lowest F1 and the highest F2 of the following vowel. Figure 61 summarizes the average results pooled over the six speakers; the precise values of the formants and their transitions are given in Table 73 below.

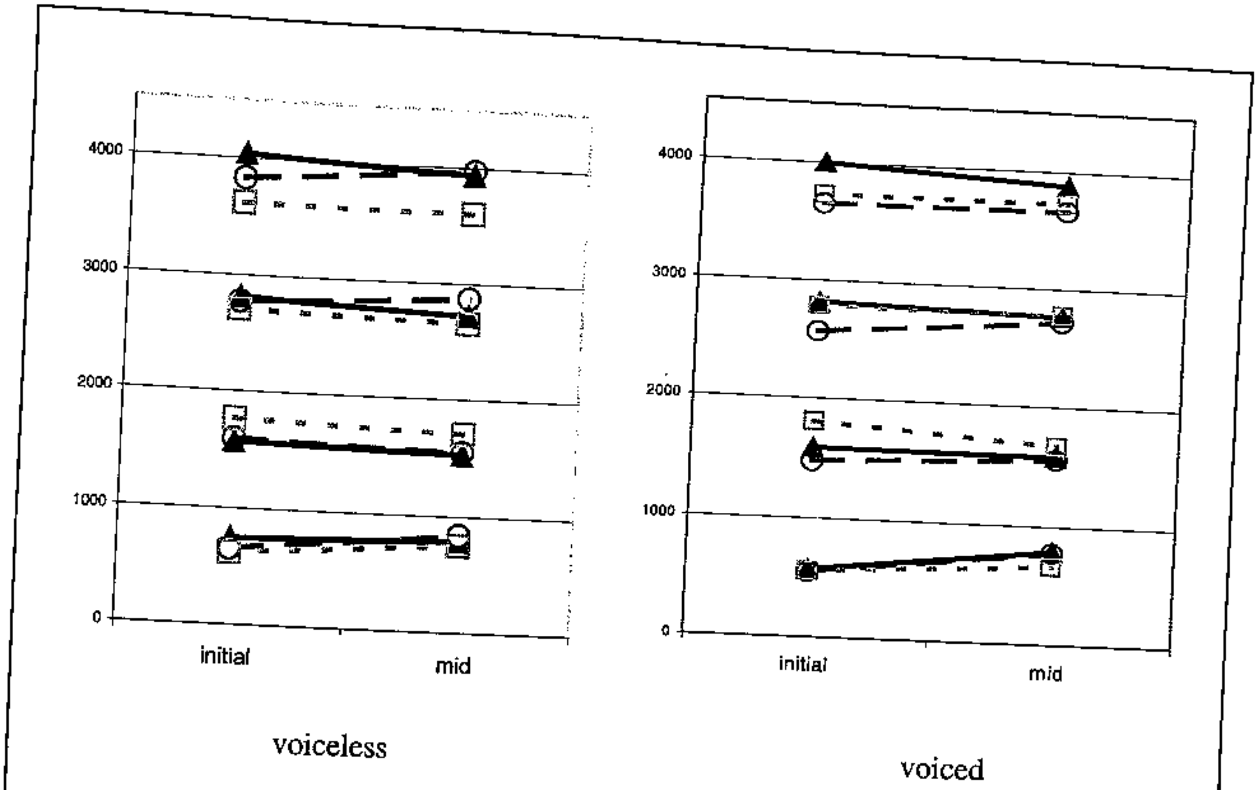


Figure 61. Vowel formant and transitions of /a/ following sibilants /s, z, ʂ, ʐ, tʃ, dʒ/

Table 73. Formant values and c-v transitions of fricatives and affricates Positive numbers indicate a lowering effect of the preceding consonant with respect to the mid point of the vowel. Negative numbers indicate a rising effect.

	s		z		ʂ		ʐ		tʃ		ʒ	
	initial	mid	initial	mid	initial	mid	initial	mid	initial	mid	initial	mid
F4	4038 -98	3940	3999 -118	3881	3830 -144	3975	3656 11	3667	3620 -10	3610	3732 -2	3730
F3	2813 -90	2723	2817 -53	2764	2771 103	2875	2666 150	2715	2705 -49	2656	2785 -8	2778
F2	1572 -38	1543	1589 -3	1586	1594 -45	1549	1477 84	11561	1763 -56	1708	1809 -135	1674
F1	741 48	788	568 221	789	654 184	838	555 221	789	619 131	750	555 106	661

Figure 62 further illustrates the results obtained regarding the influence of place of articulation in the formant structure of the following vowel with spectrograms of the words sàˀà 'I walk', ʂáʔ 'my father' and tʃàʔ 'pan' from a female speaker. Consistent with the overall results, the figure shows that the F2 of vowels following palatals had the highest values and the one that triggered the greater rising with respect to the middle of the vowel. Likewise, the palatal shows the lowest F4 of the sibilants. In agreement with the overall results, the spectrogram of /s/ shows the highest F4. Furthermore, as in the average results, the spectrograms of dentals and post-alveolars do not show striking differences, especially in the lower formants. A surprising property, observed as an overall result and also illustrated by Figure 62, is that /ʂ/ did not show the expected effects on the following vowel observed in a number of languages with retroflex sounds, lowering of F4 close to the values of F3, and higher F2 locus than denti-alveolar sounds (Ladefoged and Maddieson 1996; Stevens and Blumstein 1975). Instead, the word exemplifying the postalveolar shows an F4, F3 and F2 remaining relatively steady throughout the vowel.

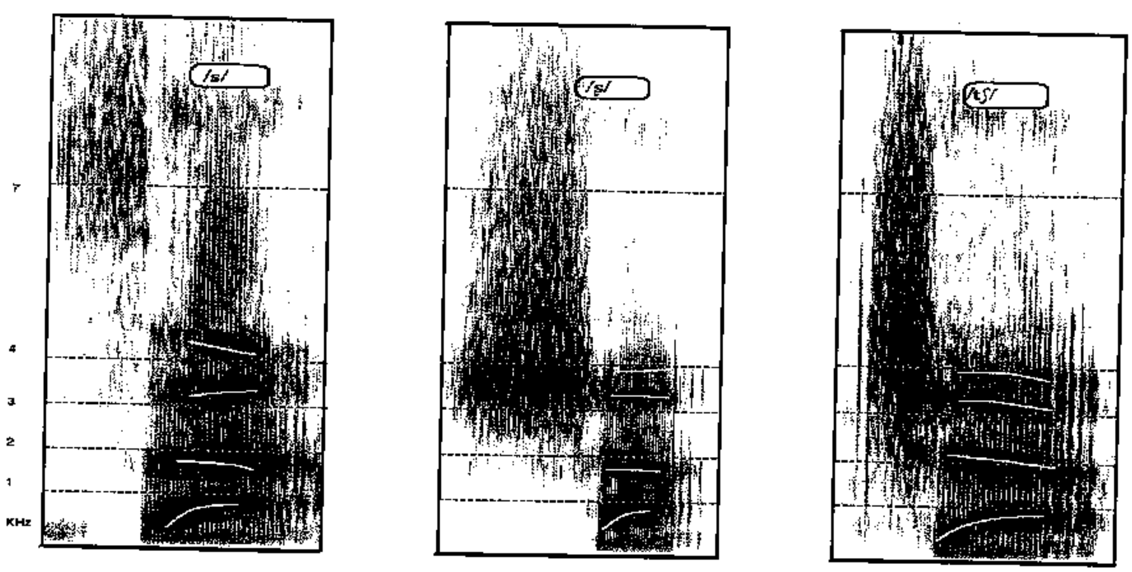


Figure 62. Spectrograms illustrating vowel formants and transitions after /s, ʂ, tʃ/ in the words /sàˀà/ 'I walk', /ʂàʔ/ 'my father' and /tʃàʔ/ 'pan'.

Stops. Overall, the formant values of the vowel following /t/ and /d/ were identical for the two stops. The similarity of the two consonants is evident in Figure 63, which summarizes the average values of the six speakers. The figure shows the characteristic locus for dental sounds at about 1700 Hz.

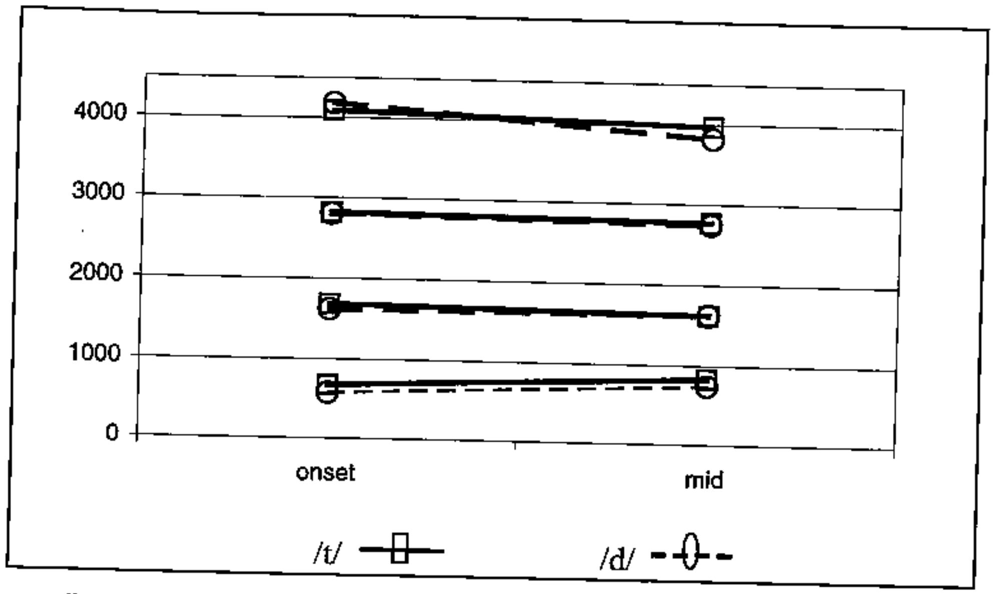


Figure 63. Vowel formant and transitions of /a/ following stops /t, d/

Even comparing the female speakers who pronounced dental stops with the speaker (f3) who pronounced them as alveolar, the results showed that there was no significant statistical difference between the two stops across subjects.

Nasals. The effects of /n:/ and /n/ on the following vowel follow closely those of stops. As shown in Figure 64, both maintain a relatively flat F2 about 1700 Hz, and a moderate rising of F1; however, unlike stops, there seems to be a systematic difference in the locus of the following vowel, such that /n/ is associated with higher formant values at the onset, especially F3 and F4, than /n:/. The correlation, however, was not statistically significant.

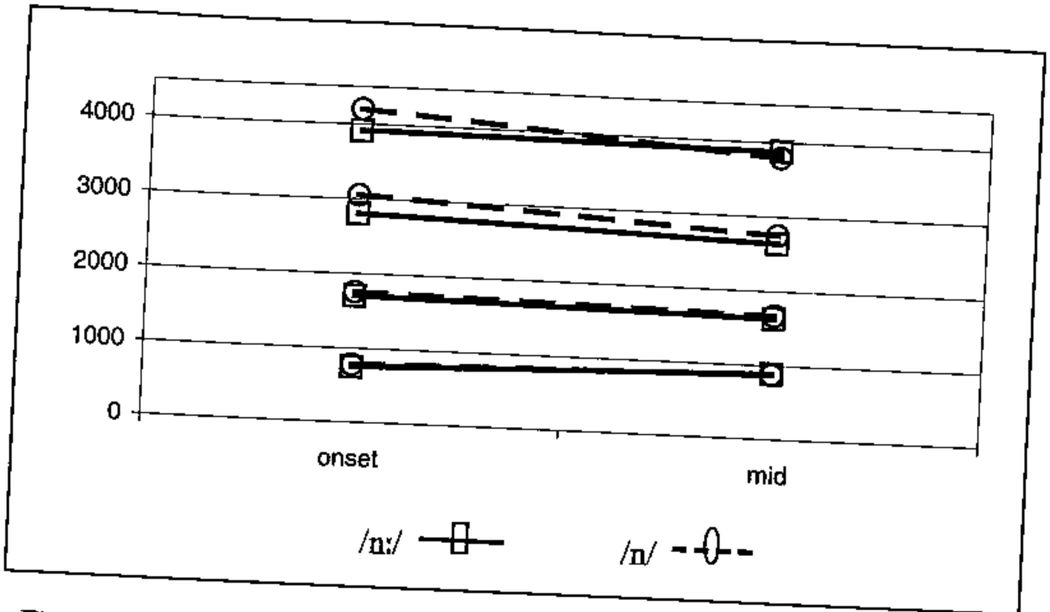


Figure 64. Average vowel formant and transitions of /a/ following nasals /n:, n/

In the production data it was shown that one speaker (m3) produced short nasals with the underside of the tongue tip, i.e. as a retroflex articulation. A detailed observation of the formant values of male subjects showed that speaker m3 consistently obtained higher formants than the rest of the group in both long and short segments. It could be speculated that for this speaker, the long nasal could also have been produced further back. Figure 65 shows the average values of five repetitions of each male speaker.

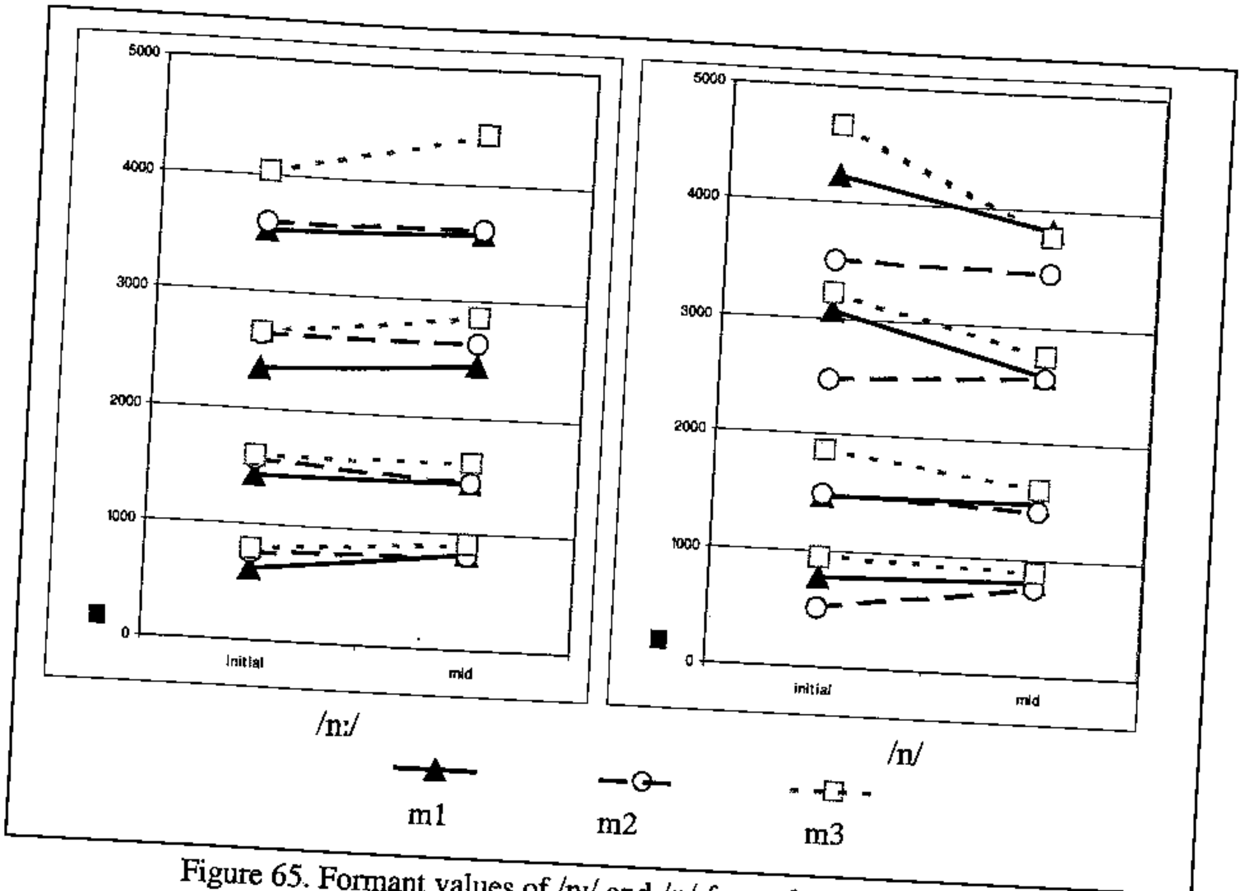


Figure 65. Formant values of /n:/ and /n/ for male speakers. Speakers m1 and m2 articulated the sounds as dental or denti-alveolars, whereas speaker m3 articulated both sounds as retroflex.

Inspection of the spectrograms of the nasals from male speakers allows us to see further differences. As shown in Figure 66 the most prominent difference is the clear lowering of higher formants, F3 and F4, at the onset of vowels following post-alveolars, in contrast with those following dentals, which show a less dramatic lowering.

