

## CHAPTER 3

### METRICALLY CONDITIONED SYNCOPE

#### 3.1 Introduction

In the theory proposed here, structures cannot be marked with respect to a constraint unless there are structures that are unmarked with respect to the same constraint. In a way, nasal vowels are only marked because plain oral vowels are not. Similarly, syllables by themselves are not marked, but syllables in certain metrical contexts are. This was already touched upon in §2.3, which discussed a range of truncation processes and other maximum size effects. In this chapter, the approach is extended to a range of diverse economy effects that are collectively known as metrically conditioned syncope.<sup>35</sup>

The interaction of some metrical constraints with MAX can produce a wide range of syncope patterns. Here, I will look at the interaction of MAX with PARSE- $\sigma$ , STRESS-TO-WEIGHT (SWP), WEIGHT-TO-STRESS (WSP), and GRPHARM. Of these constraints, PARSE- $\sigma$  and SWP are of a particular interest because some of their effects are economy effects. Thus, deletion of unfootable vowels can improve a candidate's performance on PARSE- $\sigma$ , while deletion of a vowel immediately after a stressed light syllable in a language with moraic codas produces an output that performs better on SWP than a faithful parse does.

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<sup>35</sup> *Syncope* here will refer to interconsonantal vowel deletion, e.g., /pataka/ → pat.ka or /pataka/ → pta.ka. *Apocope* is final vowel deletion, e.g., /pataka/ → patak. I will also use “vowel deletion” to refer to either or both of these processes.

The interaction of metrical constraints is well-known to be instrumental in vowel shortening, as well—as we will see, vowel shortening and syncope often coexist in the same grammar as ways to improve foot shape.

The result of both vowel shortening and syncope is structural economy, but the markedness constraints whose interaction produces these patterns are in no sense economy constraints. Rather, they militate against specific structural configurations: not all syllables but unfooted syllables, not all feet but feet with light heads, heavy non-heads, uneven parts, and so on. Deletion is not a way to get rid of *structure*, it is a way to get rid of *marked structure*.

The theory of CON developed in Chapter 2 precludes the existence of \*STRUC constraints. I argue that if such constraints were to exist, they would either contribute nothing to the understanding of metrical syncope and shortening or make the wrong predictions with respect to their application.

The chapter starts with two in-depth case studies of Hopi and Tonkawa syncope and shortening. These are cases of so-called rhythmic vowel deletion, which was first analyzed in OT by Kager 1997. His own prosodic analysis of Southeastern Tepehuan is also considered in this chapter.

I start by examining Hopi syncope and shortening. I show that when the processes are examined in the larger context of Hopi prosody, their true motivation becomes apparent: vowels do not syncope and shorten for the sake of reducing the number of syllables and moras; rather, the outputs of syncope and shortening are optimal in that they contain the minimal number of *unfooted* syllables and have the best *iambic feet*.

I then present a re-analysis of Tonkawa, where vowels delete in an alternating pattern and which is often cited as a classic example of “delete wherever you can.” When Tonkawa syncope and vowel shortening are examined in terms of foot structure, they no longer seem like default processes at all—there is every indication that syncope and shortening build *optimal trochaic feet*. I also show that economy constraints make either the wrong predictions or no predictions about where deletion and shortening should apply in Tonkawa.

The last case study is Southeastern Tepehuan, in which “the output goal of apocope/syncope is *not* to minimize the number of syllables as such, but to minimize the number of syllables that stand *outside the foot*” (Kager 1997:475). This language deletes in alternating syllables like Tonkawa, but its footing is non-iterative like that of Hopi. This difference between Southeastern Tepehuan and Hopi on the one hand and Tonkawa on the other hand is straightforwardly captured by simply re-ranking constraints, yet it cannot be easily replicated in an economy analysis. Furthermore, I show that economy constraints can produce an *unattested pattern* that is a slight variation on Southeastern Tepehuan, but they cannot account for Southeastern Tepehuan itself—this argument continues a point made in chapter 2.

I show that analyses of Hopi, Tonkawa and Southeastern Tepehuan in terms of economy principles encounter a central problem: general anti-structure constraints cannot control the locus of deletion and shortening, so deletion is predicted to occur where it doesn't. To get around this, such analyses must appeal to prosodic constraints like  $*\sigma_{\mu\mu\mu}$  and WSP, which are themselves sufficient to account for the pattern. Economy

constraints are shown to be unnecessary to account for syncope: at best they are useless and at worst harmful.

### 3.2 Metrical constraints and the typology of metrical syncope

There are several constraints whose interaction with MAXV can result in vowel deletion in metrically defined contexts. In this section, I review some of these constraints and sketch out their interaction as relevant to the case studies in this chapter.

#### 3.2.1.1 PARSE- $\sigma$

PARSE- $\sigma$  assigns one violation mark to every syllable that is not immediately dominated by a foot node:

- (1) PARSE- $\sigma$ : “Syllables are parsed by feet” (Prince and Smolensky 1993).  
*Harmonic scale*:  $\sigma / Ft \succ \sigma / PrWd \succ \sigma / PPh$  (/ = “immediately dominated by”)

PARSE- $\sigma$  is one of a larger family of EXHAUSTIVITY constraints, which require every element of the Prosodic Hierarchy to be dominated by an immediately higher level (Selkirk 1995b). I interpret Selkirk’s EXHAUSTIVITY as a formal principle that informs the harmonic scale in (1): the principle itself is formulated in fairly general terms but the resulting constraints are calibrated to penalize specific prosodic levels that are not exhaustively dominated.

The most commonly discussed effect of PARSE- $\sigma$  is not an economy effect at all—exhaustive footing. The obvious way to satisfy PARSE- $\sigma$  is to build a foot around a syllable. Depending on the ranking of the relevant constraints, satisfaction of PARSE- $\sigma$  may entail building less-than-perfect degenerate feet, creating stress clashes, and so on. These are in a sense anti-economy effects—the constraint is satisfied by the addition of foot structure.

Because syllables are (typically) headed by vowels, the deletion of a vowel can also remove violations of PARSE- $\sigma$ . For example, in Yidiñ, the last vowel of an odd-parity word is deleted but the last vowel of an even-parity word is preserved. (Round brackets indicate foot boundaries.)

(2) Yidiñ odd-parity apocope (Dixon 1977a, b)

- |    |               |                |                   |                  |
|----|---------------|----------------|-------------------|------------------|
| a. | /gindanu/     | (gin.dá:n)     | ‘moon-absolutive’ | not *(gin.dá:)nu |
| b. | /gindanu-ŋgu/ | (gínda)(núŋgu) | ‘moon-ergative’   |                  |

This pattern indicates that PARSE- $\sigma$  dominates MAXV: apocope applies when the vowel cannot be incorporated into a binary foot (Dixon 1977a, b, Hayes 1995, Hung 1994, Kirchner 1992, though see Hall 2001 for an alternative analysis without PARSE- $\sigma$ ).

If footing is not iterative, the ranking PARSE- $\sigma$   $\gg$  MAXV can favor pervasive syncope, deleting vowels wherever possible outside the main foot: /takapana/  $\rightarrow$  *tak(pána)*, /takapawana/  $\rightarrow$  *tak.pa(wána)*, /takapatawana/  $\rightarrow$  *tak.pat(wána)*, etc. A possible example of such a pattern is Afar, where deletion affects vowels outside the foot but not inside wherever the CVC syllable structure permits: /xamila/  $\rightarrow$  *xa(míla)*, but /xamila-í/  $\rightarrow$  *xam(lí)*, not \**xa.mi(lí)* (Bliese 1981).

### 3.2.1.2 The STRESS-TO-WEIGHT PRINCIPLE

Another prosodic constraint that can be satisfied by vowel deletion is SWP, which requires stressed syllables to be heavy:

- (3) STRESS-TO-WEIGHT PRINCIPLE (SWP): “Heads of feet are minimally bimoraic.”<sup>36</sup>  
*Harmonic scale:*       $\sigma_{\mu\mu\mu} \succ \sigma_{\mu\mu} \succ \sigma_{\mu}$

This constraint assigns a violation mark to a (LL) foot but not to a (H) foot. In a language with moraic consonants, it is possible to satisfy SWP by deleting the second vowel from a /CVCV/ sequence. The result is a (CVC) foot, which satisfies SWP. If the SWP is ranked above MAXV, the vowel following a light stressed syllable will delete, resulting in an output with fewer syllables. This is an economy effect, yet SWP has other effects as well. Heavy stressed syllables can also be created by vowel lengthening (as in many Germanic languages (Riad 1992), Ilokano (Hayes and Abad 1989), and Central Alaskan Yupik (Gordon 2001, Hayes 1995, Jacobson 1985, Miyaoka 1985, Woodbury 1987)) and consonant gemination (Norton Sound Unaliq (Jacobson 1985), Italian, and others). Hayes 1995:83 discusses a number of examples of iambic systems which augment stressed syllables by lengthening the vowel or geminating the consonant, including Hixkaryana, Surinam Carib, Menomini, Cayuga, Central Alaskan Yupik, Sierra Miwok, Munsee, Menomini, Southern Paiute, and many others. Gemination and lengthening are certainly not economy effects—they are quite the opposite, since they result in larger structures.

### 3.2.1.3 A mini typology of metrical syncope

The factorial typology of the three constraints SWP, PARSE- $\sigma$  and MAXV produces four types of patterns, shown in (4). First, if MAXV dominates both markedness constraints, then there is either no syncope or the pattern is essentially nonmetrical (see

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<sup>36</sup> SWP is also defined “if stressed, then heavy.” Prince (1990) names it but argues against it. SWP harks back to Prokosch’s Law (1938) and the Obligatory Branching Parameter (Halle and Vergnaud 1978, Hammond 1984, Hayes 1980). See also Fitzgerald 1999, Goodman 1990, Ham 1998, Hayes 1995, Jacobs 2000, 2001, Kager 1997, 1999, Morén 1999, Myers 1987, Riad 1992.

chapter 4 for some such patterns). In some of these languages, SWP and PARSE- $\sigma$  may actually be satisfied in other ways, i.e., through gemination, vowel lengthening, and/or exhaustive footing. Second, if PARSE- $\sigma$  dominates MAXV but SWP does not, then vowels that are unfootable in the faithful candidate will delete. This is the pattern in Yidij. Third, if SWP dominates MAXV but PARSE- $\sigma$  is ranked below MAXV, deletion will apply to LL sequences (converting them into H feet). This pattern is attested in Panare (Payne and Payne 2001). Finally, if both SWP and PARSE- $\sigma$  dominate MAXV, the result is a pattern where deletion applies both to vowels that occur in in LL sequences and to vowels that are unfootable in the faithful candidate. This kind of pattern is found in Hopi (§3.3), Southeastern Tepehuan (§3.5), and Aguaruna (Alderete 1998, Payne 1990). Tonkawa, which is the subject of §3.4, has a variation of this pattern—there are no unfootable vowels because footing is iterative, but deletion always applies after light syllables.

(4) Predicted syncope patterns with SWP and PARSE- $\sigma$

<b>MAXV</b> >>PARSE- $\sigma$ , SWP	/pataka/ → (pata)ka, not *(pat.ka)	many lgs.
PARSE- $\sigma$ >> <b>MAXV</b> >>SWP	/pataka/ → (patak), not *(pata)ka /patakata/ → (pata)(kata)	Yidij
SWP>> <b>MAXV</b> >>PARSE- $\sigma$	/pataka/ → (pát)ka, not *(pá.ta)ka /paataka/ → (páa)(ták) or (páa)ta.ka not *(pát)ka	Panare
SWP, PARSE- $\sigma$ >> <b>MAXV</b>	/patakata/ → (pa.tak)ta, not *(pa.ta)ka.ta /pataakata/ → (paták)ta, not *(patáa)ka.ta	Hopi, SE Tepehuan

3.2.1.4 ENDRULE and other constraints

Both PARSE- $\sigma$  and SWP can interact with other constraints in complex ways, so the picture in (4) is a rather incomplete. Some of the constraints that play an important role in the case studies in this chapter are defined below. WSP (see (5)) assigns violation

marks both to unfooted heavy syllables and to footed heavy syllables that are not stressed:

- (5) WEIGHT-TO-STRESS PRINCIPLE (WSP): “If heavy, then stressed.” (Prince 1990)  
*Harmonic scale:*<sup>37</sup>  $\check{\sigma}_\mu > \check{\sigma}_{\mu\mu} > \check{\sigma}_{\mu\mu\mu}$

One effect of WSP that has little to do with economy is attraction of stress to heavy syllables from light ones. In Panare, Tübatulabal, Axininca Campa, and numerous other languages, the default alternating stress pattern is disrupted to avoid unstressed heavy syllables (see Hayes 1995, McCarthy and Prince 1993b, Prince and Smolensky 1993). Another effect that does result in economy is the shortening of vowels in unstressed syllables (as in Latin; see §3.4.2.2). All three case studies discussed in this chapter have shortening of this sort. Yet another important effect of WSP is that it can prevent syncope from creating unstressed heavy syllables, as it does in Hopi (see especially §3.3.4.2).

For various reasons discussed in chapter 2, I assume that all constraints in CON are categorical (see also McCarthy to appear for additional arguments). Here I discuss how iterative vs. non-iterative footing is obtained without gradient alignment, since this will be important in this chapter.

Iterative footing violates at least one of the ENDRULE constraints (McCarthy to appear, Prince 1983), which were briefly discussed in chapter 2. These constraints require that the head foot of a prosodic word be the first (or last) foot in the prosodic word:

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<sup>37</sup> This scale actually gives rise to two constraints,  $WSP_{\mu\mu}$  “No unstressed bimoraic syllables” and  $WSP_{\mu\mu\mu}$  “No unstressed trimoraic syllables” (cf. Kager’s (1997) “gradient” WSP, which assigns two violation marks for unstressed superheavies but only one for unstressed heavies.) The relevant constraint in Hopi is  $WSP_{\mu\mu}$ .  $WSP_{\mu\mu\mu}$  plays a role in Tonkawa and Tepehuan, and also in Lebanese Arabic (chapter 4).



- (6) ENDRULE-L: “The head foot is not preceded by another foot within the prosodic word” (McCarthy to appear).

*Harmonic scale:*  $[_{PrWd} x (HdFt)\dots] \succ [_{PrWd} \dots(Ft)\dots (HdFt)\dots]$   $x$  not a foot

- (7) ENDRULE-R: “The head foot is not followed by another foot within the prosodic word” (McCarthy to appear).

*Harmonic scale:*  $[\dots(HdFt) x_{PrWd}] \succ [\dots(HdFt) \dots (Ft)_{PrWd}]$   $x$  not a foot

Consider how these constraints interact with PARSE- $\sigma$ . ENDRULE-L, for example, can be satisfied by two kinds of structures: an iteratively footed word whose leftmost foot is the head of the prosodic word, e.g.,  $(\acute{\sigma}\sigma)(\sigma\sigma)$  or  $\sigma(\acute{\sigma}\sigma)(\sigma\sigma)$ , and any non-iteratively footed word, whose head foot is both the leftmost and the rightmost foot in the word:

- (8) ENDRULE constraints and iterative footing

	ENDRULE-L	ENDRULE-R	PARSE- $\sigma$
a. $(\acute{\sigma}\sigma)(\sigma\sigma)$		*	
b. $(\sigma\sigma)(\acute{\sigma}\sigma)$	*		
c. $\sigma\sigma(\acute{\sigma}\sigma)$			**
d. $(\acute{\sigma}\sigma)\sigma\sigma$			**
e. $\sigma(\acute{\sigma}\sigma)(\sigma\sigma)$		*	*

Although at least one of the ENDRULE constraints must be violated when footing is iterative, both are satisfied when there is only one foot in the word—thus we get non-iterative footing when ENDRULE constraints dominate PARSE- $\sigma$ . Another feature of ENDRULE constraints is that they do not actually require the head foot to be leftmost or rightmost in the word—this is one of several differences between ENDRULE constraints and ALL-FT-L/R (McCarthy and Prince 1993a; see McCarthy to appear for more discussion). ENDRULE constraints do not “count” the number of feet that stand between a head foot and a word edge—a word with one offending foot is as marked as a word with twenty such feet.

As for the position of the single foot in a non-iteratively footed word, it will be determined by the positional licensing constraints of Kager 2001. These constraints include ones that require syllables at edges to be footed. Kager frames these as categorical alignment constraints, ALIGN-L(WD, FT) and ALIGN-R (WD, FT), but I will follow McCarthy's usage and call them PARSE- $\sigma$ -INITIAL (or PARSE- $\sigma$ 1 for short) and PARSE- $\sigma$ -FINAL to avoid confusion with gradient alignment constraints.

This provides the necessary background for the case studies.

### 3.3 Hopi

#### 3.3.1 Introduction

Hopi (Northern Uto-Aztecan, Southwestern USA) has a pattern of syncope and vowel shortening that applies to the second or the third underlying vowel of the word.

Thus, both underlying /LL-L/ words and /HL-L/ words surface as HL:<sup>38</sup>

(9) Suffixation on LL bases: syncope (Hill et al. 1998, Jeanne 1978, 1982)

- |    |           |       |            |     |      |            |
|----|-----------|-------|------------|-----|------|------------|
| a. | /soma-ya/ | sómya | 'tie, pl.' | cf. | sóma | 'tie, sg.' |
| b. | /soʔa-ya/ | sóʔya | 'die, pl.' | cf. | sóʔa | 'die, sg.' |

(10) Suffixation on HL bases: syncope and shortening

- |    |            |       |                 |     |       |                     |
|----|------------|-------|-----------------|-----|-------|---------------------|
| a. | /tooká-ni/ | tókni | 'sleep, future' | cf. | toóká | 'sleep, non-future' |
| b. | /mooki-ni/ | mókni | 'die, future'   | cf. | moókí | 'die, non-future'   |

In longer words, however, syncope applies only once but strikes the *third*, not the *second* vowel:

(11) In /LLLLL/ words, delete the third underlying vowel

- |    |               |              |                     |               |
|----|---------------|--------------|---------------------|---------------|
| a. | /aŋa-katsina/ | a.ŋak.tsi.na | 'Long Hair kachina' | *aŋ.ka.tsi.na |
| b. | /tuhisá-tuwi/ | tu.his.tu.wi | 'ingenuity'         | *tuh.sa.tu.wi |

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<sup>38</sup> L=light syllable, H=heavy syllable throughout.

In this section, I present a detailed analysis of Hopi phonology and argue that there is a principled explanation for this asymmetry between words with three underlying vowels and words with four underlying vowels or more. Hopi has an output target—an iambic foot (H) or (LH) at the beginning of the word, followed by at least one unstressed syllable. In words that have only three underlying vowels, syncope applies to the second vowel because this ensures a (H)L output. The weight profile of the output is also very important to the outcome of both syncope and shortening: syncope can never create an unstressed H syllable. What matters in Hopi is not the length of the output but its markedness with respect to metrical constraints.

The same constraints whose interaction favors syncope and shortening are also active in determining the stress pattern: SWP, PARSE- $\sigma$ , WSP, and NONFINALITY( $\sigma$ ). Syncope, shortening and foot construction all work together to produce outputs that are metrically optimal given the Hopi ranking.

I argue that an analysis of Hopi in terms of economy constraints is problematic. An economy principle analysis seems initially plausible: if syncope is indeed an economy process of reducing the number of syllables, feet, and moras, then /HLL/ words are a prime target for some deletion and shortening, since they contain more structure than /LLL/ words. Yet this economy principle approach encounters problems with /LLLLL/ words: since these are longer than either /LLL/ or /HLL/, economy constraints predict that deletion should apply more than once. This sort of analysis also fails to explain why deletion targets different positions in words of different length without appealing to additional mechanisms. More generally, any analysis of Hopi that is agnostic of prosodic structure misses a real connection between the surface stress pattern and the application

of syncope and shortening: metrical well-formedness is a real goal in Hopi; short words are not.

### 3.3.2 Hopi phonology: the bigger picture

Hopi syncope and vowel shortening are closely tied to stress, so I present the stress facts first (§3.3.2.1). Syncope and shortening are described in §3.3.2.2 and §3.3.2.3 respectively. I draw on the descriptions by Jeanne 1978, 1982, and Hill and Black 1998. Forms are taken from Jeanne's work, Halle 1975, and the *Hopi Dictionary* (Hill et al. 1998).

#### 3.3.2.1 Stress pattern

Hopi has CVV, CVC and CV syllables. There are generally no clusters, except word-finally two-consonant clusters are tolerated when they arise through morpheme concatenation. CVV and CVC syllables count as heavy in the weight-sensitive stress system of Hopi, which is described as follows:

- (12) Hopi stress: Stress initial syllable if heavy; otherwise stress second syllable. In disyllables, stress the initial syllable. No secondary stress has been reported.

The stress pattern is illustrated in (13)-(15).

- (13) Stress initial syllable if heavy

- a. ʔác.ve.wa            'chair'  
b. soó.ya              'planting stick'

- (14) Otherwise stress second syllable

- a. ca.qáp.ta            'dish sg.'  
b. qö.tó.som.pi        'headband sg.'  
c. ki.yá.pi              'dipper sg.'

- (15) In disyllables and monosyllables, stress first syllable

- a. kó.ho                'wood'  
b. táa.vok              'yesterday'



- |                   |               |                   |     |                     |
|-------------------|---------------|-------------------|-----|---------------------|
| d. /tuhisa-tuwi/  | tu.hís.tu.wi  | ‘ingenuity’       | cf. | tuhisa ‘ingenious,’ |
|                   |               |                   |     | túwi ‘knowledge’    |
| e. /qövisá-tapna/ | qö.vís.tap.na | ‘make pout, sulk’ | cf. | qövísa ‘bad sport’  |

The generalization that unites these patterns is that deletion produces a (H) or a (LH) sequence at the left edge of the word followed by at least one syllable; in other words, syncope produces a left-aligned iambic foot that is non-final in the word.

