PHONOLOGICAL ANALYSIS

Cumulativity and ganging in the tonology of Awa suffixes

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This article revives old descriptive data on Awa, a Papuan language of the Kainantu group. The tonal system was described in detail in a paper by Loving (1973), where he reports a series of toneless noun suffixes, falling into six classes depending on their tonal alternations when combined with a noun root. This article demonstrates that the suffixes are best understood as carrying lexical tone; the alternations in form arise from the interaction of typologically natural tonotactic constraints. While the system can be described in autosegmental terms without much difficulty, a formal constraint-based analysis is less straightforward. I show that strict ranking, as in optimality theory (Prince & Smolensky 2004 [1993]), fails to capture the data patterns due to cumulativity effects, some of which cannot be naturally captured even with local constraint conjunction (Smolensky 2006). The data are successfully modeled in harmonic grammar (Legendre et al. 1990).*

Keywords: tone, Papua New Guinea, harmonic grammar, constraint conjunction, ganging

1. INTRODUCTION. Awa (ISO 639-3: awb) is a Papuan language in the Kainantu group, spoken in the Eastern Highlands region of Papua New Guinea by about 2,000 people. It is a tonal language in which tone carries a fairly high functional load in both lexical and grammatical distinctions. This article revisits the tonology of noun suffixes, as described by Loving (1973). Loving treats most suffixes as underlyingly toneless and divides them into six classes depending on the observed tonal alternations when suffixed onto noun roots. Here I reanalyze the suffixes as indeed having underlying tone, arguing that this view greatly simplifies the analysis while at the same time abiding by common constraints on tone motivated by typological data.

The analysis brings up two main theoretical points of interest. First, Awa avoids HLH sequences, a common avoidance crosslinguistically due to the large amount of pitch excursion required in a short period of time. However, despite this constraint being ostensibly related to the time pressure for realizing tonal targets, its formulation in Awa is sensitive to particular phonological configurations. Specifically, the sequence HLH is avoided only when the two H tones are separated by a single L association line, as in H.LH, HL.H, or H.L.H (where the period indicates a syllable boundary)—HL.LH is acceptable. This suggests that the avoidance configuration is defined either by autosegmental principles (two association lines, as suggested above) or in terms of syllabic affiliation[1] (an L tone between two Hs must be associated with two syllables). It would seem that a purely phonetic formulation, sensitive to duration for all tonal targets, would favor an entire L-toned syllable between two Hs rather than two halves of contour tones. Though all of these configurations are avoided, the ban on H.LH is absolute; the creation of this sequence from suffixation always yields tone deletion, while HL.H or H.L.H sequences are sometimes tolerated.

Second, as the title indicates, the analysis of Awa relies crucially on constraint ganging. This means that no strict ranking of constraints, as in OPTIMALITY THEORY (OT; Prince & Smolensky 2004 [1993]), can be found to derive the data patterns. LOCAL

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[1] Thank you to Stephanie Shih for raising this possibility.

CONSTRAINT CONJUNCTION (Smolensky 1993, Moreton & Smolensky 2002, Smolensky 2006) likewise fails to capture the data, since some of the required cumulativity effects are not strictly local or require the conjunction of multiple low-ranked constraints. In this article, I couch the analysis in HARMONIC GRAMMAR (Legendre et al. 1990, Smolensky & Legendre 2006), using weighted constraints to capture effects of counting and ganging-up cumulativity (Jäger & Rosenbach 2006).

A final aim of this article is to bring descriptive data from fifty years ago back into the spotlight by applying current analytic techniques. Many beautiful data sets lie buried in the pages of old grammars, and the generalizations in these data may help shed light on current questions of theory and typology. It is my hope that the preliminary analysis provided here can serve as a starting point for future work on Awa, particularly since data from Papuan languages have received relatively little attention in the development of theories of tone.

The article is structured as follows: I first lay out the crucial background information on Awa tone (§2), and then reanalyze Loving's suffix classes as having lexical tone, with all one- and two-tone melodies represented on both mono- and disyllabic suffixes (§3). For each melody, I demonstrate the effects of Awa tonology and show how alternations differ depending on the length of the suffix. In §4, I define the constraint set for the analysis and discuss problems for OT and local constraint conjunction. The complete analysis of the data in harmonic grammar is provided in §5, showing how the model accounts for cases of cumulativity, and §6 concludes.

