SECONDARY PALATALIZATION IN ISTHMUS MIXE:

A PHONETIC AND PHONOLOGICAL ACCOUNT

by

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Presented to the Faculty of the Graduate School of

The University of Texas at Arlington in Partial Fulfillment

of the Requirements

for the Degree of

DOCTOR OF PHILOSOPHY

THE UNIVERSITY OF TEXAS AT ARLINGTON

December 2002

DEDICATION

To my parents, William and Hattie Dieterman, who loved me and taught me so many things by their lifestyle and example, first of all to love and obey the Lord in all aspects of life, and as a result, to take responsibility, balance work and leisure, practice good time management, and care for others and our environment. They have gone to be with the Lord but their legacy continues to bless me.

ACKNOWLEDGMENTS

So very many people have contributed to the completion of this dissertation that it will be impossible to name them all. I am so very thankful for the willingness of so many to help in any way possible and to encourage me every step of the way.

To all of the Mixe people who so graciously shared their homes and language with me, I owe a great debt of gratitude. Without their help, collecting the data for this research would have been impossible. Although I would like to acknowledge specific individuals, because of the need to maintain their anonymity for their protection, names will not be given.

To my Supervising Professor, Dr. David J. Silva: I could not have completed the work without you! Thanks for directing and redirecting my thinking in the research, analyses, and writing.

To the other members of my committee: A special note of appreciation to Dr. Donald A. Burquest and Dr. Jerold A. Edmondson whose patient classroom instruction and encouragement helped lay the foundation for this research. I appreciate Dr. Carol McKinney's helpful suggestions for a clearer explanation of difficult concepts. And sincere thanks to Dr. Robert B. Reed for rearranging his schedule to accommodate becoming a member of my committee at a very late date.

ABSTRACT

SECONDARY PALATALIZATION IN ISTHMUS MIXE

A PHONETIC AND PHONOLOGICAL ACCOUNT

Publication No. _____

Julia Irene Dieterman, Ph.D.

The University of Texas at Arlington, 2002.

Supervising Professor: David J. Silva

This dissertation is a study of the process of palatalization in Isthmus Mixe, in which every consonant in the inventory has a palatalized counterpart. This type of palatalization occurring as a secondary [i]-like articulation, simultaneous to the primary articulation of the consonant (Bhat 1974, Ladefoged 1993), is defined as secondary palatalization by Keating (1993). Occurring word initially in Isthmus Mixe, the feature of secondary palatalization alone represents the grammatical third person morpheme, palatalizing the initial consonant of the noun or verb. There are also verbal suffixes that consist solely of secondary palatalization, indicating clause-type markers (Dieterman 1995, 1998), and a deverbalizer, that palatalize the final consonant(s) of the verb.

Morpheme-induced secondary palatalization has been described in all of the Oaxacan Mixe languages; however, Isthmus Mixe is an undescribed language except for

the recent work of the author of this dissertation. It is shown that the secondary

palatalization feature in Isthmus Mixe modifies (mutates) the initial or final consonant(s)

of the word and also the vowel(s) adjacent to the consonant. Spectrograms that show the

transition formants of vowels adjacent to palatalized consonants support the claim that

even the laryngeal consonants /h/ and /ʔ/ are subject to secondary palatalization.

It is shown that representing secondary palatalization as an autosegmental feature

may be used to describe all occurrences of morpheme-induced secondary palatalization

and its phonetic effects on all of the consonants and vowels. Previous descriptions of

other Mixe languages that were based on the linear phonemic model, obscured the

phonetic reality of secondary palatalization and did not recognize secondary

palatalization as a consonant mutation. Autosegmental features that are consonant

mutations linked to morphemes have been described in a number of the world's

languages. With this initial description of secondary palatalization in Isthmus Mixe, and

references to secondary palatalization in all of the Oaxacan Mixe languages, it is hoped

that these processes will become known to the wider linguistic community and also that

further studies will be initiated in the Mixe-Zoque languages.

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1P	first person
1P_INC	first person plural inclusive
2P_PL	second person plural
3P	third person
AUX	auxiliary
CAU	causative
CLMK	clause-type marker
CUS	clitic of unknown significance
dB	decibel
DIR	directional
F1	first formant
F2	second formant
F3	third formant
F4	fourth formant
FUT	future
H1	first harmonic
H2	second harmonic
HZ	hertz

INV	inverse clause marker
LOC	locative
MAN	manner
ms	milliseconds
NEG	negative
NOM	nominalizer
OBJ	object focus
PL	plural
RAT	Revised Articulator Theory
RSLT	result
UAC	Universal Association Convention

CHAPTER 1

1 Introduction

1.1 Palatalization

Palatalization is a common phonological process in the languages of the world. What is less well known is that there are two major types of palatalization processes that have been documented: 1) palatalization which modifies the primary articulation of the consonant itself, referred to here as "primary palatalization," and 2) the addition of a high front tongue position ([i]-like) as a secondary articulation which occurs simultaneously with the primary consonantal articulation, referred to in this dissertation as "secondary palatalization" (Bhat 1974:19-20, Keating 1993:6, Ladefoged 1993:230).

Although secondary palatalization of consonants is well attested in some languages (e.g. Lithuanian, Russian), the fact that a similar phenomenon occurs in the Mixe languages of Mexico has been virtually unreported in the linguistic community. This study examines the issue of palatalization in one variety of Mixe, Isthmus Mixe, with a broader aim of contrasting the processes of primary palatalization and secondary palatalization, showing ultimately how the type of morphological-induced secondary palatalization found in the Mixe languages is best described in terms of an autosegmental feature. In accomplishing these goals, this dissertation provides a phonological sketch of

Isthmus Mixe, including acoustic analyses, and documenting the widespread effects of

secondary palatalization in the language.

1.2 Isthmus Mixe and the Mixe-Zoque language family

Isthmus Mixe, also known as Eastern Mixe or Guichicovi Mixe,[1] is a

San Juan Guichicovi
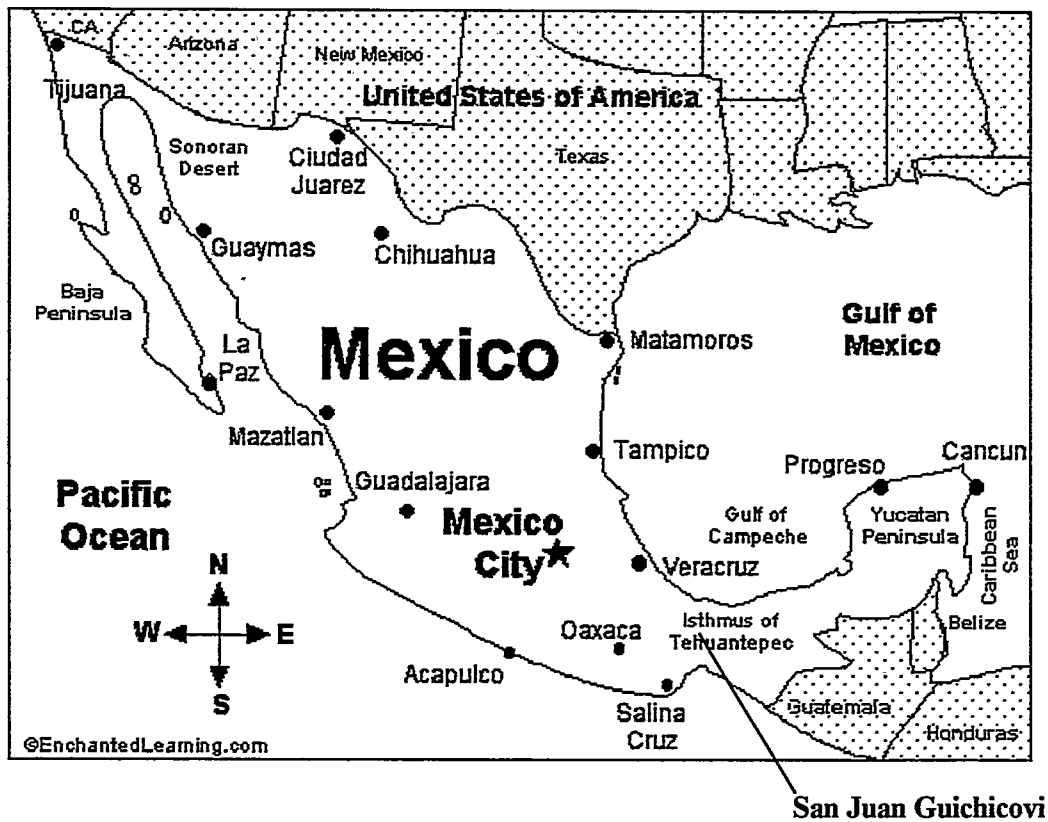
Figure 1.1. Map of Mexico.
(EnchantedLearning.com: 2001)

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[1] The names reflect geographical or political relationships. "Isthmus" is the geographical
area of the Isthmus of Tehuantepec. The label "Eastern" is in relationship to the other
Mixe languages which are spoken in areas farther west. San Juan Guichicovi is the major
city in this Mixe region.

Mesoamerican language of the Mixe-Zoque family spoken in southern Mexico in the state of Oaxaca. It is primarily an oral language, with some religious and governmental documents having been translated with the assistance of bilingual speakers (*El Nuevo Testamento en Mixe de Guichicovi* 1988, Pedro 1994). In 1990 there were reported to be 20,000 speakers (Grimes 2000:321). The Isthmus Mixe people live in the region of the Isthmus of Tehuantepec in southern Mexico (figure 1.1). Their more numerous and well-known neighbors in the Isthmus are Zapotec speakers.

Many of the relatively few speakers of the Mixe-Zoque languages are pressured by economic, educational and social factors to use Spanish, the national language of Mexico. Like so many of Mexico's indigenous languages, Mixe-Zoque languages are endangered because of the greater prestige and opportunities available to Spanish speakers.

1.3 Studies in the Mixe-Zoque languages

A historical and comparative study of the Mixe-Zoque languages by Wichmann (1995), provides a brief sketch of the phonology of every language in the Mixe-Zoque language family. He also proposes proto-Mixe-Zoque forms and devotes a large part of his book listing proto-forms with examples from many of the present day languages. His classification of the Mixe-Zoque languages is discussed in section 1.4.1.

A number of Mixe-Zoque languages have been analyzed and described by linguists with the Summer Institute of Linguistics (currently known as SIL International), and a few other authors, resulting in published linguistic articles, collections of texts,

popular dictionaries (usually with a section on grammar), reading materials, and New Testament translations. Works of the various individual Zoque languages have been published by Elson (1961),[2] Engel and Engel (1987), Foster and Foster (1948), Harrison and Harrison (1984), Knudson (1975), Lind (1964), and Wonderly (1951).

Publications about the various individual Mixe languages include those by Clark (1959), Clark and Clark (1960), Crawford (1963), Hoogshagen (1959), Hoogshagen and Hoogshagen (1993), D. Lyon (1967), S. Lyon (1967), Miller (1937), Morgan (1980), Schoenhals and Schoenhals (1982), Van Haitsma [Dieterman] and Van Haitsma (1976).

However, none of the authors listed has worked specifically on Isthmus Mixe (except for the present work of Dieterman), meaning that little of substance has been published about this variant of the language. Although Norman Nordell was instrumental in completing a translation of the Guichicovi New Testament (*El Nuevo Testamento en Mixe de Guichicovi,* 1988), his untimely death in 1990 prevented him from completing the linguistic analysis of his materials. In 1993, some data from Nordell's files were made available to the author of this dissertation, which stimulated interest in visiting the Isthmus and analyzing the language. One very preliminary account of fortis/lenis consonants in Isthmus Mixe by Bickford (1985) was written with Nordell's assistance in collecting data.

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[2] Although only one date is cited for each author here, in most cases they have published more articles and books in these languages.

The field work that ultimately led to the writing of this dissertation was first started by collecting Isthmus Mixe data during the years 1994-99. Four published (or in press) studies by Dieterman are based on these data: "Participant Reference in Isthmus Mixe Narrative Discourse" (1998), "Secondary Palatalization and Changes in Vowel Formants in Isthmus Mixe" (2002a), "Word Order Variation in Isthmus Mixe: Voice and Discourse Considerations" (2002b), and "Word Order and Inverse Voice in Isthmus Mixe" (in press). In addition, several unpublished manuscripts have been written, including a master's thesis on participant reference in Isthmus Mixe narrative discourse at The University of Texas at Arlington (Dieterman 1995). Beyond these works, no other linguistic studies of Isthmus Mixe have been published. Moreover, this study and Dieterman (2002a) are the first in any Mixe-Zoque language to include acoustic analyses, thereby representing a significant step forward in our understanding of this language family.

1.4 General surveys of Mesoamerican languages

The Mixe-Zoque language family is included in the broader designation of Mesoamerican languages. As a well-defined geographical, cultural and linguistic area, Mesoamerica is home to a number of unrelated language families (Campbell, Kaufman and Smith-Stark 1986). Although some classifications place the Mixe-Zoque languages as part of the larger Penutian group (Freeland 1930, Greenberg 1987, Sapir 1929), other surveys do not classify the Mixe-Zoque with any other language family (Campbell 1979, Suárez 1983, Yasugi 1995). Several authors have suggested that the Mixe-Zoque

languages may be traced back to the Olmecs, 1500 BCE, an ancient civilization in southern Mexico (Campbell and Kaufman 1976, Hilts 1999, Stross 1985). However, Wichmann (1995), who has done extensive studies in proto-Mixe-Zoque, does not believe there is sufficient evidence to state that the Mixe-Zoque languages are of Olmec origin.

Surveys of Mesoamerican languages, such as done by Suárez (1983) and Yasugi (1995), have compiled much phonological and grammatical data about these languages from available published sources. Yasugi (1995:65-75) includes a section on comparing Middle American[3] phonological systems with linguistic universal statements and also a chapter on the word order typology of these languages. Unfortunately, these surveys give only an incomplete picture of the phonology of the languages, since they are based on phoneme charts and linear representations and fail to include crucial non-linear features such as the palatalization and laryngealization features in Mixe as described by Hoogshagen (1984:4) and Van Haitsma [Dieterman] and Van Haitsma (1976:5-11). Not only in the Mixe languages are these features important, but as Silverman (1997:236) points out, contrastive laryngeally-complex vowels are "attested throughout the Otomanguean language group," a large family of languages in Mesoamerica. Because the surveys use simplified listings of the phonemic segments of the languages, they can only

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[3] Yasugi uses the term "Middle America" to include some languages north and south of the Mesoamerican region.

convey partial information, and thus they lack important data for cross-linguistic comparisons.

1.4.1 Mixe-Zoque surveys

Wichmann (1995) has proposed a detailed classification of Mixe-Zoque languages. Among the languages of the Zoque branch are three languages and fourteen dialects which include a place name followed by the word *Zoque* as the designation of the language or dialect. These Zoque languages are spoken in southern Mexico in the states of Chiapas, Oaxaca, and Tabasco. However, there are two Popoluca[4] languages that are also considered to be part of the Zoque branch, namely Sierra Popoluca (also known as Soteapan Zoque) and Texistepec Popoluca (also known as Texistepec Zoque). There are also two Popoluca languages that are considered to be part of the Mixe branch, Sayula Popoluca and Oluta Popoluca (Nordell 1962). The four Popoluca languages are spoken in Veracruz.

In the Oaxacan Mixe category, Wichmann lists four languages and among them seventeen dialects. Also included in the Mixe branch is the language Tapachulteco,[5] which, along with the two Popoluca languages, makes a total of seven Mixe languages. Wichmann's classification differs somewhat from earlier ones; for example, regarding the status of Tapachulteco, which Elson (1992:578) and Wonderly (1949) place with the

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[4] There are Otomanguean languages called Popoloca, sometimes confused with Popoluca because of the similarity in spelling.

[5] Tapachulteco was spoken in Chiapas, but is now extinct.

Zoque languages, and also Wichmann includes data from more languages and dialects

than the previous classifications.

The language family tree shown in figure 1.2 is taken from Wichmann (1995:10),

based on his proposed reconstructions of proto-languages in the Mixe-Zoque language

family. Isthmus Mixe is one of the Lowland Mixe languages,[6] called *Guichicovi* by

Wichmann, from the name of the major city in this Mixe region, San Juan Guichicovi.
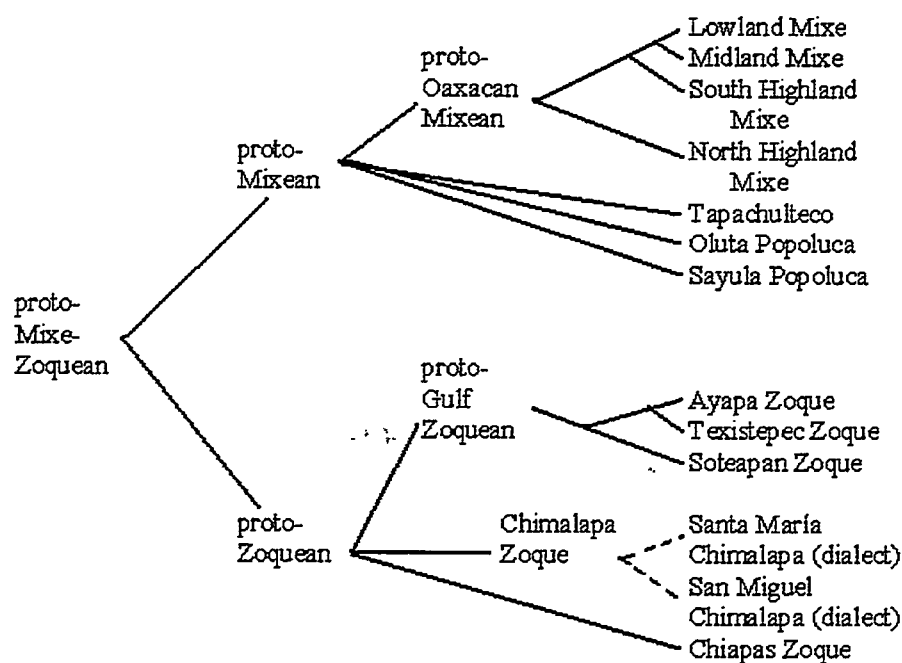
Figure 1.2. The evolution of the Mixe-Zoquean languages (Wichmann 1995:10).

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[6] Wichmann (1995) uses the term *dialect*, not *language*. Isthmus Mixe is listed as one of
the Mixe-Zoque languages in Grimes' Ethnologue (2000:321).

1.5 Isthmus Mixe typology

Since this dissertation focuses on secondary palatalization and the phonology of the Isthmus Mixe language, the following sketch of its typology and syntax will be kept to the rudiments only. The phonology is discussed in more detail in the following chapters.

Isthmus Mixe is an SOV language (Dieterman 2002b) with prepositions and postpositions, genitives and demonstratives before noun heads, and relative clauses after the head. It generally fits Greenberg's type #23: SOV, Postpositions, Genitive-Noun, Attribute-Noun (Greenberg 1966:109).[7] Transitive clauses are divided into direct (active) and inverse based on the models described in Givón (1994). The language is agglutinating, characterized by long verbs comprising several morphemes and affixes.[8]

(1) *mïnit   ha   toːʃⁱʰk   ha   ʲ-uːnk   ʲ-hanĩʲ-wow-tṳ-pⁱʰk-ʲ*
    then   the   wife   the   3P-child   3P-actually-call-trail-take-CLMK[9]

juːk-hoːtʲ
forest-center

'Then the wife actually took her children on the trail into the heart of the forest.'

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[7] It would be possible to assign Isthmus Mixe to Greenberg's type #19, which is the same as #23, except that there are Prepositions instead of Postpositions. Isthmus Mixe has only two prepositions, but several postpositions (these have not been completely analyzed); therefore #23 seems more appropriate.

[8] Some frequently occurring verbs that are only one syllable long are commonly used, but may be affixed when syntactically necessary.

[9] 3P 'third person'; CLMK 'clause-type marker'

The clause is the basic information unit with typical sentences composed of one to three clauses. Isthmus Mixe SOV(X)[10] word order in a one-clause sentence from a narrative discourse is shown in example (1).

1.6 Overview of the dissertation

Although the focus of the dissertation is on secondary palatalization in Isthmus Mixe, the material covered includes a range of related phonetic and phonological phenomena. Chapter 2 is a phonological sketch of Isthmus Mixe, including phonetic descriptions illustrated with waveforms and spectrograms of various features of the language. Chapter 3 defines primary and secondary palatalization and gives examples of each kind of palatalization, especially in the languages of the Mixe-Zoque family. Of particular importance is the presentation of the origin of secondary palatalization in the Mixe languages. Chapter 4 is a case study of the effects of secondary palatalization in Isthmus Mixe: a text of fluent continuous speech was digitized for analysis and relevant statistical tests reveal a number of consistent relationships between secondary palatalization and vowel allophones. Spectrograms illustrate the effects of secondary palatalization in various contexts. Finally, Chapter 5 discusses the implications of the Isthmus Mixe data for theoretical models of feature geometry and their ability to deal with it adequately. It will be demonstrated that not all the models are equal; in fact, the model developed by Hume (1994) is the best for the data, although this model is

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[10] SOV(X) indicates that a peripheral element may follow the verb.

modified to accommodate secondary palatalization as manifested in Isthmus Mixe.

Derivations of Isthmus Mixe syllables are shown using the autosegmental model first

developed by Goldsmith (1990). Isthmus Mixe secondary palatalization, which manifests

three homophonous morphemes, is considered to be a mutation process (Lieber 1987).

What is thus shown to be an unusual phonetic occurrence in the language is seen as

having important grammatical functions on the morphological level.

CHAPTER 2

2 Phonological sketch of Isthmus Mixe

2.1 The Isthmus Mixe data

The Isthmus Mixe data analyzed in this study are extracted from personal

narratives and other monologues spoken by various male and female native speakers and

tape-recorded on site by the author of this dissertation, between 1994 and 1999. In

addition, a recording of a text read by a male speaker in a professional recording studio

in 1995 was purchased. All speakers were from San Juan Guichicovi and Mogoñé,

located in the Isthmus of Tehuantepec, Oaxaca, Mexico.[1]

Field work began in a related Mixe language, spoken in the village of San José El

Paraíso, where the author lived for extended periods of time from 1968-1977, primarily

speaking the language of the people there, Coatlán Mixe. During that time she co-

authored *A hierarchical sketch of Mixe as spoken in San José El Paraíso* (Van Haitsma

[Dieterman] and Van Haitsma 1976). At a later period, 1994-99, she made four visits of

about three weeks each to San Juan Guichicovi and Mogoñé, during which time she

lived with the Isthmus Mixe people, conversed in Mixe with them, tape-recorded native

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[1] The names of Mixe speakers are not given because of the potential need for privacy and
protection.

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speakers, and took notes during unrecorded conversations in Isthmus Mixe with other speakers and while listening to conversations among the Mixe people.

In general, the style of language that was analyzed can be described as not completely unmonitored but also not overly formal; it is somewhat closer to vernacular speech than more formally elicited data, which tends to be unnaturally slow and overly careful. As Fant (1973:19) has noted: "A common observation when spectrograms of ordinary connected speech are studied is that modifications and omissions of speech sounds are frequent. Carefully pronounced single testwords and phrases may differ considerably from ordinary speech." Although in this study occasional reference is made to elicited words and sentences, generally preference is given to the language as used in tape-recorded continuous texts in which the speakers are communicating ideas in narrative contexts. Although, as Labov (1971:460) remarks, "the vernacular is the style which carries the greatest interest for the study of linguistic structure ...," it is recognized that the presence of the linguist and the tape-recorder affects the style of the speakers to some extent: the observer's presence colors the data. Therein is the paradox of obtaining data of everyday informal speech.

All of the segments relevant to this study have been analyzed in various contexts using the Speech Analyzer software developed by the Summer Institute of Linguistics, version 1.5 (10.6), copyright 1996-1998, by JAARS - ITCS, Waxhaw, NC. The

descriptions of basic acoustic analysis principles by Baart 1999, Fant 1973, Stevens 1998,[2] Van Summers 1987, and others were used as guides in the analysis.

One selection of fluent continuous speech, 100 seconds long, was digitized for analysis. The speaker of the text was an Isthmus Mixe male, age 42, of Mogoñé, Oaxaca, Mexico, tape-recorded in a professional recording studio in July of 1995. The text was read in normal (unemphatic) narrative style. Every native Mixe word in the selection was analyzed using the Speech Analyzer software described above. The fuller context of the narrative text encompasses the study of the individual elements under consideration. This continuous text is referred to throughout the dissertation as *Text A* (see Appendix).

2.2 Overview of Isthmus Mixe phonemes

Eleven consonants are found in native Mixe words: /p t k ʔ t͡s ʃ h m n w j/, shown in figure 2.1 (further discussed in section 2.3); the vowel phonemes /i ɨ u e a o/ are shown in figure 2.2 (further discussed in section 2.4). Additional phonemes from Spanish and other languages which are common in loan words include /b d g s l r (flap and trilled)/.[3] Only native Mixe words are analyzed in this study. The simple Isthmus

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[2] Stevens (1998) has detailed acoustic descriptions, including spectrograms, of the basic consonants and vowels, as well as descriptions of the variations of creaky and breathy voiced segments.

[3] Four words in Isthmus Mixe begin with /l/, namely, /lek/ 'toad', /lek/ 'baby', /lɨkʃ/ 'too small', and /luːt/ 'vulture.' The origin of these words is unknown; however /l/ is not included in the list of proto-Mixe-Zoque phonemes proposed by Wichmann (1995:67) who states: "A marginal phoneme /l/ occurs in probably all [Mixe-Zoque] languages. One item containing /l/ appears in [proto-Oaxacan Mixe] and another one in [proto-Mixe-Zoque], but these may be onomatopoeic."

Mixe phonemes (apart from the modification features) are nearly the same as those listed

by Wichmann (1995:67) for the proto-Mixe-Zoque phonological system: *e is central

	Labial	Alveolar	Post alveolar	Palatal	Velar	Glottal
Plosive	p	t			k	ʔ
Affricate		t͡s				
Fricative			ʃ			h
Nasal	m	n				
Approximate	w			j		

Figure 2.1. Isthmus Mixe consonant phonemes.
Every consonant may be modified by the addition of
secondary palatalization (indicated by the symbol ʲ).

	Front unrounded	Central unrounded	Back rounded
Close	i	ɨ	u
Mid	e		o
Open		a	

Figure 2.2. Isthmus Mixe vowel phonemes.
Every vowel quality may be modified by length and/or laryngealization.

instead of front, and *s realizes as /ʃ/ in Isthmus Mixe. Vowel length is phonemic in

proto-Mixe-Zoque, with laryngealization as part of the coda.

In comparing the inventories of Isthmus Mixe consonants and vowels with other

languages in the Mixe-Zoque family, the difficulty encountered is one of differing listings

or analyses regarding the phoneme inventories. According to a survey by Yasugi

(1995:416), the Mixe of San José El Paraíso has twelve consonant phonemes, Coatlán

Mixe has fifteen, Tlahuitoltepec Mixe has fourteen, Totontepec Mixe has sixteen, Oluta

Popoluca has fourteen, and Sayula Popoluca has eighteen. Zoque languages range from

twelve consonant phonemes to twenty-two.

Some of the differences in the number of consonants can be attributed to

different analyses regarding phonemes versus allophones and inclusion of loan word

phonemes in the inventory. For example, in the Mixe of San José El Paraíso, which has

one more than the eleven Isthmus Mixe consonants, the extra phoneme is /ŋ/, which in

Isthmus Mixe is analyzed as an allophone of /n/ occurring in the /nk/ cluster. In Coatlán

Mixe, /ŋ/ is listed as a phoneme, along with the voiced plosives /b d g/ which are listed as

secondary phonemes in the Mixe of San José El Paraíso, occurring mostly in loan words

and only a few shortened forms of Mixe words (Van Haitsma [Dieterman] and Van

Haitsma 1976:5-6). The Isthmus Mixe consonant inventory does not include loan word

consonants. Thus it is impossible to make an exact comparison, even with languages in

the same language family. Yasugi (1995:13) admits this problem stating:

Nevertheless, I have generally accepted the inventories proposed by authors who deal primarily with the languages in question and I utilize them in the database of my study. This raises questions about the reliability of the data, and makes it difficult to compare the data equally, but having neither sufficient data nor knowledge of the languages in question, I have chosen not to reanalyze them.

With this caveat, Yasugi nevertheless presents a phonological statistical survey of 174 languages and dialects in the Middle American area. The consonant inventory ranges from eleven to thirty-five. Certainly the Mixe languages are at the lower end of this range, regardless of how the number is ascertained, and there are no unusual consonant phonemes. In Yasugi's survey, 68% of the vowel systems are five- and six-vowel systems, including length and nasalization, with the range between three and nine vowels. Only the Mixe of San José El Paraíso and Coatlán Mixe are listed as having three contrastive lengths. The description of three contrastive lengths in Coatlán Mixe (Hoogshagen 1959) is cited by many authors because of this very unusual length feature. The other Mixe languages generally have regular and long vowels (no nasalization). The number of vowels listed for the Mixe of San José El Paraíso, Coatlán Mixe, Oluta Popoluca, and Sayula Popoluca are six, for Tlahuitoltepec Mixe, seven, and Totontepec Mixe, nine. The latter is the only nine-vowel system in the survey that also has length. There are only five other nine-vowel systems in the survey, and these five all have nine oral vowels and from three to six nasal vowels. Zoque languages are all listed as having six (oral) vowels, with only Sierra Popoluca having length (Yasugi 1995:50-3, 424-5).

Many Middle American languages are listed as having various tone systems by Yasugi (1995:54-56), mainly in the Otomanguean and Chibchan language groups; however, none of the Mixe-Zoque languages has been described as having a tone system. Not included in the survey by Yasugi (1995) are laryngeal features of breathiness and creakiness which occur in many Mesoamerican languages (Longacre 1957, Rensch 1976, Silverman 1997), including Mixe-Zoque languages. Laryngeal features are described on the syllable level in Mixe-Zoque languages as part of complex syllable nuclei (Wichmann 1995:67). Although the tone systems and laryngeal features of the Mesoamerican languages are widespread, they are not mentioned in Campbell, Kaufman, and Smith-Stark (1986) as phonemic features that define Mesoamerica as a linguistic area; in fact, there are no phonemic features at all among the five isoglosses they have found to delimit any such linguistic area that can be termed "Mesoamerican."

Comparison of the Mixe-Zoque languages with the phonologies of the world's languages is made possible by the results of a survey of 317 languages, which were "chosen to approximate a properly constructed quota sample on a genetic basis of the world's extant languages" (Maddieson 1984:5). As with any phonological survey, there are problems in determining the segment inventories; notwithstanding, general comparisons are reasonably informative. The typical number of segments (consonants and vowels) lies within a range of twenty to thirty-seven segments, with 70% of the languages falling within that range.

Copainalá Zoque and Totontepec Mixe are included among the 317 languages of the survey. Totontepec Mixe is listed as having fourteen consonants and nine vowels; Copainalá Zoque is listed as having sixteen consonants, three of which are indicated as being "somewhat anomalous" (Maddieson 1984:202), and five oral vowels and one nasal vowel, described as a "nasalized mid fronted back unrounded vowel" (Maddieson 1984:257). Isthmus Mixe, with eleven consonants and six vowels, falls below the typical range (vowel length and laryngealization features are not counted as separate segments in the survey). Most languages with less than twenty segments do not have a tone system (twenty-two out of twenty-six languages).

The most unusual feature in Mixe languages of secondary palatalization of every consonant in the inventory was not considered in Maddieson's survey because generally, "complex phonetic events [were treated] as sequences (i.e. as combinations of more elementary units)" (Maddieson 1984:6). In addition, the data sources for Totontepec Mixe (Crawford 1963, Schoenhals and Schoenhals 1965) also treat palatalization as the sequence of consonant plus /y/ (chapter 3, section 3.7.2). Neither does Yasugi's survey include secondary palatalization in the Mixe languages because it is not described on the linear phonemic level (chapter 3, section 3.5). Thus, while secondary palatalization is described in more well-known languages, the secondary palatalization of the Oaxacan Mixe languages remains undisclosed to the general linguistic community. Therefore, the research and descriptions presented in this study will focus on elucidating secondary

palatalization in Isthmus Mixe[4] (see chapter 4 in which a case study of *Text A* resulted in contextualized, in-depth analyses, frequency counts, and performance of statistical tests of the data). Prior to the presentation of secondary palatalization, the basic Isthmus Mixe consonants and vowels are described (the rest of chapter 2), including waveforms and spectrograms, and a brief sketch of syllable structure and stress. In this study, acoustic tools which have, up to now, not been exploited in descriptions of Mixe languages, are used to examine the details of the Isthmus Mixe consonants and vowels.

2.3 Isthmus Mixe consonants

2.3.1 Secondary palatalization of consonant phonemes

All of the Isthmus Mixe consonant phonemes may be supplemented by a secondary articulation of palatalization, which will be argued to be an autosegmental feature (see chapter 5, section 5.5.1). This type of palatalization is defined by Ladefoged (1993:230):

> the formal definition of a secondary articulation is that it is an articulation with a lesser degree of closure occurring at the same time as another (primary) articulation. ... Palatalization is the addition of a high front tongue position, like that in [i], to another articulation.

In the examples given throughout this dissertation, the phonetic manifestation of secondary palatalization is indicated by the symbol [j] (superscript "j").

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[4] Most of what is said about secondary palatalization in Isthmus Mixe is probably applicable to all the Oaxacan Mixe languages (see chapter 3, section 3.7.5).

2.3.2 Consonantal allophones

2.3.2.1 Voicing of /p t k t͡s h/

The most notable allophonic behavior of the Isthmus Mixe voiceless phonemes /p t k t͡s h/ is voicing in certain positions.[5] The plosives /p t k/ are generally voiced between vowels,[6] following a nasal or the glide /j/, and usually following a long vowel. Similarly, the affricate /t͡s/ has a voiced allophone that occurs between vowels or following a nasal or /j/, but only the first segment is voiced initially and then usually becomes devoiced as the transition to the sibilant begins. The examples in (1) show the plosives /t/ and /k/ voiced between vowels, and also voicing of /k/ following a long vowel. In example (2), the word for 'mother' begins with /t/ which is voiced when preceded by the prefix *n* /n-/ 'first person'. Example (3) gives the contrast of the voiceless plosive /k/ following the short creaky vowel in /pɨk/ [pɨk] 'little' which becomes voiced following the long vowel in /iːk/ [iːg] 'toy'. In example (4), the plosive of the affricate /t͡s/ is voiced following the nasal /m/.

(1) /mitow/ [midow] 'listen!'   /tikiːk/ [tigiːg] 'three'
(2) /taʰ/ [taʰ] 'mother'   /n-taʰ/ [ndaʰ] 'my mother'
(3) /pɨk/ [pɨk] 'little'   /iːk/ [iːg] 'toy'
(4) /amt͡soː/ [amd͡soː] 'oneself'

---

[5] Variants related to emphatic or slow, careful speech are not considered to be allophones. For example, the plosives are occasionally aspirated in emphatic speech but this is a stylistic variant.

[6] Exceptions to this rule usually involve two morphemes, such as clitics or compounds or a voiceless consonant cluster coda occurring morpheme final which is followed by a suffix beginning with a vowel. Plosives following breathy voice or short creaky voice vowels (sections 2.4, 2.4.3) are voiceless, as are consonant clusters composed of plosives and fricatives.

Voicing of plosives is well attested in the world's languages, but voicing of

sibilant fricatives is far less common; one reason is that "the flow impedance at the glottis

[of voiced segments] increases the difficulty of creating turbulence at the articulatory

constriction" (Ladefoged and Maddieson 1996:176-8). Isthmus Mixe is unexceptional in

regard to plosive and sibilant voicing.

