Tone, stress, and their interactions in Cushillococha Ticuna

Abstract:

Ticuna (ISO: tca; Peru, Colombia, Brazil) displays a larger tone inventory -- five level tones -- and greater tone density than any other Indigenous American language outside Oto-Manguean. Based on recent fieldwork, this article argues that, in addition to these tone properties, the Cushillococha variety of Ticuna also displays stress. Stress licenses additional tonal and segmental contrasts; conditions many phonological processes; and plays a central role in grammatical tone processes marking clause type. Empirically, these findings expand our understanding of word prosody in Amazonian languages. Theoretically, they challenge current models of stress-conditioned phonology and of grammatical tone.

Keywords: Tone; Stress; Stress-Conditioned Phonology; Amazonian Languages

Word Count (includes tables and examples; excludes abstract and references): 14,432
1. Introduction

The purpose of this paper is to describe and analyze the word-prosodic system of Ticuna – a language isolate spoken in the northwestern Amazon Basin – through data gathered in recent fieldwork in Cushillococha, Peru. The study makes two primary contributions.

First, I provide evidence that the Cushillococha variety of Ticuna displays five underlying level tones, with eight surface tones (including contours) on monosyllables. My analysis of the tone inventory supports previous analyses by L. Anderson (1959) and D. Anderson (1962), and opposes Montes Rodriguez’ (1995, 2004) argument for only three level tones. This finding is typologically consequential because it establishes Ticuna as the only American language, outside the Oto-Manguean family, to display more than three underlying tones (Hyman 2010).

Second, I argue that in addition to tone, the Cushillococha variety of Ticuna also displays fixed stem-initial stress. Stress affects almost every aspect of this variety’s phonology, including segmental and tonal contrast licensing; segmental and tonal phonological processes; and grammatical tone. With this close relationship between tone and stress, the prosodic system of Cushillococha Ticuna strongly resembles the prosodic systems of other languages with large tone inventories (such as Oto-Manguean and Tai-Kadai languages). As such, data from Ticuna offers a new, genetically unrelated testing ground for prosodic theories developed to account for tone-stress interactions in other language families.

The body of this paper is organized as follows. §2 provides background information about the Ticuna language and people, as well as the fieldwork conducted for this study. §3 describes the phonological inventory of Cushillococha Ticuna, including the inventory of tones. Next, I turn to stress. In §4, I argue that the language displays fixed, stem-initial stress realized acoustically as increased vowel duration. Over the following three sections, I then show that stress licenses additional tone and segmental alternations (§5); triggers tonal (§6) and segmental (§7) phonological processes; and conditions the outcome of grammatical tone alternations (§8). In §9 I discuss theoretical implications of the findings, and in §10 I conclude.

2. Language background

2.1. Classification and dialectology

Ticuna is an Indigenous language isolate spoken in ~160 villages and towns located along the Amazon River in northeastern Peru, southern Colombia, and western Brazil. Estimates of speaker numbers range from 38,000 (Lewis et al. 2014) to 70,000 (ISA 2017). The language continues to be acquired robustly by children in Peru and Brazil, but is not learned by children in most communities in Colombia (Santos Angarita 2005).

Based on segmental sound changes, varieties of Ticuna can be divided into three groups: eastern, western, and inland (Santos Angarita 2005; Montes Rodriguez 2005). Eastern and western varieties are spoken on the main course of the Amazon River – western ones predominantly in Peru, and eastern ones in Brazil. Based on my own observations of
communication between speakers of eastern and western varieties, these two groups are completely mutually intelligible. Inland varieties of Ticuna, in contrast, are spoken in the interfluvial area between the Amazon and Putumayo rivers, which is located entirely in Colombia. Santos Angarita (2005: 10, 27), who is both a linguist and a native speaker of Ticuna from an eastern dialect area, suggests that inland varieties are not completely mutually intelligible with the eastern and western groups.

Among previous analyses of Ticuna prosody, Montes Rodriguez (1995) examines an inland variety, Soares (2000) describes an eastern variety, and Santos Angarita (2005) compares varieties from several groups spoken within the national territory of Colombia. L. Anderson (1959) and D. Anderson (1962), two SIL missionaries, analyze the variety spoken in the 1950s in Cushillococha, Peru. I also conduct fieldwork in Cushillococha and analyze data from this same variety, as I discuss in the following sections.

2.2. Fieldwork and participants

I collected the data in this paper over approximately 13 months of fieldwork in the area of Cushillococha, Peru between 2015 and 2019. Cushillococha is a land-titled Indigenous community with ~5,000 residents, almost all of whom are Ticuna and speak Ticuna as their first and dominant language. As mentioned above, the variety of Ticuna spoken in Cushillococha belongs to the western dialect group (Santos Angarita 2005: 10).

During fieldwork, I collected phonological data on tone and stress with 14 speakers, aged 18 to ~75 years, who were born in Cushillococha or nearby. Most examples in this paper come from interviews with two people, Deoclesio Guerrero Gomez (DGG) and Lilia Witancort Guerrero (LWG). A smaller number of examples are from interviews with two other speakers, Ling Cándido Serra (LCS) and Katia Lucero Salate Cándido (KSC). DGG and LCS are male, while LWG and KSC are female. DGG was aged in his early seventies at the time of research, LCS and LWG were in their late thirties, and KSC was in her late teens.

All of the interviewees were sequential Ticuna-Spanish bilinguals and very fluent in Spanish. They spoke both languages regularly, but all reported speaking Ticuna more often. KSC had received her entire education up to age 12 in Ticuna-medium classrooms; all other interviewees had taught in Ticuna-medium classrooms and worked as interpreters or translators. They therefore possessed high Ticuna literacy and metalinguistic awareness.

I did not observe significant differences between the interviewees, or between the interviewees and the other 10 speakers who participated in data collection, in any of the prosodic phenomena described here. I did observe variation between participants in the distribution of nasality, which is discussed in §3.4.

In the following text, I refer to the study language interchangeably as ‘Ticuna’ and ‘Cushillococha Ticuna.’ Regardless of which term I use, I intend all claims in this paper only for the variety of Ticuna spoken in contemporary Cushillococha. Descriptions of other varieties of the language report somewhat different prosodic systems (Montes Rodriguez 1995, Soares 2000, Santos Angarita 2005).
2.3. Recording methods

I collected data with the consultants via elicitation sessions in their homes, using both Spanish and Ticuna as contact languages. Items cited in this paper were recorded in carrier sentences where the target item was immediately followed by the quotative verb *pa’a*, e.g., *ni³ma² ri¹ X pa’a²ʔi¹ ‘they (sg.) said X’ or *tfo’mi¹ ri¹ X pa’ta³gi¹ri¹ ‘I said X.’ Some items, which are not used to illustrate minimal tone differences, were recorded in isolation. Recordings were made with a Zoom H4N recorder sampling at 44.1kHz, generally connected to a Shure SM10A head-mounted microphone.

Apart from elicitation, I have also collected a corpus of ~116,000 words of connected speech in Ticuna representing ~150 total speakers. This corpus, described in (Redacted for anonymous review), consists mostly of recordings of informal conversation and child-caregiver interaction. Like the elicited phonological data, the corpus reflects significant inter-speaker variation in the distribution of nasality. However, it conforms to the generalizations presented here about word prosody.

3. Phonological inventory

3.1. Segmental inventory

Ticuna displays 16 phonemic consonants and 6 phonemic vowel qualities. The 16 consonants are shown in Table 1.

<table>
<thead>
<tr>
<th>Manner</th>
<th>Labial</th>
<th>Alveolar</th>
<th>Velar</th>
<th>Palatal</th>
<th>Glottal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voiceless Stop/Affricate</td>
<td>p</td>
<td>t</td>
<td>k</td>
<td>ṭ</td>
<td>?</td>
</tr>
<tr>
<td>Voiced Stop</td>
<td>b</td>
<td>d</td>
<td>g</td>
<td>j</td>
<td></td>
</tr>
<tr>
<td>Nasal</td>
<td>m</td>
<td>n</td>
<td>η</td>
<td>η</td>
<td></td>
</tr>
<tr>
<td>Fricative</td>
<td>φ</td>
<td></td>
<td></td>
<td></td>
<td>w</td>
</tr>
<tr>
<td>Approximant</td>
<td></td>
<td>r</td>
<td></td>
<td></td>
<td>w</td>
</tr>
</tbody>
</table>

The phones represented in Table 1 as /φ/ and /η/ are subject to changes in progress, both of which have also been observed in other varieties of the language.

The phone shown in Table 1 as /φ/ has recently undergone a change in manner. It is described as a labialized velar stop [kʷ] in sources from the 1950s, such as L. Anderson (1959) and D. Anderson (1962). Cushillococha speakers born before about 1960, including DGG, still usually produce the phone as [kʷ]. However, as of 2019 the majority of Cushillococha people, including LWG and KSC, produced this phone in all environments as a fricative or approximant [φ, w] rather than a stop. I therefore represent it as /φ/. This change is also observed in other eastern and western varieties (Santos Angarita 2005: 89).

Additionally, the phone shown in Table 1 as /η/ is undergoing a split. In the speech of people born in Cushillococha before about 1980, /η/ occurs before both oral and nasal vowels and is realized as [ŋ] in both environments (see §3.4 on vowel nasality). As a result, minimal pairs
such as [ŋ̃o] 'eat, bite' and [ŋ̃o] ‘appear’ contrast only in the nasality of the vowel. By contrast, most Cushillococha people born after about 1980 produce this segment as [ŋ] before nasal vowels and an approximant [Â] before oral vowels. For them, [ŋ̃o] ‘eat, bite’ and [Âo] ‘appear’ contrast in both the manner of the initial segment and the quality of the vowel.¹

Among the primary consultants for this study, DGG and LCS produced the segment undergoing the split as [ŋ] in all environments. LWG occasionally produced forms reflecting the split, but more often produced the segment as [ŋ] in all environments. KSC always produced forms reflecting the split. Since the majority of consultants do not have the split, I represent the phone as /ŋ/ throughout. This transcription is not intended as a claim about the representation of this phone by speakers who do have the split.

Turning to vowels, the six monophthongal vowel phonemes are the five cardinal vowels /i u e o a/ and a high central unrounded vowel /ɨ/. In addition to the monophthongal vowels, there are two rising diphthongs, /au/ and /ai/, which behave identically to monophthongs with respect to most phonological processes. I justify the treatment of /au/ and /ai/ as diphthongs in my discussion of the syllable template (§3.5).

3.2. Tonal inventory

3.2.1. Level and contour tones and their distribution

Cushillococha Ticuna displays a total of 7 tones (levels and contours) which can appear on monosyllabic words. An additional tone only appears on disyllabic and larger words, giving a total of 8 contrastive tone melodies. In describing the tone inventory, I assume that the TBU is the syllable; this claim is justified in §8.3.

I represent the tones using numbers 1-5, where 5 represents the highest tone. Under this scheme, the 7 tones possible on monosyllabic words are level tones 1, 2, 3, and 4, and contour tones 31, 43, and 51. (1) shows the seven lexical tone contrasts on monosyllabic words with the nucleus /u/.²

(1)
a. 1: mu¹ 'eat (fruit)'
b. 2: mu² 'send'
c. 3: mu³ 'weave'
d. 4: mu⁴ 'be many'
e. 31: mu⁵¹ 'pierce with pointed weapon'

¹ Other varieties of Ticuna also have splits in *ŋ conditioned by the nasality of the following vowel, but in all other described varieties with splits, the reflex of *ŋ before oral vowels is [ŋʰ], [g], [h], or zero, rather than an approximant (Santos 2005: 78-79; Montes Rodríguez 2005: 109).
² Transcription in (1) and all subsequent examples uses IPA, except that <r> represents the tap. Nasality is transcribed as described in §3.4.