2. Awa tone.

2.1. TONAL INVENTORY. Awa is described as having four tones, high (H), falling (HL), rising (LH), and low (L). Though Loving lists these as equal tonemes, I show in this analysis that HL and LH are best seen as the combination of L and H rather than as tonal primitives in their own right. The tonal primitives are linked to syllables, and each syllable can carry up to two tones. Examples of the tonemic contrast include the following.[2]

(1) náh 'breast'
nàh 'house'
nâh 'taro'
pǎh 'fish'

2.2. TONOTACTICS. Given these four tonal possibilities for syllables, there are sixteen possible combinations on disyllabic words. Table 1 illustrates the logically possible combinations of tones on disyllabic words (syllable 1 along the left, syllable 2 along the top), giving examples of attested combinations.[3]

[2] In this article, I use the standard orthography developed for Awa with all tones marked. The orthography deviates from the IPA in the following ways: <q> stands for glottal stop, <ah> stands for [ɔ], and <eh> stands for [æ]. High tone is indicated with an acute accent / ´/, low tone with grave / `/, falling with a circumflex / ˆ/, and rising with a hacek / ˇ/. Abbreviations used here are: CONJ: conjunctive, DU: dual, DUB: dubitative, IDENT: identificational, NSP: nonspecific, PERS: personal, PL: plural, PRED: predicative, Q: question marker, SG: singular, SP: specific, TRI: trial.

[3] In Table 1 and throughout the rest of the analysis, I restrict myself to data presented in Loving 1973, where the author specifically focuses on tone and lays out his tonal analysis of the language. More data could be gathered from the Awa dictionary (Loving & Loving 1975), but there are discrepancies between the tone transcriptions there and in Loving 1973, including troubling tone patterns (e.g. internal rising tones) that Loving insists do not occur in Awa. Future work on Awa tone is required to reconcile the two data sources and to confirm the systematicity of the gaps shown in Table 1.

	H	L	HL	LH
H	tátí 'dew'	áhtè 'fear'	—	tápǎh 'beetle name'
L	àhqkí 'yam'	àhtè 'woman'	màhgô 'man's name'	àhtě 'ear'
HL	—	âhqmè 'frog name'	nâhpô 'is it a taro?'	nâhmǐq 'it is a taro'
LH	—	—	—	—

Table 1. Disyllabic tone combinations.

As this table shows, all combinations of level tones are attested (H.H, L.L, H.L, L.H). Tonotactic restrictions come into play with contour tones.

First, rising tones are permitted only in word-final position (the bottom row, with LH in syllable 1, is unpopulated). In fact, this tonotactic restriction against nonfinal rises is so strong that even word-final rising tones are simplified in phrase-medial position. When a rising tone finds itself in the middle of a phrase, the H portion delinks from its original syllable. If an L-initial word follows, the H relinks to that syllable, creating a falling tone; otherwise, the H is merged with the following H tone.[4]

(2) Rise simplification across word boundaries

a. pěh tàhnú → pèh tâhnú

L H   L H   L   H L H

'just' 'flea'   'just a flea'

b. pěh nâh → pèh nâh

L H_1 H_2 L   L $H_{1,2}$ L

'just' 'taro'   'just taro'

In other words, rising tones are only allowed phrase-finally.

The other two unattested patterns on disyllabic words are H.HL and HL.H. Loving notes that both of these patterns are possible on the last two syllables of trisyllabic words, citing the examples in 3.

(3) a. wènáwêh 'his sister's husband'
b. áwêhwáh 'sister's husband'

Nevertheless, these two words are clearly morphologically related, suggesting that they are complex forms rather than roots. Though the exact morphological composition is not given, descriptions of the possessive system elsewhere (McKaughan & Loving 1973:32–34) suggest the following structure.