### 3.3.2.3 Vowel shortening patterns

Vowels shorten in several environments in Hopi. One is unstressed syllables.

When a second syllable long vowel is final in the word, it is shortened:

#### (20) Shortening word-finally

- |            |       |          |     |           |                      |
|------------|-------|----------|-----|-----------|----------------------|
| a. /panaa/ | pá.na | ‘act on’ | cf. | pa.naa.qe | ‘act on, conj.’      |
| b. /sowaa/ | só.wa | ‘eat’    |     | so.waa.qe | ‘eat, conj.’         |
| c. /pitii/ | pí.ti | ‘arrive’ |     | pi.tí.qey | ‘arrive, conj.+acc.’ |

Shortening also applies to closed syllables, whether derived by syncope or not:

#### (21) Suffixation on /HL/ bases: syncope and shortening

- |               |        |                 |     |        |                     |
|---------------|--------|-----------------|-----|--------|---------------------|
| a. /tooká-ni/ | tó.kni | ‘sleep, future’ | cf. | tóo.ka | ‘sleep, non-future’ |
| b. /mooki-ni/ | mók.ni | ‘die, future’   | cf. | móo.ki | ‘die, non-future’   |

#### (22) Shortening in underlyingly closed syllables

- |             |        |             |     |              |            |                 |
|-------------|--------|-------------|-----|--------------|------------|-----------------|
| a. /naaqvi/ | náq.vi | ‘eat’       | cf. | /RED-naaqvi/ | náa.naq.vi | ‘eat pl.’       |
| b. /tíisna/ | tís.na | ‘body dirt’ | cf. | /RED-tíisna/ | tíí.tis.na | ‘body dirt pl.’ |

Finally, long vowels shorten in sequences, as demonstrated by the reduplication examples in (23).

#### (23) /HL/ reduplication with shortening

- |                |           |             |     |        |
|----------------|-----------|-------------|-----|--------|
| a. /RED-noova/ | nóo.no.va | ‘food pl.’  | cf. | nóo.va |
| b. /RED-moola/ | móo.mo.la | ‘mule pl.’  |     | móo.la |
| c. /RED-ʔaaya/ | ʔáa.ʔa.ya | ‘rattle pl’ |     | ʔá.ya  |
| d. /RED-soohi/ | sóo.so.hi | ‘star pl.’  |     | sóo.hi |

I have found no long vowel prefixes or suffixes, so reduplicated forms provide the only examples of long vowels in sequences.<sup>40</sup>

To summarize, Hopi long vowels shorten in closed syllables and in unstressed positions.

### 3.3.3 Analysis of Hopi stress

#### 3.3.3.1 Non-iterative footing

Stress in Hopi is iambic (Hayes 1995, Hung 1994): a single foot is built at the left edge of the word, and the final syllable is extrametrical. The pattern results from the interaction of the following constraints:

- (24) ENDRULE-R, ENDRULE-L, PARSE- $\sigma$ , NONFINALITY( $\sigma$ ), PARSE- $\sigma$ 1.

There is no secondary stress, so both ENDRULE constraints must dominate PARSE- $\sigma$ . It is more important to have no intervening feet between the right edge of the head foot and the right edge of the prosodic word than to foot iteratively. A violation of ENDRULE-R is incurred by the iterative loser (*qötö*)(*sòm*)*pi* because the main stress foot is not final in the word. A violation of ENDRULE-L is incurred by (*qötö*)(*sóm*)*pi* because its main stress foot is not initial in the word:

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<sup>40</sup> According to Hill and Black, there is another shortening process that affects a first-syllable long vowel in compounding, e.g. *siiva* ‘metal’ + *qöpqö* ‘fireplace’ → *sivaqöpqö* ‘stove,’ *muuyaw* ‘moon’ + *taala* ‘light’ → *muytala* ‘moonlight,’ but *qöötsa* ‘white’ + *kowaako* ‘chicken’ → *qötsakowaako* ‘white chicken.’ This process is probably not part of the same system as the shortening processes discussed here. Hill and Black also do not mention whether there is secondary stress in compounds like *qötsa-kowaako*.

(25) One foot is built at the left edge

/qötösompi/	ENDRULE-R	ENDRULE-L	PARSE- $\sigma$
a. $\text{ᶯ}(\text{qötó})\text{sompi}$			**
b. $(\text{qötó})(\text{sòm})\text{pi}$	*!		*
c. $(\text{qötò})(\text{sóm})\text{pi}$		*!	*

The position of the main stress foot is determined by the high-ranking PARSE- $\sigma$ 1. PARSE- $\sigma$ 1 must dominate all the constraints that can favor non-initial feet, because the first syllable is consistently footed regardless of what follows (this will be shown shortly).

### 3.3.3.2 The role of NONFINALITY( $\sigma$ )

As we will see in §3.3.4.2, NONFINALITY( $\sigma$ ) plays a pivotal role in the outcome of syncope—the output of syncope always satisfies this constraint even if this comes at the expense of less-than-perfect footing. In addition to this effect, it controls stress assignment in LL disyllables in an interaction that Prince and Smolensky dub “rhythmic reversal” (Prince and Smolensky 1993:58).

Default stress in Hopi is iambic, which suggests that RHTYPE=IAMB (see (27)) dominates RH-TYPE=TROCHEE—witness  $(\text{kíyá})\text{pi} \succ *(\text{kíya})\text{pi}$ . However in disyllables, stress falls on the initial syllable in order to avoid violating NONFINALITY( $\sigma$ ):<sup>41</sup>

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<sup>41</sup> This NONFINALITY constraint penalizes final syllables that bear stress, but there is another version of NONFINALITY that bans final syllables not only from being stressed but from being footed—NONFINALITY(FT) (cf. Prince and Smolensky 1993). This constraint can only be active in trochaic languages (where it favors antepenultimate stress), since they alone can have footed word-final syllables that are not stressed. See chapter 4 for discussion of NONFINALITY, where a more complete version of its harmonic scale will be given.



(26) NONFINALITY( $\sigma$ ): “The prosodic head of a word does not fall on the word-final syllable” (Prince and Smolensky 1993:42).

*Harmonic scale:* [<sub>PRWD</sub>...  $\sigma$ ]  $\succ$  [<sub>PRWD</sub>...  $\sigma$ ]

Since (L) feet are generally avoided in the language (there are no L words, meaning FTBIN is undominated), the only way to satisfy NONFINALITY( $\sigma$ ) is to foot disyllables as trochees. This violates RH-TYPE=IAMB:<sup>42</sup>

(27) RHTYPE=IAMB: “Feet are prominence-final” (Prince and Smolensky 1993:56).

*Harmonic scale:* (... $\sigma$ )  $\succ$  (... $\sigma$ )

Switching to trochaic feet in disyllables is a common pattern for iambic languages. Prince and Smolensky discuss rhythmic reversal in their analysis of Southern Paiute, and numerous other examples can be found in Hung 1994 who actually briefly discusses Hopi in this context.

(28) Foot shape is sacrificed to avoid final stress

/koho/	NONFINALITY( $\sigma$ )	RHTYPE=IAMB	RHTYPE=TROCH
a. $\text{ᵛᵛ}$ (kóho)		*	
b. (kohó)	*!		*

NONFINALITY( $\sigma$ ) is very high-ranked in Hopi and dominated only by the morphology-phonology interface constraint LX $\approx$ PR. LX $\approx$ PR requires that all lexical words correspond to prosodic words, i.e., be footed, etc. We see its effect in monosyllabic words like *pám*: the only way to foot them results in final stress (30) (cf. the analysis of Latin

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<sup>42</sup> RHTYPE=IAMB according to this scale is defined “\* $\sigma$ ”<sub>Fi</sub>.” By this definition, (H) is both an optimal trochee and an optimal iamb, since it is both prominence-initial and prominence-final. This is an economy result: the smallest foot is preferred by the grammar to larger feet simply because it does not contain any non-prominent material.

extrametricality in Prince and Smolensky 1993). Monosyllables are the only forms that violate NONFINALITY( $\sigma$ ) in Hopi.

(29) LX $\approx$ PR “lexical words must correspond to prosodic ones.”

(30) Final stress not avoided when there is only one syllable

/pam/	LX $\approx$ PR	NONFINALITY( $\sigma$ )
a. $\text{pám}$		*
b. pam	*!	

### 3.3.3.3 The role of WSP

Another constraint that affects the outcome of syncope and vowel shortening is WSP (see (5)), which disfavors unstressed bimoraic syllables (CVV and CVC). Although WSP plays an important role in blocking syncope, it is not ranked high enough to affect stress placement very much. Thus, WSP is dominated by NONFINALITY( $\sigma$ ). In LH disyllables, stress falls on the initial syllable even though the result is an unstressed H syllable.

(31) Heavy syllables unstressed in final position

/mamant/	NONFINALITY( $\sigma$ )	WSP
a. $\text{mámant}$		*
b. ma(mánt)	*!	

WSP is also dominated by the constraint that determines the placement of the main stress foot in Hopi, PARSE- $\sigma$ 1. The first syllable of the word is always footed, even if this leaves heavy syllables unstressed. Footing the CVC in addition to footing the first syllable is

also a conceivable alternative, but a poor one in Hopi because it violates one of the undominated ENDRULE constraints:<sup>43</sup>

(32) Heavy syllables left unfooted outside the initial disyllabic window

/qötösompi/	PARSE- $\sigma$ 1	ENDRULE-R	ENDRULE-L	WSP
a. $\text{qöt}^{\text{ó}}\text{sompi}$				*
b. $\text{qö}(\text{tösóm})\text{pi}$	*!			
c. $(\text{qöt}^{\text{ó}})(\text{sòm})\text{pi}$		*!		
d. $(\text{qöt}^{\text{ò}})(\text{sóm})\text{pi}$			*!	

Although the constraints on footing dominate WSP, its activity is visible in unstressed vowel shortening because it is ranked above MAX- $\mu$ . Recall that long vowels never occur word-finally in Hopi—there are even alternations that show this, as in /panaa/  $\rightarrow$  (pána) but /panaa-qe/  $\rightarrow$  (panáa)qe. A long vowel can only surface if it is stressed and non-final, satisfying NONFINALITY( $\sigma$ ) and WSP. This pattern is analyzed in §3.3.4.1.

### 3.3.3.4 Summary of the analysis of stress

To sum up, NONFINALITY( $\sigma$ ) is dominated only by LX $\approx$ PR, and WSP is dominated by NONFINALITY( $\sigma$ ), ENDRULE-R, ENDRULE-L and PARSE- $\sigma$ 1. WSP and PARSE- $\sigma$  cannot be ranked with respect to each other at this point, but they will be ranked in the subsequent sections based on the evidence from syncope and vowel shortening. The rankings established so far are summarized in (33).

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<sup>43</sup> There is a plausible alternative to this analysis, namely, that consonants do not bear weight outside the main stress foot. In other words, candidates like (qöt<sup>ó</sup>)sompi violate not WSP but WEIGHT-BY-POSITION (Hayes 1989, 1994, Rosenthal and van der Hulst 1999). The WSP analysis explains both shortening and why syncope fails to create unstressed CVC syllables, which the WBP analysis does not do.

(33) Rankings for the footing pattern

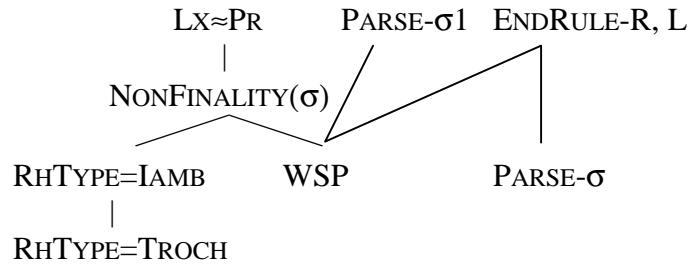


Tableau (34) shows how these rankings work together to produce the stress pattern. Since only markedness constraints interact in this ranking, inputs are omitted. Because of the number of constraints involved in this interaction, the tableau is given in the comparative format (Prince 1998a, 2000). Instead of showing the individual violation marks that each candidate incurs from each constraint, comparative tableaux show whether a constraint favors the winning candidate (W) or a loser it is being compared with (L). For every winner~loser comparison, the highest ranked constraint on which the candidates differ must favor the winner. I will use comparative tableaux throughout chapters 3 and 4 to introduce and/or summarize the more complex ranking arguments.

The first pair of forms shows that a single foot must be built at the left edge, to avoid violations of ENDRULE-R and NONFINALITY(σ). The loser’s footing, *\*ki(yapí)*, is favored by PARSE-σ-FINAL (not shown). Also, the default foot is iambic, not trochaic, as shown by the comparison *(kiyá)pi*~*\*(kíya)pi*. The next two comparisons show that the first syllable must be footed even when this results in unstressed heavy syllables: PARSE-σ1 dominates WSP. Non-iterative footing in *(qötó)som.pi* also indicates that ENDRULE-R dominates PARSE-σ: the main stress foot must be final in the word even if this means two unfooted syllables. The last two comparisons show the role of NONFINALITY(σ) in the footing of monosyllables and disyllables.

## (34) Stress pattern

	ER-R	PRS- $\sigma$ 1	LX $\approx$ PR	NF	WSP	PRS- $\sigma$	IAMB	TROCH
a. (kiyá)pi~ki(yapí)		W		W				
b. (kiyá)pi~(kíya)pi							W	L
c. (má.mant)~ma(mánt)		W			L	W		
d. (qötó)som.pi~qö(tösóm)pi		W			L			
e. (qötó)som.pi~(qötó)(sòm)pi	W				L	L		
f. (pám)~pam			W	L		L		
g. (kóho)~(kohó)				W			L	

### 3.3.4 Non-iterative footing, syncope, and vowel shortening in Hopi

Foot construction is not static in Hopi. Rather, shortening and syncope interact with foot construction to ensure (i) that the output has optimal iambic feet, i.e., (H) or (LH), and (ii) that the number of unfooted syllables is minimal and that their shape is optimal—L.

#### 3.3.4.1 Analysis of long vowel shortening

Recall that WSP is dominated in Hopi by NONFINALITY( $\sigma$ ) and PARSE- $\sigma$ 1, which means that heavy syllables cannot “pull” stress off of light syllables: *mámant*  $\succ$  \**mamánt* and *qötósompi*  $\succ$  \**qötösómpi*). Despite being dominated by these constraints, WSP is still active, and its most visible effect is vowel shortening. While unstressed CVC syllables are tolerated, unstressed CVV syllables are routinely shortened. The relevant examples are repeated in (35):

(35) Shortening word-finally<sup>44</sup>

- |    |         |                 |     |            |                      |
|----|---------|-----------------|-----|------------|----------------------|
| a. | /panaa/ | (pána) ‘act on’ | cf. | (panaá)qe  | ‘act on, conj.’      |
| b. | /pitii/ | (píti) ‘arrive’ |     | (pitíí)qey | ‘arrive, conj.+acc.’ |

Unstressed CVC syllables must be tolerated because MAXC is undominated in the language—consonants are never deleted. Thus, words like *qötósompi* cannot get around violating WSP by deleting a consonant, \**qötó*sopi**. On the other hand, long vowels are routinely shortened in unstressed positions.

Vowel shortening indicates that WSP dominates the constraint against vowel shortening, MAX- $\mu$  (McCarthy and Prince 1995). I treat MAX- $\mu$  as a constraint against shortening specifically as opposed to vowel deletion—MAX- $\mu$  and MAXV assign distinct violations, although a mora is lost in both cases. MAXV is violated when the entire vowel root node is deleted, whereas MAX- $\mu$  is violated when a mora is lost without deleting the vowel. MAX- $\mu$  is not violated when a vowel is deleted with all of its moras:

- (36) MAX- $\mu$  “No shortening”: “For every V that corresponds to V' in the output, every  $\mu$  that is linked to V has a correspondent  $\mu'$  linked to V'.”

MAX- $\mu$  must be violated in Hopi in some situations: since NONFINALITY( $\sigma$ ) prevents the last syllable in an (LH) word from being stressed, as in \**panáa*, and WSP disfavors (LH) trochees like \**pánaa*, the only possible outcome given the Hopi ranking is shortening to (LL), *pána*:

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<sup>44</sup> Jeanne analyzes these forms as exceptions to syncope based on *pánani* ‘act on, fut.’ and *sówani* ‘eat, fut.’ The stress pattern in these forms suggests that they treat *-ni* as a stress-neutral suffix (or a clitic), which also explains why syncope does not apply but shortening does: there is a prosodic word boundary between the last syllable of the base and the clitic, *[[pána]ni]*. If these are exceptional, it is not with respect to syncope. According to *the Hopi Dictionary*, they reduplicate just as LL forms, with syncope in the base: *papna*, *soswa*, etc.

(37) Shortening in word-final syllables

/panaa/	NONFINALITY(σ)	WSP	MAX-μ
a. <del>pa</del> (pána)			*
b. (pánaa)		*!	
c. (panáa)	*!		

Under this ranking, long vowels must also shorten outside the main foot (38), e.g., in reduplication (see (38)). If neither vowel is shortened, the result would violate WSP since it is impossible to foot both vowels in Hopi. Thus, *\*(nóo)noo.va* is out on WSP, and

*\*(noo)(noo)va* is out on ENDRULE constraints.<sup>45</sup>

(38) /HL/ reduplication with shortening

- a. /RED-noova/      (nóo)no.va      ‘food pl.’      cf.      (nóo)va  
 b. /RED-moola/      (móo)mo.la      ‘mule pl.’      (móo)la

As we will see shortly, WSP has another effect in Hopi: it controls the syncope process.

3.3.4.2 Analysis of short vowel syncope

The ideal prosodic word in Hopi consists of an initial iambic foot followed by a single unstressed light syllable: (LH)L or (H)L. This is in part the effect of NONFINALITY(σ), WSP, and PARSE-σ. As we will see in this section, syncope works towards this goal, as well.

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<sup>45</sup> Why not *\*(no.nóo)va*? This sort of output achieves maximal footing and preserves the long vowel in the base, performing better than *(nóo)no.va* on FAITH-IO. I assume that the reduplicant morpheme attracts stress—it is an underlyingly stressed suffix (Alderete 1998, Revithiadou 1999). Since the stressed syllable must be heavy in Hopi (see §3.3.4.2), the long vowel is realized in the reduplicant (for some related issues, see Fitzgerald 1999, Riggle 2003, Struijke 2001). Deletion of the long vowel in the base to *\*nón.va* is prevented by a special faithfulness constraint that requires input long vowels to have output correspondents—see §3.4.6.2. This analysis also explains the reduplication pattern of LL bases: /RED-koho/ → *(kók)ho*. For an alternative analysis of Hopi reduplication, see Hendricks 1999.

*Syncope in /LLL.../ words.* As shown in (39) (repeated from (19)), the third underlying vowel deletes in words that have four or more underlying vowels, the first three of which are short:

(39) Deletion in /LLL.../ words

- |                           |               |                     |                  |
|---------------------------|---------------|---------------------|------------------|
| a. /navota-na/            | na.vót.na     | ‘inform, tell’      | *(na.vó)ta.na    |
| b. /aŋa-katsina/          | (a.ŋak)tsi.na | ‘Long Hair kachina’ | *(a.ŋá)ka.tsi.na |
| c. /tuhi <u>s</u> a-tuwi/ | (tu.his)tu.wi | ‘ingenuity’         | *(tu.hí)sa.tu.wi |

The first two syllables in such words must be grouped into an iambic foot, yet the faithful parse (*a.ŋá)ka.tsi.na* violates SWP, the requirement for stressed syllables to be heavy (see (3)). Conceivably, SWP could be satisfied by lengthening the second vowel or geminating the following consonant. Neither lengthening nor gemination are available options in Hopi, though. We have seen that disyllabic forms like *sóma* do not surface as *\*sóoma* or *\*sómma*, although this would remove the need to foot them trochaically. This indicates that DEP- $\mu$  dominates SWP, preventing stressed syllable augmentation. (The forms *\*sómma* and *\*sooma* violate DEP-CONS- $\mu$  and DEP-VOC- $\mu$ , respectively.)

(40) No augmentation

/soma/	DEP- $\mu$	SWP	RHTYPE=IAMB
a. $\text{[s}^{\text{H}}\text{ó.ma]}$		*	*
b. (sóm)ma	*!		
c. (sóo)ma	*!		

Syncope in disyllables is blocked by NONFINALITY( $\sigma$ ), to which I will return shortly. In longer words, though, SWP can be satisfied by vowel deletion. Fitzgerald 1999 argues that the same ranking holds in another Uto-Aztecan language, Tohono O’odham, where base vowels syncope when a CV reduplicant is prefixed: /RED-toki/  $\rightarrow$  *tót.ki* ‘cotton,’ not *\*(tóto)ki*. The difference between Hopi and Tohono O’odham is



that in Hopi, the syncope process is generalized to all morphologically derived forms, not just reduplicated ones:

(41) SWP >> MAXV: heavy stressed syllables by syncope

/navota-na/	SWP	MAXV
a. $\text{na}^{\text{H}}(\text{navó})\text{na}$		*
b. $(\text{navó})\text{tana}$	*!	