Audio clips of each word in examples (labeled with the example number, example letter if applicable, and English gloss) appear in the Supplementary Materials. All audio clips are from recordings publicly available in [archive name redacted for anonymous review]. Please consult the text documents in the Supplementary Materials for archival citations for each example.
(2) shows six of the contrasts on monosyllabic words with the nucleus /a/. There is no example of tone 51 in (2) because there are no monosyllabic words of the form /C)a⁵¹/ (tone 51 is very infrequent in the lexicon).

(2)
   a. 1: pa¹ 'hug'
   b. 1 (modal voice): pa¹ 'be tired'
   c. 2: a² 'mosquito'
   d. 3: a³ 'give (inanimate singular object)'
   e. 4: pa⁴ 'be a young adult'
   f. 31: a³¹ 'be thin'
   g. 43: pa⁴³ 'be dry'

Beyond the 7 tones found on monosyllables, there is an additional tone – tone 5 – which has a restricted distribution. This superhigh tone does not appear on monosyllabic words like those in (1) and (2). However, tone 5 does appear in words of two or more syllables, as shown by the minimal pair of lexical words in (3) and minimal pair of function words in (4).

(3)
   a. 43.2: de⁴³ʔa² 'talk (v., n.)'
   b. 43.5: de⁴³ʔa⁵ 'water'

(4)
   a. 5.2: nu⁵a² 'here, allative case'
   b. 2.2: nu⁴a² 'here, locative case'

Even in disyllabic and larger words, like those in (3) and (4), tone 5 is still subject to some restrictions on its distribution. Tone 5 can appear on any syllable of a noun or adverbial root, such as (3b) and (4a), and on any syllable of a suffix or enclitic which attaches to nouns (or adverbs or interjections).

Tone 5 can also appear on non-final syllables of verb roots, such as (3a). However, tone 5 never appears on the final syllable of a verb root, or on the final syllable of any suffix or enclitic which can attach to verb roots. This morpheme structure constraint means that tone 5 never appears on the final syllable of a verbal word, a fact with implications for the language’s most important grammatical tone process (§8).

3.2.2. Phonetic content of the tones

Auditorily, the tones that I label as ‘level’ – tones 1, 2, 3, 4, and 5 – vary between level tones at superlow, low, mid, high, and superhigh pitch, and rising tones which begin at a superlow, low, mid, high, or superhigh pitch and display a slight rise. Thus tone 1 could be equally well described as 11 or 12, tone 2 as 22 or 23, and so on, and it would be as accurate to call these
tones ‘rising’ as to call them ‘level.’ In contrast to the level/rising tones, the ‘contour’ tones 31, 43, and 51 are always phonetically falling.

Acoustically, Figure 1 shows F0 vs. normalized time for of each of the four level tones which can occur on monosyllables (i.e., not tone 5). The left panel of Figure 1 shows data from DGG (male) and the right panel shows data from LWG (female). For each speaker, between three and six tokens of each word in (2) were analyzed. For each token, F0 was measured at nine equally spaced intervals from 0% to 90% of the duration of the vowel. F0 at each timepoint was then averaged across the tokens. Tone 1 vowels with creaky voice, in words such as (2a), were not analyzed because their creaky phonation prevented reliable measurement of F0.

Figure 1. F0 vs. normalized time for ‘level’ tones on monosyllabic words with the vowel /a/.

Figure 2 shows F0 vs. normalized time for each of the three contour tones. Figure 2 was constructed in the same way as Figure 1, using tokens of the two words in (2f,g) for tones 31 and 43, and tokens of the word tu⁵¹ ‘pull’ (1g) for tone 51. It was necessary to use a word with the vowel /u/ to exemplify tone 51 because there are no monosyllabic words with the vowel /a/ and this tone. DGG did not have complete data for tone 31 because he only produced one usable token of the word in (2f).
3.2.3. Distribution of tones in non-monosyllabic words

All of the examples so far, as well as the data for Figure 1 and Figure 2, have come from monosyllabic words. However, tone contrasts are mostly maintained in larger words.

To investigate the maintenance of tone contrasts in disyllabic and larger words, I constructed a lexical database of 378 nominal and verbal roots. This database consisted of all roots listed in the wordlist of D. Anderson (1962) which contemporary speakers recognized, and 157 additional roots that I had elicited in lexical elicitation interviews or recorded in texts. It included loanwords, but excluded morphologically complex stems, as well as inalienable nouns (which are not prosodically independent words). DGG, LCS, and KSC then recorded all of the lexical items in the database in tone frames.

The lexical database is a convenience sample and by no means represents the entire root lexicon of the language. Despite this incompleteness, the database clearly shows that tone contrasts are maintained in disyllabic and larger roots. In the 378 items, 22 of the 25 possible tone melodies involving only level tones are attested. Table 2 shows example disyllabic roots with all of the attested melodies involving only level tones. Known loanwords are excluded.
As described in further detail in §5.2, the contour tones 31, 43, and 51 occur only on the first syllable of roots. 11 of the 15 possible disyllabic tone melodies with a contour on the first syllable are attested, as shown in Table 3. In Table 3, note that three of the four unattested melodies involve tone 51, which is extremely rare in the lexicon (it appears on only 10 underived words in our database total).

### Table 3. Tone melodies on disyllabic words with a contour tone on the first syllable.

<table>
<thead>
<tr>
<th>31.1</th>
<th>ja³¹ti¹</th>
<th>be male (v.)</th>
<th>43.1</th>
<th>o⁴³na¹</th>
<th>food, generic (n.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.2</td>
<td>tai³¹ja²</td>
<td>hungry (v.)</td>
<td>43.2</td>
<td>de⁴³?a²</td>
<td>talk (v.)</td>
</tr>
<tr>
<td>31.3</td>
<td>ta¹³?t³</td>
<td>fruit sp., <em>P. caimito</em> (n.)</td>
<td>43.3</td>
<td>be⁴³?re³</td>
<td>fruit sp., <em>S. sessiliflorum</em> (n.)</td>
</tr>
<tr>
<td>31.4</td>
<td>(n.att.)</td>
<td></td>
<td>43.4</td>
<td>wi⁴³?i⁴</td>
<td>one (n.)</td>
</tr>
<tr>
<td>31.5</td>
<td>no³¹?ri³</td>
<td>at first (adv.)</td>
<td>43.5</td>
<td>de⁴³?a³</td>
<td>water (n.)</td>
</tr>
<tr>
<td>51.1</td>
<td>i³¹ra³</td>
<td>small (v.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.2</td>
<td>(n.att.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.3</td>
<td>nì³¹ã³</td>
<td>let's go! (intj.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.4</td>
<td>(n.att.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51.5</td>
<td>(n.att.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I do not attempt to construct tables on the model of Table 2 and Table 3 for trisyllabic and larger roots, as Ticuna roots of greater than disyllabic size usually either (a) are loans or (b) appear to be (diachronically) derived from morphologically complex stems.
3.2.4. Tone inventory: interim summary

Table 2 and Table 3 demonstrate that all five tone contrasts persist on the initial syllable of disyllabic roots, as well as in monosyllables. Additionally, all of the tones found on monosyllables pattern separately in the grammatical tone process described in §8. In light of these facts, I analyze all five level tones as phonemic, yielding five tonemes /1 2 3 4 5/. I treat contour tones as composed of a sequence of two level tones which have been assigned to the same TBU (syllable), not as unique tonemes.

Analyses of other varieties of Ticuna, such as Montes Rodriguez (1995), treat contrastive creaky voice as an additional phonemic tone. However, for the reasons discussed in the following section, I analyze contrastive creaky voice as orthogonal to tone. With the exception of this choice, my analysis of the tone inventory is not significantly different from other analyses of the Cushillococha variety (L. Anderson 1959). Where I depart from other authors is in positing the existence of stress.

3.3. Creaky voice

Creaky voice is contrastive on syllables with tone 1. (5) and (6) provide minimal pairs illustrating the contrast between modal voice and creaky voice tone 1 on monosyllabic words.

(5)
   a. na¹ ‘fall into trap'
   b. na¹ 'stop crying'

(6)
   a. to¹ ‘Night Monkey (Aotus sp.)'
   b. to¹ ‘other (form for noun class IV)'

All vowels except for /i/ can bear underlying creaky voice, as shown by (7).

(7)
   a. /i/: ŋi¹ ‘steal'
   b. /e/: ŋe¹ ‘drop'
   c. /u/: ŋu¹ ‘learn'
   d. /ai/: ŋai¹ ‘sew'
   e. /au/: gau¹ ‘be cold'

While /i/ never bears underlying creaky voice, it can display creaky voice on the surface due to progressive or regressive assimilation from an adjacent creaky vowel. An example is the enclitic =kiº̃a¹ ‘from, originating from,' which is often produced [=kiº̃a¹].

The restriction against creaky voice with /i/ is the only constraint against co-occurrence of segmental and suprasegmental features. /i/ can have all values of other suprasegmental features (such as tone and nasality), and other suprasegmental features can occur on all vowels.
In addition to creaky voice, Ticuna also has syllables closed by glottal stop (§3.5). It is clear that creaky voice is distinct from coda glottal stop because voice quality remains contrastive even in syllables closed by glottal stop. This is shown by the pair of derived words in (8). (See §7.1 on the realization of underlying /ɨ/ in (8) as [o].)

(8)

a. /to¹=ʔi³tʃi²/ (other=real) → [to¹ʔo³tʃi²] 'really different'
b. /tq²=ʔi³tʃi²/ (Aotus.sp=real) → [tq²ʔo⁴tʃi²] 'real/true Night Monkey'

In addition to appearing on tone 1 syllables, creaky voice also appears on tone 2 syllables in a small number of words (I am aware of less than 10). One of these words is in a minimal tone pairs with a creaky tone 1 word, as shown in (9).

(9)

a. 2: tfq² ‘break, crack, speaking of something three-dimensional’
b. 1: tfq¹ ‘be white’

Outside of the small number of underived creaky 2 words such as tfq² ‘expand,’ creaky tone 2 appears primarily as an allotone of modal voice tones 1 and 2.

Creaky tone 2 is an allotone of modal voice tone 1 in the language’s primary grammatical tone process (§8). Additionally, creaky tone 2 also appears as an allotone of modal voice tone 2 when a verb stem ending in modal 2 bears the conditional antecedent enclitic =gu² (10). (10) further shows that, while underlying creaky voice nevers appear on the vowel /ɨ/, derived creaky voice (due to creaky tone 2 allotony) is allowed on /i/.

(10)

a. No enclitic: /tʃa³=ɨ²/ (1SgSbj=make) → [tʃa³ʔɨ²] ‘I make’
b. Conditional antecedent enclitic: /tʃa²=ɨ²=gu²/ (1SgSbj.Sc=make=Sub) → [tʃa²ʔɨ²gu²] ‘if I make’

I analyze creaky voice as an additional laryngeal feature distinct from tone, not a toneme. On this analysis, Ticuna is ‘laryngeally complex’ (Silverman 1997), with orthogonal contrasts for tone and voice quality.

My treatment of tone and creaky voice as orthogonal has two analytic advantages. First, this analysis accounts for the compatibility of creaky voice with multiple tones without expanding the inventory of tonemes. Second, creaky voice tone 1 and modal voice tone 1 pattern together as triggers of tone dissimilation (§6.1). This behavior is easily explained by the analysis of creaky voice and tone as orthogonal, since creaky and modal tone 1 syllables form a natural class defined by the assignment of tone 1. In contrast, if creaky voice was analyzed as a distinct toneme, it would be necessary to posit some ad hoc feature other than tone, such as [superlow], in order to define the environment for tone dissimilation.

The main disadvantage of my analysis of creaky voice concerns the inventory. Since I treat creaky voice and tone as orthogonal, my analysis fails to explain why creaky voice only occurs with tones 1 and 2. To account for this gap in the inventory, I propose an independent
constraint *Creaky3 – penalizing the occurrence of creaky voice on a syllable which has tone 3 or a higher tone. Since all contour tones involve tone 3 or a higher tone, the *Creaky3 constraint penalizes creaky voice on all syllables with contour tones, as well as syllables with level tones 3, 4, and 5.

