

RHYTHMICITY IN THREE PANOAN LANGUAGES

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1. Introduction¹

Panoan languages, including Capanahua, Huariapano and Shipibo, are reported to have various phonological phenomena conditioned by odd/even alternations. In Capanahua, a coda /ʔ/ is pronounced in odd-numbered syllables counting from the beginning of the word (1a), but it is deleted in even-numbered syllables (1b) (Loos 1969).

(1) Capanahua /ʔ/ alternation (from Shell 1975: 39)

(a) /hono-taʔ-ki/ [ʰo.no-taʔ.ki] ‘It is a wild pig’

(b) /hono-ma-ta-ki/ [ʰo.no-ma-ta.ki] ‘It isn’t a wild pig’

In Huariapano, [h] epenthesis takes place in the coda of open odd-numbered syllables (Parker 1994). For example, when the second syllable of the progressive suffix /-ini/ occurs in an odd-numbered syllable, [h] is epenthesized (2b). Epenthesis does not apply in even-numbered syllables (2a).

(2) Huariapano [h] alternation (from Parker 1998: 29)

(a) [pi.ʰni.kaj] ‘They are eating’

(b) [,βunajʰnih.kaj] ‘They are looking, searching’

In Shipibo, the emphatic suffix /-rib/ is pronounced [-ri.ba] after an odd number of syllables (3a), and [-ri.bi] after an even number of syllables (3b) (Lauriault 1948).

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(3) Emphatic suffix /-rib/: vocalic alternations (from Lauriault 1948: 22-23; IPA)

(a) [a.¹-ri.²ba.³-ku⁴] 'did it again'

(b) [¹a.-ma.-ri.²bi.³-ku⁴⁵] 'made him do it again'

In all of these cases, the odd/even alternation is a true generalization of the data. However, the question arises why a phonological process should be based on 'mere' counting, and what counting reflects. As Parker (1998: 31) puts it, generalizations relying on odd/even number counting have no explanatory force and go against the cross-linguistic evidence that languages cannot count beyond two. Another question is why so many of these processes should occur in Panoan.

Recent investigations in Panoan languages propose that so-called odd/even alternations are actually foot- or rhythmic-based (see Safir 1979 and González 2002 for Capanahua, Parker 1994, 1998 for Huariapano and Elías 2000 for Shipibo). The aim of this paper is to explore in detail the rhythmic bases for these alternations and the connections among them. Following Safir (1979) and González (2002) I argue that Capanahua /ʔ/ deletion is foot-related. I investigate the details of foot structure in this language, taking into consideration stress opacity and related rhythmic processes, and show how the distribution of coda /ʔ/ correlates with weak and strong positions in a foot.

Parker (1994) proposes that coda [h] epenthesis is a rhythmic process; Parker (1998) argues that, though rhythmic, coda [h] epenthesis does not directly relate to stress, and proposes the existence of two different metrical tiers in Huariapano: one for stress assignment, and another for [h] epenthesis. I propose to view the phenomenon in a different light. My account centers on the observation that [h] epenthesis mimics the default pattern for secondary stress, i.e., left-to-right syllabic trochees. I propose that, as in Capanahua, rhythmicity is preferentially achieved by the occurrence of [h] in strong footed syllables, not by stress. In general, secondary stress and [h] epenthesis will coincide; cases where they do not are explained by a preference to express rhythmicity segmentally rather than by stress.

Rhythmic alternations in Capanahua and Huariapano are instances of strictly foot-sensitive consonantal processes. Capanahua exemplifies a system where not all feet are stressed, and Huariapano a system where stress and foot structure do not line up. In both cases, a rhythmic alternation is realized by means of consonantal phenomena affecting laryngeal properties of codas. On the other hand, Shipibo has some instances of vocalic alternations in at least one of its suffixes. It will be shown that foot structure conditions all these alternations in the same manner, regardless of whether they target vowels or consonants.

The organization of this paper is as follows. Section 2 discusses the basic phonology and metrical system of Reconstructed Panoan, since its stress and tonal system shed light on the metrical systems of the Panoan languages under investigation. Section 3 focuses on the analysis of the metrical system and /ʔ/ deletion in Capanahua. The metrical system of Huariapano and the phenomenon of [h] epenthesis are discussed in section 4. Section 5 discusses the metrical system and suffix alternations in Shipibo. Finally, section 6 is the conclusion.

2. The Phonology of Reconstructed Panoan

Shell (1975) presents a reconstruction of early Panoan phonology based mainly on the comparison of the phoneme inventory and cognate words of seven Panoan languages spoken in Peru: Capanahua, Shipibo-Conibo, Amahuaca, Chacobo, Cashibo, Cashinahua, and Marínahua (also known as Sharanahua). A consonant chart for Reconstructed Panoan is provided in table 5.1. Note that */*ʔ/* was a phoneme and there was no */*h/*. This detail will be important in the discussion of the metrical system of Huariapano.

Table 5.1

Consonant chart of Reconstructed Panoan (IPA; from Shell 1975)

	Bilabial	Alveolar	Post-Alveolar	Retroflex	Velar	Glottal
Stop	*p	*t			*k *kʷ	*ʔ
Fricative	*β	*s	*ʃ	*ʂ		
Affricate		*ts	*tʃ			
Flap		*ɾ				
Nasal	*m	*n				
Approximant	*w		*j			

Syllables were of the type (C) V. There was only one vowel per nucleus. Consonant clusters—involving */*ʔ/*, */*s/*, */*ʃ/* and */*ʂ/*—occurred exclusively word-medially. In such cases, syllable boundaries might have been between the consonants in the cluster, or they could derive from the loss of a vowel among them from an earlier stage in the language. This second possibility is in accordance with the development of some present-day Panoan languages, where consonant clusters have developed out of the loss of a vowel in two-morpheme words (Shell 1975: 93).

Most words in Reconstructed Panoan had two or three syllables. Four-syllable words existed but they were probably formed of more than one morpheme. There was a phonemic tonal contrast between high and low tone; most probably high tone correlated with strong stress. Two-syllable words fell into two different tonal patterns. In the first pattern, the second syllable had high tone in all cases. In the second pattern, both syllables had low tone if the word was pronounced in isolation, and high tone in the first syllable and low tone in the second syllable otherwise (Shell 1975: 94-95). This contrast was lost in Capanahua, Shipibo-Conibo and Cashibo, where disyllabic words have high tone or strong stress in the first syllable and contrasting tone or stress in the second syllable.²

Reconstructed Panoan also had three-syllable words. In the development of Panoan languages, mono-morphemic three-syllable words were generally reduced to two syllables.³ In Capanahua, Shipibo-Conibo and Cashibo such words have

² This contrast was also lost in Cashinawa and Chacobo (Shell 1975).

³ Except in Chacobo and in some cases Sharanahua.

high tone or strong stress in the second syllable (Shell 1975: 97). As shown in (4), the final vowel was lost, causing the onset to re-syllabify as the coda of the preceding syllable (4a, b) or to delete (4c). It will be shown later that this development explains some apparent exceptions to the stress pattern in Capanahua and Shipibo.

- (4) Panoan: from three-syllable to two syllable words (from Shell 1975: 96)

	<u>Reconstructed Panoan</u>	<u>Capanahua</u>	<u>Gloss</u>
(a)	*ʔa.wi.ni	[ʔa.'win]	'wife'
(b)	*[ʔ]oʔ.pos.su	[ʔoʔ.'poʔ]	'chigoe (tropical flea)'
(c)	*ra.buuta	[ra.'bu]	'two'

3. Capanahua⁴

This section discusses /ʔ/ deletion in Capanahua. (3.1) presents an overview of Capanahuan phonology including its basic stress pattern. (3.2) provides a detailed analysis of the metrical system of the language in Optimality Theoretic terms. This is essential to show how /ʔ/ deletion coincides with the metrical structure of the language. Section (3.3) discusses the distribution of /ʔ/ and rhythmic processes in coda, including deletion and metathesis, and analyzes these in Optimality Theoretical terms. Section (3.4) considers a separate process in which [ʔ] occurs as an allophone of /tʃ/, and section (3.5) discusses apparent counterexamples to a metrical account of /ʔ/ coda deletion. Finally, (3.6) is the conclusion.

3.1. The phonology of Capanahua

Capanahua belongs to the North-Central branch of Panoan (Grimes 2000). In 1969 there were about 400 speakers, but only about thirty per cent of these remained by 1998 (Loos 1969, Loos and Loos 1998). According to Jose Alberto Elías (p.c.), who did fieldwork on this language, in 2001 there were only thirty people who could speak it and some additional people who could understand it.

Capanahua has 16 consonants and 4 vowels: /a/, /i/, /o/, /u/. There is no contrastive vowel length (Loos 1969). A consonant chart is included below; note that /ʔ/ is a phoneme in the language.

Syllables are generally of the type (C)V(C). The structure CCV is found only in the adverb /ska/ 'already'. The future modal /ʂaʔn/ exemplifies the only case of the syllable structure CVCC (Shell 1975: 40); in the surface, this string is realized as CVC (see section 3.5 for discussion).

In the surface forms of the language codas are restricted to the sibilants /s/, /ʃ/, /ʂ/, to the glottal stop, and to nasals (Shell 1975: 41). Other consonants which would be syllabified syllable-finally are deleted in the surface form. Nasals only surface as codas when they precede a non-continuant, as in [tsi.'pon.ki] 'down-

⁴ Unless otherwise noted, the Capanahua data throughout this paper comes from Loos (1969) and p.c., and Loos and Loos (1998).

river'. Nasal codas delete word-finally or before a continuant, causing concomitant nasalization of preceding and following strings of vowels and laryngeals. Some examples are /βimanan/ ['βi.ma.nā] 'face' and /ʔueran-ʔue/ ['ʔu.e.rā.ʔū.ē] 'push it' (Loos 1969: 177-181). Finally, coda /ʔ/ is special in that it only surfaces in odd-numbered syllables and deletes in even-numbered syllables. Thus, the word /taʔno/ 'grub' is pronounced ['taʔ.no], but the word /βitʃiʔ/ 'I grab' is pronounced ['βi.tʃi]. The distribution of coda /ʔ/ in Capanahua is discussed in section (3.3).

Table 5.2
Capanahua consonant chart (IPA, based on Loos 1969)

	Bilabial	Alveolar	Post-Alveolar	Retroflex	Velar	Glottal
Stop	p	t			k	ʔ
Fricative	β	s	ʃ	ʂ		h
Affricate		ts	tʃ			
Flap		r				
Nasal	m	n				
Approximant	w		j			

Capanahua has both a tonal and stress contrast. Both tone and stress coincide in citation forms (Loos 1969: 187). High and low tones are phonemic; stressed syllables have high tone. High tones are realized as mid word-finally. Since tone normally correlates with stress I abstract away from it; for more details see Loos (1969: 187ff).

Only one stress per word is reported, in either the first or second syllable (Loos 1969). Thus, there is a two-syllable window for stress assignment. Stress is assigned to a second heavy syllable, or else to the first syllable (5). Heavy syllables have underlyingly a post-vocalic word-final or a post-vocalic, pre-consonantal consonant. The only exception is /ʔ/, which never makes a syllable heavy.

(5) Main stress in Capanahua

(a)	[ruus]	'just'	/man/ [mā]	'you (plural)'
(b)	['ma.po]	'head'	['kin.tʃa]	'bare'
(c)	['tsis.ti]	'ashes'	['meʃ.pi]	'clumsy'
(d)	['tʃi.tʃi.ka]	'knife'	['βi.ma.nā]	'face'
(e)	['son.ta.ko]	'girl'	['ni/.βo.na.wu]	'walk along'
(f)	[hi.'sio]	'ant'	[βa.'kof]	'foam'
(g)	[tsi.'pon.ki]	'downriver'	[ʔo.'nan.na.wu]	'learn'
(h)	/raβitʃ/	[ra.'βi] 'two'	/mapop/ [ma.'po]	'clay'
(i)	/waran/	[wa.'rā]	'squash'	
(j)	[his.'mis]	'looker'	/piʃkap/ [piʃ.'ka]	'small'
(k)	[nuʂ.'nuʂ]	'brownbird'		
(l)	/βitʃiʔ/	['βi.tʃi] 'I grab'	/rakaʔti/ ['ra.ka.ti]	'he lies down'
(m)	/pi-tʃaʔtʃikin/	['pi.tʃa.tʃi.kɪ]	'to poke him in the ribs'	

Monosyllables, which are pronouns and clitics, never carry stress (5a). In words with two syllables or more, stress falls on the initial syllable whenever the peninitial syllable lacks a coda (5b-e). When the peninitial syllable has a coda, this syllable is stressed (5f-g). Stress is sensitive to the occurrence of underlying postvocalic consonants even if these are not pronounced in the surface (5h-i). If both the initial and peninitial syllable have a coda, stress falls on the peninitial syllable (5j-k). Finally, /ʔ/ is exceptional; even if it is postvocalic underlyingly, the syllable containing it does not attract stress (5l-m).

3.2. The metrical system of Capanahua

In this section I propose an analysis of the metrical system of Capanahua. This analysis is formalized with Optimality Theoretic constraints (Prince and Smolensky 1993). A preview of this analysis appears in (6).

(6) Preview: The metrical system of Capanahua

- (a) One and only one stress per word.
- (b) Left-to-right footing.
- (c) Exhaustive footing.
- (d) Syllables can be unparsed.
- (e) Trochaic rhythm.
- (f) Quantity-sensitivity.
- (g) Stress opacity.
- (h) Initial syllable light.

(a) *One and only stress per word:* (5) show that regardless of the number of syllables within a word, there is always one and only stress per word. The only exception is monosyllables, which are always unstressed. The constraints needed to capture these facts are defined below:

- (7) GRWD=PRWD A grammatical word must a prosodic word (Kager 1999)
 STRESS PROM Maximize stress prominence ‘Only one stress per word’
 *HEAD/Ǿ Foot heads are not unstressed (González 2003)
 LEFTMOST Align (Hd-Ft, Left, PrWd, Left) ‘The left edge of the head foot coincides with the left edge of some prosodic word’ (McCarthy & Prince 1993)

Monosyllables in Capanahua are clitics and pronouns (Loos 1969: 193). Function words are usually exempt from having a stress, presumably because they cliticize to a phonological word (Hayes 1995). For this reason, GRWD=PRWD will be assumed to apply to content words only, at least in Capanahua.

I propose the constraint STRESS PROM to capture the fact that in certain languages there is only one stress per prosodic word (Halle and Vergnaud 1987, Hewitt 1992, Van de Vijver 1998). Some examples are Creek and Modern Standard Arabic, where only the main foot is stressed. In these two languages, stress can only be derived if binary feet are built from the left edge and the rightmost foot is stressed; otherwise, the wrong syllable is stressed (Van de Vijver 1998: 36-42 and references therein).

STRESS PROM conflicts with *HEAD/Ǿ, which disallows unstressed foot heads. STRESS PROM is undominated in Capanahua, since no word has more than one stress. STRESS PROM outranks *HEAD/Ǿ. GRWD=PRWD is also undominated. The ranking of LEFTMOST is established later.

(b) *Left-to-Right footing*: Two facts point to left-to-right footing in Capanahua. First, stress is assigned either to the initial or the penultimate syllable in a word, no matter how many syllables the word has: [hi.'sis] 'ant', [l'son.ta.ko] 'girl', [l'niʔ.βo.na.wu] 'walk along'. If footing was right-to-left, in a three-syllable word with all light syllables—like [l'tʃi.tʃi.ka] 'knife'—the two final syllables would be footed together and stress would fall on the second syllable. The result would be unattested *[tʃi.(tʃi.ka)]. This shows footing is left-to-right rather than right-to-left.