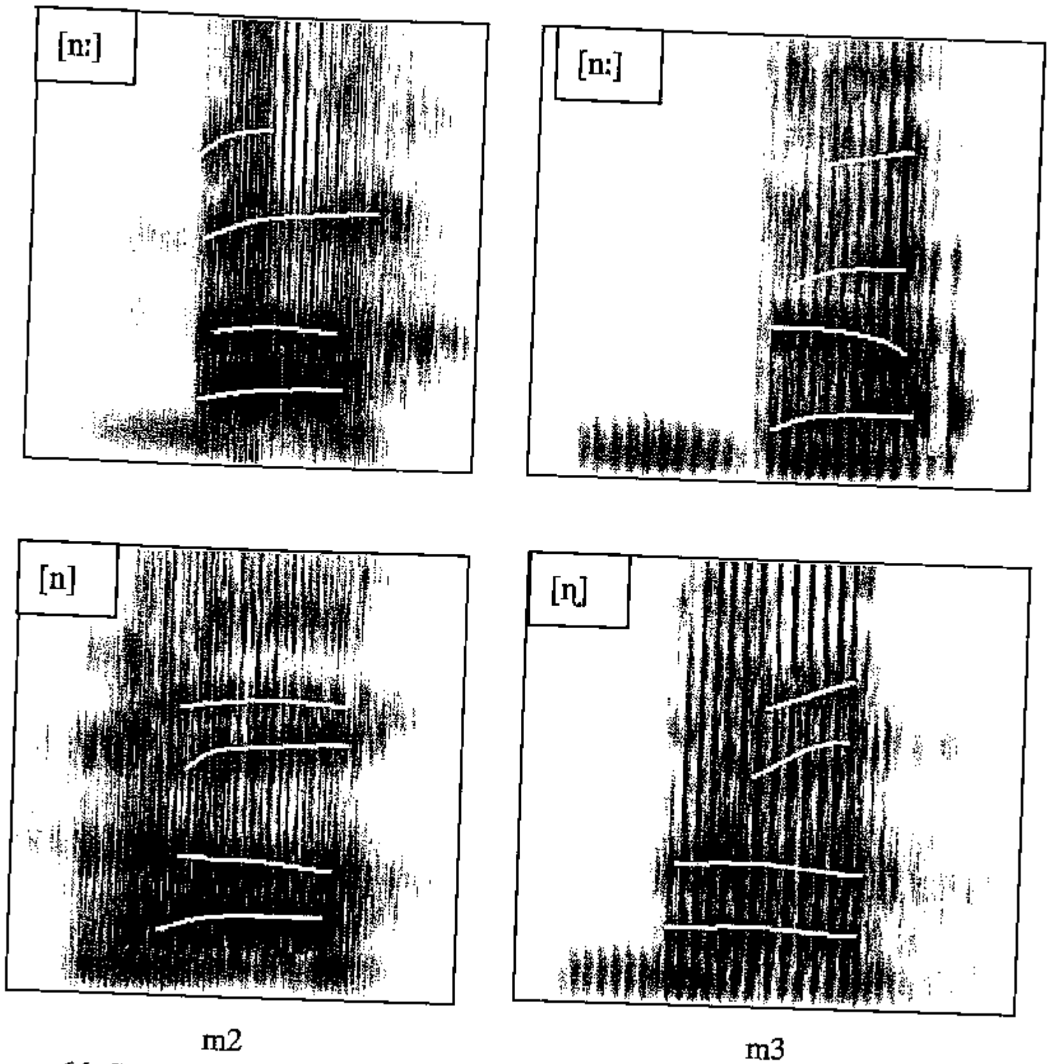


Figure 66. Spectrograms for the words /n:àˀà/ 'now' and /nàʔ/ 'hand' from speakers m2 and m3, respectively. Data from speaker m3 show a greater lowering of F3 and F4 at the onset of the vowel, suggesting a posterior constriction. Only the short nasal was proved to be retroflex in articulation.

Laterals. /l:/ and /l/ both slightly lowered F1, F3 and produced a prominent lowering of F4 at the onset of the following vowel. In general, the short /l/ lowered the formants of the vowel more than /l:/ did, especially at higher frequencies in the middle of the vowel (4331 Hz - 4031 Hz, in that order). Just as with stops and nasals, the F2 values in the middle of a vowel after laterals were basically identical (1620 Hz - 1623 Hz for /l:/ and /l/, respectively). Figure 67 shows the average formant trajectories of vowels adjacent to lateral sounds.

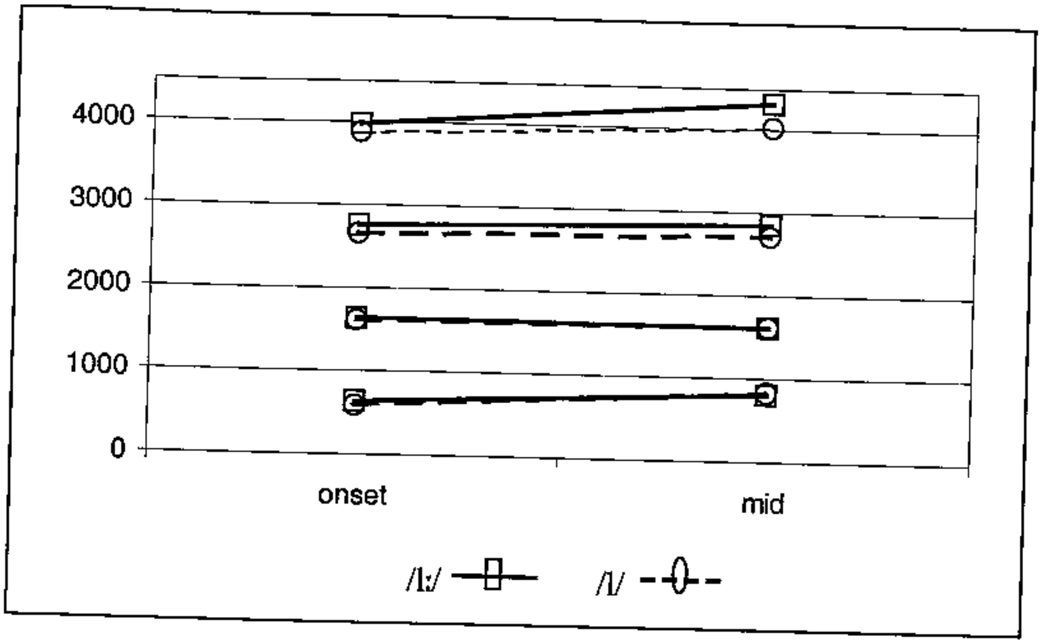


Figure 67. Vowel formants and transitions for /a/ following laterals /l:, l/

The summary of average values of formants and transitions of vowels following stops, laterals and nasals is presented in Table 74 below.

Table 74. Formant values and c-v transitions of stops, laterals and nasals. Positive numbers indicate a lowering effect of the preceding consonant with respect to the mid point of the vowel. Negative numbers indicate a rising effect.

	t		d		l:		l		n:		n	
	initial	mid	initial	mid	initial	mid	initial	mid	initial	mid	initial	mid
F4	4091	3972	4181	3817	3995	4331	3882	4031	3911	3879	4198	3795
	-119		-364		336		149		-32		-403	
F3	816	2774	2800	2745	2772	2856	2658	2725	2801	2640	3051	2750
	-42		-56		85		67		-161		-302	
F2	1684	1626	1618	1620	1649	1620	1617	1623	1701	1634	1755	1673
	-58		3		-29		6		-67		-82	
F1	676	834	576	742	643	811	596	821	752	890	782	879
	158		166		169		225		138		98	

Overall, the results are consistent with the expectation originated in theoretical models of vocal tract and its acoustic correlates (Fant, 1960; Ladefoged, 1996a; Stevens, 1998). The results failed to show significant differences in the formant transitions for vowels following dental sibilants in contrast with post-alveolars. The results were thus inconsistent with previous studies, which have shown that post-alveolar articulations, especially retroflex sounds, lower the locus of F3 (Dart 1991; Jongman *et al.* 1985; Ladefoged and Maddieson 1996 and Stevens and Blumstein 1975) as a result of the sublingual cavity/resonance. Nevertheless, despite of the non-significant difference it was possible to observe isolated data agreeing with previous research.

6.2.2.3 Centroid Frequency for Sibilants

The centroid frequency of sibilants consistently distinguished places of articulation. The results of an ANOVA test showed that the difference was statistically significant ($F(5, 174)= 52.801$), $p.= .001$. The overall trend indicated that dentals had a higher centroid frequency than the rest of the sounds in this class, /s/ being higher than /z/

(5199 Hz - 5004 Hz, respectively). The centers of gravity of palatals followed with 4588 Hz for /tʃ/ and 4626 Hz for /ʒ/. Finally, the values of post-alveolars were lower than the rest of the sibilants, /s̺/ with 4364 Hz, just before /z̺/, which was the lowest of the series with 4114 Hz. The results of an ANOVA (sibilant centroid frequency x speaker) showed the robustness of the overall findings for gravity center, as the same tendency held true across speakers: f1 ($F(5, 29) = 9.643$, $p. = .001$; f2 ($F(5, 29) = 16.074$, $p. = .001$; f3 ($F(5, 26) = 4.946$, $p. = .004$; m1 ($F(5, 30) = 24.447$, $p. = .001$; m2 ($F(5, 30) = 39.635$, $p. = .001$; m3 ($F(5, 30) = 62.545$, $p. = .001$. Figure 68 shows the average centroid frequencies of sibilants. The results are consistent with previous typological studies showing that the centroid frequency there is a tendency for fronter tongue articulations to have higher values (Gordon *et al.* 2002).

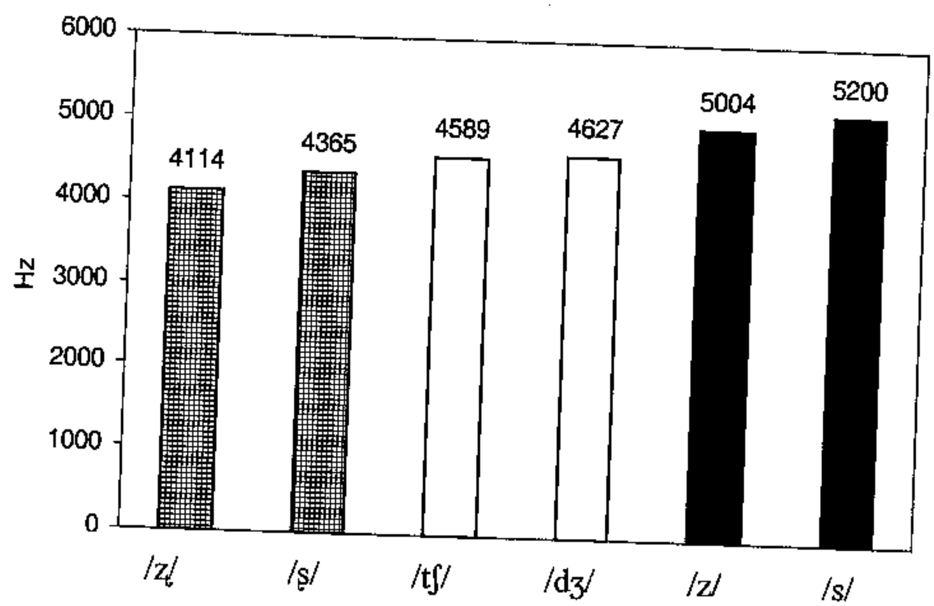


Figure 68. Centroid frequency for sibilants

6.2.2.4 Fricative Duration

The results of an ANOVA test indicated a significant effect of duration and the fricative consonants ($F(5,174) = 31.874$), $p. = .001$). A Bonferroni *post hoc* test confirmed that duration between the three places of articulation was not statistically significant for voiced consonants and that the difference was significant only for voiceless ones ($p. = .001$). As Figure 69 shows, the duration of post-alveolars was longer than dentals, whereas alveo-palatals had the shortest duration among the series. It is important to mention that /tʃ/ was shorter than /dʒ/ as in several tokens the speakers produced the fricative allophone [ʒ],which is of longer duration, rather than the affricate.

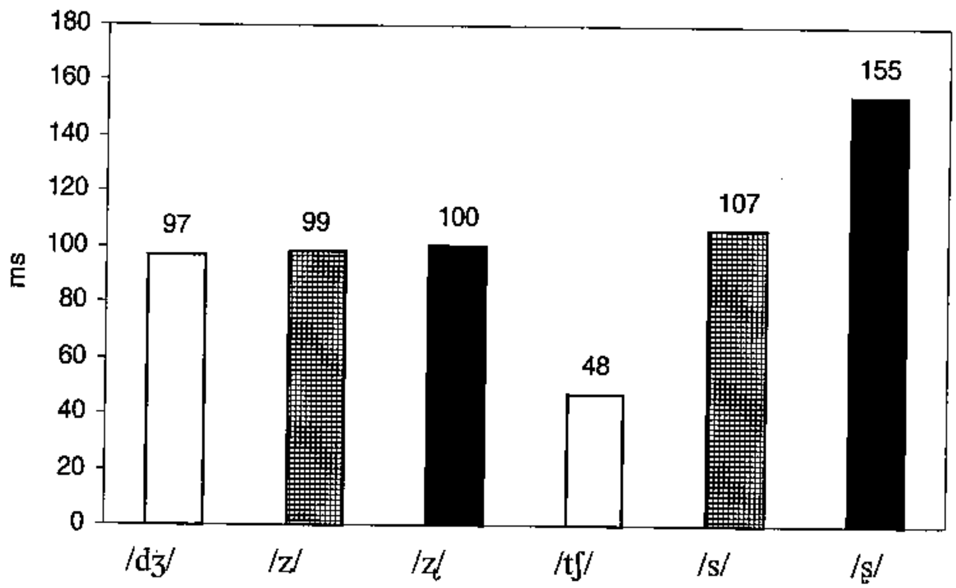


Figure 69. Average duration of sibilants

6.3 Summary and Discussion

The main goals of the analyses reported in this section were to provide a detailed phonetic account of YZ coronals and examine the articulatory and acoustic correlates of the different coronal sounds of YZ, to finally determine the differences that reliably might distinguish between these sounds. The compression of various coronal consonants in a narrow articulatory space allows us to observe the degree of variability and/or constancy in the production of these sounds. Some phonetic theories have proposed that the sounds that are perceptually salient or typologically common can show articulatory variability to the extent that the corresponding acoustic parameters show relative constancy (Stevens 1989, 1996). Similarly, it has been suggested that small phonemic systems demand less perceptual distinctiveness than larger systems (Lindblom 1990). The results obtained here are, in general, consistent with the view that articulatory variability is allowed in a compressed space as far as its acoustic properties remain constant.

The results regarding articulation showed that /t/ and /d/ fluctuated between dental and denti-alveolar but typically with a constant laminal articulation for /t/ and variation between apical and apico-laminal for /d/. In contrast, the overall acoustic analyses revealed no significant difference between the two sounds regardless of the particular gesture used in their instantiation.

Data for sibilants showed that the degree of variation in articulation depended on the specific class. Thus, even though /s/ and /z/ varied between dental, denti-alveolar and alveolar places of articulation, nearly every speaker articulated these sounds with the blade of the tongue. It seems likely that the laminal articulation occured because speakers used a tip down gesture while articulating /s/ and /z/. Similarly, /tʃ/ and /ʒ/ also diverged being either alveo-palatals or palatals, but, they showed a consistent lengthy tongue contact spreading along the blade to the dorsum. In contrast, /ʂ/ and /ʐ/ were consistently pronounced as apical, post-alveolars, and articulated with the tongue tip. Notwithstanding that the articulatory evidence is rather small, the results seem to suggest that the perceptual differentiation between the three series of sibilants is guaranteed by their homogeneous acoustic properties (mainly, spectra and centroid frequency). Hence, the results suggest that this acoustic constancy tolerates the variation found in the articulation across speakers.

Sonorant sounds present an interesting case for the present study. Place of articulation for these sounds is not contrastive, as it has been demonstrated that length is the phonemic feature differentiating the sounds in this class. Thus, in principle, sonorants are relatively unconstrained to implement place of articulation; nevertheless, some trends can be drawn from the data. There was no correlation such that long and short sonorants can be consistently associated with a particular aspect of articulation. However, it was found that /n:/ was more likely to be dental, whereas /n/ was more likely to be alveolar. This trend suggests that speakers make use of a sub-phonemic feature that additionally facilitates discrimination by the listeners. Along the same lines, it should be recalled that the two nasals have allophones determined by contex: in word final position /n/ is realized as /ŋ/, whereas /n:/ preserves its dental articulation. In other words, the contrast between the nasals is further enhanced by differences in place of articulation. Results about the production of laterals was less conclusive than nasals. The two laterals shared the common factor of being apical, but data showed that speakers were more likely to pronounce /l/ as alveolar than /l:/, which in turn, was dental half of the time.

It is worthmentioning that regardless the variability in the place of articulation of some of the coronal sounds, the production of individual speakers tended to be homogeneous. This was observed, to some degree, in sibilants and was especially notable in the production of /t/ and /d/. Data showed that speakers produced both stops in the same way, both dental or both denti-alveolar and both laminal or apico-laminal. This sharp control of the speakers over their articulation suggests a gestural economy principle (Maddieson 1997) guiding the production of sounds that, in effect, vary across speakers of the same language, i.e. despite of the freedom to produce sounds within a range of non-contrastive articulations (dental-alveolar), individual speakers prefer predominantly one type of gesture over the other.

The overall evaluation of the results seems to support the view that a relative variability in certain aspects of production is allowed, such as the portion of the tongue that makes the maximal constriction. Similar conclusions have been also proposed in a number of studies investigating the articulation of different languages (Anderson 2000; Avelino and Kim 2003; Dart 1991; among others). Thus, as a variable place of articulation contrasts with the more constant acoustic properties of a segment, it seems plausible to extend the articulatory description not only to the place or maximal contact between the articulators, but also to account for the position and shape of the tongue, which crucially contributes to the overall acoustic output. More experimental research on the perceptual correlates of the coronal constrasts is necessary to test and further study the consequences of this conclusion.

III

Studies of Tone Perception in Yalálag Zapotec

This section contains two chapters, in which I present the results of a series of experiments investigating the perception of the tone in YZ. In chapter 7, I address the basic question about the nature of tone perception in YZ. There are at least two major hypotheses on the subject. The first hypothesis conceives that in the perception of tone a series of units changing along the F0 continuum generate significant differences only when they occur in the boundary of a phonemic unit but not when they occur within the domain of the phonemic unit (Liberman, 1957; Stevens, 1997; Studdert-Kennedy, 1974). It is expected that a listener categorizes different acoustic stimuli as the same phonological tone, even though he can perceive the variations and differences among the stimuli. This perception is considered to be categorical. According to the second hypothesis, perception is independent of any category assignation and the changes along the F0 continuum will create no category boundaries. Instead, it is predicted that the discrimination between different acoustic stimuli would be similar regardless of the category. Therefore, in this view the perception of tone is regarded as a continuous phenomenon.

It is generally acknowledged that the dichotic listening method correlates well the index of ear advantage with a left hemispheric specialization for linguistic functions. In Chapter 8 I present results of a dichotic listening experiment investigating the perception of pitch in YZ. There are some studies indicating that the right hemisphere is involved in processing of F0 when the stimuli are non-linguistic (Blumstein, 1974; Efron, 1990; Goodglass, 1977; Perkins, 1996; Shipley-Brown, 1988) (music, pure tones), but other studies indicate that there is a left dominance when the nature of the stimuli is linguistic (Gandour, 1988; Gandour, 1983; Hugdahl, 1999; Zatorre, 2003; 1992). In this context, the design of the experiment will allow us to examine what is the pattern of lateralization of F0 in YZ in both conditions, lingustic and non-linguistic.

