

Intonation Patterns of Morelos Nahuatl

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Abstract

There are still relatively few studies on the phonetics and phonology of the indigenous languages of Mexico, and just a minority of them deals with less explored areas like prosody or, specifically, intonation. This study reports a preliminary analysis of Nahuatl intonation, taking into account its phonological characteristics: a) trochaic binary rhythm; b) generation of secondary stress inside rhythmic structures; c) generation of rhythmic groups according to clause structures; d) phonetic syllable lengthening at the end of sentences; e) laryngealization or voicelessness at the end of utterances, and f) vowel lengthening. Data collected by means of different methods, developed in order to obtain authentic and spontaneous utterances, show that different sentence types tend to have specific intonation patterns with many typologically common features and some original characteristics.

Index Terms: prosody, intonation, acoustic phonetics, indigenous languages, language documentation, Nahuatl

1. Introduction

Nahuatl is part of the Uto-Aztecan family and its ten dialects are spoken in vast regions of Mexico and Central America. Dialectal differences cause varying levels of intelligibility among speakers. Moreover, there are few monolingual speakers, since the language is rapidly losing ground to Spanish [1]. Here we focus on Morelos Nahuatl. In 2000, Morelos Nahuatl was spoken by 18,700 persons [2]. In the village of Cuentepec, the most dynamic community of all Morelos Nahuatl-speaking villages, there were 3,052 Nahuatl speakers who were older than five years, but only 69 of them were monolinguals [3].

Although classical Nahuatl or Aztec is one of the most documented and studied indigenous languages in the Americas, especially with respect to its polysynthetic morphology, but the phonology of its current dialects, and specifically its prosody, which is usually regarded by non-specialists as ‘very simple’, has not been studied from the approach of experimental and acoustic phonetics [cfr. 4, 5, 6, 7]. The model presented in this paper takes into account specific features of Nahuatl phonology and how they influence intonation.

2. Previous studies

2.1. Phonological inventory of Morelos Nahuatl

The phonological system of Morelos Nahuatl, specifically the variant spoken in the village of Cuentepec, is shown in Table 1. Phonemes borrowed from Spanish, used in non-assimilated loanwords, are not included. The system has a characteristic absence of voiced stops affricates and fricatives, as well as a squared vowel system. Regarding phonotactics, Table 1 shows consonantal phonemes appearing only in the onset (h^w -) or coda position (l -?). Phonetically, short and long vowels differ not only in their length but also in their quality and tension,

with short vowels being lower and lax, especially the high front vowel, $/i/ \rightarrow [i]$, and the back vowel, $/o/ \rightarrow [ɔ \sim ɔ]$. However, in spite of the existence of minimal pairs, the vowel length contrast is not robust in the variant of Cuentepec, Morelos, since it tends to be neutralized and subordinated to rhythmic structure and emphatic speech. Moreover, syllables with a glottal stop $/ʔ/$ or fricative $/h/$ in coda position, which tend to neutralize, produce a shortening of the vowel’s modal portion followed by a glottalization, which is produced as creaky voice or voicelessness. This phenomenon occurs only at the end of an utterance [6]. Other allophonic phenomena not shown in Table 1 are velar stop fronting before a front vowel, $/k/ \rightarrow [c]$, nasal velarization at the end of a word, $/n/ \rightarrow [ŋ]$, and devoicing and fricativization of the lateral consonant at the end of a word, $/l/ \rightarrow [l \sim tʃ]$.

Table 1. Phonological Inventory of Morelos Nahuatl.

CONSONANTS							
	bilabial	dental	alveolar	palatal	velar	velar-labial	glottal
Stops	p	t			k	k ^w	(-ʔ)
Affricates		ts	tʃ	tʃ			
Fricatives		s		ʃ		(h ^w -)	h
Nasals	m	n					
Lateral			l				
Approximants				j		w	
VOWELS							
		i:	i		o	o:	
		e:	e		a	a:	

2.2. Syllable structure

Nahuatl syllable structure has been traditionally (e.g. [8]) said to allow four possible syllable patterns, which are derived from the generic pattern (C)V(C), i.e. V, CV, VC, and CVC. Allegedly, there are no consonant or vowel clusters inside a single syllable (diphthongs are regarded as CV or VC structures), and a syllable is composed at most of three phonemes. However, in Cuentepec Nahuatl there is evidence of CGVC (e.g. [tʃaŋ.kis] ‘market’) and CVGC (e.g. [k^wejtʃ] ‘skirt’) structures. Last but not least, lexical stress functions as a culminative, hierarchical, delimitative and rhythmic unit [9], falling regularly on the penultimate syllable.