Secondly, /ʔ/ deletion occurs in alternate even-numbered syllables from the beginning of the word. Consider the word /ʔotʃiti- ma- raʔ- taʔ- ki/ 'It is probably not a dog'. This word has two underlying syllable-final glottal stops, of which only one surfaces: [l'ʔo .tʃi. ti.ma. raʔ. ta.ki]. Assuming glottal stop deletion is foot-sensitive, there are two possible directions of parsing; left-to-right, and right-to-left. If feet are constructed left-to-right, deletion of the glottal stop in the morpheme /taʔ/ corresponds to the second syllable of a foot: [(ʔo .tʃi) (ti.ma.) (raʔ.ta.) ki]. If feet are constructed right-to-left, deletion corresponds to the first syllable of a foot: [ʔo. (tʃi.ti.) (m.raʔ.)(ta.ki)].

Two pieces of evidence argue against right-to-left footing. First, under right-to-left parsing the initial syllable of the word remains unparsed: [ʔo.(tʃi.ti) (ma.raʔ.) (ta.ki)]. Since the initial syllable is stressed in this word, this means that it cannot be unparsed. Second, right-to-left footing does not provide a unique generalization for glottal stop deletion. Under right-to-left footing, glottal stop deletion occurs both in the first syllable of a foot [ʔo.(tʃi.ti.) (ma.raʔ.) (ta.ki)] and in the second syllable of a foot: /βitʃiʔ/ [(l'βi.tʃi)] 'I grab'. Left-to-right footing captures the stress pattern of the language and the correct generalization for /ʔ/ deletion; it occurs only in the second syllable of a foot: [(ʔo. tʃi.) (ti.ma.) (ra.ʔta) ki] 'It is probably not a dog', /βitʃiʔ/ [(l'βi.tʃi)] 'I grab'. Assuming footing is exhaustive in Capanahua (see (c) below), these two facts are easily captured through the interaction of the following constraints:

- | | |
|-----------------|--|
| (8) ALL-FT-LEFT | Align (Ft, Left, PrWd, Left)
'Every foot stands at the left edge of the prosodic word'
(McCarthy and Prince 1993; Kager 1999) |
| ALL-FT-RIGHT | Align (Ft, Right, PrWd, Right)
'Every foot stands at the right edge of the prosodic word'
(McCarthy and Prince 1993; Kager 1999) |

I assume that footing can be assigned in both directions in the same language; however, in this case, the preferred direction is left-to-right. This means the constraint ALL-FT-LEFT has priority over ALL-FT-RIGHT (Tableau 1).

(c) *Exhaustive footing*: Despite the reported lack of secondary stresses, I claim that Capanahua has exhaustive footing. One piece of evidence is the rhythmic

Tableau 1
ALL-Ft-LEFT >> ALL-Ft-RIGHT

/βana-ipi-ki/	‘planted it yesterday’	ALL-Ft-LEFT	ALL-Ft-RIGHT
☞ a.	(βa.na) (ʔi.pi) ki	**	* , ***
b.	βa.(ʔna.ʔi.) (pi.ki)	* , ***!	**

distribution of coda /ʔ/. Coda /ʔ/ deletes in even-numbered syllables beyond the first two syllables. This situation is parallel to other languages such as Norton Sound Yupik, where consonantal phenomena occur in a foot-sensitive fashion in spite of the fact that not all feet have stress (see Van de Vijver 1998, González 2003 and references therein). Thus, the fact that /ʔ/ deletion occurs in even-numbered syllables is compatible with an analysis where syllables are footed in binary groups and deletion occurs on the second syllable of each foot. Further, it has been shown that languages can only count up to two. An analysis where syllables are grouped into feet fares better conceptually than an analysis where deletion occurs in the second, fourth, and sixth positions, because it limits counting to two.

Elaborating on the last point, I assume that syllables are organized into binary feet in Capanahua. Binariness can be achieved in a syllabic or in moraic sense; feet must have either two syllables, or two moras. The undominated constraint FOOT BINARITY (henceforth FTBIN) expresses this fact (Prince 1980, Kager 1989, Prince & Smolensky 1993).

(9) FTBIN Feet are binary under moraic or syllabic analysis

(d) *Syllables might be left unparsed*: Only when syllables cannot be part of a binary foot might they be left unparsed. Specific instances include light monosyllabic words, initial syllables followed by a heavy syllable—as in /hismis/ [hi.(ʔmis)] ‘looker’, /hisis/ [hi.(ʔsis)] ‘ant’—and final stranded syllables—as in /sontako/ [(ʔson.ta).ko] ‘girl’. PARSE SYLLABLE captures the tendency to parse syllables into feet (10) (Prince and Smolensky 1993). Tableau 2 shows that FTBIN >> PARSE SYLLABLE; syllables are parsed into feet as long as FTBIN is respected.

(10) PARSE SYLLABLE Syllables are parsed by feet

Tableau 2
FOOT BINARITY >> PARSE SYLLABLE

/tʃitʃika/	‘knife’	FOOT BINARITY	PARSE SYLLABLE
☞ a.	(ʔtʃi.tʃi.) ka		*
b.	(ʔtʃi.tʃi.) (ka)	*!	

PARSE SYLLABLE outranks ALL-FT-LEFT. It is better to leave syllables unparsed than to have all feet aligned with the left edge of the prosodic word (Tableau 3).

Tableau 3
PARSE-SYLLABLE >> ALL-FT-LEFT

/niʔβonawu/	‘walk along’	PARSE SYLLABLE	ALL-FT-LEFT
☞ a. ('ni.ʔ.βo) (na.wu)			**
b. ('niʔ.βo) na.wu		*!*	

In candidate (a), the rightmost foot is misaligned from the left edge by two syllables. Candidate (b) is perfect as regards ALL-FT-LEFT, but two syllables are left unparsed, so this candidate is dispreferred. So far, GRWD=PRWD, STRESS PROM, FT-BIN>>PARSE SYLLABLE>>ALL-FT-LEFT>>ALL-FT-RIGHT.

(e) *Trochaic rhythm*. Rhythm in Capanahua is trochaic for the following two reasons. First, stress is assigned to the initial syllable unless the peninitial syllable is heavy. Second, /ʔ/ deletion occurs in the second syllable within a foot starting from the left edge of the word, and it persists to the end of the word. This means that binary feet are formed where the first syllable of the foot is the head.

Trochaic footing in Capanahua explains both main stress assignment and /ʔ/ distribution. Stress falls on the head syllable of the main foot, as in [(‘ma.po)] ‘head’, [(‘tʃi.ji.) ka] ‘knife’, and [(‘tsis.ti)] ‘ashes’. /ʔ/ deletion occurs in the ‘complement’ or weak syllable of a foot, as in /βitʃiʔ/ [(‘βi.tʃi)] ‘I grab’. Undominated RHTYPE =TROCHAIC captures trochaic footing (11).

(11) RHTYPE = T Feet have initial prominence (Kager 1999)

(f) *Quantity-sensitivity*. It has been observed that the coda content of the second syllable is relevant for main stress assignment. A second syllable with an underlying postvocalic consonant is assigned stress even if the consonant is not pronounced. This suggests that at least for main stress assignment codas are moraic.

The only exceptional consonant is /ʔ/, which is never moraic. If it were, a word like /βitʃiʔ/ [(‘βitʃi)] would be stressed on the second syllable, which has a postvocalic /ʔ/ underlyingly. Plausibly, /ʔ/ is the only non-moraic consonant in Capanahua because it is among the least sonorous consonants. Moraicity is related to sonority; vowels, the most sonorous segments, are moraic in most languages. Moraicity of coda consonants is captured through WEIGHT-BY-POSITION (Hayes 1989, Sherer 1994). The fact that heavy syllables attract stress is captured through WEIGHT-TO-STRESS (Prince 1983, Prince and Smolensky 1993). The constraint *MORAIC /ʔ/ expresses the fact that /ʔ/ is never moraic (González 2002).

(12) WEIGHT-BY-POSITION (WBP) Coda consonants are moraic
WEIGHT-TO-STRESS (WSP) Heavy syllables are stressed
*MORAIC [ʔ] The glottal stop is non-moraic

Motivation for *MORAIC [ʔ] comes from the fact that [ʔ] is the lowest sonority segment; and the lower the sonority of a segment, the less able it is to support a mora (Zec 1994, 1995; Blevins 2002). The fact that /ʔ/ is non-moraic is probably related to the deletability and insertability of /ʔ/ in the language (see section 3.3 for details).

*MORAIC /ʔ/ is undominated and outranks WBP, since /ʔ/ is non-moraic. WSP is dominated either because not all heavy syllables are stressed. WSP outranks PARSE-SYLLABLE (Tableau 4); it is better to leave a syllable unparsed (candidate (a)) than not to assign stress to a heavy syllable (candidate (c)). WSP also outranks LEFTMOST (candidates (a, c) in Tableau 5). The rankings between PARSE and LEFTMOST and between WSP and WBP have not been established yet. The moraic content of the initial syllable is irrelevant for stress assignment, since the initial syllable is always light. This is discussed in more detail in (h) below.

Tableau 4
WSP >> Parse

/his/	'ant'	WSP	WBP	PARSE
☞ a. hi. (ʔsis)				*
	μ			
b. (ʔhi.sis)		*(!)	*(!)	
c. (ʔhi. sis)		*!		
	μ			

Tableau 5
WSP >> LEFTMOST

/his/	'ant'	WSP	WBP	LEFTMOST
☞ a. hi. (ʔsis)				*
	μ			
b. (ʔhi.sis)		* (!)	* (!)	
c. (ʔhi. sis)		*!		
	μ			

(g) *Stress Opacity*: Connected with quantity-sensitivity is the fact that only some syllable-final consonants are pronounced in the surface. These include /s, ʃ, ʒ/, which are unrestricted; /m, n/, which occur only before non-continuants, and /ʔ/, which is

found in unfooted or strong syllables. All other coda consonants— /w, j, ts, tʃ, p, t, k/—delete or are never found in coda position.⁵ (13) exemplifies cases where syllable-final /w/ and /tʃ/ delete. Examples of other coda consonants are found in (5). Deletion of coda /tʃ/ is analyzed in detail in section (3.4).

(13) Coda condition (Loos 1969: 167)

- (a) /haw+jama/ [ʰo.ja.ma] ‘not come’
 (b) /raβitʃ/ [raʰβi] ‘two’

In spite of deletion, underlying postvocalic consonants make a syllable heavy and attract stress. Previous descriptions of the language state that stress is assigned before the deletion of coda consonants (Loos 1969). I will refer to this as the *rule-based approach*. In derivational terms, the fact that a coda consonant attracts stress even if deleted in the surface produces *opacity*. (14) provides a rule-based derivation for the minimal pair [ma.ʰpo] ‘clay’ and [ʰma.po] ‘head’, which differ only in the location of stress. The derived word [ʰma.po.pan] ‘clay (subject)’ is also included since it provides evidence for a final underlying /p/ in [ma.ʰpo] ‘clay’.

(14) Derivation: [ma.ʰpo] ‘clay’, [ʰma.po.pan] ‘clay’, and [ʰma.po] ‘head’

UR	/mapop/	/mapop/	/mapo/
STRESS ASSIGNMENT	ma (ʰpop)	(ʰmapo) pan	(ʰmapo)
CODA CONDITION	ma (ʰpo)	(ʰmapo) pā	—
SR	ma (ʰpo)	(ʰmapo) pā ⁶	(ʰmapo)

Since stress can be predicted from the (underlying) coda consonant, stress is not lexical. Within Optimality Theory, there are various possibilities to account for opaque cases, including Sympathy Theory (McCarthy 1998, 1999), Output-Output correspondence (Benua 1997) and Turbidity (Goldrick 2000 and Goldrick and Smolensky 2000). I propose to account for opacity in stress assignment in Capanahua with a Turbid approach.

According to the theory of turbid representations, outputs can be complex, which means that they can contain both pronounced and unpronounced material. For example, an input like /mapop/ in Capanahua maps to the output [maʰpo], where the last syllable is footed in apparent violation of footing structure. However, this output has a covert or ‘turbid’ structure, where unpronounced material influences the pronunciation of other parts of the output (Goldrick 2000). The idea is that there is a single but complex output representation rather than intermediate stages in a derivation.

Turbid Representations include two types of output associations: *projection*, and *pronunciation*. *Projection* is a structural or abstract relation between a segment/

⁵ Shell (1975: 41) mentions that there is an instance of coda /h/ in Capanahua, in the word /ʔohno/ [ʰʔoh.no] ‘there at a distance’; this word seems to have been borrowed from Shipibo. Furthermore, [h] is sometimes found in coda position in Capanahua through optional sibilant debuccalization before [r]: /his-riʔbi/ ‘ant + also’ [hi.ʰsihriʔβi] (Loos 1969: 185). Thus, I consider [h] as a possible coda in Capanahua.

⁶ In Capanahua, coda nasals delete except before a non-continuant consonant, causing concomitant nasalization of the preceding vowel. For more details, see Loos (1969).

-nasal]- μ . In Tableau 7, the final /p/ in /mapop/ is not pronounced because it violates *[-cont, -nasal]- μ . However, /p/ projects a mora and attracts stress.

Tableau 6
/his/ 'ant'

/his/ 'ant'	FT-BIN	*[-cont, -nasal]- μ	*[+cont, +son]- μ	MAX-IO	PROJECT WBP	PRON- μ	R ^{XY}
a. hi.(^h sis) μ							
b. hi.(^h si<s>) μ						*(!)	*(!)
c. hi.(^h si<s>)	*!				*		
d. hi.(^h sis)	*!				*		
e. hi.(^h si)	*!			*			
f. hi.(^h hi.sis)					*!		
g. (^h hi.si<s>) μ						*(!)	*(!)
h. (^h hi.si<s>)					*!		
i. (^h hi.si)				*!			

A comparison among candidates (a, c, f, g, i) in Tableau 7 shows that *[-cont, -nas]- μ MAX-IO, WSP and PROJECT WBP dominate PRONOUNCE- μ and R^{XY}. So far there is no direct evidence about the relative ranking of MAX-IO, WSP and PROJECT WBP, so I assume that they are not ranked between them. Undominated FTBIN has been included for comparison.

In Tableau 7, candidate (a) is optimal; it has an unpronounced mora-projecting coda and violates low-ranked PRONOUNCE- μ and RECIPROCITY. Candidates (b, d, e) fall out under undominated FTBIN. Candidate (c) violates *[+cont, +son]- μ . Candidate (f) shifts the stress to the first syllable, parsing the two syllables into a foot and deleting the coda consonant. This violates MAX-IO. Finally, candidates (g, i) violate PROJECT-WBP since they have non-moraic coda consonants, and candidate (h) violates WSP because a heavy syllable is not stressed.

(h) *Initial syllable light*. On discussing the best metrical structure for Capanahua, Safir (1979: 104) considers one option where the initial syllable is stipulated to be always light. I argue that this is the case, as supported by two different pieces of evidence. First, monosyllables are never stressed and lack high pitch, even if they have a coda consonant. Examples include [rus] 'just', [ra?] 'perhaps', and /han/ [hā] 'he'. Second, in words with both first and second heavy syllables, the second syllable is stressed rather than the first (Loos 1969). Examples include [mun'tsis] 'nail', [pij.'ka<p>] 'small' and [his.'mis] 'looker'. This

Tableau 7
/mapop/ ‘clay’

/mapop/ ‘clay’	IN	*[-cont -nas]μ	*[+cont, +son] μ	I		N μ	R
a. a.ma.(¹ po<p>) μ						*	*
b. ma.(¹ po<p>)	*!					*	
c. ma.(¹ pop) μ		*!					
d. ma.(¹ pop)	*!					*	
e. ma.(¹ po)	*!			*			
f. (¹ ma.po)				*!			
g. (¹ ma.po<p>)						*!	
h. (¹ ma.po<p>) μ					*!	*	*
i. (¹ ma.pop)						*!	

means that in words like /sontako/ ‘girl’ and /tsisti/ ‘ashes’ the first syllable is parsed as part of a two-syllable foot: [(¹son.ta).ko], [(¹tsis.ti)]. However, in words like [rus] ‘just’ and /hismis/ ‘looker’, the first syllable remains unparsed: [rus] ‘just’, [his.(¹mis)]. If this is correct, Capanahua builds moraic trochees of the form (¹LL) or (¹H) for main stress (17).

