

# New Perspectives in Mayan Linguistics



# New Perspectives in Mayan Linguistics

Edited by

Heriberto Avelino

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P U B L I S H I N G

New Perspectives in Mayan Linguistics,  
Edited by Heriberto Avelino

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# PREFACE

HERIBERTO AVELINO

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Languages of the Mayan family are perhaps the most documented and investigated in Mesoamerica. Several generations of scholars have produced notable advances in linguistic theory based on the evidence from Mayan languages. In recent years the study of Mayan linguistics has seen an unprecedented blooming; however, a book that brings together the recent findings has been missing for decades until now. The present volume aims to fill this gap and present the new perspectives of Mayan language research at the beginning of the 21<sup>st</sup> century. One of the most prominent features of the articles in this collection is the balance between the use of the most recent linguistic theories and the empirical data from which analyses are drawn. Indeed, a definitive characteristic of the book is that all of the papers provide a wealth of new descriptive material gathered in the field by their respective authors. The recent findings reported in this book have implications for a deeper understanding not only of particular aspects of the individual grammars of the Mayan family, but might have consequences for linguistic theory as well as for typological and universal generalizations. The volume brings together linguists of diverse areas of specialization—phonetics, phonology, syntax, semantics, epigraphy, lexicography and anthropological linguistics—to discuss recent analyses and data from a variety of Mayan languages. The book synthesizes the recent methodologies, theoretical models and findings of research in Mayan languages. Individual contributions to the book are summarized in the following paragraphs.

Four papers deal with the phonology and phonetics of Mayan languages. Avelino, Shin and Tilsen open the volume to present the very first in-depth phonetic analysis of the so-called ‘rearticulated’ vowels in Yucatec Maya (in fact, in any Mayan language); the authors show that the descriptive category ‘rearticulated’ corresponds to non-modal laryngealized vowels. Unlike previous descriptions, they find that diatesis alternations are not expressed by changes in the syllable type of the root. In addition, they show that underlying ‘rearticulated’ are not generally produced as a vocalic

gesture with an intervening glottal stop. Instead, laryngealized vowels are consistently produced with falling tone and laryngealized phonation towards the end of the vowel. This paper opens a new perspective to analyze not only other Mayan languages but other languages of the area with similar descriptions of rearticulated vowels.

Melissa Frazier presents an exhaustive phonetic analysis of the suprasegmental vowel properties of Western and Eastern dialects of Yucatec Maya. The analyses are supported by the most representative sample of speakers in any other phonetic account of Yucatec Maya up to date: twenty-three speakers from three different towns. The study contributes with a series of important findings about the unexplored comparative phonetics of Yucatec Maya. Frazier shows, in contra previous claims in the literature, that Eastern dialects do not show tone contrasts but the whole series of vowels have a monotone rising pitch. Another result is related to 'glottalized vowels'. It has been taken for granted by most scholars that these vowels are produced with a full glottal stop. However, based on instrumental evidence Frazier confirms previous findings from Avelino *et al.* (this volume) claiming that glottalized vowels are produced mainly with creaky phonation.

Heriberto Avelino presents a study of the intonational patterns found in focus and topic constructions in Yucatec Maya. The paper, based on a careful experimental design, investigates the semantic-prosodic correlates of focus and topic via the notion of question-answer congruence. One of the most striking findings of this study is the minimal effect of intonational patterns on lexical tones: the realization of high tone preserves its underlying specification, whereas low tone is more vulnerable to postlexical modifications.

Ryan Shosted presents the most complete phonetic study of Mayan ejectives since the pioneering study of Pinkerton (1986). Shosted integrates a coherent picture of ejectives considering the diachronic and synchronic variation between ejective and implosive stops traditionally referred to as “glottal” consonants and provides a unified, phonetic-based account or “glottalic theory” of the development of a bilabial ejective and a voiceless uvular implosive in Mayan. Shosted’s analysis has important implication for the study of Mayan historical linguistics, and for the theory of language change, in general.

Nine chapters of the book deal with a variety of topics of the morphosyntax in Mayan languages. The first paper in this section by Ana Kondic presents an extensive body of data to analyze the Middle Voice in South Eastern Huastec, the only language in the family that has an elaborated and overt middle voice. Kondic shows that the central semantic

property expressed by this voice is the notion of subject-affectedness ranging from actions directed at one's own body, but expanded to express reflexives, reciprocals and the expressions of body position, body movement, mental processes and emotions.

Charles Andrew Hofling analyzes the Mopan's voice marking system and shows the striking differences in the morphology and syntax from other Yucatecan languages. The paper discusses how Mopan has lost many of the voice suffix markers but has preserved the agentless passive marked by *b'aan*, attested in colonial Yucateco but not in other modern varieties. It is of particular interest for scholars interested in grammaticalization that Mopan has innovated an antipassive auxiliary from the intransitive root *uch*, "to happen". Overall, Hofling shows that although marking of major voices in Mopan mirrors that of other Yucatecan languages, Mopan has innovated auxiliary-marking of the antipassive voice. Finally, Hofling shows in this paper crucial evidence from Mopan for the reconstruction of Proto-Yucatecan morphosyntax.