3.4. Nasality

Nasality is contrastive on vowels in onsetless syllables and syllables with the onsets /ʔ w r η/. (11) provides a minimal nasality pair on syllables with no onset.3 (12) provides an equivalent pair with a /η/ onset.

(11)
  a. a̰we⁵¹ ‘pava, bird species’
  b. ā̰we⁵¹ ‘charcoal’

(12)
  a. ηo⁵¹ ‘appear’
  b. ηō ‘eat, bite’

In syllables with onsets other than /ʔ w r η/, nasality is predictable. The vowel of a syllable with a (voiced or voiceless) obstruent onset is always phonetically oral, and the vowel of a syllable with a nasal onset other than /η/ is always phonetically nasal. In other words, syllables may have the surface forms [TV], [DV], or [NV], but not [*TV], [*DV], or [*NV] with a nasal other than /η/.4

Given this distribution, if /η/ patterned with the other nasals in allowing only a nasal nucleus, nasality would be appropriately described as a property of the entire syllable. It would then be possible to treat the surface nasal stops as allophones of the voiced oral stops, conditioned by a syllable-level [+nasal] feature.

However, per (12), nasality is contrastive in syllables with /η/ onsets, meaning that some NV syllables do exist. I therefore treat nasality as a binary feature of vowels, encoded as [+nasal], rather than a feature of syllables. To account for the absence of TV, DV, and NV syllables with onsets other than /η/, I posit that the phonology includes a set of morpheme structure constraints against obstruent-nasal vowel sequences (*TV, *DV) and against nasal stop-oral vowel sequences involving nasals other than /η/ (*mV, *nV, *ɲV).

Nasality is compatible with all tones and with both modal and creaky voice. Since creaky nasal vowels are not widely reported in the literature on contrastive creaky voice, (13) provides examples of creaky nasal vowels of several qualities. As well as demonstrating the

---

3 The glottal stops in (12) arise from a regular process of glottal stop epenthesis which repairs hiatus between verb proclitics (which are always vowel-final) and vowel-initial verb roots. They are not underlying and therefore not included in the phonemic representation.

4 Since the nasality of vowels following nasals other than /η/ is predictable, our transcription does not include nasality marking on vowels following nasals unless the nasal is /η/.
compatibility of nasality and creaky voice, (13) also shows that nasality is contrastive on a variety of vowel qualities; all qualities can be nasal.

(13)
a. ǎ̱ ū’ stay:SgS’
b. naĩ’ ‘tie:SgO’
c. ɲiĩ’ ‘steal’
d. μuĩ’ ‘eat (fruit)’
e. maĩ’ ‘hit/kill:SgO’

3.5. Syllable structure

The Ticuna syllable template is (C)V₁V₂ʔ. There are no complex onsets. Glottal stop is the only possible coda. Its distribution is restricted: glottal codas are allowed word-finally only in derived words.

Complex nuclei are only allowed if V₁ is /a/ and V₂ is /i/ or /u/. The complex nuclei (diphthongs) /ai/ and /au/ behave as a single vowel for the distribution of tone, nasality, and creaky voice. That is, both vowels in a diphthong display the same tone (if this is a contour tone, the contour is realized only once), the same value of nasality, and the same value of creaky voice. Diphthongs pattern apart from monophthongs in that they have a restricted distribution in the word (§5.1) and behave differently in phonological processes involving vowel quality assimilation (§7.1). However, diphthongs behave identically to monophthongs in other phonological processes, such as stress-conditioned tone alternations (§6) and grammatical tone (§8).

Vowel sequences other than /ai/ and /au/ also exist, as examples earlier in this paper have already illustrated (e.g., /ua/ in [14]). However, these vowel sequences behave as disyllabic with respect to the distribution of suprasegmental features: they may have two different tones, values of nasality, and values of creaky voice. Vowel sequences other than /ai/ and /au/ also pattern away from monophthongs in tone alternations and grammatical tone. Thus, I analyze all vowel sequences other than /ai/ and /au/ as heterosyllabic.

4. Stress

Stress is fixed and root-initial (§4.1). Its primary acoustic correlate is duration (§4.2). Phonological consequences of stress are far-reaching, affecting contrast licensing (§5), lexical phonology (§§6-7), and grammatical tone processes (§8).

4.1. Stress Assignment

Every Ticuna word displays one stress on the initial syllable of the first root it contains. There are no other stresses. The following examples show that stress is root-initial on words of a variety of sizes and grammatical categories, including nouns (15), verbs (16), and adverbs (17).

(15)
a. 'de³¹ˈliquor'
b. 'poʔi³'plantain, generic'
c. 'wai⁴yu⁵ɨˈcollective labor'
d. 'wo⁹ra⁶tfi⁴a¹ˈmelon'

(16)
a. tʃa³=фа¹(1SgSbj=know) 'I know'
b. tʃa⁵ri³=мо⁶ɛ (1SgSbj=greet) 'I say hello'
c. tʃa³=нe⁵tʃa⁵i¹ (1SgSbj=sad) 'I am sad'
d. tʃa⁵ʔ=о⁶ɛ⁵ga⁵ʔɛ⁶ (1SgSbj=worried) 'I am worried'

(17)
a. 'ta⁴ma³ˈnot (standard negation)'
b. 'ta⁴gu⁵ma³ˈnever'
c. 'wo⁹e⁹ta⁴ma⁴ˈexactly'

Stress is root-initial rather than word-initial because, as shown by the morphologically complex verbs in (16), it does not occur on proclitics. Ticuna verbs typically appear with subject proclitics and can also bear additional aspect, object, and associated motion proclitics. Regardless of the number of proclitics a verb bears, stress falls on the first syllable of the verb root, not on the proclitics. This can be seen for verbs with one proclitic in (16). (18) shows that it is also true for verbs with two (a) and three (b) proclitics.

(18)
a. i⁵=tʃa⁵ri³=to¹ (Dir=1SgSbj=sit) 'I sit'
b. i⁵=tʃa³=ja⁵ri³=to¹ (Dir=1SgSbj=go.and=sit) 'I go and sit'

Stress is specific to the first root of the word. Words which contain multiple roots still contain only one stress, as shown by the compounds in (19).

(19)
a. 'pe⁴³=tfi⁴⁵ka² (sleep=NI:place.for.activity) 'bedroom'
b. tʃa³=na³=nu⁴=ta⁴ke³ (1SgSbj=3Obj=put:InamPLO=NI:bundle) 'I gather them (objects)'

Every root is restricted to either appearing as a first root in its word, like the verb roots pe⁴³ 'sleep' and nu⁴ 'put:InamPLO' in (19), or as a second/later root, like the incorporated nouns tfi⁶ka² 'place for activity' and ta⁴ke³ 'bundle' in (19). Because of this morphological classification, the language does not present alternations between stressed and unstressed forms of the same morphemes. A morpheme either always appears initially in the prosodic word, and is always stressed, or never appears initially and is never stressed.

4.2. Acoustic Correlates of Stress

I refer to these morphemes as 'proclitics' rather than 'prefixes' because they can also appear on nouns in nonverbal predication. On my analysis there are no prefixes in the language.
The primary acoustic correlate of stress is vowel duration. To assess the difference in duration between unstressed and stressed syllables, I measured the duration of all vowels in 130 tokens of 27 verb stems (16 monosyllabic, 6 disyllabic, and 5 trisyllabic) produced by DGG (n word tokens = 66) and LWG (n word tokens = 64). The verb stems were produced in tone frames as described in §1. Closed syllables occurred in some of the disyllabic and trisyllabic stems, but their vowels were excluded from analysis to control for effects of the glottal coda. This exclusion yielded a data set of 187 vowel tokens.

In the acoustic data, an analysis of variance indicated that stress and word length both had significant effects on vowel duration. Stressed syllables were longer than unstressed syllables (F[1,184] = 89.376, p = 2.2e-16). Additionally, the stressed (i.e., only) syllables of monosyllabic words were longer than the stressed syllables of non-monosyllabic words (F[1,184] = 23.425, p = 2.74e-06). Numerically, the average stressed vowel of a monosyllabic word lasted 201ms (SD = 52ms), the average stressed vowel of a non-monosyllabic word lasted 159ms (SD = 37ms), and the average unstressed vowel lasted 123ms (SD = 39ms). Since the effects of stress on vowel duration were highly significant, I did not assess whether stress also has other acoustic correlates, such as consonant duration or vowel intensity.

5. Contrast licensing in stressed syllables

Stressed syllables display a greater inventory of contrasts than unstressed syllables. The additional contrasts licensed by stress involve both segments (§5.1) and tones (§5.2).

5.1. Segmental contrasts in the stressed syllable

Recall from §3.1 above that the segmental inventory of Ticuna consists of 16 phonemes. In native-vocabulary words, six of these phonemes – the consonants /ɸ~kʷ/, /ŋ/, /ɲ/, and /d/, and the diphthongs /ai/ and /au/ – appear only in stressed syllables. That is, they appear in the first syllable of roots, but never in the non-initial syllables of roots, and never in suffixes, enclitics, or proclitics.

The distribution of /o/ is also conditioned by stress, but is slightly more complex than that of the other stress-licensed segments. /o/ appears in root-initial syllables and never appears in suffixes, enclitics, or proclitics. However, unlike the other stress-licensed segments, /o/ can appear in non-initial root syllables. Specifically, unstressed /o/ may appear in the second syllable of a root if and only if (a) the first root syllable has the nucleus /o/ and (b) the second syllable does not have a supralaryngeal onset. That is, words of the form (C)o(ʔ) exist, such as o²ʔõ⁴ ‘baby,’ but there are no words of the form (C₁)oC₂o with a supra-laryngeal C₂ (e.g., *o²to⁴).

I take the second syllable [o] in underived words like o²ʔõ⁴ ‘baby’ to be derived from underlying /a/ by a regular phonological process, which is described in §7.2. Under this analysis, underlying /o/ has exactly the same distribution as the other stress-licensed phones: it occurs only in stressed (stem-initial) syllables.

The distributional restrictions on /ɸ/, /ŋ/, /ɲ/ /d/, /ai/, /au/, and /o/ are specific to native-vocabulary words. Loanwords, regardless of origin, can display the stress-licensed phones in
non-initial syllables. Two examples are na’ra’ja¹ ‘orange (fruit)’ (< Spanish naranja ‘orange’) and tu’pau’ka¹ ‘church’ (Omagua [Tupi-Guarani] tupa ‘Christian God’ + uka ‘house’).

Some loanwords display phonological adaptation driven by the restrictions on the stress-licensed segments. Adaptation applies mainly to /d/, which is borrowed as the tap, and /o/, which is borrowed as /u/ (among other adaptations). The noun tʃu’ra’ra¹ ‘soldier, army’ (< Spanish soldado ‘soldier’) exemplifies the /d/ → [ɾ] adaptation, while the common noun a’ru’tʃu¹ ‘rice’ (< Spanish arroz) and the personal name Bi⁵tu⁴(< Spanish Victoria) exemplify the /o/-raising adaptation. Not all loanwords with /d/ and /o/ in non-initial positions display adaptation, however. For example, on morphological criteria the loan mo’to¹ ‘motorcycle’ (< Spanish motocicleta ‘motorcycle’) is highly integrated as a word of Ticuna, yet it retains its non-initial /o/.

5.2. Tonal contrasts in the stressed syllable

Three of the language’s 8 contrastive tones (§3.2) occur only on stressed syllables: tones 51, 43, and 31. This is a natural class of the contour or falling tones. Per §3.2.1, the remaining tones – those which are not stress-licensed – are either level in pitch or display a phonetic rise.

Tones 51, 43, and 31 have similar distribution to the segments discussed in §5.1. They appear on the initial syllables of roots only. and do not appear on non-initial root syllables or on any syllable of enclitics or suffixes. Unlike the stress-licensed segments, Tones 31 and 43 do appear on verb proclitics, though they are at least sometimes derived by fusion of an underlying disyllabic /3.1/ or /4.3/ sequence.