(17) Capanahua foot structure

(a)	[rus]	‘just’	/man/ [mā]	‘you (plural)’
(b)	[(¹ ma.po)]	‘head’	[(¹ kin.tʃa)]	‘bare’
(c)	[(¹ tʃit.ʃi) ka]	‘knife’	[(¹ son.ta.) ko]	‘girl’
(d)	[hi.(¹ sis)]	‘ant’	[ʔo.(¹ nan.)(na.wu)]	‘learn’
(e)	/raβitʃ/ [ra.(¹ βi)]	‘two’	/mapop/ [ma(¹ po)]	‘clay’
(f)	[his.(¹ mis)]	‘looker’	/piʃkap/ [piʃ.(¹ ka)]	‘small’
(g)	/βitʃiʔ/ [(¹ βi.tʃi)]	‘I grab’	/raka/ti/ [(¹ ra.ka.) ti]	‘he lies down’
(h)	/pi-tʃa/tʃikin/ [(¹ pi.tʃa.)(tʃi.ki)]	‘to poke him in the ribs’		

In order to capture the light status of initial syllables in Capanahua I propose the constraint INITIAL LIGHT. While this constraint seems to be specific to Capanahua, future research might reveal its application to other languages or its wider motivation.¹⁰ INITIAL LIGHT and WSP dominate WBP, as tableau (8) shows.

¹⁰ Two other languages where INITIAL LIGHT might be relevant are Cashibo and Shipibo-Conibo. Shell (1987: 2) reports that in Cashibo stress falls on the first syllable unless the second syllable ends

(18) INITIAL LIGHT Initial syllables are light

Tableau 8
INITIAL LIGHT >>WBP

/rus/	'just'	INITIAL LIGHT	WSP	WBP
☞ a. rus				*
b. rus μ			*!	
c. ('rus) μ		*!		

In tableau 9, candidate (b) is selected because both syllables are parsed together into a disyllabic foot, respecting both FTBIN and PARSE.

Tableau 9
FOOT BINARITY >> Parse

/tsisti/	'ashes'	FT BIN	PARSE
a. ('tsis.) ti			*!
☞ b. ('tsis.ti)			

So far, the ranking among stress and foot structure constraints is: GRWD=PRWD, STRESS PROM, RHTYPE=T, FTBIN, *MORAIC /?/, INITIAL LIGHT >>WBP>>WSP, LEFTMOST, PARSE>>ALL-FT-LEFT>>ALL-FT-RIGHT, *HEAD/ǫ̃. Below are summary tableaux for cases ('LL), ('HL), L('H), H(H), and ('LL)L. For simplicity, the cover constraint 'STRESS' subsumes undominated INITIAL LIGHT, GRWD=PRWD, STRESS PROM, RHTYPE=T and FTBIN.

- In disyllabic words with two light syllables, both syllables are footed together and the first syllable is stressed (Tableau 10). Candidate (a) does not violate any constraint and thus is selected as optimal.
- Disyllabic words with initial heavy and peninitial light syllables stress the first syllable. Both syllables form a foot, because of undominated INITIAL LIGHT

in a consonant. The situation in Shipibo-Conibo is similar, with the difference that the second syllable might also have stress if it ends in a nasal vowel, or in some cases, an oral vowel (Shell 1975: 47). See Shell (1975) and section 2 in this paper for the connections of these languages as to their development from Reconstructed Panoan.

(Tableau 11). Candidates (a, b, d, e) violate undominated constraints. Candidates (c, f) tie on a violation of WBP; candidate (f) loses on a violation of PARSE.

Tableau 10
('LL) /mapo/ 'head'

/mapo/ 'head'	STRESS	WBP	LEFTMOST	PARSE	AFL
☞ a. ('ma.po)					
b. (ma.'po)	*! (Rh=T)				
c. ('ma.)po	*! (FtBin)			*	
d. ma. ('po)	*! (FtBin)			*	*
e. ma.po	*! (Gw=Pw)			**	

Tableau 11
('HL): /tsisti/ 'ashes'

/tsisti/ 'ashes'	STRESS	WBP	LEFTMOST	PARSE	AFL
a. ('tsis.) ti μ	*! (Initial Light)			*	
b. tsis. ('ti)	*!(FtBin)	*	*	*	*
☞ c. ('tsis.ti)		*			
d. (tsis.'ti)	*!(Rh=T)	*			
e. tsis.ti	*! (Grw=Prw)	*		**	
f. ('tsis) ti		*		*!	

- When a disyllabic word is formed of an initial light and a peninitial heavy, the second syllable is footed on its own and stressed; the first syllable remains unparsed (Tableau 12). Candidate (a) violates LEFTMOST, but it is optimal since the other candidates violate higher-ranked constraints.
- Tableau (13) exemplifies a three-syllable word formed of three lights. The two first syllables are footed together, and the first syllable is stressed. Candidate (a) violates PARSE but is selected over candidates (b-e), which violate higher-ranked constraints.
- Finally, tableau 14 shows the four-syllable word /ʔonannawu/ 'learn'. Candidates (b, d-f) violate undominated constraints. Candidate (c) violates high-ranked WBP, and (d) high-ranked WSP. Candidate (a), with violates lower-ranked PARSE and AFL, is selected as optimal.

Tableau 12
L ('H): /his/ 'ant'

/his/ 'ant'				F		
☞ a. hi.('sis) μ				*	*	*
b. ('hi.) sis	*! (FtB)		*		*	
c. (hi.'sis)	*(Rh=T)		*			
d. hi.sis	*! (Grw=Prw)		*		**	
e. ('hi.sis) μ		*!				
f. ('hi.sis)			*!			

Tableau 13
(‘LL) L: /tʃitʃika/ ‘knife’

/tʃitʃika/ ‘knife’			F		F
☞ a. ('tʃi.tʃi.) ka				*	
b. tʃi.('tʃi.ka)			*!	*	*
c. ('tʃi.) (,tʃi.ka)	*! (SP, FB)				*
d. ('tʃi.) (tʃi.ka)	*!(FB)				*
e. (tʃi.) ('tʃi.ka)	*!(FB)		*		*

3.4. The distribution of /ʔ/

/ʔ/ is a special segment in Capanahua. It can occur as an onset or a coda. As an onset it can be epenthesis in two different cases: between vowels at a morpheme juncture (19a-c) and before liquids at a sentence juncture (19d-e). Onset /ʔ/ is also deleted word-medially in some cases (19f-i). /ʔ/ is non-deletable in the remote past morpheme (18f, h), but it can be deleted in the recent past morpheme (19g, i).

(19) Epenthesis and deletion of onset /ʔ/ (from Loos 1969: 176-177)

- | <u>Epenthesis</u> | | |
|-------------------|------------------|------------------------|
| (a) /βana-i/ | [βa.na.ʔi] | ‘planting’ |
| (b) /pi-i/ | [pi.ʔi] | ‘eating’ |
| (c) /βana-ipi-ki/ | [βa.na.ʔi.pi.ki] | ‘planted it yesterday’ |

- (d) /βana-wu/ [ʔβa.na.wu] 'plant'
 (e) /raʔmaβi +ruɾa-wu/ [ʔraʔ.ma.βi.βi.ru.ɾa.wu] 'chop now'

Deletion

- (f) /mapuɯt-ʔoʃki/ [ma.'pu.ʔoʃki] 'he ascended (remote past)'
 (g) /mapuɯt-ʔa-ʃ-ki/ ['ma.pu.taʃ.ki] 'he ascended (recent past)'
 (h) /hamak-ʔoʃki/ [ha.'ma.ʔoʃ.ki] 'he stepped (remote past)'
 (i) /hamak-ʔo-ʃ-ki/ ['ha.ma.kaʃ.ki] 'he stepped (recent past)'

Tableau 14
 /ʔonannawu/ 'learn'

/ʔonannawu/ 'learn'				F		
a. ʔo.(ʔan).(na.wu) μ				*	*	*, **
b. (ʔo.'nan).(na.wu)	*!(Rh=T)		*			**
c. (ʔo.nan).(na.wu)			*!			**
d. (ʔo.nan).(na.wu) μ		*!				**
e. ʔo.(nan.)(na.wu) μ	*! (Stress Prom)			*	*	*, **
f. ʔo.nan.na.wu	*! (Gr=Pr)		*			

/ʔ/ is also deleted in specific coda positions. The description given by Loos (1969) states that coda [ʔ] surfaces in odd-numbered syllables, including monosyllables (20a-f), but that it deletes in even-numbered syllables (20g-h).

(20) Distribution of coda /ʔ/ (from Loos 1969)

- (a) /taʔ/ [taʔ] *Declarative modal*
 (b) /raʔ/ [raʔ] 'Probably'
 (c) /taʔno/ [t¹taʔ².no] 'Grub'
 (d) /ʔiʔsap/ [ʔiʔ¹sa²] 'Bird'
 (e) /ʔonan-iʔ-ki/ [ʔo.na.niʔ³.ki⁴] 'He knows'
 (f) /ʔoʃa-kaʔina-ʔ-ki/ [ʔo.ʃa.ka.ʔi.niʔ⁵.ki⁶] 'He falls asleep'

- (g) /βitʃ-iʔ/ [¹βi.tʃi²] ‘I grab’
- (h) /rakaʔti/ [¹ra.k²a.ti³] ‘he lies down’
- (i) /pi-tʃaʔtʃikin/ [¹pi.tʃa.tʃi³.ki⁴n] ‘to poke him in the ribs’
- (j) /hono-ma-taʔ-ki/ [¹ho.no.ma.t³a.ki⁴]⁵ ‘it is not a wild pig’

A number of alternations show that /ʔ/ is underlying. The examples below involve the declarative modal /-taʔ-/ and the adverb /-raʔ-/. In (21a), /taʔ/ occurs in the fifth syllable of a word; /ʔ/ remains. However, when this suffix occurs in the sixth syllable of a word (21b), /ʔ/ is not pronounced. The same thing happens with /raʔ/.¹¹

(21) Alternations: /taʔ/ *declarative modal* and /raʔ/ ‘probably’

- (a) [ʔo.tʃi.ti³.ra.taʔ⁵.-ki⁶] ‘It is probably a dog’
- (b) [ʔo.tʃi.ti³.ma.raʔ⁵.-ta.ki⁷] ‘It is probably not a dog’

The distribution of coda /ʔ/ cannot be due to epenthesis in odd-numbered syllables since open odd-numbered syllables are tolerated, as in /mapo/ [ʔma.po] ‘head’, /tʃitʃika/ [ʔtʃi.tʃi.ka] ‘knife’.

It was stated above that syllable counting is not desirable since crosslinguistically languages do not show sensitivity to numeric count beyond two and /ʔ/ coda deletion proceeds further than the two first syllables of the word. I proposed that syllables are organized into feet in Capanahua, and that the generalization that coda [ʔ] is allowed only in odd-numbered syllables is an epiphenomenon of foot structure. More specifically, /ʔ/ deletes in the second syllable of a foot. Since Capanahua has trochees, the position where coda /ʔ/ deletes corresponds to a weak footed syllable. Coda /ʔ/ is pronounced elsewhere, i.e., in strong footed syllables and in unfooted syllables. Examples (11, 12) are restated below:

(22) Distribution of /ʔ/

- | | | |
|---|------------------------------|----------------------------|
| (a) /taʔ | [<u>taʔ</u>] | <i>declarative modal</i> |
| (b) /raʔ/ | [<u>raʔ</u>] | ‘probably’ |
| (c) /ʔiʔsap/ | [ʔiʔ. (ʔsa)] | ‘bird’ |
| (d) /taʔno/ | [(ʔtaʔ.no)] | ‘grub’ |
| (e) /ʔonaniʔki/ | [(ʔo.na.) (niʔ.ki)] | ‘he knows’ |
| (f) /ʔoʃakaʔinaiʔki/ | [(ʔo.ʃa.) (ka.ʔi.) (niʔ.ki)] | ‘He falls asleep’ |
| (g) /βitʃiʔ/ | [ʔβi.tʃi] | ‘I grab’ |
| (h) /rakaʔti/ | [(ʔra.k ² a) ti] | ‘he lies down’ |
| (i) [(ʔo.tʃi.) (ti. <u>ra.</u>) (<u>taʔ</u> . ki)] | | ‘It is probably a dog’ |
| (j) [(ʔo. tʃi.) (ti. ma.) (<u>raʔ</u> . <u>ta.</u>) ki] | | ‘It is probably not a dog’ |

¹¹ An additional alternation is shown in example (1) in this chapter.

I propose to treat deletion of coda /ʔ/ in weak footed syllables as a prominence-reducing process that aims at maintaining a rhythmic contrast between the two syllabic components of a foot. The head of a foot can have /ʔ/ as coda, but its complement cannot. This is an instance of the general tendency of languages to show rhythmicity. Other examples are discussed in González (2003: chapters 2, 3).

My proposal is that coda [ʔ] deletion achieves rhythmicity, making weak syllables weaker in Capanahua. Furthermore, I propose that coda [ʔ] deletion is a rhythmically-oriented process which, in the absence of secondary stresses, helps to organize syllables into strong and weak pairs. Prominence- and rhythmic-based consonantal phenomena occur in numerous languages (González 2003: ch. 2, 3). In some cases they reinforce metrical structure of the language. In this case, /ʔ/ deletion makes up for the lack of secondary stresses in the word. [ʔ] remains in unfooted syllables because the strong/weak contrast is not relevant in that position (11a-c).

A related process in Capanahua that shows the effect of rhythmicity is onset-to-coda /ʔ/ metathesis. /ʔ/ metathesis occurs in odd-numbered syllables, especially in fast speech (23a) (Loos and Loos 1998). If the syllable already has a coda /ʔ/, onset /ʔ/ deletes (23b).

(23) Onset-to-coda metathesis (Loos and Loos 1998: 21, 22; IPA)

- | | | | |
|-----|---------------|---------------------|-----------------|
| (a) | /kɛtsin-ʔino/ | [ke.(ʔtsɪ̃)(iʔ.no)] | ‘painted tiger’ |
| (b) | /toaʔiʔka/ | [('to.a.)(iʔ.ka)] | ‘mattress’ |

Interestingly, metathesis ‘deletes’ the onset to produce a coda, a structure which is cross-linguistically dispreferred. However, onset-to-coda metathesis creates a contrast between the two syllables of a foot that would otherwise have equal strength. The occurrence of both /ʔ/ deletion in weak syllables and metathesis in strong syllables strongly suggest that the nature of both processes is rhythmic.

Safir (1979) was the first to propose a foot structure analysis for coda /ʔ/ deletion in Capanahua, whereby /ʔ/ deletion applied in the weak position of a binary (trochaic) rhythmic group. I take his proposal a step further and claim that /ʔ/ deletion and onset-to-coda metathesis tend towards the same goal: the distinction between strong and weak syllables in a language where only one stress per word is reported. Thus, this process is not only metricaly conditioned; it also has a metrical motivation. Furthermore, I claim that metrical structure can be present in a language in the absence of stress with segmental indicators of rhythm. In the case of Capanahua and the languages considered in González (2003: ch. 2), these indicators are consonantal, and can arise through very different processes.

Next I outline an analysis in Optimality Theoretical terms of both /ʔ/ deletion and onset-to-coda movement. For /ʔ/ deletion, I propose that a force aiming toward making the weak syllable weaker takes precedence over deletion of /ʔ/ (24).