Isthmus Mixe fricative /h/ has a voiced allophone [ɦ] which occurs between

vowels only, shown in figure 2.3 [t͡sufɨ̃] from /t͡suhɨjnɨp/ 'it was getting late.'[7] One

indicator of voicing as shown by the waveform (top window in figure 2.3) and
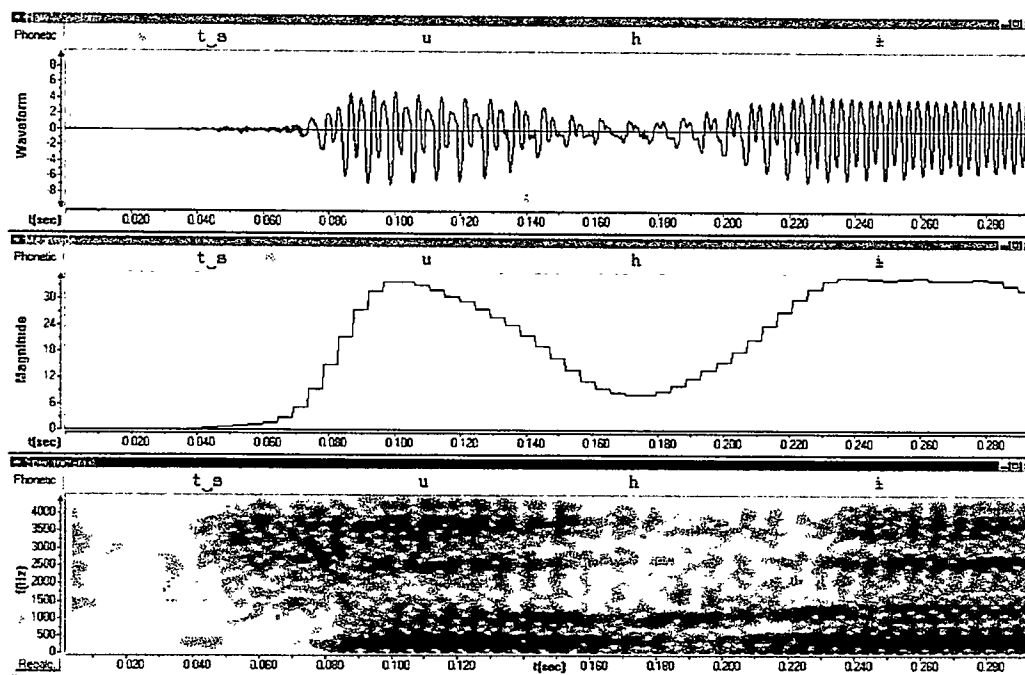
Figure 2.3. Voicing of /h/ between vowels in [t͡sufɨ̃].

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[7] This acoustic example is directly copied as one unit from the Speech Analyzer software (section 2.1).

spectrogram (lower window in figure 2.3) is repetitive or periodic speech waves. In the

waveform shown in figure 2.3, [ɦ] is approximately 50 milliseconds (ms) in duration (at

0.150 to 0.200) with six repetitive peaks above the straight line.[8] The time from one

peak to the next is a cycle, representing one opening and closing of the vocal folds. In

the spectrogram, the energy pulses of the cycle are seen as the darkest vertical lines.

Another indicator of voicing is amplitude, especially in the lower part of the

spectrogram (less than 500 Hz in figure 2.3), called the *voice bar* by Jannedy, Poletto,

and Weldon (1994:78). Amplitude is measured by the Speech Analyzer software used in

this study in decibel values (dB) with 0 dB (zero decibel) representing the softest sound

the normal human can hear and 1 dB the smallest discernable difference (Baart 1999,

Denes and Pinson 1993:40-43). The amplitude of each of the formants of [ɦ] in figure

2.3 was measured across the entire segment and the average decibel value at each

TABLE 2.1

AMPLITUDE VALUES (dB) OF THE VOICED ALLOPHONE [ɦ]
AND ADJACENT VOWELS /u/ AND /ɨ/

	F1	F2	F3	F4
[ɦ]	31.3 dB	17.3 dB	2.0 dB	-6.7 dB
/u/	35.3 dB	22.0 dB	9.3 dB	12.7 dB
/ɨ/	36.0 dB	19.3 dB	10.7 dB	8.7 dB

---

[8] The straight line that runs horizontal across the middle of the waveform represents the average air pressure; the peaks or upward spikes represent positive air pressure and those that go below the line (bottoms) represent negative air pressure. Amplitude is measured as equal to the largest deviation from the average (Baart 1999, Johnson 1997).

formant noted in comparison to the decibel values of the adjacent vowels. As displayed

in table 2.1, the amplitude of the formants of [ɦ] between the vowels shown in figure 2.3

is 31.3 dB at F1, 17.3 dB at F2, and 2.0 dB at F3, with higher formants showing

negative values (-6.7 at F4).[9] In contrast, the amplitude of /u/ is 35.3 dB at F1, 22.0 dB

at F2, 9.3 dB at F3, and 12.7 dB at F4. The amplitude of /ɨ/ is 36.0 at F1, 19.3 dB at F2,

10.7 at F3, and 8.7 dB at F4. Thus [ɦ] contrasts with the adjacent vowels by having very

little amplitude in the higher for`mants, yet it shows voicing in F1.[10] Notice the contrast

of this voiced [ɦ] with the voiceless [h] in figure 2.4, which has negative dB values in the

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[9] On the spectrogram, the first formant (F1) is shown as the dark horizontal band at the bottom, the second formant (F2) is the next dark horizontal band at about 1000 Hz in the vowel /u/ and the voiced [ɦ], and rising toward 1500 Hz in the vowel /ɨ/. The third formant (F3) is about 2500 Hz throughout and the fourth formant (F4) between 3500 Hz and 4000 Hz. The reader is referred to Baart 1999, Jannedy, Poletto and Weldeon 1994, Ladefoged and Maddieson 1996, Stevens 1998, and other descriptions of acoustic phonetics too numerous to list.

[10] Although Stevens (1998) does not describe a voiced [ɦ] between vowels, his comparison with the voiced aspiration following a plosive in /dha/ (Bengali) shows the amplitude of A2 (corresponding to F2 of the vowel) to reach over 40 dB (after an initial drop to 30 dB) and the amplitude of A3 (corresponding to F3 of the vowel) to reach over 35 dB (after an initial drop to about 28 dB). The amplitude of F2 of the initial portion of /a/ reaches just below 50 dB and F3 reaches about 45 dB. The exact dB values are not given; the relative levels are shown in a graph (Stevens 1998:476-9). Thus the amplitudes of voiced [ɦ] are about 10 dB less than the amplitudes of the corresponding formants of the vowel. In the Isthmus Mixe example, the F2 amplitude of voiced [ɦ] is 4.7 dB less than the F2 amplitude of /u/ and 2.0 dB less than the F2 amplitude of /ɨ/. The differences in the amplitude of F3 are 7.3 dB and 8.7 dB, respectively. However, the relative F3 values in Isthmus Mixe are 11.7 dB lower for /a/ and 8.6 dB lower for /ɨ/ than the F2 values. Although there are some similarities in the two examples, there are also definite differences.

lower Hz, a peak of 5.3 dB around the F2 formant of the following vowel and a second peak of 4.0 dB at the F4 formant of the vowel. The voiceless [h] shows much more frication than the voiced [ɦ], illustrating the inverse relationship between frication and voicing (Ohala 1997:689).

A comparison of the relative amplitude values of the entire segments in the middle window (Magnitude) of figure 2.3 shows the voiceless segment [t͡s] to have no visible amplitude line at the beginning of the segment and just beginning to rise above the bottom line of the window at the end of the segment, followed by a sharp rise to the peak of [u], nearly to the top of the window (the scale on the left indicates about 33 dB). From the peak of [u], the magnitude tapers down to the low area of [ɦ] at about 9 dB, then rises to the peak of [ɨ] at the top of the scale, about 34 dB. In this display, the amplitude of [ɦ] is well above the level of the voiceless affricate, yet considerably below the amplitude levels of the vowels. The differences in these amplitude values are consistent with the amplitude values of the formants shown in table 2.1, where it is shown that [ɦ] has much less amplitude in the higher formants than the vowels.

The vowel of any clitic that precedes or follows a voiceless phoneme (e.g. *ha~*[11] 'the (distal)', *~it͡sʲ* 'first person', and *~in* 'locative/manner marker') does not cause the voicing which normally occurs between vowels. In the noun phrase *ha~kajtuk*

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[11] The symbol ~ is used to indicate a clitic to distinguish it from other particles (i.e. prefixes and suffixes are indicated by a hyphen).
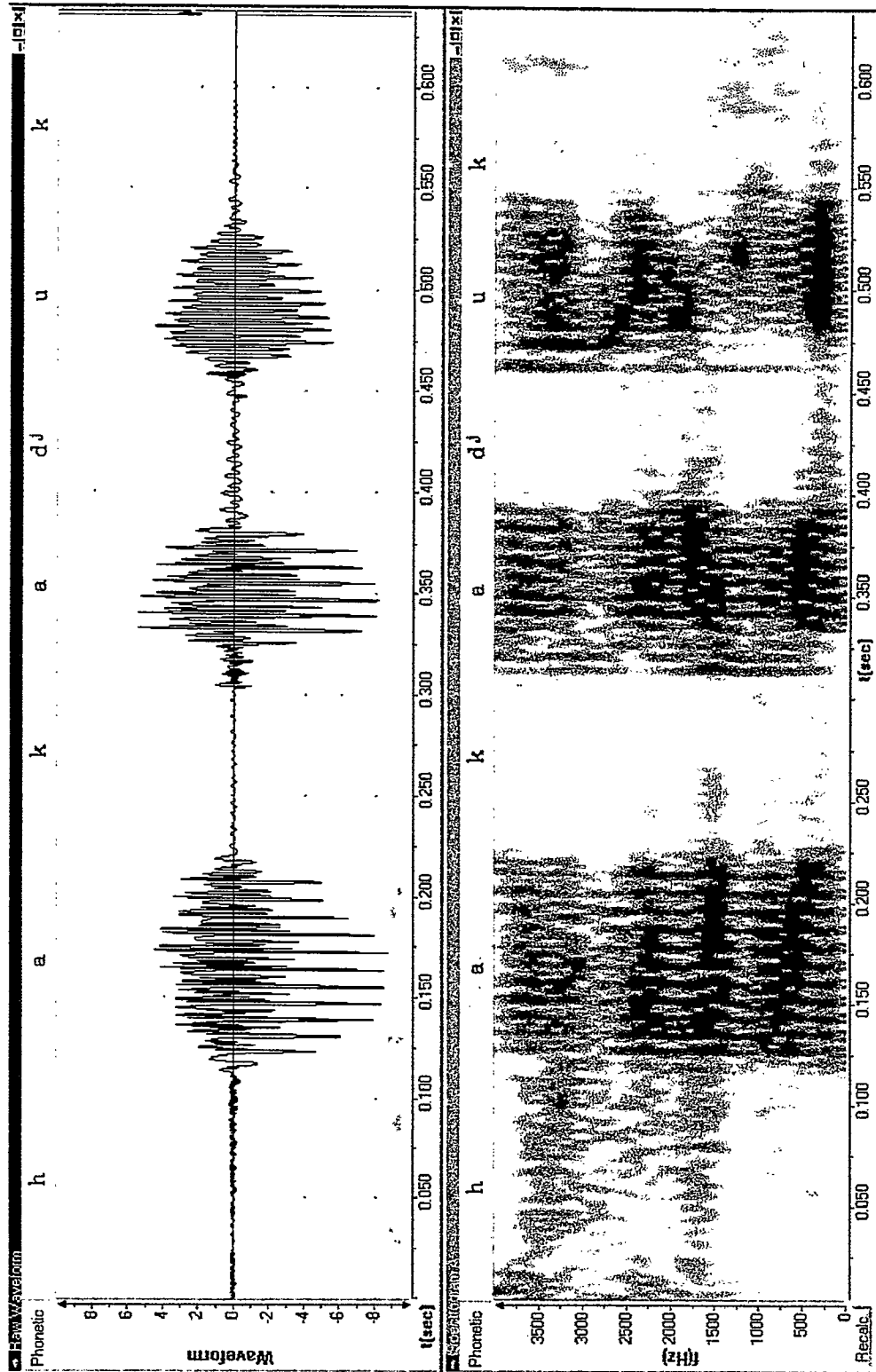
Figure 2.4. /ha~kajtuk/ [hakād^jūk] 'the leftovers.'

[hakād^{j}ūk] 'the leftovers' (figure 2.4), the clitic *ha~* 'the' immediately precedes the noun

kajtuk 'leftovers' (i.e. there is no phonetic break between the clitic and the noun), but the

vowel of the clitic does not cause voicing of the initial consonant /k/ of the noun.

2.3.2.2 Nasal place assimilation

Nasal place assimilation, a common process in the world's languages (Burquest

1998:117), occurs in Isthmus Mixe word medially and as the first member of a

morpheme-final consonant cluster, but not in word-initial position. Thus /n/ has an

allophone [m] preceding /p/ and [ŋ] preceding /k/, except in word initial position; [n]

occurs in all other environments, examples 5-7 (see chapter 5, section 5.2.1). The form

of the verb that has no affixes is shown in (5) /min/ [min] 'come!' and in (6) adding the

clause marker suffix *-p* results in nasal place assimilation /minp/ [mimb] 'he is coming.'

When a suffix beginning with /k/ is added, the allophone [ŋ] occurs as in (7). There is

also the nasal phoneme /m/ which contrasts with /n/ in morpheme initial and final

positions (examples 8-11).

(5)	/min/	[min]	'come!'[12]
(6)	/min-p/	[mimb]	'he is coming'
(7)	/min-kumpɨ/	[miŋgumbɨ]	'he is coming again'
(8)	/maʦ/	[maʦ]	'grab [it]!'
(9)	/naʃ/	[naʃ]	'pass by!'
(10)	/kom/	[kom]	'full'
(11)	/kon/	[kon]	'short'

---

[12] The exclamation point is used in the glosses to indicate the imperative form of the
verb.

In word initial position, /n/ precedes /p/ or /k/ only if /n/ is the prefix indicating

first person subject or first person possession. As a morpheme, it does not assimilate to

the place of articulation of the following consonant. As a word initial morpheme, for

example, *n* /n-/ 'first person' contrasts with *m* /m-/ 'second person'. Both /m-/ and /n-/

have voiceless allophones when they precede /ʔ/ and /h/ in word initial position as

morpheme prefixes (examples 12-15).[13]

(12) /m-kaːkʲ/   [mgaːgʲ]   'your tortilla' (m- 'your'; kaːkʲ 'tortilla')
(13) /n-pitoːʃʲ/   [nbɨdo̰ːʃʲ]   'my sister' (n- 'my'; pitoːʃʲ 'sister')
(14) /m-ṵk/   [m̥ʔṵk]   'you drink' (m- 'you'; ṵk 'drink')
(15) /n-huj/   [n̥hūj]   'I buy' (n-'I'; huj 'buy')

The other consonants (i.e. /ʔ w j/) do not have allophones (other than secondary

palatalization; see chapter 4).

2.3.3 Fortis/lenis consonants

It has been suggested by Bickford (1985), Wichmann (1995), and in the

orthography used by Nordell[14] in the Guichicovi New Testament translation that Isthmus

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[13] These occurrences are not common in the texts; this is a general statement made on the basis of only a few examples. There are six examples of /mh/ and /mʔ/ that are voiceless and one example of /mh/ that is voiced. There are five examples of /nh/ that are voiceless and one example of /nʔ/ with /n/ voiced, utterance initial. One could speculate that discourse considerations may cause voicing but not on the basis of so few examples. Much more data would have to be analyzed to obtain more examples.

[14] This was the last work published as prepared by Norman Nordell with native language assistants before Nordell's death.

Mixe has a fortis/lenis contrast. However, in the studies of the author of this dissertation,

no fortis/lenis contrasts were found, as will be discussed in the following paragraphs.

In Bickford's description of the parameters for the fortis/lenis distinction, he

states: "The primary phonetic cue for the fortis/lenis contrast in obstruents is

susceptibility to voicing. The lenis versions of the consonantal obstruents p, t, k, c, and x

are voiced in intervocalic position, whereas the fortis ones are always voiceless"

(1985:197).[15] Regarding sonorants, he says that consonantal length was the basis for

contrast, and, in fact, length was the basis in all cases, with single consonants designated

as lenis, geminate consonants as fortis. In his study, Bickford (1985) presents six pairs of

words which contrast fortis/lenis consonants. He admits that most of his examples are

morphologically complex, which he says is not important to his study. However, in four

of the examples he gives of consonants which remain voiceless (and thus fortis) between

vowels, the fortis consonants are at the juncture of two morphemes. In the example

"kappïk 'carry it (imp)'" one morpheme is *kap* 'to carry [poles]'[16] and the second

morpheme in this compound is *pik* 'to take.' As has been stated, when two voiceless

phonemes occur at morpheme junctures they do not become voiced (see section 2.3.2.1,

footnote 6). In three examples the quotative suffix follows the imperative form of the

verb. One could interpret the data as showing that the quotative suffix reduplicates the

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[15] Bickford (1985) uses the symbol "x" to refer to /ʃ/.
[16] Isthmus Mixe has a number of classifications for carrying different types of items based on size and shape and the usual means of carrying them. 'Poles' represents long, thin items.

final consonant of the verb to which it is attached. The fifth example shows a lenis *t* following a long vowel in the word "peeet 'Peter'."[17] It seems more economical to simply posit a voiced allophone of the voiceless stops which occurs following long vowels. Finally, the sixth example is given of lenis *n* in "tuuun 'oblong, oval' and fortis *n* in "tuunn 'he worked'." In this case, clause stress may lengthen the final segment, especially before a pause. This is a common phenomenon in the texts studied for this dissertation. Apparently no frames were used in obtaining these examples; they were obtained as individual tokens. Bickford (1985:198) states that "it is possible that in fast speech the length contrast is reduced or eliminated," offering an explanation of why the contrast had not been observed prior to his study.

In discussing the Mixe languages in general, Wichmann (1995:29) uses [tns] to indicate *tense* and states: "Barred means 'fortis' (tense) and the absence of a bar, 'lenis' (lax)." By *barred* he means a superscript bar over the letter corresponding to the fortis consonant. Wichmann (1995:30) states that he is uncertain about "how fortis consonants are actually pronounced ... [but] that prolonged articulation may be the defining phonetic property of fortis consonants."[18]

Referring specifically to Isthmus Mixe, Wichmann (1995:55) states: "For all

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[17] Bickford (1985:199) states: "I have also distinguished the half-long vs. long vowels, even though this difference is not contrastive." Thus one assumes one vowel is used to indicate regular length, two vowels indicate half-long, and three vowels indicate long, although this is not stated explicitly.

[18] Wichmann (1995:30) was referring to another Mixe language, not to Isthmus Mixe.

consonants there are tokens which exhibit a fortis-lenis opposition." However, he does not give any distinguishing characteristics, except that the voiced consonants are all shown to be [-tns], by which he means lenis, and the voiceless consonants are all shown with both [-tns] (lenis) and [+tns] (fortis) forms, except for the glottal stop which is shown as only [-tns]. However, by means of ordered morphophonemic rules, he eliminates the feature [tns] so that the fortis/lenis contrast is not included in the final inventory of consonants (Wichmann 1995:56). In his brief sketch of Isthmus Mixe phonology, very few examples are given, with no examples of the fortis/lenis opposition.

In the data analyzed by acoustic methods in this study, there is no evidence of a fortis/lenis contrast using the parameters of duration and amplitude, except the contrasts between the voiceless consonants and their respective voiced counterparts. Voiceless consonants are typically longer than voiced ones in all languages (Maddieson 1997:625); Isthmus Mixe is no exception in this regard. Since the nasals are always voiced in the positions where the fortis consonants are marked in *Text A*, which is written in Nordell's orthography, a detailed analysis of the nasals was made in this text, looking at the parameters of length and amplitude.

Since both Wichmann and Bickford indicate that the fortis/lenis contrast is found in syllable-final position, a search was made in *Text A* to find one utterance which contains syllable-final nasals shown as fortis and lenis in the orthography. In figure 2.5, /ʲ-hanʃʲ tem ʲ-ʔiʃ-aN-p-ʲ~ɨ/ [hʲānʃʲtemʔ ʲ ɨʃāmʲbʲ ɨ] 'he really really wanted to see him,' three nasals are included in one utterance, two of which are marked by Nordell as fortis
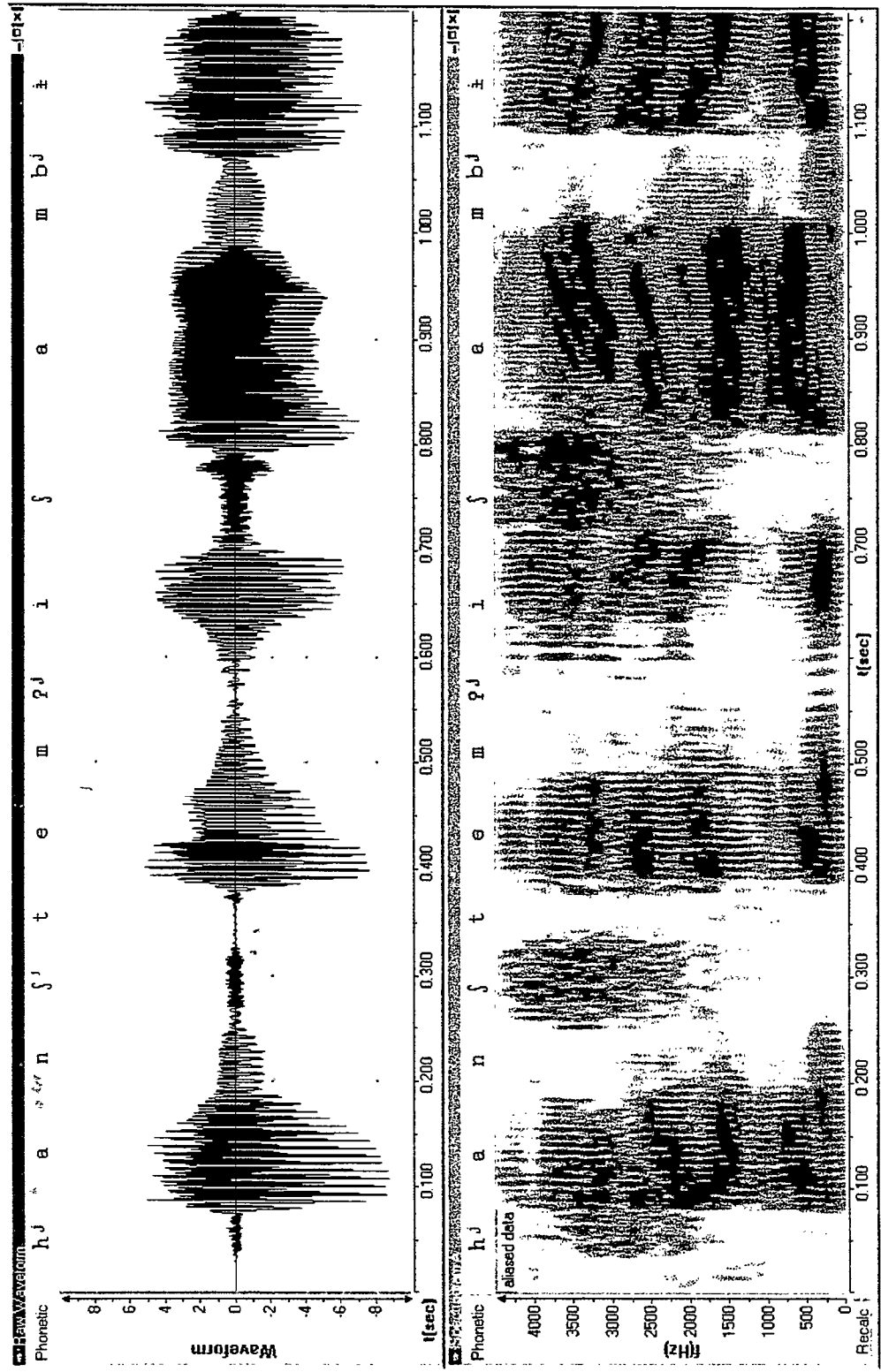
Figure 2.5. /ˡ-haŋˡ tem ˡ-ʔiʃ-am-pˡ~i/ [hˡāŋˡtemʔⁱɬjāmˡbˡⁱ] 'he really really wanted to see him.'

in the orthography of *Text A*, and one is unmarked (lenis). The primary stress in this

utterance (a grammatical clause) is on the syllable [ʃāmʲ], in which [m] is marked as

fortis and is 64.4 ms in duration. About equal secondary stresses are on each of the other

two syllables: [hʲānʃʲ] with [n] unmarked (lenis) at 63.2 ms and [tem] with [m] marked

as fortis at 60.5 ms. The amplitude of [m] in [ʃāmʲ] is greater than the amplitude of the

other two, which is expected since the greatest stress is on this syllable. Therefore, in this

clause, there is no evidence of a fortis/lenis contrast of the nasals based on duration.

Durations of individual nasal phonemes in *Text A* vary considerably, with no

indication of a fortis/lenis contrast. In over 120 occurrences of the nasal phonemes /m/

and /n/, there are eight which occur in utterance-final position, twenty-seven in syllable-

final position but utterance medially, and eighty-five in syllable-initial position (table 2.2).

Of the eight utterance final tokens, two are marked as fortis in Nordell's orthography

and six are unmarked (lenis). Measured in milliseconds, 37.5% (lenis) are 75-100 ms,

25% are 100-150 ms (these are the two marked as fortis), and 37.5% (lenis) are 150-175

ms. In syllable-final position, but utterance medially, sixteen are marked as fortis and

eleven are lenis. Of those marked fortis, 1% is less than 50 ms, 50% are 50-75 ms, 25%

are 75-100 ms, and 24% are over 100 ms. Of those unmarked (lenis), 1% is less than 50

ms, 62% are 50-75 ms, 27% are 75-100 ms, and none are over 100 ms. Of the syllable-

initial nasals (all lenis), 45% are less than 50 ms, 35% are 50-75 ms, 19% are 75-100 ms,

TABLE 2.2

DURATION OF NASALS AS MARKED FORTIS OR LENIS IN *TEXT A*

	Utterance final		Syllable final (utterance medial)		Syllable initial
duration in ms	Fortis (N 2)	Lenis (N 6)	Fortis (N 16)	Lenis (N 11)	Lenis (N 85)
<50			1%	1%	45%
50-75			50%	62%	35%
75-100		37.5%	25%	27%	19%
100-150	25%		24%		1%
150-175		37.5%			

and 1% is over 100 ms. A fortis/lenis contrast of nasals based on phonetic duration is not evident in *Text A*.

Although this small sample does not prove or disprove the presence of a fortis/lenis contrast of nasals, it suggests that no such contrast exists in *Text A*, which is considered to be representative of the language phonologically. The voiceless/voiced contrasts of the plosives are better described as allophones, as is shown in section 2.3.2.1. Moreover, no minimal or analogous monomorphemic pairs based on a fortis/lenis contrast in duration have been observed in *Text A* or in the other data of the study.

2.3.4 Acoustic nature of /ʂ/ in Isthmus Mixe

Although the /ʂ/ in some other Mixe languages is retroflexed (Crawford 1963:43, Van Haitsma [Dieterman] and Van Haitsma 1976:10), there is no acoustic evidence for retroflexion in Isthmus Mixe. According to Fant (1973:28) the "retroflex modification" of an alveolar articulation is "F_4 low and close to F_3" and of a palatal articulation is "F_3 low and close to F_2." Ramasubramanian and Thosar (1971) classify the retroflexed consonants of Tamil as palatal (stop, nasal, lateral).[19] Their data and spectrograms show that the steady-state formants of vowels adjacent to the retroflexed consonants have a lowered F3 in comparison to the steady-state formants of vowels adjacent to non-retroflexed consonants. The F3 transitions of vowels adjacent to retroflexed consonants drop down to join with the F2 transition at the border with the consonant. In the data of *Text A*, selected portions of the text immediately following *Text A*, and data obtained from other speakers of Isthmus Mixe, the phenomena associated with a markedly lower F3 of vowels adjacent to /ʂ/ do not occur.[20] Also there is no lowering of F4 such as Fant (1973) observed for alveolar articulations. In figure 2.6, [ʂɨ] /ʂɨː/ 'name,' the F3 transition is not lower than the steady-state; instead it is seen to be higher, with a distance from the F2 transition. Although the F4 transition is lower than the F4 steady-

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[19] The exact physical details of how retroflexion was produced are not discussed in either Ramasubramanian and Thosar (1971) or Fant (1973).

[20] The F3 steady-state values of /ɨ/ and /o/ adjacent to /ʂ/ in figures 2.6 and 2.7 are somewhat lower than the mean of these vowels in the case study (chapter 4, section 4.6.2), but still well above the minimum in the minimum-maximum range. (The F3 values of the case study have been analyzed but not published.)
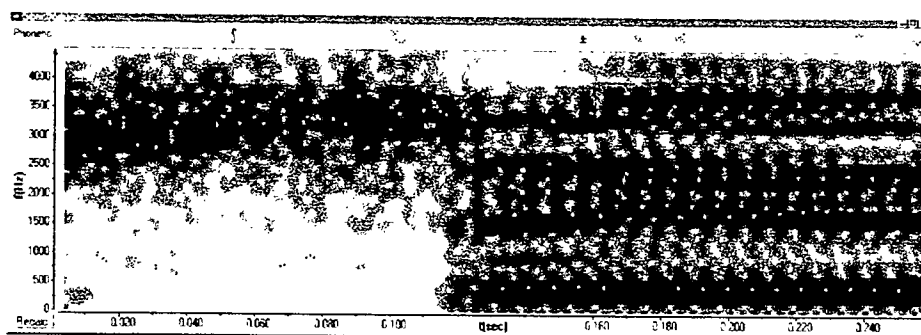
Figure 2.6. Formants of the vowel adjacent to [ʃ] in [ʃi].

state formant, it does not approach the F3 transition. Another vowel with /ʃ/, namely /o/,

shown in figure 2.7, [oʃ] from /mikoːʃk/ 'five' is similar to [ʃi] in regard to the F3 and

F4 transitions. More detailed analyses have not been made concerning the articulatory

position of the Isthmus Mixe /ʃ/; however, on the basis of the acoustic data, it is

considered to be palato-alveolar. The palatalized allophone is contrasted with the

nonpalatalized allophone in chapter 4, section 4.4.3.
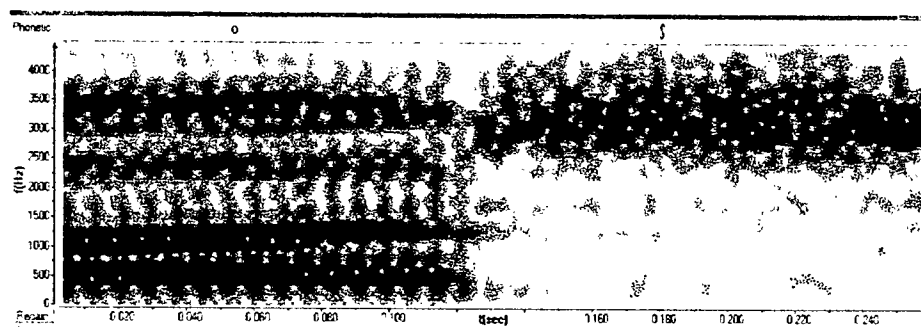
Figure 2.7. Formants of the vowel adjacent to [ʃ] in [oʃ].

2.4 Isthmus Mixe vowels

The vowels in Isthmus Mixe are described with three parameters: 1) vowel

quality (/i ɨ u e a o/ as shown in figure 2.1); 2) quantity (length); and 3) voice quality

(laryngealization), which together form the syllable nucleus (section 2.5.2). Each vowel

quality may be manifested as short or long modal voice, short or long creaky voice, and

breathy voice (always long phonetically).[21] The creaky and breathy voice qualities are

described in section 2.4.3.1. In this dissertation short modal vowels are written with the

vowel quality symbol alone, long modal vowels are written /aː/, creaky voice is indicated

by a wavy line beneath the vowel quality symbol (short creaky: /a̰/; long creaky: /a̰ː/),

and breathy voice is indicated by superscript /ʰ/ following the vowel (/aʰ/).[22] Fronted

allophones of all the vowel qualities are written with a bar over the vowel in the phonetic

transcripts [ā āː ā̰ ā̰ː āʰ].

Minimal pairs to illustrate all of the parameters of vowel quality, quantity, and

voice quality in complete sets are not found in the data. Also, some words which can be

cited to show a contrastive segment do not usually occur without affixation. Given these

caveats, a number of words are given in examples (16-18) which show vowel quality

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[21] Further studies of Isthmus Mixe voice qualities are suggested, for example using the Rothenberg Mask, spectral tilt, and inverse filtering as described by Edmondson and Li (1994), and Ní Chasaide and Gobl (1997), among others. Since the focus of this study is on secondary palatalization, only preliminary analyses were done on vowels.

[22] A non-standard symbol is used to simplify transcription and to make the contrast more apparent (i.e. the superscript /ʰ/ is much more visible than two dots below the breathy-voice vowel). Superscript /ʰ/ does not imply segmental Vh (see section 2.5.2).

contrasts: in (16) the vowel qualities /i ɨ u a/ are contrasted in breathy voice quality; in

(17) /ɨ e o a/ are contrasted in short modal voice, and in (18) /ɨ u a/ are contrasted in

long creaky voice.

(16) /tiʰ/ 'push!'; /tɨʰ/ 'break (pole)!'; /tuʰ/ 'shoot!'; /taʰ/ 'dig!'
(17) /kɨʃ/ 'finish!'; /keʃ/ 'send!'; /koʃ/ 'hit!'; /kaʃ/ 'comb!'
(18) /kɨ̰ːk/ 'sandal'; /kṵːk/ 'crowd'; /ka̰ːk/ 'banana'

Examples (19-20) show voice quality and length contrasts: in (19) vowel quality

/u/ is shown in all the combinations of voice quality and quantity (i.e. short modal, long

modal, short creaky, long creaky and breathy); and in (20) vowel quality /ɨ/ is also shown

in all the combinations of voice quality and quantity.

(19) /tuk/ 'old'; /tuː/ 'rain'; /tṵt͡s/ 'pot'; /tṵːk/ 'one'; /tuʰk/ 'to pick (fruit)'
(20) /nɨm/ 'thus'; /nɨːm/ 'duck'; /tɨ̰nʲ/ 'defecation'; /mɨ̰t/ 'son-in-law';
      /mɨʰ/ 'large'

2.4.1 Vowel quality

Wichmann (1995:53-4) has claimed that there are seven vowels: the six vowel

qualities already shown and, in addition, a short reduced vowel (schwa) that is never

stressed. However, in doing the analysis both from auditory impressions and from

instrumentally derived data, there is no evidence for a seventh vowel. In Nordell's

orthography this vowel is indicated by <ä>, occurring as the first-syllable vowel of a two-syllable root morpheme (see figure 2.11), in unstressed suffixes, and in enclitics.[23]

In the case study selection of *Text A*, there are fifty-three of these <ä> vowels (adjacent to nonpalatalized consonants).[24] In Nordell's orthography <ø> represents the full vowel /i/, which occurs in stressed syllables and with any syllable nuclei (modal short and long, creaky short and long, or breathy). Thirteen tokens of the full vowel /i/ occur in *Text A*.

In order to determine if there are significant measurable acoustic differences in these vowels, which would indicate the need to posit two separate phonemes, the formants of both types of vowels were determined using the Speech Analyzer software (see section 2.1) and statistical tests were performed using the Statistical Package for the Social Sciences (SPSS) version 10. Analysis of Variance (ANOVA) and t-tests were performed on the three categories of the vowel (i.e. full vowel, first-syllable vowel, suffix or clitic vowel) with similar results from the two types of tests. In the summary of the

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[23] This results in a distribution phenomenon specific to this vowel. There are no contrasts with the other vowel qualities in these positions. In selected portions of the text immediately following *Text A*, a verbal prefix written as <nä'ägädä> or <nä'ägä> 'intensifier' (Nordell's orthography) occurs several times. However, the speaker always pronounced it with the vowel formants of /i/. No occurrences of this prefix were found in *Text A*.

[24] Only vowels adjacent to nonpalatalized consonants are under consideration here. Vowels adjacent to palatalized consonants have an allophone conditioned by palatalization (see chapter 4, section 4.6.3).

TABLE 2.3

MEAN FORMANT VALUES (HZ) OF ISTHMUS MIXE VOWEL /ɨ/ IN FIRST
SYLLABLES, AS CONTRASTING VOWEL, AND IN SUFFIXES
DATA FROM MALE SPEAKER READING *TEXT A*
Numbers in parentheses represent standard deviations.

	First syll. (N 31)	Full Vowel (N 13)	t	p
F1	346.8 (46.5)	385.2 (38.2)	-2.853	p = 0.008*
F2	1526.5 (174.0)	1478.4 (215.0)	0.779	p = 0.484
F3	2515.5 (172.4)	2511.8 (160.0)	0.066	p = 0.946

	First syll. (N 31)	Suffix (N 22)	t	p
F1	346.8 (46.5)	388.2 (35.1)	-3.699	p = 0.001*
F2	1526.5 (174.0)	1481.6 (135.2)	1.055	p = 0.296
F3	2515.5 (172.4)	2472.7 (135.3)	1.011	p = 0.317

	Full Vowel (N 13)	Suffix (N 22)	t	p
F1	385.2 (38.2)	.388.2. (35.1)	-0.231	p = 0.819
F2	1478.4 (215.0)	1481.6 (135.2)	-0.048	p = 0.962
F3	2511.8 (160.0)	2472.7 (135.3)	0.739	p = 0.468

t-tests (table 2.3), all significant "p" values are starred. Significance is set at the 95%
confidence level (p ≤ 0.05).