6. Stress-conditioned tone processes

Stress conditions the application of many phonological processes in Ticuna. In the following sections, I describe and analyze four stress-conditioned phonological processes – two affecting tone, and two affecting segments. We begin with the processes affecting tone: tone 1 dissimilation and tone 43 assimilation.

6.1. Tone 1 dissimilation

Syllables with creaky voice and tone 1 (“tone 1 syllables”) are subject to a stress-conditioned dissimilation process in which they are realized as tone 5. This process is stress-conditioned because it applies only to stressed syllables.

6.1.1. Tone 1 dissimilation applies in stressed syllables

When an underlying tone 1 syllable bears stress and is followed by another tone 1 syllable, the word-initial tone 1 dissimilates to tone 5. The tone 1 syllable which undergoes the process must have creaky voice, but the tone 1 syllable which triggers it may have either creaky or modal voice.
(20) provides an example of tone 1 dissimilation in a verb which is tone 1 in isolation (20a). The verb undergoes dissimilation triggered by a creaky 1 syllable in (20b) and triggered by a modal 1 syllable in (20c) and (20d).

(20) Tone 1 → 5 / [#PrWd_1]
   a. /na=tʃo²/ (3Sbj=be.white) → [na=tʃo¹] ‘she/he/it is white’
   b. /na=tʃo²=ā³ti³/ (3Sbj=be.white=yard) → [na=tʃo³.ə̃ti³] ‘s/he/it has a white (i.e. sandy) yard’
   c. /na=tʃo²=a¹ne¹/ (3Sbj=be.white=land) → [na=tʃo³.o⁵ne⁵] ‘s/he/it has white (i.e. sandy) land’
   d. /na=tʃo²=gi¹/ (3Sbj=be.white=blood) → [na=tʃo³.gi¹] ‘it has white sap’ (of a tree)

Because most Ticuna nouns are disyllabic or larger, it is hard to observe tone 1 dissimilation in nouns. However, the process does occur, as shown by (21). In this example, a monosyllabic noun which is tone 1 in isolation (21a) undergoes dissimilation triggered by a creaky 1 syllable (21b) and by a modal 1 syllable (21c, 21d).

(21) Tone 1 → 5 / [#PrWd_1]
   a. /t⁰/ → [t⁰] ‘Night Monkey (Aotus sp.)’
   b. /t⁰=ā³ti³/ (Night.Monkey=yard) → [t⁵.ə̃ti³] ‘Night Monkey’s yard’
   c. /t⁰=a¹ne¹/ (Night.Monkey=land) → [t⁵.o⁵ne⁵] ‘Night Monkey’s land’
   d. /t²=gi¹/ (Night.Monkey=blood) → [t⁵.gi¹] ‘Night Monkey’s blood’

Modal voice tone 1 syllables are triggers, but not targets, of tone 1 dissimilation. This is shown in (22), where the modal voice tone 1 noun to¹ ‘other (Class IV)’ fails to undergo dissimilation in the same environments shown in (20) and (21).

(22) Modal Tone 1 → 1 / [#PrWd_1]
   a. /t⁰/ → [t⁰] ‘other’
   b. /t⁰=ā³/ (other=mouth) → [t⁵.ə̃] ‘other one’s mouth’
   c. /t⁰=a¹ne¹/ (other=land) → [t⁵.o⁵ne⁵] ‘other one’s land’
   d. /t²=gi¹/ (other=blood) → [t⁵.gi¹] ‘other one’s blood’

6.1.2. Tone 1 dissimilation fails to apply in unstressed syllables

Tone 1 dissimilation is exclusive to stressed syllables. The process does not apply if the target tone 1 syllable is not the first syllable of a root.

This is shown for a tone 1 syllable that is the second syllable of the PrWd in (23), a noun, and (24), a verb. In the verb shown in (24), dissimilation applies to the first tone 1 syllable in the stem – the verb root tʃo¹ ‘be white’ – because it is followed by a tone 1 enclitic. However, dissimilation does not apply to the second underlying tone 1 syllable, =a¹ ‘mouth,’ even when it is followed by a tone 1 syllable in another enclitic (24b).

(23) Tone 1 → 1 / [PrWd#σ_1]
   a. /ko²re²/ → [ko².re²] ‘sweet potato’
   b. /ko²re²=ā³ti³/ (sweet.potato=yard) → [ko².re².ə̃ti³] ‘yard planted with sweet potatoes’

6 See §7.2 on the assimilation of /a/ to /o/ in (21) - (22).
c. /ko²re¹=a²ne¹/ (sweet.potato=land) → [ko².re¹.a².ne¹] 'garden of sweet potatoes'
d. /ko²re¹=gi¹/ (sweet.potato=blood) → [ko².re¹.gi¹] 'sweet potato sap'

(24) Tone 1 → 1 / [PrWd#σ₁]
a. /na²=t[to¹=a¹/ (3Sbj=be.white=mouth) → [na².t[o¹.o¹] 'it has a white mouth'
b. /na²=t[to¹=a¹/ (3Sbj=be.white=mouth=Prosp) → [na².t[o¹.o¹].t[a¹i¹] 'it’s going to have a white mouth'

The dissimilation process does not differentiate between even and odd syllables. Rather, it fails to apply to all unstressed syllables, regardless of parity. This is shown by (25) and (26), which demonstrate that the process does not apply to the third syllable of a trisyllabic stem, whether the stem is a noun (25) or a verb (26). These examples use derived stems because I am not aware of any underived trisyllabic stems ending in a tone 1 syllable.

(25) Tone 1 → 1 / [PrWd#σσ₁]
a. /na²=e³ja¹/ (3=sister) → [na².e³ja¹] 'his/her/their sister'
b. /na²=e³ja¹=ti³/ (3=sister=yard) → [na².e³ja¹=t[t¹i³] 'his/her/their sister’s yard'
c. /na²=e³ja¹=gi¹/ (3=sister=blood) → [na².e³ja¹=gi¹] 'his/her/their sister’s blood'

(26) Tone 1 → 1 / [PrWd#σσ₁]
a. /na²=t[to¹=e³ja¹/ (3Sbj=be.white=sister) → [na².t[o¹.e³ja¹] 's/he has a white sister'
b. /na²=t[to¹=e³ja¹=t[a¹i¹] (3Sbj=be.white=sister=Prosp) → [na².t[o¹.e³ja¹]=t[a¹i¹] 's/he is going to have a white sister'

Since the dissimilation process treats all unstressed syllables equally, it is best analyzed as stress-conditioned. That is, it applies just in case the target syllable bears the primary stress of the prosodic word. This is superior to an analysis of the process as foot-conditioned, since – assuming that all syllables are parsed into binary feet – a foot-conditioned analysis incorrectly predicts that dissimilation will apply in non-initial odd-numbered syllables, such as the third stem syllable in (25) and (26).

The lexical database described in §3.2.3 contains no roots which violate tone 1 dissimilation, i.e. display a root-initial 11 sequence. Therefore, the rule producing tone 1 dissimilation (unlike our statements of some subsequent rules) does not need to include a specification that it applies only in morphologically derived environments. This contrasts with the next tone process I introduce, which is limited to derived environments. With this background, (27) formally states the rule producing tone 1 dissimilation.

(27) Tone 1 dissimilation
1 → 5 / _1

6.2. A related process: tone 43 assimilation

The same natural class that triggers tone 1 dissimilation – modal and creaky voice tone 1 syllables – also triggers a process of tone assimilation. Stressed syllables with underlying tone 43 are realized as tone 31 when they are followed by a tone 1 syllable.
(28) shows this for the morpheme na⁴³, a pronoun which acts as the grammatical possessor of inalienable nouns that are semantically unpossessed. This pronoun is realized with tone 43 when it is followed by enclitics that do not have initial tone 1 (28a,b). But when followed by enclitics with initial tone 1 or modal 1, the pronoun is realized as 31 (28c, d).

(28) Tone 43 → 31 / [PrWd#_1]
a. /na⁴³=a⁴³t¹/ (Dposs=leaf) → [na⁴³a⁴³t¹] 'leaf'
b. /na⁴³=t¹/ (Dposs=river) → [na⁴³t¹] 'river'
c. /na⁴³=a⁴³t¹/ (Dposs=yard) → [na⁴³a⁴³t¹] 'yard'
d. /na⁴³=a⁴³ne¹/ (Dposs=land) → [na⁴³a⁴³ne¹] 'land'

Tone 43 is also realized as 31 when followed by tone 3 syllables, as in (29).

(29) Tone 43 → 31 / [PrWd#_3]
a. /na⁴³=e⁴³t¹/ (Dposs=prey) → [na⁴³e⁴³t¹] 'game animal'
b. /na⁴³=t¹we³/ (Dposs=half.sphere) → [na⁴³t¹we³] 'half (of something spherical)'

Since tone 3 patterns with tone 1 as a trigger of the /43/ → [31] change, one might expect that tone 3 would also pattern with tone 1 and trigger tone 1 dissimilation. However, tone 3 does not trigger tone 1 dissimilation (30).

(30) 1 → 1 / [PrWd#_3]
a. /na¹=t⁰⁴³e³ja³/ (3Sbj=be.white=sister) → [na⁴³t⁰⁴³e³ja³] 's/he has a white sister'
b. /na¹=t⁰⁴³ne³/ (3Sbj=be.white=son) → [na⁴³t⁰⁴³ne³] 's/he has a white son'
c. /na¹=t⁰⁴³pa³ti²/ (3Sbj=be.white=claw) → [na⁴³t⁰⁴³pa³ti²] 'it has white claws'

My lexical database includes roots which display the environment for tone 43 dissimilation, but where it fails to apply. They include both 43.1 roots such as o⁴³na 'food' and 43.3 roots such as be⁴³re³ 'cocona, plant species (Solanum sessiliflorum).' These roots indicate that tone 43 assimilation applies only in morphologically derived environments, meaning that the formal statement of tone 43 assimilation must include a morpheme boundary in the environment.

The tone 43 assimilation rule does not, however, need to include stress as part of the conditioning environment. While tone 43 assimilation is stress-conditioned in that it only targets stressed syllables, this ‘stress-conditioning’ is epiphenomenal on the fact that tone 43 – like the other contour tones – only occurs in stressed syllables (§5.2).

With this background, (31) provides a formal statement of the rule producing tone 43 assimilation. Note that, as discussed above, there is no external motivation for positing that the triggers of this process (tones 1 and 3) share phonological features. In (31), I therefore represent the environment of this rule as disjunctive.

(31) Tone 43 assimilation
43 → 31 / _[morpheme{1, 3}]

6.3. Interim Summary
I showed in §5 that the stressed syllable licenses segmental and tonal contrasts not found in other syllables. In this section, I demonstrated that the stressed syllable also licenses a unique set of tone processes, undergoing tone alternations – tone 1 dissimilation (§6.1) and tone 43 assimilation (§6.2) – that no other syllable undergoes.

The two tone processes observed only on stressed syllables relate to stress in different ways. Tone 1 dissimilation interacts with stress via classic stress-conditioning. Tone 1 can occur on both stressed and unstressed syllables, but it undergoes dissimilation to tone 5 only when it occurs on stressed syllables (§6.1). There is no relationship with licensing; stress is simply part of the environment for the process. In contrast, tone 43 assimilation interacts with stress exclusively via stress-licensing. Because tone 43 occurs only on stressed syllables, tone 43 assimilation can occur only on stressed syllables (§6.2). Due to this relationship with licensing, there is no (formal) need to include stress in the environment for the process.

7. Stress-conditioned segmental processes

In this section, I describe and analyze two stress-conditioned segmental processes: vowel quality assimilation targeting /i/ and vowel quality assimilation targeting /oa/ sequences.