- (24) MAX-IO (NO DELETION) Every element of the input has a correspondent in the Output (McCarthy & Prince 1995)
- | | | |
|-----------|---------------------|--|
| NO CODA | (*C]) _σ | Syllables are open (Prince & Smolensky 1993) |
| *WEAK/CVC | | Weak syllables do not have codas (González 2003) |

*WEAK/CVC is a near mirror image of STRESS-TO-WEIGHT ‘If stressed, then heavy’ (Myers 1987, Riad 1992); in other words, ‘the strong get stronger’. While STRESS-TO-WEIGHT enforces heaviness of stressed syllables, *WEAK/CVC enforces weakness of non-stressed syllables, i.e. ‘the weak get weaker’.¹² Weak syllables are in this case weak footed syllables. Unfooted syllables are neither weak nor strong because they do not contrast rhythmically with any other syllable.

Additionally, the ranking *WEAK/CVC >> NO CODA is a case of a specific constraint ranked over a general constraint. The ranking *WEAK/CVC, *MORAIC [ʔ] >> MAX-IO >> NO CODA captures /ʔ/ deletion in weak footed syllables (tableaux 15-17). A comparison between candidates (a, b) in Tableaux 15, 16 shows that MAX-IO >> NO CODA. Similarly, a comparison between candidates (a) and (b), and (a) and (c) in Tableau 17 shows, respectively, that *WEAK/CVC >> MAX-IO, and that *MORAIC [ʔ] >> MAX-IO. Note that MAX-IO dominates PROJECT-WBP; [ʔ] does not delete unless forced by *WEAK/CVC, even if it violates PROJECT-WBP (Tableau 18).

Tableau 15

[ʔ] remains in strong footed syllable

/taʔno ‘grub’	*WEAK/CVC	*MORAIC [ʔ]	MAX-IO	NO CODA
☞ a. (ʔtaʔ.no)				*
b. (ʔta.no)			*!	
c. (ʔ taʔ) no μ		*!		*

Tableau 16

[ʔ] remains in unfooted syllable

/taʔ declarative modal	*WEAK/CVC	*MORAIC [ʔ]	MAX-IO	NO CODA
☞ a. taʔ				*
b. ta			*!	
c. (ʔ taʔ) μ		*!		*

*WEAK/CVC and *MORAIC [ʔ] are undominated, since they are always respected. The ranking *WEAK/CVC >> MAX-IO won’t make all codas in the language delete, since apart from /ʔ/, the rest of the codas in the language are moraic

¹² I thank Adam Ussishkin for bringing this fact to my attention.

Tableau 17
[ʔ] deletes in weak footed syllable

/βitʃiʔ/ ‘I grab’	*WEAK/CVC	*MORAIC [ʔ]	MAX-IO	NO CODA
☞ a. (‘βi.tʃi)			*	
b. (‘βi.tʃiʔ)	*!			*
c. βi.(‘tʃiʔ) μ		*!		*

Tableau 18
Max-IO >> Project-WBP

/raʔ/ ‘perhaps’	MAX-IO	PROJECT-WBP
☞ a. a. raʔ		*
b. b. ra	*!	

and will make their syllable heavy. /ʔ/ is thus deleted because it is the only weightless coda.

The distribution of /ʔ/ deletion cannot be attributed to positional faithfulness to stressed syllables (Beckman 1998), since there is only one main stress per word and /ʔ/ can surface in codas beyond the second syllable in the word. It cannot be attributed to positional faithfulness to the strong or first syllable in a foot, since coda /ʔ/ occurs in unfooted syllables.

The constraints just discussed account for the rhythmic deletion of /ʔ/ in weak syllables. In order to derive onset-to-coda /ʔ/ metathesis in strong footed positions *HEAD/CV is needed to enforce a rhythmic contrast between strong and weak syllables within the same foot (González 2003). Rhythmic contrasts in Capanahua aim at reducing prominent weak syllables, and at enhancing strong syllables. /ʔ/ has to be available inside the foot to be deleted or metathesized; epenthesis of /ʔ/ in coda is banned (25).

- (24) *HEAD/CV Head syllables are not open (González 2003)
 DEP-IO (NO EPENTHESIS) Every element of the output has a correspondent in the input (McCarthy & Prince 1995)
 LINEARITY-IO The output reflects the precedence structure of the input, and vice versa (McCarthy and Prince 1995)
 (*[c.g.]...[c.g.])_σ A sequence of [c.g.] is prohibited within a syllable (Suzuki 1998: 126)

*HEAD/CV enforces a prominence contrast between the strong (head) and weak (complement) syllables of a binary foot by way of the strong syllable having a coda. Since all consonants except for /ʔ/ are moraic and Capanahua is quantity-sensitive,

the only consonant that respects both *HEAD/CV and WBP is /ʔ/. DEP outranks *HEAD/CV. A contrast between strong and weak footed syllables is created by deletion of an underlying /ʔ/ in coda of a weak syllable, or by ‘moving’ an underlying /ʔ/ in onset to coda position in strong footed syllables rather than by epenthesis of /ʔ/ in the coda of all foot heads. Thus, DEP >> *HEAD/CV >> LINEARITY (Tableaux 19, 20).

Tableau 19
Onset-to-coda metathesis of [ʔ]

/ketsin-ʔino/ ‘painted tiger	DEP	*HEAD/CV	LINEARITY	MAX	*CODA
☞ a. ke.(¹ tsi<n>.)iʔ.no <div style="margin-left: 40px;"> </div> <div style="margin-left: 40px;">μ μ</div>			*		*
b. ke.(¹ tsi<n>.)ʔi.no <div style="margin-left: 40px;"> </div> <div style="margin-left: 40px;">μ</div>		*!			

In tableau 19, candidate (a) is preferred over candidate (b) because the disyllabic foot formed at the end of the word expresses a rhythmic contrast between its syllables; this contrast is missing in (b). Candidate (b) fares better on LINEARITY and NO CODA, but in this language expressing a rhythmic contrast within a foot has preference. Since /ʔ/ occurred in the input, no epenthesis or deletion take place, only a change in linearity. Tableau 20 shows that epenthesis of coda /ʔ/ is not permitted. Candidate (a), which violates *HEAD/CV, is selected over candidate (b), which epenthesizes /ʔ/.

Tableau 20
Failure of epenthesis in binary feet

/mapo/ ‘head’	DEP	*HEAD/CV	LINEARITY	MAX	*CODA
☞ a. (¹ ma.po)		*			
b. (¹ maʔ.po)	*!				*

(*[c.g.]...[c.g.]_σ) is a dissimilatory constraint proposed by Suzuki (1998) to account for deletion of /ʔ/ in Seri (Hokan: Mexico). In Capanahua, this constraint enforces only one instance of /ʔ/ per syllable. In strong syllables with two glottal stops, the onset /ʔ/ deletes in order to respect *HEAD/CV (Tableau 21). It is predicted that when a sequence of two /ʔ/ occurs in weak or unfooted syllables, the glottal stop surfacing in coda will delete to satisfy NOCODA, since *HEAD/CV is not relevant in unfooted positions. Unfortunately, no examples of this case have been found.

Tableau 21
Onset-to-coda metathesis of [ʔ]

/toaʔiʔka/ 'mattress'	*cg...cg] _σ	*HEAD/CV	LINEARITY	MAX	*C] _σ
☞ a. (to.a.) (iʔ.ka)		*		*	*
b. (to.a.) (ʔiʔ.ka)	*!	*			*
c. (to.a.) (ʔi.ka)		**!		*	

The set of constraints in (25) do not replace the constraints that account for coda /ʔ/ deletion. Consider Tableau 22. The set of constraints in (25) would select as optimal the candidate where no deletion applies (candidate b); rather, (a) is selected. Undominated *WEAK/CVC captures this case (Tableau 23).

Tableau 22
Deletion of [ʔ] (I)

/bitʃiʔ/ 'I grab'	DEP	*HEAD/CV	LINEARITY	MAX	*CODA
⊖ a. ('bi.tʃi)		*		*!	
☞ b. ('bi.tʃiʔ)		*			*
c. ('biʔ.tʃi)	*!		(*)	*	*
d. ('biʔ.tʃiʔ)	*!		(*)		**

Tableau 23
Deletion of [ʔ] (II)

/bitʃiʔ/ 'I grab'	*WEAK/CVC	DEP	*HEAD/CV	LINEARITY	MAX	*CODA
☞ a. ('bi.tʃi)			*		*	
b. ('bi.tʃiʔ)	*!		*			*
c. ('biʔ.tʃi)		*!		(*)	*	*
d. ('biʔ.tʃiʔ)		*!		(*)		**

A constraint penalizing [β, r] in onsets outranks DEP, since /ʔ/ is epenthesized in these cases (Tableau 24); this constraint is undominated.

This section has shown that coda /ʔ/ achieves rhythmicity through deletion and onset-to-coda metathesis. It has also been shown that /ʔ/ is epenthesized in certain situations. /ʔ/ is unique in various ways. It is the only segment epenthesized before /β, r/ sentence-initially and the only segment that undergoes rhythmic deletion and metathesis. A question is why /ʔ/ is targeted rather than any other segment. It is

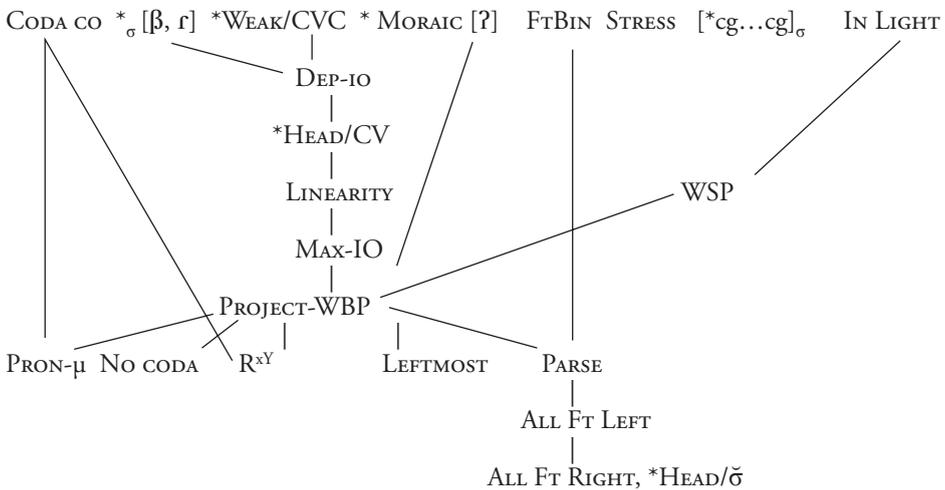
plausible that /ʔ/ is targeted because it has no place features, or because it does not contribute to weight in Capanahua, i.e., because it is non-moraic (cf. Parker 1998). The epenthesis, deletion and metathesis facts where /ʔ/ is involved suggests that both explanations are relevant. Usually, epenthetic consonants in languages are less marked, and tend to be coronal or laryngeal.

Tableau 24
 *σ [β, r] >> Dep

/βana-wu/	'plant'	* _σ [β, r]	DEP
☞ a.	(ʔβa.na.) wu		*
b.	(βa.na.) wu	*!	

So far I have provided an OT analysis of the foot and stress system of Capanahua, including opaque effects between stress and coda consonants. This analysis brings new insights to the metrical system of Capanahua and to the connection between foot structure and the distribution of /ʔ/. Capanahua exemplifies a language where rhythmicity is brought about by consonantal alternations. Specifically, /ʔ/ deletion and onset-to-coda metathesis enforce a contrast between strong and weak syllables within a foot. Furthermore, rhythmicity makes up for the lack of secondary stress in the language. To close this section, I provide a ranking lattice for Capanahua (26). For reasons of space, constraints *[-CONT, -NASAL]-μ and * [+CONT, +SON]-μ are subsumed under CODA CONDITION, and constraints RHT=T, STRESS PROM and GRWD=PRWD under STRESS.

(26) Capanahua: ranking lattice



3.5. [ʔ] as an allophone of /tʃ/

Unlike other non-continuant consonants in Capanahua, /tʃ/ does not always delete syllable-finally. In some occasions, it is pronounced as [ʔ] (27).

(27) Realization of /tʃ/ (Loos 1969 and p.c.)

(a)	/nitʃ-i/	[(¹ ni.tʃi)]	‘He walks’
(b)	/βe-nitʃi/	[(¹ βe.ni.) tʃi]	‘He walks on the surface’
(c)	/nitʃ-we/	[(¹ niʔ.we)]	‘Walk!’
(d)	/βe-nitʃ-ritʃβi-i/	[βe.(¹ ni.) (riʔ.βi)]	‘He walks on the surface again’

The morpheme ‘walk’ has /tʃ/ in the input. /tʃ/ is realized as an affricate in onsets (27a, b). (27c) shows that /tʃ/ has a [ʔ] allophone in coda position; [ʔ] is in strong footed position. Example (27d) is puzzling. The syllable with input /tʃ/ is stressed, which means that it forms its own foot; however, [ʔ] does not occur. But [ʔ] occurs as the allophonic realization of another input /tʃ/ in the third syllable of the same word.

Under a rule-based approach which depends on an odd/even generalization, the distribution of [ʔ] exemplified in (27c, d) is not problematic. /ʔ/ is simply not pronounced in coda of even-numbered syllables. Derivationally, after stress assignment, coda /tʃ/ turns into [ʔ]. Then, [ʔ] falls to the glottal stop deletion rule (28).

(28) [niʔ.we] ‘Walk!’, [βe¹ni. ri tʃ.βi] ‘He walks on the surface again’

UR	/nitʃ we/	/βe nitʃ ritʃβi/
STRESS ASSIGNMENT	¹ nitʃ.we	βe. ¹ nitʃ.ritʃ.βi
CODA /tʃ/ → [ʔ]	¹ niʔ.we	βe ¹ niʔ.riʔ.βi
CODA [ʔ] DELETION (EVEN)		βe ¹ ni.riʔ.βi
SR	[¹ niʔ.we]	[βe ¹ ni.riʔ.βi]

Under a foot structure analysis, the absence of [ʔ] in strong positions is problematic. (27d) appears to support the claim that [ʔ] distribution relates to an odd/even generalization rather than to foot structure (Loos 1969). However, this only occurs when an input /tʃ/ is involved. Consider the suffix /riʔβi/ ‘again’ (29), a lexicalized combination of [ritʃ] ‘yet’ and emphatic [βi] (Loos, p.c.).

(29) Suffix /ritʃβi/ [riʔ.βi] ‘again’

(a)	/his-ritʃβi-we/	[his.(¹ ri.) (βi.we)]	‘Look again’
(b)	/βe-his-ritʃβi-we/	[βe. (¹ is.) (riʔ.βi) we]	‘Look him in the face again’
(c)	/his-ritʃβi-ma-wi/	[his.(¹ ri.)(βi.ma.)wi]	‘Make him take a second look’
(d)	/his-ma-ritʃβi-wi/	[(¹ his.ma.)(riʔ.βi.)wi]	‘Show to him again’
(e)	/nitʃ-ritʃβi-we/	[niʔ. (¹ ri.) (βi.we)]	‘Walk again’

There appears to be a conflict between /tʃ/ mora projection and its pronunciation. /tʃ/ either projects a mora and attracts stress or it turns into [ʔ]. Compare (29a, b) and (29c, d). In (29a, c), /tʃ/ is not pronounced but it projects a mora and

attracts stress. In (29b, d), coda /tʃ/ is realized as non-moraic [ʔ], and the syllable is part of a bigger foot. Finally, in (29e) two adjacent syllables have /tʃ/ in syllable-final position. The second syllable attracts stress; /tʃ/ projects a mora but is not pronounced. The first syllable realizes /tʃ/ as [ʔ] and remains unpaired.