Note that it is the third and not the second vowel that undergoes syncope in *navótna*. Such deletion creates a perfect iambic foot (LH), packing the maximal amount of syllables into the foot while minimizing the number of unfooted syllables. Deleting in the second syllable would also satisfy SWP, but the (H)LLL result incurs more violations of PARSE- $\sigma$ . Note that this result obtains regardless of the ranking of PARSE- $\sigma$  with respect to MAXV—both candidates in (42) satisfy SWP equally well, differing only in the number of unfooted syllables. In other words, the largest foot wins:

(42) PARSE- $\sigma$  and foot-packing (PARSE- $\sigma$  and MAXV not yet ranked)

/navota-na/	SWP	MAXV	PARSE- $\sigma$
a. $\text{na}^{\text{H}}(\text{na.vó})\text{na}$		*	*
b. $(\text{náv})\text{ta.na}$		*	**

The Hopi pattern is not unique—a similar pattern of third vowel syncope has been reported for other languages, notably Southeastern Tepehuan (see §3.5) and Aguaruna. Payne (1990:163) describes third vowel deletion in Aguaruna as affecting words with “three moras or more”:

(43) Aguaruna third vowel syncope (Alderete 1998, Payne 1990)

a. /i <u>č</u> ina <u>k</u> a-na/	i.čín.kan	‘clay pot (Acc)’	cf.	i.či.nak
b. /i <u>p</u> aku/	i.pak	‘achiote’	cf.	i.pa.kun
c. /tu <u>t</u> upi/	tu.tup	‘back’	cf.	tu.tu.pín

Such patterns of deletion clearly necessitate some reference to an initial iambic foot, and the analysis can be straightforwardly couched in terms of PARSE- $\sigma$  and SWP.

*Syncope in /LLL/ words.* In words with three underlying short vowels, deletion strikes the second and not the third vowel in Hopi: /soma-ya/ → *sóm.ya*, not *\*so.máy*. The reason for this is NONFINALITY( $\sigma$ ): final stress is generally avoided in Hopi, and NONFINALITY( $\sigma$ ) disfavors the deletion pattern that would result in final stress (see (44)). This is despite the more exhaustive parsing that a final-deletion output could achieve: deleting the last vowel (as in *\*sómáy*) creates an output with a single, canonical LH iambic foot and no unparsed syllables (In fact, as we will see in §3.5, this is the output that wins in Southeastern Tepehuan, because NONFINALITY( $\sigma$ ) and PARSE- $\sigma$  are ranked in the opposite way). The output (*sóm*)ya is selected because it satisfies NONFINALITY( $\sigma$ ) at the expense of violating PARSE- $\sigma$ . Another candidate not included in the tableau is *\*(só.máy)*. It is ruled out both by SWP and WSP, since its stressed syllable is light and its unstressed syllable is heavy.

(44) Syncope does not create final stress

/soma-ya/	NONFINALITY( $\sigma$ )	PARSE- $\sigma$
a. $\text{[sóm]ya}$		*
b. (so.máy)	*!	

As mentioned above, NONFINALITY( $\sigma$ ) also explains why vowels do not delete in LL disyllables like *sóma* and *kóho*.<sup>46</sup> These contain LL trochaic feet, which violate SWP since their head syllables are not heavy. However, these violations are required by the high-ranking NONFINALITY( $\sigma$ ), as was shown in (28), and they cannot be avoided because NONFINALITY( $\sigma$ ) also dominates MAXV. Thus, /soma/ does not map to \**sóm* because this output incurs a NONFINALITY( $\sigma$ ) violation. Augmentation is not an option here, either, so the canonical LL trochee emerges instead:

(45) NONFINALITY( $\sigma$ ) and DEP- $\mu$  prevent unfaithfulness in LL disyllables

/soma/	DEP- $\mu$	NONFINALITY( $\sigma$ )	SWP	MAXV
a. $\text{[s]}\text{[o]}\text{[ma]}$ (sóma)			*	
b. (sóm)		*!		*
c. (sóo)ma	*!			

*Syncope in /HLL.../ words.* In words that begin in long vowels, SWP can be satisfied by a faithful output, without deletion. Yet syncope applies in /HL-L/ words ((46), repeated from (10)):

(46) Suffixation on HL bases: syncope and shortening

- a. /tooká-ni/            tókni            ‘sleep, future’ cf.    toóka ‘sleep, non-future’  
 b. /mooki-ni/            mókni            ‘die, future’ cf.    moóki ‘die, non-future’

Why syncope here if not to reduce the number of syllables in the output? The phonology of Hopi provides an answer to this question: syncope reduces the number of *unfooted* syllables. This has to do with the fact that footing is non-iterative. PARSE- $\sigma$  is

<sup>46</sup> Actually, the explanation could be that syncope generally does not affect morphologically underived words. The analysis here is meant to account for the failure of syncope in hypothetical derived words as well, e.g., /t-ata/ → \**tat*.

dominated by constraints such as ENDRULE-R and NONFINALITY( $\sigma$ ), but it still exerts an effect whenever it can. In /HLL/ words, it is possible to reduce the number of violations of PARSE- $\sigma$  by syncope, so this is exactly what happens in (47). (The shared violations of PARSE- $\sigma$  are required by high-ranking NONFINALITY( $\sigma$ .)<sup>47</sup>)

(47) PARSE- $\sigma$  >> MAXV: syncope after long vowels

/tookani/	PARSE- $\sigma$	MAXV
a. $\text{t}^{\text{H}}\text{ok}^{\text{H}}\text{ni}$	*	*
b. (too)ka.ni	**!	

/LLL.../ words revisited. Although PARSE- $\sigma$  dominates MAXV, there are plenty of unfooted syllables in Hopi—recall (*aŋák*)*tsi.na*. The reason for this is that WSP dominates PARSE- $\sigma$ : syncope can never create heavy unstressed syllables. WSP in a sense controls syncope. The number of unfooted syllables can only be minimized in this very specific situation: when a long vowel is followed by a CV sequence, the short vowel deletes and the long vowel shortens in the resulting closed syllable.

WSP has a dual role in Hopi. On the one hand, it requires unstressed long vowels to shorten by dominating MAX- $\mu$  (see §3.3.4.1). On the other hand, it prevents unfooted syllable syncope from creating unstressed CVC syllables by dominating PARSE- $\sigma$ . This is shown in (48). All three candidates in (48) perform equally well on SWP—deleting either the second or the third vowel creates a heavy foot head. The decision is passed down to

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<sup>47</sup> The winner here is unfaithful in more than one way: it deletes the vowel *a* and shortens the long vowel of the base. This shortening is required by  $^*\sigma_{\mu\mu\mu}$ : “No trimoraic syllables.” This constraint is not violated in Hopi (except in words with low tone—low tone must be realized on long vowels in Hopi, so low tone syllables are allowed to be superheavy CVVC). Long vowels shorten in syncope words (/tookani/ → *tok.ni*, *\*took.ni*) and in underlyingly superheavy syllables, as was shown in (22).

WSP and PARSE- $\sigma$ . The ranking WSP>> PARSE- $\sigma$  selects the candidate that packs the maximum number of syllables into the main foot but does not attempt to reduce the number of unfooted syllables further. Note also that the last candidate, *(aŋ)kats.na*, is locally harmonically bounded in this iambic system: not only does it not do any better than the winner on PARSE- $\sigma$ , it also violates WSP.

(48) Syncope cannot create unstressed H syllables

/aŋa-katsina/	SWP	WSP	PARSE- $\sigma$	MAXV
a. <sup>48</sup> (aŋák)tsi.na			tsi, na	*
b. (aŋák)tsin		tsin!	tsin	**
c. (áŋ)kats.na		kats!	kats, na	*

Under this ranking, syncope should apply whenever it cannot affect the violations of WSP—for example, when the heavy syllable is present in the output whether or not syncope applies. The testing ground for this prediction is longer words that have the shape /HLH.../. In such words, syncope still applies to the second syllable: /naala-ya-n-ta/ → *(nál)yan.ta* ‘to be alone by oneself,’ cf. *náala* ‘alone.’<sup>48</sup> Note that in *nál.yan.ta*, the second syllable is heavy whether or not syncope applies—consonants cannot be deleted. The number of unfooted syllables can be safely minimized, so syncope and shortening apply here just as in /tooka-ni/ → *tók.ni*.

*Vowel shortening revisited.* PARSE- $\sigma$  compels vowel deletion in very specific circumstances by dominating MAXV, but it can also conceivably compel vowel

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<sup>48</sup> For reasons yet to be understood, syncope generally does not apply to the second syllable of /LL-H.../ words; thus, *qötósompi* ‘headband’ is not \**qótsompi*. Any account of this pattern will also have to explain why syncope *does* apply in /HL-H.../ words. I will leave this puzzle of Hopi phonology for future research.

shortening. For example, shortening the first long vowel in a disyllable could produce an output that is exhaustively footed, as in /taavok/ → \*(távok). We do not find this in Hopi—long vowels do not shorten when they are in position to be stressed, so /taavok/ maps to (táa)vok. Shortening cannot create a violation of SWP at the expense of exhaustive parsing—foot form is praised above exhaustive footing in Hopi:

(49) Foot form vs. exhaustive footing

/taavok/	NONFINALITY(σ)	SWP	PARSE-σ
a. t̩(áa)vok	✓		*
b. (távok)	✓	*!	

To summarize, vowel shortening and syncope are used to do the things that foot building cannot accomplish in Hopi: they minimize the number of unfooted syllables, maximize the weight of stressed syllables, and minimize the weight of unstressed syllables. There is every reason to think that outputs in Hopi must meet certain standards of prosodic well-formedness, but there is no indication that there is a general economy principle at work here. This is not a pattern of “delete wherever syllable structure permits”—this sort of an approach to Hopi is not very illuminating, as we will see in §3.3.6.

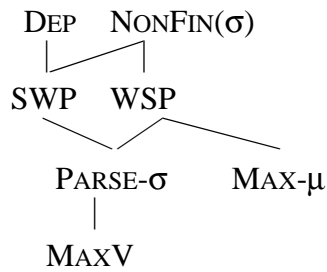
### 3.3.5 Summary of the Hopi analysis

Let us review how syncope and shortening function within the prosodic system of Hopi. The crucial rankings are summarized in (50)-(52).

(50) *Directionality of footing*: ENDRULE-R, ENDRULE-L >> PARSE-σ

(51) *Final extrametricality*: LX≈PR >> NONFINALITY(σ)>>RHTYPE=IAMB

(52) *Syncope/shortening:*



This grammar is shown in action in the comparative tableau (53). Syncope must create heavy foot heads, which is shown by the failure of *\*(so.má)ya*. Vowels are also deleted in forms like /tooká-ni/ to reduce the number of unfooted syllables; this state of affairs indicates that both SWP and PARSE- $\sigma$  dominate MAXV. The site of deletion is determined by NONFINALITY( $\sigma$ ) and WSP: deletion can never create a stressed final syllable (thus no *\*so.máy*) or an unstressed heavy syllable (thus no *\*aṅák.tsin*). The dispreference for unstressed heavy syllables is also seen in the vowel shortening process: unstressed long vowels shorten in /panaa/ and /noo-noova/. Finally, foot shape takes priority over exhaustive footing—shortening does not apply to stressable long vowels even though this might pack more syllables into the foot.

## (53) Syncope and the stress system

/soma-ya/	NONFIN	ER-R	WSP	SWP	PARSE-σ	MAXV	MAX-μ
a. (sóm)ya~(somáy)	W				L		
b. (sóm)ya~(somá)ya				W		L	
/tookani/							
c. (tók)ni~(tóo)ka.ni					W	L	L
d. (tók)ni~(tóo)kan			W				L
e. (tók)ni~(tóo)(kàn)	W	W					L
/soma/							
f. (sóma)~(sóm)	W			L		W	
/aŋa-katsina/							
g. (aŋák)tsi.na~(áŋ)ka.tsi.na					W		
h. (aŋák)tsi.na~(aŋák)tsin			W		L	W	
/naala-ya-n-ta/							
i. (nál)yan.ta~(náa)la.yan.ta					W	L	L
/panaa/							
j. (pána)~(pá.naa)			W				L
k. (pána)~(pa.náa)	W			L			L
/taavok/							
l. (táa)vok~(tá.vok)				W	L		W

The real output goal in Hopi are monopod outputs with heavy heads, non-final stress, a minimal number of unfooted syllables, and as few unstressed heavy syllables as possible.

The fact that winning outputs are shorter (i.e., more economical than their faithful competitors) is just a result of the language-specific ranking of faithfulness and markedness constraints in the grammar: syncope and vowel shortening are used because stressed syllable augmentation and iterative footing do not happen to be available alternatives.

### 3.3.6 Comparison with an economy constraint analysis of Hopi

Hopi syncope is analyzed by Jeanne 1978, 1982, who proposes the following basic rule of two-sided open syllable syncope. Rules of this sort date back to Kuroda's (1967) analysis of Yawelmani:



(54)  $V \rightarrow \emptyset / VC\_CV$  (Jeanne 1978, 1982)

The vowel deletion rule in (54) accounts for deletion in three-vowel inputs, both /HLL/ and /LLL/, but it is not sufficient for inputs with more than three vowels, such as /aŋa-katsina/ → *aŋák.tsi.na*. Jeanne does not discuss such forms—she only addresses /HLL/ and /LLL/. Yet the problem is clear: the two-sided open syllable syncope rule does not offer guidance as to which vowel to delete in longer inputs, where several medial vowels are eligible. Syncope rules can be formulated to apply directionally and iteratively (see §3.4.8.2 and Phelps 1975), but this may not help in Hopi since in /aŋa-katsina/ the *middle* vowel deletes.

The common thread for all the Hopi patterns is that the deleted vowel is post-tonic, but the syncope rule cannot be ordered after stress assignment and formulated to refer only to post-tonic vowels, because syncope sometimes deletes the vowel that would be stressed by default: in /soma-ya/, the second vowel would be stressed (cf. *kiyápi*) except that it is deleted. There are various solutions to this (see Kager 1997 for some discussion), but the point still stands: the analysis of Hopi syncope and stress assignment requires some reference to foot structure.

The same issue arises in OT analyses in terms of economy constraints. The basic syncope pattern in trivocalic words may be explained using the ranking \*COMPLEX>> \*STRUC(σ) >> MAXV, NOCODA: “reduce the number of syllables wherever possible by deleting vowels without creating clusters; codas are acceptable.” Syncope in /HL-L/ words is also expected—if it is possible to reduce the number of syllables, syncope should apply:

## (55) A \*STRUC analysis of Hopi syncope

		*COMPLEX	*STRUC( $\sigma$ )	MAXV	NOCODA
/soma-ya/	a. $\text{som.ya}$		**	*	*
	b. so.ma.ya		***!		
	c. sma.ya	*!	**	*	
	d. smya	*!	*	**	
	e. $\text{so.may}$		**	*	*
/tookani/	f. $\text{tok.ni}$		**	*	*
	g. too.ka.ni		***!		
	h. $\text{too.kan}$		**	*	*




This analysis encounters the same problem as the rule analysis: lack of control over the site of deletion. Candidates *som.ya* and *\*so.may* have identical violation profiles, yet only *som.ya* is acceptable in Hopi. Economy constraints like \*STRUC( $\sigma$ ) do not distinguish post-tonic syllables from final syllables—to them, all syllables are marked. Thus, while they express the popularly held belief that languages favor shorter structures, they do not offer much guidance as to which shorter structures are preferred to which.

The exit strategy for an economy analysis is to appeal to various markedness and faithfulness blockers (Hartkemeyer 2000, Kisseberth 1970b, Taylor 1994, Tranel 1999). The all-purpose blocker is \*COMPLEX, but its powers are exhausted after it strikes down *\*smaya*; \*Complex does not distinguish *som.ya* from *\*so.may*. These candidates can be teased apart—one could argue that *som.ya* is preferred because it preserves the word-final segment, obeying ANCHOR-R (“the rightmost element of an input has a correspondent in the output” (McCarthy and Prince 1995), Hartkemeyer 2000 applies it to syncope). In Hopi, though, this does not apply—word-final segments do get deleted in compounds, as in /tuhisa<sub>a</sub>-tuwi/ → *tuhistuwi* ‘ingenuity.’

The best explanation is the one suggested by the phonology of Hopi itself: syncope creates a H syllable at the beginning of the word because the foot is built at the beginning of the word, and because final stress is generally avoided. An analysis that places syncope in the broader context of the language’s phonology manages to capture the prosody-syncope connection and to explain the mechanics of syncope without appealing to ad-hoc explanations.

The real problems with the \*STRUC analysis come to light when we look at words with more than three underlying vowels, e.g., /LLLLL/ words. These are ripe for shortening, and yet only one vowel is deleted in each. This is spelled out in (56). The actual winner *a.ŋak.tsi.na* deletes just one vowel, and yet it loses to candidates (c) and (d), which contain fewer syllables and which are equally well-formed phonotactically. What’s worse, \*STRUC cannot distinguish (c) from (d) and (a) from (b)—they are tied in the number of syllables. Recall that under the prosodic analysis, (c) is actually harmonically bounded by (d) because (c) it has an unstressed H and does no better on PARSE-σ than (d). This contrast cannot be captured in a syllable-counting analysis.

(56) \*STRUC fails to explain longer words

/aŋa-katsina/	*COMPLEX	*STRUC(σ)	MAXV
a.  a.ŋak.tsi.na (actual winner)	✓	****!	*
b. a.ŋa.kats.na		****!	*
c.  aŋ.kats.na	✓	***	**
d.  a.ŋak.tsin	✓	***	**

Appeals to positional faithfulness constraints like ANCHOR-R do not help here.

Recall the earlier problem of distinguishing *som.ya* from *so.may*, where a possible

explanation was that word-final vowels could not be deleted. In longer words, vowels are deleted regardless of position: in /aŋa-katsina/ the vowel is deleted from the first syllable of the second word, aŋák.tsi.na, while /tuhisa-tuwi/ deletes the vowel from the last syllable of the first word, tu.his.tu.wi. In both cases, the vowel is deleted from what would be the *third* syllable—an environment that makes sense if syncope is creating LH feet but not if syllables are deleted for the sake of deleting syllables.

The account can be saved by appealing to prosodic constraints like WSP and PARSE- $\sigma$ , but this considerably weakens the economy principle stance—if economy principles cannot do without prosodic constraints and prosodic constraints are sufficient on their own, what is the use for economy principles?

There is another problem with this account, and of a more fundamental sort. It is unclear exactly what sort of economy principle is at work in Hopi, since both syllables and moras appear to be “economized” but only in certain environments. Consider *tok.ni*, which \*STRUC( $\sigma$ ) cannot distinguish from \**too.kan*. The actual winner is shorter, but not in terms of syllables—in terms of moras. Is it \*STRUC( $\mu$ ) that distinguishes them? That seems like a promising strategy, but it also predicts that shortening should apply fairly generally, even to /HL/ words like /tooká/ → \**tó.ka*. Shortening in stressed syllables could be blocked by the SWP, but by now the \*STRUC analysis has appealed to practically every markedness constraint that was argued to be instrumental in the metrical analysis!

Economy principles in phonology can be made fairly specific by making \*STRUC constraints refer to specific levels of structure. This is arguably necessary because we see their independent “effects” (though see §2.3). One could claim that Hopi has foot

economy, since only one foot is built (though the traditional PARSE- $\sigma$  analysis is usually deemed sufficient). Hopi would also have syllable economy, but of an odd sort: light open syllables are “marked” in second or third position following another light open syllable, but not later in the word—we can appeal to WSP to explain that. The same is true for long vowel economy: long vowels are preserved in the first or in the second syllable, but never in both (enter SWP). The \*STRUC constraints themselves have gradually become a useless appendage in the analysis—as can be seen in the comparative tableau below, they do no work that the other constraints cannot do:

(57) \*STRUC constraints do no work once the analysis is fully developed

		SWP	WSP	PARSE- $\sigma$	MAXV	* $\sigma$	* $\mu$
/soma-ya/	a. sóm.ya~só.ma.ya	W			L	W	W
	b. sóm.ya~smá.ya	W					
	c. sóm.ya~só.máy	W	W				
/tooká-ni/	d. tók.ni~tóo.ka.ni			W	L	W	W
	e. tók.ni~tóo.kan		W				W
/aŋa-katsina/	f. a.ŋák.tsi.na~aŋák.tsin		W	L		L	L

To gain any insight into patterns like that of Hopi, we have to appeal to devices that go beyond counting syllables, moras, and feet. What matters is the *positions* of syllables and moras and the *kinds* of feet, not their number. Independently motivated metrical constraints not only explain these patterns straightforwardly—they are sufficient by themselves.

The point here is not that \*STRUC analyses can’t be made to work—they can, once enough machinery is implemented. This is in part an Ockham’s Razor argument—\*STRUC is unnecessary in the theory, so it must be excluded from the theory. Yet these constraints are not only unnecessary but actually harmful, as we will see in §3.5.5. They are a double burden on the theory.

### 3.4 Tonkawa

#### 3.4.1 Introduction: a new look at Tonkawa

Tonkawa (Coahuiltecan, Texas, extinct) syncope is often cited as *the* example of constrained deletion of “unnecessary” vowels (Côté 2001, Hartkemeyer 2000, Kisseberth 1970b, Lee 1983, McCarthy 1986, Phelps 1975, Taylor 1994). In this section I present a re-analysis of Tonkawa. I show that the process can be better understood in terms of building better feet rather than deleting “unnecessary” vowels.

The patterns of deletion in Hopi and Tonkawa differ in a number of ways that are directly connected to their prosody. Footing is non-iterative and iambic in Hopi but is iterative and trochaic in Tonkawa, and this has consequences for deletion. In Hopi syncope results both in better feet and in more exhaustive foot parsing, while in Tonkawa only foot shape matters because footing is always exhaustive. Furthermore, in Hopi feet are iambic, (LH) and (H), while in the Tonkawa only trochaic feet are built—(H), (HL) and (LL). This difference arises because RHTYPE=IAMB and RHTYPE=TROCHEE are ranked differently in the two languages.