B'alam Mateo Toledo's paper presents a thorough analysis of non verbal predicates in Q'anjob'al. While most proposals have taken verbal predicates to analyze finiteness, Mateo Toledo takes the pains of investigating nonverbal predicates for which very little antecedents can be found. Mateo Toledo outlines a series of formal proofs showing the patterns of non verbal predicates to conclude that finiteness as a gradable clausal property defined by factors such as clausal structure, person marking and alignment, aspect, and the lexical properties of the predicate.

Romelia Mó Isém offers an analysis of the previously undescribed complement clauses in Poqomchi' that function as the object of the matrix clause. One of the most important contributions of the paper is to show three different types of complement clauses: finite complements, non-finite complements, and infinitive complements. One property that might be of interest to theoreticians is that fact that the last two types of complement clauses cannot expand their left periphery, and indication according to Mó Isém's analysis that these complements are more integrated structures, than finite complements which can be seen as more independent structures.

Jessica Coon and Omer Preminger (C&P) propose a novel analysis of a puzzling topic in Mayan linguistics, namely the identical morphology found positional stems and in the passive voice of some transitive verbs in Chol. C&P argue for an account in which the identical morphemes are better analyzed as case absorbing morphemes. C&P give plenty of evidence showing that positional roots behave like transitive roots; for instance, they can take marks of passivizers and cannot take causative

inflection. Nevertheless, C&P argue that positional roots are different from transitive roots: positional roots never appear directly in transitive stem forms, and while agents of passivized transitive roots can be expressed with *by* phrases, equivalent constructions with positional roots never appear with *by*-phrases. This indicates that the difference between transitives and positional roots is one of thematic role assignment. Transitives assign two thematic roles, whereas the positional root assigns only one.

Henrik Bergqvist presents a comparative study of the concepts of agentivity and status in Mayan languages taking a close view to the facts in the Yucatecan group. In contrast with previous accounts that study aspectual inflection markers or ‘status’ markers only from the perspective of aspect-mood marking, Bergqvist advocates for a proposal that explains the status markers in the larger context of ‘agentivity’. The discussion leads to the author to a hypothesis about the development of the markers including the agent focus constructions and “agentive” constructions in Lacandon and in Yucatec, and the further development to active-inactive split-S alignment in Mopan.

Rodrigo Gutiérrez-Bravo & Jorge Monteforte (G&M) address one of the most debated topics in Mayan linguistics—the *Agent Focus* constructions (AF)—considering the data from Yucatec Maya. G&M challenge the prevailing view about the regularity of AF. They present convincing evidence, both from elicitation as well as texts, showing that AF constructions cannot be taken as diagnostic of operator fronting (*wh*-movement). Their evidence shows that AF does not occur in a significant number of cases in which AF would be expected. Furthermore, G&M argue that AF is not a single phenomenon: some syntactic processes such as fronting of a transitive agent trigger a mandatory AF; however, in relativization AF is optional. G&M claim that one of the main functions of AF is disambiguating between subject and object relativization.

Stavros Skopeteas and Elisabeth Verhoeven's article deals with two conflicting accounts of the canonical constituent order of Yucatec Maya: Some authors argue that the canonical order is VOS while other authors argue that the canonical order is SVO. The paper outlines the structural facts about the word order possibilities and presents extensive corpus data concerning their occurrence in discourse. The empirical basis leads to the conclusion that the basic word order in Yucatec Maya is V-initial and that the root of the controversy in previous accounts is a particular constraint that bans linearizations with two postverbal lexically realized arguments in the language.

Pam Munro presents data of a number of Kiche constructions in which semantic experiencers—expressed as datives and genitives—appear to be

developing subject properties. A number diagnostics are presented by Munro: First, experiencers—like ordinary subjects, but unlike most other nominal constituents—may be preposed. Second, and more importantly, only experiencer dative subjects may strand their preposition in *wh*-questions, while non-experiencer, non-subject datives may not do this. Munro sets the data from Kiche in a typological perspective and points out that a similar pattern occurs in other languages—Chickasaw, Garifuna, German, and Macuiltianguis Zapotec, among others—in which dative-marked experiencers have acquired syntactic "behavioral" subject properties even though they retain the morphological "coding" properties of non-subjects. Munro suggests that Kiche may be undergoing a process of syntactic subjectivalization in which the initial interpretation of an experiencer or possessor as a semantic subject is the first step toward.

Søren Wichman and Cecil H. Brown present the most comprehensive account of reconstruction of Proto-Mayan syllable structure up to date. Expanding their previous research (Wichman & Brown 2007) the authors take now the challenge of proposing a reconstruction of disyllabic stems in Proto-Mayan. Throughout a detailed comparison of 24 languages of the family, Wichman & Brown reconstruct a minimal inventory of syllable nuclei \*V, \*VV, Vh, \*VV accounting for an overwhelming majority of the data. In addition, a thorough discussion of the reflexes in each of the major subgroups explains and illustrates the derivations from the proto-forms. A particularly generous contribution of the paper, is the large set of cognate sets provided by Wichman & Brown, which undoubtedly will be of great benefit for the community of Mayan scholars.

