Title
The interaction of tone and stress in the prosodic system of Iquito (Zaparoan, Peru)

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The Interaction of Tone and Stress in the Prosodic System of Iquito (Zaparoan)*

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1. *Introduction*

Although stress systems and tonal systems have each been objects of prolonged linguistic study, and the prototypical members of each type of system are relatively well understood, prosodic systems that combine the characteristics of both stress and tone systems are less well studied, and continue to pose descriptive and theoretical challenges (Hyman 2006). The goal of this paper is to describe one such prosodic system, found in Iquito, a Zaparoan language of northern Peru, and to demonstrate that a parsimonious description of the word prosodic system of this language results from carefully distinguishing the stress and tone systems of the language and examining their interaction. This strategy essentially puts into operation Hyman's (2009) call for property-driven approaches to word-prosodic typology in the analysis of so-called 'pitch-accent' systems.

The Iquito word prosodic system consists of clearly distinguishable stress and tone systems, in which stress and tone have distinct acoustic correlates. Tonal minimal pairs exist in the language, but tone is also partially dependent on the position of primary stress. The density of tones in words is low, but the language also exhibits a requirement that each prosodic word carry at least a single high tone. If a given word exhibits no lexical tones, a high tone is assigned to the syllable bearing primary stress. The result is best described as a low-density tone system (one in which many syllables do not bear tone) that is partially dependent on metrical structure.

2. *Sociolinguistic Background and Typological Profile*

Iquito is a language of the Zaparoan family. This family historically extended over a large region of present-day northwestern Peruvian Amazonia and adjacent areas of Ecuadorian Amazonia, from the Napo River valley in the north, to the Pastaza River valley in the south. Apart from Iquito, the Zaparoan family included Andoa, Arabela and Záparo.

Iquito speakers indicate that Kawarano, sometimes listed as a distinct language (e.g. Wise, 1999: 309), was a dialect of Iquito. Presently Arabela has approximately 75 elderly speakers, and Iquito has approximately 25; the remaining languages of the family are extinct or nearly so. As a member of the Iquito Language Documentation Project (ILDP; Beier and Michael 2006), I carried out the fieldwork on which this paper is based between 2002 and 2008 in the community of San Antonio de Pintuyacu, where 18 of the remaining speakers of Iquito live.

Iquito exhibits nominative-accusative alignment and SVO basic constituent order, although a preverbal focus construction allows for OSV order. Iquito has clearly distinguished classes of verbs, nouns, adjectives, postpositions, and adverbs. Verbal morphology is entirely suffixal. Tense and aspect are obligatorily marked, frequently via tense-aspect or directional-aspect portmanteaus. Nominal morphology is limited to possessive prefixes and optional number suffixes. Adjectives form a medium-sized class with some 60 members, and they agree in number and animacy with the NP-head they modify. Postpositions are a large class with approximately 40 members, and are second-position NP clitics.

3. *Phonological and Prosodic Preliminaries*

In this section I present those aspects of Iquito phonology relevant to the discussion of the Iquito word prosodic system: the phonological inventory of the language; permitted syllable types; prepausal vowel devoicing and glottalization; and minimum word phenomena.

The Iquito phonological inventory is given in Tables 1 and 2, for consonants and vowels, respectively. Symbols that I use in place of IPA symbols are given in angle brackets.

	bilabial	alveolar	palatal	velar	glottal
stop	p	t		k, k^w <kw>	
fricative		s			h
nasal	m	n			
liquid		ɾ <r>			
glide	w		j <y>		

Table 1: Iquito consonants

	front	central	back
high	i, iː <ii>	ɨ, ɨː <ɨɨ>	u, uː <uu>
mid			
low		a, aː <aa>	

Table 2: Iquito vowels

Iquito does not permit syllable codas or complex syllabic nuclei, and the only complex onsets it permits are those in which the second segment is a palatal glide. The inventory of permitted syllables is thus small: C(y)V(:).

We now turn to a discussion of prepausal phenomena that affect word-final vowels. While these processes do not materially affect either the stress or tone systems, their phonetic consequences are quite striking in the spectrograms presented later. Vowels in prepausal – frequently, utterance-final – position experience one of two forms of reduction, depending on length. Prepausal short vowels undergo devoicing, as in (1a), while long vowels are shortened and have a glottal stop appended to them, as in (2a). The prepausal effects are clearly associated with the word-final position, as evidenced in (1b) and (2b), which show that the word-final devoiced vowel and word-final shortened and glottalized vowels in (1a) and (2a) alternate with voiced and long vowels when the same syllables appear in word-medial positions, even when the words in question are in prepausal position.

(1) a. kamɨ [kamɨ̥] 'tayra (mammal sp., *Nasua nasua*)'
b. kamɨka [kamɨkḁ] 'tayras'

(2) a. suu [suʔ] 'coati (mammal sp., *Eira barbara*)'
b. suuwa [suuwḁ] 'coatis'

Both of these prepausal phenomena are clearly postlexical and are realized gradiently, depending on the care with which an individual is speaking. In highly careful speech, for example, final short vowel devoicing can result in virtually complete loss of the vowel, with only the release of the final stop signaling the presence of the deleted vowel. Significantly, neither prepausal process has any effect on the assignment of stress. Note that unless I am specifically discussing prepausal tokens, my phonetic transcriptions of Iquito words represent non-prepausal forms.

Finally, minimum word phenomena in Iquito are relevant because they play a role in the formation of prosodic words out of multiple grammatical words, a process which produces particularly long prosodic words. Prosodic words in Iquito are minimally bimoraic, as in (1a) and (2a). However, there are a number of monomoraic grammatical words, all of which are function words or, in the case of pronominal elements, belong to closed paradigms. These words alternate between two forms: a monomoraic form in cases where they form part of another prosodic word, and a bimoraic form when they constitute their own prosodic word. This alternation is illustrated with the third person non-focal pronoun in (3a&b) and with negation in (4a&b).