7.1. /i/ Assimilation

The oral vowel /i/ is subject to a stress-conditioned assimilation process in which it assimilates completely to the quality of a preceding non-central vowel. This process is stress-conditioned because it is triggered only by stressed vowels.

Other authors have noted this process in Cushillococha variety but incorrectly state that it is only conditioned by the quality of the vowel that precedes the /i/ (Anderson & Anderson 2017: 227). Vowel quality is part of the conditioning environment; however, the following data shows that stress also plays a role.

7.1.1. /i/ assimilation is triggered by stressed syllables

When the stressed (i.e., first) syllable of the PrWd contains a front or back vowel, and the second syllable of the PrWd contains underlying oral /i/ and lacks a supra-laryngeal onset, the second-syllable token of /i/ assimilates completely in quality and nasality to the vowel of the stressed syllable.

All vowel qualities other than /a/ and /i/ trigger /i/ assimilation. (32) shows a set of monosyllabic verbs with vowels of all the possible vowel qualities followed by the deintensifying enclitic /=ʔi’ra/. Front vowels (32a, b), back vowels (32c, d), and diphthongs (32e, f) trigger assimilation of the /i/ in /=ʔi’ra/. /a/ and /i/ do not trigger assimilation (32f, g).

As shown in (32e, f), diphthongs differ from other vowel qualities in their behavior in /i/ assimilation. While monophthongal vowel qualities other than /a/ trigger complete assimilation of /i/, diphthongs display fusion with /i/. The first mora of the diphthong becomes
the sole mora of its (stressed) syllable; the second mora of the diphthong is assigned to the mora occupied by the underlying /ɨ/.

(32) /i/ → V_a / [PrWdV_a(?)_], provided V_a is not /a/
a. /i/: /na^4=ti^1=ʔi^1'rə^1/ (3Sbj=stand=Deintens) → [na^4.tʃi^4.ʔi^1.ra^1] ‘s/he sort of stands up’
b. /e/: /na^4=me^4=ʔi^1'rə^1/ (3Sbj=be.good=Deintens) → [na^4.me^4.ʔe^1.ra^1] ‘it’s sort of good’
c. /u/: /na^4=na^3=mu^2=ʔi^1'rə^1/ (3Sbj=3Obj=send=Deintens) → [na^4.na^3.mu^2.ʔu^1.ra^1] ‘s/he sort of sends it’
d. /o/: /na^4=do^4=ʔi^1'rə^1/ (3Sbj=be.soft=Deintens) → [na^4.do^31.ʔo^1.ra^1] ‘it’s sort of soft’
e. /ai/: /na^4=nai^4=ʔi^1'rə^1/ (3Sbj=be.hot=Deintens) → [na^4.na^4.ʔi^1.ra^1] ‘it’s sort of hot’
f. /au/: /na^4=dau^3=ʔi^1'rə^1/ (3Sbj=see=Deintens) → [na^4.da^3.ʔu^1.ra^1] ‘s/he sort of sees it’
g. /a/: /na^4=ja^3=ʔi^1'rə^1/ (3Sbj=be.mature=Deintens) → [na^4.ja^3.ʔi^1.ra^1] ‘it’s sort of mature’
h. /i/: /na^4=na^4=i^2=ʔi^1'rə^1/ (3Sbj=3Obj=do=Deintens) → [na^4.na^4.i^2.ʔi^1.ra^1] ‘s/he sort of makes it’

/ɨ/ assimilation behaves the same in nouns, as shown by (33): it is triggered by front vowels (33a, b), back vowels (33c, d), and diphthongs (33e), but not by /a/ or /i/ (33f).

(33) /i/ → V_a / [PrWdV_a(?)_], provided V_a is not /a/
a. /ni^2=ʔi^4-ne^1/ (3.V=body) → [ni^1.ʔi^4.ne^1] ‘her (Class V) entire body’
b. /e^4=ʔi^4.tʃi^2/ (Genipa.americana=really) → [e^4.ʔe^4.tʃi^2] ‘real G. americana (plant sp.)’
c. /nu^3=ʔi^5.tʃi^2/ (Theobroma.bicolor=really) → [nu^3.ʔu^5.tʃi^2] ‘real T. bicolor (fruit sp.)’
d. /to^3=ʔi^5.tʃi^2/ (other=really) → [to^3.ʔo^5.tʃi^2] ‘really different’
e. /tʃau^4=ʔi^4.ne^1/ (1sg=body) → [tʃa^1.ʔu^4.ne^1] ‘my entire body’
f. /na^4=ʔi^4.ne^1/ (3.IV=body) → [na^4.ʔi^4.ne^1] ‘his/her/their/its (Class IV) entire body’

---

7 This form exemplifies tone 43 assimilation (§6.2).
8 The inalienable noun i^ne^1 appears in many examples throughout this section because it is one of the small number of suffixes and enclitics which begin with /i/. While I gloss i^ne^1 as ‘body,’ this gloss is extremely inadequate – among other reasons, because it suggests a mind-body dualism which is not part of the word’s meaning. See Santos Angarita (2013) for a Ticuna linguist’s definition of i^ne^1.
7.1.2. /i/ assimilation is not triggered by later syllables

/i/ assimilation does not apply if the target /i/ segment is later than the second syllable of the PrWd. The exception is when the process is triggered by the vowel /u/. Assimilation of /i/ to /u/ can take place in any syllable of the PrWd.

The absence of /i/ assimilation beyond the second syllable of the PrWd is shown in (34), a verb, and (35), a noun. (34) has a sequence of /e/ followed by /i/. If the /i/ token appeared in the second syllable, it would assimilate to the /e/, as in (32b) and (33b). But in (34) the /i/ appears in the third syllable, and therefore does not assimilate. The same applies to the sequence of /i/ and /u/ in (35).

(34) /na^4=tʃi^3i^2e^2=ʔi^tʃi^2/ (3Sbj=be.bad=really) → [na^4.tʃi^3.ʔi^tʃi^2] ‘it’s really bad’

(35) /o^5ʔi^2=ʔi^tʃi^2/ (grandfather=really) → [o^5.ʔi^tʃi^2] ‘real grandfather’

Like tone 1 dissimilation, /i/ assimilation is insensitive to syllable parity. As well as being absent in the third syllable of the word, per (34) and (35), assimilation is also absent in the fourth syllable and all later syllables. (36) and (37) demonstrate the absence of assimilation specifically in the fourth syllable.

(36) /na^4=wi^3a^e^3=ʔi^tʃi^2/ (3Sbj=sing=really) → [na^4.wi^3.a^e^3.ʔi^tʃi^2] ‘s/he really sings’

(37) /ka^3ru^1=ne^3=ʔi^tʃi^2/ (Carlos=son=really) → [ka^3.ru^1.ne^3.ʔi^tʃi^2] ‘Carlos’ real son’

While /i/ and /e/ do not trigger /i/ assimilation in third and later syllables, as shown in (34)-(37), /u/ can trigger /i/ assimilation in this prosodic environment.

(38) /u^3ku^1=ʔi^tʃi^2/ (needle=really) → [u^3ku^1ʔu^tʃi^2] ‘real needle’

(39) /tʃa^3=ti^re^4=gu^2=ʔi^tʃi^2/ (1sgSbj=port=Loc=really) → [tʃa^3ti^re^4gu^2ʔu^tʃi^2] ‘I’m right in the port’

The other back vowel, /o/, is restricted in distribution to the first two syllables of the PrWd (§5.1). /o/ does trigger /i/ assimilation when /o/ occurs in the first and /i/ in the second syllable (32d, 33d). However, /o/ does not trigger assimilation when it occurs in the second and /i/ in the third syllable (40). Thus /o/ patterns with the front vowels and diphthongs, not with /u/, in its behavior as a trigger of /i/ assimilation.

(40) /o^3ʔo^4=ʔi^ne^1/ (baby=body) → [o^3ʔo^4ʔi^ne^1] ‘baby’s body’

Recall from §5.1 that all underived words with /o/ in the second syllable have the form [(C)o(?)]o. Since /i/ assimilation derives words of this same form, it is attractive to posit that underived words with /o/ in the second syllable, like o^3ʔo^4 ‘baby,’ underlyingly have the form /o^3ʔo^4i^/ with the final /o/ in the surface form derived by /i/ assimilation. However, this analysis is impossible because there are underived words of the form [(C)o(?)]i. Two examples are the nouns o^1ʔi^3 ‘shuyo, fish species (Hoplerythrinus unitaenatus)’ and to^2ʔi^3 ‘isula, ant
species (*Paraponera clavata*). Since the /i/ tokens in these words do not undergo assimilation, /i/ assimilation must be a derived environment effect, like tone 43 assimilation.

With this data in hand, we can state the rule governing /i/ assimilation as in (41). Because the rule applies only to initial syllables and not to other odd-numbered syllables, we represent the prosodic conditioning as stress and not foot structure.

(41) /i/ assimilation
\[
/i/ \rightarrow V[a\text{-}high \text{-}low \text{ a-front a-back} \text{-}nasal] / V[a\text{-}high \text{-}low \text{ a-front a-back}]_{\text{morpheme}(?)}_{-}
\]

The /i/ assimilation rule as stated in (41) produces the correct output for assimilation of /i/ to monophthongs, but not for assimilation to diphthongs. Specifically, (41) predicts that assimilation of /i/ to a diphthong will produce a sequence of the form [V1V2.V2], while the outcome is actually [V1.V2] in forms such as (32b). In order to produce the fusion, we need the additional diphthong-monophthong fusion rule given in (42).

(42) Diphthong-monophthong fusion
\[
V_b \rightarrow \emptyset / V_a_{-}(?)V_b
\]

Since (42) does not include a morpheme boundary specification, it predicts that there will be no roots with a diphthong followed by a high vowel with the same quality as the second member of the diphthong (i.e., *ai.i, *au.u). In the lexical database, this prediction is correct: there are no roots of this form.

Last, assimilation of /i/ to /u/ is not stress-conditioned, and there is no evidence that it is a derived environment effect (i.e., no roots violate it). Therefore, I posit the additional rule given in (43) to produce assimilation of /u-/i/ sequences anywhere in the word, including root-internally.

(43) /u-/i/ assimilation
\[
/i/ \rightarrow [u] / V[+\text{high} +\text{back}]_{(?)}_{-}
\]

7.2. A related process: /oa/ assimilation

In addition to /i/ assimilation, the lexical phonology displays another vowel assimilation process which is limited to the first two syllables of the PrWd. This is assimilation of /oa/ sequences.

When the first syllable of the PrWd contains /o/, and the second syllable contains /a/ and lacks a supralaryngeal onset, the /a/ of the second syllable assimilates completely to the /o/ in quality. (44) shows the process in two verbs, (45) in a noun.

(44) a. /na^4=t\text{fo}^5=a\text{ne}^1/ (3Sbj=be.white=land) \rightarrow [na^4.t\text{fo}^5.o^1.ne^1] ‘s/he/it has white (i.e. sandy) land’
   b. /na^4=do^4=a\text{ti}^1/ (3Sbj=be.soft=leaf) \rightarrow [na^4.do^4.t\text{fo}^5.ti^1] ‘it has soft leaves’

(45)
a. /to¹=ã¹/ (other=mouth) → [to'õ¹] ‘other one’s mouth’
b. /to¹=aʔi⁵/ (other=Iben) → [to'oʔi⁵] ‘to/for the other one’

/oa/ assimilation is absent when /o/ occurs in the second syllable and /a/ occurs in the third syllable of the PrWd (46). Because [o] never occurs after the second syllable of the PrWd, it is impossible to test whether /oa/ assimilation applies if the /oa/ sequence occurs in a later position in the word.