Typologically, Nahuatl has a polysynthetic structure with the possibility of the object and even some modifiers being incorporated to the verb root. Structures above five or six syllables are not the most frequent, but they are not unusual either. In such words secondary stress is found. According to Kager’s classification [9], these synthetic structures in Morelos Nahuatl are typical of a bound or limited system,

which is also non-sensitive to quantity, and it assigns stress from right to left, producing left-oriented, i.e. trochaic feet:

$$[nik.k^w ah.k^w al.ʔaʔ.kal.'ma.ka] \quad (1)$$

/ni-k-k^wa:hk^wal-ʔaʔkal-maka/
 1SG.SUJ-3SG.OBJ-beautiful-tortilla-give.PRES
 'I give him/her beautiful tortillas.'

All three acoustic correlates (intensity, duration, and fundamental frequency or F_0) signal, to a greater or lesser extent, the location and prominence level of primary stress, secondary stress, and lexical stress throughout the sentence. As such, the only constant acoustic correlate of stress is F_0 [6].

2.3. Influence of stress and length on vowel quality

In a previous study [10] a young male speaker of Morelos Nahuatl was asked to read and record a series of sentences. From this recording, we obtained 542 vowel tokens (including 246 short vowels, and 296 long vowels, in both stressed and unstressed syllables), after eliminating every observation in unclear contexts, adjacent to a semivowel, or before any sonorant consonant. Values for the three first formants were calculated using a Praat script [11]. The values were obtained from the most stable portion of every vowel. F_2' [12] was calculated from the F_2 and F_3 values (see Table 2, Figure 1).

Table 2. Formant values of Nahuatl vowels.

Stress	Length	#	\bar{F}_1	$Q_{F_1}(0.1)$	$Q_{F_1}(0.9)$	\bar{F}_2'	$Q_{F_2'}(0.1)$	$Q_{F_2'}(0.9)$
-	a	17	594	501	658	1640	1434	1774
	a:	24	702	651	758	1703	1529	1790
+	a	76	669	566	734	1739	1592	1893
	a:	60	721	669	788	1733	1573	1846
-	e	24	503	428	582	1918	1782	2049
	e:	22	535	495	573	2095	1957	2174
+	e	30	520	452	586	2072	1916	2243
	e:	33	536	474	586	2068	1844	2207
-	i	29	376	259	455	2283	2018	2539
	i:	70	313	279	358	2462	2253	2641
+	i	21	316	286	350	2392	2315	2500
	i:	20	321	311	331	2553	2416	2707
-	o	26	473	383	540	1476	1341	1627
	o:	15	515	493	546	1398	1335	1479
+	o	23	559	484	629	1459	1340	1604
	o:	52	582	521	635	1409	1308	1511

In Table 2, the resulting data are presented according to their timbre, presence or absence of stress, and length. The next column indicates the number of occurrences (#) for each vowel category, their mean values, as well as the 0.1 and 0.9 quantiles inside every category for F_1 and F_2' . These latter values were used to plot ellipses with the most stable 80% of the occurrences of all four vowel extreme values.

In Figure 1, we observe that long vowels (depicted with dashed lines) are better delimited, since they occupy a smaller acoustic space; their spaces between stressed (black line) and unstressed (gray line) vowels intersect to a lesser or greater extent, and the different vowel timbres are clearly differentiated. Meanwhile, short vowels (depicted with solid lines) occupy larger acoustic spaces, where short unstressed /i/ covers a vast space towards /e/, whereas short unstressed /o/ and /a/ tend to occupy higher spaces, causing /a/ to intersect large areas occupied by phonological /o/. The Nahuatl vowel system is thus square, not triangular.