(3) a. nu makii [numakiː]
3sg sleep.IMPF
'S/he is sleeping.'

b. nuu [nuː] 's/he, her/him'

(4) a. ka tɨ ʃiipa [katɨʃiːpa]
NEG COP far
'It is not far.'

b. kaa [kaː] 'no'

The alternation between monomoraic bound forms and bimoraic free forms, coupled with the fact that Iquito does not permit monomoraic free forms, lends itself to an analysis of the alternation in terms of a minimum word requirement. In particular, it suggests that monomoraic grammatical words can accommodate the requirement that prosodic words be minimally bimoraic in one of two ways: by cliticizing to an adjacent grammatical word, or, if no such element is available, by undergoing vowel lengthening.

4. *Iquito Stress*

In this section I first describe the stress pattern of Iquito and then discuss methodological aspects of the determination of stress in this language, including the characterization of the acoustic correlates of stress.

For the most part, the Iquito stress system is relatively simple, consisting of right-to-left exhaustively parsed moraic trochees. The language generally does not permit degenerate feet. The language is quantity sensitive, with C(y)Vː syllables counting as heavy (recall that the language does not exhibit closed syllables).

The examination of words consisting exclusively of light syllables, as in (5a-f), demonstrates the basic trochaic pattern, as well as the general absence of degenerate feet. The reader will note an exception to the latter generalization in (5b); I return to this point below. Note that at this stage of the exposition, I suppress tone marks.

(5) a. (ˈLL)
  i. (ˈa.ʃi) ‘bird sp. (*Chloroceryle amazona*)’
  ii. (ˈi.sɨ) ‘lizard spp. (*Gonatodes spp.*)’

b. (ˌL)(ˈLL)
  i. (ˌsa)(ˈtaki) ‘laugh! (imperative)’
  ii. (ˌni)(ˈyiti) ‘female child’

c. (ˌLL)(ˈLL)
  i. (ˌku.ma)(ˈki.ha) ‘*suri* (edible beetle grub)’
  ii. (ˌna.ʃi)(ˈka.ki) ‘snap (it)! (imperative)’

d. L(ˌLL)(ˈLL)
  i. nu(ˌtaki)(ˈnaka) ‘his owls’
  ii. ki(ˌtani)(ˈkura) ‘I wove (a few days ago)’

e. (ˌLL)(ˌLL)(ˈLL)
  i. (ˌkana)(ˌnahu)(ˈkura) ‘we (excl.) wrote (a few days ago)’
  ii. (ˌnuni)(ˌkikɨ)(ˈkɨki) ‘s/he trembled’

f. L(ˌLL)(ˌLL)(ˈLL)
  i. nu(ˌniki)(ˌkɨkɨ)(ˈkura) ‘s/he trembled (a few days ago)’
  ii. ka(ˌnamɨ)(ˌyiki)(ˈkura) ‘we (excl.) returned (a few days ago)’

Turning to words containing heavy syllables, we find that all heavy syllables are stressed in Iquito, and that the stress pattern in such words shows that heavy syllables form their own foot. This indicates that the trochees in the language are moraic, and not syllabic. This is clearest in forms like that in (6a), which demonstrates that the final syllable forms its own foot. Note that if Iquito feet were disyllabic, rather than bimoraic, we would encounter the unattested stress pattern and foot structure given in (6b) instead of the attested (6a), even supposing that quantity sensitivity served to shift the stress to the heavy syllable in the rightmost foot.

(6) a. nu(ˌta.ku)(ˈrɨɨ) 's/he stood up'
b.*(ˌnu.ta)(kuˈrɨɨ)

The fact that Iquito feet are bimoraic rather than disyllabic is also evident in (7a), which shows that both heavy syllables are stressed in a word consisting solely of two heavy syllables; a disyllabic foot structure would produce the unattested (7b).

(7) a.(ˌii)(ˈpɨɨ) 'Red Howler Monkey (*Alouatta seniculus)*'
b. *(ˈii.pɨɨ)

Feet are minimally bimoraic, but trimoraic feet are found in the language, as in (8a&b), due to the process of foot formation. Iquito does not permit gaps in the right-to-left parsing of minimally bimoraic feet, meaning that an unparsed string of syllables whose two rightmost members are $\sigma_{\mu\mu}\sigma_{\mu}$ presents the parsing process with two salient parsing options: parse a degenerate monomoraic foot (i.e. $(\sigma_{\mu\mu})(\sigma_{\mu})$), or parse a trimoraic foot (i.e. $(\sigma_{\mu\mu}\sigma_{\mu})$). The language opts for the latter choice.

(8) a. (ˈsaa.pi) 'stingray'
b. (ˌmɨɨ.sɨ)(ˈyɨ.ka) '*sacha ajos* (plant sp., *Mansoa alliacea*)'

Iquito mainly avoids degenerate feet (i.e. monomoraic feet), but there is a set of systematic exceptions to this generalization, exemplified in (9a-c). The generalization covering these cases is the following: a single light syllable at the left edge of the word is parsed into a degenerate foot in precisely those cases in which doing so results in a dipodic prosodic word. Note, however, that the language does not permit degenerate feet at the right edge of the word, as in the unattested patterns in (9d&e).

(9) a. (ˌL)(ˈLL) (ˌka)(ˈha.ʃi) 'hair'
b. (ˌL)(ˈH) (ˌma)(ˈhuu) '*charichuelo* (tree sp., *Rheedia sp.*)'
c. (ˌL)(ˈHL) (ˌmɨ)(ˈtii.ha) '*taricaya* (turtle sp., *Podocnemis unifilis*)'
d. *(ˌL)(ˈL)
e. *(ˌH)(ˈL), *(ˈH)(ˌL)

The fact that the language permits an otherwise prohibited foot type in these circumstances indicates that this dispreferred foot formation pattern serves to satisfy a competing structural requirement. Furthermore, each instance of degenerate foot formation in (9a-c) conspires to yield the same result – a dipodic prosodic word – suggesting that there is a preference for prosodic words to consist of two feet. This behavior suggests that beyond the bimoraic minimum word requirement described in §3, which is effectively a requirement that a prosodic word contain at least a single well-formed foot, there is a second minimum word requirement: that the prosodic word contain at least a single colon (i.e. two feet). Whereas the language permits moraic augmentation of an underlying form to satisfy the bimoraic minimum word requirement, it does not permit it in order to meet the dipodic minimum word requirement, although it does permit the creation of a degenerate foot. We return to the issue of the role of the colon in the Iquito prosodic system in §5 below.