Alfonso Lacadena in its *Mayan Hieroglyphic Texts as Linguistic Sources* presents a fresh approach to the study of ancient mayan writing system. Lacadena persuasively demonstrates that the Mayan hieroglyphic corpus must be an integral part in the reconstruction of the history of Mayan languages. Certainly, any serious approach to the history of the development of Mayan languages could not disdain twenty centuries of written records. As Lacadena points out, there are advantages and limitations in the information provided by Mayan hieroglyphic corpus; however, a careful ponderation shows more advantages than drawbacks, such as the large ammount of texts available, the large area in which the texts have been discovered, the time depth covered by the texts. Lacadena's article is rather helpful in showing quite relevant methodological aspects. For instance, Lacadena shows cases where hieroglyphic data confirms reconstructions based on the linguistic methods and reconstructions, but also illustrates cases where traditional linguistics reconstructions and hieroglyphic data would not converge. Overall, after discussing a number

of representative cases, profussely illustrated in the paper, Lacadena concludes that hieroglyphic inscriptions should not be considered as accessory data to confirm previous linguistic hypothesis, instead they should be considered as an independent source of language data. One cannot only but agree with Lacadena in saying that the incorporation of hieroglyphic inscriptions will necessarily produce a better understanding of the history and development of the Mayan languages.

Judith Maxwell's paper deals with issues concerning discourse in Kaqchikel. She argues that while syntactically the second person independent pronoun is optional, its occurrence is partially determined by contextual/pragmatic conditions. Maxwell provides a detailed description of the sociolinguistic uses of the pronoun. Among young speakers the usage of the pronoun indicates close friendship, but when older speakers use it, it is taken as a strong directive. Maxwell argues that the use of the second person pronoun is linked to notions of solidarity among peers or invokes the status imbalance of age/respect.

As the title of the book entails, the research contained in this volume summarizes the most contemporary topics, theories and methodological frameworks used in the study of Mayan languages. We are most certain that our perspectives and understanding of Mayan languages will continue expanding to allow us to see towards farther and broader horizons.

Heriberto Avelino  
Leipzig, Summer 2011



# CHAPTER I

## THE PHONETICS OF LARYNGEALIZATION IN YUCATEC MAYA\*

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### 1 Introduction

Yucatec is the only language of the Mayan family that has developed contrastive tone.<sup>1</sup> Grammars of Yucatec, in addition to modal vowels<sup>2</sup>,

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\* We would like to thank the Yucatec Maya speakers who participated in this study: Dianella Marin, Ligia Marin, Miriam Canche, Pascual Poot, Abraham Dzul, Miguel Pech, Fernando Amilcar, Casimiro Pat, and Atanacio Dzib, without their collaboration this work could have not been possible. Thanks to Ismael May and Victor Canto for facilitating the field research. A preliminary report was presented at the 81st Annual Meeting of the Linguistic Society of America, Anaheim, California, January 6; we thank the LSA audience for inspiring comments and suggestions. Likewise, thanks also to Larry Hyman, Carlos Gussenhoven, Leanne Hinton and Bernard Comrie. All errors are our own. This study was supported by a University of California-Mexus grant awarded to Heriberto Avelino to conduct fieldwork in 2007 in Yucatan, Mexico.

<sup>1</sup> Other languages of the family have been reported to be in the process of developing tone, namely Mocho, Tuzantec and Tzotzil. However, the reports are do not provide enough evidence that tonal is lexically contrastive in these languages. Fieldwork by Avelino on San Bartolo Tzotzil in 2010 did not reveal reliable tone contrasts. In the absence of positive evidence we will consider

describe a series of 'rearticulated' or 'broken' vowels, which often exhibit varying degrees of laryngealization (Pike 1946, Blair and Vermont Salas, 1965, Fox 1970, McQuown 1970 and Fisher 1976, *inter alia*).<sup>3</sup> Examples of these contrasts are shown in Table 1 and Table 2 below.

**Table I-1. High-Low contrast**

High		Low	
tʃáak	'to parboil'	tʃàak	'rain'
míis	'to sweep'	mìis	'cat'
ʔéek'	'black'	ʔèek'	'star'
ʔáak	'turtle'	ʔàak	'herb'

**Table I-2. Types of Vowels**

Modal		Rearticulated	
pàaʃ	'music'	paʔaʃ	'break'
pèetʃ	'tick'	peʔetʃ	'rough'
pòot	'to pie'	poʔot	'spider'

Yucatec Maya exploits both the tone contrast (H or L) and the phonatory contrast of modal vs. rearticulated in its inflectional system, as well as in the lexicon.<sup>4</sup> According to grammatical studies, tone and phonation type contrasts are used in the expression of voice inflection

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Yucatec the only Mayan language with full documented contrastive tone in the lexicon and in the morphology.

<sup>2</sup> Yucatec Maya vowel nucleus includes modal long vowels, short vowels and rearticulated nuclei. The High-Low contrast occurs only on long modal vowels. Short and rearticulated do not carry contrastive tone.

<sup>3</sup> We will use the term 'rearticulated' as a cover term that reminds the label from descriptive grammatical studies. However, more precisely we use 'laryngealized' to refer to the phonological contrast to distinguish vowels produced with contrastive non-modal phonation from modal vowels. Laryngealized vowels can be phonetically implemented either as the so-called 'rearticulated' vowels or vowels with creaky phonation throughout. Moreover, because often the articulatory and auditory properties of the contrastive laryngealization in Yucatec Maya do not concur, the terms 'creaky' or 'creakiness' are only used to explicitly describe the actual phonetic instantiations of laryngeal vowels.