I propose that stress and foot structure are responsible for this split. /tʃ/ is special in the consonant system of Capanahua in that it is the only supra-laryngeal consonant that has the potential to be non-moraic. /tʃ/ is moraic only when stress is relevant. A moraic /tʃ/ attracts stress. This happens in the second syllable of the word. As seen before, the second syllable has priority over the first for stress assignment in case the second syllable is heavy.

There is a drive to parse all syllables in the word into feet. If /tʃ/ is moraic, parsing might leave a syllable unfooted. If there is an available syllable next to it, then the mora of /tʃ/ is not projected, but rather, /tʃ/ is reduced to [ʔ], creating a contrast between the two syllables of the foot.

The distribution of /tʃ/ is captured through the interaction between stress and foot structure constraints. Some tableaux are included below. Tableau (25) shows a word where /tʃ/ is pronounced as [ʔ] in coda. Candidate (a) violates PROJECT WBP. Candidates (b, c) violate high-ranked INITIAL LIGHT and *[-cont, -nasal]-μ.

Tableau 25

/tʃ/ → [ʔ]

/nitʃ-we/ 'walk'	INITIAL LIGHT	*[-cont, -nasal]-μ	*HEAD/ CV	MAX	PROJECT WBP	PARSE
a. ('niʔ.we)					*	
b. ('ni<tʃ> we μ	*!					*
c. ('nitʃ.we)		*!			*	

Tableau 26 shows a word where two underlying syllable-final /tʃ/ occur. The first is not pronounced in the surface but projects a mora, and the second is pronounced as [ʔ]. Candidates (b) and (c) violate high-ranked *[-cont, -nasal]-μ and MAX-IO, respectively. Candidate (d) violates *HEAD/CV. Candidate (a), which violates lower-ranked PROJECT WBP, is selected as optimal.

These examples suggest that there are three different sources for the glottal stop in Capanahua: underlying, epenthetic, and derived (Figure 5.1). Underlying /ʔ/ is phonemic; it is present in the input, and it is pronounced everywhere except in coda of a weak syllable in a foot. Epenthetic /ʔ/ occurs before a vowel word-medially in some cases, and sentence initially before /β, r/. It can also occur through metathesis for rhythmic reasons. Finally, there is a derived [ʔ] which is an allophone of [ʔ]; it is found in coda of certain syllables. Recognizing that there are three sources for [ʔ] and that nevertheless foot structure and stress condition them

Tableau 26
/βe-nitʃ-ritʃβi-i/ 'He walks on the surface again'

/βe-nitʃ-ritʃβi-i/	INIT. LIGHT	*[-cont, -nasal]-μ	*HEAD/CV	MAX	WBP	PARSE
a. βe.(^ʔ ni<tʃ>).(riʔ.βi) μ					*	*
b. βe.(^ʔ nitʃ;).(riʔ.βi) μ		*!			*	*
c. βe.(^ʔ niʔ.ri.) βi				*!	*	**
d. (^ʔ βe.niʔ;).(riʔ.βi)			*!	*	**	

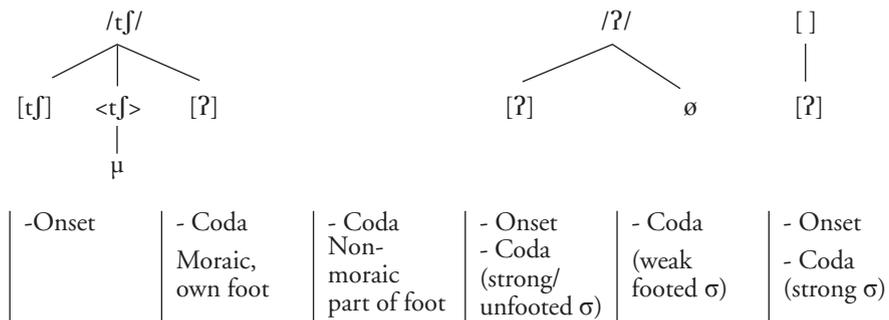


Figure 5.1
Sources of [ʔ] in Capanahua

still captures the fact that [ʔ] is never pronounced in weak footed syllables. A foot-structure analysis is superior to the descriptive generalization that all instances of coda [ʔ] occur in odd-numbered syllables; it makes clear the connection between foot structure and stress to coda deletion processes and [ʔ] distribution.

3.5. Exceptional cases

Sections 3.3, 3.4 have shown that /ʔ/ distribution is consistent with a moraic trochee analysis of foot structure in Capanahua. This section examines potential counterexamples for this distribution: (i) suffixes that always keep coda /ʔ/, and (ii) H(LL) cases with [ʔ] in the third syllable.

(i) Some suffixes always keep their glottal stop regardless of their position in the word (Loos 1969 & p.c.). This is problematic for both a foot structure and an odd/even alternation analysis, since /ʔ/ would surface in both strong and weak syllables, or both in odd and even numbered positions. Examples of these suffixes are /ʃaʔn/ *future subjunctive* and /ʃiʔk/ *future indicative*.

- (30) Suffixes keeping [ʔ]: /ʂaʔn/ *future subjunctive* and /ʂiʔk/ *future indicative*
- | | | | |
|-----|--------------------|-------------------------|----------------------------------|
| (a) | /ʂaʔn/ | [ʂãʔ] | <i>future subjunctive</i> |
| (b) | /ka-tan-ʂaʔn-wu/ | [ka('tã) (ʂãʔ.ũũ)] | 'Go over there
sometime soon' |
| (c) | /wu-ra-ja-ʂaʔn-wi/ | [('wu.ra) (ja.ʂãʔ) wi] | 'Push it sometime' |
| (d) | /ʂiʔk/ | [ʂiʔ] | <i>future indicative</i> |
| (e) | βbana-ʂiʔk-i/ | [('ba.na.) (ʂiʔ.ki)] | 'will plant' |
| (f) | /bana-ma-ʂiʔk-i/ | [('ba.na.)(ma.ʂiʔ.) ki] | 'will cause to plant' |

For the future subjunctive suffix, /ʔ/ is kept in unfooted position (30a), in strong position (30b), and in weak position (30c). Coda /n/ is not pronounced because the following syllable starts with a non-continuant; however, it nasalizes the preceding /ʔ/ and the vowel. In the future subjunctive suffix, /ʔ/ also occurs in unfooted, strong and weak syllables (30d–f). However, in this case /k/ is resyllabified as the onset of the next syllable (30e, f).

There are two possible ways to account for this distribution. One is that these suffixes are exceptional and form their own prosodic word. This is suggested by Loos (p.c.), who mentions that these suffixes seem to derive from a previous periphrastic construction in which they were auxiliaries. According to Loos, they still remain outside the prosodic word, plausibly because they maintain their stem status and start a new prosodic word. Another instance is /jaʔpa/, 'the one who has'; this suffix always maintains its glottal stop (Loos 1969).

The second alternative is to explain the status of these suffixes through opacity. As seen before, outputs in Capanahua contain covert structure, and the interaction between constraints enforcing deletion of segmental material and constraints enforcing projection of moraic consonants generally resolves in mora projection of coda consonants. For the suffix /ʂaʔn/, /n/ projects a mora, provided that /n/ is pre-consonantal or word-final. The output representation for this suffix would be [ʂãʔ<n>]. As a consequence, /ʂaʔn/ is a foot on its own. No matter what its position in the word is, this suffix is always heavy preceding a consonant-initial morpheme, and /ʔ/ is always kept because /ʂaʔn/ is always in a strong position. For [ʂiʔ<k>], /k/ resyllabifies as onset in examples (29d–f) above; before a consonant, /k/ deletes and /ʔ/ remains, as in ['has.ka.βi ska 'ha.no.ʂiʔ.ʔue] 'May you be like this forever' (Loos and Loos 1998: 508). The revised footing and output structure for the future suffixes is provided in (31).

- (31) Revised footing for /ʂaʔn/
- | | | | |
|-----|--------------------|-----------------------------|----------------------------------|
| (a) | /ʂaʔn/ | [ʂaʔ<n>] | <i>future subjunctive</i> |
| (b) | /ka-tan-ʂaʔn-wu/ | [ka ('ta <n> (ʂaʔ<n>) wu] | 'go over there
sometime soon' |
| (c) | /wu-ra-ja-ʂaʔn-wi/ | [('wu.ra) ja (ʂaʔ<n>) wi] | 'push it sometime' |
| (d) | /ʂiʔk/ | [ʂiʔ<k>] | <i>future indicative</i> |
| (e) | /bana-ʂiʔk-i/ | [('ba.na.) (ʂiʔ<k>.) ki] | 'will plant' |
| (f) | /bana-ma-ʂiʔk-i/ | [('ba.na.) ma.(ʂiʔ<k>.) ki] | 'will cause to plant' |

Two facts argue against this alternative. First, this would not explain the suffix /jaʔpa/, which also keeps its glottal stop. Second, for the future indicative suffix, /k/ has to be posited as moraic in spite of resyllabification with the following vowel (31e, f). Consequently, I assume the suffixes considered in this section are exceptional in that they are prosodically independent. However, the distribution of coda /ʔ/ in these cases is not problematic, since /ʔ/ occurs in the first syllable of a foot, which is a strong position; thus, it does not contradict other facts in its distribution.

(ii) Cases like the following would be expected to be found in Capanahua:

(a)	Odd Even Odd (H) (L L)	(b)	Odd Even Odd (H) (L L)
	 ʔ]σ		 ʔ]σ

In both cases, a heavy syllable disrupts footing; it interrupts binary syllabic footing and makes footing restart. The moraic trochee analysis and the odd/even alternation analyses make different predictions for both cases. The odd/even alternation analysis predicts that coda /ʔ/ will remain in (a) since it occurs in an odd-numbered syllable; it will delete in (b) since it occurs in an even-numbered syllable. The foot structure analysis predicts that /ʔ/ should not occur in (a) since it appears in a weak syllable; it should appear in (b), since it occurs in a strong syllable. Cases that appear to be like (a) are shown in (32).

(32) CVC L L (from Loos p.c. and Loos and Loos 1998)¹³

(a)	his-nikaʔ-bo	[('his.ni.)(<u>ka</u> ʔ.bo)]	‘those who see, seers’
(b)	('hoʂ.ko.) (roʔ.ti)		‘to fall, to trip’
(c)	('hen.ke.) (tsaʔ.pa)		‘which kind’
(d)	('han.po.) (koʔ.ti)		‘to get full with food’
(e)	tana-nikaʔ-bo	[('ta.na.) (ni. <u>ka</u> .) bo]	‘those who track’
(f)	tanan-nikaʔ-bo	[ta.(‘ran.) (<u>ka</u> .bo)]	‘those who roll things’

In (32a-d), a closed syllable occurs followed by two light syllables, the second of which has a coda /ʔ/; [ʔ] surfaces. The derivational approach captures this fact due to the assumption that /ʔ/ occurs in odd-numbered syllables. The moraic trochee account discussed in (3.2) fares as well, since under this account an initial closed syllable is always light.

In (32f), a second heavy is followed by two lights, the first of which loses its coda /ʔ/. This goes against both a derivational and a moraic trochee account, since this is odd-numbered position, and since this is strong footed position. However, compare (32f) with (32e); one syllable has been deleted in (32f). A plausible explanation is that the deleted syllable in (32f) is present and footed in the output; I will leave this matter for further investigation. Further examples including heavy syllables in non-initial syllables would be needed to support the conclusion that the

¹³ Thanks to Eugenio Loos and José Alberto Elías Ulloa for providing these examples.

examples in (32) are not counterexamples to the distribution of the glottal stop for the derivational and moraic trochee account. To the best of my knowledge, these examples are not reported in the literature.

3.6. Conclusion

The preceding sections have shown that /ʔ/ deletion in Capanahua is consistent with a foot structure analysis, whereby coda /ʔ/ deletes in weak footed syllables in order to make weak syllables weaker. /ʔ/ does not delete in unfooted syllables since the strong/weak contrast is not relevant in such positions. The fact that only /ʔ/ has this function is related to its placeless nature and the fact that it is not moraic.

A foot structure analysis of /ʔ/ deletion in Capanahua has three main advantages over an odd/even alternation analysis. First of all, this analysis obtains both the distribution of coda /ʔ/ and the stress system of the language. Second, in combination with the turbidity approach, this analysis obtains the distribution of coda /tʃ/ and apparent counterexamples. Finally, this account brings explanation to this process; namely, glottal deletion has a rhythmic motivation.

/ʔ/ deletion is fully regular in Capanahua. I propose that in the absence of secondary stresses in the language, /ʔ/ achieves a metrical effect by grouping syllables into weak and strong. I suggest that different Panoan languages achieve this effect through segment structure in different ways. In the remainder of this chapter I investigate related rhythmic processes in Huariapano and Shipibo.

4. Huariapano

Huariapano has a process of coda [h] epenthesis which mirrors in various ways coda /ʔ/ deletion in Capanahua. While laryngeal fricatives are epenthesized in Huariapano, laryngeal stops are deleted in Capanahua. Both processes take place in coda position and are rhythmically conditioned. This section focuses on how exactly [h] epenthesis is rhythmically conditioned and how it contrasts with /ʔ/ deletion in Capanahua. I will show that [h] epenthesis is strictly conditioned by foot structure, and that footing and stress do not always line up in the language.

Huariapano, also known as Wariapano or Panobo, has been extinct since 1991 (Parker 1994, Grimes 2000). The main sources for the data and description of this language are Parker (1994), (1998). Parker (1994) proposes that coda [h] epenthesis is a rhythmic process. Parker (1998) argues that, though rhythmic, coda [h] epenthesis does not directly relate to stress, and proposes the existence of two different metrical tiers in Huariapano: one for stress assignment, and another for [h] epenthesis. I argue that the distribution of coda [h] is the same as default secondary stress, and suggest that the apparent irregularity of the distribution of coda [h] regarding stress is due to conflicting ways of assigning secondary stress.

The discussion focuses on the synchronic state of the language, but it also takes into account the historical development from Reconstructed Panoan and comparative evidence from Panoan. Section 4.1 discusses the phonological and stress system of Huariapano and provides an Optimality Theoretic account of the metrical system of the language. 4.2 presents the distribution of coda [h] epenthesis. My proposed

analysis of coda [h] epenthesis is described in 4.3. Finally, section 4.4 focuses on historical and comparative evidence to bear from other Panoan languages.

4.1. Huariapano phonology

Table 5.3 shows the consonant chart of Huariapano. The only difference with the consonant phonemes of Capanahua is the lack of /ʔ/. There are 4 vowels: /i, u, a, o/.

Table 5.3
Huariapano consonant chart (IPA, from Parker 1994: 96)

	Bilabial	Alveolar	Post-Alveolar	Retroflex	Velar	Glottal
Stop	p	t			k	
Fricative	β	s	ʃ	ʂ		h
Affricate		ts	tʃ			
Flap		r				
Nasal	m	n				
Approximant	w		j			

The syllable structure is (C)V(C); glides can be the second part of an onset. /s, ʃ, ʂ, n, m, j, w, h/ can be codas. Syllable-final /n/ optionally deletes, and can also nasalize a preceding vowel (Parker 1998: 3). The distribution of coda /h/ is predictable (see section 4.2). [ʔ] occurs optionally in word final position after a vowel but it does not contribute to weight; one example is /pino/ ['pi.no]~['pi.noʔ] 'hummingbird' (Parker 1994: 97). Monosyllabic content words are stressed and must have a coda or a long vowel; ['paw] 'she'll', ['jān] 'lake', ['βo:] 'hair', ['tʃi:] 'fire' (Parker 1998: 3). Long vowels occur only in monosyllabic words.

Main stress generally falls on the penultimate syllable (33a-c). Final syllables with coda consonants are stressed (33d).¹⁴ This means that Huariapano forms quantity-sensitive, moraic trochees at the right edge of the word (Parker 1998: 5). This is the opposite edge for main stress as in Capanahua and Shipibo.