Having described the Iquito stress system, I now discuss the methodological issues involved in the empirical identification of stressed syllables in Iquito, including the specification of the acoustic correlates of stress. As mentioned in §1, the Iquito word prosodic system is an intriguing combination of a prototypical stress system with an obligatory tone system, in which tone is assigned by default to the position of primary stress. Properly distinguishing the stress and tone systems therefore requires identifying stressed syllables without relying on pitch as the primary acoustic correlate of stress, despite its perceptual salience and despite the fact that pitch peaks frequently coincide with the position of primary stress.

The identification of stressed syllables in Iquito relies on three converging forms of evidence: 1) speaker judgments; 2) acoustic evidence, in the form of consonant lengthening following stressed syllables; and 3) coherence of the description of the metrical system resulting from the first two empirical sources of evidence.

Speaker judgments on stress were elicited through two tapping tasks. In the first task, three speakers were asked to tap the table on the 'strongest' part of a word as they said the word aloud. The speakers were first trained on simple disyllabic forms, and then were asked to tap at the 'strongest' part of words of increasing size. Speakers were consistent about the syllables on which they tapped for a given word – both among speakers and across elicitation sessions. Significantly, the syllables they judged 'strongest' were not always those bearing the pitch peak of the word.

In the second tapping task, speakers were asked to tap the table on any part of the word that they deemed 'strong', not simply the 'strongest' part. As in the case of the previous tapping task, there was consistency among speakers and across sessions. We interpreted the result of the first task as an identification of the position of primary stress, and the result of the second task as identifying any stressed syllable.

The results of these speaker judgment tasks were consistent with an acoustic analysis of the same Iquito words, which indicated that the principal acoustic correlate of stress in Iquito is lengthening of the consonant following the stressed syllable.

I illustrate the lengthening of post-tonic consonants with the forms given in (10). In particular, I focus on the length of the penultimate /t/ in the form *minati* 'pineapple' as it shifts from post-tonic position in (10a&c) to non-post-tonic position in (10b&d), due to suffixation.

(10) a. (ˌmi)(ˈna.ti) 'pineapple'
b. (ˌmina)(ˈtika) 'pineapples'
c. (ˌkimi)(ˈnati) 'my pineapple'
d. ki(ˌmina)(ˈtitɨ) '(it) is my pineapple'

In order to control in part for effects of speech rate, I calculated the ratio of the duration of /t/ to the duration of /a/ in the forms considered. Table 3 provides the durations of the two segments, and in the third column, their ratio. The fourth column provides the corresponding ratio for the post-tonic consonant in precisely those cases in which the /t/ we are examining is not post-tonic.

	duration /t/	duration /a/	t/a	post-tonic C/a
10a	0.490 s	0.066 s	7.42	–
10b	0.207 s	0.075 s	2.76	4.09 /k/
10c	0.499 s	0.088 s	5.67	–
10d	0.112 s	0.075 s	1.49	2.41 /t/

Table 3: /t/ length

The results presented in Table 3 show that the *t/a* ratio is considerably higher post-tonically (7.42 and 5.67) than non-post-tonically (2.76 and 1.49). Additionally, non-post-tonic /t/ is considerably shorter than the post tonic segment (10b: t/C = 0.67; 11d: t/C = 0.62). Post-tonic /t/ is thus lengthened in comparison to non-post-tonic /t/, as can be appreciated in Figures 1 and 2.

Not only do speaker judgments and acoustic analysis yield convergent results; the analysis stemming from the results for stress in particular forms also yields a coherent metrical system. In sum, the metrical system is relatively unremarkable, with the exception of degenerate foot formation under circumstances that suggest that this process is responsive to a preference for prosodic words to satisfy a dipodic minimum word condition.

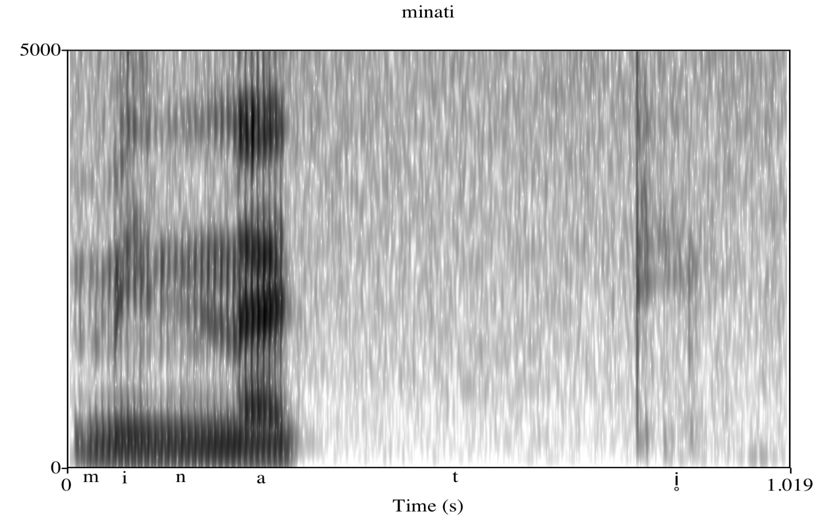

Figure 1: *minati* 'pineapple'