(4) a. wèná-wêh
3sg.sp-sister.in.law
'his sister-in-law'

b. á-wêh-wáh
3sg.nsp-sister.in.law-older.brother
'someone's sister-in-law (of their older brother)'

In the available data, the sequences H.HL and HL.H are never found on Awa roots, though we may find such sequences in compound nouns and other higher-level combi-

[4] Or, as Loving analyzes it, the H is deleted. As we will see below, H-tone deletion is heavily penalized in Awa, making a hypothesis of coalescence more compatible with the broader tonology.

nations; as the remainder of this article shows, these sequences are avoided in root-suffix combinations as well.

Moving beyond tone-melody restrictions for disyllabic words, Loving makes a more general observation that he has seen no more than two falling tones in a row. In fact, it seems plausible that even two falling tones in a row is an anomaly, since the only example given that shows this sequence is bimorphemic *nâh-pô* 'is it a taro?' (literally 'taro-Q'), a form we return to at various points here.

The fact is that we simply do not have enough data to determine stem tonotactics with any certainty. Nonetheless, the observations given by Loving are typologically natural.

(i) Falling tones can occur in any position in the word, but rising tones are restricted to the last syllable.
(ii) Falling tones after H tones are dispreferred.
(iii) Sequences of falling tones are dispreferred.

Regarding the first generalization, we can capture the lack of nonfinal rising tones with a constraint *NonFinalRise (*NFR); see 26 below for a formal definition (§4.1). Zhang (2004), among others, has found that crosslinguistically there is an implicational hierarchy wherein if a language has word-medial rising tones, it must also have rising tones on final syllables, but not vice versa. He argues that this is due to the fact that contour-tone distribution is sensitive to phonetic duration, and that final syllables tend to be longer than word-medial syllables. The fact that falling tones, but not rising tones, can occur word-medially is due to the fact that, phonetically speaking, falling tones require less duration than rising tones. Thus, the distribution of Awa's contour tones is phonetically and typologically natural.

Generalization 2 is reminiscent of patterns of 'regressive tonal absorption' (Hyman 2007a), which occurs when a contour tone is preceded by a like tone (H.HL → H.L, L.LH → L.H). Though 'progressive tonal absorption' (HL.L → H.L, LH.H → L.H) is typologically more common (one of the original 'tone rules'; Hyman & Schuh 1974), bans on sequences like H.HL are attested elsewhere, such as Luba (Bantu, Democratic Republic of Congo) and Kuki-Thaadow (Tibeto-Burman, India and Burma). I capture this effect with neighborhood constraint *H.HL, formally defined in 28 below.

Finally, generalization 3 also makes reference to a crosslinguistically uncommon sequence. Many languages avoid the general tonal sequence HLH, which can be captured by a constraint like *HLH (Cahill 2007, Hyman 2010; cf. Yip 2002 *Trough). A sequence HL.HL requires wide pitch excursion in a short period of time, with four tonal targets shared between just two syllables, arguably even worse than a sequence like HL.H. As we will see for the suffixes, though, even tritone HL.H and H.LH sequences are penalized. One disyllabic combination, H.LH, is apparently attested (as shown in Table 1) but does not conform to this restriction; Loving does not provide any estimation of the frequency of tone patterns to say whether this is a rare occurrence, but based on the tonal behavior of suffixes outlined below, I suspect it may be.[5] As noted in the introduction, the avoidance of HLH sequences appears to adhere to autosegmental principles, since a sequence with two L association lines separating the H tones, as in HL.LH, is allowed. The exact formulation for Awa is provided in 29.

[5] Given that it is the name of a beetle, it could possibly be a compound *tá-păh*, where *păh* means 'fish', but this is pure speculation. It is not clear whether the same tonotactic restrictions found within stems and affixed forms would hold in compounds.

The following sections show that the first tonotactic constraint is undominated, even with the addition of suffixes; the second tonotactic constraint is likewise never violated in the suffix data Loving gives. However, the grammar does allow occasional violations of the third constraint against HLH when alternative output candidates are less optimal or harmonic.