Significant differences are shown for F1 between the vowel in the first syllable
(346.8 Hz) and the full vowel (385.2 Hz) and also for F1 between the vowel in the first
syllable (346.8 Hz) and the suffix vowel (388.2 Hz). The differences in the mean values
for F1 show that the vowel in the first syllable manifests a first formant that is 38.4 Hz

TABLE 2.4

MEAN FORMANT VALUES (HZ) OF ISTHMUS MIXE VOWEL /ɨ/ IN FIRST
SYLLABLES, AS CONTRASTING VOWEL, AND IN SUFFIXES
DATA FROM FEMALE SPEAKER IN ELICITED SENTENCES
Numbers in parentheses represent standard deviations.

	First syll. (N 5)	Full Vowel (N 5)	t	p
F1	460.7 (12.5)	426.2 (29.7)	2.394	p = 0.059
F2	1810.8 (43.6)	1696.2 (79.4)	2.828	p = 0.029*
F3	3204.3 (85.2)	3121.8 (143.3)	1.107	p = 0.308

	First syll. (N 5)	Suffix (N 5)	t	p
F1	460.7 (12.5)	447.0 (16.2)	1.503	p = 0.174
F2	1810.8 (43.6)	1714.5 (94.0)	2.077	p = 0.086
F3	3204.3 (85.2)	3170.0 (122.8)	0.514	p = 0.623

	Full Vowel (N 5)	Suffix (N 5)	t	p
F1	426.2 (29.7)	447.0 (16.2)	-1.371	p = 0.208
F2	1696.2 (79.4)	1714.5 (94.0)	0.333	p = 0.748
F3	3121.8 (143.3)	3170.0 (122.8)	-0.571	p = 0.584

and 41.4 Hz less than the F1 of the full vowel and suffix respectively. These data indicate
that the vowel in the first syllable is slightly higher than the vowels in the other two
positions.[25] It could be said that for this speaker, /ɨ/ has a slightly raised allophone in the
first syllable position.

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[25] F1 values are inversely related to the height of the vowel (i.e. the smaller the number,
the higher the vowel).

However, the results from the same tests performed on elicited data recorded by a female speaker, shown in table 2.4, show a significant difference in the second formant (F2) between the vowel in the first syllable (1810.8 Hz) and the full vowel (1696.2 Hz). The difference in the mean values for the F2 of the vowel in the first syllable and for the F2 of the full vowel is 114.6 Hz, which indicates that the vowel in the first syllable is more fronted than the full vowel.[26] There are no other significant differences. It could be said that for this speaker, /ɨ/ has a slightly fronted allophone in the first syllable position.[27]

The t-test results in tables 2.3 and 2.4 show that the mean formant values (Hz) of these three categories do not separate the first syllable /ɨ/ and the suffix /ɨ/ (for which Nordell's orthographic symbol is <ä>) from the full vowel /ɨ/ (for which Nordell's orthographic symbol is <ø>). The acoustic data, along with the t-test results, suggest that there is one phoneme; therefore no separate phoneme is posited in this study.[28]

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[26] F2 values are related to vowel frontness and backness; the larger the number, the more fronted the vowel.

[27] It is not expected that any two speakers will speak exactly the same as one another and it is always possible that other speakers contrast these vowels according to Nordell's orthography. According to Labov (1971:456) "Heterogeneity is the rule ... " rather than homogeneity among the speakers in every-day language use.

[28] It is possible that Nordell and Wichmann had in mind the proto-Mixe forms which have one of the other vowel qualities in the first syllable (e.g. *hekém (Wichmann 1995:303), Isthmus Mixe /hikem/ 'far' or *ʔiːcɨmɨ (Wichmann 1995:235), Isthmus Mixe /ɨt͡sɨm/ 'pig') in which the first vowel in the Isthmus Mixe word is reduced in relationship to the first vowel in the proto-Mixe word.

2.4.1.1 Vowel allophones

The six vowel qualities have fronted allophones adjacent to palatalized consonants and the palatal /j/, discussed in detail in section 4.5. In addition, the vowel quality /i/ has two allophones: [ɪ] with short length (modal and creaky) and in breathy voice qualities; [i] occurs elsewhere (with long modal and long creaky voice qualities). When [ɪ] occurs adjacent to palatalized consonants, it becomes fronted, and the resulting articulation cannot be distinguished from the [i] allophone.

2.4.2 Vowel quantity

Differences in vowel length are most apparent in the primary stressed syllable of the clause, usually the verb. There are a total of thirty-nine primary stressed syllables in *Text A* with all but one of the voice qualities and quantities occurring in these syllables (missing is short creaky voice). ANOVAs were performed on the categories of the length of the vowel in milliseconds as related to: 1) voice quality and quantity; 2) vowel quality; and 3) position in the clause as the stressed syllable as the last syllable in the clause; 4) the stressed syllable in the last word in the clause (i.e. followed by a non-stressed affix); or 5) a word preceding the last word in the clause. The only significant differences were found among length of the vowel and the different voice qualities. In other words, the length of the vowel is not related to vowel quality or position in the clause. The mean of each category followed by the standard deviation is shown in table 2.5, and below the mean is the minimum-maximum (Min-Max) range.

TABLE 2.5

MEANS OF DURATION IN MILLISECONDS OF ISTHMUS MIXE
VOICE QUALITIES IN ACCENTED SYLLABLES
Numbers in parentheses represent standard deviations.

	Short (N 9)	Long (N 14)	Creaky (N 7)	Breathy (N 9)
Mean (s.d.)	96.1 ms (21.5)	165.7 ms (31.6)	202.0 ms (29.6)	173.5 ms (31.2)
Min-Max	57.5-120.8 ms	132.3-232.1 ms	166.4-244.6 ms	129.0-223.7 ms

In continuous texts, hesitation forms and some emphatic speech may be articulated by length and creakiness of the vowel. One of the common hesitation forms is the article ha~, an unstressed clitic in ordinary speech. When used as a hesitation form, it is usually in its normal position preceding the noun, and is both lengthened and laryngealized. As the speaker proceeds, it may be repeated as the usual unstressed clitic preceding the noun. The phonetically long vowels may be extended even longer for emphasis. The short forms may be uttered with greater amplitude but are not lengthened when emphasized.

2.4.3 Voice quality

Isthmus Mixe has three contrastive voice qualities: modal, creaky, and breathy. Frequency counts of voice qualities in *Text A* reveal that modal is the most frequent for all vowel qualities except /a/, in which modal and breathy occur with the same frequency. Creaky is always the least frequent. Since the frequency counts include all syllables analyzed in *Text A*, no distinction is made for length. Table 2.6 and the graph (figure 2.8) of frequencies of voice quality in *Text A* show major differences in the frequencies of

TABLE 2.6

ISTHMUS MIXE VOWEL QUALITY AND VOICE
QUALITY FREQUENCIES IN *TEXT A*

Vowel	N	Breathy	Creaky	Modal
/i/	115	2	5	108
/a/	101	45	11	45
/i/	37	6	0	31
/u/	19	3	4	12
/e/	14	1	4	9
/o/	14	0	1	13
Totals:	300	57 (19%)	25 (8%)	218 (73%)
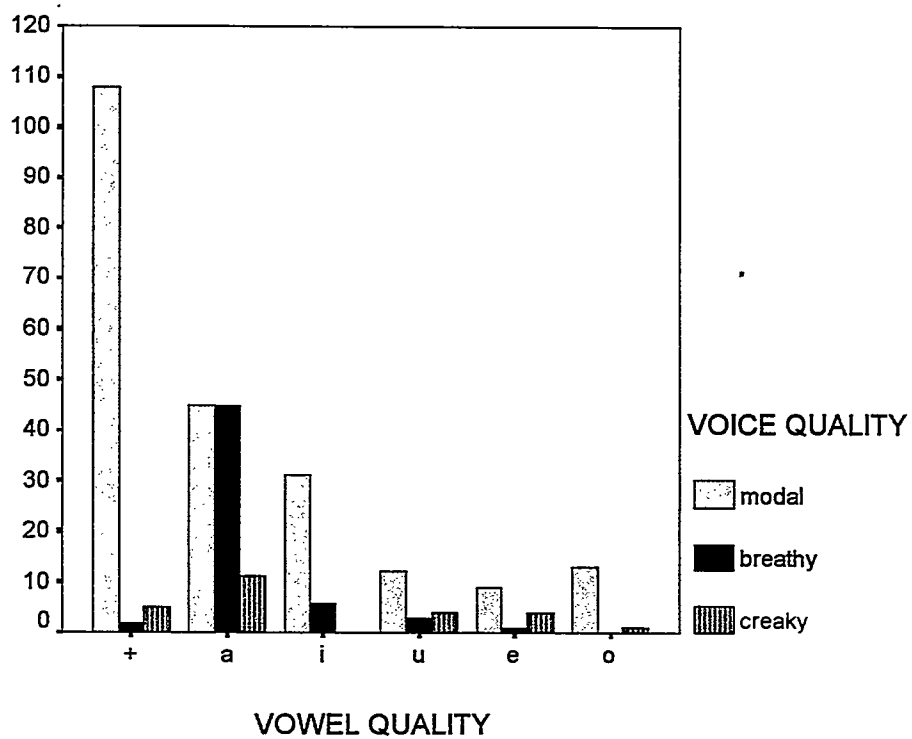
Figure 2.8. Frequencies of vowel qualities and voice qualities in Text A.

both voice qualities and vowel qualities in the selection (300 syllables). Vowel quality /ɨ/ (N = 115) is most frequent and /a/ (N = 101) is second in frequency. These two vowels make up 72 % of the total, with /i/ (N = 37) in third place, 12% of the total. The other three vowels, /u/ (N = 19), /e/ (N = 14), and /o/ (N = 14) are the least frequent.

2.4.3.1 Contrasts in modal, creaky, and breathy voice qualities

Although complete sets of minimal pairs contrasting modal, creaky, and breathy voice qualities have not been found in the language, sufficient contrasts are shown in data examples (16-20), in harmonic differentials, and in features shown by waveform and spectrographic views to establish credibility for positing these three voice qualities. The data examples have been shown in section 2.4; harmonic differentials, waveforms, and spectrograms are discussed in the following paragraphs.

Harmonic differentials are used to show contrastive differences among various voice qualities. Acoustic properties extracted from the waveform that compare the intensity of the first and second harmonic, are called *spectral tilt* or *harmonic differential* (Edmondson 1994:57). According to Johnson (1997:128-9), contrastive differences show that in breathy voice "the first harmonic tends to dominate the spectrum." In creaky voice the second harmonic has more amplitude than the first. "The difference between the amplitude of the first harmonic and that of the second harmonic is a reliable way to measure the relative breathiness or creakiness of phonation ..." (Johnson 1997:129).

Three examples taken from *Text A* show the contrasts between the three voice

qualities in Isthmus Mixe. These vowels are preceded and followed by a consonant in the

phonetic utterance: [jãːm] (Appendix line 34), [mąːw] (Appendix line 31), and [kaʰp]

(Appendix line 20). The three vowels are approximately the same duration, 170-175 ms.

As shown in figure 2.9, measurements[29] of the first harmonic (H1) and the second

harmonic (H2) were taken at intervals of about 20-25 ms (indicated by the markers on

the lines), the differential obtained (H1 minus H2 shown in decibels), and charted to

show the comparisons. The example of modal voice has little change in the harmonic

differential across the duration of the vowel. Although creaky voice begins

approximately the same as modal voice, within 50 ms H2 has a little more amplitude than
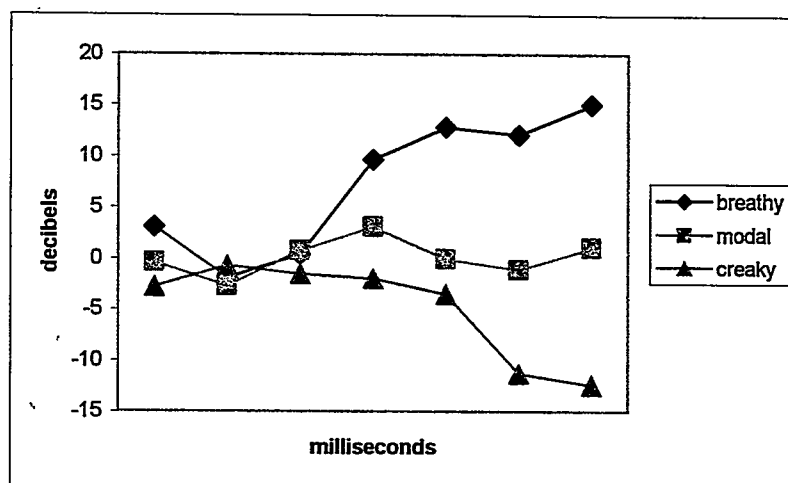
Figure 2.9. Harmonic differential contrasts in modal, creaky, and breathy voice.

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[29] Measurements were taken using the Speech Analyzer software described in section
2.1.

modal range, the breathy voice example has a sharp rise in the intensity of H1 in comparison to H2 after 50 ms. These results are consistent with the description according to Johnson (1997:128-9) (see preceding paragraph), and support the claim of three contrastive voice qualities in Isthmus Mixe.

In addition to the harmonic differentials, some differences may be observed in the waveforms and spectrograms of some examples, however differences shown in waveforms and spectrograms are not as reliable and consistent as the harmonic differentials. Information in spectrograms is intended to provide formant data; information such as intensity depends upon shading in black and white displays. Some
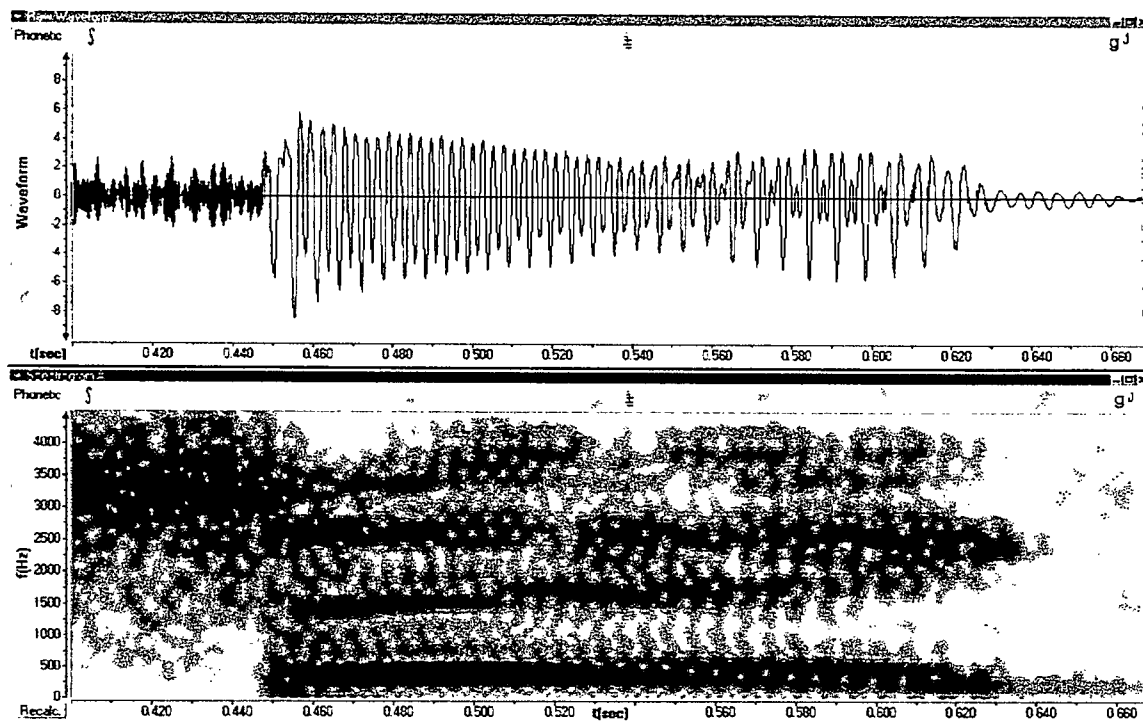
Figure 2.10. Long creaky voice [ʃi̤gʲ].

utterances in text data are not articulated with sufficient clarity to provide good resolution; the better displays are usually found in stressed syllables (see section 2.6). Given these caveats, nevertheless, some characteristics of the voice qualities may be observed in the following examples. In figures 2.10 and 2.11, the waveforms in the creaky portion of creaky vowels show irregular glottal pulses due to a small cycle-to-cycle change of period (jitter) in the fundamental frequency, and in figure 2.12 higher formants in the breathy portion of the breathy vowel are seen as having progressively less amplitude since the breathy voice glottal wave is nearly sinusoidal and thus little energy is settled in higher harmonics and formants. These acoustic examples of the different voice qualities in Isthmus Mixe (figures 2.10, 2.11, 2.12) show first the waveform and below it, the spectrogram, directly copied as one unit from the Speech Analyzer software (section 2.1). All are common words in the language.

In figure 2.10, a long creaky vowel /ɨ/ (180.9 ms) is in the primary-stressed syllable of the clause, [ʃɨ̰ːgʲ] from /jaʰkiʃɨːkʲɨn/ [jaʰkiʃɨ̰ːgʲɨn] 'he showed'; the modal portion is at the beginning, with the creakiness developing in the middle and continuing to the end. The modal part of the vowel shows regularly spaced peaks, which represent the vocal fold pulses of regular period. The second part of the creaky-voice vowel shows the peaks are farther apart, and a more irregular pattern with reduced amplitude, especially in the middle portion where the creakiness begins.
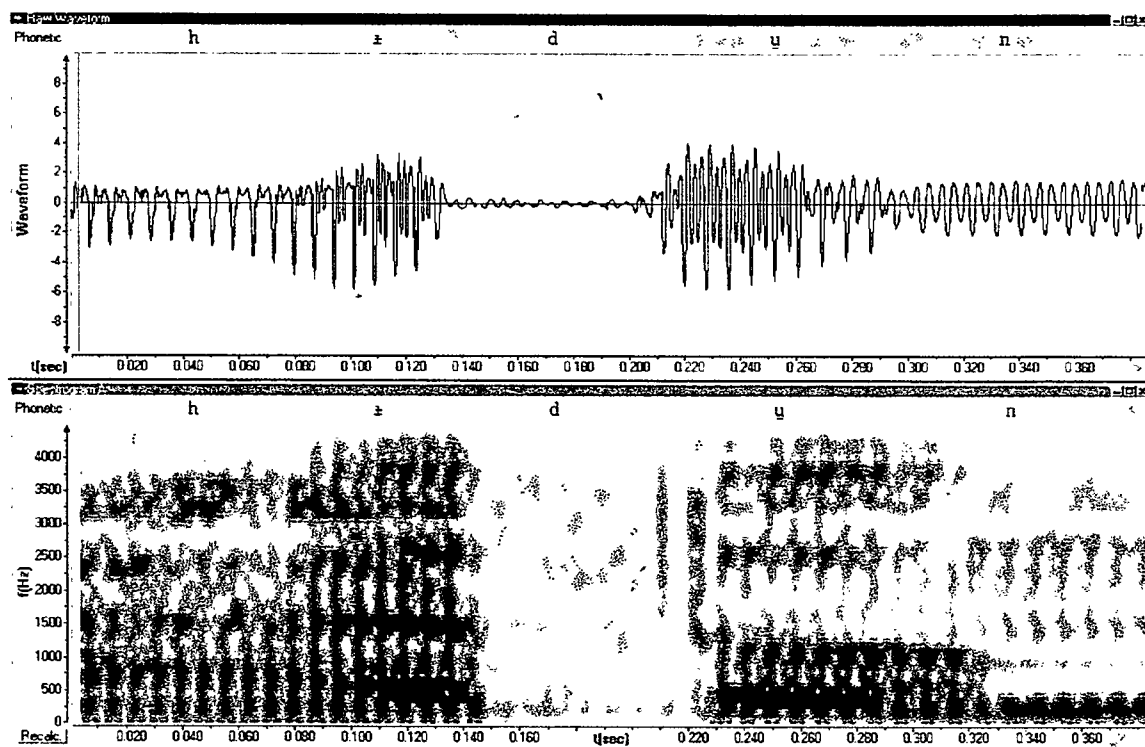
Figure 2.11. Short modal [ɨ] and short creaky voice [ʉ̰] in [ɦɨdʉ̰n].

In figure 2.11, /hitʉn/ [ɦɨdʉ̰n][30] 'AFFIRMATIVE' has a short modal /ɨ/ vowel, 44.5

ms, unstressed, in the first syllable (see section 2.4.1) and a short creaky vowel /ʉ/, 78.5

ms, with tertiary stress, in the second syllable. The short modal vowel and the first

(modal) part of the short creaky vowel show regularly spaced peaks. The second part of

the creaky-voice vowel shows a more irregular pattern and less amplitude. When a

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[30] Because this word is preceded by a word that ends in a vowel with no phonetic break,
the voiced allophone of the phoneme /h/ is seen.

creaky-voice vowel is followed by a nasal, as in this word, the laryngealization of the vowel is often heard on the first part of the nasal as well.

The breathy-voice vowel /iʰ/ (170.2 ms), in [diʰp] from /witiʰp/ [wɨdiʰp] '[Who] is walking around?' (figure 2.12), is in the primary-stressed syllable of the clause. About the first half of the vowel is phonated in modal voice, with the last half fading out to the following voiceless /p/. The amplitude of the modal portion is overall much greater than the amplitude of the breathy portion as seen by the height and depth of the peaks and bottoms in the waveform[31] and the darker color of the formants in the spectrogram. Plosives and fricatives following breathy-voice vowels are always voiceless. Although phonetically the breathy-voice vowel could be analyzed as vowel followed by /h/, it is preferable for morphophonemic reasons (see section 2.5.2) to consider this as a complex syllable nucleus, rather than as a vowel followed by a consonant.

The characteristics shown in these examples of contrasting voice qualities in Isthmus Mixe may be different than characteristics of modal, creaky and breathy voice in other languages. According to Ladefoged (2001:130) creaky voice and breathy voice are

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[31] The waveform of the breathy-voiced portion of a Hindi word is described by Ladefoged (2001:125-6) as having "a slightly lower amplitude and far less well-defined structure within each repetition" in comparison to regular voicing. "Breathy-voiced waveforms often show little more than the fundamental frequency with a few extra variations in air pressure superimposed." Basically breathy voice represents a far less efficient use of transglottal airflow than modal voice; the flow has greater volume velocity but results in lesser acoustic energy.
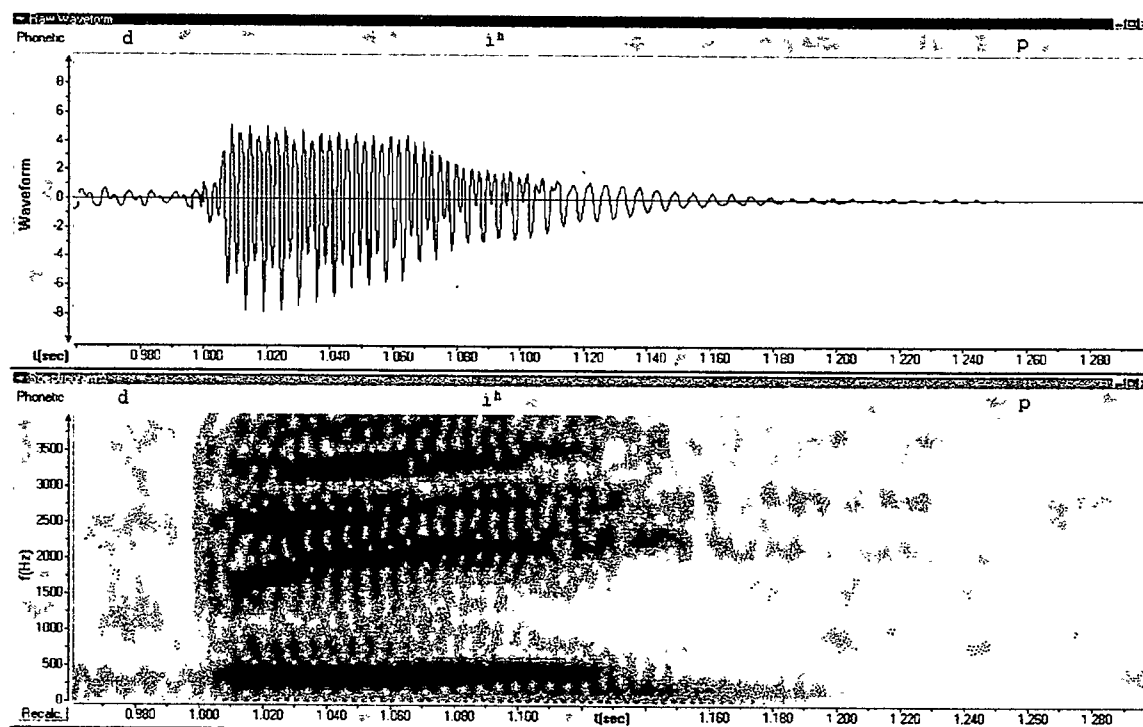
Figure 2.12. Breathy voice [iʰ].

not precise terms; instead they cover a range of voice qualities. In the examples shown

by Ladefoged, the waveforms of the breathy Hindi consonant and following vowel

(Ladefoged 2001:125-6) and the breathy Mazatec vowel (Ladefoged 2001:128-9) look

quite different. There are both language specific traits as well as some general ones.

Creaky voice in vowels is generally characterized by larger vocal pulses and a more

irregular pattern (shimmer and jitter) than modal voice, and the influence of breathy

voice on vowels is generally characterized by reduced amplitude and a less distinct

formant pattern than modal voice (Baart 1999, Herrera 2000).

2.5 Isthmus Mixe syllable structure

The most widely distributed syllable type in Isthmus Mixe is one consonant followed by one vowel nucleus with an optional coda or CV(C). However, there is also an onsetless syllable with an optional coda, V(C). Examples taken from *Text A* show common occurrences of V(C) syllables as well as CV(C) syllables. A space separates the grammatical words in the phonemic transcription in examples 21-23, and a period separates the syllables in the phonetic transcription. In (21), a noun that begins with a vowel is preceded by the article *ha~*, resulting in two contiguous vowels in the phonetic

(21) /ha~ɨːtsʲkiʃpɨ/   [ha.ɨːtsʲ.kiʃ.pɨ]   'the sake of me'

utterance. It is more usual that the article joins with the following noun in this manner; however there are some instances where a default glottal stop separates the two vowels, forming a CV(C) syllable. In an example from a story about a boy who hits the family dog, emphasis is on the dog in one place in the narration, resulting in the use of the default glottal stop (22).

(22) /ha~uk/   [haʔuk]   'the dog'

Two common words which begin with vowels, /inaʰtʲ/ 'then' and /aʰʃʲ/ 'PLURAL,' always attach phonetically to the preceding segment in connected speech. If that segment is a vowel, then these two words are pronounced without a consonantal onset to initiate
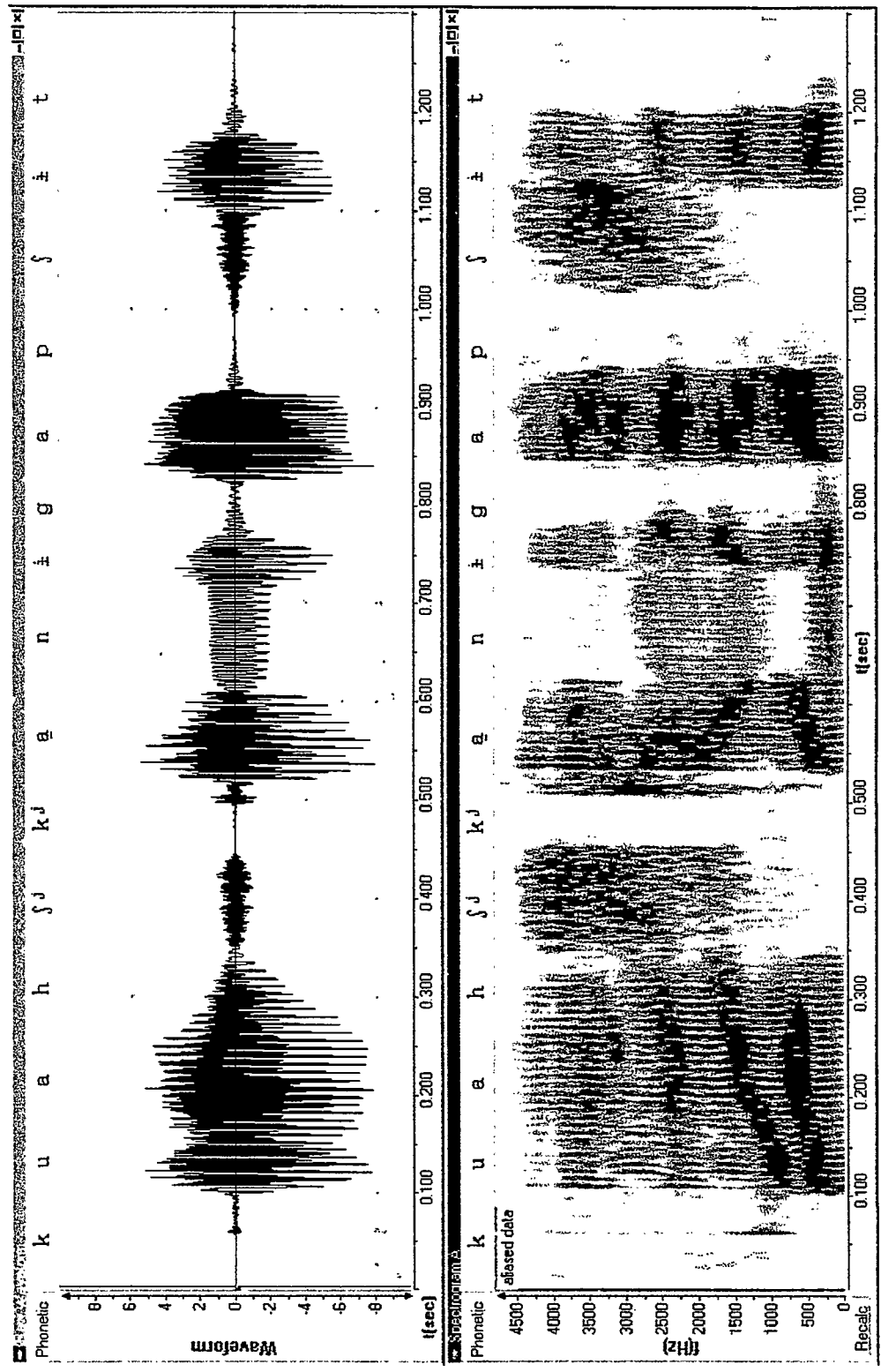
Figure 2.13. /kuaʰʃʲ-kḁ-ni-kapʃ-it/ [ku.aʰʃʲ.kⁱḁ.ni.gapʃ.it] 'that they should not say ... .'

the second word (examples 23, 24, and figure 2.13 /kuaʰʃʲ ʲ-ka̰-ni-kapʃ-ɨt/

[ku.ā̰ʰʃʲ.kʲa̰.nɨ.gapʃ.ɨt] 'that they should not say ... .'

(23) /ma: ina ʰtʲ/   [ma:.ɨ.nā̰ʰtʲ]   'where then'
(24) /ku aʰʃʲ/   [ku.ā̰ʰʃʲ]   'that they'

The glottal stop functions as the default consonant for words that begin with a vowel or to separate morphemes in compounds. In certain circumstances, a consonant occurs in an emphasized syllable or is necessary for the attachment of a prefix, for example, /uk/ 'dog.' When the word is used as a vocative to scare off an offending animal, it will be emphatically pronounced as [ʔuk] (also see example 22). In a narrative context, a nonemphatic reference, /ha~uk/ 'the dog' will be pronounced [haˈuk] (stress on the second syllable). If the third person possessive is prefixed to the word, as in 'his dog' the default glottal stop will appear to enable attachment of the word prefix, as in [ʔʲūk] /ʲ-uk/.[32] The palatalization symbol ʲ- is separated from the word with a hyphen to show it as a separate morpheme; phonetically it is shown as [ʔʲ]. In an emphatic contrastive context, [nʔuk] /n-uk/ 'my dog' and [mʔuk] /m-uk/ 'your dog' are spoken with glottal stops preceded by voiced nasals.

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[32] Attachment of secondary palatalization is always to a consonant (see chapter 5, section 5.5.1).

An example from *Text A* (Appendix line 15) of a word initial glottal stop, as evident when palatalized by the third person palatalization marker, is shown in figure 2.5: /ʲ-hanʃʲ tem ʲ-ʔiʃampʲɨ/ [hʲānʃʲtemʔʰiʃāmʲbʲɨ] 'he really really wanted to see him' (section 2.3.3) in which /ʲ-ʔiʃampʲɨ/ begins with a palatalized glottal stop. The palatalized glottal stop is approximately in the middle of the display, shown by a few irregular glottal pulses in the waveform.

The glottal stop may occur in a compound word between morphemes if the second morpheme does not begin with a consonant, as in (25) from (/tu-aːm/: tu 'trail'; -ʔaːm 'on').

(25) /tu-aːm/   [tuʔaːm]   'on the trail'
(26) /wink-ɨna̧k/   [wiŋgɨna̧k]   'different youth'

However, there are more examples in *Text A* and in other connected speech data where the second morpheme is not separated by a glottal stop, as (26) (/wink-ɨna̧k/: wink 'different'; ɨna̧k 'youth'), in which the final consonant of the first morpheme becomes the onset of the following syllable, the vowel of which begins the second morpheme. No regular patterns have been observed regarding omission or inclusion of the glottal stop in compound words.

2.5.1 Syllable onsets and codas

In syllable-initial position, only single consonants occur and any consonant in the inventory may occur as the syllable onset. The person marker morphemes (i.e. *n-* 'first person',[33] *m-* 'second person', and *ʲ-ʃ-* 'first and second person object') are word affixes, and are not considered on the syllable level. Since they prefix the syllable onset, they create a word-initial consonant cluster at the surface level.

In the coda of a (C)VC syllable, all consonants except /ʔ/ and /h/ occur. To the verb final consonant, a clause marker *-p* (also *-pʲ*) may be affixed, and similar to the person marker word affixes, this clause marker is a word affix, not part of the basic syllable coda. Plosives release into the following vowel or consonant but are usually unreleased preceding a pause. Compound words often drop the final plosive of the first word in the compound, such as /t͡saʰp/ 'heaven' and /tɨʰk/ 'house,' which combine to become [t͡saʰtɨʰk] 'church building.'

The consonants that may compose the coda of a (C)VCC syllable are restricted to /pt pk tk kt pʃ kʃ t͡sk ʔʃ ʃp ʃt ʃk mʃ nʃ nt nk/ (most may be palatalized). Some examples are: /kopk/ 'head,' /met͡sk/ 'two,' /uʃpʲ/ 'alligator,' /hemʃʲ/ 'heavy,' and /winmantʲ/ 'thought.'[34] Several of the coda clusters have arisen historically from truncation of the final syllables of proto-forms (as listed by Wichmann 1995). For

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[33] In the case of *n-* and *m-*, they serve both as possessive markers on nouns and as subject markers on verbs. The third person marker is palatalization which is considered in the following chapters.

[34] There is no known morpheme represented by palatalization in these forms.

example, from proto-Mixe *tu:tuk 'turkey,' Isthmus Mixe omits the final-syllable vowel, resulting in /tutk/. The glottal stop in the coda cluster /ʔʃ/ is either *ʔpʃ or *ʔkʃ in the proto-forms. For example, the proto-Mixe-Zoque word *po:ʔkʃ 'rest' is /po:ʔʃ/ in Isthmus Mixe.[35] Isthmus Mixe words retain the /pʃ/ or /kʃ/ cluster when there is no glottal stop in the proto-form, for example, /kapʃ/ 'talk' (in figure 2.13).

In continuous texts, usually only the first consonant of a syllable-final cluster is apparent from the transition on the preceding vowel; the second member of the cluster is not pronounced. However, it becomes apparent as part of the morpheme when a suffix or clitic follows the cluster. An example from *Text A* is /ma: ha~kaʰpt~in/ [ma:hakaʰptin] 'to the town' in which the clitic /~in/ 'LOCATIVE' attaches to /kaʰpt/ 'town' causing pronunciation of both members of the consonant cluster. When the cluster is followed by a pause, the consonants are unreleased and only the first member of the cluster is noticeable from the transition from the preceding vowel.

On the basis of the patterns of Isthmus Mixe syllable onset and coda, the affricate /ts/ is considered to be one unit: 1) there are no consonant clusters in syllable initial position; 2) syllable coda clusters are limited to two phonemes; and 3) both elements of the affricate are pronounced syllable final. Data examples of /ts/ in syllable-initial position include /tsaʰtiʰk/ 'church building' and in a consonant cluster /metsk/ 'two.' In addition, to syllable onset and coda patterns, the occurrence of [s] is always and only immediately

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[35] Wichmann's rule for Isthmus Mixe is that "/p k/ are deleted between a glottal stop and /š/" 1995:57).

following [t] in native Mixe words. Furthermore, the affricate /ts/ is considered to be one

phoneme in all of the Oaxacan Mixe languages, as well as in proto-Mixe-Zoque

(Wichmann 1995).