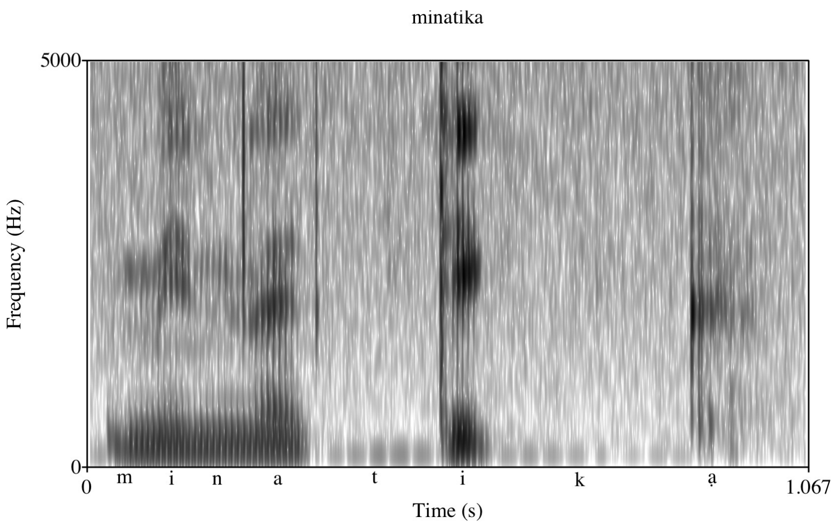

Figure 2: *minatika* 'pineapples'

5. *Iquito Tone*

Having established the basic stress pattern of Iquito, I now turn to the Iquito tonal system. Iquito exhibits a H/ø privative tone system in which the tone bearing unit is the mora. Moras are thus either specified as bearing a high tone, or are unspecified for tone. Most moras are in fact unspecified for tone, and the pitch contour of a word is interpolated from a relatively low pitch at the left edge of the word, from which it rises to the word's pitch peak (or peaks), and then drops abruptly following the pitch peak.

All prosodic words in Iquito exhibit at least a single high tone, and if a given prosodic word lacks lexically specified high tones (a common occurrence), a high tone is assigned to the syllable bearing primary stress. In this way, the tonal system is partially dependent on the stress system of the language for meeting an obligatory tone requirement. We now examine the tonal system, and its interaction with the stress system, in greater detail.

The presence of contrastive tone in Iquito is evidenced by tonal minimal pairs, as in (11a&b). The spectrograms in Figures 3 and 4 demonstrate the different positions of the pitch peaks in each word, while showing that primary stress, indicated by the lengthening of the penultimate stop /k/, is penultimate in both cases.

(11) a. máˈʃiku 'raft'
b. maˈʃíku '*paucar* (bird spp., *Icteridae* spp.)'

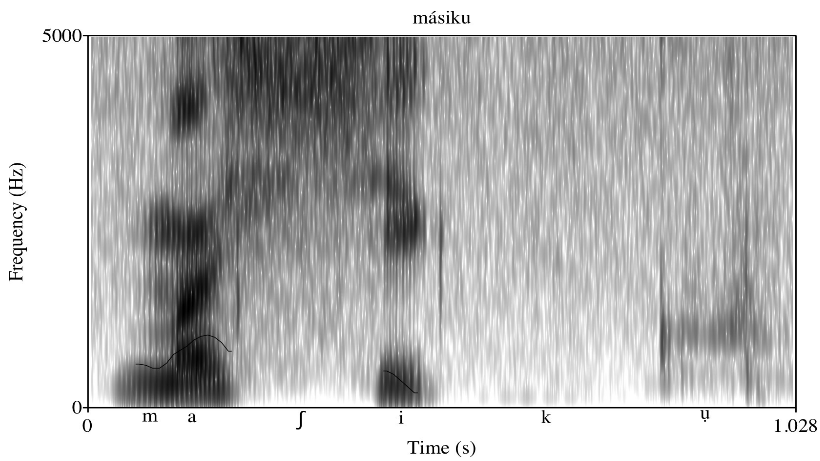

Figure 3: máʃiku 'raft'

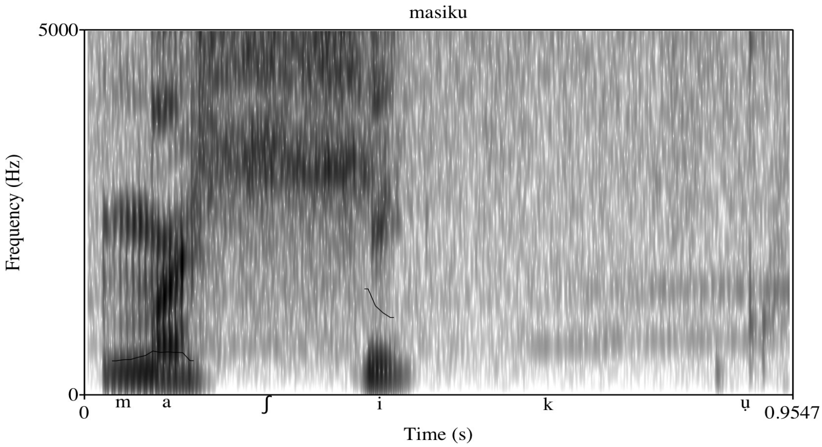

Figure 4: maʃiku '*paucar*'

Short vowels can be the locus of pitch peaks, but there is no evidence of tonal contrast due to tonal contours on short vowels. In the case of tone-bearing long vowels, however, the pitch peak of a word may be located on either the first or the second mora of the vowel (depending on the word), resulting in contrastive pitch contours on these vowels. One such contrast is evident in the tonal minimal pair in (12); the difference in the tonal contours is evident in Figures 5 and 6. These facts indicate that the mora is the tone bearing unit, and that the rising and falling pitch contours found on Iquito long vowels are due to the more general process of pitch interpolation from word edges to pitch peaks, which is discussed below.