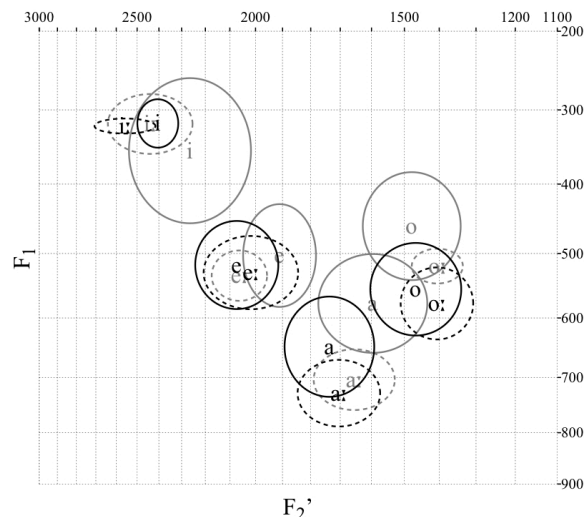


Figure 1: Distribution of Nahuatl vowels. (Black line = stressed vowel, gray line= unstressed vowel, solid line= short vowel, dashed line= long vowel)

2.4. Tones and break indices (ToBI)

For this study, we use the ToBI (Tones and Break Indices) prosodic transcription system, based on the autosegmental-metrical model or AM [13, 14, 15, 16, 17, among others]. In this transcription system, F_0 contours are analyzed as a sequence of local pitch variations based on the metrical structure of sentences. As such, there are two types of phonological elements: *pitch accents*, associated with lexically stressed syllables coinciding with nuclei of syntactic clauses, and *boundary tones*, associated with the borders of prosodic domains. There are just two basic tones: *L* (low tone) and *H* (high tone), which are combined throughout the utterance.

3. Data Elicitation

For the macro-project on the prosodic analysis of Nahuatl, within which the present investigation is placed, we have taken into account the elicitation techniques used in other projects, such as the Atlas interactivo de la entonación del español [18] the HCRC Map Task Corpus [19], and the CHILDES Project [20]. We have developed a whole series of methods and materials in order to elicit close-to-natural intonation. These materials include interviews, map tasks, narratives, and communicative situations. We have used these materials to obtain data from a number of Nahuatl varieties, including those spoken in Morelos, Guerrero, Huasteca Veracruzana and Sierra de Zongolica. This paper focuses exclusively on the results obtained for Morelos Nahuatl.

3.1. Interviews

The topics presented during interviews are previously prepared, but also improvised in order to help the native speaker talk about his/her life experiences and interests, such as life stories, descriptions of his/her work or trade, daily life, family, community, as well as folk stories, tales or legends. Ideally, the recordings should be more like a conversation than an interview, and performed by another native speaker. They yield mostly declarative sentences.

3.2. Map Task

Another elicitation technique that we have employed is the one known as ‘Map Task’ [19]. This is a cooperative task between two native speakers performing different roles: the instruction giver and the instruction follower. The instruction giver gives instructions about a path to be followed through a village map in order to arrive somewhere, and the other participant follows those instructions, trying to trace the route. However, the maps are slightly different, and both participants have to figure out how to navigate through them successfully [19, 21]. This method yields declaratives, interrogatives, and imperatives.

3.3. Narrative

In order to elicit narratives, booklets were created with image sequences depicting a story. However, this technique was not always successful for this purpose, as illiterate participants described individual images in detail instead of producing a narrative. This situation yielded mostly declaratives, but also other types of sentences.

3.4. Communicative situations

The researcher read aloud 75 common situations, intended to elicit different types of sentences as a response: declaratives, (absolute, partial, and reiterated) interrogatives, imperatives, and vocatives. For each main type of sentence, neutral and non-neutral variants were elicited. Native speaker participants were asked to act out a sentence, or to interact in a close-to-natural way, according to the given situation (see Figure 2). The questionnaire was not just translated [18, 22, 23], but also culturally and thematically adapted in order to create topics and characters, which would appear familiar to native speakers of Nahuatl. Sometimes, a Spanish version was used and adapted on the fly in order to obtain different answers.



Figure 2: Sample from the ‘Communicative Situations’ task. (4a. Look at this image and tell me what they are doing. [Possible answer:] –A woman is giving water to her son.)

4. Methodology

For this study, three native speakers of Morelos Nahuatl, one man and two women from the community of Cuentepec, were selected for the *Communicative Situations Questionnaire*. They were asked to answer every question three times. Four different speakers were also selected for the Map Task, the narratives and the interviews, in order to provide complementary data.