In contrast to the voicing of single plosives and the affricate, any consonant

cluster composed of plosives and/or fricatives remains voiceless between vowels. For

example, in /mtsokɨt/ [mdsogɨt] 'you should love,' the suffix /-ɨt/ causes voicing of the

/k/ which precedes it, but in /nɨkapʃɨt/ [nɨgapʃɨt] '[they] should [not] talk about ...'

(figure 2.13), the consonant cluster remains voiceless between the vowels.

2.5.2 Syllable nuclei

All of the syllable nuclei are composed of two obligatory features, namely, one

vowel quality (/i ɨ u e a o/), one voice quality feature (modal or creaky or breathy), and

one optional quantity feature (length), resulting in complex syllable nuclei[36] when the

voice quality is creaky or breathy. Phonemically, the Isthmus Mixe creaky vowel could

be described as vowel plus /ʔ/, and the breathy vowels could be described as vowel plus

/h/. However, phonetic, distributional, and morphophonemic reasons are given by

Crawford (1963:78-79) for why he posits complex syllable nuclei in Totontepec Mixe

and these reasons are probably applicable to all the Mixe languages. Crawford explains:

> the sequence VʔV is actualized as laryngealization of part of the vocoid
> span. There is no sharp break in phonation. This occurrence of the
> phoneme /ʔ/ is distinct from its occurrence syllable initially, where it is a
> quite perceptible glottal stop or catch (1963:78-9).

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[36] The term *complex syllable nuclei* is taken from Crawford (1963:78).

In Isthmus Mixe, the same type of laryngealization is seen in the creaky-voice vowels, shown in the waveforms and spectrograms of figures 2.10 and 2.11; that is, the laryngealization is part of the middle and latter portions of the vowels and no sharp break in phonation occurs (also shown by the harmonic differentials, see section 2.4.4). In contrast, in figure 2.5 which shows the glottal stop consonant, there is a break in the phonation.

Likewise, the breathy portion of the breathy vowel of Isthmus Mixe also shows phonetic difference from the consonant /h/. In figure 2.12, the breathy portion of the vowel shows progressive loss of amplitude from the modal voice portion of the vowel, with weakening formant structures. In contrast, the voiceless allophone of /h/ or [h], shown in figure 2.4, is fricative with random bursts of energy between 1500 Hz and 3500 Hz. The voiced allophone of /h/ or [ɦ], shown in figure 2.3, has voicing in F1 and F2, with moderate amplitude in these formants (table 2.1).

Speaking of Totontepec Mixe, Crawford (1963:79) states: "The distributional evidence is that there seems little dependence between the glottal elements /h/ and /ʔ/ and the following phonemes or clusters, whereas within termini, ... there is a great deal of restriction in the combinations which occur." In Isthmus Mixe this is also true; if one were to posit creaky-voice vowels as /Vʔ/ and breathy voice vowels as /Vh/, that is, as vowel plus consonant, then all syllable coda could potentially contain one or the other of these two consonants, adding complexity to the coda.

Morphophonemically, all of these syllable nuclei participate in vowel ablaut in verb roots. Many of the verb roots have two forms or allomorphs. The choice of which allomorph to use is governed by a following stem or suffix or by clause type. For example, short creaky alternates with long creaky in /kiʃi̯k/ ~ /kiʃi̯ːk/ 'to appear'; breathy voice alternates with short modal voice in /peʰt/ ~ /pet/ 'to climb'; long modal alternates with short modal in /miːn/ ~ /min/ 'to come.' More detail regarding the use of the allomorphs can be found in descriptions of other Mixe languages (Crawford 1963:79, Hoogshagen 1984:6, Van Haitsma [Dieterman] and Van Haitsma 1976:21-22).

Other authors describing Mixe languages in which similar complex syllable nuclei are posited include Clark (1981 - Oluta Popoluca), Clark (1983 - Sayula Popoluca), Lyon (1980 - Tlahuitoltepec Mixe), Schoenhals and Schoenhals (1982 - Totontepec Mixe), and Wichmann (1995:16) who states that all Oaxacan Mixe dialects "have ablauting verb roots."

Given the reasons just mentioned, it does not seem expedient to seek alternative ways of describing the Isthmus Mixe vowel complexities. However, the terminology and symbols used to describe voice qualities reflects a greater unity in the syllable nuclei than previously used terminology and symbols. For example, this analysis uses the term *long creaky voice*, symbolized as /a̰ː/, to refer to what was previously described as *rearticulated* and/or written as vowel-glottal stop-vowel <aʔa>.[37]

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[37] Either a full sized glottal stop or a smaller raised glottal stop; orthographies use <aʼa>.

2.6 Stress

Stress is predictable when morphophonemic rules are applied. In a verb-final clause, enclitics and one classification of suffixes are unstressed and are usually composed of a short /ɨ/ followed by one consonant, or just short /ɨ/. The primary clause stress then falls on the syllable immediately preceding these suffixes or clitics, which is usually CVC(C).[38] The stress pattern of a typical clause is seen in figure 2.13, which is explained in example (27). The first line of example (27a) shows the phonetic utterance and the numerals underneath indicate approximate stress (1 = primary, 2 = secondary, 3 = tertiary). Stress levels are based on the pitch pattern and amplitude as shown by the Speech Analyzer tool and impressionistic perception. For example, the first syllable, [ku], has the numeral 3 below it to indicate that it is pronounced with tertiary stress; the second syllable, [āʰʃʲ], has the numeral 2 below it to indicate that it is pronounced with secondary stress, and so on. The two syllables with no numeral below them are unstressed. Periods indicate syllable breaks. The second line of the example (27b) gives

(27a) [ku.āʰʃʲ.kʲā̰.nɨ.gapʃ.ɨt]
      3 2 3   1   (1 = primary stress)

(27b) ku   aʰʃʲ ʲ-ka̰-nɨ-kapʃ-ɨt
       that   they 3P-NEG-about-talk-should[39]
       '... that they should talk about [it].'

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[38] A few verbs end in a breathy voice vowel, which may take primary stress.
[39] 3P 'third person'; NEG 'negative.'

the grammatical words of the phonetic utterance, with affixes separated by a hyphen. The next line gives the literal gloss, and the last line the free translation.

In noun phrases, clitics and one classification of noun suffixes are unstressed and the noun word receives the phrase stress, which is usually a secondary stress in a verbal clause. A prefix is likely to receive tertiary stress in the clause, or secondary stress under some conditions, rather than being unstressed. The first syllable in a two-syllable root is always unstressed (see section 2.4.4, figure 2.11).

2.7 Morpheme-induced secondary palatalization

Typologically, the Isthmus Mixe consonant inventory shows no unusual phonemes among the world's languages (Maddieson 1984); and the vowel inventory, along with the complex syllable nuclei, is common in Mesoamerican languages (Herrera 2000, Silverman 1997). What is very unusual is the palatalization feature in which every Isthmus Mixe consonant and vowel may be modified by secondary palatalization which usually manifests a morpheme (see chapter 3, section 3.7.5).

In most of the world's languages that have a set of palatalized consonants in complementary distribution with plain consonants, the palatalized consonants occur adjacent to front vowels only, or in the case of word-final palatalization, historically there was a front vowel which is now truncated to consonant palatalization, for example, Lithuanian (Kenstowicz 1972), Nenets (Salminen 1999), and Russian (Comrie 1981). In these languages, palatalization is not related to a morpheme. Extensive research by the author of this dissertation has not revealed any languages, except the Oaxacan Mixe

languages, in which the entire consonant inventory may be modified by secondary palatalization manifesting a morpheme. Thus, this type of palatalization appears to be typologically rare.

The remainder of this dissertation is dedicated to explaining the phonological processes of palatalization, especially as found in the Mixe-Zoque languages and specifically in Isthmus Mixe, both from the phonetic perspective of a detailed case study, and from theoretical implications. In chapter 3, a distinction is made between primary and secondary palatalization, and a review of the existing descriptions of palatalization in the Mixe-Zoque languages is given. Original to this dissertation is a discussion of the origin of secondary palatalization in the Oaxacan Mixe languages. In chapter 4, a case study of *Text A* will reveal that all of the Isthmus Mixe consonants (including the laryngeal consonants, /h/ and /ʔ/), may be palatalized, and that a complete set of vowel allophones occurs adjacent to palatalized consonants. This case study of the phonology of the language utilizing acoustic analyses of continuous text data is the first of its kind in the Mixe-Zoque languages.

CHAPTER 3

3 General considerations on palatalization

3.1 Introduction

The definitions of the basic types of palatalization processes given in chapter 1,

section 1.1 are reviewed here: 1) primary palatalization, which modifies the primary

articulation of the consonant itself, and 2) secondary palatalization, which is the addition

of a high front tongue position ([i]-like) as a secondary articulation which occurs

simultaneously with the primary consonantal articulation (Bhat 1974:19-20, Keating

1993:6, Ladefoged 1993:230).[1] However, these major types of palatalization processes

have not always been differentiated, which often results in ambiguity. Bhat (1974:19)

states that palatalization was considered to be a single diachronic or morphophonemic

process by linguists and the cover term *palatalization* was commonly used without

making important and necessary distinctions as to the type of palatalization process.

Hume (1994) uses the term *palatalization* for what is defined here as secondary

palatalization and *coronalization* for what is defined here as primary palatalization. She

states:

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[1] The terms *primary palatalization* and *secondary palatalization* are from Keating
(1993:6) who quotes the definition by Ladefoged (1982:210) and states: "This is called
secondary palatalization because the palatalization is a secondary articulation added to a

> In Palatalization, the consonant acquires a vowel-like articulation while maintaining its original major place of articulation. In Coronalization, a front vocoid affects a change in the consonant's major place of articulation, either from velar to nonanterior coronal, or from anterior coronal to nonanterior coronal (Hume 1994:129).

However, since the term *palatalization* has a long history of being used for both processes, the modifiers of *primary* and *secondary* are used in this dissertation to distinguish the two processes.

One additional term may cause confusion, that is, *palatal*. Hume (1994:79) distinguishes palatalized consonants and palatals, stating: "... palatalized consonants are specified for secondary vocalic features whereas palatals are not." In clarifying the use of these terms, it is to be noted that the process of primary palatalization creates palatal segments, while the process of secondary palatalization creates palatalized segments. In addition, there are inherently palatal segments (i.e. articulations made in the palatal area) that are not the result of any known process. For example, in English, the palatal consonant /ʃ/ as in /ʃoᵘ/ 'show' is always articulated in the palatal area; there is no process involved that causes it to move to the palatal area. Likewise, there are palatalized segments with a secondary articulation of palatalization that are not the result of any known process. Authors using the term *secondary articulation of palatalization* may include consonants palatalized by the process of secondary palatalization as defined

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primary one. ... This can be called *primary palatalization* because the primary articulation is affected and there is no separate secondary articulation."

here, and also palatalized consonants in which no process of palatalization is known. Further explanations and examples are given in the following sections.

3.2 Primary palatalization

In the process of primary palatalization the point of articulation of the affected consonant moves toward the palatal region, usually in the presence of front vowels or the palatal segment /j/. Primary palatalization mainly affects alveolar and velar articulations and consonants located between them. For example, in English, /k/ in *keep* is more palatal than /k/ in *karma*. English orthography often reflects this difference in using <k> in more palatal environments (e.g. *key, kiss, keg*), and <c> preceding vowels which do not have a palatalizing effect (e.g., *car, cold, cut*). Many uses of <k> in nonpalatalizing environments are in words of non-English origin (e.g. *karma* from Sanskrit and *karate* from Japanese).

Bhat (1974) gives many examples of different kinds of primary palatalization in the world's languages. For example, in contrast to the palatalization of the velar stop /k/ in English, Bhat indicates that in a number of languages, alveolar or alveopalatal consonants are palatalized but not velar consonants. Bhat cites Wonderly (1949) stating that "in some ZOQUIAN [sic] languages, a contiguous /y/[2] palatalizes an alveolar consonant to an alveopalatal one, but not a velar consonant" (1974:22). In some

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[2] Bhat (1974) uses /y/ following the Americanist phonetic symbols. Italics and slashes, which have been added to this quotation from Bhat for the reader's convenience, represent phonemes.

languages apical palatalization occurs before a high-back vowel. Bhat cites Miller (1967)

stating that "in PAPAGO, /t d s n/ are palatalized before /i e/ and /u/" and "in

TEPEHUAN, /d/ is palatalized before /i e u/" (1974:24). Another type of primary

palatalization adds stridency or friction to the consonant. Bhat lists a number of

languages in which this type of palatalization occurs; citing Chomsky and Halle (1968),

he states that "in WEST SLAVIC, /t d/ become dental affricates before /y/" (1974:27).

Just how primary palatalization is manifested is a language specific matter; nevertheless,

some kind of primary palatalization is very common cross-linguistically (Hume 1994,

Keating 1993, Ladefoged and Maddieson 1996).

3.3 Secondary palatalization

In contrast to primary palatalization, secondary palatalization does not

necessarily change the place of articulation of the main articulator. In Isthmus Mixe, for

example, there is a contrast between /pa̰m/ [pa̰m] 'illness' and /ʲ-pa̰m/ [pʲa̰m] 'her illness'

in which the primary bilabial articulation of the palatalized plosive is still bilabial.

According to Bhat, secondary palatalization usually affects all of the consonants

of a language, resulting in contrasting sets of plain and palatalized consonants. As

compared to primary palatalization, secondary palatalization is much less common and is

areal in occurrence. Moreover, languages in which secondary palatalization occurs may

have some type of primary palatalization as well (Bhat 1974:36). This description by

Bhat is true of all of the Oaxacan Mixe languages. As an example that secondary

palatalization is relatively uncommon, Maddieson (1984:95) states that: "True

palatalized consonants, that is, ones with a palatal secondary articulation usually

perceptible because of a /j/-like offglide, occur in about 10% of the languages in the

survey ... ." Although Totontepec Mixe is included in his survey of 317 languages, it is

not shown to have [secondary] palatalization because the palatalization in Totontepec

Mixe is analyzed as a sequence of consonant plus /j/ (section 3.7.2).

Although the terms primary and secondary palatalization make valid distinctions

regarding the processes of palatalization, it is still necessary to describe language specific

parameters as to the outcome of these processes. Mester and Itô (1989:268) note that:

> Palatalization does not have the same surface realization among all
> segments. The characterization 'palatalized' is strictly speaking only
> accurate for noncoronals, i.e. labials and velars. Palatalization of coronals
> (*t, d, s, z, n*) on the other hand, changes their primary place of articulation
> to palatal/alveopalatal ... .

In keeping with the parameters set forth by Bhat (1974:36) that [secondary]

palatalization often affects all of the consonants of a language, rather than "only a limited

portion of the consonantal system" and that in Isthmus Mixe secondary palatalization

usually manifests a morpheme (see section 3.7.5), the term secondary palatalization is

applied to this phenomenon for all of the Isthmus Mixe consonants, with the realization

that the primary place of articulation of the coronal consonants changes. An additional

distinction is that primary palatalization is usually caused by the immediate phonetic

environment, whereas in Isthmus Mixe the palatalizing effects are not caused by an

adjacent segment, but are morpheme-induced.

3.4 Palatalized consonants

According to Hombert and Maddieson (1998), secondary articulations of palatalization are among the distinctive characteristics occurring in few languages which can be used in language identification by listening to a small sample. Russian is mentioned as a well-known example. However, if a linguist traveling in Mexico were to hear a language with widespread secondary articulations of palatalization, it is more likely that one of the Mixe languages was being spoken. To date, this fact about secondary palatalization in the Mixe languages is never mentioned in the literature. Hombert and Maddieson (1998:121) point out that many phonetic types are not represented in the phoneme list of a given language but that language recognition by listening for distinctive characteristics "must be based on a knowledge of the full phonetic range of possibilities in the language."

To demonstrate the phonetic differences in Russian among examples of nonpalatalized consonants and palatalized consonants followed by a vowel, and nonpalatalized consonants followed by the phoneme /j/, Ladefoged & Maddieson (1996:364) have printed comparative spectrograms of /pot/, /pʲotr/ and /pjot/. As they note, the spectrograms show:

> the distinction between palatalization and a sequence with j. In pʲotr
> 'Peter' the transition away from the palatal position, indicated by a falling
> F2, begins immediately on consonant release. In contrast, in pjot 'drinks'
> there is a short steady state before the transition begins.

Secondary articulations of palatalization have been described in Russian and all the Slavic languages (Comrie 1981, Fant 1970, Ladefoged 1993). They are also a noted features in such languages as Irish (Ní Chiosáin 1994), Lithuanian (Kenstowicz 1972), and Nenets (Yurak) (Salminen 1999).

In less well-known languages, N. McKinney (1990:257) describes both Tyap and Jju as having a phonetic contrast between plain and secondary articulations, giving the examples of plain vs. palatalized: [tɑk] 'leg' and [tʲɑk] 'to finish.' An example in Jju is: *kam* 'to scold' and *kʲaŋ* 'thing' (N. McKinney 1984:178). There are no known palatalization processes in present-day Tyap and Jju causing the secondary articulation of palatalization in these languages (C. McKinney: 2002 pc).

In addition to the secondary articulations of palatalization in Tyap and Jju, N. McKinney (1990:257) states: "there is allophonic palatalization before front vowels ... " which is defined as primary palatalization in this dissertation. Examples[3] include: /tsop/ [tsop] 'a hook' as compared to '/tʃi/ [tʃi] 'return cut (a farming term)'; /dzop/ [dzop] 'investigate' and /dʒi/ [dʒi] a noun class particle (N. McKinney 1990:256). In this type of process, primary palatalization results in palato-alveolar consonants.

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[3] The article by N. McKinney (1990) shows examples of minimal pairs of fortis vs. lenis stops and affricates; however one can see the effects of primary palatalization in some of the examples.

3.5 Palatalization in Mesoamerican languages

Primary palatalization occurs in many Mesoamerican languages, some of which are included in the languages mentioned in Bhat (1974) (e.g. Tepehuan, Zoque), and in descriptions of individual Mesoamerican languages by other authors, including Central Pame (Berthiaume 2000, Gibson 1956), Mayan Chontal (Keller 1959, Justeson 1985), and Southeastern Tepehuan (Willett 1985).

In an areal-typological description of middle American languages, Yasugi (1995:23) states that "secondary articulations are of two types; labialization and palatalization. ... Palatalization is observed in alveolar /t^y/, palato-alveolar /č^y/ and velar /k^y/, /t^y/ being more common than /k^y/. /č^y/ is very rare."[4] The phonemes /t^y/ and /d^y/ are listed in the database of phonological systems for most of the Zoque languages, including Copainalá Zoque (1995:215-6), for which data Yasugi cites Wonderly (1951) as the source. In his description of Copainalá phonemes, Wonderly (1951:106) states that "t is alveolar: tatah *father*," and "t^y is a stop produced with the blade of the tongue in alveopalatal position and the tip down: t^{y}atah *his father*." In a further explanation Wonderly (1951:118) states: "When y precedes t in word initial clusters, metathesis occurs followed by palatalization of the t and loss of the y ... ." The only phonemes with

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[4] Yasugi (1995:12) uses the Americanist symbols which include using <y> for the palatal consonant and superscripted <y> following a consonant to indicate a palatalized consonant.

a secondary articulation of palatalization shown in the Copainalá Zoque phoneme chart are /t^y/ and /d^y/ (Wonderly 1951:105).

Yasugi does not refer to secondary palatalization in the Mixe languages because they have never been described as having palatalized consonants as phonemes. The palatalization is handled in other ways to avoid doubling the consonant inventory. For example, Crawford (1963) decides on a sequence of the consonant plus /y/ (section 3.7.2), Hoogshagen (1984:4) refers to palatalized allophones of the consonants, and Van Haitsma [Dieterman] and Van Haitsma (1976:5-11) call [secondary] palatalization a suprasegmental phoneme (section 3.7.4). Since secondary palatalization is not on the linear phonemic level, it is not included in Yasugi's survey.

In his survey of Mesoamerican languages, Suárez (1983) apparently uses the term *palatalization* to refer to secondary palatalization as defined in this study. His reference to "Mixe from El Paraíso" is authored by Van Haitsma [Dieterman] and Van Haitsma (1976):

> Palatalization as a feature affecting all members of a consonant system was exemplified with Mixe from El Paraíso. Except for languages such as this, where palatalized consonants contrast with sequences Cj, linguists may differ in their analysis of the same language as to whether the consonant is palatalized or a sequence Cj. Nevertheless, palatalized dentals may be said to occur in some Otomanguean languages, Coastal Chontal and Uto-Aztecan languages; palatalized velars are uncommon (some Mayan languages) and only Amuzgo has both [palatalized /t/] and [palatalized /k/] (Suárez 1983:44).

3.6 Palatalization in Zoque languages

Zoque languages generally show evidence of primary palatalization but not of secondary palatalization. However, the descriptions available are not explicit regarding the type or extent of the palatalization manifested, with the exception of Wonderly (1951), quoted in section 3.6.1 and Elson, section 3.6.2.

Wichmann (1995) describes the phonology of all the Mixe-Zoque languages in relationship to Proto-Mixe-Zoque but does not distinguish between primary and secondary palatalization. He states: "The use of metathesis of /y/ as an isogloss characterizing the whole [Mixe-Zoque] language family is clearly off the mark" (Wichmann 1995:153). This may be an indication that the Zoque languages are not characterized by secondary palatalization in the same way that the Mixe languages are.

3.6.1 Copainalá Zoque

Wonderly (1951:117-8, 140) describes Copainalá Zoque as having a third person prefix *y-* that palatalizes the alveolar consonants (primary palatalization as here defined) and assimilates to the alveopalatal consonants, with all the other consonants--labial, velar and glottal--the /y/ metathesizes. Only one example of secondary palatalization is described by Wonderly: "The cluster wy is actualized as an unrounded bilabilal spirant with the tongue in palatal position: wyin *his face*, ... When the following vowel is mid or low, the cluster ends in a palatal off glide ... " (1951:107).

Wonderly's description is reinterpreted by Sagey (1986:106-111) to indicate palatalization of all of the consonants: "Thus, I analyze the fact that the palatal

articulation in [py], [ky], [ʔy], etc. is perceived as an offglide as simply an acoustic effect of the transition to the following vowel." She does admit that Wonderly says [y] and [p] metathesize. In view of the differences in Russian among /pot/, /pʲotr/ and /pjot/ as shown by Ladefoged & Maddieson (1996:364), Zoque may also have the distinction between palatalization and a sequence with /j/. Further study is indicated to clarify the interpretation of this Zoque data.

3.6.2 Sierra Popoluca

In Sierra Popoluca, Elson (1960) states that the alveolar consonants /t c s n/ morpheme initial become palatalized as [tʸ č š ñ] when preceded by /ih/, /j/, any of the alveopalatal consonants [tʸ č š ñ], or by the morphophoneme [iʸ] within a word. In a reference to the Gulf Zoquean languages, which include Sierra Popoluca, Wichmann (1995:191) says that "coronal stops [sic] /t c n s/ become palatalized ... in the vicinity of /i/", which is an apparent example of primary palatalization as defined in this study.

3.6.3 Francisco León Zoque

In their dictionary (Zoque-Spanish) of Francisco León Zoque, Engel and Engel (1987:335) write a section heading as: "La metátesis de la *y*, la palatalización," translated as *the metathesis of y, palatalization*. They list two examples which show /y/ as third

(1) y + tøc → tyøc   *su casa (de él)* 'his house'[5]
(2) y + pejtu → pyeju   *lo barrió* 'he/she swept it'

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[5] The English translations are added here for the readers' convenience.

These examples are written in the orthography of the language which does not

distinguish whether a consonant is palatalized or is occurring contiguous to /j/, since

orthographies in Mexico use <y> to express both /j/ and palatalization. Although the

heading indicates that palatalization is involved in the process of metathesis, there is no

indication of which consonants are palatalized, since the authors do not give phonetic

details of this phenomenon.[6]

3.6.4 Other Zoque language descriptions

Other authors writing about various Zoque languages, such as Harrison, Harrison

and García (1981, Copainalá), Harrison and Harrison (1984, Rayón), Knudson (1975,

Chimalapa) indicate that palatalization in these languages is similar to one of those

described above. In all of these Zoque languages except Chimalapa, the third person

possessive prefix on nouns and/or the third person subject prefix on some types of verbs

(or verbal clauses) is one cause of palatalization. In the languages more fully described, it

is evident that only primary palatalization occurs, with the exception of one instance of

secondary palatalization described in section 3.6.1.

3.7 Palatalization in Mixe languages

Wichmann (1995:9) classifies the Mixe languages according to the Oaxacan Mixe

subgroup (four languages and among them seventeen dialects), and three other Mixe

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[6] These types of dictionaries are written for general use; they do not give detailed
linguistic descriptions.

languages not spoken in Oaxaca: Sayula Popoluca, Oluta Popoluca, and Tapachulteco. The Oaxacan Mixe languages and dialects are named according to a place name with the word *Mixe* following. According to Wichmann (1995:xix), in all the Oaxacan Mixe languages, all consonants except the glottal stop may undergo palatalization. However, in Hoogshagen (1984:4), Van Haitsma [Dieterman] and Van Haitsma (1976:5-11), and in this study the glottal stop is included along with all of the other consonants as being mutated by secondary palatalization.

3.7.1 Sayula Popoluca and Oluta Popoluca

According to Wichmann (1995:184-5), the coronal affricate is palatalized preceding a high front vowel in Oluta Popoluca and preceding or following a high front vowel in Sayula Popoluca. These are examples of primary palatalization. Clark (1959, 1961) makes no mention of palatalized consonants in Sayula Popoluca, other than the alveopalatal affricate and the sibilant counterpart which contrast lexically with the palatal affricate and sibilant. Palatal /j/ is one of the consonant phonemes.

3.7.2 Totontepec Mixe

In describing Totontepec Mixe, Crawford (1963:39) states that "... sequences of another consonant plus /y/ pattern very much as single phoneme units, so that there is considerable evidence for a series of palatalized phonemes." However, rather than doubling the number of consonant phonemes by positing palatalized consonants, Crawford chooses to phonemicize the palatalized consonants as a sequence of the

consonant plus /y/.[7] He says that if he had chosen to posit palatalized consonants as phonemes, for example, "what is now phonemicized as /ty/ would be treated as /t^y/, and would consist of the simultaneous contrastive features of /t/ (voiceless central stop consonant) plus a sequential feature of palatal release" (1963:39). Schoenhals and Schoenhals (1982) indicate that /y/ following the initial consonant of the word is the third person marker. Apparently all of the consonants may be palatalized in word initial position. From these sources it appears that this palatalization in Totontepec Mixe is the same as described in section 3.7.4 for Coatlán Mixe.

3.7.3 Tlahuitoltepec Mixe

In his description of Tlahuitoltepec Mixe, Lyon (1980) does not discuss the palatalization of consonants, except to indicate palatalized allophones in the examples. From the list of allophones that are written in phonetic brackets in comparison to the example words written in slant lines, it is evident that most of the consonants in the inventory are palatalized by the third person possessor morpheme; for example, /p/ has a palatalized allophone [p^y], shown in /pya·ht/ [p^{y}a·ht] 'his broom.' Lyon (1980:25-9).[8]

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[7] Because the palatalization in Totontepec Mixe is phonemicized as Cy, Maddieson (1984) does not include Totontepec Mixe among the languages having palatalized consonants.

[8] The Tlahuitoltepec words are shown as examples of the fronted allophone of /a/ which occurs before or after the /y/ (Lyon 1980:28). The fronting arrow over the [a] is omitted here. There is a misprint in the actual example given for /p/ and [p^y] as /p^{y}ɔhk/ [p^{y}ɔhk^h] with the superscript [p^y] in phonemic slashes (Lyon 1980:25). Note that none of the phonemic examples have superscripted letters. /p^{y}ɔhk/ should have been written /pyɔhk/; palatalized consonants are phonemicized as /Cy/ as in Totontepec Mixe.

The word for 'broom' without the third person marker is given in the vocabulary list as

pa·ht. From the examples given it is evident that Lyon has phonemicized Tlahuitoltepec

Mixe palatalized consonants as /Cy/ just as Crawford has done for Totontepec Mixe.

Wichmann (1995), in describing all the Oaxacan Mixe languages, follows

Crawford and Lyon in treating palatalization as the phonemic palatal consonant /j/.

However Wichmann (1995:57-8) does not say that /j/ metathesizes with the following

consonant, but that /j/ palatalizes the following consonant.

3.7.4 Coatlán Mixe (including San José El Paraíso)

In Van Haitsma [Dieterman] and Van Haitsma (1976:5-11), palatalization in the

Mixe of San José El Paraíso[9] is similar to that in the other Oaxacan Mixe languages (i.e.

secondary palatalization of nearly all of the consonants). It is called a suprasegmental

phoneme of consonants to avoid positing palatalized consonants as phonemes, which

would nearly double the consonant inventory, and to maintain the more simple syllable

onset. The authors state that all primary consonants may be palatalized, writing

palatalization as a tilde over the consonants. Distinct from palatalization is the phoneme

/y/ which does not palatalize the first person marker prefix *n-* or the second person prefix

m- when they precede a word beginning with /y/. The contrasts are shown in these

examples: /nyaH^{2}o'k/[10] 'I killed him' and /ño'k/ 'he lit it' in which /ny/ is a sequence of

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[9] One of the villages in the Coatlán Mixe district is called San José El Paraíso; the
language spoken there is considered to be the same language as Coatlán Mixe.
[10] The capital H indicates what is called an aspirated vowel in the Mixe of San José El
Paraíso (Van Haitsma [Dieterman] and Van Haitsma 1976:5-11).

the first person *n-* plus /y/ and /ñ/ is a palatalized /n/, the third person palatalization

morpheme plus /n/.

Hoogshagen (1984:4), in describing the effects of palatalization on the entire

consonant inventory of Coatlán Mixe, writes the third person marker as *y-* preceding the

word initial consonant and states that in initial position the *y-* indicates that the

palatalized allophone of the consonant occurs: /mo·k/ 'corn'; /ymo·k/ [m̃okʰ] 'his corn.'

However, if the word initial consonant is /y/ and the second person marker occurs,

palatalization does not occur: /yoˀok/ 'mother-in-law'; /myoˀok/ [myoˀokʰ] 'your-

mother-in-law.'

Hoogshagen and Hoogshagen (1993) in their dictionary of Coatlán Mixe (Mixe-

Spanish), represent palatalization by the use of the orthographic <y> and in the

phonology section describe the pronunciation of <yC> (C represents any consonant) as a

palatal articulation of the consonant which follows <y> and a palatal off-glide from the

consonant on the following vowel. It is stated that the <y> represents a morpheme, (i.e.

as a prefix it is third person; as a suffix (written <Cy>) it indicates adverbial concordance

of the verb). Although this is a popular grammar written in Spanish, and not a linguistic

description, it gives a more complete depiction of the palatalization phenomena than

have been presented in other descriptions, either linguistic or popular. Palatalization in

Coatlán Mixe is basically the same as the secondary palatalization described in this study

for Isthmus Mixe (i.e. morphemically-induced secondary palatalization).

3.7.5 The origin of secondary palatalization in the Oaxacan Mixe languages

Consonant mutation is known to occur in some of the world's languages as the result of the reduction of former overt prefixes. Greenberg (1977) found that former prefixes had been reduced to consonant alterations in Wolof and Fula. Mc Laughlin (2000) describes consonant mutation in Seeree-Siin as representing a morpheme. Spencer (1998:133) mentions that a consonant mutation "often arises historically from the effects of prefixes which induce phonological alternations but which are then lost."

It is probable that historical processes of syllable truncation have resulted in the secondary palatalization found in all present-day Oaxacan Mixe languages. At some earlier period, the *ʔi-* third person prefix of the Popoluca languages was truncated to secondary palatalization of the initial consonant in the Oaxacan Mixe languages. In Sayula Popoluca the third person possessive prefix is *ʔi-*[11] and in one type of clause, the third person subject prefix is also *ʔi-* (Clark 1959, 1961). Oluta Popoluca also has the third person possessive prefix *ʔi-*, and in four types of clauses the third person subject prefix is *ʔi-* (Clark 1981). In Sierra Popoluca, Elson (1961) shows examples of certain transitive clauses using the third person subject prefix *ʔi-*, and Lind (1964) shows examples of *ʔi-* as third person possessor on nouns throughout his article, in addition to some transitive clauses having the third person subject prefix *ʔi-*.

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[11] Popolucan vowels are preceded by a glottal stop when they occur word initial including the third person prefix; although the glottal stop is not written in Clark 1961, 1981 or in Lind 1964, it is written here for consistency.

There is also a word-final secondary palatalization morpheme that indicates certain clause types in the Oaxacan Mixe languages. Wichmann (1995:102-3) shows several proto-Mixe aspectual verb suffixes as *-*hi* and two proto-Zoque aspectual verb suffixes as *-*hi* and *-*i/e*. Thus, it appears that the clause-type palatalization morpheme in the Oaxacan Mixe languages is a result of the truncation of the proto-Mixe-Zoque suffix(es).

Another verbal suffix in Isthmus Mixe manifested by secondary palatalization is a deverbalizer. For example, the verb /tṳːt/ 'to lay eggs' is nominalized by the suffix /-ʲ/ resulting in /tṳːtʲ/ 'egg.' These same forms occur in Coatlán Mixe.[12] According to Wichmann (1995:483) the proto-Mixe form is *tuʔt-i(k) 'egg' and the form in present day Sayula Popoluca is /tuʔtiʼk/. The suffix *ik is listed as a proto-Mixe-Zoque deverbalizer (Wichmann 1995:541). The nominalizer manifested by word-final secondary palatalization in Isthmus Mixe is the result of truncation of final /i/ plus consonant of proto-Mixe-Zoque words.

Another example of the truncation of the word-final syllable that results in secondary palatalization is shown by the proto-Mixe-Zoque *ʔápit 'thorn,' which in present day Sayula Popoluca is /ʔapit/ and in Oluta Popoluca /ʔapíʼt/. Several Zoque languages have a two syllable form with the second vowel /i/ (Wichmann 1995:248-9).

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[12] Isthmus Mixe and Coatlán Mixe data are mine. Wichmann uses the question mark for the glottal stop.

Isthmus Mixe has dropped /i/, substituting a final palatalized consonant cluster /ʔaptʲ/,

and in Coatlán Mixe the word is truncated to /ʔapʲ/. No meaning or grammatical function

is apparent in this type of secondary palatalization.

The possible origin of secondary palatalization in the Oaxacan Mixe languages

has not been discussed in any of the published works about the Mixe-Zoque languages.

It may have been that writing about the origin of secondary palatalization did not fit in

with the purposes of the authors; or it may have been overlooked because secondary

palatalization was not noted in the descriptions of specific Mixe languages as an

important phonological process. Whatever the reasons for the lack of recognition of

secondary palatalization in the Oaxacan Mixe languages, it is hoped that this study will

elucidate the phenomenon and contribute important data to the body of general linguistic

knowledge.

3.8 Palatalization as an autosegmental feature

Beginning with the description of Copainalá Zoque by Wonderly (1951), a

number of the Zoque languages were described as having a third person prefix *j-* that

caused primary palatalization in some instances and that metathesized with other

consonants (e.g. labial, velar and glottal) (see section 3.5 and the individual language

descriptions in section 3.6). The term metathesize simply means "an alteration in the

normal sequence of elements" (Crystal 1997:240) and does not give any indication as to

whether any phonological processes are caused by the metathesis. In the case of

Copainalá Zoque described by Wonderly (1951), Sagey (1986:106-111) interpreted the

data to mean that that all of the consonants had undergone a process of palatalization[13] (section 3.6.1), thus it is ambiguous as to whether there is actually a sequence of two consonants (e.g. pj, kj, hj), or one palatalized consonant.

In the Mixe languages, Crawford (1963) phonemicized the third person prefix *j*-, together with the initial consonant of the word, as Cj (section 3.7.2). He clearly stated this sequence indicated [secondary] palatalization of the initial consonant, not an actual sequence of two consonants. However, it seems that the concept of the sequence of two consonants prevailed, because in the survey done by Maddieson (1984), the language described by Crawford (1963) is not included with the languages that have secondary palatalization (section 3.3) and no other authors who discuss palatalization in detail have included the Mixe languages among their examples. In this type of representation, the fact that palatalization manifests the third person morpheme is also not apparent. It is to be noted that the earlier descriptions of the Mixe languages attempted to describe all the features using the linear model; the development of autosegmental models came later.[14]

Secondary palatalization as an autosegmental feature will be shown to be the most appropriate way to handle morphemically-induced secondary palatalization in the

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[13] Sagey (1986:106-111) does not use the terms primary and secondary palatalization. However, in her analysis, the Copainalá Zoque labial, velar and glottal consonants undergo what it called secondary palatalization in this dissertation (she indicates a secondary articulation) and the alveolar and alveopalatal consonants undergo what is here called primary palatalization.