<sup>4</sup> The phonetics of the three-way prosodic opposition is similar in both in verb inflection and in the lexicon (see section 3 and *passim*.)

paradigms in transitive verbs (Bricker & Po'ot, 1981, Orie & Bricker 2000). Table 3 summarizes the generalizations found in traditional grammars. The active voice carries the underlying form of the verb root, the antipassive has low tone, and middle voice is marked by high tone and the passive voice changes the nucleus root to a rearticulated vowel. Inflection of three verbs is presented in Table 4 below. These illustrate the three tone classes of verbs labeled as Low, High and Rearticulated nucleus, identified in descriptive studies. As the table indicates Rearticulated vowels undergoes no prosodic changes.<sup>5</sup> Nevertheless, as it will be shown later, our findings depart from previous studies in the phonetic implementation of the tone-syllable forms.

**Table I-3. Grammatical Voice Type and Type of nucleus associated with underlying tone**

Grammatical Voice	Vowel Type/Tone
Active (AK)	Underlying Form
Antipassive (AN)	Low tone
Middle (MD)	High tone
Passive (PS)	Rearticulated

**Table I-4. Verb inflection illustrating the vowel nuclei alternations**

Active	Antipassive	Middle	Passive	Gloss
tin tàab	tàab nahen	táab	ta'abi	'to graft'
tin cháach	chàach nahen	cháach	cha'achabi	'to grasp'
tin ta'ak	ta'ak nahen	ta'a	ta'akbi	'to hide'

The lexical and morphosyntactic function of laryngeal features in Yucatec Maya is well documented; however, a thorough investigation of their phonetic properties is needed. Thus, the goals of the present study are: (i) to provide a detailed acoustic analysis of laryngeal phenomena in Yucatec Maya, i.e. tone and phonation; and (ii) to give an account of the phonetic realization of morphosyntactic categories (i.e. grammatical voice) in Yucatec Maya. To the best of our knowledge the present study represents

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<sup>5</sup> These labels will be maintained here. It should be noticed that this terminology may cause some potential confusion as the verb classes can be realized phonetically as Low, High and Rearticulated syllables; for instance, an underlying verb of the High class can be implemented phonetically as Low tone in the antipassive, this is to say, the morphological specification of antipassive will “override the underlying tone”). The relevant clarifications will be stated throughout in the paper so that confusion will be avoided.

the first in-depth phonetic examination of tone and laryngealization of in Yucatec Maya vowels (see also Frazier, this volume).

## 2 Methods

### *Participants*

Eight native speakers of Yucatec (3f, 6m; 24 - 35 years old) participated in this study. Each subject was recorded individually in the presence of the first author in a classroom or their home (in Yucatan, Mexico), in which case ambient noise conditions did not interfere with the quality of the data recorded. The session lasted between 60 and 70 minutes (including short breaks). The subjects were instructed to read the materials at a normal speed, simulating as much as possible his/her pronunciation in normal spontaneous conversation. Data were recorded on audio cassettes (Marantz recorder, PMD222), using a head-mounted unidirectional microphone (Shure SM10A-CN). Signal processing, digitization and phonetic analysis were done with the Praat software (Boersma & Weenink, 2007). Statistical tests were conducted with Statview software.

### *Materials*

The corpus consisted of 46 verbs that contained all of the underlying vowel contrasts in verb stems. These forms were selected to produce the four inflectional paradigms of grammatical voice. Each speaker repeated each inflected form a minimum of 4 times.

### *Procedures*

Laryngealized vowels were classified in three categories based on inspection of spectrograms. Type 1 are vowels in which a conspicuous glottal stop was present. Type 2 are vowels that began with modal voicing and transitioned to creaky phonation. Type 3 are vowels which began and ended with modal voicing and which contained creaky phonation in the middle. Type 3 differs from Type 1 in that no glottal stop-like closure occurred.