Tonkawa provides another insight into vowel deletion processes: it shows that apocope and syncope are uniform in process but have different targets, at least in this language. This lends support to one of the central ideas of this work: there is no inherent unity to economy effects.

The traditional analysis of Tonkawa *is* in terms of economy constraints and rules. I argue that here, just as in the case of Hopi, the prosodic analysis requires no economy constraints, yet the economy analysis cannot do without prosodic constraints. Because

prosodic constraints are sufficient on their own, I argue that economy constraints are unnecessary.

In §3.4.2 I introduce the overview of Tonkawa prosodic phonology, including its syllable structure, vowel shortening patterns, and the three vowel deletion processes of hiatus elision, apocope, and syncope. I then develop an analysis of Tonkawa prosody, vowel shortening (§3.4.3), and syncope (§3.4.5). Section §3.4.8 discusses alternative analyses of Tonkawa.

### 3.4.2 Tonkawa patterns

Words of Tonkawa consist of CVC, CVV, and CVVC syllables, with occasional CV syllables in-between: “each syllable of a Tonkawa word must begin with a consonant and, if possible, be composed of consonant plus vowel plus consonant” (Hoijer 1933:21). Except for two systematically exceptional cases, CV syllables do not occur in adjacent positions.<sup>49</sup> As for the weight of these syllables, I will assume that all syllables are heavy except for CV—arguments will be provided throughout the analysis.

The patterns of shortening and syncope follow the following generalizations, which will be exemplified shortly:

- (58) Generalization for vowel shortening: A long vowel shortens following an initial light syllable /#LH.../, in what would be the weak branch of a trochaic foot.
- (59) Generalizations for vowel deletion: Vowel deletion applies:
- a. Word-finally;
  - b. To the first of two vowels in hiatus;
  - c. To a non-root-final vowel in (what would be) the weak branch of a LL trochaic foot.

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<sup>49</sup> Some CV sequences arise because long vowels and root-final vowels cannot be deleted. See § 3.4.6.

### 3.4.2.1 Stress

Unlike Hopi stress, the Tonkawa pattern is not described in detail, though much can be inferred from vowel shortening and syncope. Hoijer's descriptions are as follows:

- (60) Accent in Tonkawa is evenly distributed—each syllable receives substantially the same accentuation. (Hoijer 1933:22)
- (61) Tonkawa utterances consist of a succession of more or less evenly stressed syllables.<sup>50</sup> (Hoijer 1946:292)

I take these statements to mean that Tonkawa footing is iterative; this is hardly surprising since Tonkawa words consist mostly of heavy syllables. Additional evidence for iterativity of footing comes from the distribution of long vowels.

### 3.4.2.2 Vowel shortening as evidence for trochaic feet

Hoijer's description of stress is not detailed enough to deduce whether Tonkawa has iambic or trochaic stress, but the patterns of vowel shortening strongly indicate that footing is trochaic. The distribution of long vowels is limited in a way similar to the Latin pattern called *brevis brevians* or "iambic shortening":

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<sup>50</sup> Hoijer goes on to add that "disyllabic forms, however, are generally pronounced with a somewhat heavier stress on the final syllable, whereas in polysyllabic words the main stress moves to the penult." It is possible that the remark about disyllables refers to apocope words like *notox* 'hoe,' where the second syllable is the heavier one. However, the placement of main stress does not play a central role in any of the processes discussed here, so it will not be analyzed or considered further.



(62) Latin (Allen 1973, Mester 1994, Prince 1990, Prince and Smolensky 1993)

- |    |            |   |              |                                   |
|----|------------|---|--------------|-----------------------------------|
| a. | /ego:/     | → | (ego)        |                                   |
|    | LH         |   | (LL)         | not *(LH)                         |
| b. | /de:sino:/ | → | (de:)(si.no) |                                   |
|    | HLH        |   | (H)(LL)      | not *(H)L(H), (HL)(H) or *(H)(LH) |
| c. | /ambo:/    | → | (am)(bo:)    |                                   |
|    | HH         |   | (H)(H)       | no change                         |
| d. | /studeo:/  | → | (stu.de)(o:) |                                   |
|    | LLH        |   | (LL)(H)      | no change                         |

This shortening allows for the elimination of unstressed H syllables and for exhaustive footing into ideal trochaic feet, (H) and (LL) (Hayes 1995, Prince 1990). The Tonkawa pattern is similar—the only difference is /HLH/ words, where shortening does *not* apply. I will return to this in the analysis of shortening in §3.4.4.

The actual facts of Tonkawa shortening are as follows. Long vowels surface faithfully in the first syllable ((a)-(b) in (63)) and in a syllable that follows a heavy syllable ((c)-(d) in (63)), but they shorten following a light *initial* syllable (64). This distribution makes sense if a canonically trochaic (H) or (LL) foot is built at the left edge, but not if it is a canonical iamb (LH) or (H)—(LH) makes a better iamb than (LL), as we saw in §3.3. The inferred footing of the outputs is shown using round brackets.

(63) Long vowels surface as long in the first syllable or following H

- |    |                  |                  |                                  |                           |
|----|------------------|------------------|----------------------------------|---------------------------|
| a. | /kaana-oʔ/       | (kaa)(noʔ)       | ‘he throws it away’              |                           |
| b. | /kaana-n-oʔ/     | (kaa.na)(noʔ)    | ‘he is throwing it away’         |                           |
| c. | /nes-kaana-oʔ/   | (nes)(kaa)(noʔ)  | ‘he causes him to throw it away’ |                           |
| d. | /yaaloo-na-oʔ/   | (yaa)(loo)(noʔ)  | ‘he kills him’                   | *(yaa)lo..., *(yaa.lo)... |
| e. | /taa-notoso-oʔs/ | (taa)(not)(soʔs) | ‘I stand with him’               |                           |

(64) Vowel shortening after initial light syllable

- |    |                    |                   |                         |                     |
|----|--------------------|-------------------|-------------------------|---------------------|
| a. | /xa-kaana-oʔ/      | (xa.ka)(noʔ)      | ‘he throws it far away’ | *(xa.kaa)(noʔ)      |
| b. | /ke-yaaloo-na-oʔ/  | (ke.ya)(loo)(noʔ) | ‘he kills me’           | *(ke.yaa)(loo)(noʔ) |
| c. | /ke-taa-notoso-oʔ/ | (ke.ta)(not)(soʔ) | ‘he stands with me’     | *(ke.taa)(not)(soʔ) |
| d. | /we-naate-oʔ/      | (we.na)(toʔ)      | ‘he steps on them’      | *(we.naa)(toʔ)      |

There is no shortening in syllables after the second syllable, since there the long vowel can be stressed:

(65) No shortening after noninitial light syllable

- a. /ha-koxo-naa-ken/ (hak.xo)(naa)(ken) ‘you went in’ \*(hak)(xo.na)(ken)  
 b. /we-tasa-sooyan-oʔs/ (wet.sa)(soo.ya)(noʔs) ‘I swim off with them’

Long vowels in closed syllables also follow this pattern—they appear long in the first syllable or after a heavy syllable, as shown in (66), but shorten following a light initial syllable (67).

(66) CVVC surfaces faithfully word-initially or after a heavy syllable

- a. /soopka-oʔ/ (soop)(koʔ) ‘he swells up’  
 b. /cʰaapxe-oʔ/ (cʰaap)(xoʔ) ‘he puts up a bed’  
 c. /ʔatsoo-k-laknoʔo/(ʔat)(sook)(lak)(noʔo) ‘came to life, it is said’ (ʔatsoo- ‘to revive,’  
 -k ‘participial verb suffix,’ -laknoʔo ‘narrative enclitic’)<sup>51</sup>

(67) CVVC shorten after light syllable

- a. /ke-soopka-oʔ/ (ke.sop)(koʔ) ‘I swell up’  
 b. /we-cʰaapxe-oʔ/ (we.cʰap)(xoʔ) ‘he puts up several beds’

To summarize, the pattern of vowel shortening indicates that Tonkawa has a requirement for there to be a trochaic foot—(H), (LL), or (HL)—at the left edge of the word.

### 3.4.2.3 Vowel deletion patterns

Kisseberth 1970b identifies three circumstances under which vowels delete in Tonkawa. *Apocope* deletes word-final vowels, and *hiatus elision* affects vowels in

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<sup>51</sup> In Hoijer’s orthography, *c* is the dental affricate, and *ts* is a cluster of two consonants.

hiatus.<sup>52</sup> The third process is *syncope*, which deletes vowels roughly in the environment of vowel shortening.

*Hiatus elision.* When two vowels meet at a morpheme boundary, as in (68), the first is deleted. Hiatus sequences are underlined in the URs.

(68) Vowel deletion resolves hiatus

- |     |                              |                           |                          |
|-----|------------------------------|---------------------------|--------------------------|
| a.  | /ke-we-yamaxa <u>oo</u> -ka/ | kew.yam.xoo.ka            | ‘you paint our faces’    |
|     |                              | *kew.yam.xa <u>oo</u> .ka |                          |
| cf. | /ke-yamaxa-n-oʔ/             | key.ma.xa.noʔ             | ‘he is painting my face’ |
| b.  | /pile <u>o</u> ʔ/            | pi.loʔ                    | ‘he rolls it’            |
|     |                              | *pi.le <u>o</u> ʔ         |                          |
| cf. | /pile-n-oʔ/                  | pi.le.noʔ                 | ‘he is rolling it’       |

*Apocope.* Most words end in consonants (though there are a few exceptions, as Phelps 1975 and Kisseberth 1970b both note). Underlyingly final vowels are deleted by a productive process of apocope.

(69) Word-final vowel deletion (apocope)

- |    |                    |        |                        |                |                    |
|----|--------------------|--------|------------------------|----------------|--------------------|
| a. | /notox <u>o</u> /  | no.tox | ‘hoe’                  | cf. not.xo.noʔ | ‘he is hoeing it’  |
| b. | /picena <u>a</u> / | pi.cen | ‘steer, castrated one’ | cf. pic.na.noʔ | ‘he is cutting it’ |

*Syncope.* As shown in (70), syncope deletes every other vowel of the word, starting from the second and proceeding rightwards (with some exceptions, discussed below). If the word underlyingly begins in /LL/, the second vowel is always deleted to create a (H) foot (see (a), (d)). If the word begins in /LLL/, then a (HL) foot is created (see (b), (e), (g)). The examples are shown with their inferred foot structure.

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<sup>52</sup> My terminology differs from that of Kisseberth 1970b and Phelps 1975. Their Word-Final Vowel Deletion corresponds to my *apocope*; their Vowel Elision is my *syncope*, and their Vowel Truncation is my *hiatus elision*. Hiatus elision has been called *synaloepha*, but Trask 1996 defines this as coalescence of vowels across a word boundary. In Tonkawa, deletion applies word-internally between adjacent morphemes.

(70) Syncope

a. /yak <u>ap</u> a-oʔ/	(yak)(poʔ)	‘he hits it’
b. /we-y <u>ak</u> ap <u>a</u> -oʔ/	(wey.ka)(poʔ)	‘he hits them’, <sup>53</sup>
c. /ke-y <u>ak</u> ap <u>a</u> -nes-ʔoʔ/	(key)(ka.pa)(nes)(ʔoʔ)	‘they two strike me’
d. /ke-w <u>e</u> -y <u>am</u> ax <u>a</u> -oo-ka/	(kew)(yam)(xoo.ka)	‘you paint our faces’
e. /y <u>am</u> ax <u>a</u> -noʔ/	(yam.xa)(noʔ)	‘he is painting his face’
f. /nes-y <u>am</u> ax <u>a</u> -oʔ/	(nes)(yam)(xoʔ)	‘he causes him to paint his face’
g. /ke-y <u>am</u> ax <u>a</u> -oʔ/	(key.ma)(xoʔ)	‘he paints my face’

Syncope is directional, which is shown in (71). This directionality property was first noted by Phelps 1975, and it has always been a puzzle under the “delete wherever you can” approach. Phonotactic constraints permit the deletion of either the second or the third underlying vowel, and yet it is the second syllable that is consistently affected. This pattern is not puzzling if a trochaic foot is constructed at the left edge as shown—(*wén.to*) is a better trochee than (*wé.not*):

(71) Left-to-right directionality

a. /we- <u>n</u> otoxo-oʔ/	(wen.to)(xoʔ)	*we(not)(xoʔ)
b. /ke-w <u>e</u> -y <u>ak</u> ap <u>a</u> -nesʔ-oo-ka/	(kew)(yak.pa)(nes)(ʔoo.ka)	*ke(wey)(kapa)...
c. /ke-w <u>e</u> -y <u>am</u> ax <u>a</u> -oo-ka/	(kew)(yam)(xoo.ka)	*ke(wey)(maxa)...

The following examples show that unlike Hopi, Tonkawa syncope is iterative. In a /LLLLL.../ sequence, syncope will apply to the second and the fourth vowels (I have not found any /LLLLL.../ words in Hoijer’s corpus). The root of the last form in (72) drops its /h/ after a consonant.

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<sup>53</sup> According to Hoijer’s analysis of this form, the root is not *yakapa* but *kapa*. The prefix *ya-* is causative (Hoijer 1949:28-29, 72). Witness the reduplicated form he gives, *yakakpa-* (rep.) ‘to hammer, hit, strike’. This suggests that the stem condition on vowel deletion traditionally assumed in the literature on Tonkawa is not entirely correct: some prefixes may be affected as well (/ke-we-yamaxa-oo-ka/ → *kew.yam.xoo.ka* ‘you paint our faces,’ /ke-tas-hecane-oʔs/ → *ket.sec.noʔs* ‘he lies with me’).

(72) Syncope is iterative

- |    |   |                            |                       |
|----|---|----------------------------|-----------------------|
| a. | /ke-w <u>e</u> -yak <u>a</u> pa-nesʔ-oo-ka/ | (kew)(yak.pa)(nes)(ʔoo.ka) | ‘you two strike us’   |
| b. | /ke-w <u>e</u> -yam <u>a</u> xa-oo-ka/      | (kew)(yam)(xoo.ka)         | ‘you paint our faces’ |
| c. | /ke-t <u>a</u> s-(h)ec <u>a</u> ne-oʔs/     | (ket)(sec)(noʔs)           | ‘he lies with me’     |

There is one exception to iterativity: if the vowel in the syncope position is root-final, syncope does not apply (shown in (73) a, c, d). In this respect syncope is unlike hiatus elision and apocope, which routinely apply to the last vowel of the root. This is most striking in forms like (b) and (c): hiatus elision *targets* the root-final rather than the suffix-initial vowel in (b), but syncope fails to delete the root-final vowel in (c).

Examples (d) and (e) make the same point for apocope.

(73) Root-final vowel never syncopates but may elide or apocopate

- |    |                      |                   |                   |                    |
|----|----------------------|-------------------|-------------------|--------------------|
| a. | /ya-seyake-n-oʔ/     | (yas)(ya.ke)(noʔ) | * (yas)(yak)(noʔ) | ‘he is tearing it’ |
| b. | /p <u>i</u> le-oʔ/   | (pi.loʔ)          | * (pi.leʔ)        | ‘he rolls it’      |
| c. | /p <u>i</u> le-n-oʔ/ | (pi.le)(noʔ)      | * (pil)(noʔ)      | ‘he is rolling it’ |
| d. | /we-notoxo-n-oʔ/     | (wen)(toxo)(noʔ)  | * (wen)(tox)(noʔ) | ‘he is hoeing it’  |
| e. | /notox <u>o</u> /    | (no.tox)          | * (not.xo)        | ‘hoe’              |

In words like /notoxo/, where the phonotactics allow only one of syncope or apocope to apply, apocope wins: *notox*, not \**not.xo*.

Syncope applies in almost the same environment as vowel shortening: after #CV (above) but not after #CVC *or* #CVV. This is shown in (74) for both monomorphemic and complex words. (I rely on Hoijer’s (1949) analysis of underlying forms, since alternations are not always available.) In this Tonkawa is unlike Hopi, where deletion does apply after long vowels with a subsequent shortening of the vowel (/took<sub>a</sub>-ni/ → (*tok*)ni). The reason for this difference lies not in iambic vs. trochaic footing but in the iterativity of footing: in Tonkawa, the syllable after the initial H syllable is footed, but in Hopi it is not:

(74) Initial long vowels do not condition second syllable syncope

- |                     |                  |                    |                             |
|---------------------|------------------|--------------------|-----------------------------|
| a. /heepane-ook/    | (hee.pa)(nook)   | ‘council’          | *(hep)(nook), *(heep)(nook) |
| b. /taa-notoso-oʔs/ | (taa)(not)(soʔs) | ‘I stand with him’ | *(tan.to)(soʔs)             |
| c. /xaa-yakew/      | (xaa.ya)(kew)    | ‘butter’           | *(xay)(kew)                 |
- cf. xaa ‘fat,’ koykew- ‘to make,’ ya.kew.ʔan ‘sausage’

It is all the more interesting that deletion does not apply after long vowels to yield \*(heep)(nook), etc. since there is no general prohibition on long vowels in closed syllables in Tonkawa. They are found both in morphologically derived and basic environments:

(75) Long vowels in closed syllables

- |                                 |                                    |                   |
|---------------------------------|------------------------------------|-------------------|
| a. /xa-henk <sup>w</sup> aana-/ | <u>x</u> een.k <sup>w</sup> aa.na- | ‘to run far away’ |
| b. /xaan-eel/                   | xaa. <u>nee</u> l                  | ‘there he goes!’  |
| c. /xeecwal/                    | <u>x</u> eec.wal                   | ‘alligator’       |

Recall from (66) and (67) that CVVC syllables surface faithfully word-initially or after a heavy syllable but not after an initial light syllable, /soopka-oʔ/ → soop.koʔ ‘he swells up’ but /ke-soopka-oʔ/ → (ke.sop)(koʔ) ‘I swell up.’ There is a process of closed syllable shortening, but it only applies when the long vowel occurs in a closed syllable that follows a light syllable—the one environment where a heavy syllable cannot head its own foot.

These complex patterns can be summarized in a fairly simple way by referring to weight and feet—the following generalizations are repeated from (58) and (59).

(76) Generalization for vowel shortening: A long vowel shortens following an initial light syllable /#LH.../, in what would be the weak branch of a trochaic foot.

(77) Generalizations for vowel deletion: Vowel deletion applies

- a. Word-finally;
- b. To the first of two vowels in hiatus;
- c. To a non-root-final vowel in (what would be) the weak branch of a LL trochaic foot.

### 3.4.3 Analysis of metrical foot parsing in Tonkawa

Most aspects of the unfaithful mappings in Tonkawa can be elucidated under specific assumptions about its system of metrical foot parsing. In this section, I lay out these assumptions, which inform the analysis of shortening and syncope that follows.

Foot parsing in Tonkawa must be iterative. This assumption is consistent with Hoijer’s descriptions in (60)-(61), and further evidence for it will be provided in the analysis of vowel shortening in §3.3.4. Consider now tableau (78), where several possible foot parses for the input /pile-n-o?/ are given. Main stress falls on the rightmost foot, which suggests that ENDRULE-R dominates ENDRULE-L: no foot stands between the main stress foot and the *right* edge of the word, but a foot may stand between the main stress foot and the *left* edge of the word—compare (a) and (b). Furthermore, constructing just one foot (as in (c)), which would be both initial and final in the word, is not an option because PARSE- $\sigma$  also dominates ENDRULE-L:

(78) Iterative footing

/pile-n-o?/	PARSE- $\sigma$	ENDRULE-R	ENDRULE-L
a. $\text{p}^{\text{H}}\text{il}^{\text{H}}\text{e}(\text{n}^{\text{H}}\text{o}?)$			*
b. $(\text{p}^{\text{H}}\text{il}^{\text{H}}\text{e})(\text{n}^{\text{H}}\text{o}?)$		*!	
c. $\text{p}^{\text{H}}\text{il}^{\text{H}}\text{e}(\text{n}^{\text{H}}\text{o}?)$	*!*		

Tonkawa has trochaic feet: (H), (LL), and (HL). In a form like *pi.le.no?*, there will be an initial secondary stress.

(79) Trochaic, not iambic feet

/pile-n-oʔ/	RHTYPE=TROCHEE	RHTYPE=IAMB
a. $\text{p}^{\text{h}}\text{è}(\text{p}^{\text{h}}\text{i}.\text{l}^{\text{e}})(\text{n}^{\text{h}}\text{o}ʔ)$		*
b. $(\text{p}^{\text{h}}\text{i}.\text{l}^{\text{e}})(\text{n}^{\text{h}}\text{o}ʔ)$	*!	

As we will see in §3.4.4 and §3.4.5, a trochaic analysis is necessary to explain the patterns of shortening and syncope.

My extensive examination of Hoijer’s (1933, 1946, 1949) corpus has not uncovered any CV monosyllables, so I assume that degenerate feet ( $\acute{L}$ ) are not allowed in the language—FTBIN is undominated. L monosyllables can be excluded under the ranking Prince and Smolensky (1993) propose for Latin word minimality effects: FTBIN >> {LX ≈ PR, MAX}.