[14] Although only the word initial third person morpheme is discussed here, in at least some of the Mixe languages, there are also verb-word final palatalization morphemes (see section 3.7.5, chapter 4, section 4.4.7 and chapter 5, section 5.5.1).

Oaxacan Mixe languages (chapter 5). Describing secondary palatalization as an autosegmental feature obviates the need for a set of palatalized consonants on the phonemic level and does not complicate the linear consonant-vowel structures of the syllable. The phonetic manifestation of the morpheme is clearly revealed by the autosegmental approach.

In addition, in describing Mixe secondary palatalization as an autosegmental feature, it can also be recognized as a consonant mutation; thus it can be compared with other consonant mutations in the world's languages which are morphemes and are described as autosegmental features, such as labialization and palatalization in Chaha (McCarthy 1983), continuant and voicing in Nuer (Lieber 1983), continuant and nasalization in Fula (Lieber 1983) and palatalization in Japanese mimetics (Archangeli and Pulleyblank 1994, Mester and Itô 1989).

CHAPTER 4

4 A case study of secondary palatalization in Isthmus Mixe

4.1 Introduction

Given that the morpheme indicating third person manifests itself as palatalization of the initial consonant of the word, secondary palatalization in Isthmus Mixe is widespread. This third person morpheme affixes to nouns and verbs, which all begin with one consonant followed by one vowel. Since all the consonant phonemes in the language may occur word initial and they may be followed by any of the six vowel qualities,[1] every consonant and every vowel may be affected by palatalization in word-initial syllables. While palatalization in other languages is usually caused by the phonetic influence of an adjacent front vowel, palatalization in Isthmus Mixe is morphologically induced: there is no purely phonological trigger for the process.

In the waveforms and spectrograms shown in figure 4.1, it can be seen that there is no overt phonetic influence causing palatalization of the consonant /p/. There is nothing preceding the palatalized consonant [pʲ] in [pʲām] (from /ʲ-pa-meʰts-ʲ/ 'they follow arrived') to trigger palatalization, nor is the low vowel /a/ which follows [pʲ] a

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[1] One exception is that consonant /j/ is not followed by vowel /i/.
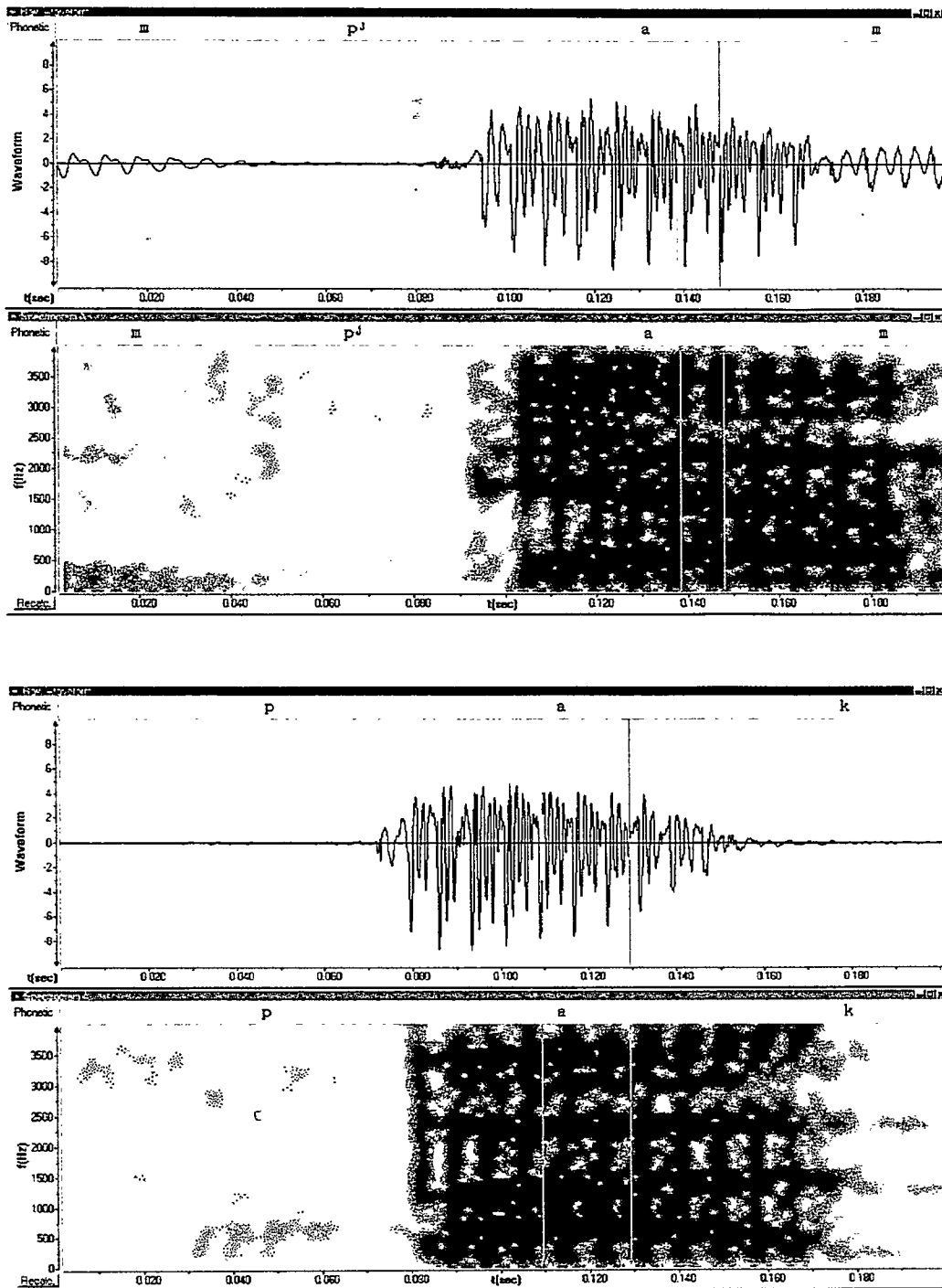
Figure 4.1. Comparison of [pʲ] in [pʲām] with [p̀] in [pak].

trigger. Palatalization is a manifestation of the third person morpheme affixed to the consonant.

The most characteristic indication of the palatalization of a consonant as seen on a spectrogram is a raised F2 transition of the adjacent vowel. In figure 4.1, a raised F2 transition is seen adjacent to the palatalized consonant [pʲ] in [pʲām]; in contrast, the F2 transition is low following the plain consonant [p] in [pak]. The palatalization is heard as occurring simultaneously with the primary consonantal articulation, and as a short glide transition on the vowel.

Besides word-initial palatalization, some types of clause-final markers[2] consist of secondary palatalization which palatalizes the verb-final consonant or consonant cluster (see chapter 3, section 3.7.5 and chapter 4, section 4.4.6). In addition, there are a number of other palatalized word-final consonants or consonant clusters also related to a historical process of final-syllable truncation (chapter 3, section 3.7.5). Thus there is also considerable word-final palatalization.

A study of the effects of secondary palatalization on Isthmus Mixe consonants and vowels was made on *Text A*, which is fluent continuous speech, 100 seconds long (see Appendix). There are a total of 356 syllables, which averages 3.56 syllables per

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[2] Palatalization of the final consonant of the verb is characteristic of the three types of conjunct clauses, and it also occurs in conjunction with the verb-final suffix *-p* in one of the nonconjunct clauses. These clauses are described in Dieterman 1995 and Dieterman 1998.

second.[3] All consonants and vowels (except those found in non-Mixe words, such as Spanish names) were analyzed, a total of 398 consonants and 300 vowels.[4] See section 2.1 for a description of *Text A*, and section 4.3 for methodology. The frequency counts of the consonants and vowels in this text in relationship to secondary palatalization show the widespread effects of palatalization and give an overview of the language.

4.2 Frequency counts of Isthmus Mixe consonants

The frequency counts of the consonants in the language vary considerably. In table 4.1, the consonant frequencies are listed in order from the most numerous to the least. Of 398 consonants analyzed, the numbers from highest to lowest frequencies are: /t/ with 71, of which 46 are plain consonants and 25 are palatalized consonants; /n/ with 67, of which 58 are plain consonants and 9 are palatalized; /m/ with 61, of which 49 are plain and 12 are palatalized; /k/ with 48, of which 33 are plain and 15 are palatalized; /ʃ/ with 35, of which 14 are plain and 21 are palatalized; /h/ with 33, of which 24 are plain and 9 are palatalized; /j/ with 31 which are all palatal;[5] /p/ with 26, of which 17 are plain and 9 are palatalized; /w/ with 13, of which 9 are plain and 4 are palatalized; /ts/ with 8 of which 3 are plain and 5 are palatalized; /ʔ/ with 5 of which 4 are plain and 1 is

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[3] As a basis for comparison, Ladefoged (2001:169) says that English-speaking network newscasters speak at about three syllables per second.

[4] The syllable count included the non-Mixe words, whereas only the segments in native Mixe words were analyzed in depth.

[5] No difference has been observed in /j/ when the palatalization morpheme also occurs. However, rather than set /j/ apart as a separate category, it has been included with the palatalized consonants.

TABLE 4.1

ISTHMUS MIXE CONSONANT FREQUENCIES IN *TEXT A*

Consonant	N	Plain	Palatalized
/t/	71	46	25
/n/	67	58	9
/m/	61	49	12
/k/	48	33	15
/ʂ/	35	14	21
/h/	33	24	9
/j/	31	0	31
/p/	26	17	9
/w/	13	9	4
/t͡s/	8	3	5
/ʔ/	5	4	1
Totals:	398	257 (64.6%)	141 (35.4%)

Isthmus Mixe Consonants
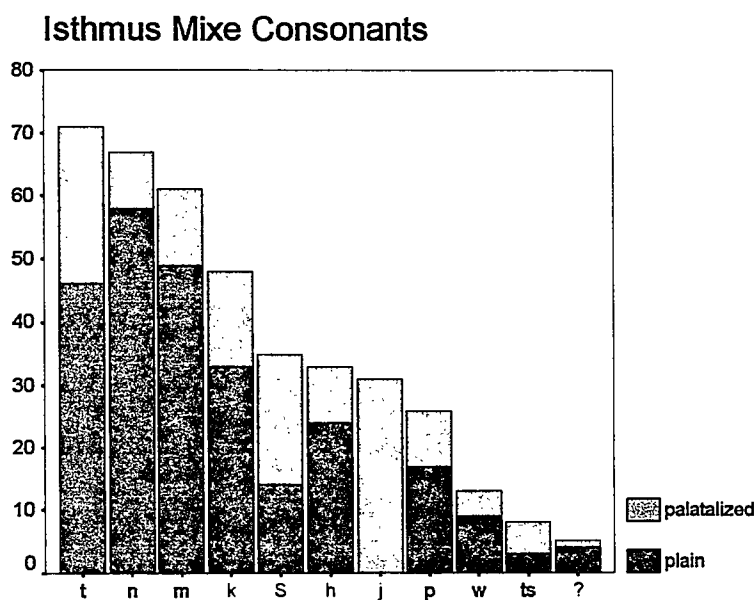
Figure 4.2. Isthmus Mixe Consonant Frequencies in *Text A*.

palatalized. Totals are 257 (64.6%) plain consonants and 141 (35.4%) palatalized

consonants or roughly two-thirds plain and one-third palatalized consonants in the 100

seconds of text analyzed.

In figure 4.2, each consonant is divided by those which are palatalized, the upper

section of the bar, and those not palatalized (plain), the lower section of the bar. The

phoneme /ʃ/ is represented by the upper case S, and the glottal stop by the question

mark. The exact numbers represented by the bars in figure 4.2 are given in table 4.1.

4.3 Methodology

When a text is analyzed with the goal of identifying every phoneme, a

combination of methods is employed. In analyzing *Text A*, for what were identified as

vocoid sounds, the goal was to measure the first three formant frequencies. The Speech

Analyzer software (see chapter 2, section 2.1) utilizes two cursors and averages the

values between the cursors. The analyst looks at the spectrogram and places the cursors

in an area where the formants are level, which is identified as the steady-state portion of

the vowel, avoiding the edges of the vowel adjacent to consonants or another vowel,

known as the transition areas (Speech Analyzer Tutor 2001).[6] Notice the placement of

the cursors (vertical lines) in the bottom half of figure 4.1 (section 4.1) in the steady-

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[6] According to Kent and Read (1992:116), "[o]ne fairly reliable temporal constant of
stop articulation is that the transition from stop to vowel or from vowel to stop is about
50 ms in duration. Within this 50 ms interval, all formant frequencies shift from their
values for the stop to their values for the vowel." In general, Isthmus Mixe transitions
conform to this description, except in the case of vowels of short duration in which at
least one formant may not level out.

state portion of the vowel /a/. However, some vocoid segments do not show a level area

in all the formants. In such a case, the cursors are positioned approximately in the middle

of the segment, or in the case of a vocoid adjacent to a palatalized consonant, at least

where F1 and F3 are level, and even if this area does not meet the criteria of all level

formants, the values of the formants are counted as the steady-state values. Such a

vocoid segment is seen in the upper half of figure 4.1, with the cursors set to encompass

one full cycle period (usually about 10 ms). The steady-state values of F1, F2, and F3 are

the usual formant measurements used in various tests and comparisons in this chapter.

The spectrum displays the average of the formants between the cursors, with

measurements taken by placing the cursor at the peaks (one cursor is utilized in spectrum

measurements). A readout of the formant value appears at the lower right side of the

window, along with the dB reading. In figure 4.3, the formant value of F1 (the cursor is

at the peak of F1) is 641.8 Hz and the amplitude reading is 18.1 dB. The analyst does a

visual check of the readout with the formant displayed in the spectrogram and the

approximate amplitude of the waveform to confirm the consistency of the readout

figures with the displays. It may be necessary to reposition the cursors in the

spectrogram slightly to one side or the other to get a spectrum that represents the

formant values, because if the cursors do not encompass a full cycle period, the

information upon which the spectrum is based is incomplete (Baart 1999, Speech

Analyzer Tutor 2001). In figure 4.3, the cursors are set 9.5 ms apart, shown third from
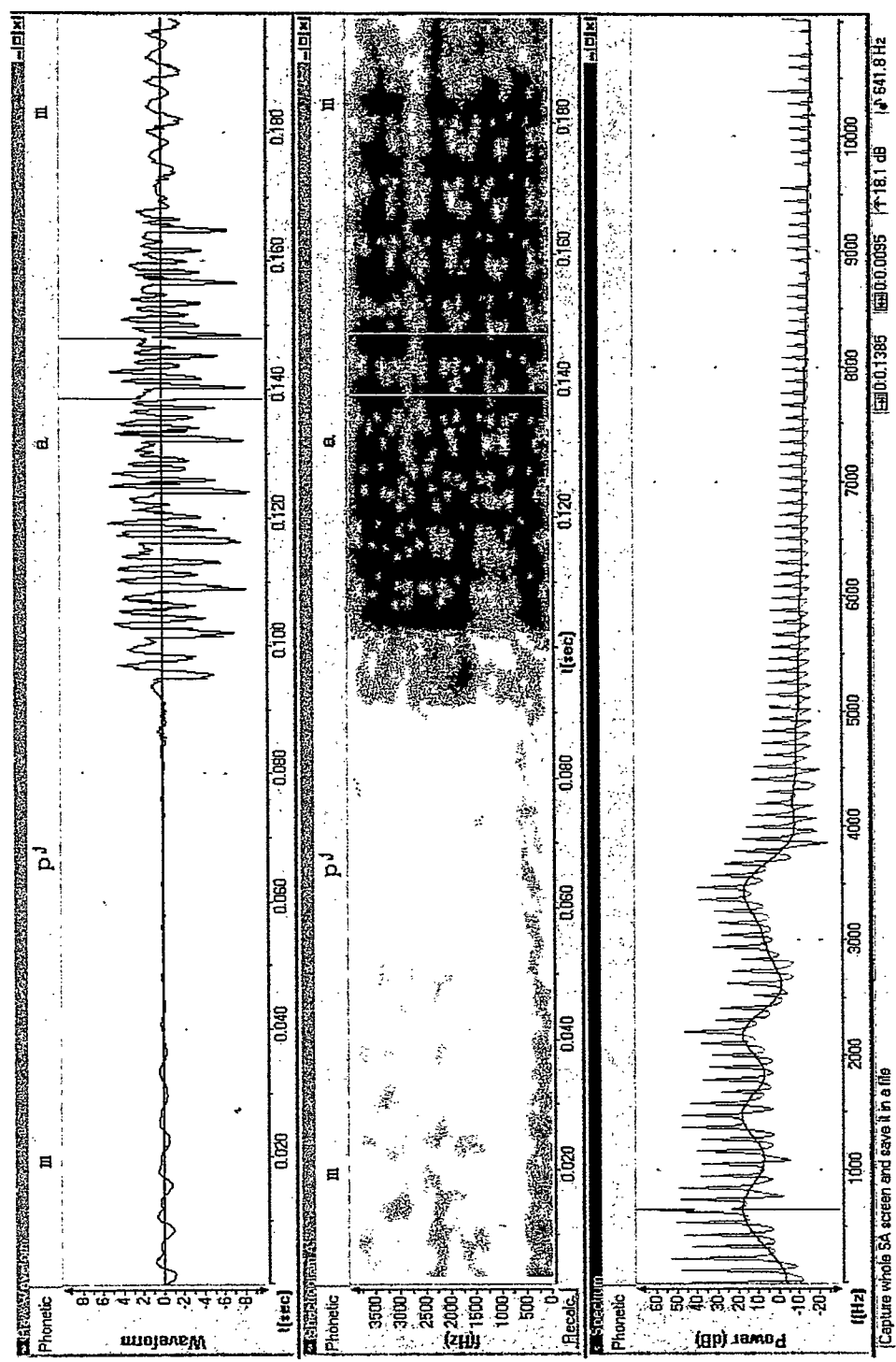
Figure 4.3. Spectrum of steady-state area of [a] in [pʲam].

the right at the lower right side of the window. This distance is approximately one cycle

period as can be observed in the waveform graph. Other examples of spectrums are

shown in figures 4.6 and 4.8.

Although exact figures are utilized as the results in the various readouts, it must

be remembered, as Fant (1973:5) observed: "Spectrographic pictures convey an

overflow of data which are non-essential for descriptive purposes. ... Any description of

the speech wave ... must be based on approximations."

Phonetic juncture measurements (section 4.4.2) are the averages of a full cycle

period of the phonetic junctures of the vowel formants as close to the consonant

transitions as the spectrum can be obtained. The general shape of the transitions may be

described from the appearance in the spectrogram; for example, the transitional F2

formant adjacent to a palatalized consonant is significantly higher than the transitional F2

formant adjacent to a plain consonant (see figures 4.1, 4.6 and 4.7).

In identifying consonant phonemes, the waveform and spectrogram were

examined. Since the speaker was reading *Text A*, the orthography offered some clues,

although he did not always read exactly what was written. The Speech Analyzer

software has a feature of slowing the rate of speech without noticeably distorting the

sound. At 35-50% of normal speed, most sounds could be identified (if not identifiable at

normal speed). For words ending with an unreleased voiceless consonant cluster, the

consonant adjacent to the vowel could usually be identified by the transitions from the

vowel; the second member of the cluster was included in the frequency count as

implicitly there. These silent consonants did not enter into any of the analyses or

statistical tests performed on *Text A*. Omissions or modifications of some segments is an

expected phenomenon when analyzing textual data (Fant 1973:19).

4.4 Isthmus Mixe consonantal modifications resulting from secondary palatalization

Secondary palatalization in Isthmus Mixe not only occurs as a secondary

articulation of the consonants /p m h ʔ w/, it also changes the primary position of the

consonants /t k t͡s ʃ n/. These definitions imply that secondary palatalization does not

modify the primary articulation of the palatalized consonant. This is true of the Isthmus

Mixe consonants that are not in close proximity to the palatal region, (i.e. /p m h ʔ w/).

However, Hall (2000:22) argues that "[s]ince secondary palatalization is articulated with

the tongue blade/front, this articulation is by definition laminal; it is therefore only natural

that an apical sound like [t̪] shifts to a laminal [t̪] when palatalized." It is likely that all of

the alveolar[7] and velar phonemes in Isthmus Mixe move toward the palatal region when

palatalized.[8] Nonetheless, the term secondary palatalization is used to describe the

process of palatalization for all the Isthmus Mixe consonants, because palatalization is

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[7] Referring to Isthmus Mixe, Wichmann (1995:58) states that when /t/ is palatalized it may be dentalized.

[8] Since no palatographic data are available from Isthmus Mixe speakers, more detail cannot be given as to exact place of articulation and the tongue involvement.

associated with one of the morphemes of palatalization, rather than the phonetic environment that is usually related to primary palatalization.

A question then arises as to whether secondary palatalization of /t/ and /k/ results in the articulation of both of these phonemes in the same palatal area. Another topic to be addressed is whether /ʃ/ has a palatalized allophone, since, as a palato-alveolar consonant, it is already close to the palatal region. And finally, what effects does palatalization have on the affricate /t͡s/? These issues are discussed in the following sections, along with a discussion of secondary palatalization of the nasal consonants. The phoneme /j/ has not been observed to undergo any change when affixed by the secondary palatalization morphemes.

A display of schematized spectrograms (figures 4.4 and 4.5) shows at a glance the differences in the steady-state formant values and the transitions of the vowel /ɨ/ following plain consonants and palatalized consonants /p k t ʃ h/ in Isthmus Mixe. These are based on spectrograms of *Text A* utterances and selected portions of the text immediately following *Text A*. The steady-state formants of /ɨ/ are the mean formant values as shown in table 4.4 (see section 4.6.2). The F1 steady-state mean of /ɨ/ adjacent to a plain consonant (376.3 Hz) is significantly greater than the F1 steady-state mean adjacent to a palatalized consonant (335.9 Hz), and the F2 steady-state mean of /ɨ/ adjacent to a plain consonant (1517.0 Hz) is significantly less than the F2 steady-state mean adjacent to a palatalized consonant (1763.8 Hz). In addition, F2 is distinctly raised
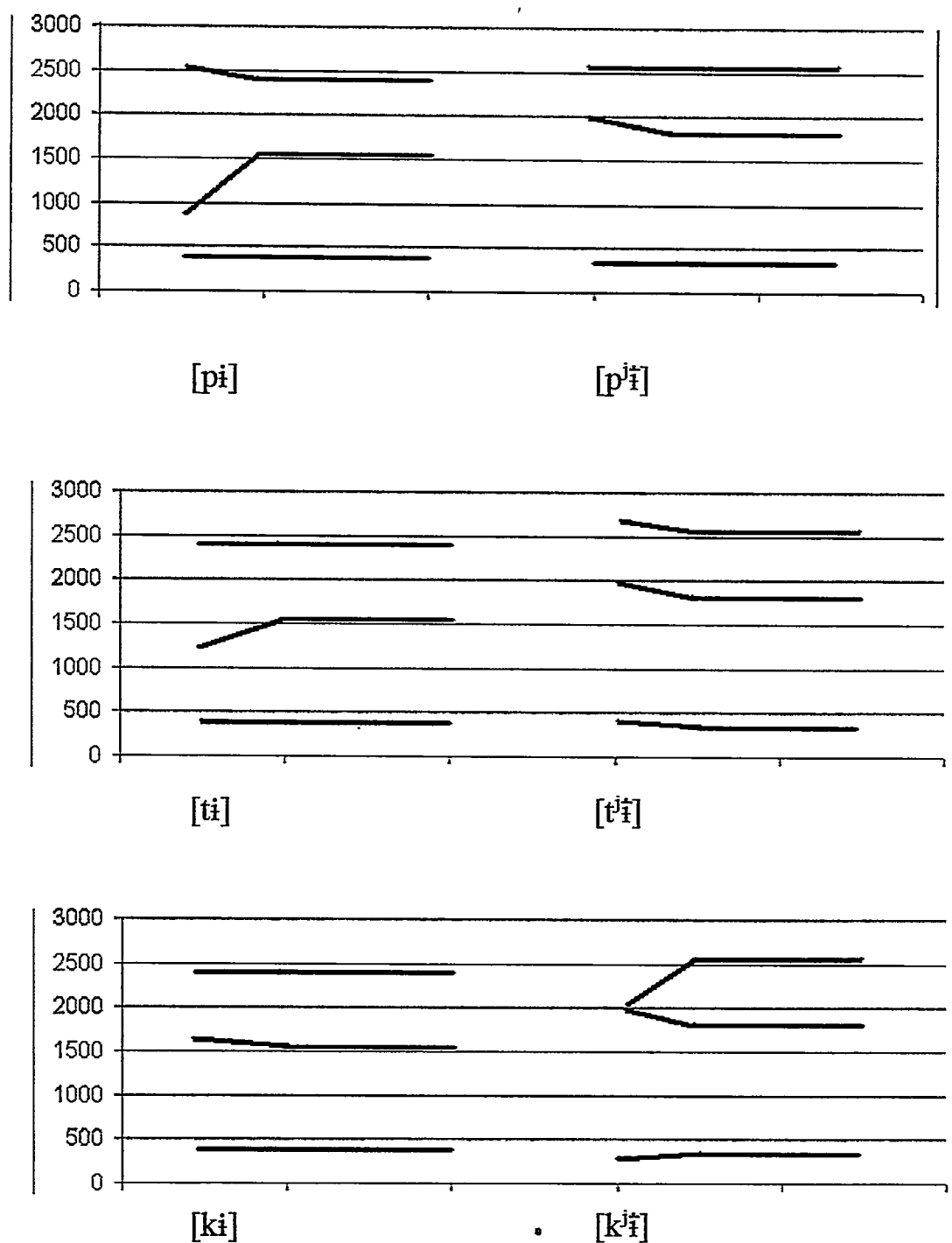
Figure 4.4. Schematized spectrograms contrasting transitions from plain consonants with transitions from palatalized consonants /p t k/.
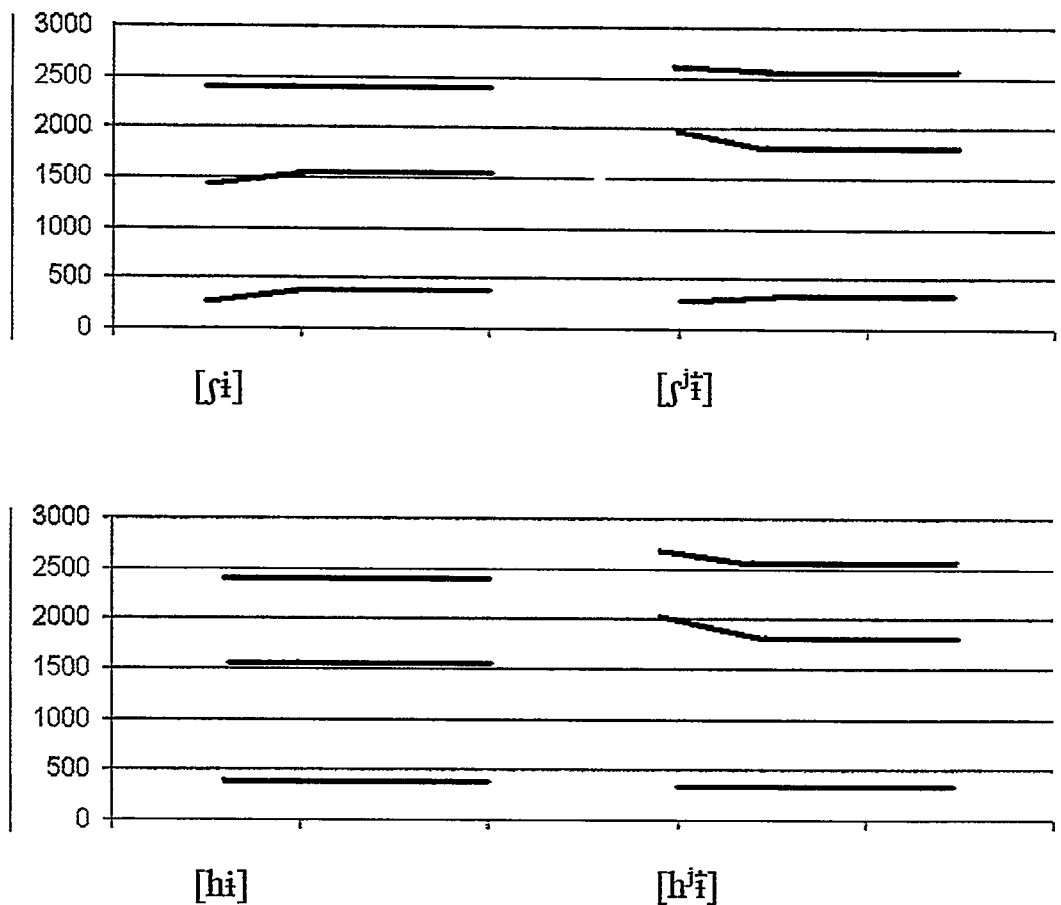
Figure 4.5. Schematized spectrograms contrasting transitions from plain
consonants with transitions from palatalized consonants /ʃ h/.

in the transitions to the palatalized consonants in comparison to F2 transitions to plain

consonants.

4.4.1 Secondary palatalization of /t/ and /k/ in Isthmus Mixe

As discussed in section 4.4, the plosives /t/ and /k/ are assumed to move toward

the palatal area when palatalized. The question was raised as to whether secondary

palatalization of /t/ and /k/ results in the articulation of both of these phonemes in the same palatal area. However, the acoustic evidence shows considerable differences in the transition formants of vowels adjacent to palatalized /t/ and /k/, which suggests that these two palatalized phonemes maintain distinct articulation areas. Both palatalized phonemes are shown in one syllable in figure 4.6, [dʲa̰ːkʲ] from /mitʲa̰ːkʲ/ 'talk.' At the [dʲa̰ː] juncture, the cursors are 9.7 ms apart, about one full cycle period, and the spectrum shows the formant values. The phonetic junctures of the vowel formants measured as close as possible to the consonant (section 4.4.1). As shown in table 4.2, at the [dʲa̰ː] juncture, the formant values are: F1 366.7, F2 2028.5, F3 2853.7, F4 3369.4; and the [a̰ːkʲ] junctures are: F1 309.4, F2/F3 2337.9, F4 3804.9, with the F2 and F3 transitions nearly merging in this spectrogram, a typical example. The most notable differences in the phonetic junctures are in the F2, F3 and F4 values. In the [dʲa̰ː] junctures, F2 and F3 are over 800 Hz apart, with F4 about 500 Hz higher than F3. In

TABLE 4.2

COMPARISON OF THE PHONETIC JUNCTURE FORMANT VALUES
OF THE PALATALIZED CONSONANTS /t/ AND /k/

	F1	F2	F3	F4
[dʲa̰ː] juncture	366.7	2028.5	2853.7	3369.4
[a̰ːkʲ] juncture	309.4	2337.9	2337.9	3804.9
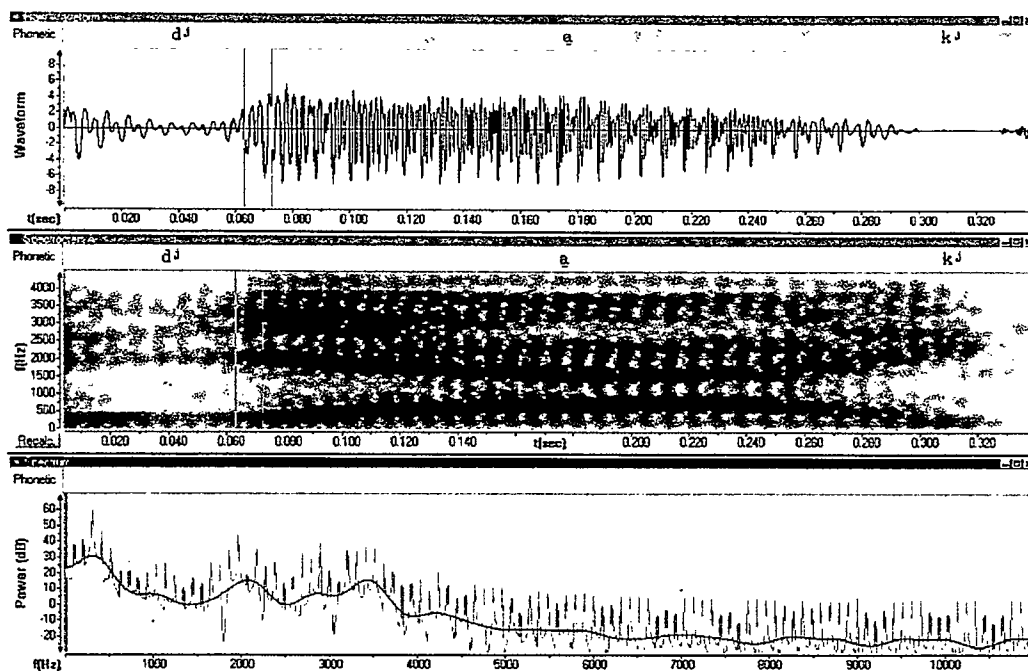
Figure 4.6. Transitions adjacent to [dʲ] and [kʲ].

contrast, in the [a̤ːkʲ] junctures, F2 and F3 merge about 300 Hz higher than the F2 of the

[dʲa̤ː] juncture, and F4 is nearly 500 Hz higher than the F4 of [dʲa̤ː].

A comparison may also be made with the transitions adjacent to plain /t/ and /k/.

In the example in figure 4.7 of the same phonemes that are not affected by palatalization,

[da̤ːg] from /yaʰmihita̤ːkit/ 'be overcome,' the difference in the F1 phonetic juncture

formants indicates that the [da̤ː] juncture is 22.9 Hz greater than the [a̤ːk] juncture; the

F2 phonetic juncture formant at the [da̤ː] juncture is 114.6 Hz less than the [a̤ːk]

juncture; the F3 phonetic juncture formant at the [da̤ː] juncture is 114.6 Hz greater than

the [a̤ːk] juncture; the F4 phonetic juncture formant at the [da̤ː] juncture is 68.8 Hz

greater than the [aːk] juncture (see table 4.3). The phonetic juncture formant values

adjacent to the palatalized consonants (figure 4.6 and table 4.2) follow the same pattern

as the pattern of the phonetic juncture formant values adjacent to the plain consonants in

figure 4.7 and table 4.3, with the F1 phonetic juncture formants of [dʲạ̈ː] a little greater

than the [ạ̈ːkʲ] juncture; the F2 phonetic juncture formant at the [dʲạ̈ː] juncture is less than

the [ạ̈ːkʲ] juncture; the F3 phonetic juncture formant at the [dʲạ̈ː] juncture is less than the

TABLE 4.3

COMPARISON OF THE PHONETIC JUNCTURE FORMANT VALUES
OF THE PLAIN CONSONANTS /t/ AND /k/

	F1	F2	F3	F4
[dạ̈ː] juncture	435.5	1489.9	2670.3	3724.7
[ạ̈ːk] juncture	412.6	1604.5	2555.7	3655.9
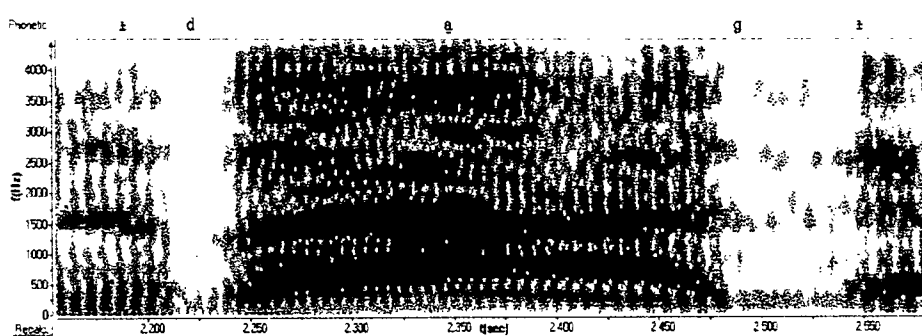
Figure 4.7. Transitions adjacent to [d] and [g].

[ãːkʲ] juncture.[9] As expected, palatalization raises the F2 of each transition; however the general distinctions between the phonetic juncture formants of two consonants is maintained, suggesting that [dʲ] and [kʲ] are articulated in different areas.