7 The perception of Tone in Yalálag Zapotec

7.1 Introduction

A long tradition of research on speech perception, starting with the pioneering study by Liberman *et al.* (1957), has shown that a series of consecutive stimuli extracted from a physical continuum is sorted by listeners into discrete units rather than being perceived as continuous. The results of several studies have also demonstrated that stimuli classified as belonging to different categories are discriminated accurately, while stimuli identified as belonging to the same category are difficult for listeners to differentiate (Harnad, 1987; Pisoni, 1972; Repp, 1987; Studdert-Kennedy, 1974). The vast majority of research on the auditory processing and perception of pitch has dealt with non-speech stimuli. Early studies demonstrated that there is a close relation between the sinusoidal frequency of pure tones and their pitch (Flanagan, 1957; Moore, 2001; Nabelek, 1969) so that, in general, the frequency of the tone corresponds to its pitch. However, it is questionable that these findings can be extrapolated directly to linguistic stimuli. Most studies of speech perception have focused on segmental properties (voice onset time, frication noise, vowel formant structure, segmental duration, etc). In contrast, there are comparatively fewer studies of the perception of linguistic tone (Abramson, 1976; Chuang, 1972; Gandour, 1978; Hombert, 1975; House, 1990; Howie, 1972; La Velle, 1974; Wang, 2001). Most of the research available suggests a categorical perception for linguistic tone. However, some studies (Abramson, 1977; Francis, 2000) report contrary evidence suggesting that the perception of pitch is non-categorical. Therefore, because in languages with contrastive tone the basic acoustic parameter underlying the linguistic function is the fundamental frequency, and because pitch is highly correlated with frequency, the study of the listener's subjective evaluation of frequency in tone languages presents crucial evidence regarding speech perception. Hence, the aim of the study presented in this chapter is to investigate the patterns of pitch perception by native listeners of Yalálag Zapotec (henceforth YZ). Two experiments were carried out that addressed three central issues in this section: first, the pattern of identification of F0 stimuli as varied along a continuum; second, the pattern of discrimination of matching pairs differing in their frequency values, and third the correlation between tone identification and tone discrimination functions.

7.2 Phonological Preliminaries

In the previous chapter I discussed the phonetic properties of tone in YZ, which are summarized as follows. High tone is essentially realized as level, although slight variations (either rising or Falling) can occur toward the end. Nevertheless, these variations are non-phonemic. Often, Low tone presents allophonic non-modal phonation. The most frequent pattern is a sequence of modal phonation followed by an increase in creaky voice towards the end of the syllable: /v̀/ [v̀ˑ] ~ [v̀v̰]. The main characteristic of Falling tone is the prominent slope from high to low frequency within the syllable nucleus. In modal syllables the fall is continuous, while in the rearticulated type the Falling tone is distributed in two parts: the first part of the nucleus bears high pitch, and the second bears low pitch. Figure 70 below illustrates the F0 contours of a representative triple contrast between High, Low and Falling tones in modal syllables. The High and

Low tones illustrated by /já/ 'temazcal' (traditional sweathouse) and /jà/ 'bell' are fairly steady, in contrast with the significant trajectory observable in /jâ/ 'cane'.

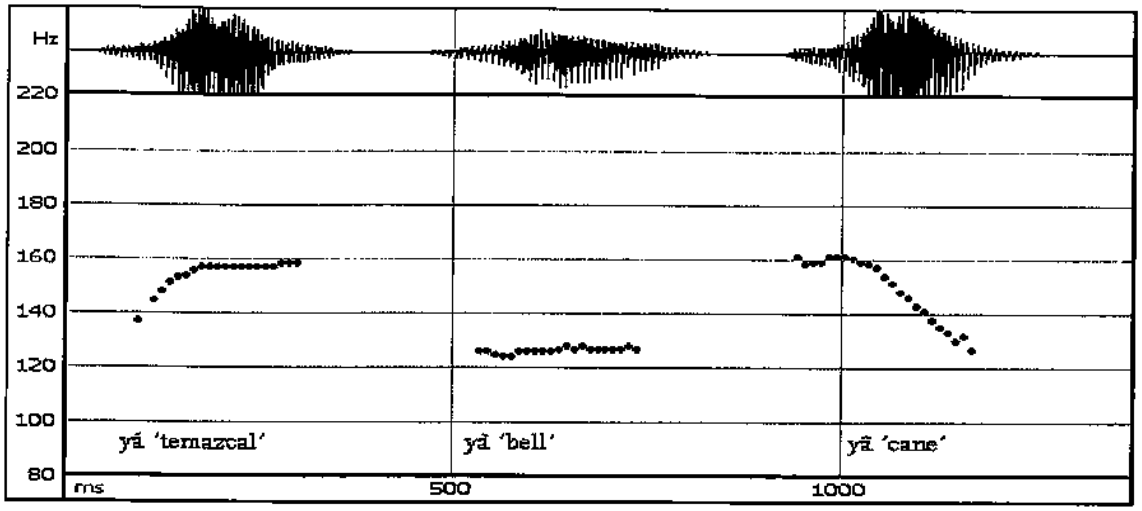


Figure 70. Contrast between High, Low and Falling tone

7.3 Method

7.3.1 Materials

The stimuli for the two experiments consisted of a series of resynthesized (PSOLA) variations of minimal pairs in which, other things being equal, the F0 was modified in intervals of 5 Hz with respect to the frequency obtained in the original, unmodified word. All the stimuli were produced by the Praat program (Boersma, 2003). A set of 16 minimal pairs for tone were selected (appendix 3). Six major cases of manipulation along the F0 continuum were distinguished and tested in the experiments. The panels in Figure 71 illustrate the pitch contours of the stimuli produced for the experiment. The first spectrogram to the left shows the superimpossed pitch track of the unmodified word, and the subsequent forms represent its resynthesized variations. The six different cases of continuum variation are as follows.

a. High to Low (H>L). The frequency value of a High tone word was reduced in intervals of 5 Hz until a value similar to a Low tone was reached.

b. High to Falling (H>F). The frequency value of the offset of a High tone word was decreased in intervals of 5 Hz until a value similar to the offset of a Falling tone was reached.

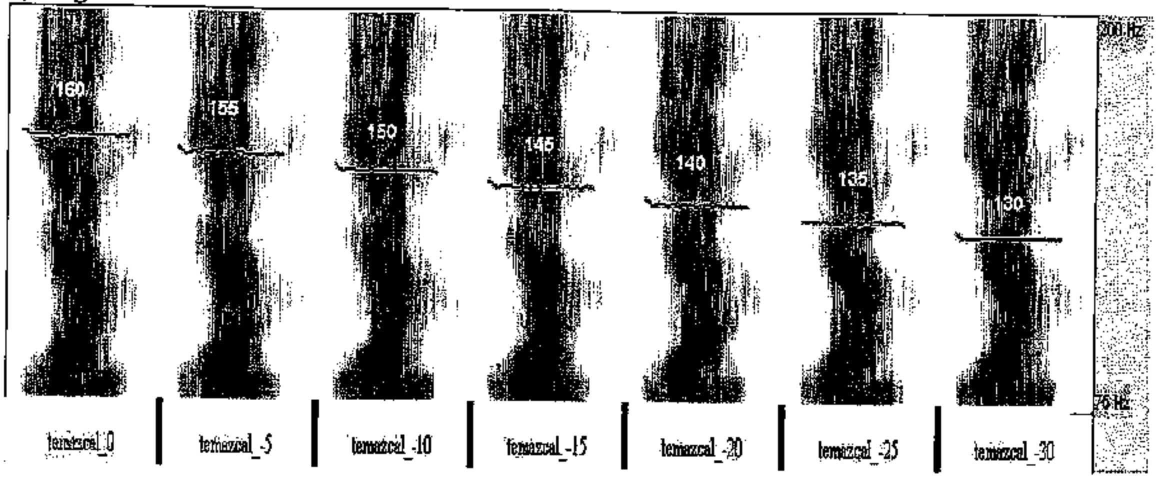
c. Low to High (L>H). The frequency value of a Low tone word was increased in intervals of 5 Hz until a value similar to a High tone was reached.

d. Low to Falling (L>F). The frequency value of the onset of a Low tone word was increased in intervals of 5 Hz until a value similar to the offset of a Falling tone was reached.

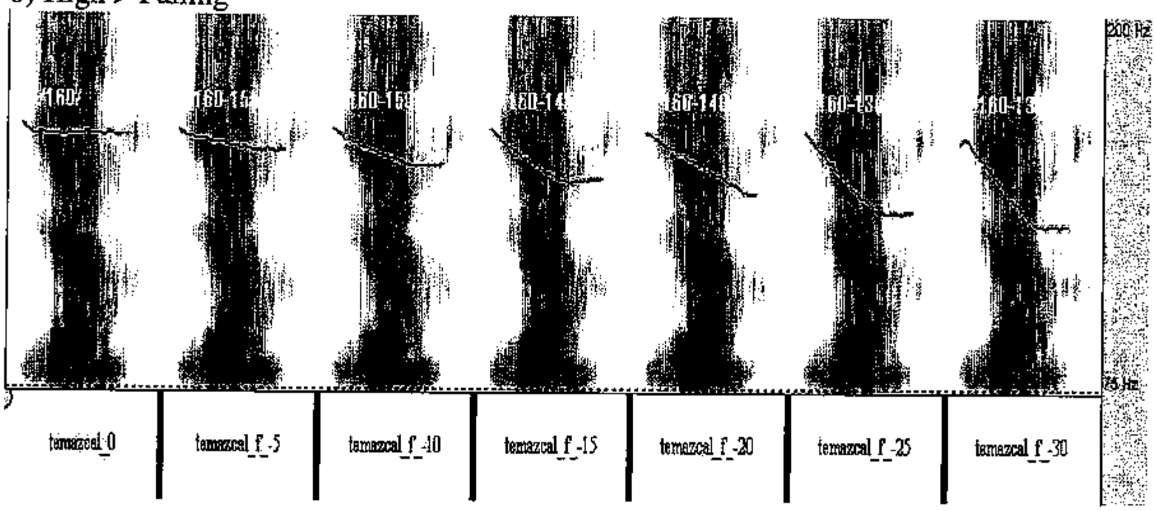
e. Falling to Low (F>L). The frequency value of the onset of a Falling tone word was decreased in intervals of 5 Hz until a value similar to a Low tone was reached.

f. Falling to High (F>H). The frequency value of the offset of a Falling tone word was increased in intervals of 5 Hz until a value similar to a High tone was reached.

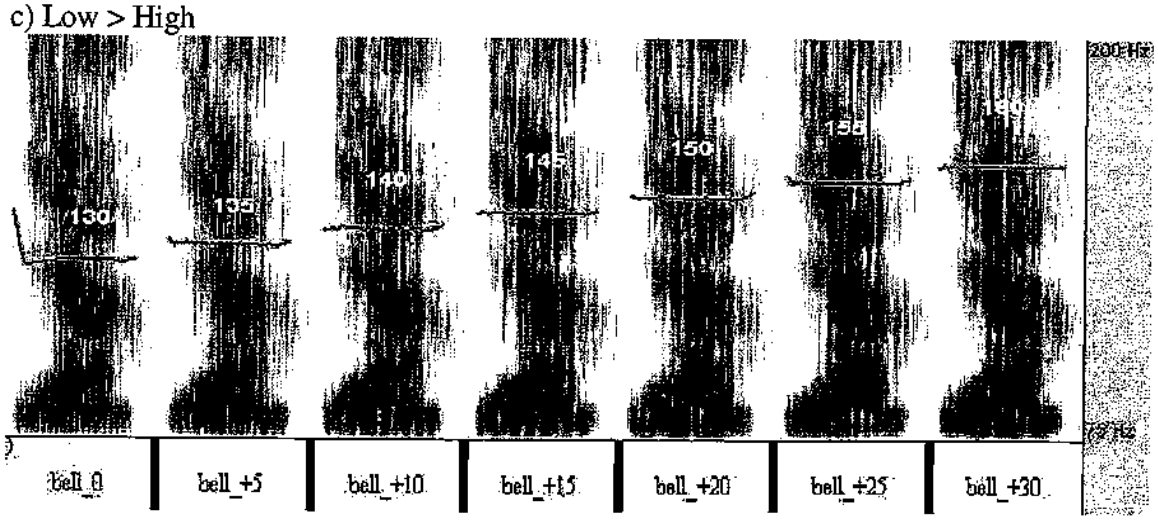
a) High > Low



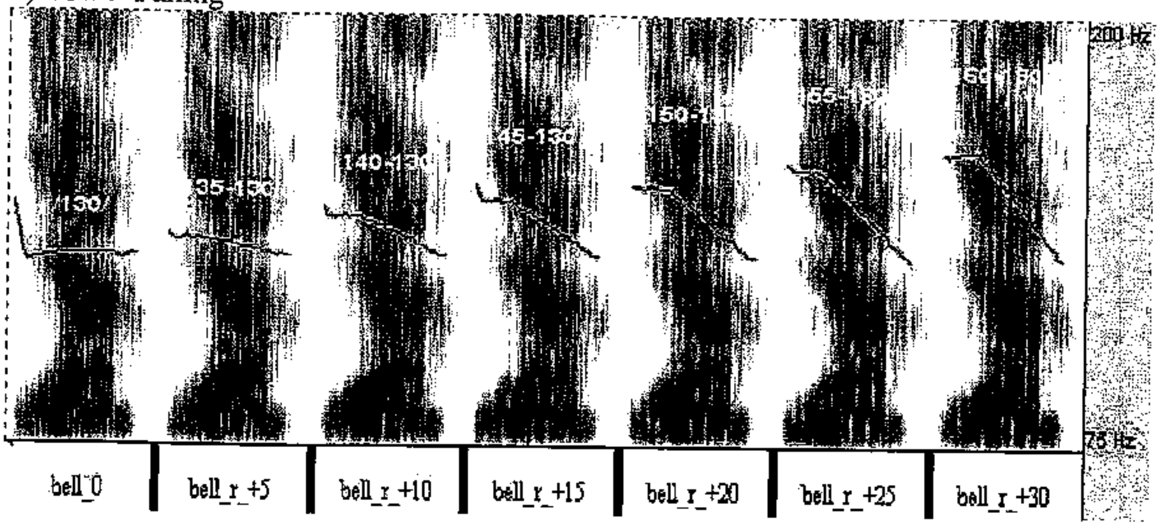
b) High > Falling



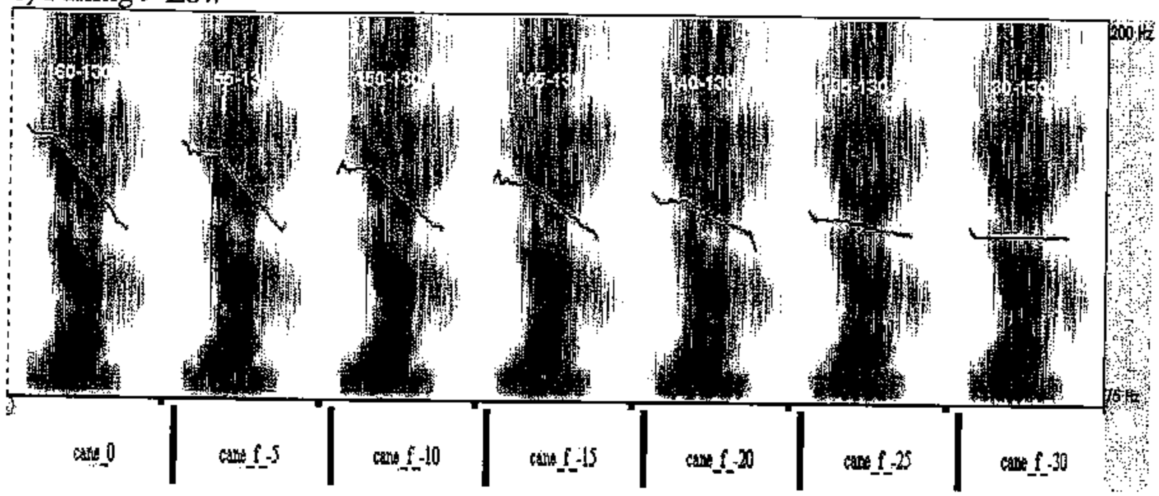
c) Low > High



d) Low > Falling



e) Falling > Low



f) Falling > High

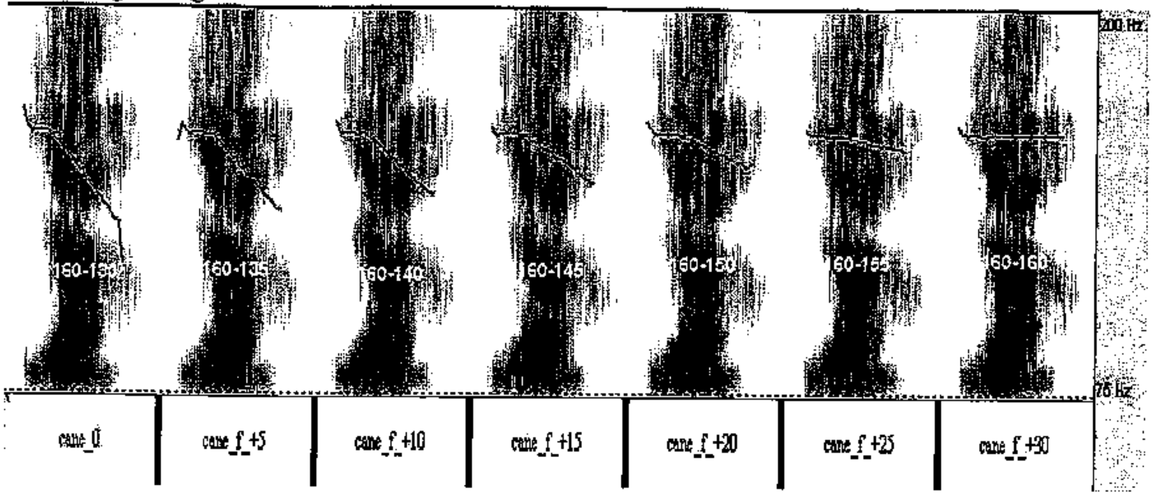


Figure 71. Pitch contours of the resynthesized stimuli words with modified intervals of 5 Hz. The panels illustrate the different continua used in the experiment. The leftmost spectrogram with superimposed F0 track represents the underlying form of the word for each panel, whereas subsequent forms represent the resynthesized versions along the six continua (a) High>Low, (b) High>Falling, (c) Low>High, (d) Low>Falling, (e) Falling>Low and (f) Falling>High.