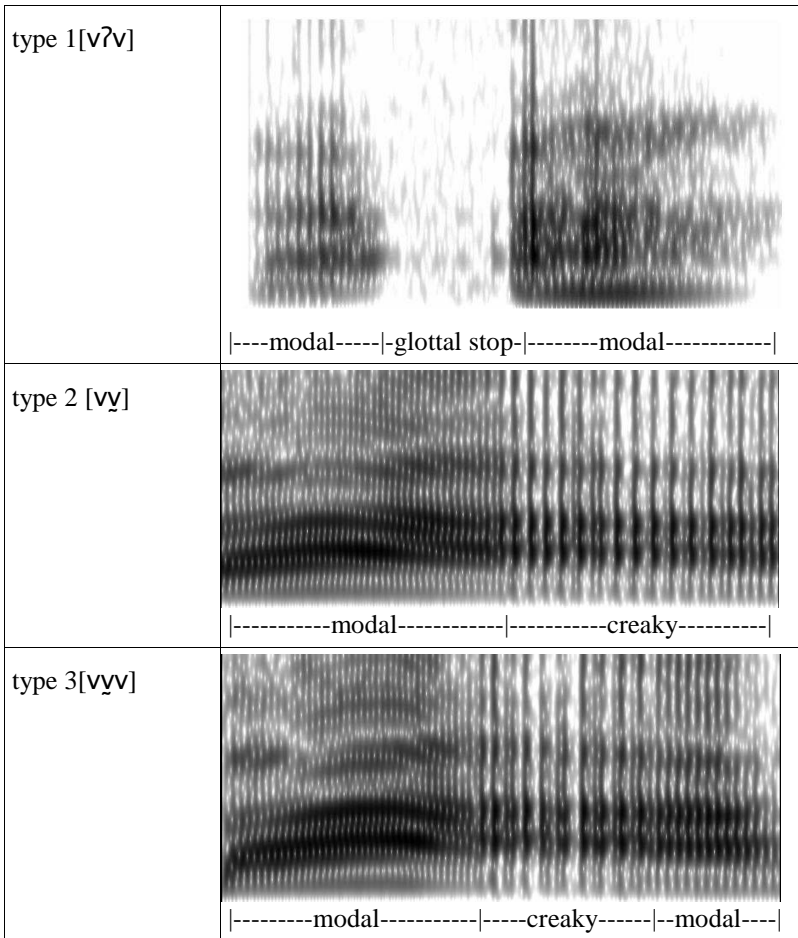


Figure I-1. Types of laryngealized vowels

Recent research has proved that different spectral measurements correspond to the degree of abruptness or gradualness of vocal fold closure (Hanson et al. 2001, Slifka and Surana 2006). Stevens (1998) has shown that a configuration of the vocal folds tight together will cause two major effects on the spectrum. On the one hand, it will produce greater amplitudes of the spectrum at high frequencies compared to that of modal voice, and, on the other, it will produce smaller amplitudes at low frequencies. Several studies have corroborated this correlation in laryngealized phonation where it is expected that the energy of the second

harmonic (H2) will be higher than that of the first harmonic (H1), when compared to modal phonation in which the magnitude of the first harmonic is higher than that of the second. Thus, the relative amplitude of the first two harmonics (see Figure 2), H1-H2, can be considered as an indicator of the degree of vocal fold opening (Klatt and Klatt 1990; Hanson *et al.* 2001; Holmberg 1995; Ladefoged 1983). A script was used to automate spectral measurements (based on Remijsen, 2004). Measurements of pitch and fundamental frequency were made at three points in each vowel (25%, 50%, and 75% of vowel duration). The pitch range was set to 60 – 350 Hz. The spectral peak corresponding to H1 was detected within a window  $\pm 1/10$  of the estimated pitch; H2 was detected based upon the estimate of H1 using the same window size. A total of 2486 tokens were analyzed. Type 1 vowels ( $n=135$ , 5% of total tokens) were excluded from the analyses because they lack conspicuous spectral peaks during the glottal stop.

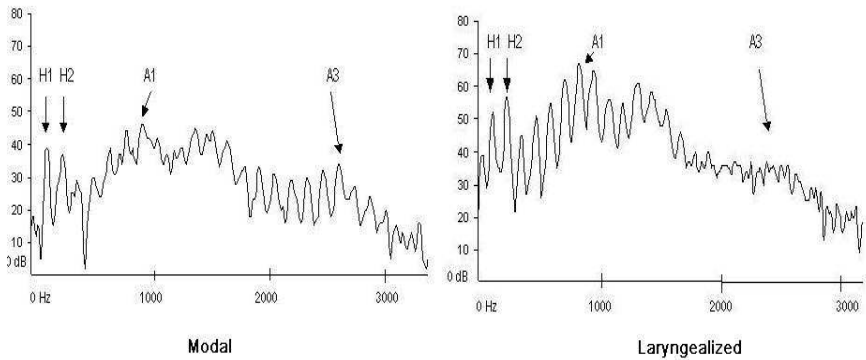


Figure I-2. Spectrum envelope of modal and laryngealized phonation types

## 3 Results

### 3.1 Fundamental Frequency

The first results show that F0 differed substantially according to both the tone of the vowel and the presence of laryngealization. Figure 3 shows the average F0 at each of the three points in H tone, L tone and rearticulated vowels for males and females. For females, F0 in H tone vowels rises slightly from vowel onset to offset, and in L tone vowels falls slightly. In contrast, rearticulated vowel F0 starts at the same level as high tone and

falls lower than in L tone vowels. For males, rearticulated vowels F0 starts at frequencies higher than in underlying H tone vowels and falls toward the end of the vowel. The difference between low and high tone F0 is smaller than it is for females, yet consistently distinguishes between low and high tones.

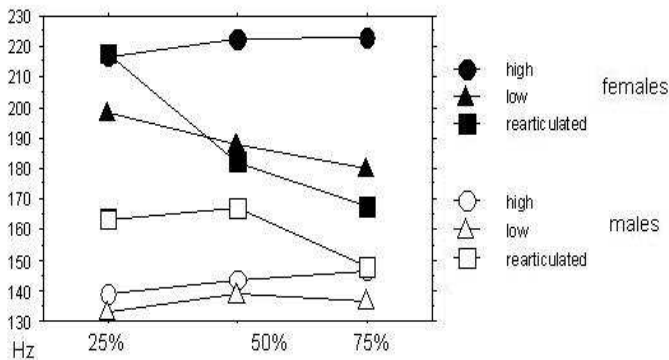


Figure I-3. F0 by vowel type

Figure 4 shows the results of the pitch contour associated with the four different grammatical voice types split by the underlying tone of the verb base.