(12) a. ˈtúuku 'tumpline' b. ˈtuúku 'ear'

It is useful to distinguish two kinds of tones in Iquito: *lexical tones* and *metrical tones.* Lexical tones are insensitive to metrical structure and to the presence of other lexical tones, while metrical tones are both sensitive to the metrical structure of words and affected by the presence of lexical tones in the word. I will argue that, as the names suggest, lexical tones are associated with specific moras in a morpheme as part of the morpheme's lexical entry, while metrical tones are not, but rather are assigned to the syllable bearing primary stress in precisely those cases in which the prosodic word contains no lexical tones.

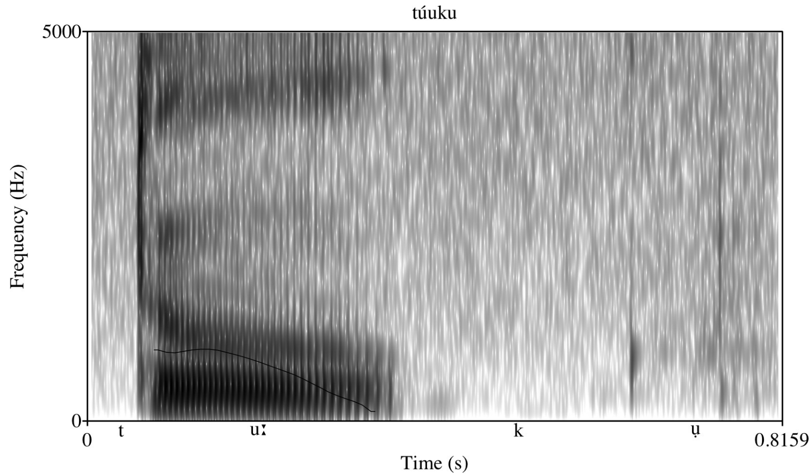

Figure 5: *túuku* 'tumpline'

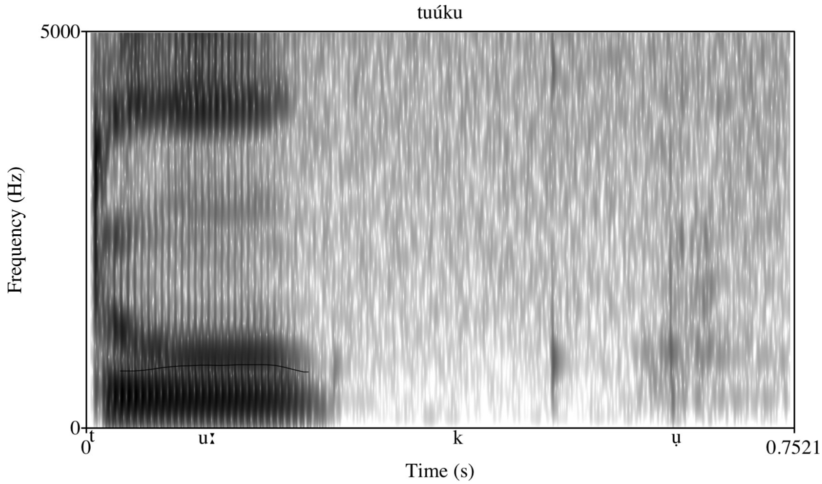

Figure 6: *tuúku* 'ear'

The differing sensitivity of Iquito lexical and metrical tones to metrical structure is exemplified in (13). First consider (12a&b), a tonal minimal pair with identical stress patterns. The plural counterparts to these forms are given in (13a&b), augmented with the plural suffix *-ya*. Note that for both forms in (13), primary stress has shifted to the light penultimate syllable, in accord with the stress pattern described in §4, but that while the tone in (13a) remains on the same syllable as in (12a), the tone in (13b) has shifted rightwards from the syllable on which it appeared in

(12b), with the effect that it continues to coincide with the syllable bearing primary stress.

(13) a. ˌtúuˈkuya 'tumplines' b. ˌtuuˈkúya 'ears'

The mobility of metrical tones and their robust association with primary stress is exemplified in (14a-d), demonstrating the progressive rightward movement of the metrical tone in the given forms as morphology is added.

(14) a. ˌ*mɨˈyíti* 'shelter'
b. ˌ*mɨyiˈtíka* 'shelters'
c. ˌ*mɨyiˌtikaˈhína* 'in shelters'
d. *mɨˌyitiˌkahiˈnáhi* 'from inside shelters'

Lexical and metrical tones are also distinguished by their behavior in the presence of lexical tone-bearing morphemes. Specifically, lexical tones are unaffected by the addition of other lexical tone-bearing morphemes, while metrical tones are eliminated by the addition of such morphemes. Consider, for example, how the lexical tone in (12a) and the metrical tone in (12b) differ in how they respond to the addition of the lexical tone-bearing first person possessive prefix *kí-*, illustrated in (15). The lexical tone in (12a) is unaffected by the addition of the tone-bearing prefix in (15a), while the metrical tone in (12b) is eliminated upon the addition of the prefix in (15b). In addition to being sensitive to metrical structure, then, metrical tones do not co-occur with lexical tones in a given prosodic word (this generalization is qualified below).

(15) a. kíˈtúuku 'my tumpline' b. kíˈtuuku 'my ear'

When metrical tone is assigned to syllables with long vowels, it is always assigned to the second mora of the vowel, as in (12b). Lexical tones may appear on either the first or the second mora of long vowels, so that lexical tones on heavy syllables may either be rising, as in (16a), or falling, as in (17a). The forms in (16b) and (17b) confirm that these tones are lexical.

(16) a. iímina 'dugout' b. iíminaka 'dugouts'

(17) a. níiki 'bone' b. níikiwa 'bones'

Most Iquito morphemes do not bear lexical tone, and among those that do, most only bear a single lexical tone. A very small number of long lexical roots carry two lexical tones, e.g. *hámanakɨɨ́* 'choke'.

Having distinguished lexical tones from metrical tones, I now describe the interaction of tone and stress in Iquito. It is useful to begin by considering the number of tones Iquito prosodic words may carry, and in particular, the number of lexical and metrical tones.