2.3. Floating tones: evidence from phrasal tonal allomorphs. Before turning to the main point of this article, Awa noun suffixes, I must briefly address the issue of what Loving calls 'tonally differentiated allomorphs' of nouns, which I argue provide evidence for word-final floating L tones. The system is basically replacive (Welmers 1973, McPherson 2014): certain modifiers trigger grammatically conditioned tonal melodies on following words that completely overwrite those words' lexical tone.[6] Loving divides modifiers into three classes. Class I words cause the following word to take an LH tonal melody, as in 5.

(5)	a.	kàwèq	'good'	+	nàh	'house'	→	kàwèq nǎh	'good house'
	b.	ànòqtâh	'big'	+	kàpàtà	'bird'	→	ànòqtâh kàpátá	'big bird'

All words that end in L (be it a level L or the L portion of HL) are part of class I, along with some rising- or H-final words, such as *wìěhq* 'yellow' or *wítpéh* 'laughing', though Loving does not provide examples of these with a following modified noun.

Class II words cause the following word to take an H melody, as in the examples in 6.

(6)	a.	kàpàntéh	'sick'	+	kàpàtà	'bird'	→	kàpàntéh kápátá	'sick bird'
	b.	pàpùsǎ	'black'	+	wéh	'man'	→	pàpùsà wéh	'black man'

The example in 6b displays phrase-medial rise simplification, following the tonotactic principles laid out in §2.2. Class II consists of both H- and rising-final words, but no L- or falling-final words. Finally, class III words do not cause any perturbation of the following words. This class is semantically different from the others, containing the words as *ítè* 'not', *mòqkě* 'all', *pěh* 'just', and possessives (all ending in the possessive suffix *-ně*).

When taken together with data from the suffixes, this phrasal allomorph pattern suggests that the initial L triggered by class I words arises from a floating L tone. This is particularly clear in the case of H-final class I words, where the following L tone could not be attributed to spreading from the stem. In the case of L-final words, all of which belong to class I, at least three options are available: (i) all L-final words are followed by a floating L tone; (ii) all final L tones are required to spread across a morpheme boundary; (iii) some L-final words are followed by a floating L, and others spread an L tone. Given the supposedly unified nature of L-final words in Loving's description, the third option seems untenable, and it is not clear that native speakers would posit such a distinction in the absence of evidence. Both of the remaining options have drawbacks. On the one hand, richness of the base (Prince & Smolensky 2004 [1993]) would predict underlying forms both with and without floating L tones, and if anything, floating L tones following L-final words might be reasonably ruled out by an obligatory contour principle (OCP) constraint against adjacent L tones. On the other hand, any rule or constraint requiring L to spread onto the following morpheme would be opaque, since de-

[6] The mechanism behind replacive tone is not entirely clear. Harry and Hyman (2014) argue for a two-step process of lexical-tone deletion followed by the insertion and association of a floating melody. McPherson 2014 argues for a constructional approach, where phrasal constructional schemas impose phonological requirements on constituent words. Other possibilities include listed allomorphs, which could be selected in something akin to Hayes's (1990) precompiled phrasal phonology, or the use of cophonologies to capture a dominant/recessive distinction in tonal behavior (Inkelas 1998). An analysis of Awa replacive tone is beyond the scope of this article, and I remain agnostic on the topic here.

rived final L tones (such as those left behind from rising-tone simplification) do not show this spread. Further, the existence of an L-spreading process in a language without an H-spreading process is typologically rare (Hyman 2007b).

In the following analysis, I pursue the first option and assume that all L-final nouns are followed in Awa by a floating L tone. These floating tones may be viewed as the phonologization of phonetic L carryover, which may have obscured an earlier distinction between plain L-final stems and L-final stems with a floating L. With this assumption in place, the analysis proceeds in a straightforward way without the need for opaque, typologically unnatural constraints enforcing spreading of underlying final L tones in derived environments.

In sum, by positing floating tones in Awa, the morphotonological effects of Loving's class I and II are unified: both condition a replacive {H} melody on the following noun, but this {H} overlay surfaces as {LH} after class I words due to the docking of the floating tone. In a longer phrase, the initial modifier imposes its overlay on all following words. All words after the initial modified word take H, which is natural if we assume that their whole tone pattern (including potential floating Ls) is overwritten with the grammatically controlled {H} and the floating tone docks only to the left edge of the whole domain, as in 7, for example.