4.4.2 Secondary palatalization of the palato-alveolar sibilant

Given that the palato-alveolar sibilant is already close to the palatal region, a study was made to determine if any distinction between plain and palatalized /ʃ/ could be discovered from the acoustic data. In looking at the tokens of plain and palatalized /ʃ/ adjacent to vowels in *Text A* and other data, it was found that in general, palatalization of the palato-alveolar sibilant ([ʃʲ]) in Isthmus Mixe results in higher F2 and F3 transitions than the steady-state of vowels both preceding and following [ʃʲ]. When the vowels are /ɨ/, which is the most common vowel quality in these positions, F2 and F3 are about 150 Hz higher at the phonetic junctures with the consonants, while F1 may be a little lower. In contrast, when the plain [ʃ] is preceded or followed by /ɨ/, the F2 phonetic juncture is generally 150-200 Hz lower than the steady-state of the vowels; F3 has not shown a consistent pattern but in some instances remains level; F1 tends to be a little lower (figure 4.8). The greatest difference, then, is seen in F2 values which are definitely higher for transitions preceding and following [ʃʲ] than transitions preceding and following [ʃ].

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[9] F4 formants are included only for more descriptive completeness; they are not considered to be determinative for phoneme identification.
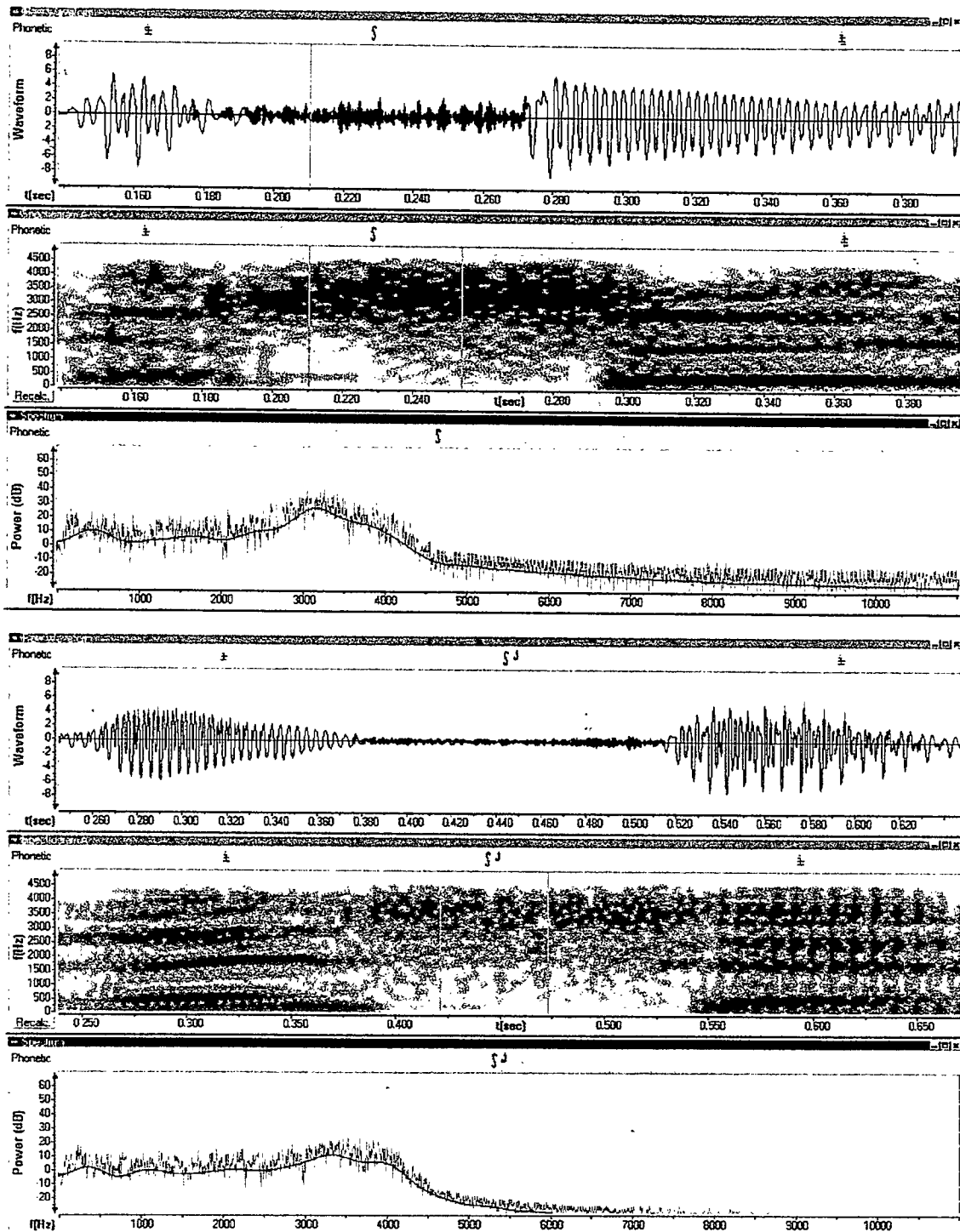
Figure 4.8. Comparison of [ʃ] in [ɨʃɨ] and [ʃʲ] in [ɨ̃ʃʲɨ̃].

There are not enough tokens of all occurrences to perform statistical analyses.[10]

Another distinction is seen in the spectrums of plain and palatalized /ʃ/ (figure 4.8). The spectrum of [ʃʲ] shows the major peak of energy at 3300.6 Hz with a smaller peak at 3885.1 Hz. The spectrum of [ʃ] shows one peak of energy at 3151.6 Hz. A possible third distinction is indicated by the durations of the segments: [ʃʲ] is 138.7 ms and [ʃ] is 87.0 ms. In all the tokens of these two segments between vowels in *Text A*, [ʃʲ] is always greater than 100 ms and [ʃ] is less than 100 ms. It seems likely that a little more duration could add a slight emphasis to the palatalized segment because of the added morpheme.[11] On the basis of differences in transition formants, energy peaks as shown by the spectrums, and segment lengths of [ʃ] and [ʃʲ] between vowels, the acoustic data suggest an empirical distinction between plain and palatalized /ʃ/.

One word-initial prefix, *ʲ-ʃ-* 'first and second person object,' attaches to the verb word, with subsequent palatalization of the verb-initial consonant, resulting in the only word-initial palatalized consonant cluster in the language. In figure 4.9, *ʲ-ʃ-* prefixes to the verb /niwɨːj/ 'to know' in /ʲ-ʃ-niwɨːj-ʲ/ [ʃʲnʲɨwɨːj] '... [he] knows me' (*ʲ-ʃ-* 'first person object'; /niwɨːj/ 'to know'; /-ʲ/ 'clause-type marker'). The raised F2 formant

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[10] Although the frequency count of /ʃ/ shows that it is not rare in occurrence, it is often found as the second member of a consonant cluster word final, or as part of a word prefix, in which it precedes a consonant.

[11] Usually the [ʃʲ] that occurs between vowels carries the clause type morpheme, followed by the vowel of a clitic.
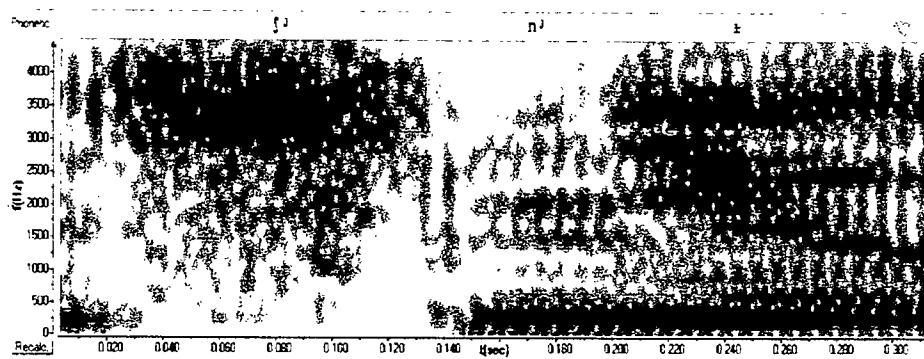
Figure 4.9. [ʃʲnʲɨ] from verb-initial prefix ʲ-ʃ and verb-initial /n/.

transition from [nʲ] to [ɨ] shows that the palatalization from the ʲ-ʃ- morpheme also

palatalizes the following consonant.

4.4.3 Secondary palatalization of /t͡s/ in Mixe

The affricate [t͡s] becomes [t͡ʃʲ] when palatalized, with both elements becoming

palatalized. The contrasts may be seen in figure 4.10 which shows an initial plain

affricate (preceded by word affix n-), /n-t͡saːt͡sʲ/ [nd͡saːt͡ʃʲ] 'my pain,' in the upper half of

the figure, and the palatalized affricate, /ʲ-t͡saːt͡sʲ/ [t͡ʃʲaːt͡ʃʲ] 'its pain' in the lower half. In

the transition following [s] (shown in the upper half of figure 4.10), F1 and F2 are seen

in the spectrogram to be lower than the steady-state formants of the vowel, while F3 is

higher. In contrast, the transitions of both F2 and F3 following [ʃʲ] (shown in the lower

half of figure 4.10) are distinctly higher than the steady-state formants of the vowel,

while F1 is lower. The shape of the spectrum of [ʃʲ] in the palatalized affricate is similar
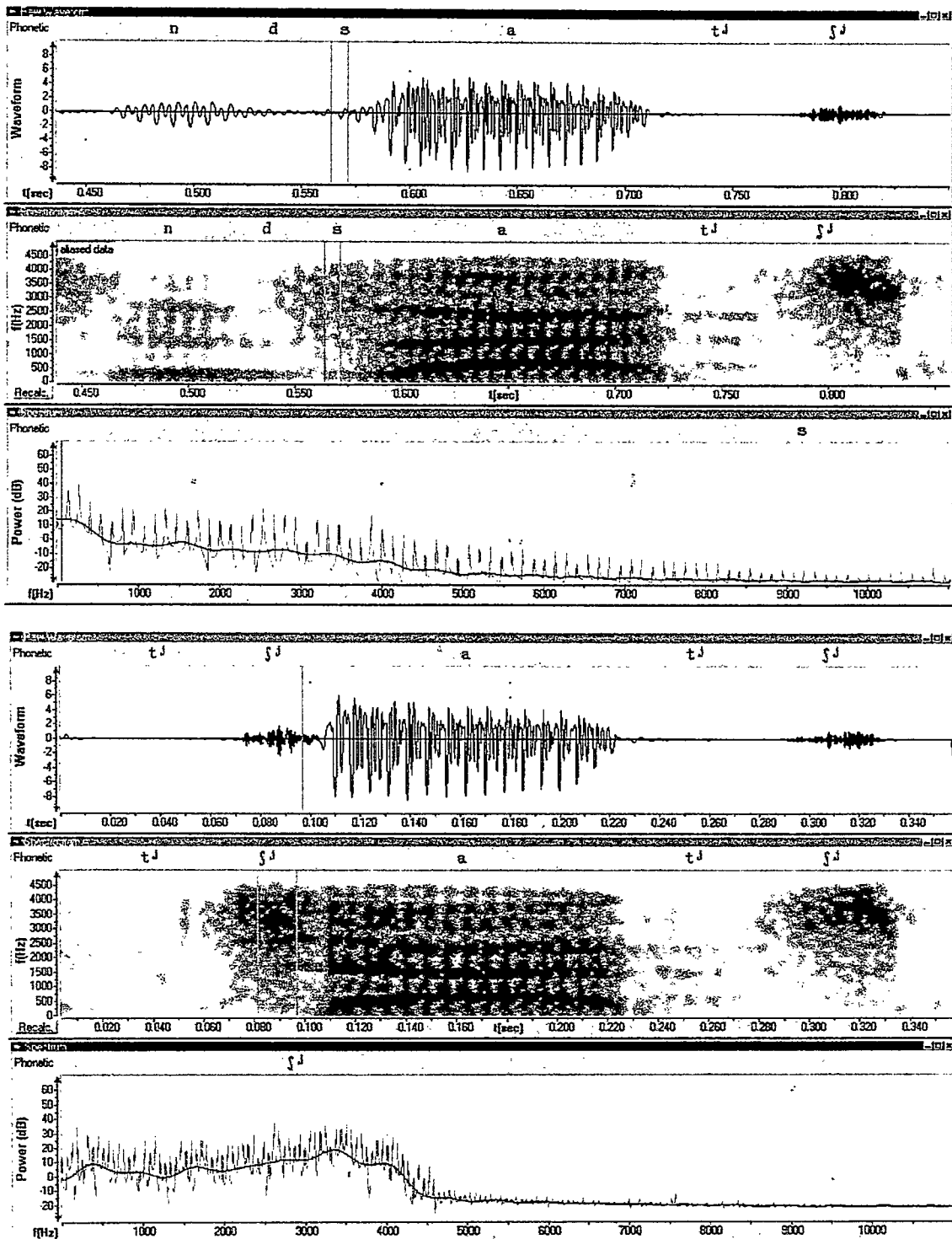
Figure 4.10. Comparison of plain affricate [nds̃a:t͡ʃʲ] and palatalized affricate [t͡ʃʲa:t͡ʃʲ].

to the spectrum of [ʃʲ] in section 4.4.3, figure 4.8. The spectrum of [s] shows just a downward line with no peaks.

4.4.4 Secondary palatalization of the nasal consonants

The effects of secondary palatalization of the nasal consonants /m/ and /n/ follow the same pattern as palatalization of the labial and alveolar stops. Moreover, because these two phonemes are also word prefixes, they may occur preceding the word-initial /j/ phoneme of a noun or verb. Thus in word-initial position there is a distinction seen between the nasal palatalized by the third person morpheme ʲ- and the sequence of the first person morpheme n- or the second person morpheme m- which precedes the initial /j/ of the word.[12] For example, in /n-jaʰniiʃɨj/ [njaʰniiʃɨj] 'I showed [you it]' the word initial [nj] contrasts with the word initial [nʲ] in /ʲ-naʰʃ-ʲ/ [nʲaʰʃ-ʲ] 'he passed by.' Likewise, the second person example in /m-jaʰʃiatɨt/ [mjaʰʃiadɨt] 'you will name [him]' the word initial [mj] contrasts with the word initial [mʲ] in /ʲ-metsɨt/ [mʲe͡dsɨt] 'he will arrive.'

In the examples shown in figure 4.11, the most obvious contrast is in the length of the nasals. The length of each example shown in figure 4.11 is the same (200 ms) so that at a glance one may see that [mʲ] (101.5 ms) is more than twice the length of m-

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[12] The distinction between the nasal palatalized by the third person morpheme ʲ- and the sequence of the first person morpheme n- or the second person morpheme m- which precedes the initial /j/ of the word is also found in Coatlán Mixe (see chapter 3, section 3.7.4).
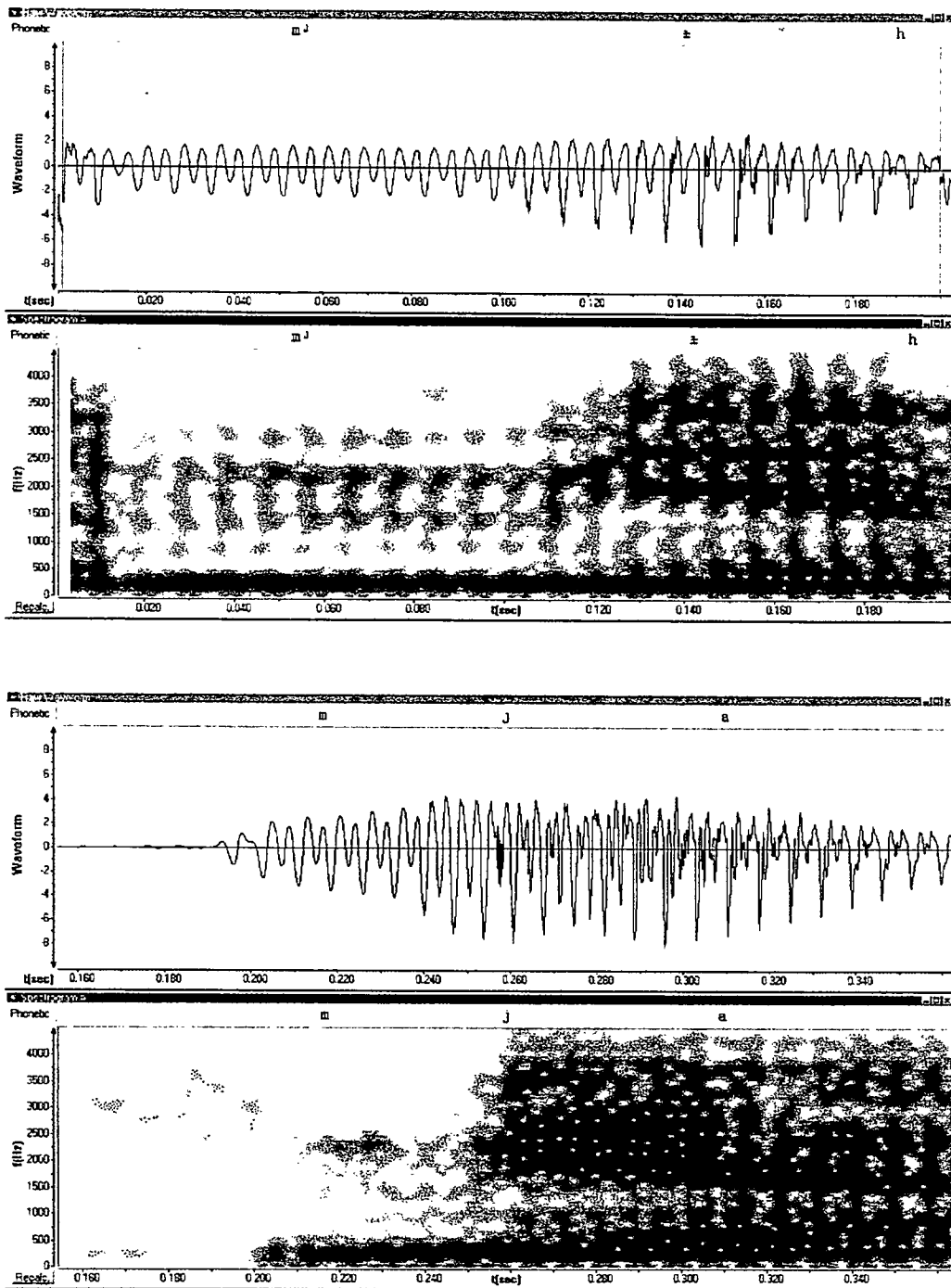
Figure 4.11. Comparison of palatalized [mʲ] and [mj] sequence.
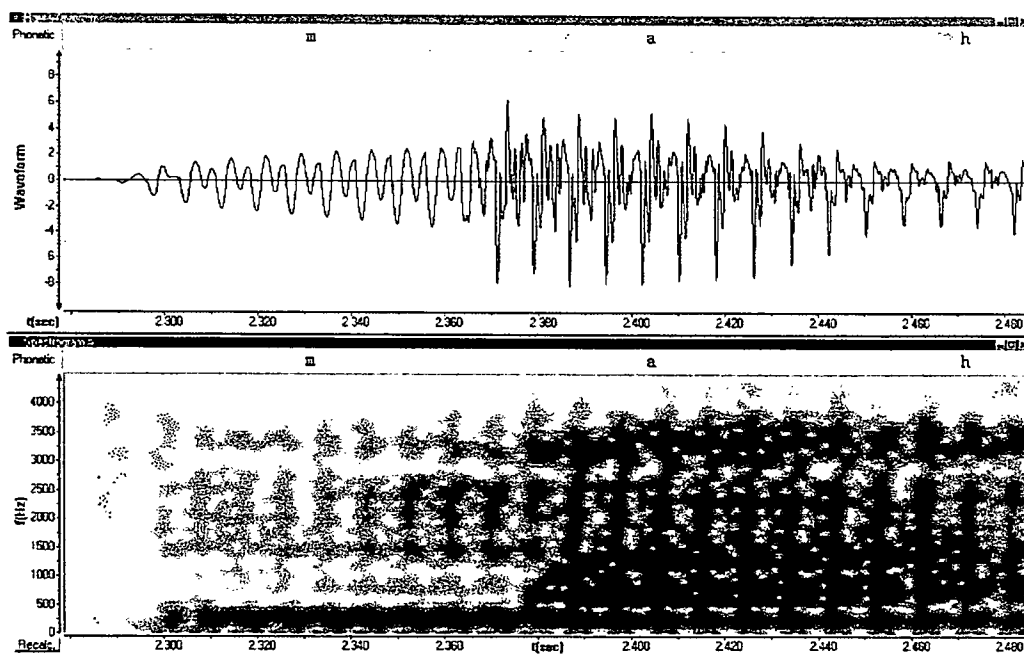
Figure 4.12. Plain [m] followed by a vowel.

preceding /j/ (44.7 ms). Another comparison is the length of plain /m/ preceding a vowel

(78.6 ms) from /ma/ [ma] 'at,' shown in figure 4.12, about half way between the length

of those shown in figure 4.11. Stress is not considered to be a factor in these differences:

/m^j/ is the onset of an unstressed syllable; the other two syllables receive tertiary stress.

The upper formants of /m/ preceding /j/ are weaker and less defined than the upper

formants of the other two.

4.4.5 Examples of palatalized /h/ and /ʔ/ in Isthmus Mixe

Several clear examples of both palatalized /h/ and palatalized /ʔ/ occur in *Text A*

and other data, usually word initial with the third person morpheme as the cause of

palatalization. Thus the morphemes that are palatalized in these examples also occur

without word-initial palatalization. Both plain [h] and palatalized [hʲ] are adjacent to the

same vowel /a/ in figure 4.13, [hāhʲɨ] from /ha~ʲ-hɨjmɨt/ 'his companions,' (Appendix

line 29) showing the contrast in the transition from plain [h] to [ā] and the transitional

palatal glide that precedes [hʲ]. The phonetic juncture formants, listed in (1) and (2),

show the typical palatalization pattern of a wider spread between F1 and F2 than

between the F1 and F2 of the plain consonant. F2 and F3 are notably higher in the

(1) Phonetic juncture of [hā]: F1 481.3 F2 1627.4 F3 2796.4 F4 3621.5
(2) Phonetic juncture of [āhʲ]: F1 320.9 F2 2166.0 F3 2956.8 F4 3564.2
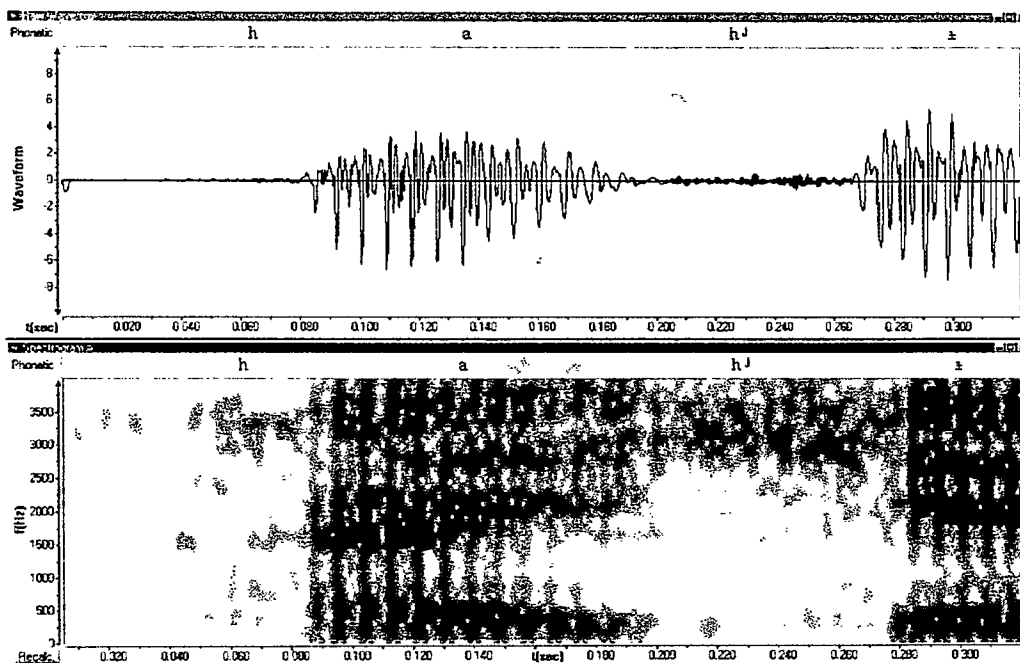
Figure 4.13. [hahʲ] showing both plain and palatalized /h/.

palatalized transitions than in plain transitions. Both the waveform and the spectrogram show more frication in the palatalized [hʲ] than the slight frication of plain [h].

In figure 4.14, the word initial palatalized glottal stop [ʔʲɨ] from /ʲ-itaːk-ʲ/ 'he went down' is the onset of a short unstressed syllable, a typical example. Even with the short duration of the vowel, the effects of the palatalized glottal stop can be seen comparing the waveform and the spectrogram, with irregular glottal pulses throughout the vowel and the raised second formant adjacent to the glottal stop.
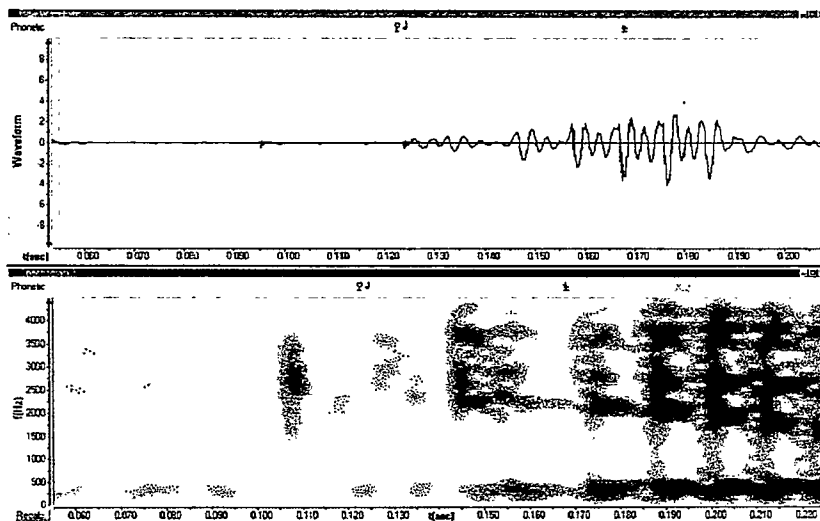
Figure 4.14. Palatalized glottal stop [ʔʲɨ].

The context of figure 4.15 is shown in section 2.3.3, figure 2.5. Here only the initial syllable of the word is shown, the onset of which is the syllable [ʔʰɨ] from the morphemes ʲ-ʔiʃ 'third person' and 'to see', receiving tertiary stress. The phonetic juncture formants of [ʔʰɨ] in (3) may be compared with the steady-state formants of [ɨ] in

(4), showing the F2 value of [ʔʲɨ] more than 200 Hz at the phonetic juncture than at

steady-state of [ɨ], F3 more than 300 Hz greater, and F4 more than 200 Hz greater.

(3) Phonetic juncture of [ʔʲɨ]: F1 286.5 F2 2292.1 F3 3071.4 F4 3736.1
(4) Steady-state of [ɨ]:   F1 298.0 F2 2085.8 F3 2762.0 F4 3506.9

The raised F2 and F3 transitions from the palatalized consonant to the vowel are

consistent with the effects of palatalization throughout the language.
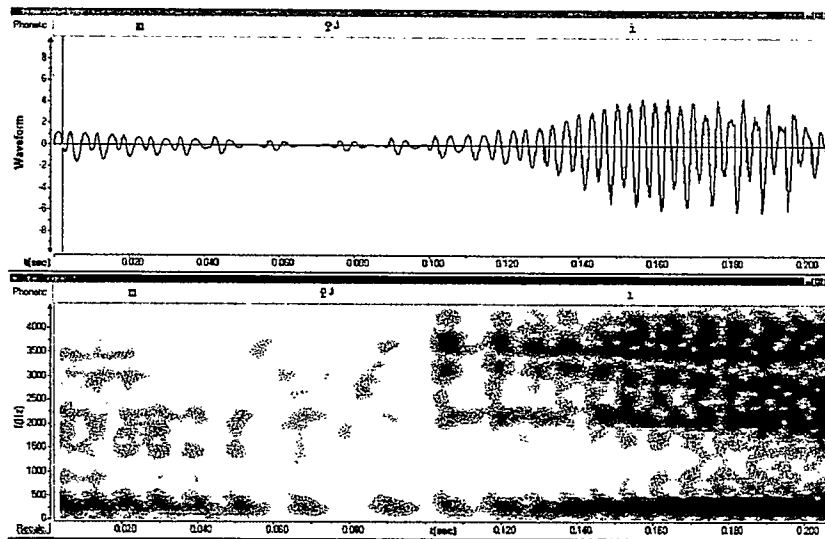
Figure 4.15. Palatalized glottal stop [ʔʲɨ].

One of the supporting evidences of secondary palatalization as an autosegmental

feature (instead of other suggested interpretations) is based on the phonetic data showing

the same type of vowel transition phenomena following the palatalized glottal stop as

follows other palatalized consonants. This is discussed further in sections 4.7 and 5.5.1.

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4.4.6 Secondary palatalization of verb-final consonant clusters

When the verb-final consonant cluster in Isthmus Mixe is suffixed by a clause-type morpheme, both consonants are mutated by this palatalization and the vowels which precede and follow this consonant cluster are also affected.[13] A common cluster is [mb] from the verbal suffix -aN 'DESIDERATIVE/FUTURE' and the verb word suffix -p which indicates an intransitive nonconjunct clause (/-aN-p~ɨ/ [ambɨ]). When this cluster is palatalized by the morpheme indicating a transitive nonconjunct clause, both consonants are palatalized (/-aN-p-ʲ~ɨ/ [āmʲbʲɨ]) and the fronted allophones of the adjacent vowels occur (i.e. one palatalization autosegment affects both consonants in the cluster, and the vowels preceding and following the cluster). In the first spectrogram in figure 4.16, the formants of the transitions to the vowels are typical for transitions from bilabial consonants (Ladefoged 2001, Stevens 1998), noting especially the lowered second formants preceding [m] and following [b]. In the second spectrogram in figure 4.16, the second formants in the transition areas are raised because of effects of the adjacent palatalized consonants.

Besides the [mb] verb-final cluster, any consonant except /h/ and /ʔ/ may occur verb final and be followed by the intransitive nonconjunct clause-type suffix -p.[14] The

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[13] The vowel that follows this verb-final cluster is the vowel of a clitic; it is not part of the verb word but is nonetheless affected by the palatalization of the preceding consonant.

[14] However, verb-final plosives are usually dropped before the morpheme -p, similar to the dropping of final plosives of the first morpheme in compound words (chapter 2, section 2.5.1).
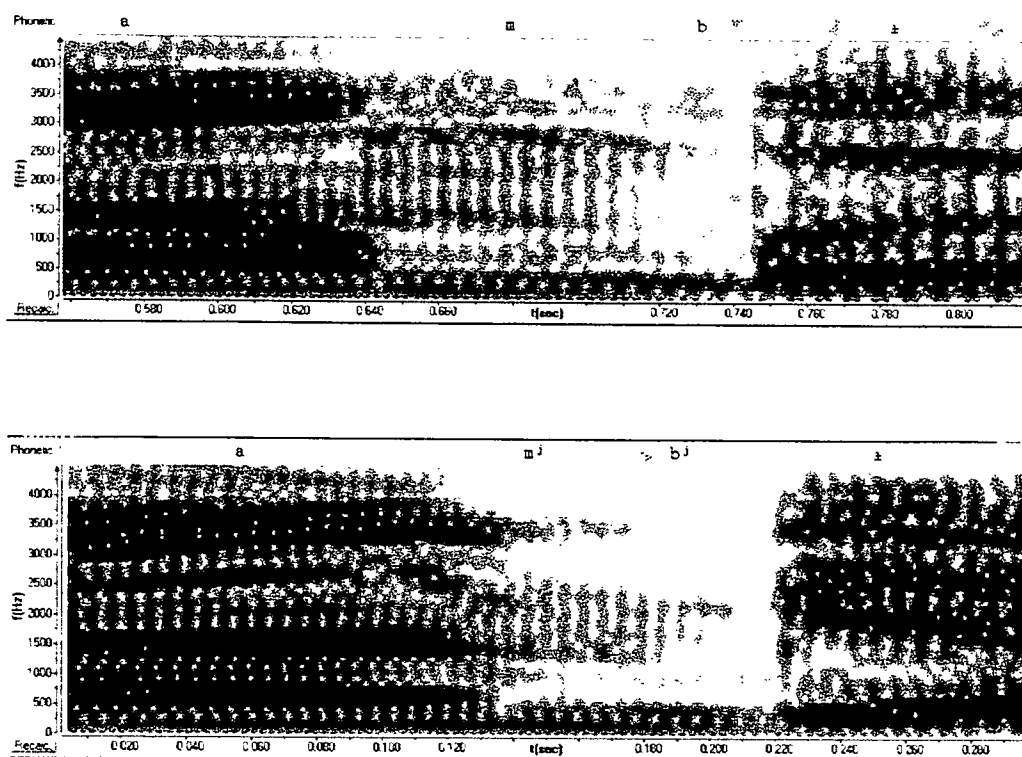
Figure 4.16. Contrast of [ambɨ] and [āmʲbʲɨ].

resulting consonant cluster may be palatalized by the morpheme which indicates a

transitive nonconjunct clause, similar to the [mʲbʲ] cluster, for example, /m-jaʰ-pạm-

naʰʃ-p-ʲ/ [mjāʰpạmnāʰʃʲpʲ] 'you heal' (m- 'second person; jaʰ 'causative'; pạm 'illness';

naʰʃ 'pass'; -p 'nonconjunct clause'; -ʲ 'transitive'), in which verb final /ʃ/ and the

morpheme -p form a word final consonant cluster and are both palatalized by -ʲ

'transitive.'

4.4.7 Palatalization of consonants following palatal /j/

One palatalization process in Isthmus Mixe is not related to the type of morpheme-induced secondary palatalization discussed above: when a word is composed of more than one morpheme and the final phoneme of the first morpheme is /j/, the initial plosive of the following morpheme becomes palatalized and voiced, with /j/ absorbed into the palatalized consonant. One example is seen in chapter 2, section 2.3.2.1, figure 2.4, the phrase /ha~kajtuk/ [hakādʲūk] 'the leftovers,' in which /kajtuk/ is composed of /kaj/ 'food' and /tuk/ 'cut off.' The initial plosive of the second morpheme, /t/, becomes palatalized and voiced ([dʲ]) and the phoneme /j/ is no longer apparent.

In another example, figure 4.17, palatalization and voicing of the initial /k/ of the morpheme *kitaːk* 'to go down' occurs when preceded by the morpheme *ijnaːj* 'to sit', resulting in /ʲ-ijnaːj-kitaːk-ʲ/ [ʔʲɨnʲāːgʲɨdāːkʲ] 'they sat down.' The first syllable of /ijnaːj/ is not a known morpheme and perhaps could be written as simply /ɨnʲaːj/; it is written as /ijnaːj/ by analogy to this palatalization process. When /ijnaːj/ precedes /kitaːk/, the final /j/ of /ijnaːj/ palatalizes the /k/ of /kitaːk/, which becomes voiced [gʲ], and the /j/ is absorbed. Palatalization of [gʲ] is seen by the transitions on the vowels that precede and follow it, especially the raised second formants. This same process occurs when a suffix beginning with a plosive follows a morpheme ending in /j/ as in /ʲ-nɨmaj-kumpɨ/
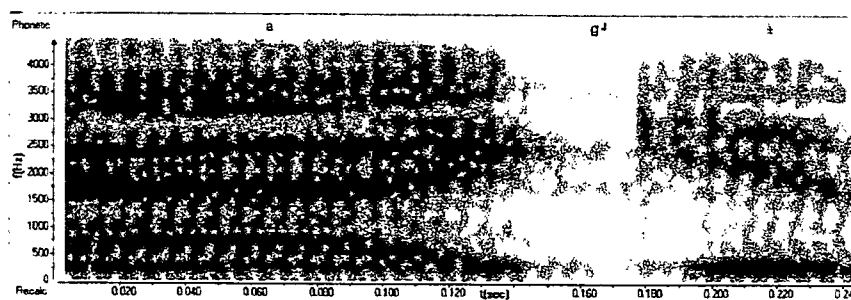
Figure 4.17. [aːgʲɨ] from morpheme final /j/ and morpheme initial /k/.

[nʲɨmāgʲūmbɨ] 'he said [it] again' (ʲ- 'third person'; nɨmaj 'to say [it]'; kumpɨ 'again').[15]

If the consonant that follows the coda /j/ in a compound is already voiced, palatalization of the voiced consonant occurs and /j/ is absorbed, for example [kāmʲūk] /kaj-muk/ 'eat together!' (kaj 'to eat'; muk 'together').[16] Theoretical implications of this process are discussed in chapter 5, section 5.3.