In addition to light monosyllables, another situation where degenerate feet are an issue arises when a L syllable occurs between two H syllables or initially before a H syllable. In such situations, exhaustive footing cannot be achieved without constructing a less-than-perfect trochaic foot (HL) or (LH)—in the terminology of Mester 1994, the light syllable is “prosodically trapped.” In Latin, HLH and LH words undergo shortening. In Tonkawa, they do not—I assume that such words are footed exhaustively. Thus, a (HL) foot is preferred to both (H)L and (H)(L). The suboptimal parses violate PARSE- $\sigma$  or FTBIN; the optimal uneven trochee parse violates GRPHARM:

(80) No degenerate feet or prosodic trapping

/we-notoxo-oʔ/	FTBIN	PARSE- $\sigma$	GRPHARM
a. $\text{w}^{\text{h}}\text{è}(\text{w}^{\text{h}}\text{è}.\text{t}^{\text{h}}\text{o})(\text{x}^{\text{h}}\text{o}ʔ)$			*
b. $(\text{w}^{\text{h}}\text{è})\text{t}^{\text{h}}\text{o}(\text{x}^{\text{h}}\text{o}ʔ)$		*!	
c. $(\text{w}^{\text{h}}\text{è})(\text{t}^{\text{h}}\text{o})(\text{x}^{\text{h}}\text{o}ʔ)$	*!		



Under this ranking, (HL) feet are also preferred to either (LH) or to (L)(H); thus, we get *(wet.sa)(soo.ya)(noʔs)* ‘I swim off with them’ and not *\*(wet)(sa.soo)(ya.noʔs)*, *\*(wet)sa(soo)ya(noʔs)* or *\*(wet)(sa)(soo)(ya)(noʔs)*. The parse *\*(wet)(sa.soo)(ya.noʔs)* would violate WSP (see next section), *\*(wet)sa(soo)ya(noʔs)* would violate PARSE- $\sigma$ , and *\*(wet)(sa)(soo)(ya)(noʔs)* would violate FTBIN. Violating GRPHARM is the least of four evils here.

In the metrical theories of Prince 1990 and Hayes 1995, uneven trochees are seen as inferior to (H) and (LL). The uneven trochee analysis is not the only possible analysis of Tonkawa, but the alternative cannot be implemented without some additional complications—I will return to this in §3.4.4. The rankings established in this section are:

- (81) *Iterative footing, main right*: PARSE- $\sigma$ , ENDRULE-R >> ENDRULE-L
- (82) *Trochaic, not iambic feet*: RHTYPE=TROCHEE >> RHTYPE=IAMB
- (83) *No degenerate feet; uneven trochees okay*: FTBIN, PARSE- $\sigma$  >> GRPHARM

### 3.4.4 Analysis of vowel shortening in Tonkawa

The trochaic analysis of Tonkawa explains various aspects of the vowel shortening process. First of all, second-syllable shortening shows that (LH) feet are strongly disfavored. Second, the failure of long vowels to shorten outside of the #LH environment is consistent with their status as heads of iterative feet. Third, the non-application of shortening in certain environments shows that sequences of (H) feet are preferred to both (HL) and (LL) feet, and that feet with heavy heads are preferred to (LL). The constraints that are instrumental in this pattern are GRPHARM, WSP, SWP, and PARSE- $\sigma$ .

3.4.4.1 #LH vowel shortening

Vowels shorten in /LH.../ words but not in /HL.../, which is consistent with trochaic footing—if Tonkawa were iambic, then there would be no reason to shorten in the already perfect iambic foot (LH). This is exactly parallel to *brevis brevis* in Latin (see §3.4.2.2).

(84) *Brevis brevis* shortening, Tonkawa-style

/xa-kaana-oʔ/	RHTYPE=TROCHEE	RHTYPE=IAMB
a. $\text{ᵛ}(xá.ka)(noʔ)$		*
b. $(xa.káa)(noʔ)$	*!	

Unstressed heavy syllables are marked in both iambic and trochaic languages with respect to WSP. Vowel shortening in /xa-kaana-noʔ/ → (xa.ka)(noʔ) is favored by the ranking WSP>>MAX-μ: unstressed vowels must be short. As shown in (85): the (LL) foot beats the inferior trochaic candidate (LH) despite being unfaithful to length.

(85) Shortening: WSP>>MAX-μ

/xa-kaana-oʔ/	WSP	MAX-μ
a. $\text{ᵛ}(xá.ka)(noʔ)$		*
b. $(xá.kaa)(noʔ)$	*!	

A plausible way to avoid both shortening and the unstressed heavy syllable is to build a (H) foot away from the left edge, leaving the first syllable unfooted:

\**xa(kaa)(noʔ)*. This option is not available because footing is always exhaustive. It is also not possible to avoid violating WSP and PARSE-σ by building a LH foot, since this violates RHTYPE=TROCHEE. A degenerate foot analysis (as in (e)) is out on FTBIN:

## (86) Non-alternatives to shortening

/xa-kaana-oʔ/	PARSE-σ	WSP	RHTYPE=TROCHEE	FTBIN	MAX-μ
a. $\text{[xà.ka]}(\text{nóʔ})$					*
b. $\text{xa}(\text{kàa})\text{(nóʔ)}$	*!				
c. $(\text{xà.kaa})\text{(nóʔ)}$		*!			
d. $(\text{xa.kàa})\text{(nóʔ)}$			*!		
e. $(\text{xà})(\text{kàa})\text{(nóʔ)}$				*!	

Shortening affects long vowels in the second syllable whether it is open (CVV) or closed (CVVC). Shortening in a CVVC sequence does not eliminate the violation of WSP, but it diminishes the problem. The heavier the syllable, the worse it is in unstressed position (Prince and Smolensky 1993), so an unstressed bimoraic CVC syllable is better than an unstressed trimoraic CVVC syllable. This is encoded in the WSP harmonic scale, which gives rise to two WSP constraints: the “regular” WSP, or  $\text{WSP}_{\mu\mu}$ , and  $\text{WSP}_{\mu\mu\mu}$ :

(87) Harmonic scale for unstressed syllable weight:  $\check{\sigma}_{\mu} \succ \check{\sigma}_{\mu\mu} \succ \check{\sigma}_{\mu\mu\mu}$   
*Constraints:*  $\text{WSP}_{\mu\mu\mu}$ ,  $\text{WSP}_{\mu\mu}$

(88)  $\text{WSP}_{\mu\mu\mu}$ : “No unstressed trimoraic syllables.” ( $\text{WSP}_{\mu\mu}$  and  $\text{WSP}_{\mu\mu\mu}$  are the categorical alternative to Kager’s (1997) gradient WSP.)

Throughout the analysis, I use WSP for  $\text{WSP}_{\mu\mu}$  unless a distinction needs to be explicitly made between the two constraints.

As shown in (89),  $\text{WSP}_{\mu\mu\mu}$  dominates MAX-μ, so unstressed CVVC syllables shorten to CVC (see (a)). The only alternative to this is deleting the coda consonant (c), which violates the undominated MAXC.

(89) Shortening of superheavy unstressed syllables

/ke-soopka-oʔ/	WSP <sub>μμμ</sub>	MAXC	WSP <sub>μμ</sub>	MAX-μ
a. $\text{ke}(\text{ké.sop})(\text{kóʔ})$			*	*
b. $(\text{ké.soop})(\text{kóʔ})$	*!		*	
c. $(\text{ké.so})(\text{kóʔ})$		*!		*

WSP<sub>μμ</sub> must be dominated by PARSE-σ—if there were no need to foot everything, the superheavy syllable could head its own trochaic foot and shortening would not be necessary:

(90) Unstressed heavy syllables tolerated to foot initial syllable

/ke-soopka-oʔ/	PARSE-σ	WSP <sub>μμ</sub>	MAX-μ
a. $\text{ke}(\text{ke.sop})(\text{koʔ})$		*	*
b. $\text{ke}(\text{soop})(\text{koʔ})$	*!		

Thus, vowels shorten in the second syllable to reduce the weight of an unstressed syllable, which is the weak branch of a left-aligned trochaic foot. This is a very specific environment for shortening, but it really amounts to unstressable long vowels being shortened but not stressable ones. Uneven (HL) trochees are a very efficient way to achieve exhaustive footing—if (HL), (H), and (LL) feet are allowed but (LH) feet are frowned upon, then #LH sequences are the only environment where shortening becomes necessary.<sup>54</sup> The only place where H syllables cannot be stressed is after an initial light syllable—PARSE-σ requires that the second vowel be incorporated into the initial trochaic

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<sup>54</sup> Except for medial ...(LL)LH... As we will see shortly, such sequences routinely undergo syncope in Tonkawa and surface as (HL)(H) instead.

foot, and WSP requires that the second vowel be light. Everywhere else, long vowels can head their own feet, because footing is iterative.

At the end of §3.4.3 I alluded to the complications that arise in the analysis of vowel shortening if (HL) feet are not admitted into the system. The difficulty lies in explaining why “prosodically trapped” light syllables are not allowed initially but are allowed medially. Observe the following asymmetry:

- |      |                           |                      |   |                    |
|------|---------------------------|----------------------|---|--------------------|
| (91) | Shortening applies        | /xa-kaana-oʔ/        | → | xa.ka.noʔ          |
|      |                           | <u>LHH</u>           |   | <u>LLH</u>         |
| (92) | Shortening does not apply | /we-tasa-sooyan-oʔs/ | → | wet.sa.soo.ya.noʔs |
|      |                           | <u>LLLHLH</u>        |   | <u>HLHLH</u>       |

If prosodically trapped, unfooted L syllables are allowed medially, as they would have to be under a strict (H)/(LL) analysis, then the obligatory footing of initial syllables could be explained by appealing to a high-ranking requirement for the initial syllable to belong to a foot:

- (93) PARSE-σ1: “\*σ<sup>o</sup>/[PrWd\_\_\_, where σ<sup>o</sup> denotes a syllable that is not contained by a foot.” (McCarthy to appear; cf. ALIGN-L(WD,FT) of McCarthy and Prince 1993a and Kager 2001).
- Harmonic scale:* [PrWd(Ftσ ...)] > [PrWdσ<sup>o</sup>.....]      σ<sup>o</sup>/\_\_\_PrWd (immediately dominated by the PrWd)

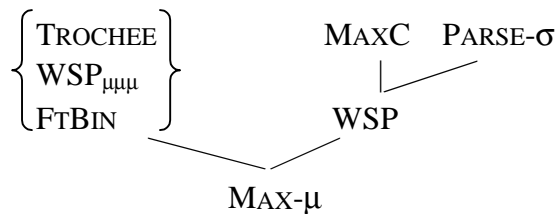
While this is an equally workable analysis, it is slightly more complicated, so I opt for allowing (HL) trochees into the Tonkawa foot inventory.

There is also an equally viable alternative to the analysis of CVVC shortening in words like /ke-soopka-oʔ/ → *ke.sop.koʔ*, namely that codas contribute no weight in CVVC syllables and that the shortening of vowels here is the same exact process as CVV shortening. Under this analysis, CVC syllables count as light in (CV̇.CVC) feet but as heavy in (CV̇C) or (CV̇C.CV) feet. In this case WSP would have to dominate WEIGHT-

BY-POSITION (“Coda consonants are moraic,” Hayes 1989, 1994, Rosenthal and van der Hulst 1999). I use  $WSP_{\mu\mu\mu}$  because it also plays a role in the analysis of Lebanese Arabic in chapter 4, where a WEIGHT-BY-POSITION account is not as straightforward.

To summarize, the analysis of second syllable vowel shortening I presented relies on the assumption that footing is exhaustive, i.e., #L(H)... is not allowed, and that unstressed syllables must be as light as possible. The rankings presented in this section are given in (94).

(94) Rankings for #LH vowel shortening



#### 3.4.4.2 Where shortening doesn't apply: the role of faithfulness

Any analysis of vowel shortening in Tonkawa must explain not only where it applies but also where it does not apply. This is relevant to the issue of economy, as well, because economy constraints and metrical markedness constraints differ in their predictions for shortening.

In Tonkawa, shortening does not apply to long vowels in initial syllables or in syllables that follow (H), i.e., /*yaaloona-oʔ*/ does not shorten to \*(*ya.lo*)(*noʔ*) or \*(*yaa.lo*)(*noʔ*), /*nes-kaana-noʔ*/ does not shorten to \*(*nes.ka*)(*noʔ*). These candidates are not gratuitously unfaithful, since both of them do better than the actual winners (*yáa*)(*lóo*)(*nóʔ*) and (*nés*)(*káa*)(*nósʔ*) on \*CLASH, the constraint against adjacent stresses (Hammond 1984, Kager 1994, Liberman 1975, Liberman and Prince 1977, Prince 1983,

Selkirk 1984b). Since shortening does not apply here, MAX- $\mu$  must dominate \*CLASH, GRPHARM, or any other constraint that might favor shortening in these environments:

(95) No shortening even if clash or uneven feet result

/yaaloona-oʔ/	MAX- $\mu$	GRPHARM	*CLASH
a. $\text{y}^{\text{aa}}(\text{l}\ddot{\text{o}})(\text{n}\acute{\text{o}}?)$			**
b. $(\text{y}\grave{\text{a}}.\text{lo})(\text{n}\acute{\text{o}}?)$	**!		
c. $(\text{y}\grave{\text{a}}.\text{lo})(\text{n}\acute{\text{o}}?)$	*!	*	
/kaana-n-oʔ/			
d. $\text{k}^{\text{aa}}(\text{n}\acute{\text{a}}.\text{na})(\text{n}\acute{\text{o}}?)$		*	
e. $(\text{k}\grave{\text{a}}.\text{na})(\text{n}\acute{\text{o}}?)$	*!		

Violations of GRPHARM and \*CLASH could also in principle be avoided without shortening, by simply not footing exhaustively. This, however, is not an option under the already established ranking  $\text{PARSE-}\sigma \gg \text{MAX-}\mu$ : forms like  $*(\text{k}\acute{\text{a}}\text{a})\text{na.no}?$  or  $*(\text{y}\acute{\text{a}}\text{a})\text{loo.no}?$  would incur egregious violations of  $\text{PARSE-}\sigma$  as well as WSP. As argued in the previous section,  $\text{PARSE-}\sigma$  dominates WSP, which dominates MAX- $\mu$ . Since MAX- $\mu$  in turn dominates GRPHARM and \*CLASH, we get (96) through transitivity of domination. The tableau is given in comparative format to make the ranking argument more compact:

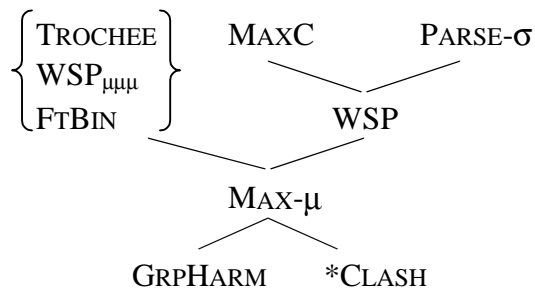
(96) Non-footing is not an option for avoiding clash or uneven feet

/yaaloona-oʔ/	PARSE- $\sigma$	WSP	MAX- $\mu$	GRPHARM	*CLASH
a. $(\text{y}\grave{\text{a}})(\text{l}\ddot{\text{o}})(\text{n}\acute{\text{o}}?) \sim (\text{y}\acute{\text{a}}\text{a})\text{loo.no}?$	W	W			L
b. $(\text{y}\grave{\text{a}})(\text{l}\ddot{\text{o}})(\text{n}\acute{\text{o}}?) \sim \text{ya.lo}(\text{no}?)$	W		W		L
c. $(\text{y}\grave{\text{a}})(\text{l}\ddot{\text{o}})(\text{n}\acute{\text{o}}?) \sim (\text{y}\grave{\text{a}}.\text{lo})(\text{n}\acute{\text{o}}?)$			W		L
d. $(\text{y}\grave{\text{a}})(\text{l}\ddot{\text{o}})(\text{n}\acute{\text{o}}?) \sim (\text{y}\grave{\text{a}}.\text{lo})(\text{n}\acute{\text{o}}?)$			W	W	L
/kaana-n-oʔ/					
e. $(\text{k}\acute{\text{a}}\text{a}.\text{na})(\text{n}\acute{\text{o}}?) \sim (\text{k}\grave{\text{a}}.\text{na})(\text{n}\acute{\text{o}}?)$			W	L	
f. $(\text{k}\acute{\text{a}}\text{a}.\text{na})(\text{n}\acute{\text{o}}?) \sim (\text{k}\acute{\text{a}}\text{a})\text{na.no}?$	W	W		L	
g. $(\text{k}\acute{\text{a}}\text{a}.\text{na})(\text{n}\acute{\text{o}}?) \sim \text{ka.na}(\text{n}\acute{\text{o}}?)$	W		W	L	

This pattern reveals an “anti-economical” aspect of shortening: shortening in words like /yaaloona-oʔ/ *could* yield a word with fewer feet and/or moras, yet it does not apply because it is more important to be faithful than to avoid clashes and uneven feet. This selective application of shortening turns out to be a major problem both for rule-based and \*STRUC analyses: shortening needs to “know” the weight of adjacent syllables in order to apply. The easiest way to analyze this process is in terms of foot structure: the heavy-headed (H) and (HL) feet and sequences of adjacent (H) feet are preferred to (LL) in Tonkawa, even though such sequences may violate GRPHARM and \*CLASH. Shortening only applies to unstressed heavy syllables that cannot head their own feet; if they can head their own feet, they are ideal. This fine control of shortening is possible with metrical constraints but not with a general economy constraint like \*STRUC( $\mu$ ), because \*STRUC( $\mu$ ) favors shortening in *all* situations. I will return to this in §3.4.8.4.

The new rankings that were established in this section are diagrammed below:

(97) *Vowel shortening*



These rankings are shown in action in the comparative tableau (98). The undominated constraints MAXC, RHTYPE=TROCHEE, and all the candidates that violate them have been left out. The comparisons between the winners (*we.na*)(*toʔ*) and (*ke.sop*)(*koʔ*) and their respective losers show the role of FTBIN, WSP, WSP $_{\mu\mu\mu}$  and PARSE- $\sigma$  in shortening;



the success of *(kaa)(noʔ)*, *(kaa.na)(noʔ)* and *(yaa)(loo)(noʔ)* shows why shortening fails to apply elsewhere.

(98) Vowel shortening

/we-naate-oʔ/	WSP <sub>μμμ</sub>	FTBIN	PRS-σ	WSP	MAX-μ	GRPHR	*CLASH
a. (wè.na)(tóʔ)~(wè.naa)(tóʔ)				W	L		
b. (wè.na)(tóʔ)~we(náa)(tóʔ)			W		L		W
c. (wè.na)(tóʔ)~(wè)(náa)(tóʔ)		W			L		W
/ke-soopka-oʔ/							
d. (kè.sop)(kóʔ)~ke(sòop)(kóʔ)			W	L	L		W
e. (kè.sop)(kóʔ)~(kè.soop)(kóʔ)	W				L		
/kaana-n-oʔ/							
f. (kàa.na)(nóʔ)~(kà.na)(nóʔ)					W	L	
/kaana-oʔ/							
g. (kàa)(nóʔ)~(ká.noʔ)				W	W		L
/yaaloo-na-oʔ/							
h. (yàa)(lòo)(nóʔ)~(yàa.lo)(nóʔ)					W	W	L
i. (yàa)(lòo)(nóʔ)~(yà.lo)(nóʔ)					W		L
j. (yàa)(lòo)(nóʔ)~ya.lo.(nóʔ)			W		W		L

Shortening in Tonkawa applies only to the second vowel in #LH. This is because (LH) feet are only an issue word-initially, where PARSE-σ and RHTYPE=TROCHEE force the second vowel into the weak branch of the foot by dominating MAX-μ and RHTYPE=IAMB, respectively. Everywhere else long vowels can and indeed must head their own feet. After a single light syllable word-internally in /we-tasa-sooyan-oʔs/ → *(wet.sa)(soo.ya)(noʔs)*, the long vowel does not shorten—the (HL)(HL)(H) output violates only GRPHARM, which is low-ranked in Tonkawa.

This is a very limited economy effect—shortening applies just once in a very specific environment. Not so for syncope, which is the subject of the next section.

### 3.4.5 Analysis of Tonkawa syncope

Syncope is directional and iterative, just like footing. Recall from Hoijer's descriptions that every syllable in Tonkawa is heavy and stressed. There is an output goal in Tonkawa: the ideal word consists of feet with heavy heads. Heavy foot heads were important in Hopi, as well, where /LLL/ words mapped to (H)L and /LLLL/ to (LH)L. Because Tonkawa is trochaic, syncope creates not (LH) but (H) and (HL) feet out of /LL/ sequences. This suggests that SWP dominates MAXV in Tonkawa just as in Hopi:

(99) Syncope: SWP >> MAXV

		SWP	MAXV
/yakapa-oʔ/	a. $\text{y}^{\text{H}}\text{àk}(\text{p}^{\text{H}}\text{ó}ʔ)$		*
	b. $(\text{y}^{\text{H}}\text{à}.\text{ka})(\text{p}^{\text{H}}\text{ó}ʔ)$	*!	
/ke-we-yamaxa-oo-ka/	c. $\text{k}^{\text{H}}\text{èw}(\text{y}^{\text{H}}\text{à}^{\text{H}}\text{m})(\text{x}^{\text{H}}\text{ó}^{\text{H}}.\text{ka})$		**
	d. $(\text{k}^{\text{H}}\text{è}.\text{we})(\text{y}^{\text{H}}\text{à}.\text{ma})(\text{x}^{\text{H}}\text{ó}^{\text{H}}.\text{ka})$	**!	
/ke-tas-(h)ecane-oʔs/	e. $\text{k}^{\text{H}}\text{è}^{\text{H}}(\text{s}^{\text{H}}\text{è}^{\text{H}}\text{c})(\text{n}^{\text{H}}\text{ó}^{\text{H}}ʔ\text{s})$		**
	f. $(\text{k}^{\text{H}}\text{è}.\text{ta})(\text{s}^{\text{H}}\text{è}.\text{ca})(\text{n}^{\text{H}}\text{ó}^{\text{H}}ʔ\text{s})$	**!	