7.3.2 Subjects

Nine right-handed subjects, native speakers of YZ, with no history of abnormal hearing (ages 14-32; four females, five males) participated in the experiment. Each subject was tested individually by me in in Yalálag, Oaxaca, Mexico; the experiment was carried out in a quiet room so that ambient noise conditions did not interfere with the experiment. The experiment lasted between 40 and 50 minutes, depending on the time consumed in the practice trials. There were three resting periods of at least 3 minutes during the experimental trials. The experiment was performed after the subject was familiar with and confident about the task. Data were collected, recorded and processed using the Psyscope program (Cohen, 1993).

7.4 Procedure

Subjects were told they would be participating in a series of experiments in which they would hear words or pairs of words that might differ only in tone. During the first experiment, subjects were presented with the stimuli one by one to gain information about how the subject would identify them as a word with one of the three tones, High, Low or Falling. During the second experiment, subjects were presented with the stimuli in a forced choice "same"/"different" paradigm to determine how subjects would discriminate the stimuli on the basis of these comparisons. In the next sections, I will describe in detail the procedures followed for the identification and discrimination experiments.

7.4.1 Identification

Three blocks of 140-item were prepared (4 words x 5 repetitions x 7 steps x 9 subjects = 3780). The intertrial interval was 300 ms. Each block contained two of the six variations of the three tones High, Low and Falling (henceforth H>L, H>F, L>H, L>F, F>H, F>L) which were used for the analysis. A two-alternative forced-choice procedure was used throughout. The subjects were presented with a single auditory stimulus while a pair of photographs recalling the referents of the minimal pair for tone were displayed simultaneously alongside on a computer screen for 700 ms. The subjects were instructed to respond by pressing one of two keys covered with colored paper, a green key if the auditory stimulus corresponded to the visual stimulus on the right side of the screen, and a red key if the auditory stimulus corresponded to the visual stimulus on the left side of the screen. No feedback was given. The experiments were introduced to the subjects by instructions in their native language (see Appendix 4). Before the experimental trials, the subjects were presented with the series of individual visual stimuli and the respective synchronized auditory stimuli of the unmodified words over the computer. The purpose of this preparation task was to ensure the recognition of the words and, more importantly, to familiarize the participants with the tone range of the speaker's voice used in the stimuli. Before the experimental trials began, the participants completed a practice session. The stimuli used in the practice session were different from those tested in the experiment. The subjects were instructed to respond "as quickly as possible". They were instructed to repeat the practice trials until they felt confident about the task.

7.4.2 Discrimination

Eight subjects participated in the discrimination task (one of the subjects failed to participate). Three blocks of 240-item sequences of auditory stimuli were presented. The stimuli were arranged in pairs, consisting of an A stimulus and a B stimulus. The B stimulus which was either identical to, or a variation of the A stimulus (for A=B: 12 words x 3 repetitions x 7 steps x 8 speakers = 2016; for A≠B: 12 words x 6 repetitions x 5 steps x 8 speakers = 2880, rendering 4896 total items). The subjects were instructed to determine whether the stimulus in the pair were the same word repeated twice or different words by pressing one of two keys selected for that purpose in a keyboard. Participants used their left index finger to press a red key labeled 'different', and their right index finger to press a green key labeled 'same'. The interstimulus interval was 300 ms and the intertrial interval was 700 ms. A pointer centered in the screen was displayed during the intertrial period in order to focus the attention of the subjects before the next trial began. No feedback was given. The A and B pairs were adjacent to each other in the continuum and separated by 10 Hz. For instance, the stimuli prepared for a H tone word was varied as follows: in one trial where the frequency of the A stimulus was not modified at all (H = 0) was paired with that of a B stimulus which was lowered 10 Hz with respect to the frequency of the High tone word (H – 10); in a second trial, stimulus H - 5 was paired with a stimulus H – 15; in a third trial, H -10 was paired with H – 20, and so on for the remaining stimuli on the continuum until the lower value reached the frequency of the corresponding Low tone word in the minimal pair. Matching pairs where A=B were also included for all the points on the continuum. The stimuli pairs were randomized.

7.5 Hypotheses

Hypothesis 1. The subjective evaluation of the frequency of units changing uniformly along the F0 continuum will produce significant differences only when they occur at the boundary of a phonemic unit but not when they occur within the domain of the phonemic unit (Harnad, 1987; Liberman, 1957; Pisoni, 1972; Stevens, 1997; Studdert-Kennedy, 1974). Therefore, it is expected that a listener will categorize different acoustic stimuli as one of the three phonological tones of YZ regardless of the particular values of F0. In other words, the stimuli will be perceived as H, L or F categorically. Thus, the identification of particular stimuli will depend on the tonal range assigned by the listener to a particular phonemic tone. This hypothesis would be falsified if the results show that pitch is independent of category, in which case the identification of the changes along the F0 continuum will indicate no category boundaries at all.

Hypothesis 2. Discrimination of stimuli will be more accurate between categories than within them. The radical version of this hypothesis claims that all stimuli in a given identified category should be perceived as the same, whereas stimuli from different categories should be perceived as different (regardless of the fact that they are separated by equal magnitudes as the within-category stimuli on the continuum). Thus, it is predicted that a listener will discriminate better between members of a stimuli pair that are placed in the opposite side of a tonal boundary assigned for a particular tone (H, L or F) than between members of a stimuli pair situated within a given category, even if the physical difference between the two members of the pair is equivalent (10 Hz). A result showing that the discrimination between different acoustic stimuli is similar regardless of the category would be enough to falsify the hypothesis, in which case the perception of tone would indicate a continuous perception of pitch.

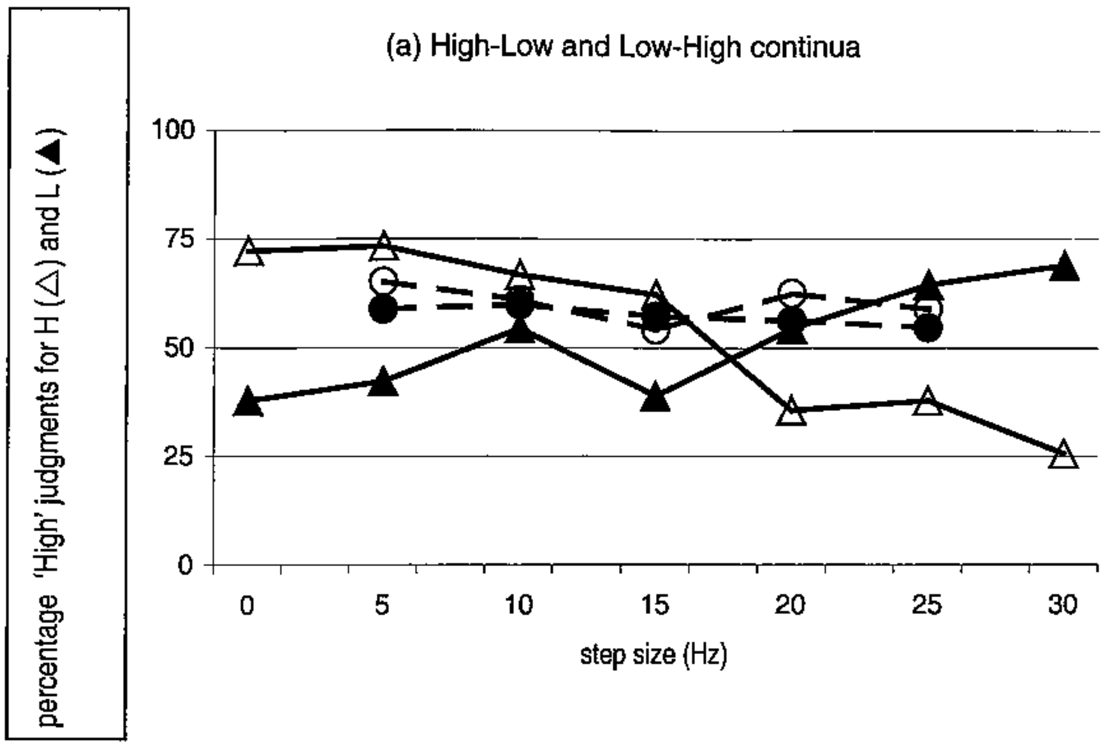
7.6 Results

The percentage of the identification function pooled across subjects is shown in the three graphs of Figure 72. The triangles connected by solid lines in the three graphs represent the identification functions for each of the three continua; graphs (a) and (b) show the percentage of responses labeled as "High" and "Low" tone along the points in the continua H>L and L>F, respectively; graph (c) shows the percentage of responses identified as 'High' along the continuum H>F. In general, the white and black triangles tend to be mirror images of one another, since they contain almost the same nominal stimuli, but in the reverse order. For instance, in the left extreme of the H>L continuum the step marked as "0" means that the respective stimuli for the High and Low tone continua were not modified at all, i.e. they correspond to a High tone word at 160 Hz and to a Low tone word at 130 Hz. The next step "5" means that the High tone word was decreased by 5 Hz, whereas the Low tone word was increased by 5Hz.

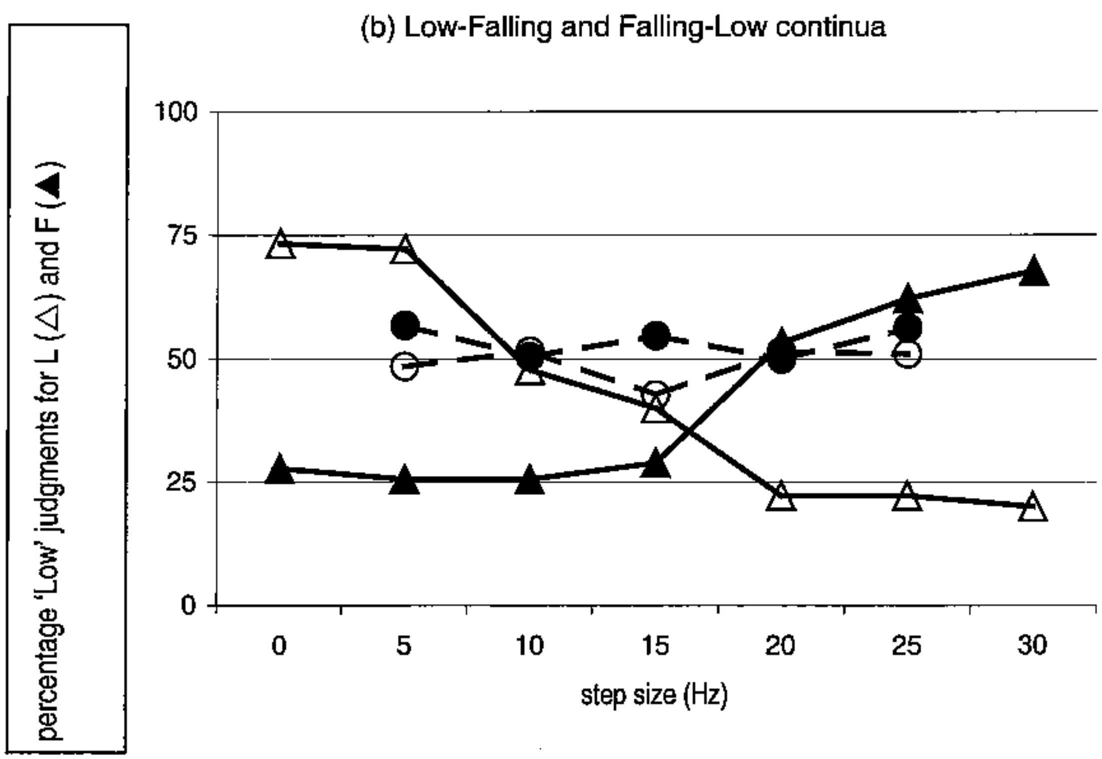
The first point to note is that even the completely unmodified words were not identified with 100% accuracy. The best results obtained are about 75% of correct identification of the unmodified words.

Nevertheless, the results indicate that overall listeners partitioned the tone space in two categories along the continua formed by the H>L and L>F tones, in contrast to the pattern observed for H>F continua, for which these seems not to be any clear boundary between tone categories. Graphs (a) and (b) further show that the category shift for the continua H>L and L>H occurs between the stimuli corresponding to 15 and 20 Hz.

Discrimination functions pooled across the subjects for the six continua are also displayed in Figure 72 by circles connected by dotted lines. The graphs show the percentage of correct discrimination for adjacent A-B pair trials separated by 10 Hz. Thus, the figure should be read as the discrimination between stimuli pairs 0-10, 5-15, 10-20 and so on; the corresponding symbols appear between these two points in the graph. Similar symbols will be used in subsequent figures. Overall, the results show a null discrimination of the six continua, as no category peak discrimination is observed in any of the figures. Instead, the results indicate values close to chance performance.



(a) High-Low and Low-High continua
percentage 'High' judgments for H (△) and L (▲)
100
75
50
25
0
0
5
10
15
20
25
30
step size (Hz)



(b) Low-Falling and Falling-Low continua
percentage 'Low' judgments for L (△) and F (▲)
100
75
50
25
0
0
5
10
15
20
25
30
step size (Hz)

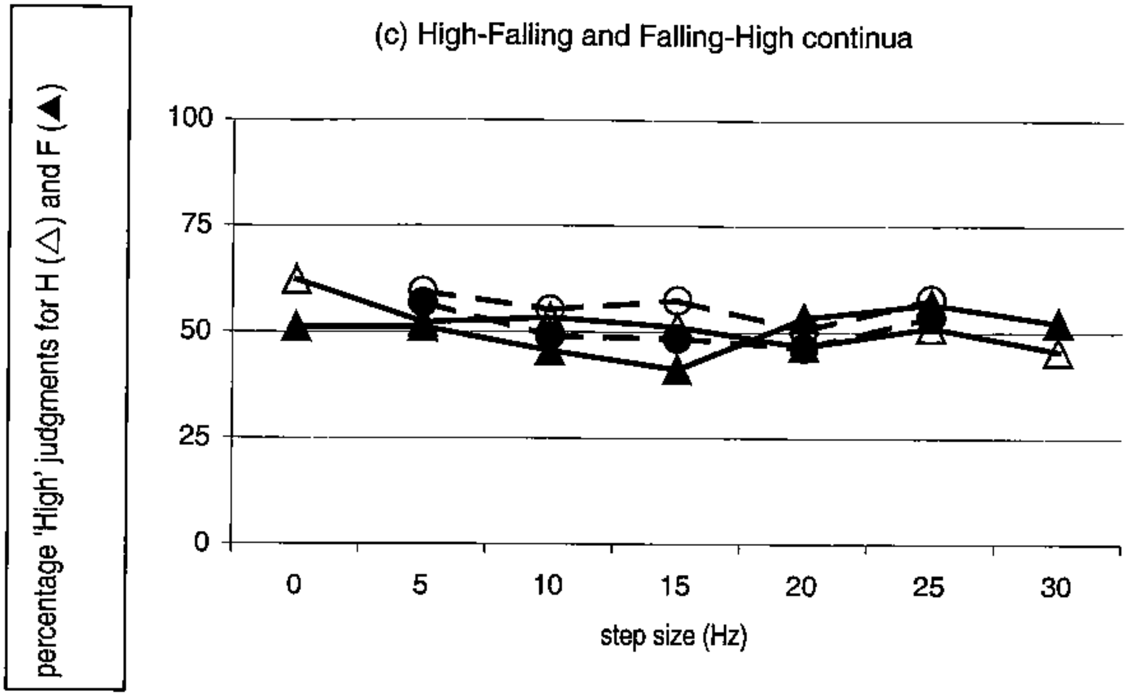


Figure 72. Overall identification and discrimination function for the continua (a) H>L, L>H, (b) L>F, F>L and (c)H>F, F>H. The continua ranges from 130 Hz in the lowest level to 160 Hz in the highest.

Previous literature has shown that tone boundaries are susceptible to individual variation with respect to their particular place in the continuum. Since the overall results are averaged over the eight subjects, they might conceal individual differences. For this reason and to observe the range of individual variation, results for each subject are also presented in this section.

Out of the eight subjects for whom identification and discrimination data are available, only two, m8 and m10, showed a reliable identification and discrimination of the stimuli continua into tone categories, while the rest of the subjects did not show any systematic pattern. Figure 73 illustrates the identification and discrimination functions of subject m8, who obtained the closest approximation to a categorical perception pattern.

Panels (a) and (b) show that the continua were divided into two tone categories. The figures also show an abrupt shift and crossover for both continua between the stimulus corresponding to variations of 15 and 20 Hz. In contrast, graph (c) shows a performance close to chance for most of the continua.

The results for subject m8 also showed a correct discrimination of contiguous stimuli in the continua of panels (a) and (c). In (a) the discrimination peak in the continuum H>L occurs in the pair trial 10-20, whereas the discrimination peak in the opposite direction, L>H, occurs one step later in the pair 15-25. In (c) the peak discrimination for both continua occurs at the same point (between the pair 10-20). The figure in panel (b), in contrast, shows no indication of discrimination between the L>F continua.

The responses obtained for subject m10 also revealed a pattern of categorical perception, although slightly less confident than those for subject m8. The figures for subject m10 show a crossover of tone identification in the continua involving H-L and L-F tones, while the responses for H-F were for the most part erratic. Unlike subject m8, m10 did not show clear discrimination peaks in any of the continua, with exception of that formed by the L-F tones, which showed the closest pattern to a discrimination peak.