4.5 Frequency counts of Isthmus Mixe vowels

In the case study of *Text A* (see chapter 2, section 2.1 and Appendix), the 300 vowels were analyzed in detail as described in "Secondary Palatalization and Changes in

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[15] Although the examples show plosives voiced between vowels, which might be attributed to that voicing rule (see chapter 2, section 2.3.2.1), the same process occurs when the clause marker suffix *-p* follows a verb ending in /j/, as in /iːts̑ʲ joj-p ts̑ʲam/ [iːds̑ʲ joᵇʲ ts̑ʲām] 'I'm walking now' (iːts̑ʲ 'I'; joj 'to walk'; *-p* 'clause marker'; ts̑ʲam 'now.'

[16] There is the possibility of a modification of this process related to the primary stress of the clause. It has been observed that when the syllable of the morpheme ending in /j/ is under primary stress, the /j/ is retained, even while palatalizing and voicing the following plosive. However, there are too few examples of this phenomenon in the texts under consideration to posit this as a general pattern.

TABLE 4.4

ISTHMUS MIXE VOWEL FREQUENCIES IN *TEXT A*

Vowel	N	Plain	Palatalized
/ɨ/	115	66	49
/a/	101	29	72
/i/	37	24	13
/u/	19	14	5
/e/	14	6	8
/o/	14	8	6
Totals:	300	147 (49%)	153 (51%)
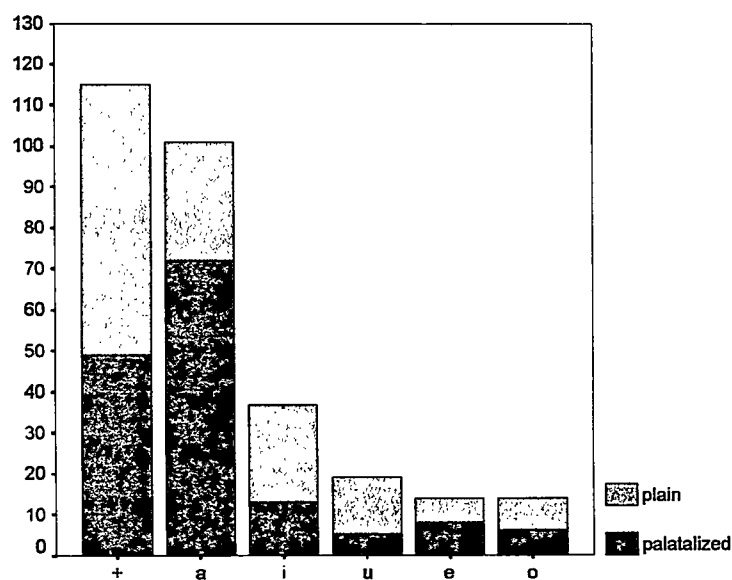
Figure 4.18. Isthmus Mixe vowel frequencies in *Text A*.

Vowel Formants in Isthmus Mixe" (Dieterman 2002a). A summary is given here.

The frequency counts of the six vowel qualities in the language, namely /i ɨ u e o a/, vary considerably (table 4.4 and figure 4.18). Each vowel quality is divided by those adjacent to plain consonants, the upper section of the bar (figure 4.18), and those adjacent to palatalized consonants, the lower section of the bar. In referring to vowels adjacent to palatalized consonants, there may be a palatalized consonant preceding the vowel, following the vowel, or both.[17] Of the 300 vowels analyzed, just over half of the vowels are adjacent to palatalized consonants (51%). Given that all of the vowels in the 100 second sample of continuous narrative text were included in the analysis, it appears that the effects of palatalization are a major phonetic feature of the language.

4.6 The effects of palatalization on Isthmus Mixe vowels

4.6.1 Procedures

The vowels were analyzed using the Speech Analyzer software (chapter 2, section 2.1). For measuring the Isthmus Mixe vowel formants, the spectrum was calculated over the steady-state portion of the vowel; transition areas from the preceding or following consonants were avoided (section 4.3). Vowel formants F1, F2, and F3 were measured.

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[17] The consonant phoneme /j/ is grouped with the palatalized consonants regardless of the occurrence of the autosegmental morpheme for this particular study of the effects of palatalization on 300 vowels.

Using the Statistical Package for the Social Sciences (SPSS) version 10, Analysis

of Variance (ANOVA) and t-tests were performed on the six sets of vowels in the

language, (i.e. those adjacent to palatalized consonants and those adjacent to plain

consonants). Because some vowel qualities have few occurrences in *Text A* (used to

show the frequencies), additional tokens were analyzed from selected portions of the text

immediately following *Text A* to bring the total of each group to thirty, the number

minimally suitable for reliable t-test results.

4.6.2 Results of ANOVA and t-tests

A preliminary series of ANOVAs showed that the effects of the palatalization of

either the previous or following vowels were generally independent of the effects of the

place of articulation of the previous segment (Dieterman 2002a). Therefore, since place

of articulation did not show a significant difference in formant values in relationship to

palatalization, the data were pooled across place of articulation to form six vowel sets,

those adjacent to palatalized consonants and those adjacent to plain consonants. Thus the

model was simplified, and further analyses were done exclusively on the effects of

palatalization of the preceding or following segment (or both) on the formant values of

the vowels.

A series of independent t-tests were performed on each of the six vowel qualities,

using the Grouping Variable of the two categories, palatalized and plain. These t-tests

show statistically significant differences in F2 means for all vowels adjacent to palatalized

consonants versus plain consonants. In table 4.5, upper case C with superscript j (C^j)

TABLE 4.5

MEAN FORMANT VALUES (HZ) OF ISTHMUS MIXE VOWELS
ADJACENT TO PALATALIZED AND PLAIN CONSONANTS
Numbers in parentheses represent standard deviations.

		$C^j\_$	$C\_$	t	p
/i/	F1	317.4 (30.9)	322.1 (32.6)	0.566	p = 0.574
	F2	2232.8 (121.9)	2132.9 (97.8)	-3.502	p = 0.001*
	F3	3582.9 (106.9)	3474.9 (231.4)	-2.320	p = 0.024*
/ɨ/	F1	335.9 (44.5)	376.3 (44.2)	3.524	p = 0.001*
	F2	1763.8 (150.3)	1517.0 (179.6)	-5.770	p = 0.000*
	F3	2521.8 (108.3)	2482.0 (136.8)	-1.250	p = 0.216
/u/	F1	344.6 (30.7)	339.2 (34.1)	-0.648	p = 0.519
	F2	1079.5 (84.0)	1006.6 (48.2)	-4.126	p = 0.000*
	F3	2423.1 (151.2)	2424.6 (131.7)	-0.041	p = 0.967
/e/	F1	406.9 (32.8)	447.0 (51.3)	3.611	p = 0.001*
	F2	1920.8 (77.1)	1870.0 (70.2)	-2.672	p = 0.010*
	F3	2584.1 (90.6)	2562.5 (78.3)	-0.984	p = 0.329
/o/	F1	449.2 (56.2)	433.8 (56.4)	-1.064	p = 0.292
	F2	1184.7 (108.0)	1083.3 (82.5)	-4.086	p = 0.000*
	F3	2401.7 (105.0)	2476.3 (124.4)	2.507	p = 0.015*
/a/	F1	640.6 (65.7)	634.1 (45.8)	-0.448	p = 0.656
	F2	1617.1 (71.1)	1421.1 (108.0)	-8.304	p = 0.000*
	F3	2370.0 (95.1)	2341.8 (154.5)	-0.853	p = 0.397

indicates a palatalized consonant adjacent to the vowel and plain upper case C indicates a

plain consonant adjacent to the vowel. Values of "p" which are starred are statistically

significant.

Given that F2 values are related to vowel frontness and backness, and that the

F2s of the steady states of these Isthmus Mixe vowels adjacent to palatalized consonants

are significantly greater than the F2s of vowels not adjacent to palatalized consonants,

the analyses of the acoustic data suggest that in Isthmus Mixe, the process of

palatalization is best viewed as a case of fronting of the vowels. For example, the F2 of

/i/ adjacent to a palatalized consonant (C^ji) is 2232.8 Hz which indicates that the vowel

is more fronted than /i/ adjacent to plain consonants (Ci) at 2132.9 Hz.

4.6.3 Formant plot of Isthmus Mixe vowels

A vowel formant plot of the data in table 4.5, shown in figure 4.19, is

constructed with the F1 means on the vertical axis, smaller numbers at the top

descending to the larger. The F2 means are plotted on the horizontal axis with the

smaller numbers beginning at the right so that it resembles the articulatory vowel space.

Although palatalization causes fronting of the vowels, the means of the

palatalized vowels do not impinge upon other phonemic vowel spaces. This is not to say

that a few individual tokens do not overlap the minimum and maximum ranges of other

vowel spaces. One might suppose that /i/ when adjacent to a palatalized consonant,

would encroach upon the vowel space of /i/ adjacent to plain consonants, its closest
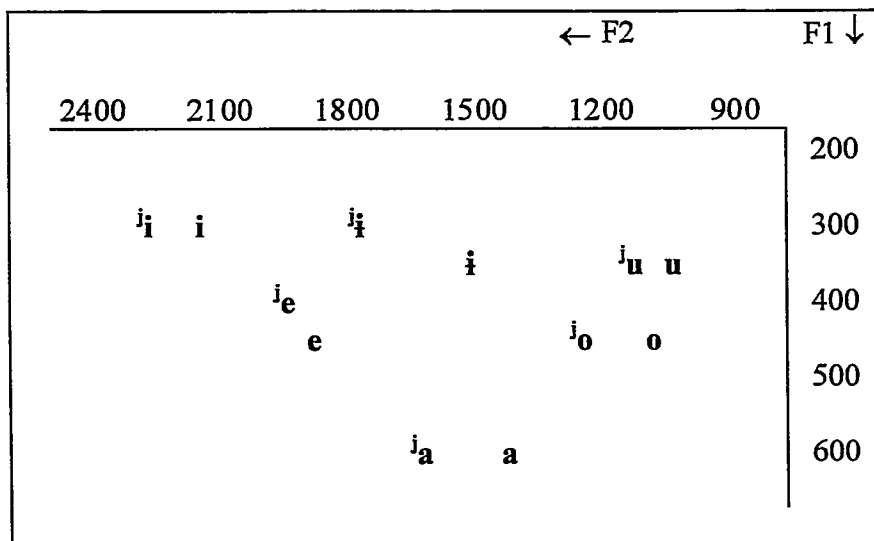
Figure 4.19. Isthmus Mixe vowels adjacent to palatalized and plain consonants.
The symbol ʲ preceding the vowel indicates vowel means adjacent to palatalized consonants. A plain vowel indicates vowel means adjacent to plain consonants.

neighbor. However, even though palatalization fronts /Cʲɨ/, the F2 mean is still 369.1 Hz

less than the F2 mean of the plain vowel /Ci/. A few individual tokens of /Cʲɨ/ do shift

into the range of the formants of /Ci/. Overall, this does not affect the F2 mean of /Cʲɨ/.

On the average then, no vowel quality shifts into the formants of another vowel quality,

even when fronted by the effects of palatalization. Each vowel quality demonstrates two

allophones, one which occurs adjacent to plain consonants and a second, more fronted

version, which occurs adjacent to palatalized consonants.

4.7 Summary

Secondary palatalization of every consonant in the Isthmus Mixe inventory is attested, including the laryngeal consonants /h/ and /ʔ/. Occasional reference in the literature is made to palatalized /h/, such as in foreign words in Lithuanian (Kenstowicz 1971:8), and to both palatalized /h/ and /ʔ/, such as in Copainalá Zoque (Sagey 1986:108-9, see chapter 5, section 5.4), and in Coatlán Mixe (Hoogshagen 1984:4, Van Haitsma [Dieterman] and Van Haitsma 1976:5-11), where the entire consonant inventory is said to be modified by morpheme-induced palatalization, which implies that the laryngeal consonants /h/ and /ʔ/ are also palatalized. However, Wichmann (1995:xix) does not recognize palatalization of the glottal stop in the Oaxacan Mixe languages. The lack of references to palatalized /h/ and /ʔ/ in the literature (other than descriptions of Mixe-Zoque languages) suggests that palatalization of these laryngeal consonants is of infrequent occurrence in the world's languages. Because the palatalization of these consonants is morphemically induced in the Oaxacan Mixe languages, any description of the grammar of these languages necessitates an adequate treatment of the palatalized laryngeal consonants (further discussed in chapter 5, sections 5.4 and 5.5).

In the past, when the linear model was used in the Mixe languages to describe secondary palatalization, the third person marker was represented by the phoneme /j/ word initially (Wichmann 1995) or by metathesis of /j/ with the consonant (Crawford 1963). A most unusual set of consonant clusters occurs, either as jC (Wichmann) or Cj (Crawford) in that nearly every consonant in the inventory occurs in these clusters as

C.[18] In either case, the phonetic reality of simultaneity is obscured and the link to the morpheme is not overtly expressed.[19] In addition to the evidence that secondary palatalization modifies every consonant in Isthmus Mixe (except /j/), it has been shown that every vowel quality is also affected, in that the fronted allophone occurs adjacent to palatalized consonants. See chapter 5, section 5.3 for further discussion regarding the linear model representation.

To date, there has been no explanation of secondary palatalization in the Oaxacan Mixe languages that encompasses all of the aspects of this phenomenon in one unified description. It will be shown in chapter 5, section 5.5.1 that a single autosegmental feature may be used to describe all occurrences of morpheme-induced secondary palatalization and its phonetic effects on all of the consonants and vowels, thus explicating the relationship between the morphemes represented by secondary palatalization and the phonetic manifestations.

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[18] Wichmann (1995) omits the glottal stop as being palatalized, as well as the palatal consonant; Crawford (1963) omits only the palatal consonant.
[19] Crawford (1963:39, 79-81) discusses the third person marker morpheme as the /j/ of the Cj cluster and the importance of morphophonemics in his description of Totontepec Mixe. However, his description was written before the autosegmental theory was developed.

CHAPTER 5

5 Theoretical Implications

5.1 Introduction

Although the previous chapters have been mainly descriptive in character, it is essential to consider the theoretical implications of the data. According to Chomsky and Halle (1968), generative phonological theory has as its foundation the phonetic structure of speech. Their phonological representation is a linear arrangement of phonetic matrices to represent each sound segment. There is still some controversy over minor phonetic details, but in general, the universal inventory of contrastive elements is described according to the vocal tract articulators. Linear phonological representations characterize each sound as a feature matrix fully specified with distinctive features as provided by Universal Grammar. Phonological theory textbooks such as Durand (1990) and Kenstowicz (1994) describe in detail this linear arrangement and also present a hierarchical display of features in a non-linear approach known as feature geometry which has largely superseded the linear model.[1]

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[1] It is assumed the reader is familiar with generative phonology and the classic works of Chomsky and Halle (1968), Kenstowicz and Kisseberth (1979), the more recent work of Kenstowicz (1994), and other notable works too numerous to mention here.

A non-linear representation has at minimum three tiers that are essential to the representation. The most basic tier is the timing tier, which may be characterized by Xs that suggest that each slot equals one abstract unit of time, or by consonants and vowels that suggest a tier divided into two types of timing elements. The second tier, located above the timing tier, organizes the units of timing into syllables which are formed per language specific constraints. A third tier is below the timing tier, representing the featural makeup of the individual segments.

5.2 Feature geometry representations

The Isthmus Mixe data shown in the previous chapters are more adequately represented using feature geometry models, rather than linear models, since feature geometry provides a better balance between phonetic and phonological perspectives than the linear models are able to do. In applying feature geometry models to the Isthmus Mixe data, nasal place assimilation and voicing spread will be explained in section 5.2.1. Although a relatively simple model adequately explains the nasal process, this application of feature geometry to the nasal-plosive consonant cluster is complicated by the addition of a secondary palatalization morpheme that expresses a verbal suffix clause-type marker (section 5.5.1). Both consonants in the nasal-plosive consonant cluster are mutated by this palatalization, and the vowels which precede and follow this consonant cluster are also affected. All verb-final consonants and consonant clusters may be palatalized by the clause-type palatalization morpheme.

Alternative models of feature geometry relative to the sources of secondary palatalization in Isthmus Mixe will then be considered. It will be shown that the vowel-place models proposed by Hume (1994), Ní Chiosáin (1994) and Clements and Hume (1995) more adequately represent the Isthmus Mixe data than articulator models proposed by Sagey (1984) and Halle, Vaux, and Wolfe (2000).

5.2.1 Isthmus Mixe nasal place assimilation and voicing spread

Before considering detailed analysis of palatalization, however, the usefulness of the feature-geometric approach is illustrated by examining a more straightforward phonological process in Isthmus Mixe, nasal place assimilation. Widespread in the world's languages, nasal place assimilation is also found in the Mixe languages (Crawford 1963:44-5, Van Haitsma [Dieterman] and Van Haitsma 1976:13-4). An example in Isthmus Mixe is shown in the examples related to the verb /tuN/ 'to work', in which /N/[2] assumes the place of articulation of a following a plosive (chapter 2, section

(1)	/tuN/	[tun]	'he worked'
(2)	/tuNɨp/	[tunɨp]	'he should work'
(3)	/tuNp/	[tumb]	'he works'
(4)	/tuNtɨkiːj/	[tundɨgiːj]	'he began to work'
(5)	/tuːNk/	[tuːŋg]	'work (noun)'

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[2] In Isthmus Mixe, the archiphoneme /N/ occurs in morpheme-final position and in the morpheme-final cluster /Nk/ [ŋg]. It contrasts with *n-* 'first person' and *m-* 'second person' which are word-initial morpheme prefixes. The phoneme /m/ occurs in morpheme-final position and contrasts with /N/ by not assimilating to a following plosive.

2.3.2.2): The default articulation is alveolar [n], occurring word final as in /tuN/ (1) and between vowels as in /tuNip/ (2).

In addition to place assimilation, the nasals spread voicing to a following plosive. Although sonorants are considered to be underspecified for [voice] in many languages, in Isthmus Mixe [+voice] must be specified because of the voicing spread of /N/.

Nasal place assimilation and voicing assimilation processes may be described using a feature tree, such as that developed by Halle (1992). This feature tree is used to formulate common sound change processes such as assimilation, whether single-feature, complete, or partial (Kenstowicz 1994:150-8). In Isthmus Mixe, the examples (3-5) of partial assimilation illustrate the utility of the feature tree in which the soft palate tier,
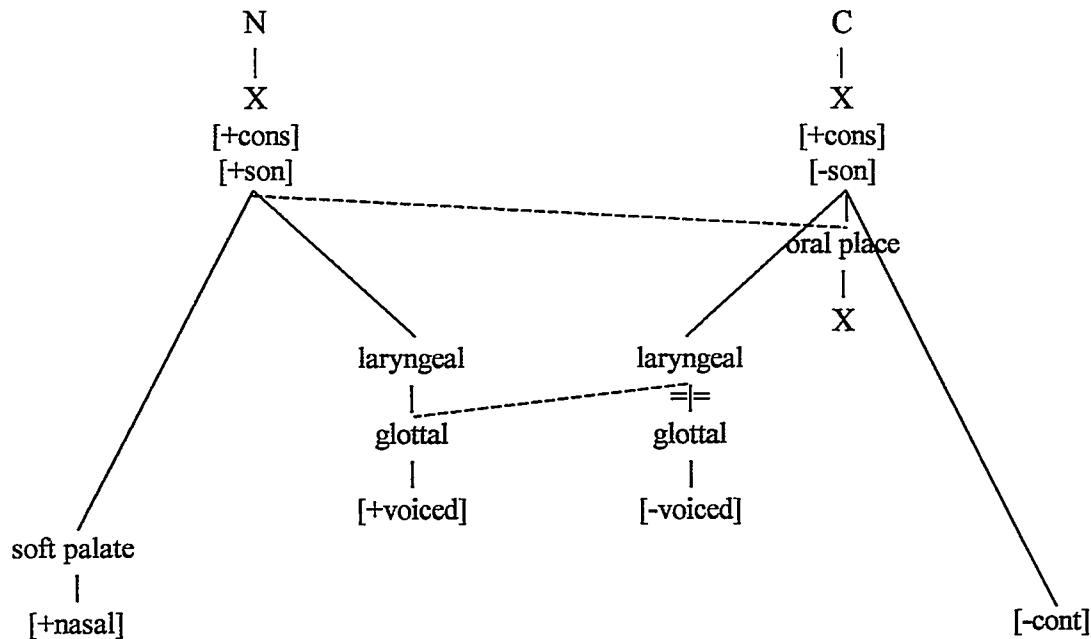
Figure 5.1. Isthmus Mixe nasal place and voice assimilation.

oral place tier and laryngeal tier are all separate (figure 5.1). In the case of Isthmus Mixe

nasal /N/, the oral place node of the consonant that follows /N/ spreads leftward to

associate itself with the root node of /N/, and the laryngeal node of /N/ [+voice] spreads

rightward to the laryngeal node of the following consonant.

Feature geometry allows this two-way assimilation to be shown in one diagram,

reducing redundancy and expressing the simultaneous nature of these processes. The

phonological rules recognize the natural class at the oral place node while the other

features remain independent. This model is both phonetically faithful and phonologically

relevant, a simple, yet fully adequate and elegant explanation of the data.

5.3 Sources of Isthmus Mixe palatalization

One of the palatalization processes in Isthmus Mixe occurs when a word-medial

consonant is preceded by the phoneme /j/; this configuration occurs when two

morphemes are combined in the word (e.g. adjective plus noun, or verb plus verb, or

when an affix is added).[3] Consonants preceded by /j/ are palatalized, the /j/ is absorbed

(in most cases), and, if the consonant is a plosive, it becomes voiced; thus there is a

simple phonetic coalescence of /j/ with the following consonant.[4] This is a linear process

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[3] There are a few two-syllable words in which the initial consonant of the second syllable is palatalized but the first syllable is not a known morpheme. These are presently written with the first syllable terminating in /j/ by analogy. See the example in the following paragraph. Further studies in the morphology of the language are needed.
[4] The fronted allophones of the vowels always occur adjacent to /j/ or a palatalized consonant.

(typical of SPE processes) that does not involve one of the morphemes that is manifested by secondary palatalization in Isthmus Mixe. The phonological process is shown in (6).

(6) $\_j + C \rightarrow \_C^j$
$\qquad\qquad$ [+vc]

An example[5] in the data is /majtṳ:/ [mād^{j}ṳ:] (Appendix line 14), consisting of /maj/ 'many' and /tṳ:/ 'thing.' When these words are joined in a compound, the final /j/ of the first word palatalizes the /t/ of the second word, the resulting palatalized consonant is also voiced (i.e. [d^j]), and the /j/ is absorbed. A two-verb compound example is /ojɨ:jtɨkaʰt͡s/ [ōjɨ:d^{j}ɨgaʰt͡s] 'to fix [it] again,' which consists of /ojɨ:j/ 'to fix' and /tɨkaʰt͡s/ 'to change.' When /ojɨ:j/ precedes /tɨkaʰt͡s/, the final /j/ of /ojɨ:j/ palatalizes the /t/ of /tɨkaʰt͡s/, which becomes voiced [d^j], and the /j/ is absorbed.

Although this linear process results in consonants that are palatalized by secondary articulations of palatalization, it is different from the type of secondary palatalization that manifests a morpheme or is the result of final-syllable truncation by the fact that it spreads voicing to the consonant that it palatalizes, and it never affects a consonant cluster, since no consonant cluster occurs morpheme initial. Positionally, secondary palatalization that expresses a morpheme always occurs word initially or word finally, whereas, linear palatalization occurs only word medially.

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[5] Additional examples are described in chapter 4, section 4.4.8.

In the case of verb-final secondary palatalization, the consonant(s) that precede secondary palatalization are palatalized, whereas, when a morpheme ends in a consonant and is followed by a morpheme beginning with /j/ in a compound, the consonant preceding /j/ is not palatalized. For example, when /mɨk/ 'strong' precedes /joːj/ 'to walk,' it is pronounced [mɨkjoːj] as in the expression /ʲ-ką-mɨk-joːj-ʲ/ [kʲ ą̄mɨkjǫːj] 'he doesn't walk well.'

A second source of palatalization in all the Oaxacan Mixe languages is related to historical processes of syllable truncation from which arise four categories of secondary palatalization: 1) the third person marker word initial (i.e. ʔi- has become secondary palatalization); 2) verb-final clause-type markers (i.e. *-hi or *-i/e have become secondary palatalization); 3) a deverbalizer; and 4) other word final palatalization.[6] See chapter 3, section 3.7.5 regarding the origin of secondary palatalization in the Oaxacan Mixe language for examples and further explanation. These historical processes have been completed, with the result that secondary palatalization has replaced these syllable affixes in the Oaxacan Mixe languages.

In present-day Isthmus Mixe, there is no phonemic basis causing the secondary palatalization that represents the morphemes (i.e. the third person, a verb-final clause-

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[6] There are possibly other categories of secondary palatalization related to syllable truncation not yet discovered, since an extensive study of related languages has not been undertaken.

type marker,[7] and a deverbalizer). These morphemes are represented by secondary palatalization alone, which attaches to the word-initial consonant in the case of the third person marker, and the word-final consonant or consonant cluster in the case of the clause-type marker and the deverbalizer.[8] Since any consonant in the language may occur in the word-initial position, any model that is used to describe these abstract palatalization morphemes must be able to accommodate secondary palatalization of the complete inventory of Isthmus Mixe consonants.

5.3.1 Previous representations of secondary palatalization

The question may be asked as to why the affixes represented by secondary palatalization cannot be represented simply by a /j/ prefix or suffix. This has been done in the past, especially by Crawford (1963) in describing Totontepec Mixe, in which he phonemicized the third-person prefix *j-* as Cj. Crawford includes a text and its analysis, where mention is made of /y/ as third person: "{vyá·hny} 'he said' has the person-prefix {y} 'third person' which is metathesized with the stem-initial consonant, ..." (1963:164). In his phonetic description, Crawford indicates the Cj sequence patterns as one phonemic unit (see chapter 3, section 3.7.2). Moreover, Crawford does not give any reason for preferring Cj (i.e. the metathesis of the prefix) over jC (i.e. prefix plus initial consonant).

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[7] Palatalization of the final consonant of the verb is characteristic of the three types of conjunct clauses, and it also occurs in conjunction with the verb-final suffix *-p* in the nonconjunct direct-transitive clause. These clauses are described in Dieterman 1995 and Dieterman 1998.

[8] This is also true of Coatlán Mixe. Further study of the other Mixe languages is needed in this regard.

As shown in section 5.3, in Isthmus Mixe there is a sequence of Cj word medial, in which the consonant that precedes /j/ is not palatalized. Therefore, if one were to adopt the representation of the third-person morpheme as a linear segment /j/ which metathesizes with the following consonant, palatalizes it, and is absorbed in the process, another rule would have to be made for Cj in word-medial position.

In contrast to Crawford's metathesized prefix *j-*, Wichmann (1995) does not metathesize the third person prefix *j-*; rather he indicates that /j/ palatalizes a following consonant, with /j/ absorbed in the process (see chapter 4, section 4.4.7). This type of palatalization does not cause voicing of the following consonant. However, he does not mention the process in which word-medial /j/ palatalizes and voices the following plosive, as happens in Isthmus Mixe (see section 5.3). Wichmann (1995:22-3, 44-5, 167, 173) describes umlauting of vowels as effected by palatalized consonants on adjacent vowels in some Mixe languages; however, neither Crawford nor Wichmann mention that [secondary] palatalization affects both consonants in a cluster.[9]

The effects of palatalization have been shown to extend over multiple segments by Van Haitsma [Dieterman] and Van Haitsma (1976) and Hoogshagen (1984), as described previously (see chapter 3, section 3.7.4). Van Haitsma [Dieterman] and Van

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[9] Wichmann (1995:94) does not posit the possibility of a word-initial consonant cluster in proto-Mixe-Zoque. According to Schoenhals and Schoenhals (1982:307), the person markers in two clause types in Totontepec Mixe are the prefix *ʃ-* (non-palatalized) which would not result in a word-initial palatalized consonant cluster; in contrast there is one Isthmus Mixe person marker, *ʲ-ʃ-* (palatalized) that results in a palatalized consonant cluster word initial (see chapter 4, section 4.4.2 and chapter 5, section 5.5.1).

Haitsma (1976:5-11) refer to [secondary] palatalization in the Mixe of San José El Paraíso as a suprasegmental phoneme, written as a tilde over one consonant or two consonants in a cluster. Distinct from palatalization is the phoneme /j/ which does not palatalize the first person marker prefix *n-* or the second person prefix *m-* when they precede a word beginning with /j/. Hoogshagen (1984:4) describes the same distinctions in Coatlán Mixe. In Isthmus Mixe, the differences between *m-* 'second person' followed by a word initial /j/ (i.e. the sequence of /mj/) and the third person morpheme as manifested by secondary palatalization attached to a word initial /m/ (i.e. /m^j/) are described and shown by waveform and spectrogram displays in chapter 4, section 4.4.4. Thus a word-initial consonant cluster of a nasal person marker followed by a stem-initial /j/ behaves differently than the word-initial secondary palatalization of a stem-initial nasal.

In Isthmus Mixe, the morphemes manifested by secondary palatalization are morphologically prefixes and suffixes; however the phonological features of secondary palatalization are not well represented by the linear phoneme /j/ plus consonant, because the secondary palatalization feature and the consonant to which it attaches does not behave as an ordered consonant cluster of either jC or Cj. Rather, it behaves as an unordered complex segment (see section 5.4). The domain of secondary palatalization in Isthmus Mixe is not just one adjacent consonant, but includes a consonant cluster in both word-initial and word-final positions, and adjacent vowels, as shown in chapter 4, sections 4.4.2 and 4.4.6, and further described in section 5.5.1. Therefore an

autosegmental model better describes the process of secondary palatalization than is possible with a linear description. As an autosegmental feature, secondary palatalization in Isthmus Mixe is recognized as a mutation process, comparable to other mutation processes such as described by Lieber (1983), McCarthy (1983), and Mester and Itô (1989) (see section 5.6.2).

Before describing the autosegmental model, nonlinear feature geometry models that have been used to describe secondary articulations are briefly described in the following sections relative to their suitability for describing the Isthmus Mixe data. These are basically of two types: articulator models (Sagey 1986; Halle, Vaux, and Wolfe 2000) and vowel-place models (Hume 1994; Ní Chiosáin 1994).

5.4 Articulator models

Sagey (1986) has proposed an articulator model for representing complex segments (e.g. palatalized or labialized consonants), which are represented as phonologically unordered. A complex segment behaves as one unit in its interactions with adjacent segments. For example, in Isthmus Mixe, a palatalized consonant between two vowels will cause the raising of the second formant in both vowels (see chapter 4, sections 4.4.5 and 4.4.6). In contrast, a consonant cluster is phonologically ordered and interacts with constituents to its immediate left and immediate right consistent with the features of each element of the cluster. In Isthmus Mixe, the cluster /kʃ/ occurs between two vowels /ɨkʃɨ/ (Appendix line 19), in which the transition formants of /ɨ/ preceding /k/

show a slight raising of the second formant, typical of the vowel preceding a velar

consonant. On the other hand, the first and second formants of /ɨ/ following /ʃ/ are

slightly lowered as is typical adjacent to /ʃ/ in Isthmus Mixe (see chapter 4, section 4.4.2,

figure 4.8). Given these observable phonetic differences, it follows that secondarily-

articulated segments (e.g. C^j) and consonant clusters (e.g. Cj) should be assigned

different phonological representations.

Using data from Copainalá Zoque (Wonderly 1951),[10] Sagey (1986:108-9)

shows representations of the process of secondary palatalization of labials, coronals,

dorsals, and laryngeals.[11] Almost all of the examples show the third person morpheme *y*-

prefix as resulting in the secondary articulation on the initial consonant of the word.

Thus, as the Copainalá Zoque data is interpreted by Sagey, at least in word-initial

position, the palatalized consonants are derived from the third person morpheme.

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[10] Wonderly's description is reinterpreted by Sagey (1986:106-111) to indicate palatalization of all of the consonants: "Thus, I analyze the fact that the palatal articulation in [py], [ky], [ʔy], etc. is perceived as an offglide as simply an acoustic effect of the transition to the following vowel." She does admit that Wonderly says [y] and [p] metathesize (see chapter 3, section 3.6.1). Here Sagey's models are based on palatalization of consonants; she also shows a model for metathesis, in which the elements of the complex segments are phonologically ordered (a marked rule). (Sagey 1986:114-5.)

[11] Sagey does not use the term *secondary palatalization*. She states: "Such derivations show that the palatalization or labialization in the resulting complex segment is actually a phonologically unordered additive articulation on the segment" (Sagey 1986:105). The use of *secondary palatalization* in this section is in accordance with the definitions set forth in this dissertation.

```
 x      x      ==>        x        x
 |      |                 |        |
root   root             root     root
 |      |                 |        |
supra  supra            supra    supra
 |      |                 |        |
place  place            place    place
 |      |                 |       / \
dorsal labial          dorsal dorsal  labial
 |↗                       \    /
[-back]                    [-back]
```
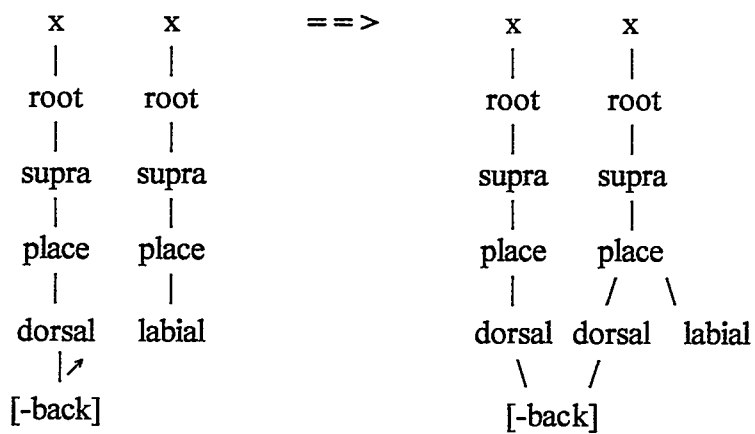
Figure 5.2. Representation of secondary palatalization
              of a labial by Sagey (1986:108).

```
 x      x      ==>        x        x
 |      |                 |        |
root   root             root     root
 |      |                 |       | \
supra  |                supra   supra \
 |    laryng              |       |  laryng
place                   place   place
 |                        |      /
dorsal                  dorsal dorsal
 |↗                       \    /
[-back]                    [-back]
```
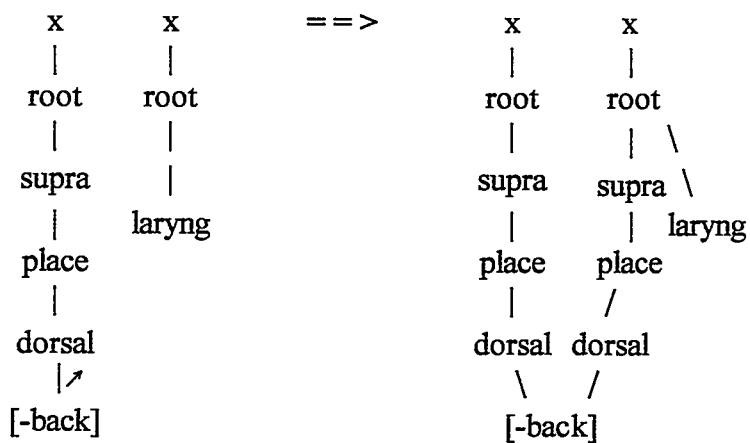
Figure 5.3. Representation of secondary palatalization
              of a laryngeal by Sagey (1986:108).

Sagey's labial and the laryngeal representations are shown here in figures 5.2 and 5.3.[12]

Sagey (1986:109-10) claims that her representations as shown in figures 5.2 and 5.3 are

"the proper representations" for /py/ and /ʔy/ as "phonologically unordered."

The representations in figures 5.2 and 5.3 do not indicate which articulation is

considered to be primary and which is secondary. Sagey (1986:202) defines the primary

articulator as "the articulator to which the degree of closure features of the segment

apply." She labels this articulator as the *major* articulator, since the term *primary*

articulator has been defined in various ways.[13] Thus, in order to represent degree of

closure, along with primary and secondary articulations, Sagey uses an arrow[14] to
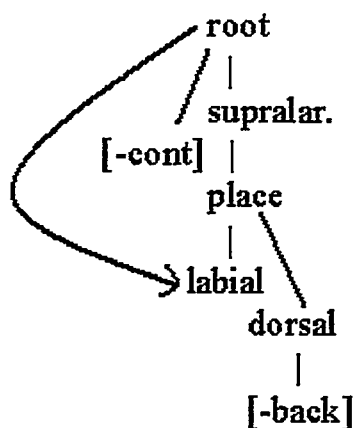
Figure 5.4. Representation of [pʲ] by Sagey (1986:217).