(33) Huariapano main stress (from Parker 1998: 2–5; IPA)

- (a) ['hi.wi] 'branch, stick' ['ta.poʔ] 'cot'
 (b) ['win.ti] 'oar, paddle' ['rus.βi] 'rope'

¹⁴ Parker (1998: 4) reports that final syllables with underlying coda consonants are stressed. However, the only consonant that can delete in the surface is /n/, and this deletion is optional, not obligatory (Parker 1998: 3). Thus, the right generalization appears to be that final syllables with codas are stressed, and that deletion of syllable-final /n/ is a phonetic process. One further argument is that [h] epenthesis can occur in a syllable where a coda nasal has deleted: [jāh.'tā] 'afternoon; late' (Parker 1998: 29) (see also section 5.3). Consequently, unlike in Capanahua, opacity-related constraints are not needed in the account of the metrical system of this language.

- | | | | | |
|-----|-------------|----------------|----------------|---------|
| (c) | [ka.'no.ti] | 'bow (weapon)' | [ram.bo.ʂo.βo] | 'knees' |
| (d) | [ja.'wiʃ] | 'opossum' | [ʂa.'βin] | 'bee' |

There are exceptional forms where stress falls on a light final syllable. Such words form about a quarter of disyllabic nouns and adjectives (Parker 1994: 98). Some examples are [uʃ.'ta] 'garbage' and [jo.'βu] 'witch'. In most cases verbal suffixes are extrametrical; even if their last syllable is heavy, it does not attract stress. For instance in /nika-panan/ [₁nih.ka.'pa.nan] 'that you might hear' main stress is attracted by the light penult rather than by the heavy final syllable.

Secondary stress is left-headed and quantity-insensitive. This means that for secondary stress Huariapano forms syllabic trochees. There are opposing directions for secondary stress: left-to-right, and right-to-left (34).

(34) Secondary stress (from Parker 1998: 6–10; IPA)

- | | | |
|-----|-------------------------------------|-----------------------|
| (a) | [(₁ma.na.) ('paj.) ri] | 'I will wait' |
| (b) | [(₁jo.mu.) (₁ra.no.) ('ʂi.ki)] | 'he is going to hunt' |
| (c) | [(₁ha.βom.) ('bi.βi)] | 'they' |
| (d) | [(₁ku.βjaj.) βa. ('ʂi.ki)] | 'I cooked' |
| (e) | [('wa.nu.) ki. ('raŋ.) ki] | 'they have returned' |
| (f) | [(₁jo.mu.) (₁raj.βa.) kan.('ʂi.ki)] | 'they hunted' |
| (g) | [βis.(₁ma.noh.) (₁ko.no.) ('ʂi.ki)] | 'I forgot' |
| (h) | [mi.(₁βom.βi.) ('ra.ma)] | 'you (plural)' |

Examples (34a-b) are ambiguous as to the directionality and quantity-sensitivity of secondary stress. Examples (34c-d) show that secondary stress is quantity-insensitive. (34c) does not determine directionality, but (34d) does; secondary stress is assigned left-to-right; if it was assigned right-to-left, [βjaj] would have been stressed. (34e-f) are crucial to establish left-to-right directionality of secondary stress. (34g-h) show that secondary stress can be assigned right-to-left from the main foot. Without counting ambiguous cases, left-to-right parsing of secondary stresses has a statistical frequency of 66% and right-to-left parsing of 34% (Parker 1998: 9).

The analysis of the metrical system of Huariapano described below is based on (1998: 10–26), but departs in some respects from it. Only the main details of the analysis relevant for the discussion of [h] epenthesis have been included; I refer the reader to Parker (1998) for further details. In some occasions, constraint names have been changed in order to make comparison easier with Capanahua.

Undominated RH=TROCHAIC and GRWD=PRWD enforce left-oriented feet and stress in all grammatical words, respectively. The ranking FT BIN>> PARSE ensures binary footing and parsing of as many syllables into feet as possible, provided these feet are binary (Tableau 27).

The constraint RIGHTMOST enforces main stress towards the right edge of the word (34).¹⁵ RIGHTMOST dominates ALL-FT-LEFT. This captures the conflicting directionality of main and secondary stress, ensuring that main stress surfaces at the rightmost edge, and that all other feet are built from the left edge (Tableau 28).

¹⁵ MAIN RIGHT in Parker (1998).

Tableau 27
FtBin>>Parse

/jawɪf/	‘opossum’	FT BIN	PARSE
☞ a.	ja.(‘wiɸ)		*
b.	(ja).(‘wiɸ)	*!	

Tableau 28
Rightmost >> All-Ft-Left

/haβombiβi/	‘they’	RIGHTMOST	ALL-FT-LEFT
☞ a.	(,ha.βom.)(‘bi.βi)		**
b.	(‘ha.βom.)(bi.βi)	**!	

- (35) RIGHTMOST Align (Hd-Ft, Right, PrWd, Right)
 ‘The right edge of the head foot coincides with the right
 edge of some prosodic word’ (McCarthy & Prince 1993)

Words with right-to-left secondary stress assignment are specified in the input with the ranking ALL-FT-RIGHT>>ALL-FT-LEFT, overriding default secondary stress assignment from the left (Parker 1998). Words with stress on the final light syllable, like [us.‘ta] ‘garbage’ are also specified for stress in the input. Exceptional verbal suffixes, as in /nika-panan/ [,nih.ka.‘pa.nan] ‘that you might hear’, with no stress on a final heavy syllable are analyzed as having an extrametrical mora. I will assume that in all of these cases stress is specified in the input; the constraint STRESS IDENTITY, adapted from Parker 1998: 20, will ensure that the specified syllable in the input will keep its stress (or lack of stress).

- (36) STRESS IDENTITY If syllable σ_1 is specified as [α stress] in the input, then its Output correspondent σ_2 must be [α stress].

PROJECT WBP outranks PARSE and RIGHTMOST (Tableaux 29, 30).¹⁶ These two last constraints are not ranked with respect to each other. PROJECT WBP is dominated by STRESS IDENTITY, since in extrametrical suffixes the coda consonant is not moraic (Tableau 31; the extrametrical mora of the suffix is represented as <n> in the input).

To capture quantity-sensitivity in the main foot I propose the relativized constraints WEIGHT-TO-STRESS-MAIN and RH-CONTOUR-MAIN.¹⁷

¹⁶ In Parker (1998), Peak Prominence: ‘H>’L (Prince and Smolensky 1993).

¹⁷ In order to capture quantity-sensitivity for main stress, Parker (1998) proposes relativizing PEAK PROMINENCE for main stress with the constraint PEAK PROMINENCE-MAIN.

The ranking so far is STRESS IDENTITY, RH=TROCHAIC, GRWD=PRWD, FT-BIN, WEIGHT-TO-STRESS-MAIN, RH-CONTOUR-MAIN >>PROJECT WBP >> RIGHTMOST, PARSE >> ALL-FEET-LEFT >> ALL-FEET-RIGHT.¹⁸ Summary tableaux and a ranking lattice are given below. For simplicity, FT-FORM is used to refer to the undominated constraints.

—Tableau (32) shows a word where main stress is assigned on a penultimate heavy syllable and secondary stress falls on the leftmost syllable. Candidates (d-g) violate high-ranked FT-FORM or PROJECT WBP. Candidate (c) loses on multiple violations of RIGHTMOST and PARSE. At this point, candidates (a, b) tie. Candidate (a) is selected since candidate (b) has more violations of ALL-FEET-LEFT.

Tableau 32

/wanukiraŋki/ 'they have returned'	FT-FORM	PROJECT WBP	RIGHT MOST	PARSE	AFL	AFR
a. (,wanu.)ki.(¹ raŋ.)ki μ			*	**	***	*, ***
b. wa.(,nu.)ki.(¹ raŋ.)ki μ			*	**	*, ***!	*, **
c. (¹ wa.nu.)ki.(,raŋ.)ki μ			***	*!	***	*, ***
d. (,wa.nu.)ki.(¹ raŋ.)ki μ	*! (Rhcont main)			*	***	***
e. (,wa.nu.)ki.(raŋ.)ki		*!		*	***	***
f. wantu.ki.raŋ.ki	*!(Gw=Pw)			*****		
g. (wa.,nu.)ki.(¹ raŋ.)ki μ	*! (Rh=T)		*	**	**	*, ***

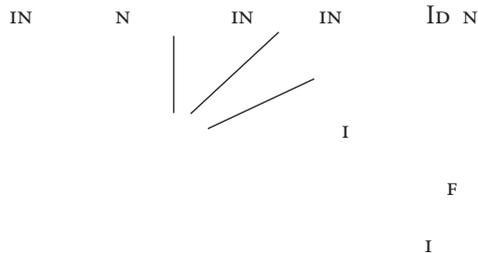
—Tableau 33 shows a word where the leftmost foot has two syllables with codas. Candidates (d-g) violate undominated constraints. Candidates (b, c) have multiple violations of RIGHTMOST and PARSE, so at this point candidate (a) wins.

¹⁸ Another undominated constraint is ALL-FEET-RIGHT >> ALL-FEET-LEFT for words that have non-default secondary stress.

Tableau 33

/kuβajβaʃiki/	'I cooked'			I			
a. (,kuβ.jaj.) βa.(ʃi.ki)					*	***	***
μ μ							
b. kuβ.jaj.βa.(ʃi.ki)					**!*	***	***
c. (ʃi.ki) βa.(,kuβ.jaj.)				**!*	*	***	***
μ μ							
d. (,kuβ.jaj.)(βa.)(ʃi.ki)	*! (FtBin)					** , ***	** , ***
μ μ							
e. kuβ.jaj.βa.ʃi.ki	*! (Gr=Pw)				*****		
f. (,kuβ.jaj.)(βa.ʃi.ki)	*! (Rh=T)			*	*	**	* , ***
μ μ							
g. (,kuβ.jaj.) βa.(ʃi.ki)		*!*			*	***	***

(38) Ranking lattice for Huariapano (I)



4.2. Coda [h] epenthesis

[h] epenthesis occurs in codas of odd-numbered syllables before voiceless onsets. The quality of /h/ varies depending on the nature of the previous vowel. It has the following allophones: [h] after /a/, [ç] after /i/, [x] after /u/, and [w̥] after /o/ (Parker 1994: 115). Allophones of /h/ are not shown in the Huariapano data discussed in this chapter. /h/ is phonemic only in word-initial position (39). /h/ never occurs intervocally or word-finally.

(39) Phonemic /h/ (from Parker 1994: 96-97)

- (a) ['ha.naʔ] 'tongue' ['ka.naʔ] 'macaw'
- (b) ['a.noʔ] 'paca rodent'

Epenthetic [h] occurs word-internally in coda position before voiceless consonants (40, 41). Epenthesis does not occur initially if the syllable has main stress; cf. (40a, b) with (40c). Epenthesis does not occur if the syllable already has a coda (40d).

(40) [h] epenthesis in initial syllables (Parker 1994: 100-101, 108-109; 1998: 26)

- | | | | | |
|-----|-----------------------------|------------------|------------------------|---------------|
| (a) | [ku <u>h</u> 'puɪn] | '(I) open' | [pa <u>h</u> .'tsa.ku] | '(we) washed' |
| (b) | [,βi <u>h</u> .tsa.'kaŋ.ki] | '(they) laughed' | | |
| (c) | ['na.kəʔ] | 'flea' | ['pi.ku] | '(he) ate' |
| (d) | [βoʃ.'kaʔ] | 'head' | | |

In non-initial syllables, stress or its lack thereof does not determine [h] epenthesis (41). Epenthesis occurs in unstressed syllables (41a), main stressed syllables (41b, c) and secondary stressed syllables (41c). Epenthesis does not occur before a voiced onset (cf. 41 d, e). [h] is never epenthesized in even-numbered syllables (42).

(41) [h] epenthesis in non-initial syllables (from Parker 1994: 101, 102)

- | | | |
|-----|---|---------------------------|
| (a) | [,ja.na.pa <u>h</u> 'kwĩŋ] | '(I) will help' |
| (b) | [,βo.no'ʃi <u>h</u> .kæʃ] | '(they) will take, carry' |
| (c) | [,jo.mu.,ra <u>h</u> .ka.'ti <u>h</u> .kæʃ] | '(they) hunted' |
| (d) | [,paj.ri.'ra <u>h</u> .kãʃ] | 'still; yet (they)' |
| (e) | [,paj.ri.'ra.naj] | 'still; yet (they)' |

(42) No epenthesis in even-numbered syllables (Parker 1994: 102)

- | | | |
|-----|----------------------|---------------------|
| (a) | [,iʃ.to.ki'raŋ.ki] | '(it) came running' |
| (b) | [,kæj.βa.kãn.'ʃi.ki] | '(they) went' |

[h] epenthesis is quite regular. Out of 115 morphemes, only 9 are exceptional and do not undergo epenthesis even if all conditions are met. In other words, [h] epenthesis has a statistical productivity of 93% (Parker 1998: 30-31). (42) shows cases where [h] epenthesis fails in the initial unstressed syllable before a voiceless consonant.

(43) Exceptional morphemes (from Parker 1994: 116)

- | | | | |
|-----|-------------|-------------------------|--------------------------|
| (a) | [ku.'pu.ki] | *[ku <u>h</u> .'pu.ki] | 'he/it closed' |
| (b) | [tʃu'ʃi.ku] | *[tʃu <u>h</u> .'ʃi.ku] | 'he/it dried (up)' |
| (c) | [hi.'ki.ki] | *[hi <u>h</u> .'ki.ki] | 'he/it entered, went in' |

First I review the account developed by Parker (1994), (1998). Parker (1994), (1998) argues that /h/ is moraic based on the occurrence of [h] epenthesis in light unfooted syllables, as in [kuh.('puɪn)] 'I open'. If [h] is moraic, the light syllable can be footed, and no syllables remain unparsed: [(kuh.)('puɪn)]. Parker (1998) concludes that epenthesis is rhythmic but not directly related to stress, since it can occur in main-stressed, secondary-stressed and unstressed syllables. Parker (1998) proposes the existence of both a rhythm and a stress tier to account for the apparent contradiction of a rhythmically-oriented, stress-insensitive process. The

stress tier encodes main and secondary stress placement, while the rhythm tier encodes [h] epenthesis. These two tiers are not required to coincide (Parker 1998: 36). (44) exemplifies both tiers for the word [a,ri.βah.'kaŋ.ki] 'they repeated'. The stress tier is formed respecting the metrical constraints that capture stress and footing. The rhythm tier is formed through quantity-insensitive trochees starting from the left edge of the word. Epenthesis of [h] occurs in the first or strong syllable of every foot in this tier where coda [h] is admissible.

(44) Stress and rhythm tiers (adapted from Parker 1998: 35)

- (a) *Stress tier* a.(,ri.ba) ('kan.ki)
 (b) *Rhythm tier* (a.ri.) (bah.kan.) ki

More specifically for (44), the main foot is created in the stress tier via a moraic trochee aligned with the right edge. Secondary stress in this word is assigned via a syllabic trochee constructed leftwards from the main foot. The rhythmic tier forms left-to-right syllabic trochees. [h] is epenthesized in the third syllable of the word, since this syllable is the head in this tier and requires a coda. Epenthesis does not apply to the first syllable because of the requirement that a coda [h] precedes a voiceless consonant. To formalize this idea, Parker (1998: 34) proposes the constraints ALL-FT-LEFT-RHYTHM and HEAVY FOOT HEAD-RHYTHM (45).