(The shared violation marks of MAXV incurred by hiatus elision are suppressed in tableaux throughout this section.)

Just as in Hopi, the augmentation solution is not available: vowels are never lengthened and consonants are never geminated (in fact, geminates are generally prohibited in Tonkawa—see Kisseberth 1970b, McCarthy 1986). This suggests that DEP- $\mu$  dominates MAXV. Thus, vowels must be deleted because of the language-specific ranking of SWP and faithfulness, not because vowels or syllables are somehow marked or undesirable.

It is in principle also possible to avoid violations of SWP *and* MAXV by simply not footing the syllables after the second one, as in  $*(\text{ket}.\text{se})\text{ca}.\text{no}ʔ\text{s}$ . In this case, syncope

is non-iterative because foot parsing is non-iterative. This is not an option in Tonkawa because PARSE- $\sigma$  dominates MAXV. The ranking argument here is parallel to the one presented in the analysis of shortening, where #LH shortening could not be avoided by not footing the first syllable.

(100) Iterative footing means iterative syncope

/ke-tas-(h)ecane-oʔs/	PARSE- $\sigma$	MAXV
a. $\text{[ke]([ket])(sec)(noʔs)}$		**
b. (ket.se)ca.noʔs	**!	*

In a way, Tonkawa syncope is a more impressive economy effect than what happens in Hopi—recall that there, syncope applied only once in the vicinity of the main stress foot but not elsewhere. In Tonkawa, the well-formedness requirements on feet are enforced by syncope throughout the word because the feet themselves are present throughout the word. This difference between Hopi and Tonkawa is due to the language-specific ranking of PARSE- $\sigma$  and ENDRULE constraints.

### 3.4.5.1 Directionality

In a line of /LLL.../, deletion could in principle affect either the second or the third underlying vowel, but it is inevitably the *second* vowel that syncopates. This result follows from already established rankings, shown in (101). Syncope affects the second vowel in /we-yakapa-oʔ/ because this creates a H foot head at the beginning of the word—footing into (HL) is permitted because GRPHARM is low-ranked.<sup>55</sup> The

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<sup>55</sup> In a strict (H)/(LL) analysis, the directionality of syncope would have to be attributed to PARSE- $\sigma$ 1 (see (93)).

alternatives are a (LH) foot or a L(H) sequence with the first syllable left unfooted, which violate either WSP or PARSE- $\sigma$ :

(101) The directionality of syncope

/we-yakapa-oʔ/	PARSE- $\sigma$	WSP	GRPHARM
a. $\text{w}^{\text{e}}\text{y}^{\text{ka}}\text{p}^{\text{a}}\text{o}^{\text{ʔ}}$			*
b. $\text{we}(\text{y}^{\text{àk}})\text{p}^{\text{a}}\text{o}^{\text{ʔ}}$	*!		
c. $(\text{w}^{\text{è}}.\text{yak})\text{p}^{\text{a}}\text{o}^{\text{ʔ}}$		*!	

This directionality of syncope is also consistent with a trochaic analysis. Consider tableau (102), where the two candidates differ in foot type. The winner deletes the second vowel, making four good trochees. The loser deletes the third vowel and has three iambic feet, (LH)(LH)(H). The (LL) foot of the winner violates RHTYPE=IAMB, but this is tolerated. The (LH) feet of the loser fatally violate RHTYPE=TROCHEE. (The last vowel of the root in (a) cannot delete for independent reasons—see §3.4.6.)

(102) Syncope builds trochaic feet

/ke-yakapa-nes-ʔoʔ/	RHTYPE=TROCHEE	RHTYPE=IAMB
a. $\text{k}^{\text{e}}\text{y}^{\text{ka}}\text{p}^{\text{a}}\text{n}^{\text{e}}\text{s}^{\text{ʔo}}\text{ʔ}$		*
b. $(\text{ke}.\text{y}^{\text{àk}})(\text{pa}.\text{n}^{\text{e}}\text{s})\text{ʔo}^{\text{ʔ}}$	**!	

No independent parameters for syllable or rule directionality are needed here—the interaction of the foot parsing constraints alone produces the necessary results.

Directionality is a long-standing issue in accounts of syncope that use economy rules and constraints (Broselow 1992a, Davis and Zawaydeh 1996, Farwaneh 1995, Ito 1986, Mester and Padgett 1994, Phelps 1975). If syncope is simply pruning stray syllables without reference to their context, then arbitrary directional parameters are necessary to explain language-specific patterns and cross-language variation. In actuality, the output

of deletion has to look a certain way because of markedness—structure is not removed to make outputs shorter but to make them more harmonic.

### 3.4.5.2 No syncope after long vowels

Syncope in Tonkawa applies after short vowels but not after long ones—in this, Tonkawa is unlike both Hopi (§3.3) and Southeastern Tepehuan (§3.5). The reason syncope does not apply in /HL.../ words is that there is really nothing to gain, given the Tonkawa ranking. The faithful renderings of these inputs already have a heavy syllable in the right place. The relevant data<sup>56</sup> are repeated from (74) in (103):

(103) Initial long vowels do not condition second syllable syncope

- |                     |                  |                    |                             |
|---------------------|------------------|--------------------|-----------------------------|
| a. /heepane-ook/    | (hee.pa)(nook)   | ‘council’          | *(hep)(nook), *(heep)(nook) |
| b. /taa-notoso-oʔs/ | (taa)(not)(soʔs) | ‘I stand with him’ | *(tan.to)(soʔs)             |
| c. /xaa-yakew/      | (xaa.ya)(kew)    | ‘butter’           | *(xay)(kew)                 |

The failure of syncope here is not surprising under the SWP analysis—the faithful output satisfies SWP *and* MAXV, so deletion is unnecessary. Syncope after long vowels is not completely pointless, though, because it could improve performance on GRPHARM. GRPHARM must therefore be dominated by MAXV:

(104) Uneven feet not fixed by syncope

/heepane-ook/	MAXV	GRPHARM
a. $\text{[heepane-ook]}$ (hee.pa)(nook)		*
b. (heep)(nook)	*!	

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<sup>56</sup> Words like /kaana-n-oʔ/ and /naate-n-oʔ/ do not qualify as evidence here, because the second vowel is root-final and cannot be deleted for independent reasons. See §3.4.6.

Another way to avoid the violation of GRPHARM would be to shorten the first vowel without deleting the second, as in *\*(he.pa)(nook)*, but this is ruled out by the previously established ranking MAX- $\mu$ >>GRPHARM.

Tonkawa is the opposite of Hopi and Southeastern Tepehuan, where the ranking PARSE- $\sigma$ >>MAXV favors syncope of unfooted syllables after the long vowel (recall the Hopi /tookani/ → *tók.ni*). In Tonkawa, syllables after long vowels are footable, because PARSE- $\sigma$  is ranked above ENDRULE-L. The chief effect of this ranking is iterative footing, which adds structure instead of removing it. The same constraint, PARSE- $\sigma$ , is satisfied in different ways in these languages: in Hopi and Southeastern Tepehuan, structure is lost (vowels), and in Tonkawa, structure is gained (additional feet).

Although all three languages end up with shorter words than they would have without syncope and shortening, there are real differences between their syncope processes. We could speak of “unfootable syllable syncope” in Hopi, “SWP syncope” in Hopi and Tonkawa, and so on. The same constraints are active in all three languages discussed here, but whether or not their interaction results in economy effects depends on their language-specific rankings.

#### 3.4.5.3 A digression: the “no-superheavy-syllables” alternative

A more traditional analysis of the lack of syncope after long vowels invokes the prohibition on superheavy syllables: “...Syncope is blocked in these cases, since the output has [a] superheavy syllable CVVC, that exists underlyingly for some rare morphemes, but that no phonological rule in Tonkawa is supposed to produce” (Lee 1983:32-33). This rule-blocking explanation does not really work. Superheavy syllables are not banned in general—only in unstressed positions. Recall that CVVC syllables do

shorten following a light initial syllable, as in /*ke-soopka-oʔ*/ → (*ke.sop*)(*koʔ*), but they do not shorten when they can be stressed, i.e., initially (as in (*soop*)(*koʔ*) ‘he swells up’) or after heavy syllables (as in (ʔat)(sook)(lak)(noʔo) ‘came to life, it is said’).

Furthermore, as Phelps 1975 notes, some processes in Tonkawa do create superheavy syllables. One such process is *h*-deletion/vowel coalescence, /*xa-henk<sup>w</sup>aana-*/ → *xeen.kwaa.na-* ‘to run far away.’

These are not really obstacles to an OT account, because \* $\sigma_{\mu\mu\mu}$  can be dominated by the constraints responsible for coalescence, while still blocking other processes. This is sketched in (105). MAX- $\mu$  must be ranked above \* $\sigma_{\mu\mu\mu}$ : there is no shortening to get rid of underlying superheavy syllables, as in /*soopka-oʔ*/ → *soop.koʔ*, not \**sop.koʔ*. In addition, \* $\sigma_{\mu\mu\mu}$  must dominate any constraint that would favor syncope after long vowels, e.g., GRPHARM. Thus /*xaa-yakew*/ maps to (*xaa.ya*)(*kew*), not \*(*xaay*)(*kew*). The result is that underlying superheavy syllables surface faithfully but new ones are not created.

(105) The “no-new-superheavies” alternative

		MAX- $\mu$	* $\sigma_{\mu\mu\mu}$	GRPHARM
/xaa-yakew/	a. $\text{☞}$ ( <i>xaa.ya</i> )( <i>kew</i> )			*
	b. ( <i>xaay</i> )( <i>kew</i> )		*	
	c. ( <i>xay</i> )( <i>kew</i> )	*!		
/soopka-oʔ/	d. $\text{☞}$ ( <i>soop</i> )( <i>koʔ</i> )		*	
	e. ( <i>sop</i> )( <i>koʔ</i> )	*!		

The problem with this explanation is that it misses a real generalization: there is a strong pressure to have a heavy syllable at the left edge of the word, but the evidence for the role of \* $\sigma_{\mu\mu\mu}$  in the grammar of Tonkawa is rather weak. I will assume that \* $\sigma_{\mu\mu\mu}$  is ranked below MAX- $\mu$  but that it plays no role in blocking syncope.

#### 3.4.5.4 Interim summary

To summarize, I have argued that the directionality of syncope, its iterative application, and its non-application after long vowels are entirely consistent with the prosodic system of Tonkawa. The only new rankings established in this section are:

(106) *Iterative syncope*: SWP, PARSE- $\sigma$ >>MAXV>>GRPHARM

I also argued against the traditional blocking analysis of the failure of syncope after long vowels. Syncope fails to apply after long vowels not because it is blocked by \* $\sigma_{\mu\mu\mu}$  but because it is never triggered in that environment in the first place. Syncope is gratuitous when there is already a word-initial heavy syllable.

The main points of the analysis of syncope are summarized in the comparative tableau (107). The comparison *(yak)(poʔ)~(yáka)(poʔ)* supports the ranking SWP>>MAXV. Deletion of the second rather than the third vowel in *(wey.ka)(poʔ)* demonstrates the effect of PARSE- $\sigma$  in controlling the directionality of syncope. Syncope fails to apply after a long vowel in *(xaa.ya)(kew)* because SWP is already satisfied, and all the constraints that would favor syncope in this environment (e.g., GRPHARM) are ranked too low to have any effect. Finally, *(ket)(sec)(noʔs)* shows that syncope must be iterative because it is tied to foot building, and non-iterative footing is not an option.



(107) Syncope in Tonkawa

/yakapa-oʔ/	PARSEG	SWP	MXV	GRPHRM	ER-L
a. (yàk)(póʔ)~(yàka)(póʔ)		W	L		
/we-yakapa-oʔ/					
b. (wèy.ka)(póʔ)~we(yàk)(póʔ)	W			L	
/xaa-yakew/					
c. (xàa.ya)(kéw)~(xàay)(kéw)			W	L	
/ke-tas-(h)ecane-oʔs/					
d. (kèt)(sèc)(nóʔs)~(két)se.ca.noʔs	W		L		L

To conclude the analysis, we need to address some situations where syncope is blocked.

This is done in the next subsection.

### 3.4.6 Blocking of long and root-final vowel syncope in Tonkawa

#### 3.4.6.1 Introduction: the facts

There are systematic exceptions to syncope in Tonkawa that involve long vowels and root-final vowels.<sup>57</sup> Underlyingly long vowels shorten but do not syncopate in the positions where short vowels delete, and root-final vowels also systematically fail to syncopate. The following examples illustrate this:

(108) Long vowels shorten but do not syncopate

- a. /xa-kaana-oʔ/    (xa.ka)(noʔ)    ‘he throws it far away’ \* (xak)(noʔ)  
 b. /ke-yaaloona-oʔ/    (ke.ya)(loo)(noʔ)    ‘he kills me’    \*(key)(loo)(noʔ)  
 cf. /ke-yamaxa-oʔ/    (key.ma)(xoʔ)    ‘he paints my face’

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<sup>57</sup> There are other well-known sets of exceptions that have to do with glottalized consonants, clusters, and the OCP—the reader is referred to the work of Kisseberth 1970b, McCarthy 1986, and Phelps 1975 for discussion, as I will not treat these here.

(109) Root-final vowels do not syncopate

- a. /ya-seyake-n-oʔ/ (yas)(ya.ke)(noʔ) 'he is tearing it' \*(yas)(yak)(noʔ)  
b. /pile-n-oʔ/ (pi.le)(noʔ) 'he rolls it' \*(pil)(noʔ)

The explanation for both of these classes of exceptions is faithfulness.

### 3.4.6.2 Special protection for long vowels

Syncopate in many languages affects only short vowels in a particular environment. In some cases, this can be explained in terms of markedness. For example, in Hopi, short vowels syncopate in the second syllable of /LLL/ words but long ones do not syncopate in /LHL/ because the SWP can be satisfied without deletion. Since the language is iambic, a (LH) foot can be built and syncopate is unnecessary.

In Tonkawa, a markedness explanation will not work, because shortened vowels fail to delete in the same environment where underlyingly short vowels do delete. This is a chain shift: long vowels map to short ( $VV \rightarrow V$ ), and short ones map to zero ( $V \rightarrow \emptyset$ ) in the same environment. Chain shifts are analyzed in OT using the idea of “relative faithfulness” (Gnanadesikan 1997, Kirchner 1996, McCarthy 2003, Prince 1998b): for the Tonkawa chain shift, the claim is that the mapping from a long vowel to zero is categorically less faithful than the deletion of a short vowel.<sup>58, 59</sup> Thus, long vowels do not delete because a faithfulness constraint requires long vowels to make it to the surface:

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<sup>58</sup> McCarthy 2003 analyzes the Bedouin Arabic chain shift using faithfulness constraints that refer to a ternary duration scale  $a > i > \emptyset$  (cf. Gnanadesikan 1997). Scales of this sort are prohibited in the theory of CON developed in chapter 2. Note also that the obvious solution of representing long vowels as sequences of two vowels is neither available nor illuminating in Tonkawa: long vowels are tolerated on the surface, but underlying sequences of short vowels undergo hiatus elision.

<sup>59</sup> Unlike feature change chain shifts (Beckman in press, Kirchner 1996), chain shifts that involve segmental deletion cannot be analyzed in terms of Local Conjunction. MAX

(110) MAX-LONG-V: “An input long vowel has a correspondent in the output.”

MAX-LONG-V belongs to the MAX-POSITION family of constraints (Beckman 1998, ch.5), which protect a prominent element of the input.<sup>60</sup> Long vowels are one of Beckman’s (1998) privileged positions, along with root-initial syllables, syllable onsets, and others.

MAX-LONG-V requires each underlying long vowel to have some correspondent on the surface but does not require that it be long: it is violated by the mapping  $VV \rightarrow \emptyset$  but not by  $V \rightarrow \emptyset$  or  $VV \rightarrow V$ . This constraint is ranked above SWP, so light stressed syllables are tolerated when the alternative is wholesale deletion (rather than mere shortening) of a long vowel:

(111) Long vowels are not deleted even when this results in LL feet

/we-naate-oʔ/	MAX-LONG-V	SWP	MAXV
a. $\text{we}^{\text{H}}(\text{we.na})(\text{to}^{\text{H}})$		*	
b. $(\text{wen})(\text{to}^{\text{H}})$	*!		*

Long vowels are never deleted in Tonkawa, so MAX-LONG-V is undominated. It is violated in other languages, however—we will see in §3.5 that long vowels are deleted in Southeastern Tepehuan.

The behavior of /LH.../ words shows that SWP is dominated not only by MAX-LONG-V. It would be possible to avoid the whole issue of deleting or shortening long vowels in #LH forms if only feet could be built around the long vowels themselves, as in

constraints cannot be locally conjoined in any domain because their joint violation is impossible to detect (Moreton and Smolensky 2002).

<sup>60</sup> MAX-LONG-V also bears some similarity to Kager’s (1999) HEAD-MAX-BA “every segment in the base’s *prosodic head* has a correspondent in the affixed form.” This constraint does not require the correspondent to be a prosodic head, it only requires that the stressed vowel have a correspondent.

\*we(nàa)(tóʔ) or \*ke(sòop)(kóʔ). That this doesn't happen suggests the ranking PARSE-

$\sigma \gg$ SWP:

(112) Heavy heads not as high a priority as exhaustive parsing

/we-naate-oʔ/	PARSE- $\sigma$	SWP
a. $\text{w}^{\text{e}}(\text{w}^{\text{e}}.\text{na})(\text{t}^{\text{o}}\text{ʔ})$		*
b. we(nàa)(tóʔ)	*!	

### 3.4.6.3 Apocope, hiatus elision and the root-final vowel

Root-final vowels are subject to a faithfulness constraint of the Anchor family

(McCarthy and Prince 1995):

(113) ANCHOR-R(ROOT): “Every root-final segment in the input must have a corresponding segment in the output.”<sup>61</sup>

ANCHOR-R must dominate SWP, because SWP is violated just in case the alternative requires the root-final vowel to delete:

(114) SWP violated to save the last vowel of the root

/ya-seyake-n-oʔ/	ANCHOR-R	SWP
a. $\text{y}^{\text{a}}(\text{y}^{\text{a}}.\text{ke})(\text{n}^{\text{o}}\text{ʔ})$		* $(\text{y}^{\text{a}}.\text{ke})$
b. (yas)(yak)(noʔ)	*!	

The interesting twist is that ANCHOR-R can be violated under some circumstances in Tonkawa. When the last vowel of the root is either word final or ends up in a two-vowel sequence through morpheme concatenation, it apocopes or elides as required.

The relevant facts are repeated in (115). The root-final vowel of *pile-* is preserved in the

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<sup>61</sup> An equally viable alternative is ANCHOR-EDGE (Nelson 1998), a constraint that protects segments at either edge from deletion.

environment for syncope (a), but the suffix vowel is the one that survives in the hiatus context (b). Examples (c) and (d) make the same point for apocope.

(115) Root-final vowel never syncopates but may elide or apocopate

a. /pile-n-oʔ/	(pi.le)(noʔ)	*(pil)(noʔ)	‘he is rolling it’
b. /pile-oʔ/	(pi.loʔ)	*(pileʔ)	‘he rolls it’
c. /we-notoxo-n-oʔ/	(wen)(toxo)(noʔ)	*(wen)(tox)(noʔ)	‘he is hoeing it’
d. /notoxo/	(no.tox)	*(not.xo)	‘hoe’

These facts suggest that apocope and syncope satisfy *different* constraints that must be transitively ranked through ANCHOR-R. This result is impossible to replicate using \*STRUC(σ): it would have to be simultaneously ranked above and below ANCHOR-R. The argument is developed below.

Apocope and hiatus elision satisfy FINALC and ONSET, respectively. FINALC is defined as follows:

(116) FINALC: “Every prosodic word ends in a consonant” (McCarthy and Prince 1994a).

*Harmonic scale:* [PrWd...C] > [PrWd...V]

Independent motivation for FINALC comes from processes other than apocope.

McCarthy and Prince (1994a:22) use FINALC in their analysis of consonant epenthesis in Makassarese words that violate CODACOND: /rantas/ → *rantasaʔ* ‘dirty.’ Since both consonant epenthesis and apocope result in a consonant-final word, FINALC is assumed to be responsible for both.<sup>62</sup>

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<sup>62</sup> There may be a more interesting story to be told about apocope. It seems that in many languages prosodic words are required to end in *heavy syllables* (...VV or ...VC), not just in consonants (see Yapese (Jensen 1977, Wen Hsu 1969) and possibly Southeastern Tepehuan (§3.5), though Kager analyzes it using FINALC as well). There are also languages that have the opposite requirement, in which all words must end in vowels

FINALC and ONSET both dominate ANCHOR-R, as shown in (117). The suffix vowel is preserved in *piloʔ* because ANCHOR-L protects the morpheme-initial segment of the suffix *-oʔ* from deletion.<sup>63</sup> Candidate *\*pileʔ* loses because it keeps the root-final vowel and deletes the suffix-initial vowel:

(117) FINAL-C, ONSET >> ANCHOR-R

		FINALC	ONSET	ANCHOR-L	ANCHOR-R
/notoxo/	a. <del>no</del> notox				*
	b. notoxo	*!			
/pile-oʔ/	c. <del>pi</del> pi.loʔ				*
	d. pi.le.oʔ		*!		
	e. pi.leʔ			*!	

We saw earlier from the behavior of words like (*pi.le-*)(*n-oʔ*) that ANCHOR-R dominates SWP. Therefore FINALC transitively dominates SWP: although the two constraints do not inherently conflict, they are ranked in Tonkawa.