---

[12] Sagey (1986:108) shortens supralaryngeal to "supra" and laryngeal to "laryng" in the models.

[13] Sagey (1986:199-202) discusses previously published definitions of primary and secondary articulations and proposes her own definition.

[14] Sagey's arrow is called "notational clutter" by Kenstowicz (1994:149), who replaces it with an asterisk.

indicate the major (consonantal) articulator. In figure 5.4, Sagey's model for a

palatalized [p][15] (i.e. [p^j]) represents the major articulator [p] by the arrow from the root

node to the labial place. The secondary articulation of palatalization is shown by the line

from "place" to "dorsal" place.

Sagey's model accommodates both the glottal place as the primary articulator

(/h ?/) and the oral place as the secondary articulator (palatalization); this is an important

part of her model that has not been seen in other descriptions. Although secondary

palatalization of consonants other than those orally articulated is not a common

phenomenon, in Isthmus Mixe, the glottal consonants /h/ and /?/ are palatalized (chapter

4, section 4.4.5).

In their Revised Articulator Theory (RAT), Halle, Vaux, and Wolfe (2000) retain

the grouping of secondary articulations under Place; their example of [p^j] is shown in

```
                    X
                    |
                  Place
                 /     \
              Lips     Body
               |         |
           [-round]   [-back]
```
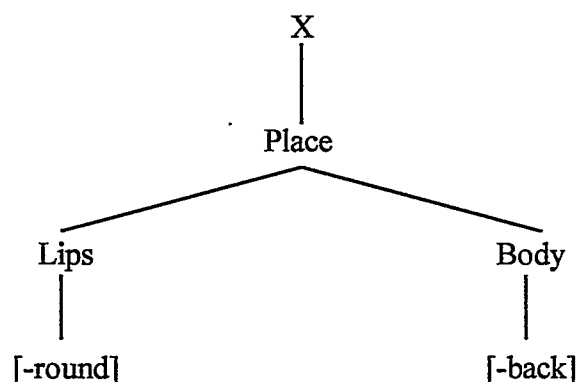
Figure 5.5. Representation of [p^j] in RAT.

---

[15] Sagey uses [py] for what in this dissertation is written as [p^j].

figure 5.5 (Halle, Vaux, and Wolfe 2000:404). Since they do not mention laryngeal

consonants, it cannot be assumed their revisions could accommodate the palatalized /h/

and /ʔ/. In the feature tree model followed by RAT, the Guttural node is parallel to the

Place node (Halle, Vaux, and Wolfe 2000:389); there is no indication of how the two

nodes could be configured into one model.

5.5 A vowel-place model by Hume

In contrast to the articulator models by Sagey (1986) and Halle, Vaux, and Wolfe

(2000), the vowel-place model includes the degree of constriction, along with the

designation of consonant (C) and vowel (V). This model is referred to as *A Constriction-*

based Model by Clements and Hume (1995) and as *Vowel-Place Theory* by Halle, Vaux,

and Wolfe (2000).

Hume (1994) argues that front vowels and coronal consonants should be

considered as a natural class because of the many languages in which either consonants

become coronal adjacent to front vowels, or vowels become fronted adjacent to coronal

consonants. Thus, she classifies front vowels as [coronal] rather than [-back]. She states

that "in order to include palatal consonants in the class of coronal sounds we need to

redefine [coronal] to refer to an articulation implemented by raising the tip, blade and/or

front of the tongue" (Hume 1994:15).

Hume uses the term *palatalization* to refer to what is called secondary

palatalization in this study and the term *coronalization* to refer to what is here called

primary palatalization (see chapter 3, section 3.1). She states that: "Palatalization, properly speaking, is triggered by a front vowel" (1994:139).

Assuming that secondary palatalization in the Oaxacan Mixe languages is historically derived from the prefix *ʔi-* in the Popoluca languages, or in the case of most word-final secondary palatalization, truncation of word-final suffixes shown in proto-Mixe-Zoque forms (see chapter 3, section 3.7.5), then the Isthmus Mixe data can be explained neatly by Hume's representation. The model by Hume (1994:137), shown here in figure 5.6, best shows the process of secondary palatalization of consonants as found

```
        C                        V
        :                        :
      Cons                     Cons
        |                        |
      place                    place
   [F]/  |                        |
        |                        |
      (Voc)                     Voc
        |                        |
     (place)- - - - - - - - - - place
                                  |
                             [coronal]
                                  |
                              ([-ant])
```
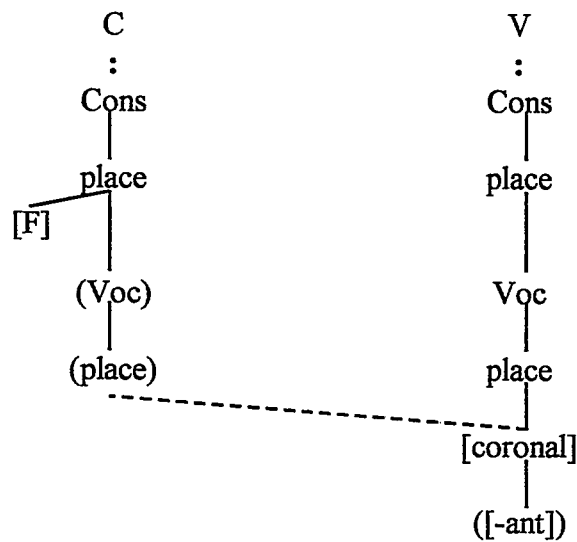
Figure 5.6. Representation of palatalization by Hume (1994:137).

in Isthmus Mixe in which the vocoidal [i] feature that is linked to one or two consonants

is an autosegmental feature that manifests an independent morpheme.[16] In Hume's

model, the vowel-place feature is independent of the consonantal feature. It is assumed

that if this model shows linking of the vocoid feature to one consonant, the vocoid

feature could link to two consonants, although Hume does not mention linking to more

than one consonant.

Hume's model organizes consonants and vowels in a symmetrical manner, based

on "the degree and location of a segment's constriction ..." (Hume 1994:15-6).

According to Hume (1994:16), the organization of each constriction (Cons) "is made up

of a place node dominating the segment's articulator(s), and a stricture node dominating

features referring to the degree of constriction of the segment's articulation." In

explaining her example, Hume (1994:137) states that "the feature [coronal] spreads from

the front vowel to an interpolated VOC place node of the consonant. The result is a

vocoidal place specification superimposed on the original major articulation of the

consonant." In Isthmus Mixe, the spreading vocoidal feature which palatalizes the

consonant is then deleted, since the syllable from which the trigger vocoid originated has

been truncated, and the vocoid is non-syllabic at this point: Regarding this process,

---

[16] In the model by Hume (1994:137), "C" indicates *consonant*, "V" indicates *vowel*,
"cons" refers to *constriction*, and "Voc" refers to *vocoidal*. Hume's example is a partial
representation, omitting nodes irrelevant to the spreading of the vocoidal feature in
secondary palatalization.

Hume (1994:141) states: "Recall that a non-syllabic vocoid trigger is not realized phonetically when Coronalization or Palatalization apply. We may thus assume that subsequent to assimilation, the trigger is deleted if non-syllabic." Thus Hume explicitly captures the sense that secondary articulations are vowel-like features that are imposed upon the consonants and are not part of the underlying consonantal features.

Hume's description of secondary palatalization explains the process which may have occurred in the historical development of the morphemes manifested by secondary palatalization in Isthmus Mixe. As mentioned in chapter 3, section 3.7.5 and above in section 5.3, the third person prefix of ?i- is still present in the Popoluca languages and suffixes consisting of a high front vowel (and a consonant in some cases) are posited in proto-Mixe-Zoque by Wichmann (1995). Synchronically, these affixes are all represented by secondary palatalization alone in Isthmus Mixe (and at least the third person prefix is represented by secondary palatalization alone in all of the other Mixe languages that have been described).

An important aspect of Hume's model is that the vowel place features are independent of the consonant place features. This is a claim that Ní Chiosáin (1994) supports with data from Irish, arguing that Irish palatalization as it interacts with lenition and nasal place assimilation can be adequately described only by a representation in which secondary vowel place features are structurally independent of primary consonantal features. In the examples given by Ní Chiosáin (1994), the concept of vowel place as independent of the primary consonantal feature more clearly represents

secondary palatalization as a feature added to the primary articulation which does not change the primary articulation features. In the articulator models, however, the secondary vowel place features are shown as structurally dependent on primary consonantal features. These models would indicate that palatalization is an integral part of the primary consonant, rather than, as the Irish data show, independent of the primary consonant.

In Isthmus Mixe, secondary palatalization is not caused by the immediate phonetic environment and as such is better represented as a feature added to the primary consonant as in Hume's model, and thus not dependent on the primary consonantal features as in Sagey's model. Although not explicitly described, Hume's model will also accommodate glottal place as the major articulator and oral place as the minor articulator, such as is required by the Isthmus Mixe data.

5.5.1 The vowel-place model applied to Isthmus Mixe data

In present-day Isthmus Mixe, the segmental vowel that spreads the palatalization feature to the consonant in Hume's model (figure 5.6) is no longer part of the language; the remnant of this vowel is secondary palatalization, described here as a vocalic node with the vowel-place feature of coronal [cor]. When linked to consonants, this vowel-place feature [cor] results in a secondary articulation of palatalization (see chapter 4, section 4.1); when linked to vowels it results in the occurrence of the umlauted (fronted) allophones (chapter 4, section 4.6). In order to be able to link the one feature, which represents a morpheme in most cases, to a single consonant or a consonant cluster and to

the adjacent vowels, the vowel-place feature [cor] is best shown on a separate tier from the segmental phonemes.

A tree diagram (figure 5.7) representing the word /ʲ-ka̰ːk/ [kʲa̰ːk] 'her banana' is adapted from the model in Clements and Hume (1995:292), with a vocalic node on a separate tier, linked to the place nodes of both the consonant and the adjacent vowel. In the constriction model of Clements and Hume (1995:292), features or nodes that occur on the same line are on the same tier. Thus, in the representation in figure 5.7, the place nodes of both the consonant /k/ and the vowel /a/ are on the same tier. It is this tier, then, to which the vocalic node links by means of a universal association convention
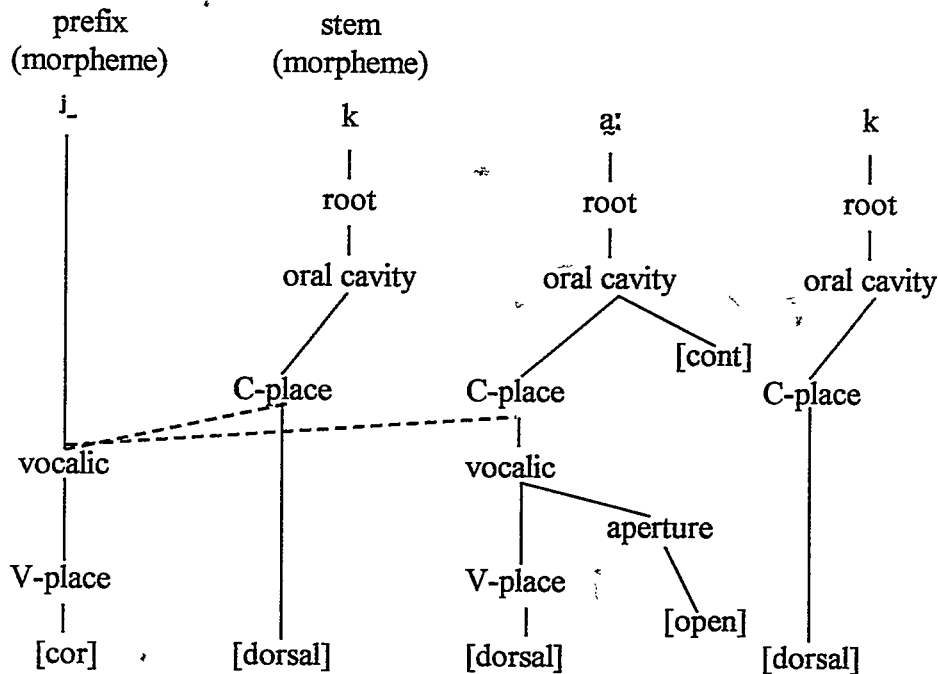
Figure 5.7. Representation of /ʲ-ka̰ːk/ [kʲa̰ːk] 'her banana.'

(UAC). Since the vocalic node of the prefix morpheme of secondary palatalization cannot cross the association line of the vocalic node of the vowel, the effects of secondary palatalization are blocked from the consonant that follows the vowel. Thus the initial consonant of /kaːk/ is palatalized, and the fronted allophone of the vowel occurs, but the final /k/ of the word is not affected.

Another word-initial example of secondary palatalization occurs when the first- and second-person object marker, consisting of the secondary palatalization feature as an autosegmental feature and the phoneme /ʃ/ attach to the initial syllable of a verb, as in (7). As /ʃ/ is attached to the beginning of the verb, two consonants occur as a word-initial cluster and the autosegmental feature causes secondary palatalization of both consonants as well as fronting of the following vowel.

(7)   *niwɨːj*   'to know'   *ʲ-ʃ-niwɨːj* [ʃʲnʲɨwɨːj]   '[he] knew me'

By the UAC, the autosegmental feature is associated to the initial consonant of the stem, which in this case is the linear part of the prefix, ʃ-, spreads to the following consonant, then to the following vowel, where further spread is blocked by the vocalic association line.

The palatalization autosegment that manifests a person marker (i.e. *ʲ-* 'third person' and *ʲ-ʃ-* 'first and second person object') always attaches word initially. Since all Isthmus Mixe nouns and verbs begin with one consonant followed by one vowel (nucleus), the autosegment-bearing units are always one consonant followed by one

vowel when marked by ʲ- 'third person', and two consonants followed by one vowel when marked by ʲ-ʃ- 'first and second person object.'

In addition to secondary palatalization of word-initial segments, word-final consonant clusters and adjacent vowels may also be palatalized by a clause-type marker in Isthmus Mixe (see chapter 4, section 4.6.6). In the case of the verb word-final autosegment palatalization that is the direct-transitive clause marker, the pattern of attachment is the same as for the word-initial attachment, following the UAC, however the spread is bidirectional, since the clitic vowel that follows the suffix is also affected. In example (8), /ʲ-iʃ-aN-p-ʲ~ɨ/ [ʔʲiʃāmʲbʲɨ] 'he wanted to see [him]' (the waveform and spectrogram are shown in chapter 4, figure 4.16), (/ʲ- '3P'; iʃ 'to see' –aN 'DESIDERATIVE'; -p 'nonconjunct clause marker'; -ʲ 'direct-transitive'; ~ɨ 'DIR') the four word-final linear phonemes are palatalized by a single vocalic feature.

(8) iʃ-aN 'to want to see'   ʲ-ʔiʃ-aN-p-ʲ~ɨ [ʔʲiʃāmʲbʲɨ]   'he wanted to see [him]'

These examples in Isthmus Mixe illustrate the need for a theory that adequately describes the effects of one feature (secondary palatalization), representing a morpheme, on two to four segments of a word. As described by Burquest (1998:243), "In summary, Autosegmental Phonology correctly expresses the fact that some specific phonological features have more than a single segment as their domain ... ."

By utilizing the autosegmental model, the vocalic tier that represents palatalization in Isthmus Mixe is linked to the morphemic level of the language and is seen not simply as an interesting phonological process, but also as an important part of the morphology. In addition, because secondary palatalization usually represents a morpheme in Isthmus Mixe, a discussion of mutation processes follows.

5.6 Mutation processes

Autosegmental representations are used to analyze and describe mutation processes such as umlaut and other processes in which there are two or more allomorphs of a lexical stem. Secondary palatalization in Isthmus Mixe can be defined as a consonant mutation and vowel umlaut.[17]

Mutations are defined by Lieber (1987:72) as:

> phenomena in which lexical stems exhibit two or more allomorphs that differ only in a single marginal segment (for example, an initial or final C or a vowel closest to either end of the word) and which appear in distinct morphological, syntactic, or phonological environments.

She describes *central cases* as mutations of initial or final consonants in relationship to morpheme affixes. The general characteristics of mutation are introduced in four points (Lieber 1987:87-8):

> PARAMETERS
> (i) Mutation features are projected on their own tier. They are not part of the melody or skeleton.

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[17] There is also the vowel ablaut as described in chapter 2, section 2.5.2 which is another type of vowel mutation in Isthmus Mixe.

(ii) Since mutation involves the projection of an autosegmental tier, there must be an Initial Association Rule in each case which attaches the mutation tier (usually) to the skeleton. There are, however, no Spreading rules for this tier in any of the central cases.

OTHER ASSUMPTIONS
(iii) Mutation in the central cases is triggered by floating features which either are or are part of prefixes or suffixes: that is, in central cases, mutation is nothing more than affixation. ...
(iv) In all central cases of mutation there is underspecification of an initial (or final) stem segment, but which stem segment, if any, is underspecified does not have to be stipulated within the theory.

Lieber's PARAMETERS state that there is "no Spreading" in the central cases.

Except for this "no Spreading" rule, secondary palatalization in Isthmus Mixe meets all

the requirements of Lieber's definition of mutations. As was discussed in section 5.5.1,

the vocalic feature spreads to an adjacent consonant if one occurs, and bidirectionally to

the adjacent vowels. In Lieber's examples, no consonant clusters are shown, and she

makes no mention of them. Her "no Spreading" rule seems to be an important criterion,

however, she leaves open the possibility that some type of spreading might occur as a

marked situation. She states:

> There is no Spreading in mutation languages. ... In a language with
> mutation prefixes, there is normally no way for anything but the initial
> consonant to mutate; for languages with mutation suffixes, only the final
> consonants can alternate (Lieber 1987:95-6).

Lieber (1987:96) then discusses one condition under which a nonlocal mutation might

occur, in which "the consonant nearest to the mutation affix [was] already prespecified

for the mutation features and if a subsequent consonant were underspecified... ,"
however, not a situation similar to the Isthmus Mixe data.

A further complexity of the Isthmus Mixe consonant mutation is that secondary
palatalization expresses at least four distinct morphemes and one non-morpheme
occurrence, as well as that one morpheme is a prefix and three morphemes are suffixes
(see chapter 3, section 3.7.5). Since the Isthmus Mixe data was unavailable to Lieber, no
accommodation to this unusual type of mutation could be expected.

5.6.1 Local vs. nonlocal mutations

Lieber (1987) discusses whether the autosegmental feature that causes consonant
mutation can occur on only one tier or on more than one. She says that many
phonological studies take for granted that a distinctive feature must be restricted to one
tier. In contrast, morphological descriptions may assume that the same distinctive feature
may appear on more than one tier concurrently. If distinctive features are restricted to
one tier, then the consonant mutation must be local, which is the unmarked case.
However, if the same distinctive features may appear on more than one tier, the
consonant mutation will be nonlocal, the marked situation.

Given that the mutation caused by Isthmus Mixe secondary palatalization
manifesting the third-person prefix palatalizes the initial consonant of the word and also
causes umlauting of the following vowel, then the mutation is nonlocal according to
Lieber's definition. In the same way, the clause-type suffixes manifested by secondary
palatalization affect the final consonant (or cluster) of the verb and also trigger umlauting

of the adjacent vowel(s). Although Lieber (1987) discusses consonant mutation in detail and also vowel umlauting, she does not discuss any type of mutation which affects consonant clusters and the adjacent vowels, nor do other authors who discuss mutations (e.g. McCarthy 1983, Mc Laughlin 2000, Spencer 1998). Thus it appears that secondary palatalization as found in Isthmus Mixe is an unusual type of mutation.

5.6.2 Mutations of secondary palatalization in Chaha and Japanese

In Chaha (McCarthy 1983:178-9), the final consonant of the root is palatalized to indicate a second person feminine singular subject. However, labial and the *r/n* consonants do not receive palatalization. Some of the examples (15) from McCarthy 1983:179) show the Imperative in the second person masculine singular with the final non-palatalized consonant and the second person feminine singular with the palatalized final consonant.

(17) Second person   Second person
     masculine singular   feminine singular

masculine singular	feminine singular	
nəmæd	nəmæd^y	'love'
nəkəs	nəkəs^y	'bite'
fəræx	fəræx^y	'be patient'

In describing this type of phenomenon, McCarthy (1983:176) states that "... a morpheme can consist of as little as a single phonological distinctive feature ... ."

According to Mester and Itô (1989:268), there is a palatal prosody called

mimetic palatalization in Japanese, which adds the semantic element of *uncontrolledness*

to the base form. Three of their examples of minimal pairs are shown in (16).

(18) a. poko-poko   'up and down movement'
       p^{y}oko-p^{y}oko   'jumping around imprudently'

     b. kata-kata   'homogeneous hitting sound'
       kat^{y}a-kat^{y}a   'nonhomogeneous clattering sound'

     c. kasa-kasa   'rustling sound, dryness'
       kas^{y}a-kas^{y}a   'noisy rustling sound of dry objects'

Mester and Itô (1989:268) note that:

> Palatalization does not have the same surface realization among all
> segments. The characterization 'palatalized' is strictly speaking only
> accurate for noncoronals, i.e. labials and velars. Palatalization of coronals
> (*t, d, s, z, n*) on the other hand, changes their primary place of articulation
> to palatal/alveopalatal .... In the interest of consistency and ease of
> representation, we adopt the morphophonemic representation C^y and will
> use the general term 'palatalized consonants'.

It was noted in chapter 4, section 4.4 that most likely all of the alveolar and velar

phonemes in Isthmus Mixe move toward the palatal region when palatalized.

5.7 Topics for further consideration

A further theoretical implication may be found in Featural Alignment, described

by Akinlabi (1996:243): "Featural Alignment ... aligns a featural element with specific

edges of grammatical categories (such as a noun stem, a verb stem, etc.); this is therefore

morphological alignment." In addition to tonal feature morphemes, Akinlabi (1996:240)

gives examples of non-tonal featural morphemes such as labialization in Chaha (indicating third person masculine object), palatalization in Zoque (indicating third person singular), and nasalization in Terena (first person possessive), among others. Alignment constraints are expanded from the original category of vowel harmony to include all autosegmental features functioning as affixes.

In Isthmus Mixe, secondary palatalization as a word prefix refers to third person, but manifests different aspects of grammatical and lexical forms. When prefixed to a noun word (a word is composed of the root morpheme and optional affixes), secondary palatalization indicates third person possession (19). When prefixed to a verb word, secondary palatalization indicates third person subject in two clause types,[18] as in (20), and third person object in one clause type.[19]

(19) /uːnk/   'child'   /ʲ-uːnk/   'her child'
(20) /kapʃ/   'speak!'   /tiː ʲ-kapʃ-ʲ/   'he already spoke'
(21) /mɨpɨk/   'obey!'   /kap ʲ-ʃ-mɨpɨk-ʲ/   '[she] doesn't obey me'

In examples (20) and (21), the imperative form of the verb, as indicated by the exclamation point in the gloss, is unmarked for person or clause type. The secondary palatalization suffix marks a conjunct clause type in the second part of these examples. A combination of the segmental phoneme /ʃ/ combined with secondary palatalization (ʲ-ʃ-)

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[18] Secondary palatalization indicates third person subject in nonconjunct direct-transitive clauses and in conjunct intransitive clauses (Dieterman 1995, 1998).
[19] Secondary palatalization indicates third person object in conjunct inverse-transitive clauses (Dieterman 1995, 1998).

as a verb word prefix indicates first or second person object in nonconjunct and conjunct

inverse-transitive clause types (example 21).

Constraints for these featural affixes following the model by Akinlabi (1996) are

suggested as follows (examples 22-29):

(22) ALIGN-3-POSS
          Align (3 possessive (^{j}-), noun word, L)
          The palatalization morpheme as third person possessive must be
          aligned with the left edge of the noun word (as a prefix).

(23) PARSE-3-POSS
          Third person possessive must be realized in the output.

(24) ALIGN-3-SUBJ/OBJ
          Align (3 subject/object (^{j}-), verb word, L)
          The palatalization morpheme as third person subject or object
          must be aligned with the left edge of the verb word (as a prefix).

(25) PARSE-3-SUBJ/OBJ
          Third person subject or object must be realized in the output.

(26) ALIGN-ADVERBIAL CLAUSE
          Align (adverbial clause (^{j}-), verb word, R)
          The palatalization morpheme as an adverbial clause type must be
          aligned with the right edge of the verb word (as a suffix).

(27) PARSE-3-ADVERBIAL CLAUSE
          An adverbial clause type must be realized in the output.

(28) ALIGN-1/2-OBJ

          Align (1/2 object (^{j}-ʃ-), verb word, L)
          The morpheme ^{j}-ʃ- as first or second person object must be
          aligned with the left edge of the verb word (as a prefix).

(29) PARSE-1/2-OBJ
          First or second person object must be realized in the output.

According to Akinlabi (1996:259), co-occurrence constraints are universals, which "are low ranked and have no surface effect" in Zoque, in which, he says, all consonants participate in the palatalization of the third person singular (see chapter 3, section 3.6.1). Regardless of the interpretation of the Zoque data, in Isthmus Mixe it has been observed that all consonants are mutated by the secondary palatalization morpheme of third person without exception. Just how the third person morpheme, along with the other morphemes associated with secondary palatalization, can be described more adequately using Featural Alignment awaits more study of this particular theory.

With the writing of this dissertation, the linguistic community is confronted with empirical data not previously available regarding secondary palatalization of every consonant in the inventory, including the laryngeal consonants /h/ and /ʔ/ which have not been considered in most of the studies on palatalization. In addition to this phenomenon in Isthmus Mixe, in at least one other Mixe language, Coatlán Mixe (including San José El Paraíso) (see section 3.7.4), the same secondary palatalization phenomenon occurs, (i.e. the palatalization of all consonants with the third person morpheme). It is likely that this is true in all of the Mixe languages, although it is not possible to be certain because the descriptions treat palatalization as metathesis of the prefix, rather than secondary palatalization (see chapter 3, section 3.8).

Therein is a challenge to the readers to consider research regarding the occurrences of palatalization in any or all of the Mixe-Zoque languages. Notice that

Wichmann (1995) has listed seven Mixe languages, with seventeen dialects, and five Zoque languages, with fourteen dialects (see chapter 1, section 1.4.1), but there are relatively few descriptions published (chapter 1, section 1.3).

Apart from the issues related to palatalization, there is a great need for detailed phonetic descriptions of the laryngeal features of the vowels in all the Mixe-Zoque languages, for example, using the Rothenberg Mask and inverse filtering to obtain airflow data as described by Edmondson and Li (1994), and Ní Chasaide and Gobl (1997). The actions of the glottis itself may be viewed by means of a fiberoptic laryngoscope, with recordings of the pictures obtained as the sounds are being produced (Edmondson 2000:classroom viewing of previously recorded pictures). Modern technology provides the opportunity for in-depth analyses not previously obtainable.

There are, of course, many more topics that could be mentioned, especially in the field of popular grammars,[20] bilingual dictionaries, collections of texts, health information, and topics of local interest. Materials that are useful in the everyday life of the native speakers are of utmost value in encouraging the continued use of these endangered languages. The sincere desire of the author of this dissertation is that the readers may be inspired to work with the native speakers of the Mixe-Zoque languages

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[20] A popular grammar is written in the national language for the purpose of acquainting school teachers, medical workers, and others in the area who may wish to learn something about the language of the people with whom they are working, and also for the bilingual native speakers who may wish to learn how to describe their language in grammatical terms.

to produce practical materials for the people, as well as to continue the more theoretical

descriptions of these languages.

APPENDIX

TEXT A

1. mínit ʲ-mítojaʰtˀ-ʲ [1]
    ⁷then 3P-hear-CLMK[2]

2. nepʲatʲɨ *hesus* ha iʰʃtaʰnt ɨnaʰtʲ jaʰ-kiʃɨ:k-ʲ-ɨn
    how *Jesus* the signs then [he]-CAU-happen-CLMK-MAN

3. kap ɨnaʰtʲ ʲ-nɨʰwɨ:j nepʲɨ hatun ʲ-winmantʲat-ɨt
    NEG then 3P-know what thus 3P-think-FUT

4. iʃ   nɨhe: aʰʃ-ʲ ɨnaʰtʲ ʲ-mɨna:n-ʲ
    because some PL then 3P-say-CLMK

5. ku ʲ-tiʰj ha *huan* ɨnaʰtʲ ti   · ʲ-huʰʲpik-ʲ
    that 3P-say the *John* then already 3P-become_alive-CLMK

6. iʃ   ti: ha *huan* ɨnaʰtʲ jik-o:k-ʲi:
    because already the *John* then [he]-CAU-die-CLMK

7. nɨhe: aʰʃ-ʲ ɨnaʰtʲ ʲ-mɨna:n-p-ɨ
    ⁸some PL then 3P-say-CLMK-CUS

8. ku ʲ-tiʰj he *elías* ha *dios*-mɨjda:k-ʲ hekʲ   jaʰwaʔʃipɨ
    that 3P-say the *Elijah* the God-talk-NOM long_ago preacher

9. nɨhe: aʰʃ-ʲ ɨnaʰtʲ ʲ-hak-mɨna:n-p-ɨ
    some PL then 3P-more-say-CLMK-CUS

10. ku ʲ-tiʰj ha hekʲ-hɨja:j   ti   ʲ-huʰʲpik-ʲ
    that 3P-say the long_ago-person already 3P-become_alive-CLMK

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[1] Short modal vowels are written /a/, long /a:/, short creaky /a̰/; long creaky /a̰:/, breathy voice /aʰ/, palatalization /ʲ/.

[2] Abbreviations of grammatical words and markers used in the gloss line are: 1P 'first person'; 1P_INC 'first person plural inclusive'; 2P_PL 'second person plural'; 3P 'third person'; AUX 'auxiliary'; CAU 'causative'; CLMK 'clause-type marker'; CUS 'clitic of unknown significance'; DIR 'directional'; FUT 'future'; INV 'inverse clause marker'; LOC 'locative'; MAN 'manner'; NEG 'negative'; NOM 'nominalizer'; OBJ 'object focus'; PL 'plural'; RSLT 'result'. Words in brackets are understood from the context. Although many morphemes have been identified in the text, this is not an exhaustive morphemic description.

11. ha *dios*-mɨjda̠ːk-ʲ   hekʲ   jaʰwaʔʃɨpɨ
    the God-talk_about-NOM long_ago preacher

12. mɨnit-ɨ   *erodes* ʲ-mɨnaːn-ʲ ɨːt͡sʲ-ɨ *huan* n-jaʰ-joʔ-puʰʃ-ɨ
    [9]then-CUS *Herod* 3P-say-CLMK 1P-CUS *John* 1P-CAU-neck-cut-DIR

13. pɨn-ɨta hɨtṵn wɨtiʰ-p
    who-this thus walking_around-CLMK

14. majtṵː-hɨt͡sʲ   hɨtṵn mɨtoj jaʰ-kɨʃɨːk-ʲ
    many_things-1P thus [I]-hear [he]-CAU-happen-CLMK

15. ʲ-haːnʃʲ   tem ʲ-ɨʃ-aːn-p-ʲ-ɨ   *erodes* ha *hesús* ɨnaʰtʲ
    3P-really really 3P-see-want-CLMK-DIR *Herod* the *Jesus* then

16. ko ha *hesus* ʲ-jɨjmɨːt   aʰʃʲ ʲ-wɨmpɨʰtɨkaʰt͡s-ʲ
    [10]when the *Jesus* 3P-companion PL 3P-return_again-CLMK

17. mɨnit-ɨ   *hesus* aʰʃʲ jaʰ-mɨt-mɨjtaːk-ʲ
    then-CUS *Jesus* PL [they]-OBJ-with-talk-CLMK

18. nepʲatʲ aʰʃʲ ɨnaʰtʲ tɨ   ʲ-wɨtit-ʲ
    how PL then already 3P-walk_around-CLMK

19. mɨnit aʰʃʲ ʲ-mɨt-nɨkʃ-ɨ   paktuːm
    then PL 3P-with-go-DIR desert

20. him mɨwinkon ma   ha kaʰpt ɨnaʰtʲ ʲ-ʃɨ-at-ʲ-ɨn   *betsaida*
    there nearby   where the town then 3P-name-be-CLMK-LOC *Bethsaida*

21. ko ha kṵːk aʰʃʲ hɨtṵn ʲ-mɨtoj-aʰt ·
    [11]when the crowd PL thus 3P-hear-be

22. mɨnit-ɨ   *hesus* aʰʃʲ him ʲ-pa-meʰt͡s-ʲ
    then-CUS *Jesus* PL there 3P-follow-arrive-CLMK

23. mɨnit aʰʃʲ ʲ-nɨmaːj-jɨ ko aʰʃʲ him ʲ-mɨmɨːw-ɨt
    then PL 3P-tell-INV that PL there 3P-stay-FUT

24. mɨnit-ɨ   *dios*-mɨjda̠ːk-ʲ aʰʃʲ jaʰ-mɨt-mɨjdaːk-ɨ   ·
    then-CUS *God*-talk-NOM PL [them]-OBJ-with-talk-INV

25. ko   ha   *dios*   ha   ʲ-miːhaː   jaʰ-kiʃɨk-ạːn-ʲ
    that   the   *God*   the   3P-glory   [he]-CAU-happen-FUT-CLMK

26. mɨntɨ   pạm   hɨjaːj   aʰʃʲ   maj   jaʰ-mɨkpɨʰk-ɨ
    then   sick   person   PL   many   [them]-CAU-get_well-INV

27. ͡tsuhiːj-nɨ-p   ɨnaʰtʲ
    [12]late_afternoon-RSLT-CLMK   then

28. mɨnit-ɨ   *hesus*   ʲ-winkume͡tsɨj-jɨ
    then-CUS   *Jesus*   3P-approach-INV

29. ha   ʲ-hɨjmiːt   aʰʃʲ   ha   nɨmaʰme͡tspɨ
    the   3P-companion   PL   the   twelve

30. mɨnit-ɨ   *hesus*   ʲ-nɨmaːj-jɨ
    then-CUS   *Jesus*   3P-tell-INV

31. nɨmạːw   jɨ   hɨjaːj   aʰʃʲ   ko   aʰʃʲ   nɨkʃ-ʲ   ʲ-poʔʃ-nɨ
    tell   the   person   PL   that   PL   go-AUX   3P-rest-RSLT

32. ko   aʰʃʲ   nɨkʃ-ʲ   ʲ-kaj-ɨʃtạːj   winktuːm
    that   PL   go-AUX   3P-food-search   other_place

33. ma   ha   kaʰpt   ʲ-winkon-ɨn
    to   the   town   3P-close-LOC

34. jaː   maː   aʰʃʲ   n-ʔiʰt-ɨm   kapɨ   tiː   jaː
    here   where   PL   1P-be-1P_INC   NEG   thing   here

35. mɨnit-ɨ   *hesus*   ʲ-mɨnaːn-ʲ   uk   ·jaʰ-kaj   miʰ͡ts
    [13]then-CUS   *Jesus*   3P-say-CLMK   just   CAU-eat   2P_PL

Free translation[3]

[7]Then [Herod] heard that Jesus was doing miracles. He didn't know what to think, because some people said that John had been raised from the dead (because [Herod] had already killed John). [8]Some people were saying that [he was] *Elijah*, the prophet (from long ago). Also some people were saying that the prophets (from long ago) had been raised from the dead. [9]Then Herod said, "I had John's head cut off. Who can this be walking around? I hear about many things he does." Herod really, really wanted to see Jesus. [10]When Jesus' companions returned, then they told Jesus what had happened on their trip. Then they went with him to the desert near a town called Bethsaida. When the crowd heard about it, they followed Jesus there. Then he told them that they could stay there. Then he talked with them about God's word, that God would manifest his glory. Then many sick people were healed. Then it got late in the day and his companions, the twelve, approached him. Then they told Jesus, "Tell the people that they should go rest now, that they should go search for food somewhere, in a nearby town. Here where we are, there isn't a thing." [13]Then Jesus said, "You just feed them yourselves."

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[3] This selection is the reading of Luke 9:7-13, from *El Nuevo Testamento en Mixe de Guichicovi* (1988), used in the case study of chapter 4. The superscript numbers at the beginning of the gloss line correspond to the verse numbers, also marked with superscript numbers in the Free Translation. Words in italics are loan words from Spanish and are not included in the frequency counts and analyses. The Free Translation is my own based on *Text A*; it is not taken from any version of the gospel of Luke.

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Chief areas of research interest have included the study and descriptions of endangered languages, especially the Mixe languages of southern Mexico. Her descriptions of two Mixe languages include acoustic and articulatory phonetics, phonology, morphology, and higher levels of grammar, including discourse levels. As opportunity arises, she would like to continue research of the Mixe languages and publication of her findings.