(46)
a. /o²ʔo⁴=ã¹/ (baby=mouth) → [o²ʔo⁴ã¹] ‘baby’s mouth’
b. /bo²ʔo⁵=aʔi⁵/ (grub.sp=Iben) → [bo²ʔo⁵aʔi⁵], *[bo²ʔo⁵oʔi⁵] ‘to/for grubs’

The lexical database described in §3.2.3 does not contain any underived words of the form [Co(ʔ)a]. As such, there is no evidence that /oa/ assimilation is limited to derived environments. Thus, I posit that all surface [(C)o(ʔ)o] words have underlying /a/ in the second syllable and display surface [o] in the second syllable due to /oa/ assimilation. On this account, for example, the underlying form of the word ‘baby’ is /o²ʔã⁴/, and its surface form [o²ʔo⁴] reflects the outcome of /oa/ assimilation. Per §5.1, this permits the generalization that in native-vocabulary words, underlying /o/ occurs only in the stressed syllable.

With this background, /oa/ assimilation can be modeled with the rule shown in (47).

(47) /oa/ assimilation

7.3. Interim summary

§6 described how the stressed syllable undergoes processes – tone 1 dissimilation and tone 43 assimilation – which no other syllable undergoes. This section further showed that the stressed syllable also triggers processes – /i/ and /oa/ assimilation – that no other syllable triggers. The processes which the stressed syllable uniquely triggers are segmental, while the processes (described in §6) which it uniquely undergoes are tonal.

This section and §6 have concentrated on narrowly phonological alternations. However, the stressed syllable also behaves exceptionally with respect to grammatical tone alternations. Therefore, in the following section, I turn to the language’s most important grammatical tone process – showing that in this process as well, the stressed syllable patterns apart from all other syllables.

8. Stress-conditioned grammatical tone processes

Ticuna displays an extensive set of grammatical tone alternations affecting the final syllables of verb stems. These alternations are triggered mostly by nominalizing constructions. Thus, I refer to these alternations collectively as the nominalizer tone circle.
Exactly like the narrowly phonological processes described in the previous two sections, this grammatical tone process is also stress-conditioned. In §8.1, I introduce the nominalizer tone circle and discuss the morphosyntactic contexts where it applies. Then, I lay out the alternations caused by the circle on stressed syllables (§8.2) and unstressed syllables (§8.3). In §8.4 I discuss interactions between the nominalizer tone circle and other tonological processes, and in §8.5 I give an interim summary.

8.1. Triggers of the nominalizer tone circle

Several different morphemes trigger the nominalizer tone circle. The most common trigger morphemes are nominalizers, which appear on verbs to derive relative clauses. I refer to these morphemes as 'nominalizers' because the constituents which they derive have the external syntax of nouns (e.g., can bear case and possess other nouns).

The nominalizers agree in noun class with the head noun of the relative clause that they derive. They are listed, together with their noun classes, in (48).

(48)

a. \(= e^3 \text{Nmlz:} I \)

b. \(= k i^3 \text{Nmlz:} II \)

c. \(= \hat{r}^5 n e^4 \sim = n e^4 \text{Nmlz:} III^9 \)

d. \(= \hat{r}^4 \text{Nmlz:} IV \)

Not all nominalizers trigger the nominalizer tone circle. Specifically, the nominalizer for noun class V is syntactically identical to the nominalizers in (48), deriving relative clauses. It is also segmentally identical to the class II nominalizer, with the segmental form \(= k i^3 \). However, the noun class V nominalizer does not induce the nominalizer tone circle on its host, while the noun class II nominalizer does.

(49) illustrates the nominalizer tone circle, including its non-application in class V nominalizations, by comparing relative clauses formed with the nominalizers in (48) vs. with the class V nominalizer. In (49)a-c), each of the nominalizers in (48) causes a monosyllabic verb root which is underlyingly tone 1, the root \(m u^1 \)'eat (raw fruit),' to be realized as tone 5 – one of the tone circle alternations. On the other hand, in (49d), the class V nominalizer has no effect on the tone of this same verb stem. This same pattern holds regardless of verb stem properties: the class V nominalizer never affects stem tone.

(49)

a. /bu^3 e^3 ja^4 ta^3 i^3 i^3 \(m u^1 \) =e^3/ (baby:I Lnk:I Pouteria.caimito eat.fruit =Nmlz:I) \(\rightarrow [bu'e^3 ja^4 ta^3 i^3 i^3 \text{mu'e}^3] \)
‘the baby (class I) that ate P. caimito (fruit species)’

b. /\(\eta e^3 ti^4 ki^3 \) ja^4 ta^3 i^3 i^3 \(m u^1 \) =ki^3/ (young.man:II Lnk:II Pouteria.caimito eat.fruit =Nmlz:II) \(\rightarrow [\eta e^3 ti^4 ki^3 ja^4 ta^3 i^3 i^3 \text{mu'ki}^3] \)

\(^9\) This morph displays stress-conditioned segmental allomorphy. It is realized as \(= \hat{r}^5 n e^4 \) when adjacent to the stressed syllable and \(= n e^4 \) elsewhere.
‘the young man (class II) that ate P. caimito’

c. /duiʔiʔi4 i4 ta3ʔi3 mu1 =ʔi4/ (person:IV Lnk:IV Pouteria.caimito eat.fruit =Nmlz:IV) →
   [duiʔiʔi4 i4 ta3ʔi3 mu1ʔi4]
   ‘the person (class IV) that ate P. caimito’

d. /pa ki3 i4 taʔi3 mu1 =ki3/ (young.woman:V Lnk:V Pouteria.caimito eat.fruit =Nmlz:V) →
   [pa ki3 i4 taʔi3 mu1ki3]
   ‘the young woman (class V) that ate P. caimito’

I take the failure of the Class V nominalizer to induce the tone circle – as represented by the contrast between (49a-c) and (49d) – as evidence that it is neither syntactic status as nominalizers nor phonological form that causes the Class I, II, III, and IV nominalizers to induce the nominalizer tone circle. Instead, I assume that triggering the circle is a lexical property of the nominalizers listed in (48).

As well as the nominalizers listed in (48), there are a variety of other syntactic constructions which also trigger the nominalizer tone circle. However, in the following subsections I exemplify the tone circle alternations exclusively with the nominalizers shown in (48). However, the same alternations occur – on the same syllable – whether the tone circle is triggered by one of the nominalizers from (48) or by another construction.

Before moving to the alternations, I note that D. Anderson (1963: 369) is the only other work about Ticuna which describes the tone circle. While the alternations given by Anderson are mostly correct, the list of triggering environments is incorrect (at least in contemporary Cushillococha). She lists interrogative clauses, conditional antecedents, the complementizer naʔ, and the enclitic =ʔiɾa1 ‘somewhat’ as triggering the circle. In fact, conditional antecedents and =ʔiɾa1 are never triggers, interrogatives trigger the circle only if they are formed with normalized clauses (e.g., focus constructions), and naʔ triggers the circle only if it takes a normalized clause as its complement.

8.2. The nominalizer tone circle on stressed syllables

The nominalizers trigger the tone circle on the final syllable of the verb stem which hosts them. They are always adjacent to the stem-final syllable; nominalizers can never be separated from stems by adverbs, verb arguments, or other material.

On stressed syllables – i.e. on monosyllabic verb roots – the tone circle causes the eight alternations shown in (50). Tone 5 is not included as a target in (50) because it is never the only tone of a monosyllabic word (§5).

(50)
a. /1/ → [5]
b. /1/ → [2]

Readers who compare examples in this work to L. Anderson (1959), D. Anderson (1963), etc. should be aware the Andersons use a tone notation system where 5 is the lowest tone.
(51) depicts the changes shown in (50) graphically. Following (51), (52) – (59) provide example verb roots of each tone undergoing the circle. Examples are given with nominalizers for noun classes I, II, and IV. Class III is mostly omitted. This is for semantic reasons. Since Class III does not contain any animate nouns, subject relative clauses like the Class I, II, and IV examples are – for most verbs – semantically unacceptable.

(51)

(52) Tone 1
a. /pa¹/ (hug) →
   [pa³e³] 'the one (Class I) that hugged (it)'
   [pa³ki³] 'the one (Class II) that hugged (it)'
   [pa³ʔi⁴] 'the one (Class IV) that hugged (it)'

b. /mu¹/ (eat fruit) →
   [mu³e³] 'the one (Class I) that ate (a fruit)'
   [mu³ki³] 'the one (Class II) that ate (a fruit)'
   [mu³ʔi⁴] 'the one (Class IV) that ate (a fruit)'

(53) Tone 1
/pa¹/ (be tired) →
   [pa³e³] 'the one (Class I) that’s tired’
   [pa³ki³] ‘the one (Class II) that’s tired’

11 Stressed syllables with tone 2 are realized as tone 5 before the Class I nominalizer -e³, but tone 2 before other triggers of the tone circle (54).
[paʔtʰ] ‘the one (Class IV) that’s tired’

(54) Tone 2

a. /ja²/ (be mature) →
   [ja’e³] ‘the one (Class I) that’s mature’
   [jaʔki³] ‘the one (Class II) that’s mature’
   [jaʔtʰne³] ‘the one (Class III) that’s mature’
   [jaʔtʰtʰ] ‘the one (Class IV) that’s mature’

b. /mu²/ (send) →
   [mu’e³] ‘the one (Class I) that sent’
   [muʔki³] ‘the one (Class II) that sent’
   [muʔtʰtʰ] ‘the one (Class IV) that sent’

(55) Tone 3

a. /a³/ (give, inanimate singular object) →
   [a³e³] ‘the one (Class I) that gave (it)’
   [a³ʔki³] ‘the one (Class II) that gave (it)’
   [a³ʔtʰtʰ] ‘the one (Class IV) that gave (it)’

b. /mu³/ (weave) →
   [mu³e³] ‘the one (Class I) that wove’
   [mu³ki³] ‘the one (Class II) that wove’
   [mu³ʔtʰtʰ] ‘the one (Class IV) that wove’

(56) Tone 4

a. /pa⁴ʔtʰ/ (be a young adult) →
   [pa’e³] ‘the one (Class I) that’s young’
   [paʔtʰtʰ] ‘the one (Class IV) that’s young’

b. /mu⁴/ (be numerous) →
   [muʔe³] ‘many (Class I)’
   [muʔki³] ‘many (Class II)’
   [muʔtʰtʰ] ‘many (Class IV)’

(57) Tone 31

a. /a³¹/ (be thin) →

---

12 Participants find the Class II form paʔki³ semantically unacceptable for reasons involving noun class. All human referents in Class II are men/boys, and this verb cannot be predicated of individual men.
[a’e³] ‘the one (Class I) that’s thin’
[a’ki³] ‘the one (Class II) that’s thin’
[a’ʔi⁴] ‘the one (Class IV) that’s thin’

b. /mu³¹/ (pierce.with.spear) →
[mu’e³] ‘the one (Class I) that pierced (it)’
[mu’ki³] ‘the one (Class II) that pierced (it)’
[mu’ʔi⁴] ‘the one (Class IV) that pierced (it)’

(58) Tone 43
a. /pa⁴³/ (be.dry) →
[pa³¹e³] ‘the one (Class I) that’s dry’
[pa³¹ki³] ‘the one (Class II) that’s dry’
[pa³¹ʔi⁴] ‘the one (Class IV) that’s dry’

b. /ũ⁴³/ (go:SgS) →
[ũ³¹e³] ‘the one (Class I) that went’
[ũ³¹ki³] ‘the one (Class II) that went’
[ũ³¹ʔi⁴] ‘the one (Class IV) that went’

(59) Tone 51
a. /ko⁵¹/ (tease) →
[ko⁵¹e³] ‘the one (Class I) that teased’
[ko⁵¹ki³] ‘the one (Class II) that teased’
[ko⁵¹ʔi⁴] ‘the one (Class IV) that teased’

b. /tu⁵¹/ (pull) →
[tu⁵¹e³] ‘the one (Class I) that pulled’
[tu⁵¹ki³] ‘the one (Class II) that pulled’
[tu⁵¹ʔi⁴] ‘the one (Class IV) that pulled’

8.3. The nominalizer tone circle on non-stressed syllables

On unstressed syllables, the nominalizer tone circle causes a different – though partially overlapping – set of alternations than on stressed syllables. The tone circle alternations which occur on unstressed syllables are shown in (60). Tones 31, 43, 51, and 5 are not included as targets in (60) because they never occur on non-stressed syllables (tones 31, 43, 51) or never occur on the final syllable of a verb stem (tone 5).