(118) FINALC, ONSET, ANCHOR-L >>> ANCHOR-R >>> SWP

The interplay of apocope and syncope can be seen directly in words like /notoxo/, where the normal application of syncope is disrupted and apocope applies instead, as in *no.tox* not *\*not.xo*. The prediction of the analysis presented so far is that such words should be footed as trochees with initial stress, so this is one of the situations where WSP must be violated to foot the initial syllable: (*nó.tox*).

(e.g., Sidamo (Moreno 1940)). Since I cannot do this large and interesting topic justice here, I will assume that FINALC is the relevant constraint in Tonkawa.

<sup>63</sup> An alternative to ANCHOR-L is MAX-MI (Casali 1997), which prohibits the deletion of morpheme-initial segments.

Vowel deletion applies non-uniformly in Tonkawa: two processes can delete the root-final vowel, while the third is not allowed to. This is an important result that can only be obtained when vowel deletion is triggered by *different* markedness constraints. However attractive a uniform explanation for both apocope and syncope might be, languages like Tonkawa show that it is not attainable. A \*STRUC analysis of apocope and syncope cannot explain why syncope fails to delete root-final vowels while apocope does so routinely. No single markedness constraint can favor both because no constraint can be simultaneously ranked below and above ANCHOR-R. Tableau (119) shows this: if \*STRUC is ranked below ANCHOR-R, only medial deletion is possible. If \*STRUC were ranked above ANCHOR-R, only final deletion is possible. The two patterns cannot coexist in the same language under any ranking:

(119) Apocope and syncope cannot be analyzed with a single M constraint

		ANCHOR-R	*STRUC(σ)
/ke-yamaxa-n-oʔ/	a. $\text{key.ma.xa.no}^?$		****
	b. $\text{key.max.no}^?$	*!	***
/notoxo/	c. $\text{not.xo}$		**
	d. $\text{no.tox}$	*!	**

This is yet another piece of evidence for the claim that there is no inherent unity to the various vowel deletion processes—economy effects result from the interaction of diverse markedness constraints. This theme will be continued in chapter 4, where I examine deletion processes that affect only a subset of a language’s vowel inventory.

### 3.4.7 Summary of the Tonkawa analysis

We are now ready to consider the global interaction of the vowel deletion and shortening processes in Tonkawa. I have presented arguments for the following rankings:

(120) *Feet are trochaic*: RHTYPE=TROCHEE >> RHTYPE=IAMB

(121) *Iterative footing*: PARSE- $\sigma$ , ENDRULE-R >> ENDRULE-L

(122) *No degenerate feet but uneven feet are okay*: FTBIN, PARSE- $\sigma$  >> GRPHARM

(123) *Syncope, apocope, and shortening*:

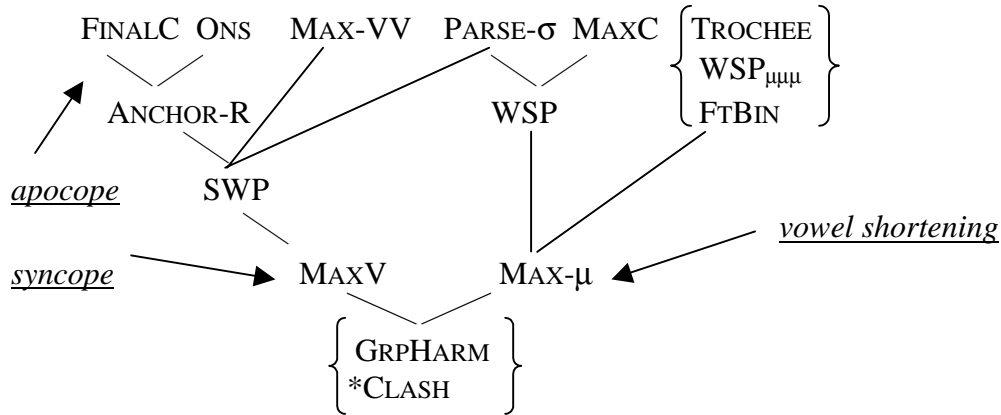


Tableau (124) illustrates the ranking in action. RHTYPE=TROCHEE, FTBIN, WSP<sub>μμμ</sub> and ONSET are left out to save space, as are all candidates that violate these constraints. To make the tableau easier to read, I have placed the winning output next to each input rather than next to the losers in the comparisons. The rows with inputs/winners are therefore grayed out to avoid confusion (the input is not being compared to the winner).

The first couple of comparisons in (124) show why syncope cannot delete the root-final vowel (ANCHOR-R) and why syncope targets the *second* vowel in many forms but not the third or fourth. The loser candidate that deletes the *third* vowel, \**ya(sey.ke)(noʔ)*, is actually harmonically bounded within this constraint set: no constraint favors it. Next, the apocopating candidate *notox* is shown. Apocope words do not follow the usual syncope pattern because of FINALC, and in such words the deletion of word-final vowels is permitted and indeed required. The next three inputs show the distribution of long vowels and the non-triggering of syncope after long vowels. The winning output for /*we-naate-oʔ*/ shortens the second vowel but doesn't delete it; this is



because of MAX-LONG-V, PARSE- $\sigma$  and WSP. The winning output for /*yaaloo<sup>h</sup>na-oʔ*/ is faithful to vowel length and is exhaustively parsed into (H) feet. No shortening is required because faithful, iteratively footed outputs already satisfy SWP, GRPHARM, and WSP. The winning output for /*xaa-yakew*/ is also faithful to its underlying vowels—deletion is gratuitous because (HL) feet are acceptable (MAXV >> GRPHARM) and SWP is already satisfied. Next, shortening does not apply to uneven trochees either because either SWP or MAX- $\mu$  prevents it: /*kaana-noʔ*/  $\rightarrow$  (*kaa.na*)(*noʔ*). And, finally, the normal application of syncope in /*notoxo-oʔ*/ supports the ranking SWP >> MAXV, MAX- $\mu$ .

## (124) Tonkawa, summary tableau

/ya-seyake-n-oʔ/→ (yàs)(yà.ke)(nóʔ)	Mx:FINC VV:	PARSE-σ	ANC R	SWP	WSP	Mx:V	Mx-μ	ER-L	GRP HRM	*CLSH
a.~(yàs)(yàk)(nóʔ)			W	L		W				W
b.~ya(sèy.ke)(nóʔ)		W		L					W	L
/notoxo/→(nó.tox)										
c.~(nót.xo)		W	L	L	L				W	
/we-naate-oʔ/→ (wé.na)(tóʔ)										
d.~(wé.naa)(tóʔ)					W		L			
e.~we(náa)(tóʔ)		W		L			L			W
f.~(wèn)(tóʔ)	W			L		W				W
/yaaloo-na-oʔ/→ (yàa)(lòo)(nóʔ)										
g.~(yà.lo)(nóʔ)				W			W			L
h.~(yàl)(nóʔ)	W					W	W			L
i.~(yáa)loo.noʔ		W			W			L		L
j.~(yàa.lo)(nóʔ)							W		W	L
/xaa-yakew/ → (xàa.ya)(kéw)										
k.~(xàay)(kéw)						W			L	W
/kaana-noʔ/→ (kàa.na)(nóʔ)										
l.~(kà.na)(nóʔ)				W			W		L	
/notoxo-oʔ/→ (nòt)(xóʔ)										
m.~(nò.to)(xóʔ)				W		L				L

In short, Tonkawa syncope and vowel shortening result from the interaction of prosodic constraints on foot shape and parsing: there is a requirement for stressed syllables to be heavy, and it is enforced by syncope since neither vowel lengthening nor gemination are available. Syncope is iterative because footing is iterative; whenever there is an underlying /LL/ sequence neither of whose syllables can be incorporated into a foot

with a heavy head, the second vowel is lost and a (H) foot surfaces. Likewise, vowel shortening applies in a very specific circumstance—when the long vowel cannot head its own foot, i.e., after an initial light syllable. There is no requirement for words to be shorter in Tonkawa and there is no dispreference for syllables, but there are various requirements on what feet and syllables in them must look like.

### **3.4.8 Comparison with economy analyses of Tonkawa**

#### **3.4.8.1 Introduction: Kisseberth's analysis**

Economy *is* the traditional analysis of Tonkawa (though obviously \*STRUC( $\sigma$ ) hasn't always been its formal implementation). The idea behind Kisseberth's (1970b) original analysis is that syncope and vowel shortening are generalized processes—almost “delete vowel” or “delete mora.” These processes are blocked by various constraints: Kisseberth discusses prohibitions on tautosyllabic consonant clusters, prohibitions on clusters of glottalized consonants with non-glottalized consonants, the impossibility of deleting the last vowel of the root (ANCHOR-R in the present analysis), and the prohibition on adjacent identical consonants (which McCarthy 1986 casts as the OCP, though see Rose 2000b and chapter 4). These various constraints limit the application of syncope.

This is the classic economy approach to syncope, which has been adopted in some form or another by Côté 2001, Hartkemeyer 2000, Taylor 1994, and others. Kisseberth notes that hiatus elision, apocope and syncope are three distinct processes (an assumption shared in the present analysis), and formulates three distinct rules for them. He does, however, observe that shortening and syncope seem to be related in a way that a rule-based analysis cannot capture: “...it is [...] clear that shortening of long vowels and

deletion of short vowels [...] [are] the same phonological process” (Kisseberth 1970b:121). The reason they look like the same phonological process in Tonkawa is that both processes have to do with trochaic foot structure; shortening lightens the weak branch of a trochee and syncope removes what would be the weak branch to give weight to the head. Yet missing the connection between shortening and syncope is not the only problem of the “delete wherever you can” approach.

#### 3.4.8.2 Directionality

Phelps 1975 argues that Kisseberth’s approach misses another aspect of syncope in Tonkawa—its directionality. To capture it, she develops a directional, iterative vowel deletion rule, given here in somewhat simplified form:

(125) Vowel Elision (iterative, rightward)

$$V \rightarrow \emptyset / VC(V) \_ CV$$

This rule attempts to collapse syncope, hiatus elision and shortening. A vowel is deleted following another vowel—this is shortening, assuming that long vowels are really sequences of two short vowels. A vowel is also deleted in a two-sided open syllable—this is syncope. The rule does correctly delete the first of two eligible vowels in words like /we-notoxo-oʔ/, but it captures the directionality of syncope rather arbitrarily: it is not a feature-spreading rule or a metrical stress rule, so its “iterative, rightward” application seems ad hoc. The rule also encounters some empirical problems—it incorrectly applies to all non-initial long vowels that are preceded by CV syllables, e.g. /yaaloona-oʔ/ should shorten the second vowel to \*yaa.lo.noʔ. Furthermore, syncope is wrongly predicted by this rule to apply after long vowels in /xaa-yakew/, yielding \*xaay.kew.

The problem is, of course, that the context for shortening is not determined by syllable structure but by *foot* structure. To prevent the rule from overapplying, the context must be restated and expanded to refer to the length, moraic weight or foot structure of both the surrounding syllables and of the target environment.

Interestingly, the success of this directional rule analysis of syncope cannot be replicated in terms of \*STRUC without appealing either to prosodic constraints or to arbitrary directionality constraints (such as the syllable alignment constraints of Mester and Padgett 1994—see chapter 2). Under the \*STRUC approach, the basic pattern of deletion results from \*STRUC( $\sigma$ ) dominating MAXV. Overly enthusiastic deletion of vowels is prevented by \*COMPLEX:

(126) Economy analysis of the basic pattern

/we-notoxo-oʔ/	*COMPLEX	*STRUC( $\sigma$ )	MAXV
a. $\text{we}^{\text{H}}\text{.to}^{\text{H}}\text{.xo}^{\text{H}}\text{?}$		***	**
b. $\text{we}^{\text{H}}\text{.not}^{\text{H}}\text{.xo}^{\text{H}}\text{?}$		***	**
c. $\text{went}^{\text{H}}\text{.xo}^{\text{H}}\text{?}$	*!	**	***

As can be seen in (126), this rule brings back one of the problems of Kisseberth’s original “delete-where-you-can” analysis. \*STRUC( $\sigma$ ) cannot capture the directional application of syncope: (a) and (b) are tied, though (a) is the actual winner. The analysis cannot control directionality of deletion without some prosodic constraint, e.g., PARSE- $\sigma$ 1.

### 3.4.8.3 Preventing syncope after long vowels in the economy analysis

In my analysis, the problem of preventing syncope after long vowels in was already addressed in §3.4.5.2 and §3.4.5.3, where I argued that avoidance of superheavy syllables is not the right explanation for the non-application of syncope in words like

/xaa-yakew/ → xaa.ya.kew. Let's see how \* $\sigma_{\mu\mu\mu}$  works with the economy constraint analysis.

The result in (127) initially looks encouraging: syncope applies wherever possible but never creates superheavy syllables. Since MAX- $\mu$  prevents shortening all the way to \*xay.kew, the non-economical trisyllabic output is the winner.

(127) Blocking syncope after long vowels

/xaa-yakew/	MAX- $\mu$	* $\sigma_{\mu\mu\mu}$	*STRUC( $\sigma$ )	MAXV
a. xaa.ya.kew~xay.kew	W		L	W
b. xaa.ya.kew~xaay.kew		W	L	W

This success quickly diminishes, however, when the ranking in (127) is put in the larger perspective of Tonkawa shortening patterns.

#### 3.4.8.4 Controlling shortening

Metrical shortening is a general problem for economy principles, because long vowels are marked not generally but only in some environments. \*STRUC( $\sigma$ ) cannot directly favor shortening, because a syllable with a long vowel incurs as many violations as a syllable with a short vowel.<sup>64</sup> The alternatives are \*STRUC( $\mu$ ) and \*STRUC(FOOT).

MAX- $\mu$  must be dominated by *some* constraint that favors shortening. Suppose this constraint is \*STRUC( $\mu$ ). Shortening applies to superheavy syllables when they immediately follow an initial light syllable (e.g., /ke-soopka-oʔ/ → ke.sop.koʔ).

Therefore, \*STRUC( $\mu$ ) must dominate MAX- $\mu$ . Shortening might be prevented in the

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<sup>64</sup> One could imagine a situation where syllable economy is in conflict with avoidance of superheavy syllables, where every instance of deletion after a CVVC sequence will be accompanied by vowel shortening.

initial syllable by IDENT-σ1, which requires the first syllable to be faithful (Beckman 1998). (Shared violations of \*STRUC(μ) are suppressed in the tableau):

(128) Shortening of peninitial CVVC

		IDENT-σ1	*STRUC(μ)	MAX-μ
/ke-soopka-oʔ/	a. $\text{ke.sop.koʔ}$			*
	b. $\text{ke.soop.koʔ}$		*	
/soopka-oʔ/	c. $\text{soop.koʔ}$		*	
	d. $\text{sop.koʔ}$	*!		

However, superheavy syllables do appear in non-initial position in words like /ʔatsoo-k-lakno ʔo/ (ʔat)(sook)(lak)(no ʔo) ‘came to life, it is said.’ Under the WSP analysis, shortening does not apply because the heavy syllable is a foot head and it is preceded by a footed syllable. For \*STRUC(μ), the relative position of the superheavy syllable makes no difference—the ranking in (128) wrongly favors shortening in any non-initial syllable.

Both \*STRUC(μ) and \*STRUC(FOOT) are excellent drivers of shortening in the abstract, but they generally fail when applied to Tonkawa. The problem is that shortening occurs not generally but only in a special environment, i.e., after a light initial syllable. Long vowels appear faithfully in the initial syllable or following a heavy syllable. The relevant data are repeated below.

(129) Long vowels surface as long in the first syllable or following H

- a. /kaana-oʔ/            (kaa)(noʔ)            ‘he throws it away’
- b. /kaana-n-oʔ/        (kaa.na)(noʔ)        ‘he is throwing it away’
- c. /nes-kaana-oʔ/      (nes)(kaa)(noʔ)      ‘he causes him to throw it away’
- d. /yaaloona-oʔ/        (yaa)(loo)(noʔ)        ‘he kills him’            \*(yaa)lo..., \*(yaa.lo)...
- e. /taa-notoso-oʔs/     (taa)(not)(soʔs)        ‘I stand with him’

(130) Vowel shortening after initial light syllable

- |    |                    |                   |                         |                     |
|----|--------------------|-------------------|-------------------------|---------------------|
| a. | /xa-kaana-oʔ/      | (xa.ka)(noʔ)      | ‘he throws it far away’ | *(xa.kaa)(noʔ)      |
| b. | /ke-yaalooana-oʔ/  | (ke.ya)(loo)(noʔ) | ‘he kills me’           | *(ke.yaa)(loo)(noʔ) |
| c. | /ke-taa-notoso-oʔ/ | (ke.ta)(not)(soʔ) | ‘he stands with me’     | *(ke.taa)(not)(soʔ) |
| d. | /we-naate-oʔ/      | (we.na)(toʔ)      | ‘he steps on them’      | *(we.naa)(toʔ)      |

There are no morphological features unique to non-shortening environments that could single them out for special status with respect to positional faithfulness constraints.

Thus we find that vowels fail to shorten in the first syllable of the word (*kaa.noʔ*, *yaa.loo.noʔ*, *taa.not.soʔs*) and in the second syllable (*nes.kaa.noʔ*, *yaa.loo.noʔ*); in the root (*kaa...*) and in the prefix (*taa...*). However, we also find that some of these environments allow shortening as long as they are preceded by a CV syllable, and even then not always: for example, /ke-yaalooana-oʔ/ does not map to \**ke.ya.lo.noʔ*, which would be expected if shortening was about reducing the number of feet or moras. It seems impossible to correctly constrain shortening if \*STRUC is driving it.

In short, both Phelps’ iterative rule analysis and the \*STRUC analysis run into problems because deletion and shortening are sensitive to metrical context in Tonkawa—there is no principle of syllable, mora, and foot economy, but there are accidental economy effects that arise when the words are massaged into their optimal metrical shape.

I have argued that Tonkawa vowel shortening and syncope apply in metrically determined environments. Among the constraints instrumental in Tonkawa were SWP, WSP, and PARSE-σ. Observe that these are also the constraints that were instrumental in Hopi, yet the outcome is very different. Hopi has non-iterative syncope, whereas in Tonkawa it is iterative. Conversely, in Hopi, long vowels shorten in several



environments, while in Tonkawa they only shorten in one environment: the peninitial syllable following a light syllable.

These differences are baffling facts under the “delete/shorten where you can” approach, but they fall out straightforwardly if we abandon the idea that word length, syllable/mora/foot count, or other measures of structural economy play any role in grammars. If we look instead for explanations in terms of overall well-formedness, whether in terms of metrical constraints or other requirements (see chapter 4), we will find that there is nothing special to economy effects—deletion is just one among several ways to satisfy these requirements.

### **3.5 Southeastern Tepehuan**

#### **3.5.1 Introduction**

The Hopi and Tonkawa patterns do not by any means exhaust the range of logical possibilities for metrically induced syncope. This section summarizes the analysis of Southeastern Tepehuan by Kager 1997. Kager’s goal is different from the goals of the present study—he is concerned primarily with showing that superficially opaque metrical syncope patterns can be analyzed to great effect in OT by revising certain assumptions about these languages’ prosodic systems. Nevertheless, his approach is very much in line with the one pursued here: he argues that syncope results from the interaction of metrical constraints with MAXV and that there is no syllable economy at work.

SE Tepehuan is both like and unlike Hopi and Tonkawa: its syncope is iterative as in Tonkawa, but its stress is iambic and non-iterative as in Hopi. Not surprisingly, this pattern involves the interaction of the same constraints that are active in Hopi and Tonkawa: WSP, PARSE- $\sigma$ , NONFINALITY( $\sigma$ ), SWP, and FINALC.

Much of SE Tepehuan deletion *looks* like syllable economy, as Kager himself notes, but it is also clear that deletion fails to apply in some circumstances (e.g., inside a foot) although deletion there would reduce the overall number of syllables. This is because SE Tepehuan syncope reduces the number of *unfooted* syllables, not all syllables. This was already addressed in chapter 2: while syncope may minimize the number of unfooted syllables or maximize the weight of foot heads, no language deletes vowels to reduce the number of syllables inside well-formed feet. Patterns of syllable reduction that are agnostic of prosody cannot exist in the Lenient theory, yet syllable economy constraints predict that they should occur.

### 3.5.2 The patterns of deletion in Southeastern Tepehuan

According to Willett 1982 and Willett 1991, Southeastern Tepehuan (Uto-Aztecan, Mexico) has CV(V)(C) syllable structure, and consonant clusters are forbidden. Stress in Southeastern Tepehuan is much like that of its Uto-Aztecan relative, Hopi—Kager (1997:474) describes it as follows: “accent falls on the initial stem syllable when it is heavy (i.e. either long-voweled, diphthongal, or closed). It falls on the second stem syllable if this is heavy while the first syllable is light.” There is no secondary stress, which Kager takes to be evidence of non-iterative footing.<sup>65</sup> Examples are given in (131) (I follow Kager’s standardized transcriptions of the data from Willett 1982, Willett 1991).

(131) Southeastern Tepehuan stress

a. (vóo)hi                    ‘bear’

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<sup>65</sup> Lack of reported surface secondary stress need not imply non-iterative footing. There is other evidence of the lack of secondary footing in Southeastern Tepehuan—for example, it has vowel shortening outside stressed syllables, just like Hopi. See also chapter 4 for discussion of Lebanese Arabic, which also lacks surface secondary stress but has other evidence of iterative feet (cf. Hayes 1995, McCarthy 1979 and others).

- b. (vát)vi.rak           ‘went to bathe’
- c. (ta.káa)rui?       ‘chicken’
- d. (ta.píiʃ)           ‘flea’

The difference between Hopi and Tepehuan is that stress may fall on the last syllable, meaning that NONFINALITY(σ) is not active (unusually for iambic languages—see Hung 1994), and naturally this has consequences for the directionality of syncope and apocope.