**Low tone.** In the speech of the females the active (ak) and passive (ps) show a falling pattern, while the antipassive (an) has an intermediate frequency and the middle voice (md) reaches the lowest frequency. In males, the passive voice stands out with a falling contour that falls from high frequencies. The forms in active show a slightly higher tone than antipassive and middle voices, which in turn remain undifferentiated.

**High tone.** In females, forms inflected in passive and active show the highest frequencies, respectively, whereas antipassive and middle are almost identical. For males, passive and middle voices have the highest frequencies and follow a rising contour, while active and antipassive have lower frequencies and an almost level contour.

**Rearticulated vowels.** In females, all the grammatical voices show a rather dramatic falling F0, except for the antipassive, which exhibits the smallest fall. For males the results show more variation: F0 in active and antipassive forms are falling and level respectively, while F0 in middle and passive voice rises towards the mid portion of the vowel and then falls towards the end.

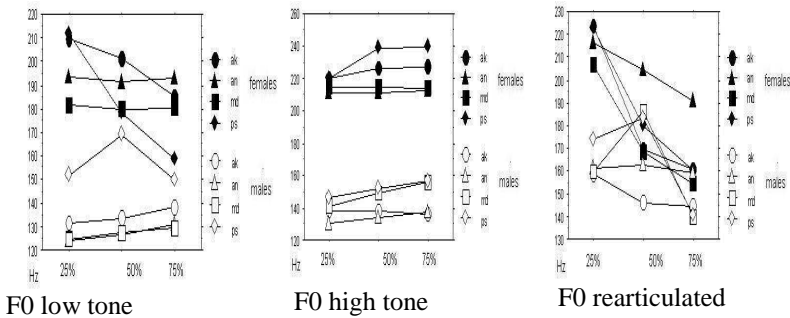


Figure I-4. F0 of low, high tone and rearticulated vowels by grammatical voice

The results of the distribution of tones within grammatical voice categories are summarized in Figure 5. Panel (a) shows the tone values for active forms. Females show the most differentiated tones: high tones are slightly rising, low tones are implemented as falling contours, and in rearticulated vowels, the falling contour is exaggerated. In males the difference between high and low tone is not as prominent as in females, yet both H and L tones contrast substantially with the falling tone of rearticulated vowels. Panel (b) shows the tone of the antipassive voice. The patterns for females show a level contour for high and low tones, which are well differentiated, and a falling contour for the rearticulated vowel, which is not as prominent as in the active forms. In males, rearticulated vowels are produced with a high level tone; high and low tones are consistently differentiated and show a slightly rising pattern. Panel (c) shows the pitch contours of the middle voice. The data for females is quite similar to the results obtained for the active forms, with the difference that the low tone in the middle voice is rather flat. The males produced well differentiated pitch contours in middle voice. F0 rises with a slightly greater slope in the high tone vowels compared to the low tone vowels. Rearticulated vowels in middle voice followed the pattern of increasing F0 with a fall towards the end of the vowel.



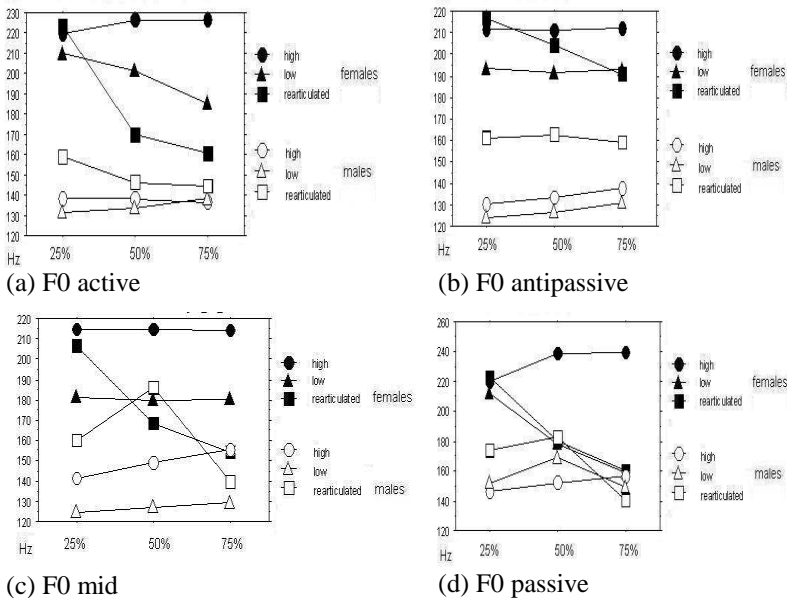


Figure I-5. F0 of grammatical voices by high, low tone and rearticulated vowel

Panel (d) shows F0 contours for passive voice. In females, F0 remains high frequencies throughout the vowel, in contrast with low and rearticulated vowels in which F0 exhibits a prominent fall. Males show a differentiation of the three tone-phonation types. The rearticulated vowel F0 again shows the pattern of an initial rise and a subsequent drop in F0, which also occurs in the low tone. Only the high tone does not fall; instead, it has a slightly rising contour. Unexpectedly, the high tone has the lowest pitch of the series.