- (45) ALL-FT-LEFT-RHYTHM Align (Foot, L, PrWd, L) 'The left edge of every rhythmic foot must be aligned with the left edge of some prosodic word'
 HEAVY FOOT HEAD-RHYTHM The head syllable of a rhythmic foot must be heavy

ALL-FT-LEFT-RHYTHM ensures left-to-right footing of the rhythm tier and HEAVY FOOT HEAD-RHYTHM achieves rhythmic [h] epenthesis. Together, these constraints enforce [h] epenthesis in a left-to-right fashion regardless of stress. The failure of coda [h] epenthesis to apply in initial main-stressed syllables is explained through the constraint [*SG-σ₁ & *SG-'σ]. This conjoined constraint penalizes the occurrence of /h/ in initial syllables with main stress. To avoid deletion of [h] onsets in this same position, Parker proposes the constraint [Max-onset (sg) & Max-σ₁ (sg)]; this penalizes deletion of underlying /h/ in initial main-stressed syllables.

4.3. Proposal

It is desirable that metrical processes occur in one tier only. One exclusive metrical tier enforces theoretical economy and restrictiveness. Further, as shown in González (2003), many consonantal processes, including epenthesis and deletion, are sensitive to stress. An analysis in which a rhythmic consonantal process is totally unrelated to stress (or foot structure) misses a connection with consonantal processes in other languages which show similar conditioning contexts.

My analysis involves only one metrical tier and focuses on [h] epenthesis as a process where two separate metrical tendencies converge. The first is the creation of

a rhythmic contrast between syllables within a foot, as in [(,βiḥ.tsa.) ('kaŋ.) ki] '(they) laughed'. Epenthesis of [h] in strong footed syllables creates a contrast between the strong and weak members of the foot, in the same way as /ʔ/ deletion in Capanahua. [h] epenthesis proceeds left-to-right and coincides with default secondary stress assignment. This shows that foot construction proceeds from the left edge.

The second metrical tendency is stress assignment. Main stress is assigned to the opposite edge of the word and it can override left-to-right footing if there is a conflict. Further, some words have non default secondary stress. In these cases, I propose that secondary stresses are faithful to the input, and left-to-right footing still applies. Apparently, in both non-default secondary stress cases and in cases involving extrametrical suffixes, [h] epenthesis and stress assignment conflict, with [h] epenthesis appearing to occur in weak footed syllables.

I suggest that this conflict should be seen in a different light. There is a cross-linguistic tendency for head syllables to be stressed and to have codas, and for weak footed syllables to be unstressed and to lack codas (González 2003). The universal rankings *HEAD/σ >>* HEAD/'σ, and *HEAD/CV >>*HEAD/CVC express the tendency for head syllables to be stressed and have codas. The universal rankings *WEAK/'σ >>*WEAK/σ, and *WEAK/CVC >>*WEAK/CV capture the tendency for weak syllables to be unstressed and open. The apparent irregularity in the metrical system of Huariapano concerning [h] epenthesis can be viewed as a preference for rhythmicity to be realized segmentally rather than through stress. Together with the irregularity of the metrical pattern of some words in the system, this can lead to the violation of *HEAD/σ and even *WEAK/'σ in some cases. The violation of *WEAK/'σ, though rare, is typologically predicted (González 2003).

In Huariapano, *HEAD/CV outranks *HEAD/σ, since it is more important to create rhythmic contrasts segmentally than through stress. *HEAD/CV also outranks DEP-IO, since epenthesis occurs in all binary feet where the first syllable lacks a coda and [h] epenthesis is permissible. *HEAD/CV is outranked by PARSE, since epenthesis of [h] occurs in otherwise unfooted open syllables, which are thereby footed. These rankings will be shown in the following tableaux. In the following discussion, undominated *CLASH, WEIGHT-TO-STRESS-MAIN and RH-CONTOUR-MAIN are incorporated into the cover constraint FTFORM. The cases that need to be accounted for are listed in (46). Each will be illustrated with a tableau.

(46) (a) *Epenthesis*

- | | | |
|---------------------------------------|---------------------------|------------------|
| (i) Initial σ before main stress: | [kuh. 'puŋ] | 'I open' |
| (ii) Secondary stressed syllable: | [,βiḥ.tsa'kan.ki] | 'they laughed' |
| (iii) Main 'σ (extrametrical suffix): | [,βo.no.'sih.kajŋ] | 'they will take' |
| (iv) Non-default secondary stress: | [βis,ma.noh.,ko.no'si.ki] | 'I forgot' |

(b) *Lack of epenthesis*

- | | | |
|-------------------------------------|-----------|------------|
| (v) Main stressed initial syllable: | ['pi.kuŋ] | '(he) ate' |
|-------------------------------------|-----------|------------|

(i) *Initial syllable before main stress* (Tableau 34). [h] epenthesis applies in this case. Candidate (f) violates FT-BIN and *HEAD/CV. Candidate (d) epenthesis [h] and stresses the resulting foot; this violates *CLASH. Candidates (b, c, e) violate PROJECT WBP (additionally, for candidate (e) [h] epenthesis is not licensed by a [-voi] consonant; this is not shown in the tableau). Candidate (a) violates *HEAD/σ̄ since there is a foot head that is not stressed; however, this candidate is selected as optimal because the competitors violate higher-ranked constraints. This tableau shows that PARSE >>*HEAD/σ̄.

Tableau 34

/kuɸuɸn/ 'I open'	FT FORM	PROJECT WBP	*HEAD/ CV	*HEAD/σ̄	DEP	*HEAD/ CVC
☞ a. (kuh).(pɸun) μ μ				*	*	**
b. ku.(pɸun)		*!				*
c. kuh.(pɸun)		*!			*	
d. (,kuh).(pɸun) μ μ	*! (*CLASH)				*	**
e. (kuh).(pɸunh) μ μ		*!			**	**
f. (ku.)('pɸun)	*! (FT-BIN)		*	*		*

(ii) *Epenthesis in secondary-stressed syllables* (Tableau 35). Candidates (d, e) violate undominated constraints. Candidate (b, f) violate high-ranked PROJECT WBP. Candidates (a, c) tie on a violation of PARSE. Candidate (c) epenthesis [h] in the weak syllable of the foot and violates *H/CV. Candidate (a) is selected as optimal.

(iii) *Extrametrical suffixes*. When the last syllable of the word is extrametrical, epenthesis applies to the preceding syllable (tableau 36). I assume that extrametrical suffixes are specified for stress in the input. The symbol < > in the input means that the syllable is specified for lack of stress. Candidates (b, c, e) violate undominated constraints. Candidate (b) violates the restriction against [h] epenthesis before voiced consonants. Candidate (c) violates RH-CONTOUR-MAIN, because the main foot is (HL). Candidate (e) stresses the final syllable and violates IDENT-STRESS. Candidate (a), which has only one violation of PROJECT WBP, is selected over candidate (d), which has two violations of PROJECT WBP.

(iv) *Non-default secondary stress*. The final case where epenthesis applies is words with right-to-left secondary stress, as [βis,ma.noh,ko.no'si.ki] 'I forgot' (Tableau 37). In this case, secondary stress is realized as right-to-left, but

Tableau 35

/βitsakanki/ 'they laughed'	FT FORM	WBP	PARSE	*H/ CV	*H/σ	DEP	*H/ CVC
a. (,βih.tsa.)('kan.)ki μ μ			*			*	**
b. (,βi.tsa.)('kan.)ki μ		*!	*	*			*
c. (,βi.tsa.h.)('kan.)ki μ μ			*	*!		*	**
d. βi.(,tsah.)('kan.)ki μ μ	*! (*CLASH)		**			*	**
e. (,βih.tsa.)('kanh.)ki μ μμ	*! (*FTBIN)		*			**	**
f. (,βih.tsa.)('kan.ki) μ		*!				*	**

Tableau 36

/βo.no.sih.<kajn>/ [-stress] 'they will take, carry'	FT FORM	WBP	PARSE	*HEAD/ CV	*HEAD/σ	DEP
a. (,βo.no.) ('sih.) kajn μ		*	*	*		*
b. (,βoh.no.) ('sih.)kajn μ μ	*! H-VOI	*	*	*		**
c. (,βo.no.) ('sih. kajn) μ	*! RHCON- MAIN	*		*		*
d. (,βo.no.) ('si. kajn		**!		*		
e. (,βo.no.) (sih.) ('kajn)	*! IDENT STRESS	**		*	*	*

Tableau 37

/βis.ma.no.,ko.no.si.ki/ 'I forgot'	FT FORM	PARSE	*H/CV	*W/'σ	*H/σ̃	DEP	*H/ CVC
☞ a. (βis.,ma.)(noh.,ko.) (no.'si.) ki		*	*	***	***	*	**
b. (βis.,ma.)(noh.,ko.) (noh.'si.) ki	*! RHT=T	*				**	***
c. βis.(,ma.noh.) (,ko.noh.) ('si.ki)		*	**!*			*	**
d. (,βis.ma.)(,noh.ko.) (,no.si.) ki	*! ID STRESS	*	*				*

left-to-right footing and epenthesis apply. This causes strong footed syllables to be unstressed and weak footed syllables to be stressed. I assume that secondary stress is specified in the input for this and other exceptional words. Candidate (b), which epenthesizes [h] in the second and third feet counting from the left, violates RHTYPE-T, because the main foot has final prominence. Candidate (d) realizes stresses from the left as well as [h] epenthesis but violates IDENT [stress], since this word is prespecified for secondary stress. Candidates (a, c) tie on a violation of PARSE. In candidate (c) footing is assigned right-to-left, and as a result [h] epenthesis coincides with weak footed syllables. Since strong footed syllables have no codas, this violates *HEAD/CV more times than candidate (a), and thus (a) is selected as optimal. Note that candidate (a) violates *WEAK/'σ. *WEAK/'σ is dominated by *HEAD/CV; otherwise, candidate (a) would not be optimal.

(v) *No epenthesis in main stressed syllables.* In tableau 38, candidates (b, c) show epenthesis of [h] but violate RH-CONTOUR-MAIN and PROJECT WBP respectively; candidate (d) violates PARSE. Candidate (a), which violates *HEAD/CV, is selected as optimal. This tableau shows that PARSE outranks *HEAD/CV.

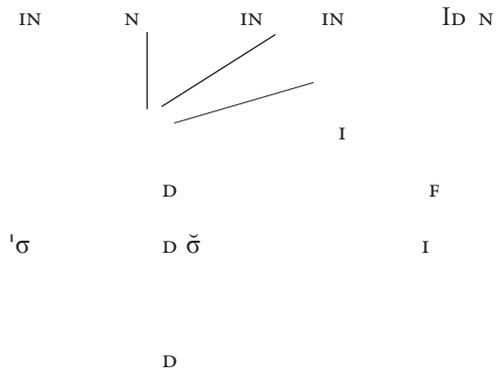
Tableau 38

/pikw/ 'he ate'	FT FORM	PROJECT WBP	PARSE	*HEAD/ CV	*HEAD/σ̃	DEP	*H/ CVC
☞ a. ('pi.kw)				*			
b. ('pih.kw) μ	*! (RHCON MAIN)					*	*
c. ('pih.kw)		*!				*	*
d. ('pih.) kw μ			*!			*	*

This analysis of Huariapano [h] epenthesis and stress does not rely on the language-specific separation between a stress and a foot structure tier. Rather, it is based on the preference for rhythmicity contrasts to be realized segmentally rather than through stress. This is shown in cases where main stress and non-default secondary stress coincide with [h] epenthesis.

An important tendency in the metrical system of Huariapano is parsing as many syllables into feet as possible, even if [h] has to be epenthésized, and even if this violates *HEAD/ǫ̃. In the following section I will propose a historical explanation for this tendency. A revised ranking lattice for Huariapano closes this section.

(47) Ranking lattice for Huariapano (II)



4.4. The relationship between secondary stress and [h] epenthesis

This section discusses the connection between secondary stress and [h] epenthesis from a historical and comparative perspective. A summary of the facts of the metrical system of Huariapano is given in table 5.4.

Table 5.4
The metrical system of Huariapano

IN	ND	N I
<ul style="list-style-type: none"> • Moraic trochees • Right edge of the word <p><i>Exceptions:</i> — Antepenult/ final light stress (nouns) — Extrametrical verbal suffixes</p>	<ul style="list-style-type: none"> • Syllabic trochees <p><i>Left-to-right:</i> more common (About 67%) <i>Right-to-left:</i> less common (About 34%)</p>	<ul style="list-style-type: none"> • Syllabic trochees • Left to right <p><i>Exceptions:</i> — It does not occur in 12 verbs</p>

Quantity sensitivity is important for main-stress assignment but not for secondary-stress assignment or [h] epenthesis. Two directionality patterns exist with

respect to secondary stress; left-to-right from the beginning of the word, and right-to-left from the main foot in the word. Coda /h/ epenthesis follows exactly the same quantity-insensitivity and directionality as the most widely attested pattern of secondary stress assignment. Finally, there are exceptions to the default assignment of main and secondary stress and [h] epenthesis.

Coda [h] epenthesis has exactly the same environments as default secondary stress assignment; it occurs in alternate syllables from the beginning of the word. The differences are that epenthesis is licensed by a following voiceless onset, and that epenthesis does not occur in syllables with coda consonants. I hypothesize the following historical scenario for the development of the current metrical stage of the language. This scenario is supported by historical evidence from the metrical system of Proto-Panoan, and by comparative evidence from related Shipibo and Capanahua (Table 5.5).

Table 5.5
Metrical system in Panoan

	Proto-Panoan	Capanahua	Shipibo	Huariapano
Tone	Yes	Yes	No	No
Main Stress	? Leftmost	Moraic trochee Leftmost	Moraic trochee Leftmost	Moraic trochee Rightmost
Secondary stress	?	No	Rightmost (Morphological)	Syllabic trochee Bidirectional
Laryngeal process <i>Directionality</i> <i>Type</i>	?	/ʔ/ deletion Trochee Left to Right	None	[h] epenthesis Syllabic trochee Left to Right

In an early stage of the language main stress was assigned at the leftmost edge (Shell 1975). When tones were lost from the development of Proto-Panoan, [h] epenthesis developed in Huariapano from the left in order to create a rhythmic contrast between strong and weak syllables. Secondary stress might have developed at the same time or later; the lack of secondary stress in Capanahua, which has a related process of /ʔ/ deletion, and the emergence of secondary stress in Shipibo for certain suffixes suggests that secondary stress developed out of [h] epenthesis. At some point main stress shifted to the right edge of the word in Huariapano. This caused the development of right-to-left secondary stress in a subset of words in the language, triggering the apparent mismatch between [h] epenthesis in words with right-to-left secondary stress.

Capanahua, Shipibo and Huariapano have moraic trochees for main stress. However, while Capanahua and Shipibo build the main foot at the leftmost edge, Huariapano builds it at the rightmost edge. Both Shipibo and Huariapano show quantity-insensitive secondary stress at the opposite edge from main stress. In

Shipibo, secondary stress is optional in words of four syllables or more with certain suffixes. In Huariapano, it is usually assigned left-to-right from the beginning of the word, but can also be assigned right-to-left from the main stressed foot.

The distribution of /ʔ/ in Capanahua suggests that footing is persistent in spite of the absence of secondary stresses. Coda /ʔ/ is deleted precisely in weak footed positions; it is pronounced in strong footed syllables and in unfooted syllables. In Shipibo there is some evidence for persistent footing in the alternation of the suffix [riβi/riβa] ‘again’ and in morphological secondary stress (see section 5). Footing in Huariapano is clearly persistent since secondary stresses are assigned in all feet (excepting, obviously, main-stressed feet). [h] epenthesis takes place in both strong footed and otherwise unfooted syllables. [h] epenthesis parses syllables into feet and creates a contrast between strong and weak syllables. I hypothesize that the creation of a contrast between strong and weak syllables was the original function of [h] epenthesis; its parsing function derived through the development of main stress at the opposite edge of the word.