All Iquito prosodic words carry at least one tone,[i] with the total number of tones depending on the number of lexical tones in the word. If a prosodic word contains one or more lexical tones, then all lexical tones appear in the surface form, as in (18a), which bears three lexical tones. In such cases, no metrical tone is assigned to the word, as evident from the fact that adding morphology to the word, as in (18b), does not result in shifts in the positions of any tones in the word, despite a change in the position of primary stress. Moreover, it will be noted that no metrical tone is assigned to the syllable bearing primary stress in (18b).

(18) a. ˌkínáˌhuuˈtɨɨ́
kí= náhuu -tɨɨ́ -ø
1S= write -CAUS -PERF
'I made (someone) write .'

b. ˌkínáˌhuuˌtɨɨ́ˈkura
kí= náhu -tɨɨ́ -ø -kura
1S= write -CAUS -PERF -REC.PST
'I made (someone) write (a few days ago).'

If a word contains no lexical tones, however, a single metrical tone appears on the syllable bearing the primary stress in the word, as in (13b) and (14a-d) above. Metrical tones are thus assigned to words that are otherwise toneless, and they are eliminated when morphemes bearing lexical tones are added. Given that all Iquito prosodic words bear at least one tone, we can understand the assignment of metrical tones as a means for Iquito prosodic words to meet a requirement that they bear at least one tone – an obligatory tone requirement.

The interaction between stress and tone in Iquito is thus grounded in the role of primary stress in identifying a default position for a required high tone in those words that do not carry any lexical high tones. The fact that many Iquito words fall into this category contributes to the difficulty in distinguishing tone from stress in the analysis of Iquito prosody.

One final aspect of the tone system remains to be described: an unexpected effect of word size on the interaction of lexical and metrical tone. Evidence was presented above that lexical tones and metrical tones do not coexist in Iquito prosodic words and that the presence of lexical tones eliminates metrical tone in a prosodic word. As it turns out, however, there are systematic exceptions to this generalization involving lexical tones that are located sufficiently far from the right edge of the word. Briefly, if all the lexical tones in a word are located to the left of the rightmost colon (i.e. the two rightmost feet), then a metrical tone is assigned to the position of primary stress, in accord with the principles outlined above.

This phenomenon is illustrated by the forms based on *pirusu* 'electric eel', given in (19a). The metrical nature of the tone in (19a) is illustrated by the movement of the tone under suffixation in (19b), and the elimination of the tone under addition of a lexical tone in (19c). The key pair of forms that illustrates the role of the position of lexical pitch relative to the rightmost colon is (19c&d), pitch tracks for which are given in Figures 7 and 8, respectively. In (19c), the lexical tone occurs within the rightmost colon, and no lexical tone is assigned to the syllable bearing primary stress. In (19d), however, the lexical tone appears to the left of the rightmost colon, and we see that a metrical tone is assigned to the penultimate syllable, which bears primary stress; (19e) demonstrates that the rightmost tone in (19d) is metrical, as it shifts under the addition of further morphology.

(19) a. (ˌpi)(ˈrú.su) 'electric eel'
b. (ˌpi.ru)(ˈsú.ka) 'electric eels'
c. (ˌkí.pi)(ˈru.su) 'my electric eel'
d. kí(ˌpi.ru)(ˈsú.ka) 'my electric eels'
e. kí(ˌpi.ru)(ˌsu.ka)(ˈhá.ta) 'with my electric eels'

We see, then, that the colon is an important constituent in the Iquito prosodic system in two ways: as a target prosodic word size (as discussed in §4); and as the domain in which lexical tone and metrical tone are incompatible. The latter phenomenon indicates that the obligatory tone requirement should be rephrased to require a tone in the rightmost colon of the word.

In closing this discussion of Iquito tone, I wish to discuss the process of pitch interpolation that produces the pitch contours of Iquito words. A key part of the analysis presented here is that only the pitch peaks of a word (i.e. its high tones) need be specified; the remainder of the pitch contour arises from interpolation between the high tones and pitches at the edges of the prosodic word. In forms with a single high tone in word-medial position, such as *ˌnumáˈʃiku* 'his *paucar*', the pitch rises relatively gradually from the left edge of the word to the the pitch peak, after which it falls quite rapidly, as shown in Figure 9. A similar gradual rise is evident in forms like *tuúku* 'ear', as shown in Figure 6.

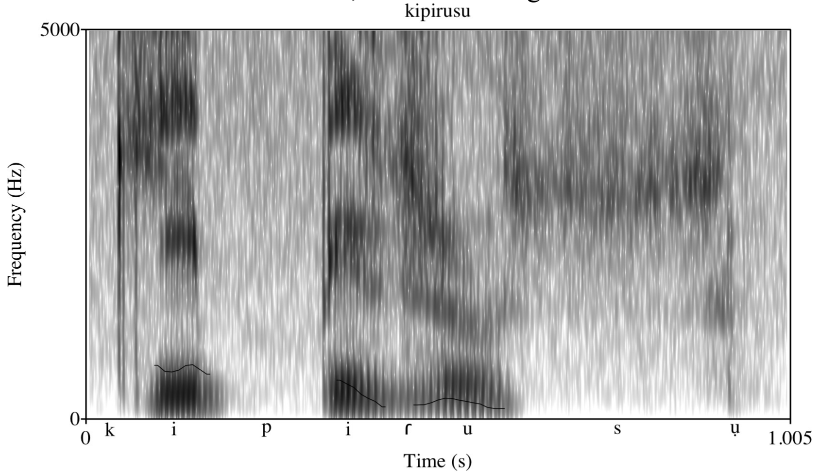

Figure 7: *kípirusu* 'my electric eel'