(60)
a. /1/ → [5]
b. /1/ → [3]
The differences between the nominalizer tone circle on stressed syllables, represented in (50), and on non-stressed syllables, represented in (60), come down to the behavior of tones 1 and 4. Stressed tone 1 syllables are realized as tone 2 in the circle, but non-stressed ones are realized as tone 3. Likewise, stressed tone 4 syllables are realized as tone 1 in the circle, but non-stressed ones are realized as tone 5. Other differences between the circle on stressed vs. non-stressed syllables are epiphenomenal on differences in the inventory of the two syllable types.

(61) depicts the changes shown in (60) graphically. Below (61), (62) – (66) provide examples of the alternations on disyllabic verb stems with each possible stem-final tone. Trisyllabic verb stems display exactly the same alternations in the circle as disyllabic ones. Outcomes of the circle on trisyllabic stems are shown in (67) – (71).

(61)

![Diagram of the tone circle]

(62) Tone 1 Disyllabic

/ŋu='a'=ʔɨ/ (hurt=mouth) →

[ŋu'a³e³] ‘the one (Class I) whose mouth hurts’
[ŋu'a³ki³] ‘the one (Class II) whose mouth hurts’
[ŋu⁵a⁵ʔɨ] ‘the one (Class IV) whose mouth hurts’

(63) Tone 1 Disyllabic

/wiʔja¹/ (urinate) →

[wiʔja³e³] ‘the one (Class I) that urinates’
[wiʔja³ki³] ‘the one (Class II) that urinates’
[wiʔja³ʔɨ] ‘the one (Class IV) that urinates’

(64) Tone 2 Disyllabic

/de⁴³a²/ (talk) →

[de⁴³a⁵e³] ‘the one (Class I) that talks’

---

13 As with stressed syllables, unstressed syllables with tone 2 are realized with tone 5 before the Class I nominalizer, but with tone 2 before all other triggers (64, 69).
14 The realization of the verb root as tone 5 is in these examples is due to tone 1 dissimilation, not the tone circle. The realization of the second stem syllable as tone 5 is due to the tone circle. See §8.4.
[de⁴³a'ki³] 'the one (Class II) that talks'
[de⁴³a²ti⁴] 'the one (Class IV) that talks'

(65) Tone 3 Disyllabic
/i³ni⁵/ (listen) →
[i³ni²e³] 'the one (Class I) that listens'
[i³ni³ki³] 'the one (Class II) that listens'
[i³ni³ti⁴] 'the one (Class IV) that listens'

(66) Tone 4 Disyllabic
/o⁴gi⁴/ (vomit) →
[o⁴gi³e³] 'the one (Class I) that vomits'
[o⁴gi³ki³] 'the one (Class II) that vomits'
[o⁴gi³ti⁴] 'the one (Class IV) that vomits'

(67) Tone 1 Trisyllabic
/ju²=e³ja⁵/ (die=sister) →
[ju²e³ja⁵e³] 'the one (Class I) whose sister died'
[ju²e³ja³ki³] 'the one (Class II) whose sister died'
[ju²e³ja³ti⁴] 'the one (Class IV) whose sister died'

(68) Tone 1 Trisyllabic
/tʃi³³e²=ga⁵/ (bad=voice) →
[tʃi³³e³ga³e³] 'the one (Class I) that sounds bad'
[tʃi³³e³ga³ki³] 'the one (Class II) that sounds bad'
[tʃi³³e³ga³ti⁴] 'the one (Class IV) that sounds bad'

(69) Tone 2 Trisyllabic
/ta⁴³=i³tʃi³/ (big=really) →
[ta⁴³i³tʃi³e³] 'the one (Class I) that’s really big'
[ta⁴³i³tʃi³ki³] 'the one (Class II) that’s really big'
[ta⁴³i³tʃi³ti⁴] 'the one (Class IV) that’s really big'

(70) Tone 3 Trisyllabic
/wi³ja³e³/ (sing) →
[wi³ja³e³e³] 'the one (Class I) that sang'
[wi³ja³e³ki³] 'the one (Class II) that sang'
[wi³ja³e³ti⁴] 'the one (Class IV) that sang'

(71) Tone 4 Trisyllabic
/pu⁴³ra⁴³ki⁴/ (work) →
[pu⁴³ra⁴³ki³e³] 'the one (Class I) that worked'
[pu⁴³ra⁴³ki³ki³] 'the one (Class II) that worked'
[pu⁴³ra⁴³ki³ti⁴] 'the one (Class IV) that worked'
The identical behavior in the disyllabic, (62) – (66), and trisyllabic, (67) – (71), stems above shows that parity does not matter to the nominalizer tone circle – only the distinction between the stressed syllable and the other syllables of the stem.

In addition, these examples further show that the morphological composition of the stem is irrelevant to the effects of the tone circle. For example, compare the underived disyllabic stem wi³a¹ ‘urinate,’ in (63), with the derived trisyllabic stem t’ia³=e³=ga¹ (bad=voice) ‘sound bad’ in (68). Under the circle, the final tone 1 syllable in (63), an underived stem, and (68), a derived stem, behave exactly the same. Both are realized as tone 3, while a stressed tone 1 syllable subject to the circle (i.e. a monosyllabic verb root) would be realized as tone 2.

Last, the outcomes of the tone circle on multisyllabic stems demonstrate that the tone circle does not display effects of the Obligatory Contour Principle (OCP) (Leben 1973; Odden 1986). If the OCP applies at the lexical level in Ticuna, stems with level tone melodies – such as the melodies 1.1 (example (63), 3.3 (65), 4.4 (66), and 3.3.3 (70) – would be modeled as involving a single tone associated with multiple vowels. Assuming that the nominalizer tone circle affects the identity of this single tone, the circle is predicted to change the tone of every stem syllable. Thus, a /4.4/ verb such as o³gi⁴ ‘vomit’ should be realized as [5.5] when subject to the circle, while a /3.3.3/ verb such as wi³ja⁴e³ should be realized as [2.2.2]. In fact, only the last syllable changes under the circle. This is true for both disyllabic stems, as shown by (63), (65) and (66), and trisyllabic stems, as shown by (70). For example, underlying /4.4/ o³gi⁴ ‘vomit’ is realized as [4.5] [o³gi⁴], not [5.5] as predicted by the OCP analysis, and underlying /3.3.3/ wi³ja⁴e³ ‘sing’ is realized as [3.3.2] [wi³ja⁴e³], not [2.2.2] as predicted by the OCP analysis.

This indicates that the OCP does not apply at the lexical level in Ticuna. Stems with level tones, such as /4.4/ and /3.3.3/, should be represented as involving multiple tones with the same value – each linked to a distinct TBU – rather than a single tone linked to multiple TBUs.

8.4. Interactions of the nominalizer tone circle and other tone alternations

The nominalizer tone circle counterbleeds the process of tone 1 dissimilation in disyllabic stems with the underlying tone melodies /11/ and /11/.

Recall from §6.1 that tone 1 dissimilation applies to stressed tone 1 syllables which are immediately followed by another tone 1 or modal 1 syllable. Per §§8.2-8.3, the nominalizer circle also applies to tone 1 and 1 syllables, causing tone 1 syllables to be realized with tone 5, and tone 1 syllables to be realized with tone 3. Tones 3 and 5 are not triggers of tone 1 dissimilation. Thus, when the tone circle applies to the second syllable of a /11/ or /11/ stem, it eliminates the triggering environment of tone 1 dissimilation.

This raises the question of whether the dissimilation still applies when the nominalizer tone circle also applies. It does: when a disyllabic /11/ or /11/ stem undergoes the circle, both the tone 1 dissimilation and the tone circle apply. As shown in (72) and (73), the initial syllable is realized as tone 5, undergoing the same tone 1 dissimilation process as if the stem were not nominalized. The second syllable is realized with the tone assigned by the circle. That is, the second syllable is realized with tone 5 if it is underlyingly tone 1 (72), and tone 3 if it is underlyingly modal 1 (73).
The nominalizer tone circle is a morpho-tonological process targeting verb stems, triggered by certain morphosyntactic constructions involving subordination or relativization. Because the constructions that trigger the circle are not a natural class, I treat the nominalizer tone circle as a lexical property of some subordinating morphemes, rather than a grammatical tone process directly marking subordination.

The nominalizer tone circle applies to the final syllable of the verb stem. It fails to affect any tones on syllables to the left of the final syllable. If the final syllable is also the stressed syllable – that is, if the verb stem is monosyllabic – then the nominalizer tone circle causes the tone alternations shown in (50) (§8.2). If the verb stem is not monosyllabic, and the tone circle therefore applies to a non-stressed syllable, then the circle causes the alternations shown in (60) (§8.3). Among the five tones that can occur on both stressed and non-stressed syllables (tones 1, 1̰, 2, 3, and 4), the circle causes different changes on stressed vs. non-stressed syllables for two – tones 1 and 4. It causes the same changes on two other tones – tones 1̰ and 3 – and generally fails to cause changes to tone 2.

While the nominalizer tone circle is sensitive to the phonological distinction between stressed and unstressed syllables, it is not sensitive to any other properties of the verb stem, such as its syllable parity or morphological composition (§8.3). Additionally, the nominalizer tone circle never affects any syllable other than the stem-final syllable. Contrary to the predictions of the OCP (§8.3), in stems with a sequence of syllables with the same tone, it affects only the tone of the final syllable, not the tone of preceding syllables with the same tone. Likewise, in verb stems where the underlying representation meets the environment for tone 1 dissimilation, the circle fails to bleed dissimilation (§8.4). Thus, non-final syllables of a verb subject to the circle are always realized with exactly the same tones which they would display elsewhere.

9. General discussion

In the preceding sections, we have seen that in Ticuna, stress licenses additional segmental and tonal contrasts (§5), conditions phonological processes involving both segments and tones (§§6, 7), and conditions the outcome of the primary grammatical tone process (§8). In this section, I discuss broader implications of these phenomena – first, how they affect our typological understanding of word prosody in Amazonian languages (§9.1), and second, how they impact theoretical understanding of the relationship between tone and stress (§9.2).

9.1. Typological implications

As described here, the prosodic system of Ticuna is radically different from the prosodic system of all other Amazonian languages. In order to contextualize this description for readers
who are not familiar with Amazonian languages, here I note some of the most important differences between Ticuna and other languages of the region.

While many other Amazonian languages have contrastive tone, no other language in the region has more than two underlying tone levels (Hyman 2010, Epps and Salanova 2013: 2). As such, the tonal inventory of Ticuna – with five level tones and three contours (§3.2) – is substantially larger than the inventory of any other language in the region. This remains true even if some of the tones, such as level 5 or the contours, are seen as marginal because of their restricted distribution.

Related to the differences in inventory size are differences in the relationship between tone and stress. Although tone and stress coexist in a number of Amazonian languages, their interactions are always unlike those seen in Ticuna. For example, several Amazonian languages from unrelated families – including Iquito (Zaparoan; Michael 2011) and Kashibo-Kakataibo (Panoan; Zariquiey Biondi 2018) – display prosodic systems where lexical tone and stress are both present, and both realized as high pitch. This is clearly distinct from the situation in Ticuna, where tone and stress have dissociable acoustic correlates (§4.2).

A more comparable kind of tone-stress interaction appears in Hup (Naduhup; Epps 2008: 86), where only stressed syllables bear contrastive tone (i.e., stress licenses tone). But while stress plays a role in tone licensing in Ticuna (§5.2), it licenses not the presence of tone, but the availability of additional tone contrasts. There are no other Amazonian languages where stress expands the tone inventory in this way. Since other languages also have fewer tone contrasts to license, this difference can likewise be seen as epiphenomenal on inventory size.