### 3.1.1 Interim Summary: F0

The results obtained allow us to go back to the initial question about the expression of grammatical voices as a function of tone patterns. Table 5 below shows a summary of the findings so far. Overall, the results strongly indicate, contrary to traditional descriptions, that Yucatec Maya does not mark voice categories by tone-phonation features. Instead, the underlying tones remain unaltered throughout different voice categories, the only exception being the change from underlying low tone to falling in the passive voice.

**Table I-5. Summary of pitch contours of grammatical voice categories**

		Active	Antipassive	Middle	Passive
/Low/	Female	Low	Low	Low	Falling
	Male	Low	Low	Low	Falling
/High/	Female	High	High	High	High
	Male	High	High	High	High
/Rearticulated/	Female	Falling	Falling	Falling	Falling
	Male	Falling	Falling	Falling	Falling

However, from the summary above it cannot be seen whether antipassive and middle voices could potentially be distinguished by further differences in pitch height. Table 6 represents the relative pitch height relations between active, middle and antipassive F0 forms of the three underlying tones in both males and females. Overall, the findings show that females and males have opposite tendencies: middle voice F0 is higher than antipassive in males whereas antipassive is higher than middle in females; therefore, it is inconclusive whether pitch height can be used as a clue to distinguish between grammatical voices.

**Table I-6. Relative pitch high of grammatical voice of males and females**

Sex	UR	Relative pitch height	Overall pattern
Male	L H R	AK > MD ~ AN MD > AK > AN MD > AN > AK (at 50% of the vowel)	MD > AN
Female	L H R	AK > AN > MD (up to 50% of the vowel) AN > AK > MD (after 50% of the vowel) AK > AN ~ MD AN > AK > MD	AN > MD

The frequency and distribution of Type 1 vowels (i.e. vowel nuclei with a full glottal stop) deserves a special mention. The results showed that only four out of eight speakers produced Type 1 vowels. Furthermore,

it should be noticed that type occurs almost exclusively in underlying rearticulated vowels and passive forms with underlying low tones.<sup>6</sup> Table 7 shows the detailed frequency and distribution of Type 1 vowels found in our data.

**Table I-7. Frequency and distribution of type 1 vowel (v7v) across grammatical voice categories**

	Active	Antipassive	Middle	Passive	Total
/Low/	5 (3.7%)	0	0	20 (14.8%)	25 (18.5%)
/High/	0	0	0	1 (0.7%)	1 (0.7%)
/Rearti- culated/	27 (20%)	16 (11.9%)	36 (26.7%)	30 (22.2%)	109 (80.7%)
Total	32 (23.7%)	16 (11.9%)	36 (26.7%)	51 (37.8%)	135 (100%)

### 3.2 Spectral Slope

The overall results, summarized in Figure 6, show that H2 is consistently higher than H1 in rearticulated vowels for both female and male subjects (i.e. the absolute values are smaller than the corresponding ones in modal vowels). In females modal vowels have positive values (i.e. the first harmonic is higher than the second), with high tone vowels having larger values than low tone vowels. The rearticulated vowels, in turn, change throughout the vowel starting in modal values close to those of modal vowels and progressively falling to negative values correlated with increased creakiness. In males, the absolute values are either close to zero or negative. Vowels with high tone are at the top of the range (around 0 dB) (i.e. they are more modal than low tone (-2 dB)) and vowels with rearticulated phonation are at the bottom in the range of -5 dB (i.e. the creakiest of the series).

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<sup>6</sup> There are five incidences in the active voice coming from two stimuli words produced by a single speaker, F2. This may well be an idiosyncrasy of this subject.

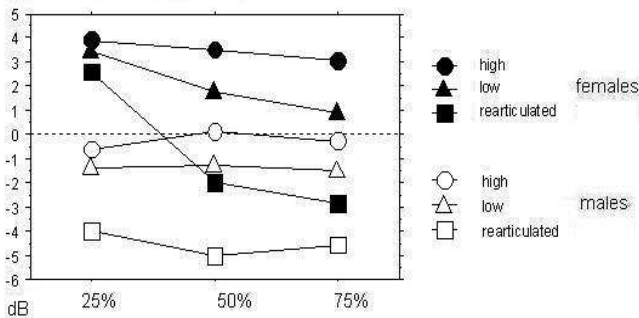


Figure I-6. H1-H2 by tone and rearticulated vowel

Figure 7 presents the results of spectral slope of low, high and rearticulated vowels split by voice categories. Panel (a) shows the results for vowels with low tone. In the speech of females, passive and active show a pronounced declination going from high positive values (5 dB) and falling to negative values (-2 dB and 0 dB, respectively). Antipassive and middle voices remain steady at 3 dB. Males show overall a steady level slope in all four grammatical voices. Passive shows the highest value (close to zero) followed by antipassive and middle with values between -1 and -2 dB, respectively followed then by active with the lowest magnitude around -3 dB. The results of high tone for females in panel (b) show a general tendency for a downtrend in all the voice types. Passive has the greatest slope followed by middle voice. The difference between these two voice categories is that the middle voice values remain high until the middle portion of the vowel and drops only during the last portion. In contrast, the passive voice falls regularly from the beginning until the end of the vowel (5 dB – 3 dB). Active and antipassive voices show a rather moderate falling slope centered around 3 dB. Males show a similar tendency for passive and middle voices in the sense that there is a conspicuous decay towards the second half of the vowel. Active and active voice types show an increased spectral slope (i.e. an increase in properties of modal phonation). The results of the rearticulated vowel type are presented in panel (c). The most prominent property in the speech of females is the uniform declination of the spectral tilt along the course to the vowel. Males, in turn, have either a flat pattern or a drop restricted to the middle of the vowel.