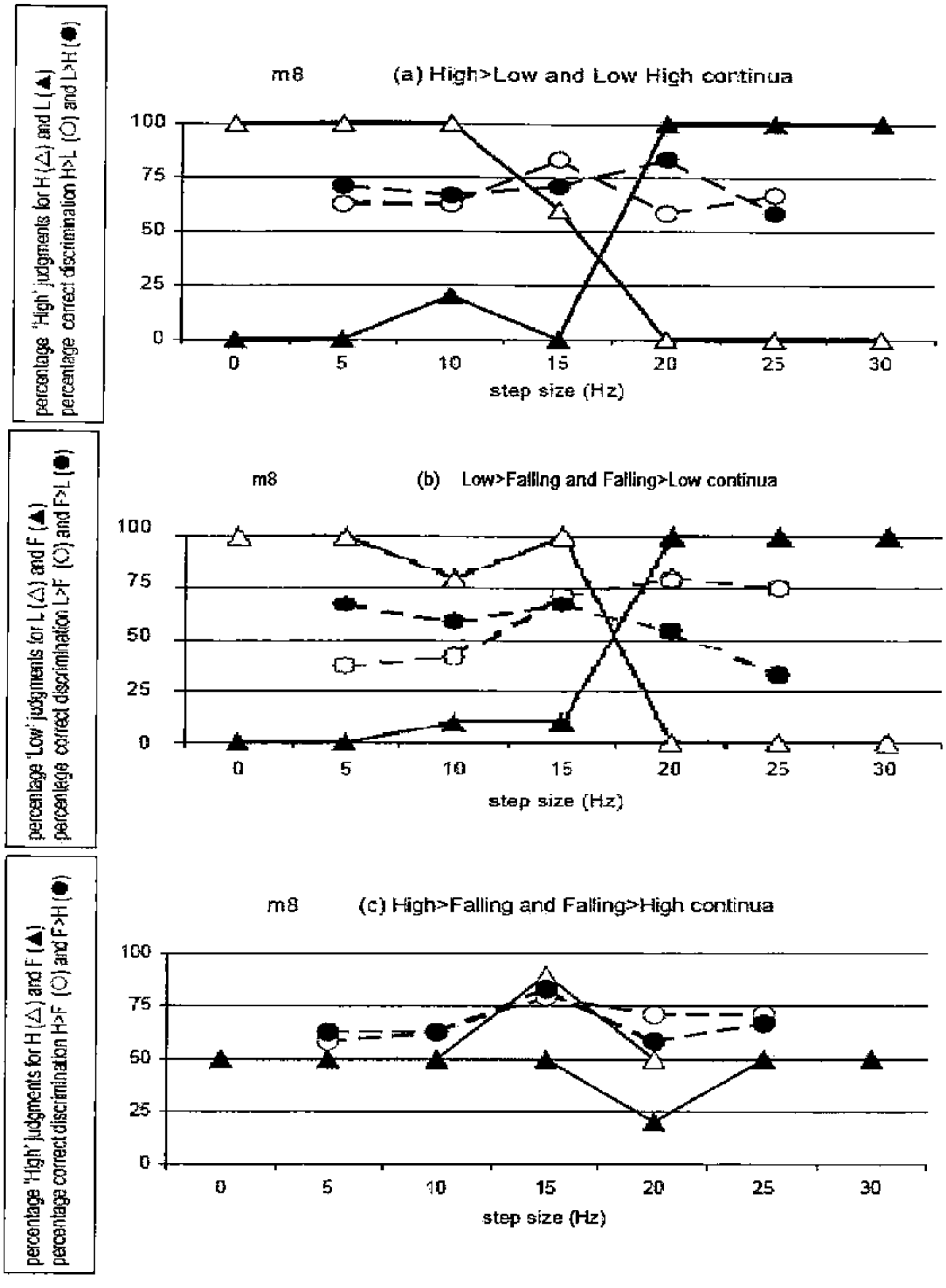
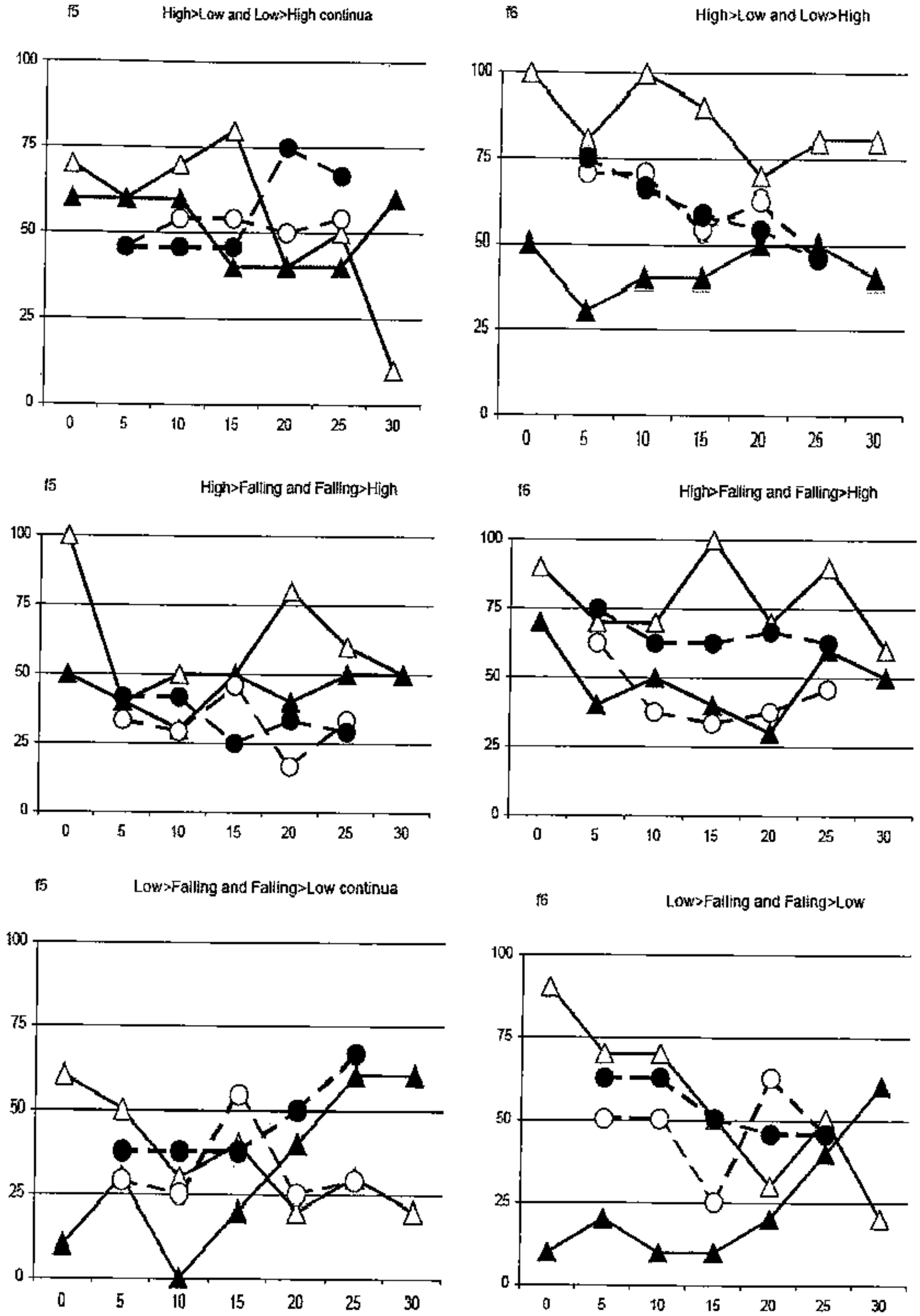


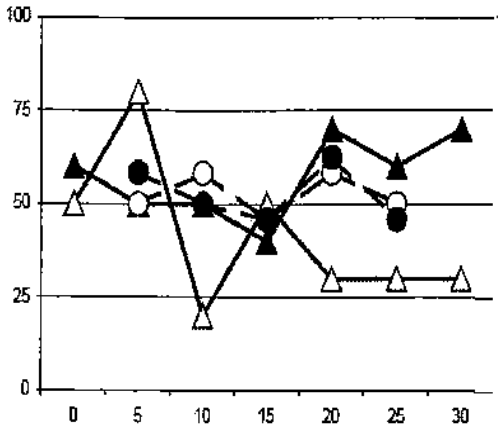
Figure 73. Identification and discrimination function for the continua (a) H>L, (b) L>F and (c) H>F for subject m8, who obtained indices supporting categorical perception. In contrast, panel (c), showing the continua H>F and the reverse F>H, showed patterns close to chance performance.

Results for the rest of the subjects (f5, f6, f7, f8, m9 and m11) are summarized in Figure 74. The overall data did not reveal a consistent pattern in either of identification ot discrimination tasks, identification or discrimination. The only other trace of a possible identification of tone categories was observed in subject f8, whose data showed a crossover in the continua L>F and F>L between the stimulus 15 and 20. Such a pattern might be taken as indicative of an adequate identification of tone categories.

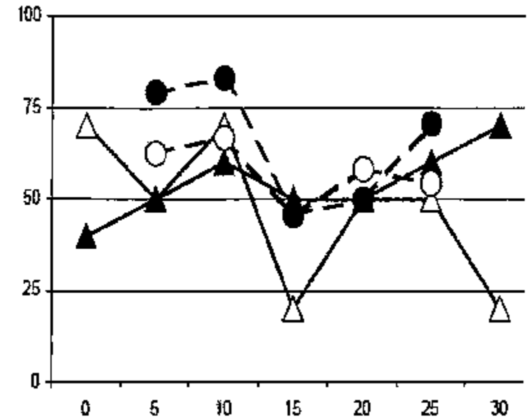


f5
High>Low and Low>High continua
f6
High>Low and Low>High
f5
High>Falling and Falling>High
f6
High>Falling and Falling>High
f5
Low>Falling and Falling>Low continua
f6
Low>Falling and Faling>Low

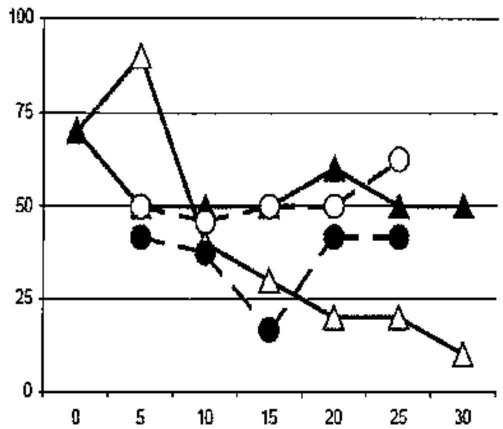
f7 High > Low and Low > High continua



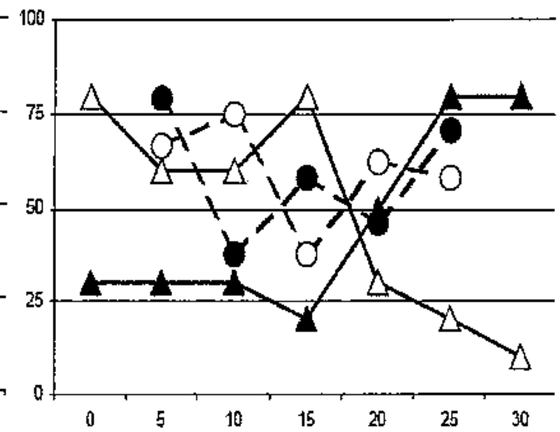
f8 High>Low and Low>High continua



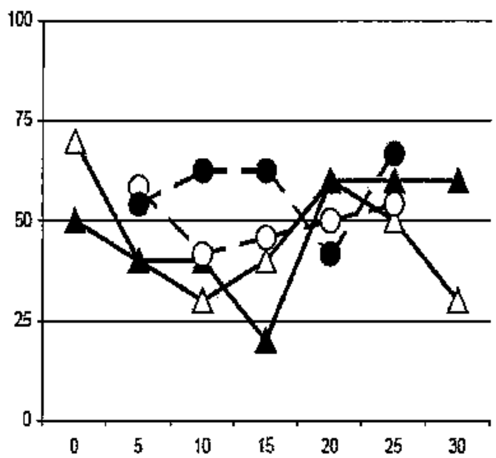
f7 Low>Falling and Falling>Low continua



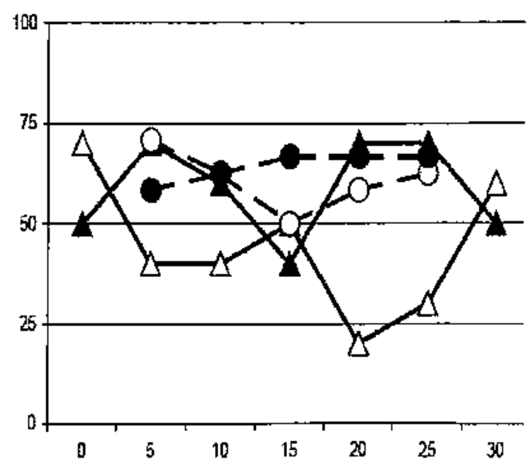
f8 Low>Falling and Falling>Low continua



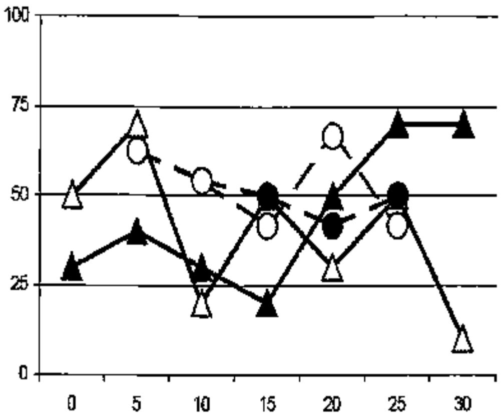
f7 High>Falling and Falling > High continua



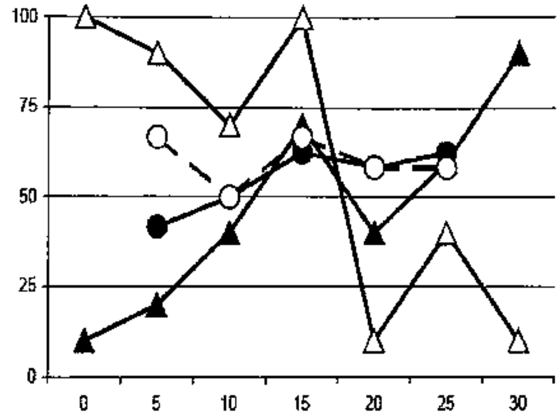
f8 High>Falling and Falling>High



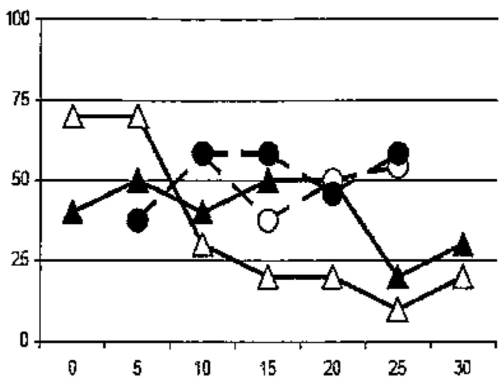
m9 High>Low and Low>High continua



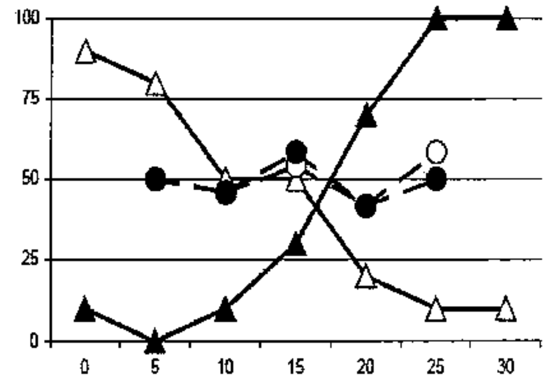
m10 High>Low and Low>High continua



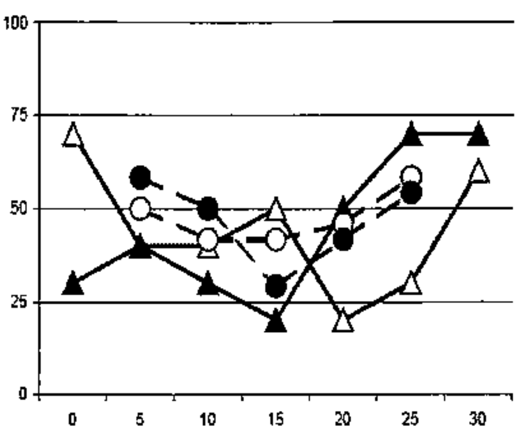
m9 Low>Falling and Falling>Low continua



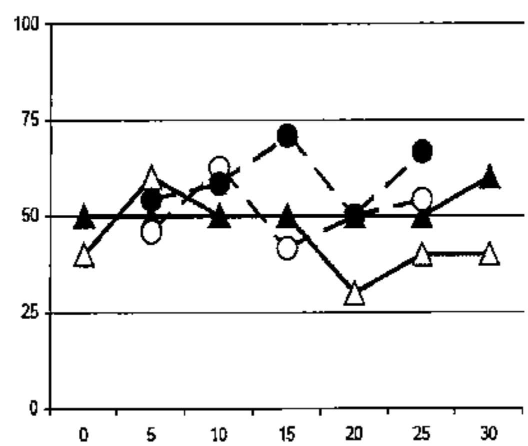
m10 Low>Falling and Falling>Low continua



m9 High>Falling and Falling>High continua



m10 High>Falling and Falling>High continua



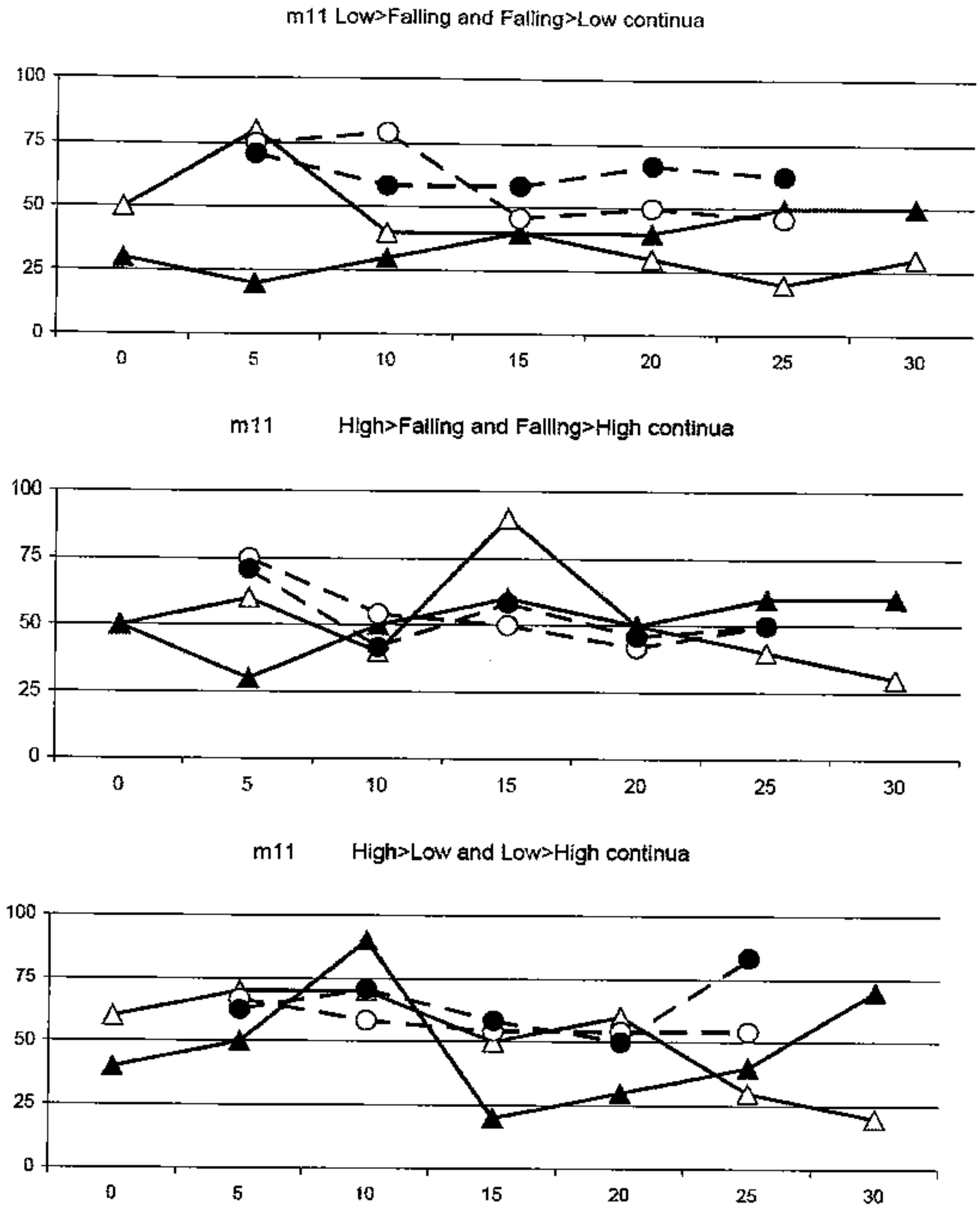


Figure 74. Identification and discrimination functions for the continua (a) H>L, (b) L>F and (c) H>F for subjects f5, f6, f7, f8, m9, m10 and m11. Only subject m10 showed a trend of categorical perception in the continua H>L and L>F. The rest of the subjects did not show any generalized pattern.