Both Capanahua and Huariapano have laryngeal processes sensitive to rhythmic structure. In Huariapano this process is rendered obscure because the existence of conflicting stress patterns in the language. The pattern in Huariapano follows left-to-right secondary stress assignment everywhere, conflicting with right-to-left secondary stress and with main stress assignment in some cases; mainly, when there are extrametrical suffixes that cause stress to shift to the penultimate syllable even if the final syllable is heavy.

[h] epenthesis scans the entire word, including the main stressed foot. This suggests that epenthesis generally applied from the left, as deletion of /ʔ/ in Capanahua. This would explain two facts in the distribution of [h] epenthesis: the restriction to odd-numbered syllables, and the absence of [h] epenthesis in initial syllables with main stress. [h] epenthesis would not occur because no secondary stress is needed.

Unfooted and strong footed syllables share a common property in both Capanahua and Huariapano. In Capanahua, these two types of positions resist deletion of coda /ʔ/; deletion occurs in weak footed syllables, and onset-to-coda metathesis occurs in strong footed syllables. In Huariapano, these two types of syllables undergo [h] epenthesis. In both Capanahua and Huariapano, it is crucial to create a contrast between strong and weak syllables. In Huariapano, this tendency is found side by side with a tendency for exhaustive parsing. Common to both languages is the resistance of weak syllables to be prominent.

Finally, there is the question of whether /ʔ/ deletion and [h] epenthesis is significant or just coincidence. Note that /h/ was not a phoneme in Proto-Panoan, but a subsequent development in some of the Panoan languages. It is possible that [h] was selected as an epenthetic segment in Huariapano because it was not phonemic in the language. Relevant to this question is the non-moraicity of /ʔ/ in Capanahua, and the moraicity of /h/ in Huariapano. Since /h/ is more sonorous than /ʔ/ it can be explained that /h/ is moraic in Huariapano while /ʔ/ is not in Capanahua. But it is possible that the moraicity of /h/ is relevant only in the most recent stage of Huariapano, provided the tendency to parse as many syllable into feet derived after the tendency of creating a contrast between strong and weak

footed syllables. Coming back to the first question, it would be necessary to establish precisely how a coda /ʔ/ or /h/ affect the syllable where it occurs, namely, whether the previous vowel is shortened, lengthened, or devoiced; whether the overall length of the syllable is increased or decreased; and so on. Phonetic studies might help to elucidate this question.

5. Shipibo

This section describes the phonological system of Shipibo, focusing on its metrical system and on the rhythmic alternation of the suffix [riba/ribi] ‘again’. Contrary to Capanahua or Huariapano, Shipibo expresses rhythmicity through vocalic alternations. However, Shipibo is similar to Capanahua and Huariapano in that a prominence contrast is expressed through segmental alternations.

Section 5.1 describes the metrical system of Shipibo, and section 5.2 the rhythmic alternation of the suffix [riba/ribi] ‘again’.

5.1. The metrical system of Shipibo

Shipibo is closely related to Capanahua and Huariapano. It has about 30,000 speakers (Grimes 2000). Shipibo has about 50% intelligibility with Capanahua in spite of different phonological and grammatical systems. It is not intelligible with Huariapano except for brief conversations (Shell 1975: 25). The data and the description of Shipibo in this section are taken from Elías (1999), (2000), (2001).¹⁹

Shipibo and Capanahua have similar consonants and vowels (see Table 5.2). Both languages have the same syllable structure (C)V(C) and the same coda restriction: only nasals and sibilants can be codas. Most words in Shipibo have two or three syllables. Words with four or more syllables are either compounds or suffixed forms. As in Huariapano, monosyllabic words always have a long vowel and can also have a coda consonant. Examples include /hi/ [hi:] ‘hair’ and /kin/ [ku'n] ‘desire’. Long vowels are not found elsewhere in the system (Elías 1999).

Unlike Capanahua, Shipibo lacks tone (Shell 1975: 46-52). Main stress is assigned to moraic trochees as near as possible to the left edge of the prosodic word (48). (48b) crucially shows that stress is left-oriented; /atapa/ ‘hen’ has three light syllables, and stress falls on the leftmost syllable. (48d) shows that stress is quantity-sensitive; if the second syllable is heavy, it is stressed. For main stress, Shipibo is similar to Capanahua.

(48) Main stress in Shipibo (from Elías 2000)

- | | | | |
|---------------|---------------------|----------------|-------------------------|
| (a) [ˈti.ta] | ‘mother’ | (b) [ˈa.ta.pa] | ‘hen’ |
| (c) [ˈβis.bi] | <i>kind of wasp</i> | (d) [tʃa.ˈras] | <i>catalan</i> (a bird) |

A difference with Capanahua is that in Shipibo secondary stress is optional in words of four syllables or longer, depending on the type of suffix added to the word. There are two types of suffixes: prosodic, and non-prosodic (cf. Elías 2000,

¹⁹ I thank José Alberto Elías for making available his work on Shipibo and for his helpful comments on Panoan.

type I/II classification). Prosodic suffixes—including /-¹fu.ku/ *diminutive*; /-¹run.ki/ *reportative*; and /-nin/ *ergative*—form a foot of their own and carry their own stress. Non-prosodic suffixes are not footed on their own and do not carry stress. Examples are /-βu/ *plural*; /-ra/ *evidential*; and /-a; -ki; -ai/ *finished action (interrogative/indicative/indicative-interrogative)*. On occasion, non-prosodic suffixes can modify the main stress of the word. One case is the ergative suffix /-an/. When added to a disyllabic syllable, this suffix causes stress to shift from the first to the second syllable. The reason for this shift is that this suffix contains a coda consonant, and stress is attracted by a heavy second syllable.

Secondary stress appears to be morphologically determined. Elías (2000) suggests that prosodic suffixes were independent words in a previous stage of the language. Below is a paradigm of the word /a.ta.pa/ ‘hen’ with different types of suffixes added. (49a-c) show that certain suffixes do not carry secondary stress even if the word has four or more syllables. (49d-f) show that some suffixes introduce secondary stress; more than one secondary stress is possible, depending on how many prosodic suffixes are added to the word (49g). (49h) shows a word with a non-prosodic suffix and a prosodic one. Secondary stress is only seen in the prosodic suffix. (49i) shows that compounds have secondary stress on the second word.

(49) Paradigm: /atapa/ ‘hen’+ suffixes.

(a)	[¹ a.ta.pa.bu]	‘hen (plural)’
(b)	[¹ a.ta.pa.ra]	‘hen (evidential)’
(c)	[¹ a.ta.pa.bu.ra]	‘hen (plural, evidential)’
(d)	[¹ a.ta.pa, ₁ nin]	‘hen (ergative)’
(e)	[¹ a.ta.pa, ₁ run.ki]	‘hen (reportative)’
(f)	[¹ a.ta.pa, ₁ fu.ku]	‘hen (diminutive)’
(g)	[¹ a.ta.pa, ₁ fu.ku, ₁ run.ki]	‘hen (diminutive, reportative)’
(h)	[¹ a.ta.pa.bu, ₁ run.ki]	‘hen (plural, reportative)’
(i)	[¹ a.ta.pa, ₁ bi.ni]	‘rooster (hen+male)’

5.2. Rhythmic alternations

Shipibo has a rhythmic alternation which suggests that footing is exhaustive even if secondary stress is not always realized. The existence of this rhythmic alternation was first noted by Lauriault (1948), who notes that the emphatic suffix /riβ/ has two allomorphs, [ribi] and [riba], depending of the number of moras that precede. After an even number of moras [ba] occurs (50a, c, d); after an odd number of moras [bi] occurs (50b, e).

(50) Emphatic suffix /riβ/: alternations (from Lauriault 1948: 22-23; IPA)

(a)	[¹ a. ² -ri. ³ ba. ⁴ -kw]	‘did it again’
(b)	[¹ a.-ma. ² -ri. ³ bi. ⁴ -kw ⁵]	‘made him do it again’

- (c) [¹a.-ma.-ruu.si.-ba.-ku⁶] ‘merely made him do it again’²⁰
- (d) [¹a.-pa.ri.-ri.ba.-ku⁶] ‘did it first again’
- (e) [¹ja.kā.-pa.ri.-ri.bi.-ku⁷] ‘he sat down again and immediately’

This distribution is consistent with foot structure, as noted by Elías (2000), who states that [ribi] surfaces when the prosodic word has unfooted syllables and [riba] when all of the syllables in the prosodic word are footed. The foot structure for the examples in (50) is given in (51).

(51) Emphatic suffix /rib/: footing

- (c) [a,(‘ri.) (ba.ku)] ‘did it again’
- (d) [(‘a.ma.) (ri.bi.) ku] ‘made him do it again’
- (e) [(‘a.ma.) (ruu.si.) (ba.ku)] ‘merely made him do it again’
- (f) [(‘a.pa.) (ri.ri.) (ba.ku)] ‘did it first again’
- (e) [(‘ja.kā.) (pa.ri.) (ri.bi.) ku] ‘he sat down again and immediately’

I propose this is another instance of a rhythmic contrast encoded as a segmental pattern independently of stress. In this case, it is a vocalic pattern which determines rhythm. The choice of [i] or [a] as the last vowel of the emphatic results from the inherent sonority of the vowel. [a] is more sonorous than [i]; in forms selecting [riba], [ba] is footed as the strong syllable of the foot. In forms selecting [ribi], [bi] is footed as the weak part of the foot. This suggests that the most sonorous vowel is selected in positions favoring maximal sonority.²¹

This rhythmic alternation can be analyzed with the mechanism of Prominence Alignment (Prince and Smolensky 1993). The combination of the foot prominence and vocalic prominence scales in (52) results in the constraint hierarchies in (53), which express the cross-linguistic tendency for weak syllables to avoid sonorous vowels, and the tendency for head syllables to avoid non-sonorous vowels.

(52) Prominence scales

<u>Foot prominence</u>	Head _{prom} > weak	(Kenstowicz 1996)
<u>Vocalic prominence</u>	a _{prom} > e, o _{prom} > i, u	(Prince and Smolensky 1993)

²⁰ The underlying form is /a-ma-ris-riba-ki/ (Lauriault 1948: 23). It appears that assimilation takes place between an adjacent /sr/ sequence with /s/ surfacing.

²¹ The emphatic suffix in Shipibo [ribi/riba] is realized as [riʔ.bi] or [ri.bi] in Capanahua, depending on rhythmic considerations (see section 3). This suffix appears to derive from a combination of /ritʃ/ + /βi/ (Loos p.c.).

(53) Constraint hierarchies

*HEAD/i,u >> *HEAD/e,o >> *HEAD/a/	Head syllables do not have non-sonorous vowels'
*WEAK/a >> *WEAK/eo >> *WEAK/i, u	'Weak syllables do not have sonorous vowels'

This rhythmic alternation only occurs for one suffix. I assume that the last vowel of the suffix 'again' is not specified in the input; the choice of this vowel is brought about by the constraint ranking. The ranking of the prominence/sonority constraints in (52) with MAX STRESS and *HEAD/ǝ in Shipibo derive this vocalic rhythmic alternation (tableaux 38, 39). In tableau 38, if the second syllable of 'again' is footed as head, its nucleus will surface as the most sonorous vowel, /a/. Candidate (a) loses to *HEAD/i and candidate (c) loses to MAX STRESS, since it expresses rhythmicity through secondary stresses. Candidate (b) is selected as optimal.

Tableau 38

/apari-ribV-ki/ 'he did it again and again'	MAX STRESS	*WEAK/a (RIBV)	*HEAD/i (RIBV)	*HEAD/ǝ
a. ('a.pa.) (ri.ri.) (bi.ki)			*!	**
☞ b. ('a.pa.) (ri.ri.) (ba.ki)				**
c. ('a.pa.) (,ri.ri.) (,ba.ki)	*!			

In tableau 39, the second syllable of 'again' surfaces as a weak footed syllable, and its nucleus is realized as [i]. Candidate (b) loses because it realizes rhythmicity through secondary stresses. Candidate (c) loses because [a] is too sonorous to occur in the weak syllable of the suffix. Candidate (a), which violates **HEAD/ǝ, is selected as optimal.

Tableau 39

/jaka-pari-ribV-ki/ 'he sat down again and immediately'	MAX STRESS	*WEAK/a (RIBV)	*HEAD/i (RIBV)	*HEAD/ǝ
☞ a. ('ja.ka.) (pa.ri.) (ri.bi) ki				**
b. ('ja.ka.) (,pa.ri.) (,ri.bi) ki	*!			**
c. ('ja.ka.) (pa.ri.) (ri.ba) ki		*!		

Similar to related Capanahua and Huariapano, Shipibo has some form of rhythmic alternations. Unlike them, the alternation is vocalic and it only affects one suffix. This alternation is productive and suggests that footing is exhaustive in Shipibo even if secondary stresses are not realized.

6. Conclusions

This paper has explored rhythmic processes in Capanahua, Huariapano, and Shipibo. In all of these languages, rhythmically-conditioned segmental phenomena create a contrast between strong and weak footed syllables within the foot. In Capanahua this contrast is achieved through coda /ʔ/ deletion in weak syllables and onset-to-coda metathesis in strong syllables. It has been argued that both of these processes achieve persistent footing and make up for the absence of secondary stress in the language. In Huariapano, the strong-weak rhythmic contrast within foot syllables is achieved through [h] coda epenthesis. [h] epenthesis reinforces default left-to-right secondary stress and achieves the parsing of otherwise unfooted syllables into feet.

Shipibo makes use of rhythmic alternations in the suffix [riba/ribi] ‘again’. In this case, a vocalic process creates a rhythmic contrast. The second syllable of this suffix is pronounced [bi] or [ba] depending on whether the suffix attaches to a footed or unfooted syllable. In the first case, the suffixes is pronounced [ribi], footed [(ri.bi)]. In the second case, the suffix is pronounced [riba], footed [(...ri)(ba...)]. This paper proposes that these two forms alternate for prominence reasons; since /a/ is more sonorous than /i/, this vowel is selected in strong footed syllables, while /i/, less sonorous, is preferred in weak footed syllables.

Both Capanahua and Huariapano have strictly foot-conditioned consonantal processes, and in both of them a laryngeal segment in coda creates a rhythmic contrast within a foot. Capanahua has only one stress per word, but nonetheless, /ʔ/ deletion and onset-to-coda metathesis occur persistently within the word. In Huariapano, [h] epenthesis can be found in both stressed and unstressed syllables. Persistent footing explains the distribution of [h] epenthesis. It is proposed that the exceptions for [h] epenthesis are also foot-based; [h] epenthesis conflicts with words where secondary stress is assigned right-to-left from the main foot, and in words where the last syllable is extrametrical. In these cases, the conflict is explained through the preference to create rhythm through consonantal processes rather than through stress.

Panoan languages evidence the four predictions about rhythmic processes made in González (2003). Rhythmic processes might increase the prominence of the head footed syllable, as [h] epenthesis in Huariapano. Rhythmic phenomena might decrease the prominence of the weak footed syllable, as Capanahua /ʔ/ deletion. They might do both at the same time in the same language, as in Capanahua, where /ʔ/ deletion occurs side by side with onset-to-coda metathesis. Finally, a rhythmic process might achieve both rhythmic aims at the same time, as in Shipibo.

It remains to be investigated how rhythmicity conditions consonantal processes in other languages. Some additional examples to consider include related Panoan languages, such as Amahuaca, where nasal consonants have plosive release in onsets of even-numbered syllables (Rusell 1975, Shell 1975), and Yaminahua, where a number of suffixes show epenthesis of both consonants and vowels material in odd-numbered syllables and deletion in even-numbered syllables (Eakin 1991, Faust and Loos 2002; see also Loos 1999). The study of these and related phenomena in

Panoan, currently underway, will contribute to our understanding of rhythmically-conditioned consonantal processes and to the ways that rhythmicity can be expressed cross-linguistically.

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