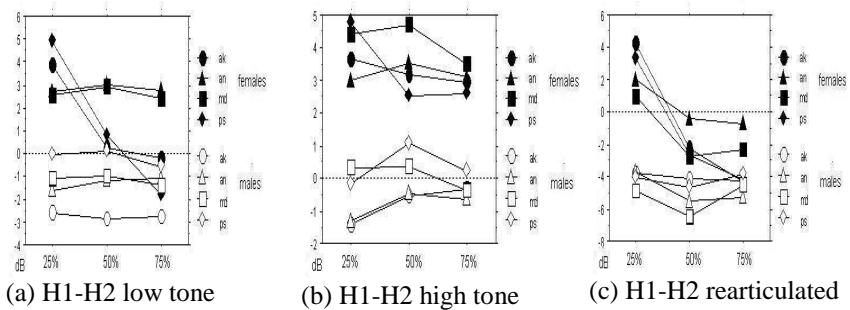


Figure I-7. H1-H2 by tone and rearticulated vowel

Figure 8 shows the results of spectral slope grouped by grammatical voice. The patterns of active are shown in panel (a). In the speech of the females the low tone and rearticulated vowels start at the same values and fall towards the end of the vowel. However, the rearticulated vowel has a greater fall than the low tone. High tone vowels, in contrast, have an almost level value. The patterns of males are for the most part a level spectral tilt; the hierarchy of height from high to low magnitudes has high tone followed by low tone and rearticulated vowels at the bottom. The results for the antipassive voice of both females and males in panel (b) show that high and low tones have similar flat spectral slopes, in marked contrast with the rearticulated vowels which have a continuous falling. A similar pattern to the antipassive is found in the results of middle voice. High and low tones do not show that much variation and remain relatively steady throughout the vowel, whereas rearticulated vowels have a falling spectral slope. The most important difference is that in the speech of males there is a drop restricted to the center of the vowel. Finally, the results of the passive forms in panel (d) show that females have a consistent falling in the three categories, high, low and rearticulated, with the rearticulated having the lowest (more negative values) than low and high tone vowels. Rearticulated vowels exhibit decreasing spectral tilt and are at the bottom of the scale. High and low tones in these vowels--unlike the female vowels--rise and then fall slightly.

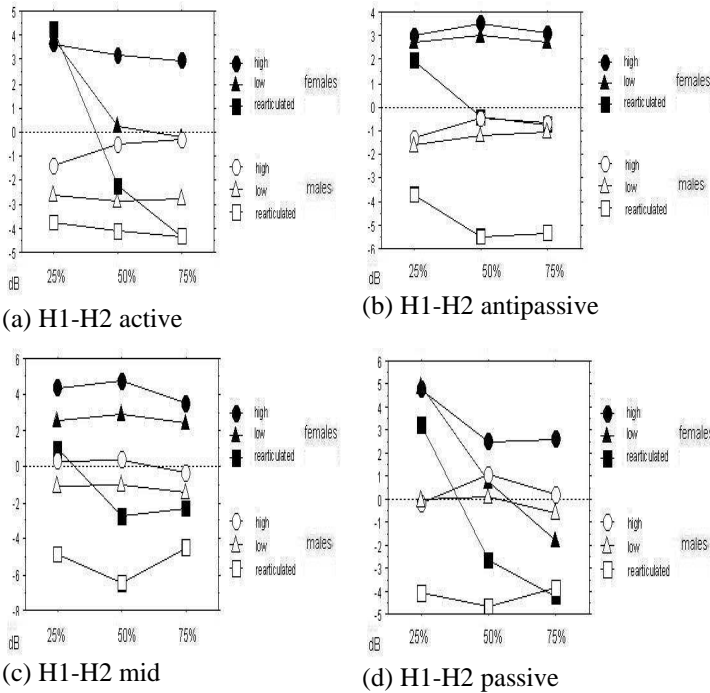


Figure I-8. H1-H2 of grammatical voices by high, low tone and rearticulated vowel

### 3.3 Interim Summary: H1-H2

Taken together, the results show that males have negative values in all the instances of any grammatical voice, (i.e. males produce more creaky phonation). Furthermore, there is a consistent arrangement of the values from different voice types. Passive is the least creaky followed by middle and antipassive and finally active voice. Female speech has positive values, and thus, more modal phonation (with the only exception of passive voice towards the end of the vowel (75%). There is no discernible pattern of phonation values associated with different grammatical voice types other than towards the second half of the vowel active and passive voice have the least modal values. These tendencies are captured by Figure 9 below.