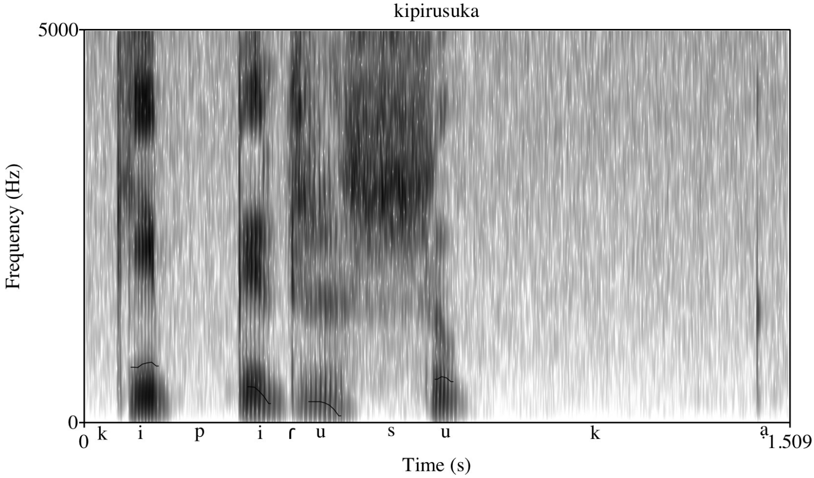

Figure 8: *kípirusúka* 'my electric eels'

Words with a high pitch at the left edge of the word exhibit a gradual drop in pitch across the word, as evident in the form ˌ*kípi*ˈ*rusu* 'my electric eel', as shown in Figure 7. Similarly a word with a high pitch toward the right edge of the word, such as ˌ*matu*ˈ*kátɨ* '(they) are *gamitanas* (fish sp., *Colossoma macropomum*)', shows a gradual rise to the pitch peak, as shown in Figure 10.

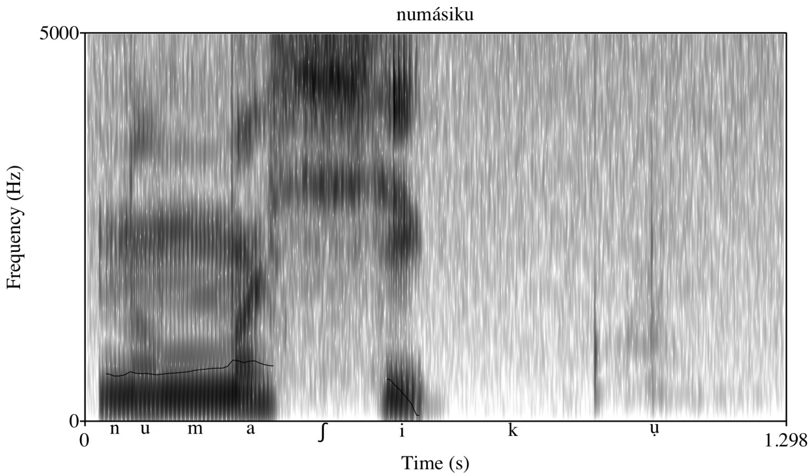

Figure 9: *numáʃiku* 'his *paucar*'

Words with multiple high tones show similar behavior, except that pitch drops from one pitch peak before rising to meet the next one. This basic behavior is exhibited by the form *kíminatikátɨ* '(they) are my pineapples', as shown in Figure 11. Pitch falls from the leftmost high tone (*kí*) across two syllables (*mina*), before rising on (*tɨ*) in anticipation of the peak (*ká*). The form *kípirusúka* 'my electric eels' exhibits similar behavior, as shown in Figure 8.

In summary, most words tend to have a small number of high tones, with most syllables being unspecified for tone. Pitch on those syllables is determined by a process of interpolation, whereby pitch rises from the left edge of the word to the first high tone, and drops from the last high tone towards the right edge of the word. If a word has multiple high tones, pitch will tend to drop and then rise again between high tones.

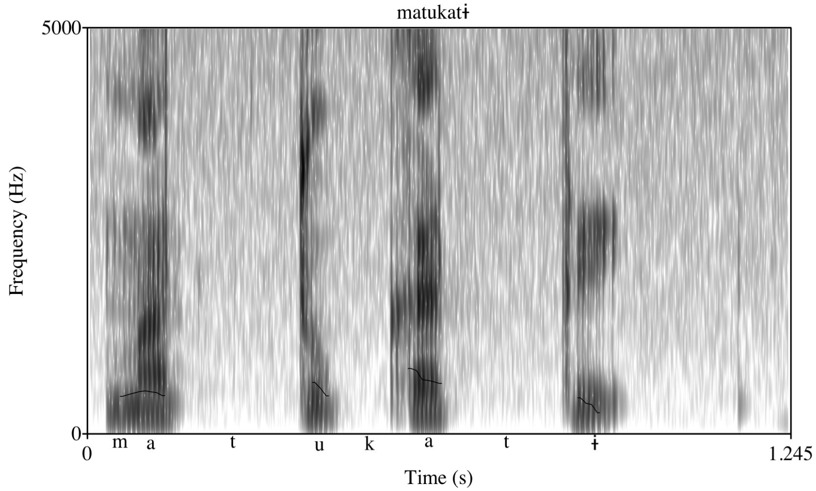

Figure 10: *matukatɨ* '(they) are *gamitana*'

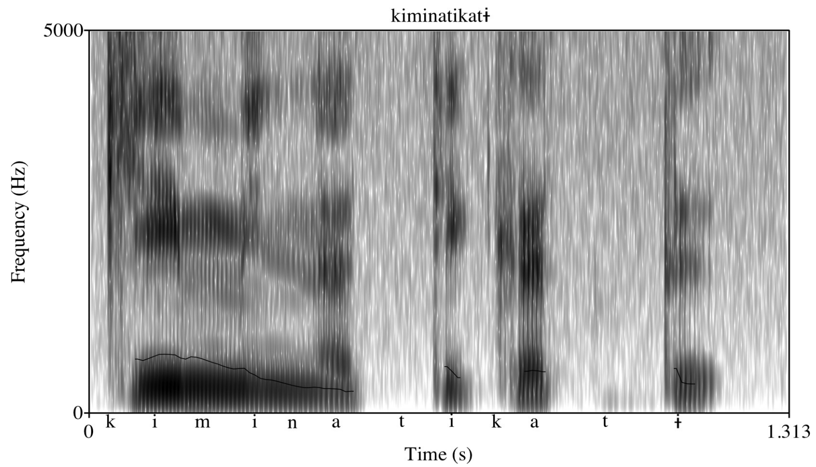

Figure 11: *kíminatikátɨ* '(they) are my pineapples'