7.7 Summary and Discussion

Previous studies present contradictory evidence with respect to the question of whether the perception of pitch in tone languages is categorical or not (Abramson, 1976; 1977; Chuang, 1972; Francis, 2000; Gandour, 1978; Hombert, 1975; House, 1990; Howie, 1972; La Velle, 1974; Wang, 2001). The overall results obtained in the present research do not support the premise that all listeners can identify categories within successive F0 stimuli. The results of the identification task show that there is a category boundary for the H>L and L>F continua after a variation of approximately 15 Hz with respect to the frequencies corresponding to the tone of the unmodified word. However, the pattern exhibited by the H>F continua does not support an identification function, as the responses oscillate at close to chance levels. Furthermore, the overall results obtained in the discrimination experiment did not show a category distinction for any of the three continua. Therefore, the results indicate that a *stricto sensu* hypothesis of categorical perception of tone in YZ should be rejected.

Nonetheless, the results obtained for some individuals lend partial support to the categorical perception of tone hypothesis. On the one hand, two of the subjects showed robust patterns of a categorical mode of perception, as oberved in the crossover of labeling functions, coinciding with good discrimination of the stimuli in the corresponding continua. The two subjects are consistent and their scores strongly suggest that they are sensitive to tone category distinctions. On the other hand, however, data for the rest of the subjects revealed a random pattern of responses.

The abrupt shifts obtained for the subjects who showed a consistent pattern of identitification suggest that they possess thresholds of sensitivity associated with linguistic categories. The results revealed a pivot of category shifting at 145 Hz. High and Low tones varied up to this point are tolerated as plausible exemplars of their respective categories. This suggest that for these subjects a non-linearity occurs in the vicinity of 145, thus, indicating, a tone category boundary.

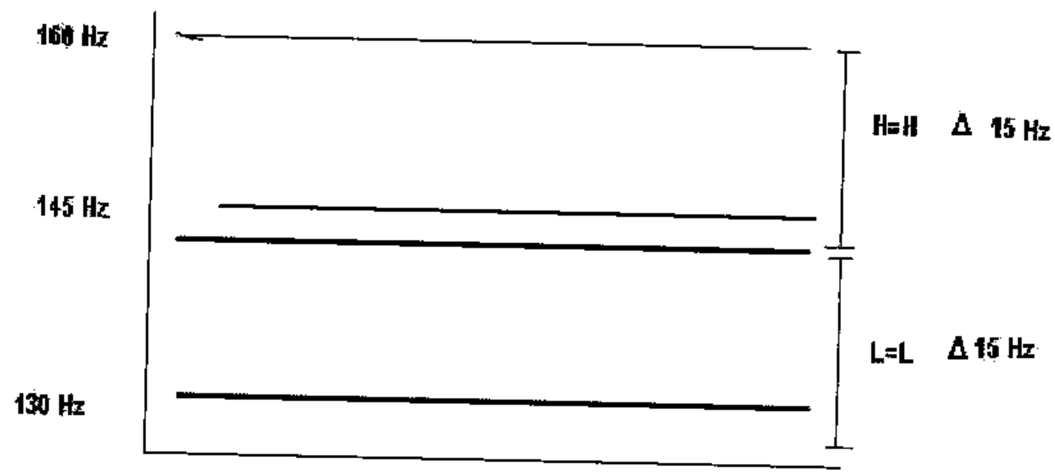


Figure 75. Ranges of identification and category pivot shift for H and L tones in the H>L continua.

Nevertheless, the failure of even these subjects to make a realiable identification in the continua H>F indicates that a psychoacoustic explanation is insufficient. It is not clear why there are no comparable results in these continua. Some alternative explanations are considered below.

A *post hoc* inspection of the stimuli did not show any important difference that might be considered a potential factor exerting influence on this outcome. Figure 76 illustrates spectrograms of the unmodified words used as stimuli in the H>F continua. A simple comparison of the words shows considerable similarities: the formants have like values and trajectories (F1=669 Hz, F2=1583 Hz, and F3=2819 Hz in the middle of the vowels); equivalent vowel duration for both tokens (70 and 97 msc for High and Fallig tone words, respectively); and finally, the intensity values are essentially the same (about 90 dB for both words). Therefore, these acoustic properties cannot be considered as nuisance variables affecting the perception of F0.

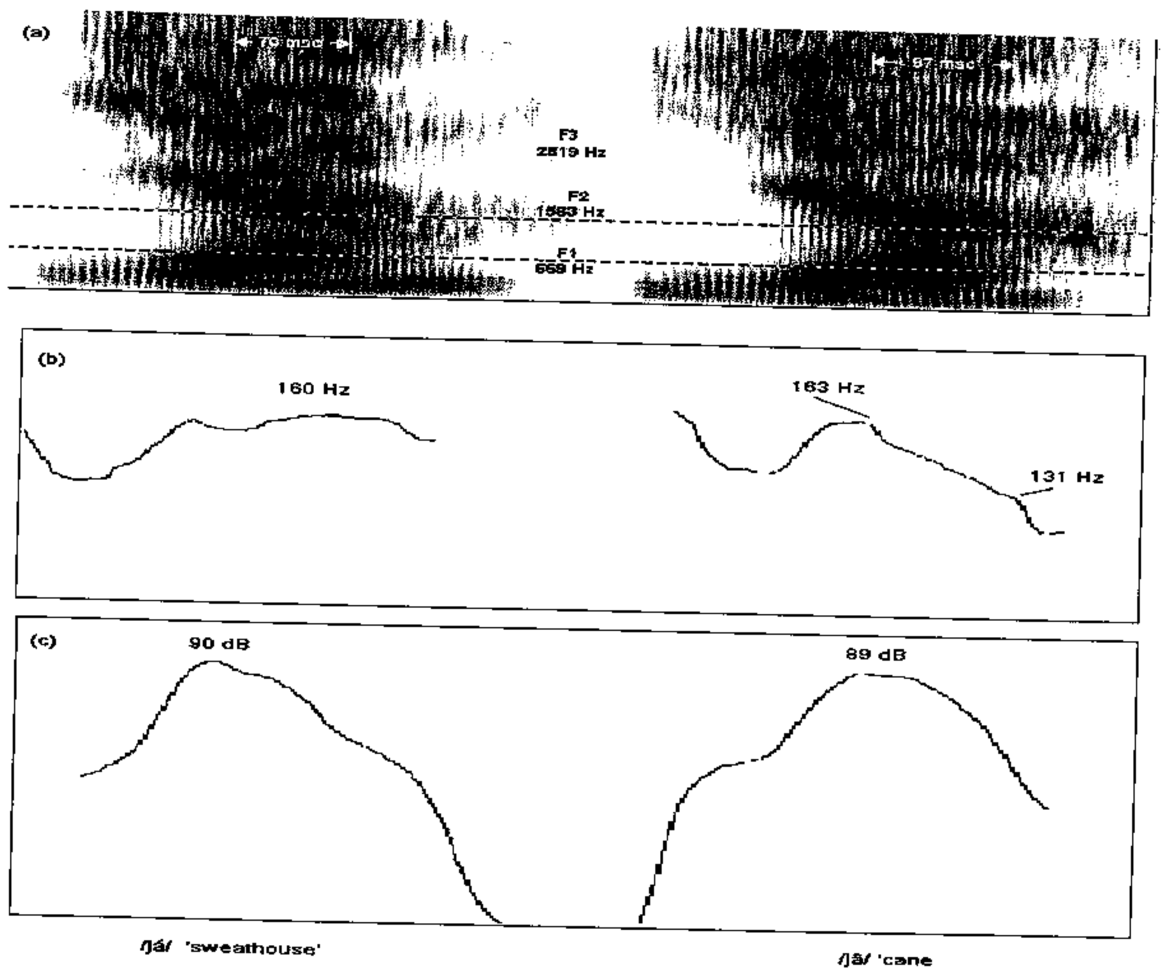


Figure 76. Acoustic properties of unmodified words /já/ 'sweathouse' and /jâ/ 'cane' used as base of the stimuli in the H>F continua. Panel (b) shows that F0 is distinct, but intensity (c), duration and formant structure (a) proved not to be critical in explaining the pattern obtained in the continua H>F for subjects m8 and m10.

One possible explanation is that the subjects experienced hysteresis effects: the subjects continued with the same category judgment past the point where they would have given the other response had they started at the other end of the continuum. Moreover, the block corresponding to the H>F trials was tested first. It is possible that subjects were not completely habituated to the task during this block.

Another possible account comes from the fact that High tone words uttered in isolation may show F0 declination (i.e. a slight lowering at the end of the utterance). Although the final declination of High tone words is not as prominent as the slope observed in phonemic Falling tone words, this canonical pronunciation could have influenced the way in which subjects had perceived the series of shifted stimuli in the final portions of the High and Falling tones. Thus, one can speculate that listeners have developed a large threshold of variation in the perception of High tones which contrast with the very prominent down excursion of Falling tones.

As a whole, the results of this study cannot support any conclusive generalization regarding the status of tone perception in YZ. If the pattern showed by most of the subjects is considered to be symptomatic of the general trend, then the conclusion should be that YZ listeners do not perceive tone categorically. Nevertheless, the negative evidence provided from these individuals does not completely negate the validity of the results of the two subjects supporting a pattern of categorical perception. There is always the possibility that non-controlled factors had influenced the experiment. For instance, it is often the case in these types of experiment, that subjects who performed at chance do not understand the nature of the task (although a training session was included in the experimental design). Another common confounding variable is the difficulty of the task itself; thus, it is also possible that the task employed in the present experiment was arduous enough for some of the subjects that they developed a random response strategy. In any event, additional research is needed to further establish the validity of the findings obtained in the present study. The only suitable conclusion inferred from the present results is that some of the subjects obtained scores that strongly support a categorical perception of tone, but some others obtained scores that do not support such a pattern. This pattern is not an unlikely outcome in similar previous experiments. Frequently, the literature reports both types of results, on one hand a group of subjects clearly show support for a categorical perception hypothesis, but another group fails to provide evidence for it (Liberman et al 1957, Masaro et al 1985, Pisoni 1971, Wang 1976). In this context, I would like to suggest that the failure to obtain a consistent pattern should not necessarily lead to the rejection of the categorical perception hypothesis. A conclusive answer to the issue could be found by extending the study to a larger population.

8 Functional Specialization in Tone Perception: Evidence from Dichotic Listening in Yalálag Zapotec

This study reports the patterns of hemispheric lateralization of pitch in Yalálag Zapotec as inferred from the index of ear advantage in a dichotic listening experiment. The overall results show a consistent right ear advantage for lexical tone, in contrast with the inconsistent pattern found for non-linguistic pitch stimuli. Selective attention to pitch stimuli in dichotic listening supports the hypothesis that forcing the attention to one ear enhances the perception of the attended ear rather than suppressing the intrusions from the non-attended ear. The correlation between the contrastive tones of Yalálag Zapotec and their pattern of lateralization shows better discrimination of High and Falling tones than of Low tone. Consequences of these and other findings are discussed.

8.1 Introduction

An important tradition of clinical and experimental studies suggests that there is a left hemisphere specialization substrate for linguistic functions, while the right hemisphere is less involved in linguistic tasks (Fitch, 1997; Kraemer, 1992; Liberman, 1973; Moffat, 2000) The model of asymmetrical functions in the human brain, particularly the linguistic dominance of the left hemisphere, has been grounded mainly on clinical evidence. Findings of many studies point out that the possibilities of aphasia following damage of the left hemisphere of the brain are far higher than in cases where the lesion affects the right hemisphere (Corina, 1998; Kraemer, 1992; Penfield, 1959; Robin D. A., 1990; Robin, 1990; Russell, 1961) More recent evidence from non-aphasic populations suggests a similar conclusion. In particular, the results of dichotic listening studies in normal subjects and commissurotomized patients have demonstrated a consistent right ear advantage (REA) in linguistic stimuli, an observation that has been interpreted as a reliable indication of left hemisphere superiority in processing such stimuli (Bryden, 1988; Darwin, 1971; Elias, 2000; Foster, 1999; Hugdahl, 1988; 2003; Kimura, 1961; 1967; Shankweiler, 1967; Shtyrov, 2000; Sidtis, 1982; Studdert-Kennedy, 1970; Zaidel, 1976; Zhang, 2001).

However, other studies have indicated that the right hemisphere is specially involved in processing stimuli based on fundamental frequency, such as pure tones and intonation (Blumstein, 1974; Efron, 1990; Goodglass, 1977; Perkins, 1996; Shipley-Brown, 1988). However, other studies of perception in languages which use phonemic tone contrasts (Gandour, 1988; Gandour, 1983; Hugdahl, 1999; Zatorre, 2003; 1992) suggest that there is a left hemisphere dominance in the perception of phonemic tone. Particularly relevant for this study, experiments that have used a dichotic listening technique to examine the processing of linguistic vs. non-linguistic use of pitch (Van Lancker 1980, Van Lancker and Fromkin 1973, 1978, Wang, Jongman and Sereno 2001, Moen 1993, 1994) have reported a right ear advantage in discriminating tone. In harmony with the general accepted model of hemispheric specialization for language, these results have been interpreted as an indication that the perception of lexical tone is lateralized to the left hemisphere.

Because the acoustic parameter fundamental frequency (F0) underlies a range of linguistic and non-linguistic functions the study of functional specialization for the perception of F0 in languages with contrastive use of pitch presents crucial evidence to understand how tonal stimuli is processed in the brain. In this chapter I report an investigation of the patterns of hemispheric specialization for tone perception in native listeners of Yalálag Zapotec using a dichotic listening technique. I address three specific matters: first, the pattern of lateralization of pitch perception of phonemic tone in Yalálag Zapotec, in contrast with non-linguistic stimuli; second, the role of selective attention in the perception of tone; and third, the correlation between the contrastive tones of Yalálag Zapotec and their pattern of lateralization.

8.2 Method

Two experiments were designed to test pitch perception and laterality in linguistic and non-linguistic stimuli. The first experiment consisted exclusively of words whereas the second included the hummed versions of words ("hums"). Following previous studies (Van Lancker and Fromkin 1973, 1978), I assume that the hummed versions of words are non-lingustic stimuli. Selective attention was investigated by three experimental conditions: non-forced (NF), forced to the left (FL) and forced to right (FR).

8.2.1 Participants and Materials

Six right-handed subjects, native speakers of YZ, without history of abnormal hearing (ages 30-50; 3 females, 3 males) were binaurally presented with a set of minimal pairs of tone and a set of pairs of hums differing in their F0 values. Each subject was tested individually in the presence of the experimenter in the Phonetics Laboratory at UCLA or in her or his home, in which case ambient noise conditions did not interfere with the experiment. Trials consisted of 32 words (Appendix 3) and an equal number of hums. The experimental stimuli thus consisted of 16 dichotic pairs of words and 16 dichotic pairs of hums. The stimuli were counterbalanced, so that the total number of tokens was 32 per experiment (32x3 = 96 total). The words selected were minimal pairs for tone, i.e., other things being equal, variation in F0 was the only difference between the members of a pair. In order to control for possible differences related to lexical accessibility, the words were of the same grammatical category and presumably of equal frequency. For the experiments with hums, the same native speaker whose voice was used to produce the word stimuli produced also the hummed versions of the same words. This procedure was designed to ensure that: the pitch of the hums would be similar to that of the words, and that native listeners would be able to reproduce the sound.

8.3 Dichotic task

Before commencing the experimental trials, the subjects listened to the same words in isolation that would be tested in a binaural condition. The purpose of this preparation task was to ensure the recognition of the words and, more importantly, to make the listeners familiar with the tone range of the speaker's voice used in the stimuli. In the experiment on non-linguistic stimuli, the subjects listened to the words followed by their respective hummed versions. There was a practice session before the experimental trials. The words in the practice session were different from those tested in the experiment. The subjects repeated the practice trials as many times as they wanted until they felt confident with the task. The experiments were introduced to the subjects by instructions in their native language (see Appendix 4). The subjects were asked to repeat "as soon as possible" the word or hum that they had heard. The responses were tape-recorded. The method of oral responses was intended to reveal perceptual accuracy, since the subject had to match one of the words of the dichotic pair. In standard procedures of dichotic listening tasks, the subject is asked to press a button which selects one of a pair of words or images from a computer screen. However, there is evidence showing that handedness has some effect biasing the responses (see Mazzucchi *et al.* 1981 and Minami 1995 for a discussion on the relevance of these factors). The present design using oral responses aimed to avoid a handedness bias, especially because the interference of reading with the perception of dichotic stimuli is not yet fully understood. Moreover, since YZ is a language without a written tradition, the protocol in which a written word is selected from a screen would have been clearly inappropriate. Hence, oral responses seemed to be the best approach for the present experiment.