Last, and related, grammatical tone has been described in other Amazonian languages, such as Bora (isolate; Thiesen and Weber 2012) – which is in contact with Ticuna today in the Cushillococha region – and several Tukanoan languages, including Kotiria (Stenzel 2013), Barasana (Gomez-Imbert and Kenstowicz 2000), and Máihíki (Farmer 2015). As in Ticuna, grammatical tone in other Amazonian languages tends to apply to verbs and mark nominalization or subordination (categories that often overlap). For example, the most productive grammatical tone process in Bora marks subordination (Thiesen and Weber 2012: 89-92) and grammatical tone in Máihíki arguably marks nominalization (Farmer 2015: 21-24).

Despite this similar grammatical function, the Ticuna nominalizer tone circle is phonologically quite different from the nominalizing and subordinating grammatical tone processes seen in Bora and Tukanoan languages. The nominalizing/subordinating tone processes seen in other Amazonian languages have relatively simple additive or subtractive effects, such as linking a high tone to the left edge of the verb in Bora, or deleting all non-root tones in Máihíki. In contrast, the Ticuna nominalizer tone circle does not simply add or remove tones from the verb stem. Instead, it subjects the verb stem to a set of alternations which includes both chain shift and circle shift components. Though chain and circle tone shifts are well attested in other world areas, such as Southeast Asia (Mortensen 2006), I am not aware of grammatical tone processes with chain/circle shift components in any other Amazonian language. As with the differences in contrast licensing, this difference can be seen as epiphenomenal on the tonal inventory. Chain and circle shifts are only logically possible in systems with more than two
values – otherwise, they are toggles (Baerman 2007) – and outside Ticuna, Amazonian tone systems only have two values.

Last, this comparative discussion raises the question of how the Ticuna tone system came into being. Answering this question would offer insights both for Amazonian linguistics and for our general understanding of the genesis of complex tone systems. But given the current tools of historical linguistics, the question cannot be answered. Since Ticuna is an isolate and does not have written historical records, nothing can be known about its historical phonology.

9.2. Theoretical implications

Phonologists interested in tone and stress are a primary audience for this study. I want to draw this audience’s attention to three properties of the Ticuna prosodic system.

9.2.1. Coexistence of tone and stress

There has been much debate about whether tone and stress can coexist within a language’s prosodic system (Hyman 2006). As described in this paper, the word prosody of Ticuna provides clear evidence that they can. Because of this language’s large tone inventory and large number of stress-conditioned processes, there is no coherent way to analyze its phonology without both tone and stress. Furthermore, and unlike in many East and Southeast Asian languages with both tone and stress (Brunelle 2017), there is no reason to treat the tones of unstressed syllables in Ticuna as reduced or neutralized.

In the nature and extent of its interactions between tone and stress, Ticuna looks most similar to Oto-Manguean languages, and especially Trique languages such as San Martín Itunyoso Trique (DiCanio 2008). Exactly like Ticuna, Itunyoso Trique displays fixed stress, lexical tone, and a prominent role for stress in contrast licensing for both segments and tones. The stress pattern is opposite that of Ticuna: while Ticuna stress is word-initial (§4.1), Trique stress is word-final (DiCanio 2008: 20). Yet stress has almost identical effects on segmental and tonal contrast in the two languages. In both Itunyoso Trique and Ticuna, stressed syllables allow additional consonant phonemes (DiCanio 2008: 42; §5.1); are the only syllables which license the vowel /o/ (DiCanio 2008: 48; §5.1); and are the only syllables which allow contour tones (DiCanio 2008: 157; §5.2). Many of the tonal and segmental contrast-licensing properties of stress found in Itunyoso Trique are also seen in other Mixtecan languages (DiCanio 2008: 30) and Oto-Manguean languages more broadly (DiCanio and Bennett 2018: 412).

While Oto-Manguean languages are the closest point of comparison for the stress-tone interactions discussed in this paper, they generally do not display stress-conditioned phonological processes. Ticuna, in contrast, has many stress-conditioned phonological processes (§§6-8) – perhaps reflecting the fact that it has much more agglutinating morphology than any Oto-Manguean language. Because the language displays stress-conditioned processes in addition to stress-based contrast licensing, Ticuna represents an even clearer example of stress-tone coexistence than Itunyoso Trique and prosodically similar Oto-Manguean languages.
9.2.2. Stress-conditioned phonology: Consequences for positional faithfulness

Stress-conditioned phonological processes are generally understood in terms of positional faithfulness (Beckman 1998) and to a lesser extent, positional markedness (Zoll 2004 [1998]). Since positional faithfulness is a very general concept, the stress-conditioned phonology seen in Ticuna could be modeled using the theory. However, I argue that positional faithfulness is not an analytically useful concept for all stress-conditioned phenomena in the language.

More specifically, positional faithfulness is helpful for understanding the segmental stress-conditioned processes presented here, but not the tone processes. The segmental processes of /i/ and /oa/ assimilation (§7) do represent an example of positional faithfulness (defined as increased faithfulness to stressed syllables), since they preserve the vowel quality of the stressed syllable and apply assimilation to other syllables. In contrast, the stress-conditioned tonal processes of tone 1 dissimilation and tone 43 assimilation represent the precise opposite of positional faithfulness. They repair marked tonal sequences by changing the tone of the stressed syllable, rather than those of unstressed syllables (§6). Similarly, the nominalizer tone circle causes tone alternations on both stressed and unstressed syllables. Where the alternations are different, as with tone 4, they are larger in magnitude (i.e., less faithful) on stressed syllables (§8), providing further evidence against positional faithfulness.

In sum, the tone phonology of Ticuna is clearly stress-conditioned, but that stress-conditioning involves prioritizing faithfulness to the tones of unstressed syllables. When morphology creates a marked tonal sequence, it is the tones of stressed syllables that change to repair it, and when grammatical processes cause tone change, that change is larger on stressed syllables. Studies that examine stress-conditioned phonology via the positional faithfulness framework do not contemplate unstressed syllable faithfulness, instead focusing phonologically on stressed syllable faithfulness (Beckman 1998) and phonetically on the articulatory and perceptual causes of reduction in unstressed syllables (i.e., unstressed syllable markedness; Gonzalez 2003).

With this context, modeling the stress-conditioned tone processes using positional faithfulness is completely possible. We only need to rank faithfulness to tone in unstressed syllables above general faithfulness to tone. But using positional faithfulness to analyze this phenomenon is not necessarily insightful. It provides no explanation for why Ticuna reverses the strong cross-linguistic pattern toward increased faithfulness to stressed syllables, or for why this reversal in positional faithfulness is found only for tone processes, not segmental ones.

Therefore, I suggest that the stress-conditioned tone processes require a different model than positional faithfulness. Positional markedness (Zoll 1998/2004), though less prominent in the literature than positional faithfulness, could easily be used to model tone 1 dissimilation and tone 43 assimilation. Constraints in this analysis would penalize marked structures on stressed syllables (e.g., tone 1 on a stressed syllable), possibly with phonetic motivations (e.g., the decreased airflow of creaky vowels conflicts with the increased duration associated with stress). On the other hand, while positional markedness may accommodate the simpler tone alternations, it is not clear that this theory can model the stress-conditioned portions of the nominalizer tone circle, which I discuss next.
9.2.3. Nominalizer tone circle: Consequences for models of grammatical tone

As the most important contribution in this paper, I want to draw readers’ attention to the nominalizer tone circle (§8) and its theoretical consequences. Most phonological processes described in this paper are fairly phonetically natural – assimilatory or dissimilatory – even when the repairs they make are phonetically unexpected, as in the case of tone 1 dissimilation. The tone circle, in contrast, is strikingly phonetically unnatural. It appears unmotivated by markedness, eliminating structures which are otherwise phonologically unmarked in the language. It is minimally constrained by faithfulness, making repairs that involve large phonetic changes to the underlying tone. And it eludes natural class analysis, giving disparate treatment to phonetically and (otherwise) phonologically similar tones.

Because of this unnaturalness, the tone circle cannot be modeled under any of the most recent theories of grammatical tone, such as those articulated by Mortensen (2006), McPherson and Heath (2016), Sande (2018), or Rolle (2018). The accounts of Mortensen (2006), McPherson and Heath (2016), and Sande (2018) are not appropriate to the tone circle because they are specific to grammatical tone phenomena that have different basic characteristics. Mortensen (2006) models tone circles that have the same number of inputs and outputs, while the nominalizer tone circle has different input and output inventories. McPherson and Heath’s (2016) account examines invariant replacive grammatical tone assigned by one constituent to another (e.g., L tone assigned by nominal possessors to the nouns they possess), while the nominalizer tone circle’s melodies are variable and not entirely replacive. And Sande (2018) models scalar tone shifts, while the nominalizer tone circle lacks the internal consistency of a scalar shift.

Rolle’s (2018) account of grammatical tone, based mostly on African languages data, comes closest to an adequate account of the tone circle. He analyzes all grammatical tone as floating tones, associated with morphemes that potentially also have segments and their own tones. Whether the floating tone of a grammatical morpheme replaces underlying tones, or combines with them according to general rules of the language’s tonology, is determined by a morpheme-specific constraint ranking (Rolle 2018: ch. 3).

Rolle’s grammatical tone architecture is very general, and therefore also very powerful. To use it to produce the facts that we saw in §8, all that we must add is the statement that grammatical tone morphemes may undergo phonologically conditioned suppletive allomorphy (Paster 2006) – that is, that the identity of the floating tones of a grammatical tone morpheme may undergo allomorphy conditioned by the tone and/or stress of another syllable in the environment. We can then restate the alternations of the circle by listing as many allomorphs of the floating grammatical tones as we observe unique input-output tone pairs. (74) shows how the beginning of this list of allomorphs would look, assuming for the purposes of argument that the morpheme which triggers the tone circle has no segmental content.

(74)

a. [⑤] / 1_ Accounts for /1/ → [5] in stressed and unstressed syllables
b. [② [+creaky voice]] / ’1_ Accounts for /1/ → [2] in stressed syllables
c. [③] / 1_ Accounts for /1/ → [3] in unstressed syllables
Yet effectively, the Rolle-style analysis suggested in (74) is different from the simple lists of alternations given in (51) and (61) only in notation. (51) and (61) represent the tone circle as a change to a tone that is already present in the underlying representation of the stem, while (74) represents it as linking of a floating tone. Analyzing the tone circle within this model, like analyzing the stress-conditioned phenomena using positional faithfulness, is possible. But it does not lead to different or greater insights about the circle than modeling it through rules.

In sum, most existing theories of grammatical tone cannot describe the nominalizer tone circle. Rolle’s (2018) theory can, with some adaptation; however, the Rolle-style analysis is not substantially different from a list of the surface alternations. These issues show that the nominalizer tone circle demands either (a) a new theoretical approach to grammatical tone, or (b) an analysis as something besides grammatical tone, such as ‘morphological’ or ‘inflectional’ tone, a concept most often encountered in Oto-Manguean linguistics (Palancar 2016).

10. Conclusion

From the beginning of this paper, my overview of the tone inventory (§3.2) made clear that – on the surface – tone is much more conspicuous than stress in the phonology of Ticuna. Yet stress is still present, as shown by the increased duration of stressed syllables (§4), the increased number of segmental and tonal contrasts licensed in stressed syllables (§5), and the large number of phonological processes conditioned by stress (§§6-8). Stress-conditioned processes are present in the segmental phonology (§6), general tone phonology (§7), and grammatical tone (§8), as well as in other domains (such as morphology) not covered in this paper. These findings seriously trouble our typological understanding of the phonology of Amazonian languages (§9.1). Many of the results are also challenging to model under current phonological theories. They represent important new data for theories of stress-conditioned phonology in general, stress-tone interactions, and grammatical tone (§9.2).
References


https://doi.org/10.1002/9780470756171.ch18