6. *Previous analyses of the Iquito prosodic system*

In this section I compare the analysis presented here with previous analyses of tone and stress in Iquito. The earliest work on the Iquito prosodic system was carried out by Robert and Elizabeth Eastman, SIL missionaries who worked in the community of San Antonio de Pintuyacu between 1957 and 1961. Their analysis of the Iquito prosodic system is quite different from the one presented here, but there is considerable convergence regarding the basic empirical facts regarding pitch.

Eastman and Eastman (1963) posits a privative H/ø tone system but no stress system. Perhaps the most striking difference between the tonal representations given in that work and those given in this chapter is the considerable number of adjacent high tones that appear in many forms given by Eastman and Eastman, as in (20a) and (21a). For each of these examples, I posit a single high tone, as in (20b) and (21b). This discrepancy is mainly due to the fact that I analyze only pitch *peaks* as corresponding to high tones, with pitch interpolated between peaks and word margins, as discussed in the previous section. Eastman and Eastman (1963), on the other hand, appears to mark *all* syllables with relatively high pitch as bearing high tone, including ones which, under the analysis presented here, are not tone-bearing *per se*, but across which tone rises towards a peak, or falls from one. In other words, the representations in Eastman and Eastman (1963) more closely resemble phonetic representations of the pitch contours of given forms than those given in this paper.

(20) a. ʃináákɨ́ (Eastman and Eastman (1963): p. 167)
b. ʃinaákɨ 'clothing'

(21) a. úúmáána (Eastman and Eastman (1963): p. 188)
b. umáana 'large'

One consequence of the Eastman and Eastman (1963) representations is that there is no way to directly distinguish contrastive rising and falling pitch over long vowels (as in (20b) and (21b)). In most cases, however, this contrast can be recovered from their examples, based on whether high tones are marked prior to the peak (which is the only tone that I mark in my representations), in the case of falling tones, as in (21b); or whether they mark high tones after the peak, in the case of rising tones, as in (20a). With few exceptions, then, it is possible to systematically translate the representations in Eastman and Eastman (1963) to my representations. This convergence between results obtained almost 50 years apart suggests that the basic empirical facts given in each body of work with respect to tone is essentially correct.

The major analytical point of divergence between the two approaches lies in the fact that Eastman and Eastman (1963) does not posit that Iquito exhibits a stress system, which, among other consequences, means that their work does not address the tendency for high tones to appear on the penultimate syllable.

The analysis that I have presented in this paper was developed in part in a series of ILDP-internal research reports, including Michael (2004) and Rauschuber (2005a,b). An alternative account was presented by another ILDP participant in Sullón (2005). That analysis was based on the premise that the highest pitch peak in the word always corresponds to primary stress, and that any other perceptually prominent syllable bears secondary stress. The combination of the fact that pitch peaks and primary stress need not in fact coincide, and the empirical difficulties resulting from subjective judgments of prominence led Sullón to develop an analysis with numerous classes of special cases, plus the need to posit low tones to account for pitch contour contrasts on long vowels. Despite unresolved difficulties with Sullón's (2005) analysis, it was influential in highlighting the need to move beyond subjective judgments of prominence.

7. *Discussion and Conclusion*

In his deconstruction of the typological category of pitch-accent systems, Hyman (2009) notes that the literature on such systems converges on the following set of definitional characteristics:

1. Obligatoriness (at least one tone per word)
2. Culminativity (at most one tone per word)
3. Privativity (H/ø vs. e.g. H/L)
4. Metricality (position of tones restricted by metrical structure)

Hyman (2009) ultimately goes on to identify each of these properties in systems that are normally considered tonal, and argues that these properties are therefore not diagnostic of pitch-accent systems. Nevertheless, it is useful to consider the Iquito prosodic system in relation to the set of features invoked in discussions of pitch-accent systems. We see that the Iquito tonal system exhibits some of these characteristics (obligatoriness and privativity) often attributed to pitch-accent systems, but exhibits others partially or not at all. In particular, Iquito tone is not culminative, since multiple lexical tones may surface in a word. If we were to restrict our attention to metrical tone, of course, it would be possible to argue that Iquito tone is culminative, but this would come at the cost of obligatoriness (recall that metrical tones do not appear in words containing lexical tones). With regard to the criterion of metricality, the distribution of Iquito tone is partially dependent on metrical structure, in that when lexical tones are absent from the rightmost colon of a word, metrical tone is assigned to the syllable bearing primary stress. However, lexical tones are not restricted by metrical structure, arguably making the Iquito system only partially 'metrical' in terms of the above criterion.

Although Hyman's (2009) critique of 'pitch-accent' as a word-prosodic typological category might render the following conclusion unsurprising, it is clear that the Iquito word-prosodic system does not fit even the dubious set of definitional criteria given above. Despite the important role of the stress system of the language in meeting the obligatory tone requirement via the assignment of metrical tone, the tonal system is non-culminative, tilting the Iquito prosodic system towards a low-density tone system.

In summary, Iquito exhibits both a low-density tonal system and a stress system, each of which can be identified by means of distinct acoustic correlates: pitch vs. post-tonic consonant lengthening. However, these two systems interact in satisfying the obligatory tonal condition that all Iquito prosodic words exhibit at least one high tone. In a sense, then, the stress system can be seen as supplementing the low-density tone system when Iquito words fail to satisfy tonal well-formedness criteria.

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i Prosodic words in Iquito are defined as the domain for stress and tone assignment and as the unit which must satisfy the bimoraic minimum word requirement.