The experiment lasted lasted between 90 and 120 minutes overall. There was a recess of five to ten minutes between each section of the experiment. The experiment was performed after the subject was familiar and confident with the task. Each dichotic pair was edited for onset synchronization. The dichotic stimuli were normalized in duration and amplitude (70 dB) so that, other things being equal, the only difference between the dichotic pairs was its fundamental frequency. Stimuli normalization was done with the PSOLA-resynthesis function of the Praat program (Boersma, 2003). The stimuli were recorded on three compact disks (one for each instructional condition: forced to left, forced to the right and non-forced) that contained the dichotic stimuli stored in audio files. Subjects responses were recorded on analogue tapes. Statistical analysis were obtained with SPSS and Statview software. In order to ascertain the accuracy of the responses after the experimental session was over, each subject listened to his responses and gave the corresponding glosses in Spanish or English to the experimenter. Reaction times were measured directly from the recorded responses. In the case of hums the F0 traces of the oral responses recorded were inspected to confirm a match with one of the components of the members of the dichotic stimulus.

8.4 Hypotheses

Hypothesis 1. Based on the robust evidence accumulated over the last decades, the basic hypothesis to test in this study is that if lexical tone entails the processing of linguistic stimuli, then a right ear advantage (REA) is predicted, whereas a left ear advantage (LEA) would be expected for the processing of non-linguistic stimuli such as hums.

Hypothesis 2. If selective attention is conceived as a condition that enhances responses from the attended ear, it is expected that the responses of the attended ear (left or right) will increase according to the forced condition in comparison with the non-forced condition. Thus, specifically, a greater REA is predicted for the lexical tone stimuli when the condition is forced to the right ear than in the non-forced condition. On the other hand, a reduction in responses from the right ear is expected when the condition is forced to the left. The opposite tendency is expected for the non-linguistic stimuli; that is, a greater LEA is predicted when the condition is forced to the left in comparison to the non-forced condition. If the results show the reverse tendency, that could suggest that selective attention is not a process of enhancement of the attended ear but rather a process that inhibits the intrusions from the non-attended ear.

Hypothesis 3. A REA is expected for the processing of lexical tone. However, it is not immediately obvious what would be the pattern of lateralization among the three different tones. Nevertheless, it is possible to advance two potential hypotheses with respect to the saliency of the tones in a dichotic situation based on the psychoacoustic properties of the stimulus: the complexity hypothesis and the excitatory hypothesis. In the complexity hypothesis the degree of complexity of the signal will resolve the decision of subjects regarding the perception of the dichotic stimuli. Thus, because the Falling tone is a more complex signal, it could be considered inherently more distinguishable than a simple level tone, Low or High and therefore it is expected a REA for Falling tones. In the excitatory hypothesis the characteristic frequencies of excitation of each tone will be computed to decide the perception of the tone in a dichotic condition. There is evidence that the excitatory patterns of high frequencies over the auditory nerve fibers are 'stronger' than those of low frequencies. Thus, the excitatory hypothesis predicts that in the dichotic pair High-low the High tone will have perceptual salience over a Low tone. The two hypotheses can be empirically tested in the present study since in the duplet

High-Falling tones, both hypotheses can be valid. Thus, if the results indicate a greater advantage of H tone over F tone, we can propose that excitatory 'saliency' overrides complexity of the signal. However, if Falling has a greater advantage over H, that would indicate that complexity overrides saliency.

8.5 Results

8.5.1 Linguistic Stimuli

Overall, the results combined across the three conditions (NF, FR and FL) showed a tendency to a greater incidence of responses from the right ear in processing lexical tone: Right ear 56% (316) versus left ear 44% (248). The same tendency was observed across all speakers, except for one, EC, who showed the opposite tendency.

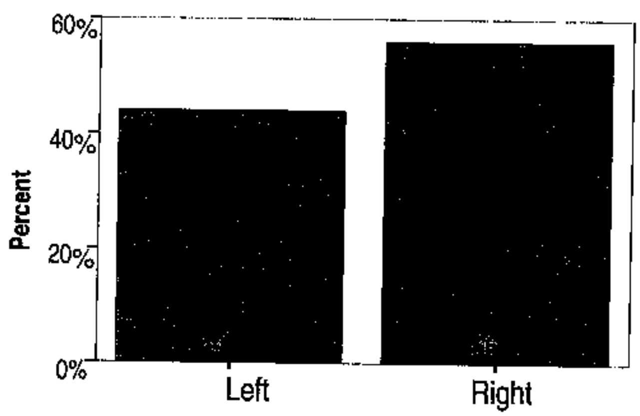


Figure 77. Average frequencies of ear responses

The results showed an essentially identical reaction time for responses coming from the left ear and those from the right ear (mean 990 ms versus 985 ms (F .762, df 2, sig. 467)). The results hold overall and by speaker.

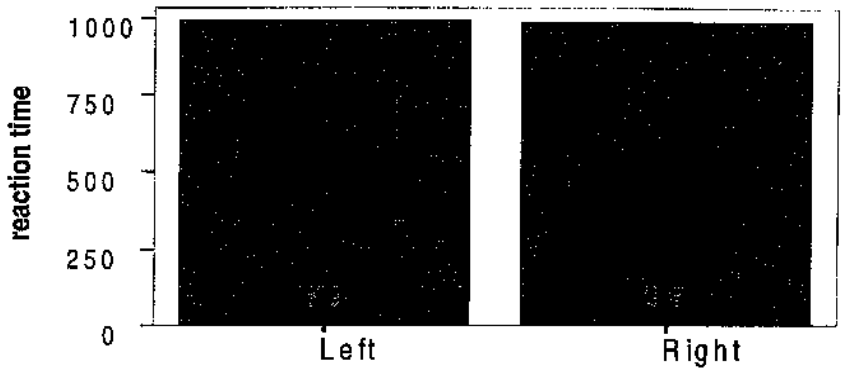


Figure 78. Overall reaction times by ear response

Examination of the results for selective attention presented in Figure 79 below revealed an overall REA, yet this advantage showed a higher score when the attention was non-forced or when the attention was forced to the right than when attention was forced to the left. The same tendency was observed across speakers (except for EC, who showed the opposite trend). When attention was forced to the right, an increased REA was observed, compared to non-forced and forced to the left conditions.

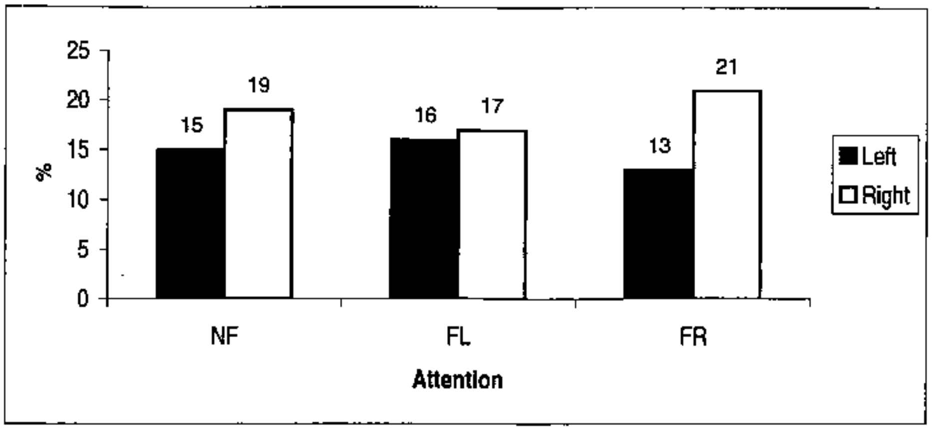


Figure 79. Selective attention

Figure 80 summarizes the findings regarding the interaction of tone and ear advantage. The results showed a robust trend for a REA for all the tones.

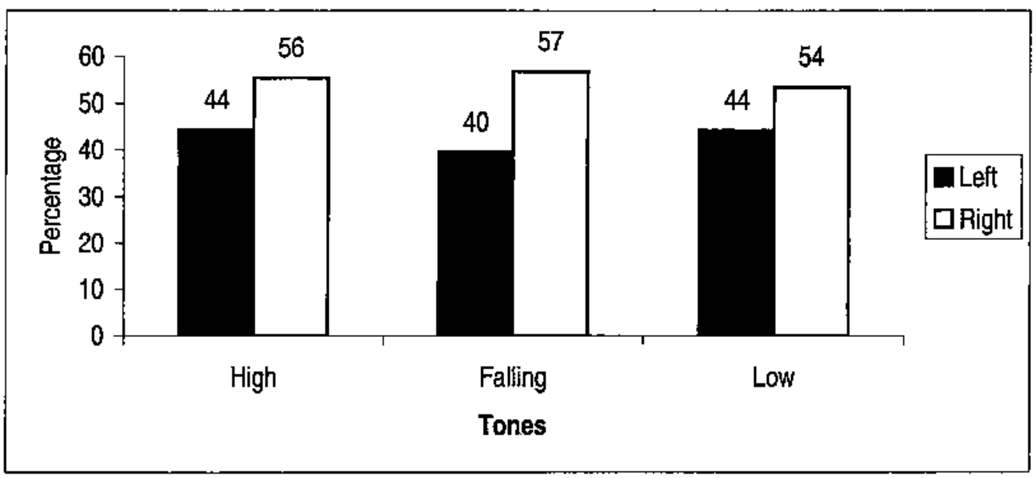


Figure 80. Ear advantage and tone

Nevertheless, a closer inspection of the data revealed intra-listener variation. The results of each subject are presented in Figure 81 below. First, there was a robust REA for Falling tone across four speakers (except EC). Second, there was a robust REA for Low tone across speakers (moderate in EV and LEA for EC). Third, there was a robust

REA for High tone in three speakers (SA, EX, RR); no ear advantage in two (JB and EV); and LEA for one (EC).

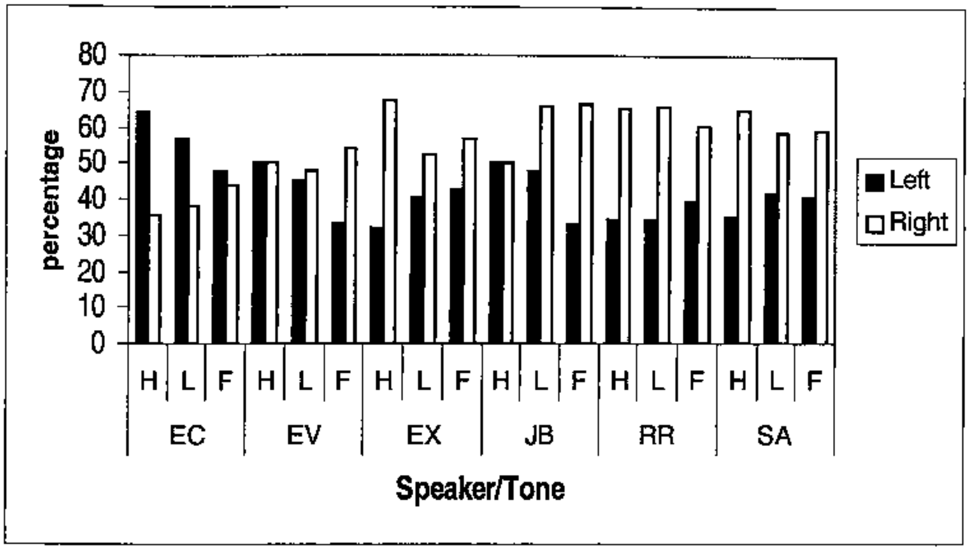


Figure 81. Intraspeaker variation by tone and ear advantage

With respect to the interaction of tone and selective attention, the results showed the following patterns. First, there was a REA for all the tones except Low tone in the forced to the left condition (FL). Second, High and Falling tones showed a REA regardless of the attention condition. Third, with attention forced to the left, Falling and Low tones showed a greater incidence of intrusions from the left ear than did High tone.

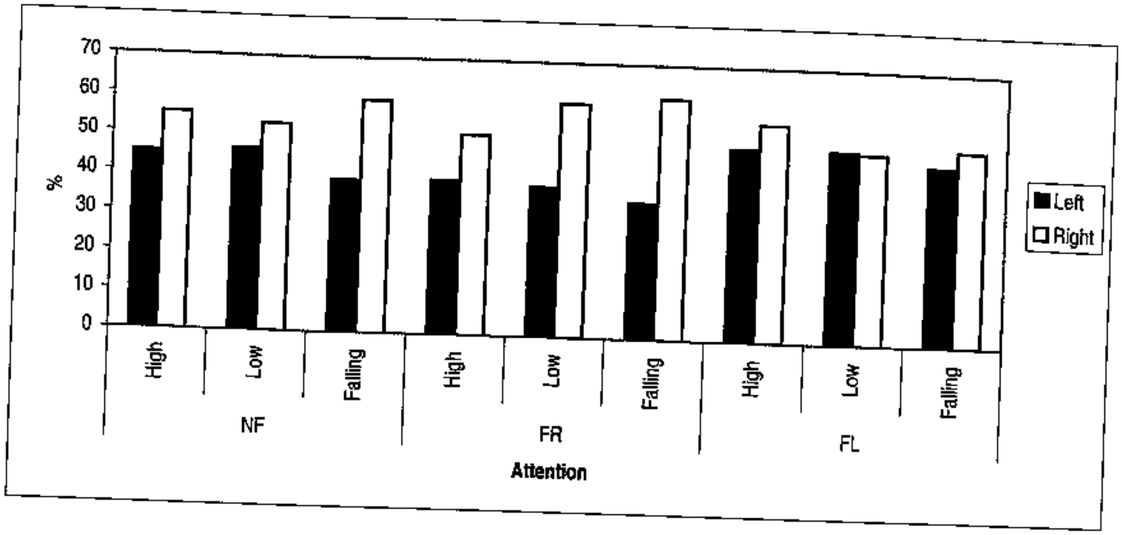


Figure 82. Selective attention and tone

The results regarding the interaction of dichotic pairs of tone and selective attention are summarized in Table 75. First, in general, High and Falling tones showed a consistent REA. Second, selective attention to the right enhanced the overall REA, although the highest differences were found in NF. Third, Low tone showed the 'weakest' score when matched with H or F, as indicated by the absence of a clear EA in the dichotic pair F-L, and the LEA in the dichotic pair H-L.

Table 75. Dichotic pairs of tone and selective attention interaction

Tone Left-Tone Right	Overall	FL	NF	FR
H-F	REA (65-35%)	REA (64-34%)	REA (64-36%)	REA (67-33%)
F-H	REA (64-36%)	no EA (50-50%)	REA (75-25%)	REA (66-34)
H-L	LEA (51-49%)	no EA (50-50%)	LEA (63-37%)	REA (61-39%)
L-H	REA (58-42%)	LEA (49-51%)	REA (66-34%)	REA (59-41%)
L-F	REA (60-35%)	REA (50-44%)	REA (68-26%)	REA (61-35%)
F-L	no EA (48-47%)	LEA (50-44%)	REA (50-47%)	REA (50-44%)

8.5.2 Non-linguistic Stimuli

Overall, the results showed a greater incidence of responses from the left ear in processing hums: 52% (151) > 48% (137). Only one speaker (SA) deviated from this tendency, showing a slight preference for the right ear (52% > 48%).

With respect to the interaction of selective attention and the ear response the results showed a greater score for the left ear in both forced conditions than in the non-forced condition. Although the scores for the forced conditions are similar, the individual scores differ with respect to the distribution of responses. Table 76 summarizes these findings.

Table 76. Ear responses and forced conditions for hums

	Forced to the left	Forced to the right	Non-forced
Left ear	55%	55%	49%
Right ear	45%	45%	51%

The results regarding the interaction of tone type and response showed that listeners were more likely to identify the tones when they were delivered to the left ear than when they were delivered to the right ear: High= 50.5% > 49.4%, Falling= 53% > 47% and Low = 53.5% > 46.5 %.

The results for the specific interactions of tones in the dichotic task are summarized in Table 77. Conspicuously, there is no homogeneous distribution of tone identification. However, a few generalizations emerge. First, Low tone was less often identified than High or Falling tone in the dichotic stimulus. This tendency was observed regardless of the condition directing the attention. This is absolute in the dichotic pairs involving High and Low tone. As for the pairs involving Falling and Low tone, the tendency is similar with the exception of the pair L-F under the condition forcing the attention to the right ear and the non-forced condition, where there was no ear advantage at all. Second, the identification of pairs formed by High and Falling tone performed below chance when the High tone was delivered to the right ear.

Table 77. Ear advantage of dichotic pairs and attention conditions for hums

	Overall	FL	NF	FR
H-F	REA 39%-61%	REA 33%-67%	REA 33%-67%	no EA 50%-50%
F-H	no EA 50%-50%	no EA 50%-50%	no EA 50%-50%	no EA 50%-50%
H-L	LEA 57%-43%	LEA 58%-42%	LEA 54%-46%	LEA 58%-42%
L-H	REA 47%-53%	REA 46%-54%	REA 46%-54%	REA 42%-58%
L-F	REA 46%-54%	REA 33%-67%	no EA 50%-50%	LEA 55.5%-44.5%
F-L	LEA 65%-35%	LEA 77%-23%	no EA 50%-50%	LEA 66%-34%

The results showed a non-significant interaction between reaction time and ear response (one factor ANOVA $F(1, 289) = 0.218$ $p > .05$). No other significant interactions between any of the conditions tested were observed.

8.6 Summary and Discussion

The results of the present study have shown that there is a consistent REA in the processing of lexical tone, suggesting a left hemisphere advantage for the processing of tone by listeners of Yalálag Zapotec. In contrast, there was a tendency for a LEA for hums, which could be interpreted as a right lateralization for non-linguistic stimuli. On this interpretation the findings of the present study are consistent with the theory which proposes that the left hemisphere is highly specialized for linguistic functions, whereas the right hemisphere is less involved in linguistic tasks (Fitch, Miller and Tallal 1997, Kraemer 1992, Liberman 1973, Moffat and Hampson 2000, among others). Particularly, the results of this study showing a consistent REA for phonemic tones suggest that there is a left hemisphere dominance in the processing of F0 when it is part of the linguistic system. The results obtained in the present study are consistent with similar findings by Van Lancker and Fromkin (1973, 1978), Wang, Jongman and Sereno (2001), Moen (1993), Gandour and Dardarananda (1988) and Gandour, Petty and Dardarananda (1988), all of which report a REA in the processing of phonemic tone. Likewise, the findings of the present study indicating a right hemisphere dominance for processing F0 in a non-linguistic context also confirm previous research (Blumstein, 1974; Efron, 1990; Goodglass, 1977; Hugdahl, 1999; Perkins, 1996; Shipley-Brown, 1988).