All linguistic productions were recorded in audio as stereo WAV files with an Olympus LS-11 recorder at a 44.1MHz sample rate, and in video as a backup. The questionnaire was recorded in a soundproof room at the Universidad Autónoma de Querétaro, Mexico, while the complementary data were recorded in quiet spaces in Cuentepec. The resulting audio

files were edited in Audacity, and then segmented, transcribed and prepared in Praat [24, 25].

5. Results

Figure 3 shows a sample image obtained by means of superposing all three utterances of the male speaker, corresponding to three superposed emissions of a partial interrogative sentence, with a H% [H*+H] [H*] [h* H*] LH% pattern, where brackets show the domain of phrasal structures.

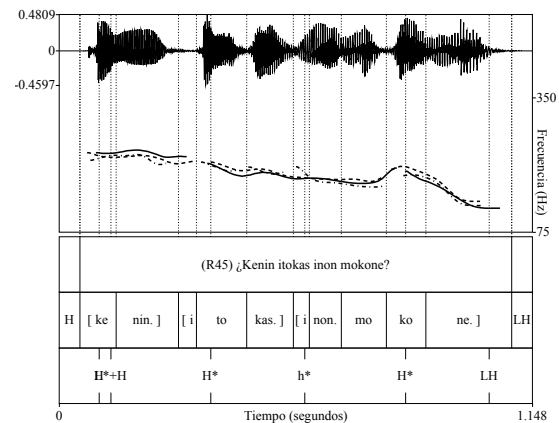


Figure 3: Three emissions of the same partial interrogative sentence. (‘How will you name your child?’)

The results obtained from the quantitative and qualitative analysis of all sentences in a given category, their pitch accents and their simplified global contours were mapped on to the stylized contours shown in Figure 4. For the sake of simplicity, secondary stress pitch accents (notated with lower case h* in Figure 3) are not depicted here, since they show the same inventory as is used for primary stress, and the difference between primary and secondary accents is just relative and contextual. On the other hand, H* differs from * in that H* is a perceptually clear F₀ peak (over +1.5 semitones), while * is not so easily perceivable, because its F₀ is under 1.5 st, relative to its surrounding syllables. Parentheses and slashes show second-best alternative pitch accents (also depicted with a thinner line), which correspond mostly to local emphasis.

5.1. Declaratives

Neutral declaratives (A.1. in Figure 4) have by far the simplest contours: low initial and final boundary tones (L%) and unperceivable nuclear and prenuclear stresses (*) or, alternatively, peaks within the stressed syllable domains (H*). Non-neutral declaratives (A.2.) differ from neutral ones in that the initial and final accents are early rises (L+H*). Their final boundary might be a fall or a steep fall (L% or LL%).

5.2. Absolute interrogatives

Both neutral (B.1. in Figure 4) and non-neutral (B.2.) absolute interrogatives have a low nuclear accent followed by a rise to a level tone (L* HL%). However, neutral ones have a high initial boundary tone followed by a low/falling tone, while non-neutral ones have a similar contour with respect to non-neutral declaratives, except for the nuclear pitch accent and final boundary tones (L+H* L% vs. L* HL%, which is a low tone followed by a steep rise that ends at a mid/neutral level).