Syncope deletes odd-numbered vowels following the stressed syllable. Deletion affects both short (a-e) and long vowels (f,g). Deleting vowels are underlined.

(132) Syncope

- |                                  |                        |                              |                                     |
|----------------------------------|------------------------|------------------------------|-------------------------------------|
| a. /t̥i-t̥i <u>r</u> ovij/       | (t̥i <u>t</u> ).ro.pij | ‘ropes’                      | cf. (b)                             |
| b. /t̥i <u>r</u> ovij/           | (t̥i <u>r</u> ).vij    | ‘rope’                       | cf. (a)                             |
| c. /to-topaa/                    | (tót).pa               | ‘pestles’                    | cf. (topáa)                         |
| d. /taa-t <u>a</u> kaarui?/      | (táat).ka.rui?         | ‘chickens’                   | cf. (ta.káa)rui?                    |
| e. /taa-t <u>a</u> piiʃ/         | (táat).piʃ             | ‘fleas’                      | cf. (ta.píiʃ)                       |
| f. /gaa-g <u>a</u> aga?/         | (gáaʔŋ).gaʔ            | ‘he will look around for it’ | cf. (gáa)gim ‘he is looking for it’ |
| g. /tu# maa-m <u>a</u> tuʃidza?/ | tu# (máam).tuʃ.dzaʔ    | ‘will teach’                 |                                     |

These are all reduplicative examples—here, just as in Hopi, the reduplicant attracts stress, which entails that it also be heavy.<sup>66</sup>

As in Tonkawa, final vowels are subject to apocope, but an interesting twist is that although long vowels syncope, they do not apocope when they are in the strong position of an iamb—cf. (a-c) with (d,e):

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<sup>66</sup> Reduplicants are not always stressed in SE Tepehuan—sometimes the reduplicant is short and the base is stressed, e.g., /RED-huk/ is *hu.húk* ‘pines.’ Whether a stem takes the stressed or the short reduplicant is unpredictable—I assume that the difference between these stems are lexically encoded and that the base-stressed forms are lexically marked as subject to OO-DEP (see §2.3), which acts as a size-restrictor for the reduplicant.

(133) Apocope

a. /tu# huana/	tu# (huán)	‘he is working’	cf. tu# (huá).nat ‘he was working’
b. /hij# novi/	hij# (nóv)	‘my hand’	cf. /novi-ʔn/ (no.víʔn) ‘his hand’
c. /novi/	nóv	‘hand’	
d. /ga-gaa/	ga.gáa	‘cornfields’	*gaʔn, cf. (gáa) ‘cornfield’
e. /ʔaʔii/	ʔa.ʔí	‘child’	*ʔa.ʔí, ʔaʔ

Deletion also exhibits a directionality effect of sorts: when either apocope or syncope is possible, apocope is preferred over syncope (this is also the case in Aguaruna (Payne 1990)—see (43)). Note the difference between Hopi and SE Tepehuan in this respect: /LLL/ words surface as (LH́), not as (H́)L. (This difference correlates with the ranking of NONFINALITY(σ) in the two languages, to which I will return shortly.)

(134) Apocope wins over syncope

a. /hij# noo-novi/	hij#(nóo)nov	‘my hands’	*hij#(nóon)vi
b. /ʃi#ʔomij/	ʃi#(ʔo.mín)	‘break it!’	*ʃi#(ʔóm)ni
c. /naa-nakasiʔi/	(naan)ka.siʔ	‘scorpions’	*(naan)kas.ʔi

Kager’s generalization is that “the output goal of apocope/syncope is *not* to minimize the number of syllables as such, but to minimize the number of syllables that stand *outside the foot*” (Kager 1997:475, emphasis in the original).

### 3.5.3 Kager’s analysis of Southeastern Tepehuan

Kager analyzes this pattern as serving “exhaustivity of metrical parsing.” (Kager 1997:479). In other words, PARSE-σ is the main motivating force behind both syncope and apocope in Southeastern Tepehuan. Since Kager goes into a fair amount of detail in his analysis, I will not do so here—instead I will focus on the comparison between Southeastern Tepehuan on the one hand and Hopi and Tonkawa on the other. I will also look at how economy principles deal (or, rather, do not deal) with these differences.

### 3.5.3.1 Footing and syncope

The Southeastern Tepehuan stress system is much like Hopi: an iambic foot is built at the left edge of the word, and no other feet are. The same ranking holds of both languages. (Kager (1997) uses gradient alignment—his analysis is recast in terms of categorical constraints here.)

(135) ENDRULE-L, ENDRULE-R >> PARSE- $\sigma$

However NONFINALITY( $\sigma$ ) is inactive in SE Tepehuan; disyllabic LH words like *topáa* ‘pestle’ surface with iambic rather than trochaic stress. This has consequences for syncope and apocope: in all the places where Hopi avoided deletion so as to obey NONFINALITY( $\sigma$ ), SE Tepehuan has it.

Just as in Hopi, PARSE- $\sigma$  and SWP dominate MAXV in SE Tepehuan. Vowel deletion creates stressed heavy syllables and reduces the number of unfooted syllables. In (136), syncope creates a (H) foot, because (LL) crucially violates SWP. Note that the number of unfooted syllables is one in both the winner and the loser. Not so in (137), though: here, SWP is satisfied by both the winner and the loser, but syncope applies anyway, since the number of unfooted syllables can be reduced further.

(136) Syncope to make stressed syllables heavy

/ tírovij/	SWP	MAXV
a. $\text{tí}^{\text{H}}\text{r}^{\text{L}}\text{ó}^{\text{H}}\text{v}^{\text{L}}\text{i}^{\text{L}}\text{j}^{\text{L}}$		*
b. $(\text{tí}^{\text{H}}\text{r}^{\text{L}}\text{ó}^{\text{H}})\text{v}^{\text{L}}\text{i}^{\text{L}}\text{j}^{\text{L}}$	*!	

(137) Syncope to get rid of unfooted syllables

/taa-tapij/	PARSE- $\sigma$	MAXV
a. $\text{tá}^{\text{H}}\text{a}^{\text{L}}\text{t}^{\text{L}}\text{.p}^{\text{H}}\text{i}^{\text{L}}\text{j}^{\text{L}}$	*	*
b. $(\text{tá}^{\text{H}}\text{a}^{\text{L}})\text{t}^{\text{L}}\text{.p}^{\text{H}}\text{i}^{\text{L}}\text{j}^{\text{L}}$	**!	

In this respect SE Tepehuan and Hopi are almost identical—they only differ in their acceptance of superheavy syllables, which Hopi bans but SE Tepehuan doesn't.

### 3.5.3.2 Apocope

Although SE Tepehuan resembles Hopi in its syncope patterns, it is more like Tonkawa when it comes to apocope. Both in Tonkawa and SE Tepehuan, FINALC (defined in (116)) dominates MAXV, favoring apocope. The only exception to apocope is canonically iambic LH words like *topaa*.<sup>67</sup> Kager attributes the behavior of LH words to the requirement for prosodic words to be minimally disyllabic (DISYLL).

(138) DISYLL: “The PrWd is minimally disyllabic” (Ito and Mester 1992, Kager 1997, McCarthy and Prince 1993b).



This constraint is violated by words like *nov*, but the alternative *\*(noví)* is ruled out by the higher-ranking SWP. This is summarized in the comparative tableau (139): the comparison in (a) supports the ranking ranking FINALC >> MAXV; comparison (b) shows that where an SWP violation is at stake, the disyllabic requirement is violated, and finally the (e)~(f) comparison supports the argument for DISYLL >> FINALC.

(139) Apocope satisfies FINALC

		SWP	DISYLL	FINALC	MAXV
/nakasiʔi/	a. (nák)siʔ~(nák)si.ʔi			W	L
/novi/	b. ☞(nóv)~(no.ví)	W	L	W	L
/topaa/	c. ☞(to.páa)~(tóp)		W	L	L

<sup>67</sup> There are also phonotactic constraints that block apocope, such as the constraint against word-final *h* (witness *voohi*, *\*vooh* ‘bear’) and *\*COMPLEX* (witness *hupna*, *\*hupn* ‘pull out’).

### 3.5.3.3 Iterativity of syncope: WSP and FINALC

Apocope sets the direction for vowel deletion in SE Tepehuan (the relevant data are repeated in (140)).

(140) Apocope wins over syncope

- a. /hij# noo-novi/    hij#(ɲóo)nov ‘my hands’    \*hij#(ɲóon)vi  
 b. /ʃi#ʔomiji/        ʃi#(ʔo.mín) ‘break it!’    \*ʃi#(ʔóm)ni  
 c. /naa-na<sub>k</sub>asiʃi/    (naan)ka.siʃ ‘scorpions’    \*(naan)kas.ʃi

Although footing is not iterative in SE Tepehuan, vowel deletion is, and it has a pseudo-directional character. Directionality in this case has two sources: the first is PARSE-σ, the second is FINALC.

In the case of /LLL/ words, the choice of deletion site is straightforward: the deletion of the third vowel creates a larger LH foot with no unparsed syllables, while the deletion of the second vowel makes an H foot with an unfooted syllable following it. Since SWP is satisfied by both candidates, the choice is handed down to PARSE-σ, which selects the larger foot (141). Recall that this option was not available in Hopi, where the equivalent of (b) is the winner. This difference arises because PARSE-σ and NONFINALITY(σ) are ranked in the opposite ways in Hopi and SE Tepehuan.

(141) Final stress tolerated for exhaustive footing

/ʃi#ʔomiji/	SWP	PARSE-σ	NONFINALITY(σ)
a. <sup>1</sup> ʃi#(ʔo.mín)	✓		*
b. ʃi#(ʔóm)ni	✓	*!	

NONFINALITY(σ) is never crucially active in SE Tepehuan—it is dominated by FINALC (142), since apocope routinely creates words with final stress (a~b). FINALC

must also dominate WSP, because vowel deletion creates words with unstressed CVC syllables (c~d). In this too SE Tepehuan is the opposite of Hopi: there syncope was non-iterative because unstressed heavies were avoided.

(142) Apocope creates violations of WSP and NONFINALITY( $\sigma$ )

		FINALC	WSP	NONFINALITY( $\sigma$ )
/ʃi#ʔomiji/	a. $\text{ʃi}\#(\text{ʔo.mín})$			*
	b. $\text{ʃi}\#(\text{ʔóm})\text{ni}$	*!		
/hij# noo-novi/	c. $\text{hij}\#(\text{nóo})\text{nov}$		*(nov)	
	d. $\text{hij}\#(\text{nóon})\text{vi}$	*!		

Kager ranks WSP below PARSE- $\sigma$ , as well. Consider /tu# maa-matufidzaʔ/, where violations of FINALC or SWP are not an issue. Here syncope applies twice, creating the only output that has only two unfooted syllables (143). The alternatives invariably fail on PARSE- $\sigma$ , although some (b,d) perform better than the winner on WSP.

(143) Iterative syncope creates maximally footed candidate

/tu# maa-matufidzaʔ/	PARSE- $\sigma$	MAXV	WSP
a. $\text{tu}\#(\text{máam})\text{tu}\text{f}\text{.d}\text{z}\text{a}\text{ʔ}$	**	**	**
b. $\text{tu}\#(\text{máa})\text{ma}\text{.tu}\text{.f}\text{i}\text{.d}\text{z}\text{a}\text{ʔ}$	***!*		*
c. $\text{tu}\#(\text{máa})\text{mat}\text{.f}\text{i}\text{.d}\text{z}\text{a}\text{ʔ}$	***!	*	**
d. $\text{tu}\#(\text{máam})\text{tu}\text{.f}\text{i}\text{.d}\text{z}\text{a}\text{ʔ}$	***!	*	*

Note that WSP is not completely inactive in SE Tepehuan: there is a process of vowel shortening that affects unstressed long vowels /taa-takaaruiʔ/ → (táat).ka.ruiʔ ‘chickens,’ so WSP must dominate MAX- $\mu$ . This fact supports Kager’s claim that footing is non-iterative and suggests that a covert footing analysis (Hall 2001) is probably not the right analysis.



### 3.5.4 Summary of the analysis of Southeastern Tepehuan

Syncope is iterative in SE Tepehuan because exhaustivity of footing overrides WSP, not because footing is iterative (cf. Tonkawa). This brings up a more general implication of the present approach to rhythmic vowel deletion: iterative syncope need not correlate with iterative footing. Moreover, directionality of footing does not cement the options for syncope—other constraints can interfere. In Hopi, WSP prevents syncope from applying outside the main stress foot. In SE Tepehuan, the relative ranking of WSP and PARSE- $\sigma$  is reversed and the pattern becomes iterative. In Tonkawa, the source of iterative syncope is iterative footing. We see consequences of these differences in the surface stress patterns: Hopi and SE Tepehuan lack secondary stress while Tonkawa has plenty.

Kager's results are summarized in the comparative tableau (144). The first group of comparisons shows why syncope and apocope must occur—the faithful *(naká)síŋi* violates both FINALC and SWP, while *(nakás)ŋi* and *(naká)síŋ* violate one of the two. The last loser, *(nák)síŋi*, is harmonically bounded by *(nakás)ŋi*: *(nakás)ŋi* could be a winner in Hopi but *(nák)síŋi* incurs a superset of its violations and could never win in an iambic language. The result is, generally, that given a choice between HLL and LHL, iambic languages should go for the latter—the distribution of weight is ideal in LHL because it maximizes the number of footed syllables while minimizing the number and weight of unfooted syllables. If other constraints intervene (e.g., FINALC), then HH may beat LHL, but HLL never can.

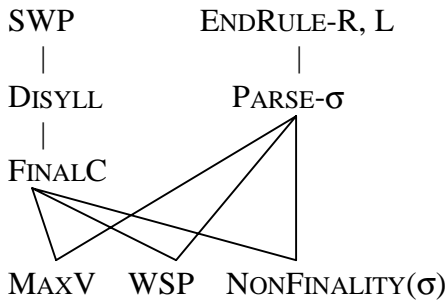
The next two comparisons, (e) and (f), demonstrate the role of PARSE- $\sigma$  and FINALC in SE Tepehuan. The only thing preventing PARSE- $\sigma$  from wiping out all the unfooted syllables is \*COMPLEX, undominated in this language (not shown). Finally the last two comparisons show the workings of apocope in shorter words, demonstrating the violable preference for disyllabic prosodic words.

(144) SE Tepehuan apocope and syncope

/nakasiŋi/	PARSE $\sigma$	SWP	DI $\sigma$	FINALC	MAXV	NONFIN	WSP
a. (nák)siŋi~(naká)siŋi	W	W		W	L		L
b. (nák)siŋi~(naká)siŋ		W			L		
d. (nák)siŋi~(nakás)ŋi				W	L		L
c. (nák)siŋi~(nák)siŋi	W			W	L		L
/ŋi#ʔomiji/							
e. ŋi#(ʔomíŋ)~ŋi#(ʔóm)ŋi	W			W		L	
/tu# maa-matufidzaʔ/							
f. tu# (máam)tuŋ.dzaʔ~ tu# (máam)tu.ŋi.dzaʔ	W				L		L
/novi/							
g. (nóv)~(noví)		W	L	W	L		
/topaa/							
h. (topáa)~(tóp)			W	L	L		

Some of Kager's crucial rankings are summarized below. The reader is referred to Kager's work for a more complete picture—he also analyzes vowel shortening and reduplication shapes, which are too complex to discuss here.

(145) Rankings for SE Tepehuan



To summarize, Kager’s analysis accounts for a variety of economy effects in SE Tepehuan using the same core constraints that are active in Hopi and Tonkawa. The very presence of constraints like WSP, SWP, MAXV, PARSE- $\sigma$ , FINALC and NONFINALITY( $\sigma$ ) in CON predicts the existence of this syncope pattern. These constraints are by no means parochial—all were originally proposed to deal with processes other than syncope and vowel shortening.

**3.5.5 An Economy analysis of Southeastern Tepehuan**

Since SE Tepehuan is the opposite of Hopi when it comes to deletion outside the main stress foot, it looks like there may be a glimmer of hope for the economy principle analysis: deletion really does appear to apply wherever it is possible to reduce the number of syllables. In *tu# (maam)tu.f.dʒaʔ*, the number of syllables is reduced from five in the underlying */tu# maa-matufidʒaʔ/* to three:

(146) \*STRUC favors syncope

<i>/tu# maa-matufidʒaʔ/</i>	*COMPLEX	*STRUC( $\sigma$ )	MAXV
a. $\text{tu# maam.tu.f.dʒaʔ}$		***	**
b. <i>tu# maa.ma.tu.f.i.dʒaʔ</i>		****!*	
c. <i>tu# maamtʃ.dʒaʔ</i>	*!	**	***

However, Kager is justified in his claim that vowels are not simply deleted for the sake of reducing the number of syllables—this pattern really reduces the number of *unfooted* syllables. In the following example, deletion fails to apply, although it could reduce the number of syllables in the word from two to one.

(147) No deletion after light syllables

- a. /takaaruiʔ/      (ta.káa)ruiʔ    ‘chicken’      \*tak.ruiʔ  
 b. /va-voohi/      (vapóo)hi      ‘bears’      \*vavhi  
 c. /va-vajnum/      (vapái)num    ‘metals’      \*vavnum

These forms cannot be explained away by appealing to MAX-LONG-V: recall that long vowels do delete after heavy syllables in forms like /gaa-gaagaʔ/ (gáaʔŋ).gaʔ ‘he will look around for it’ (SE Tepehuan is unlike both Hopi and Tonkawa in this respect). Deletion does not apply after light syllables because it is gratuitous: the (LH) foot is already perfect; reduction to (H) serves no purpose and incurs additional violations of MAXV. Candidates with such deletion are locally harmonically bounded:

(148) Syllable reduction candidate harmonically bounded

/va-voohi/	SWP	PARSE-σ	MAXV
a. $\text{[va]}\text{[v]}\text{[p]}\text{[o]}\text{[o]}\text{[h]}\text{[i]}\text{[ʔ]}$	✓	*	
b. (váv)hi	✓	*	*!

\*STRUC(σ) cannot replicate this result: wherever deletion can apply, it should do so, whether it’s inside or outside the foot.

(149) Wrong prediction: deletion inside the foot

/va-voohi/	*STRUC(σ)	MAXV
a. $\text{[va]}\text{[v]}\text{[p]}\text{[o]}\text{[o]}\text{[h]}\text{[i]}\text{[ʔ]}$	***!	
b. $\text{[va]}\text{[v]}\text{[p]}\text{[o]}\text{[o]}\text{[h]}\text{[i]}\text{[ʔ]}$	**	*

This sort of pattern simply does not occur—there is no general preference between (H) and (LH) feet. In fact, if anything, (LH) feet may be preferred to (H) under some circumstances, e.g., if the prosodic word is required to be disyllabic. The preference never goes in the other direction—no language deletes a long vowel to opt for a (H) foot instead of a (LH) foot.

In order to avoid this outcome, \*STRUC( $\sigma$ ) would have to be ranked *below* MAXV, and the syncope pattern would have to be attributed to the interaction of metrical constraints with MAXV. But this move amounts to admitting that \*STRUC( $\sigma$ ) has nothing to do with syncope at all—which is what has been argued in this chapter.

One could argue that an economy principle analysis that is agnostic of prosodic constraints is unfairly oversimplified: of course other factors play a role in syllable economy; this has been known since the work of Kisseberth 1970b. Yet syllable economy not only fails to illuminate the patterns of vowel deletion in Hopi and Tonkawa—its very presence in UG predicts an unattested syncope pattern that is a mere variation on Southeastern Tepehuan.

### **3.6 Chapter summary**

This chapter has presented three case studies of rather different syncope and shortening patterns in Hopi, Tonkawa, and Southeastern Tepehuan. I argued that independently motivated prosodic constraints achieve a great deal of success in accounting for the structure-reducing processes in these languages. The differences between the three languages are systematic. Syncope is iterative in Tonkawa because footing is iterative. Syncope is non-iterative in Hopi because unstressed heavy syllables are marked, while in Southeastern Tepehuan the opposite is true—unstressed heavy

syllables are tolerated, so syncope is iterative. A simple re-ranking of the constraints WSP, SWP, PARSE- $\sigma$ , ENDRULE, and MAXV produces these different patterns of syncope and shortening:

(150) Syncope is non-iterative, cannot create unstressed heavy syllables (Hopi):  
WSP >> PARSE- $\sigma$  >> MAXV

(151) Syncope is iterative, can create unstressed heavy syllables (SE Tepehuan):  
PARSE- $\sigma$  >> MAXV, WSP

(152) Syncope applies after long vowels (Hopi & SE Tepehuan):  
ENDRULER, ENDRULE L >> PARSE- $\sigma$  >> MAXV

(153) Syncope does not apply after long vowels (Tonkawa):  
ENDRULE-R, PARSE- $\sigma$  >> MAXV, ENDRULE-L

Vowel deletion processes are not uniform because constraints in CON are not uniform. The only thing that is common to all vowel deletion processes is that some markedness constraint dominates MAXV.

In other languages, the same markedness constraint will be satisfied in another way. SWP is satisfied by syncope in the three languages described here, which happens to make words shorter. Yet it can also be satisfied by making words longer through augmenting the stressed syllable. The same is true for PARSE- $\sigma$ : in some languages, unfooted syllables are avoided through deletion, in others—through the addition of foot structure. Even in the same language, a single constraint can have both an economy effect and an anti-economy effect: in Hopi, WSP is satisfied by vowel shortening, but it also blocks unfooted syllable syncope. No constraint has only economy effects because no constraint is an economy constraint in the Lenient theory of CON. Economy effects are side effect, not a goal.