Two general accounts have been proposed regarding the hemispheric specialization of pitch: a theory of so-called "functional hierarchy" of pitch processing, put forward by Van Lancker (1980), and a theory of pure pitch processing, represented mainly by Ivry and Robertson (1998). In Van Lancker's account the association of pitch processing with the left or right hemisphere depends on its function. Hence, more specialized linguistic functions of pitch as in the use of phonemic tone would be lateralized to the left hemisphere, whereas less or non-linguistic uses such as pure tones, singing or even intonation would be processed primarily in the right hemisphere. According to Ivry and Robertson, the asymmetries observed in linguistic tasks (as well as a broader range of perceptual phenomena) are explained as a dissimilar "power" of each hemisphere, which is further conditioned by attentional mechanisms. Overall, the findings obtained in this study are consistent with the view that proposes a functional processing of pitch. Thus, since phonemic tone is a highly specialized linguistic function in the sound pattern of YZ, it is processed primarily in the left hemisphere. In contrast, because of the non-linguistic nature of hummed words, they tended to be processed by the right hemisphere. It is not clear how Ivry and Robertson's proposal could account for these facts and the asymmetrical results based on the type of stimuli under different attention conditions.

The results in the present study indicate a consistent tendency for a REA in processing lexical tone; however, the number of responses from the left ear suggests that the right hemisphere is also active in the processing of tone. In fact, recent studies suggest that this is the case. Andy *et al.* (1984) presented electroencephalographic evidence of direct brain stimulation showing that the right hemisphere is active in performing linguistic tasks. Other studies on split-brain subjects have also indicated that the right hemisphere is active in the processing of some linguistic functions (Gazzaniga and Hillyard 1971, Zaidel 1976). Similarly, in a recent study on a large pediatric hemispherectomy population Curtiss *et al.* (2002) found that language outcome was not correlated with side resected, but mainly with etiology of the neuropathology. Thus, the results of the present study are consistent with the view that although the left hemisphere is prepotent for linguistic functions, the right hemisphere makes a significant contribution to the entire linguistic processing in ways yet undefined. The specific nature and extent of its contribution should be further investigated, however.

This study also investigated attentional effects in dichotic listening to pitch pairs. Traditional models of dichotic listening would have predicted a null effect of attention on ear advantage (e.g. Kimura 1967, Siditis). Instead, the findings obtained in the present study partially confirm the initial hypothesis anticipating a positive interaction between ear advantage and directed attention of the subjects. Accordingly, for the linguistic stimuli there was an increase in the scores for the attended ear and a concurrent decrease in scores for the unattended ear in the forced conditions versus the non-forced condition. The results are thus consistent with several recent studies addressing the issue of selective attention in dichotic listening (Asbjørnsen, 1995; Hugdahl, 1986; O'Leary, 2003). However, against the predictions about the lateralization for the non-linguistic stimuli, the results showed a LEA in the forced conditions and a minor REA in the non-forced condition. This pattern can be interpreted as an effect of attention enhancing the right-hemisphere processing of non-linguistic stimuli. Thus, the findings regarding the effects of directed attention in dichotic listening to pitch stimuli support the hypothesis that forcing attention to one of the ears enhances the performance of the attended ear rather than suppressing intrusions from the non-attended ear.

One of the novel issues addressed in this study was the relationship between the individual pitches in a dichotic listening condition. The results showed that, unlike linguistic stimuli, the interaction of non-linguistic pitch stimuli did not show a pattern at all. Such a result may suggest that the non-linguistic nature of hums is either irrelevant or more demanding for processing. The predictions concerning the interaction among individual lexical tones were supported in part. First, it was hypothesized that the Low tone would be the least 'salient' tone in the dichotic task. The overall results for both types of stimuli, linguistic and non-linguistic, confirmed this expectation, when Low tone was delivered to the right ear, there were more intrusions from the left ear. The vulnerability of Low tone was also observed with regard to selective attention. Even though there was a REA for Low tone delivered to the right ear under forced to the right condition for linguistic stimuli, the magnitude of the enhancement was smaller than those obtained for High and Falling tones (see Table 75). Second, I suggested two possibilities for the interaction between H and F tones. In one of them it was predicted that the inherent complexity of F would be more salient than the characteristics defining H. In the other, the high frequencies of H would exceed the perceptual properties of F. If the non-forced condition is taken as a diagnostic of the natural trend of lateralization, the higher score for High tone in the dichotic pair F-H (where High is delivered to the right ear) may indicate a perceptual preference for high frequencies over the complex signal of F. Nevertheless, if the condition forcing attention to the left is considered as an index to measure intrusions to the prepotent left hemisphere, then the crucial results showing a REA in the pair H-F and lack of ear advantage in the pair F-H may indicate that the perceptibility of F is greater than that of H. Thus far, the conclusion seems to be that there is no single factor determining the perception of dichotic stimuli; rather, both factors, the complexity of the signal and the patterns of excitation, appear to be involved.

8.7 Concluding Remarks

In conclusion, based on the index of ear advantage, the evidence suggests that the processing of lexical tone by Yalálag Zapotec listeners occurs in the left hemisphere, in contrast with non-linguistic stimuli, which are processed in the right hemisphere. The results are consistent with other similar studies of tone languages (Moen, 1993; Van Lancker, 1973; 1978; Wang, 2001). However, while the findings indicate a left hemispheric specialization for phonemic tone, they do not exclude involvement of the right hemisphere in the overall processing. Furthermore, the results of the present study should be evaluated in the light of two recent PET studies (Gandour, 2000; Klein, 2001) investigating the perception of F0 in tone languages using a similar behavioral paradigm to the present study have found a significant activation in frontal, parietal and parietooccipital regions of the left hemisphere only in native listeners of tone languages when presented to linguistic stimuli, in contrast with listeners of non-tone languages who showed a right inferior frontal cortex activation. Since this study has presented initial evidence to suggest a pattern of brain lateralization for pitch processing in YZ, it would be desirable in future research to examine the current findings in the light of modern neuroimaging techniques to fully understand the hemispheric specialization of pitch in a tone language.

Appendix 1. Corpus Used in the Acoustic Analysis of Modal and Laryngealized Vowels

/a/

1. za	'fat'
2. za	'beans'
3. la	'hot'
4. da	'come!'
5. sla	'bitter'
6. la	'sharp'

/a'a/

7. ra'al	'up'
8. wala'a	'to make
9. bla'a	'rough'
10. kuan la'a	'bean plant'
11. bla'a	'crumb'
12. da'a	'soyate' (traditional belt for woman'
13. lta'a	'up hill'

/e/

14. te	'grey'
15. de	'ash'
16. le	'then'
17. le	'many'
18. ze	'each'

19. /e'e/	
20. le'e	'He' (respectful form)
21. ze'e	'wall'
22. ze'ed	'salt'
23. wale'e	'to lie down'
24. wchle'e	'to suck'

/i/

25. zi	'odor'
26. li	'truth'
27. tuli	'straight'
28. wasi	'squeeze'
29. zit	'far'

/i'i/

30. zi'i	'heavy'
31. lsi'i	'waist'
32. chedi'i	'be ashamed'
33. chejni'i	comprender

34. cheshni'i	'scare'
35. ti'ite	'quick'
36. di'ide	'jasper'

/o/

37. to	'one'
38. yo	'ground'
39. ro	'root'
40. sot	'whipe'
41. yito	'again'

/o'o/

42. wado'oz	'to put something upside down'
43. wlo'o	'to put inside'
44. do'oxho'	'rotten'
45. yo'o	'house'
46. lo'o	'pal'
47. cho'o	'to get inside'
48. no'or	'woman'

/u/

49. zu	'fermented'
50. zu	'it flies'
51. du	'rope'
52. nu	'who'
53. bsu	'adobe'
54. wazu	'drunken'
55. tuli	'right' address

Appendix 2. List of Vowels used in the Analisys of the Timing of Nonmodal Phonation

1. ba	tomb	127.sete	quick	128.xit	to jump
2. da	come	129.wej	hoe	130.yit	squash
3. dach	empty	131.wej	to drink	132.zit	far
4. ga	nine	133.wete	to grind	134.blli'n	foam
5. gach	blond	135.wete	to sell	136.ni'x	urine
6. la	hot	137.wex	to grab	138.bi'	what?
7. lla	day	139.xhbe	Isabel	140.bxhi'ill	badger
8. pap	potato	141.yej	flower	142.li'ix	field
9. waras	make it thin	143.yej	stone	144.xhi'ill	breast
10. xhad	plough	145.yell	hole	146.zi'i	heavy
11. yaj	rain	147.yell	town	148.go	sweet potato
12. za	fat	149.yes	cigar	150.gor	old
13. za	walk	151.be'	air	152.sot	whip
14. zapj	chayote stem	153.be're'	flesh	154.top	trash
15. ba'	animal	155.lle'	jar	156.wahoxh	to peel off
16. cha'	pan	157.wale'	to suck	158.waxhob	to shake corn
17. da'	mat	159.ye'l	banana	160.wazoj	to write
18. ga'	green	161.be'e	in the morning	162.wxox	to toast
19. la'	Oaxaca	163.be'es	fox	164.dxho'	earthquake
20. na'	hand	165.be'ex	soot	166.lo'	inside
21. ra'	name	167.blle'e	ant	168.bllo'on	pitaya
22. sla'	bitter	169.chje'es	oppossum	170.no'or	woman
23. ta'll	crushed	171.le'e	he	172.bsu	adobe
24. xa'	father	173.le'e	belly	174.btup	smeared
25. xha'	cloth	175.ye'e	excrement	176.chud	buzzard
26. ya'	hill	177.ye'es	pot	178.du	rope
27. ya'	pot	179.ze'ed	salty	180.du	maybe
28. za'	corn	181.bchit	rainbow	182.gul	wet
29. ba'a	polished	183.bich	overblown	184.kup	cop
30. ga'a	basket	185.bite	pazote plant	186.lull	moustache
31. na'a	my hand	187.bllin	mule	188.lu'll	tongue
32. nna'a	now	189.chin	thirteen	190.watub	to roll up
33. wa'ale	chintete	191.git	squash	192.watup	trash
34. beb	trash	193.lli	tranquil	194.wazu	drunken
35. bej	cloud	195.llir	grill	196.wube	broom
36. bej	well	197.llit	bone	198.zu	fermented
37. bel	sing!	199.nis	water	200.zu it	will fly
38. bel	fish	201.pich	dove	202.ku'll	back
39. bell	bull	203.rill	house		
40. bell	tomato	204.sib	high		
41. bellez	squirrel	205.sit	Mexico		
42. bellj	chicken	206.wasi	to squeeze		
43. bet	skunk	207.xhid	cat		
44. nez	road	208.xhixh	candy		

Appendix 3. Tone Pairs Stimuli used in the Perceptual Experiments (IPA transcription)

High		Low	
ʒén	'smoke'	ʒèn	'blood'
já	'temazcal'	jà	'bell'
zá	'fat'	zà	'bean'
jít͡ʃ	'grindstone'	jìt͡ʃ	'hair'
bʒín	'mule'	bʒìn	'foam'
dé	'there is'	dè	'ashes'
jáʔ	'hill'	jàʔ	'square'
zí̯ʔlè	'sheep'	zì̯ʔlè	'cotton'

High		Falling	
zú	'fermented beverage made of pinneaple'	zù	'to fly'
já	'temazcal' (sweathouse)	jà	'cane'

Falling		Low	
jêz	'cigar'	jèz	'corncob'
jâ	'cane'	jà	'bell'
jêʒ	'town'	jèʒ	'hole'
yéʔèl	'baby corn'	yèʔèl	'banana'
bên	'give me!'	bèn	'do it!'
láò	'monkey'	làò	'eye'

Appendix 4. Instructions in Zapotec used for the Perceptual Experiments

1. Non-forced attention

Zapotec: Gani wzenayo' lue' to list da sill gake'. Ton yenlo sill kone nayo' chaure'. Ye ton yenlo' sill kone nayo' rbezere'. Bengukle' le ballite dan yenlo' sill na'.

English: Here you will hear a list of words. One word will come to the right ear and one will come to the left ear. Repeat the word that you hear first as soon as possible.

2. Forced to the right

Zapotec: Gani wzenayo' lue' to list da sill gake'. Ton yenlo' sill kone nayo' chaure'. Ye ton yenlo' sill kone nayo' rbezere'. Bengunkle le ballite dan yenlo' sill kone nayo' chaure'.

English: Here you will hear a list of words. One word will come to the right ear and one will come to the left ear. Repeat the word that you hear to the right as soon as possible.

3. Forced to the left

Zapotec: Gani wzenayo' lue' to list da sill gake'. Ton yenlo sill kone nayo' chaure', ye ton yenlo' sill kone nayo' rbezere. Bengunkle le ballite dan yenlo' sill kone nayo rbezere'.

English: Here you will hear a list of words. One word will come to the right ear and one will come to the left ear. Repeat the word that you hear to the left as soon as possible.

Appendix 5. Information about the consultants

The source of data in this dissertation comes from my own field notes. In this appendix I introduce the basic information of my consultants and the codes that identify them in the dissertation. Some of the consultants preferred remain anonymous; in consequence, I only reveal the code and the relevant socio-demographic information. f means female, m male.

All of the consultants were born and raised in Yalálag (at least otherwise indicated). All of them are fluent bilingual Zapotec-Spanish, and some others have different degrees of competence in English. All of them speak Zapotec on a daily basis.

f1. Daria allende. 34. Bilingual Zapotec-Spanish. Born in Yalálag, raised in Yalálag and Oaxaca City. Spanish learned at school, since elementary education. Speaks both languages on a daily basis, Zapotec is used at home. Spoke mainly Zapotec until she was 15 when she moved to Oaxaca City. She works as an educator. Participates in radio shows reading Zapotec poetry.

f2. Daisy Alonso. 14. Bilingual Zapotec-Spanish. Born in Yalálag. Acquired Zapotec and Spanish simultaneously. Zapotec is used at home mainly. Reads and writes in Zapotec. Participates in bilingual radio shows.

f3. Estela Canseco. 48, Trilingual Zapotec-Spanish-English. Zapotec is the dominant language. Born and raised in Yalálag. Spanish learned at school (since elementary education). English learned in the US. Lived and spoke mainly Zapotec until she was 28 when she moved to Oaxaca City, where she used actively Spanish. Moved to the US in 1987.

f4. Margarita Manuel. 47. Bilingual Zapotec-Spanish. Born in Yalálag. Spanish learned at school, since elementary education. Currently she lives in Oaxaca City, where she use both languages on a daily basis, Zapotec is used at home and in the neighborhood. Spoke mainly Zapotec until she was 20 when she moved to Oaxaca City. She has lived in the US for a period of 4 years.

f5. Anonymous. 14. Bilingual Zapotec-Spanish. Born, and raised in Yalálag, where he lives. Uses both languages on a daily basis. Writes in Spanish. She is a secondary student.

f6. Luvia Aquino 32. Bilingual Zapotec-Spanish. Dentist. Born and raised in Yalálag. She has lived in Oaxaca City. Her permanent residence is in Yalálag.

f7. Adelaida Primo. 15. Bilingual Zapotec-Spanish. Born, and raised in Yalálag, where he lives. She is completed the secondary education.

f8. Anonymous. 13. Bilingual Zapotec-Spanish. Born and raised in Yalálag. Uses both languages on a daily basis. Spanish at school mainly. Writes in Spanish. She is a secondary student.

f9. Elizabeth Eslava. 33. Trilingual Zapotec-Spanish-English. Zapotec is the dominant language. Born and raised in Yalálag. Spanish learned at school (since elementary education). English learned in the US. Lived and spoke mainly Zapotec until she was 28 when she moved to Oaxaca City, where she used actively Spanish. She moved to the US in 1987, where she uses Zapotec on a daily basis.

m1. Alejandro Allende. 33. Bilingual Zapotec-Spanish. Born in Yalálag, raised in Yalálag and Oaxaca City. Spanish learned at school, since elementary education. Currently he lives in Oaxaca City, where he uses both languages on a daily basis, Zapotec is used at home. Spoke mainly Zapotec until she was 14 when she moved to Oaxaca City.

m2. José Bollo. 34. Trilingual Zapotec-Spanish-English. Born and raised in Yalálag. Spanish learned at school, since elementary education. English learned in the US at a community college for a period of one-year instruction. Lived and spoke mainly Zapotec until he was 18 when he moved for the first time to the US; moved to the US since 1989, where he uses the three languages. Speaks Zapotec on a daily basis. Writes poetry and literature in Zapotec. José Bollo is the main consultant in this dissertation.

m3. Alex Aquino. 19. Bilingual Zapotec-Spanish. Born in the US, moved to Yalálag at the age of 2, where he has lived since then. He has visited the US several times for periods of one week to two months. Claims not to be proficient in English.

m4. Mario Molina. 46. Bilingual Zapotec-Spanish. Born in Yalálag, started learning Spanish at elementary school. Lived in Yalálag until he was 15, when moved to Oaxaca City. He is a bilingual teacher and writer, author of Zapotec poetry.

m5. Irwin Manuel. 14. Bilingual Zapotec-Spanish. Born and raised in Yalálag. Moved to Oaxaca City at the age of 10. Learned Spanish at primary school. Uses both languages on a daily basis. Writes and reads Zapotec. He is a secondary student.

m6. Venancio Vargas. Trilingual Zapotec-Spanish-English. Zapotec is dominant. Learned Spanish at elementary school. He has been in the US three times for periods of two years each

m7. Apolonio Allende. 68. Bilingual Zapotec-Spanish. Knows some Mixe. Zapotec is dominant. Lived in Yalálag until he was 34, when he moved to Oaxaca City. Speaks Zapotec with his wife on a daily basis.

m8 Aristides Aquino. 2x. Bilingual Zapotec-Spanish. Lives in Oaxaca City and Yalálag Musical knowledge.

m9. Francisco Aquino. Bilingual Zapotec-Spanish. Shoemaker.

m10. Juvencio Aquino. 14. Student, secondary school. Bilingual Zapotec-Spanish
m11. Anonymous. 13. Student, secondary school. Bilingual Zapotec-Spanish.

m12. Anonymous. 14. Student, secondary school. Bilingual Zapotec-Spanish.

m13. Anonymous. 55. Peasant. Bilingual Zapotec-Spanish. Zapotec is the dominant language.

m14. Anonymous. 53. Peasant. Bilingual Zapotec-Spanish. Zapotec is the dominant language.

m15. Francisco Limeta. 33. Bilingual Zapotec-Spanish. Lives in Yalálag. He is a video producer and printer.

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