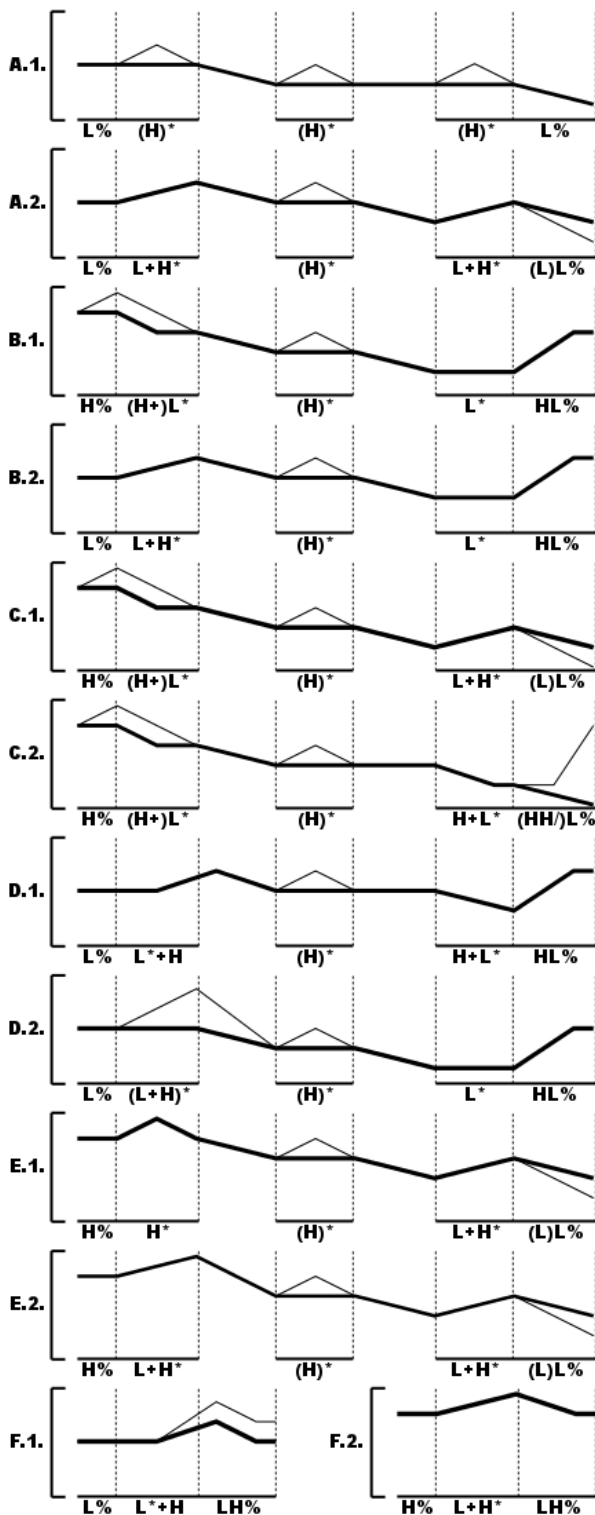


Figure 4: *Intonation Patterns of Morelos Nahuatl.*

5.3. Partial interrogatives

Partial interrogatives, both neutral (C.1. in Figure 4) and non-neutral (C.2.), have the same contours as neutral absolute interrogatives (H% L* or H% H+L*), but they have different

nuclear pitch accents: neutral ones resemble non-neutral declaratives (A.2.) and non-neutral ones have a falling tone (H+L*) followed by totally different contours: a fall or a steep rise, L% vs. HH% (maybe due to pragmatic factors).

5.4. Reiterated interrogatives

Neutral (D.1.) and non-neutral (D.2.) reiterated interrogatives have a characteristic low initial boundary tone, and a rising to level final boundary tone. They differ only in the first prenuclear tone (L*+H vs. * or L+H*), and the nuclear tone (H+L* vs. L*).

5.5. Imperatives

Imperatives, both commands (E.1.) and pleas (E.2.), begin with high tones, and end with nuclear early rises followed by low/extra low final tones (L+H* L% / LL%). Their prenuclear accents differ in peak alignment (H* vs. L+H*).

5.6. Vocatives

Vocatives have falling to level final tones (LH%), but they have different initial tones, L% vs. H% for calls (F.1. in Figure 4) and phrase-edge vocatives (F.2.), respectively, and nuclear F₀ peak alignments (L*+H vs. L+H*), where calls have a deeper pitch range.

6. Conclusions

We propose a combinatorial model made up of isolated tones, which also takes into account the trochaic binary rhythm of Nahuatl, and its automatic generation of secondary stress inside rhythmic structures according to phrasal (clause) structures, as shown in Figure 5. So far, we have identified slightly different intonation contours for each of the main pragmatically neutral sentence types, where neutrality is mainly expressed by means of simpler or less salient tones. The combinatorial model in Figure 5 must be taken as provisional and subject to revision based on the results of further data collection and analysis.

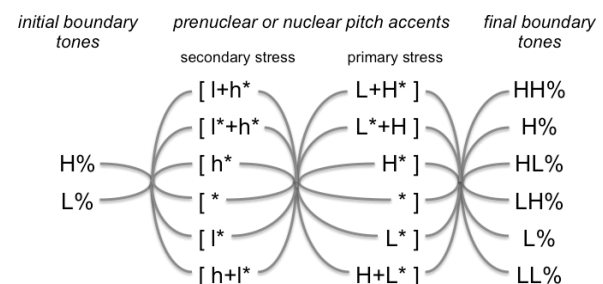


Figure 5: *Tone combinations in Morelos Nahuatl.*

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