(7) a. ítòqkě + sèhìǒ + pàtòsǎ + wèhùqkè
'no good' (I) 'foolish' (I) 'blind' (II) 'people' (II)
b. ítòqkè sèhíó pátósá wéhúqké
'bad, foolish, blind people'

We will see more evidence for this floating L from class I words in the next section.

3. Awa noun suffixes.

3.1. A specified reanalysis of loving's suffix classes. Noun stems can take a wide variety of suffixes, with meanings ranging from canonical categories like plural to adjective-like meanings such as 'elongated' (*-kaqta*) or 'similar' (*-tahnsa*). Loving makes an initial division between suffixes with underlying tone and suffixes without, with the latter split into six classes. I argue that the data strongly suggest underlying tone for all suffixes, which eliminates the need for dividing affixes into semantically arbitrary classes, each with idiosyncratic phonology.

First, Loving presents the suffixes he believes to have underlying tone based on the fact that they have only a single tonal allomorph. In this class, we find L-toned suffixes, both monosyllabic and disyllabic.

(8) a. tàhnú-è[7] 'a flea'
b. nàh-tàpà 'big house'

Based on the analysis here and Loving's discussion elsewhere of rising-tone simplification (see §2.2 above), we would expect final-rise simplification to create falling-tone allomorphs of these suffixes, but the examples in 8 are the only ones Loving gives, so we cannot be sure. I assume in this article that a tonotactic constraint strong enough to operate across word boundaries would find the same repair in this case.

All of the other suffixes to which Loving assigns tone are at least trisyllabic, with complex tone patterns. He gives three dubitative suffixes, illustrated in 9, though 9b and 9c are clearly built off of 9a.

[7] Loving describes *-è*, like *-tàpà*, as augmentative but does not have any correlate of this meaning in the gloss.

(9) a. -tàpîtǎ
b. -tàpîtàmô
c. -tàpîtàpómò

Loving gives no examples of these suffixes on a noun; for the sake of testing the model, I take his description at face value (i.e. that they always surface faithfully) and include a hypothetical example *òyétá-tàpîtǎ* ‘an egg?’ in the grammar. Even though these suffixes create violations of tonal constraints, particularly of *HLH, the tonal density of the suffixes is such that not much can be done to repair these violations, barring the deletion of one or more tones. As I show in the analysis below, these repairs are disfavored. The consequence is that high-density suffixes also have just a single tonal allomorph (with the probable exception of rising-tone simplification).

Next, Loving outlines six classes of supposedly toneless suffixes according to their tonal behavior. The criterion he uses to distinguish toneless suffixes from those with underlying tone appears to be the presence of multiple allomorphs, but as I show below, all of the allomorphs of the toneless classes follow straightforwardly from modifications of underlying tones to accommodate both tonotactic constraints and floating tones. Table 2 summarizes the behavior of monosyllabic suffixes (Loving’s classes 1–3), illustrating which allomorph is selected after each final tone. When the tonal behavior of the suffix is the same regardless of the presence of a floating tone (class I vs. class II nouns), Loving typically only provides an example for one configuration; in these cases, I have hypothesized an example based on his description.

	UR (LOVING’S TONAL CLASS)		
STEM ENDS IN	/H/ (CLASS 1)	/LH/ (CLASS 3)	/HL/ (CLASS 2)
…H	H póétáhq-mé ‘egg-IDENT’	H òyétá-táq ‘egg-on’	L póétáhq-pò ‘pig-Q’
…LH	H ànôwà-téh ‘mother-CONJ.PL’	H pàh-sáhq ‘fish-collecting’	HL ànôwà-sêq ‘mother-PERS.DU’
…H(L)	H (hypothesized ex.) *tàhnú-mé* ‘flea-IDENT’	L tàhnú-kà ‘flea-ACT’	L (hypothesized ex.) *tàhnú-pò* ‘flea-Q’
…LH(L)	H (hypothesized ex.) *ápòkèh-mé* ‘treetop-IDENT’	LH *ápòkèh-kǎ** ‘treetop-ACT’	HL (hypothesized ex.) *ápòkèh-pô* ‘treetop-Q’
…L(L)	LH àhtè-mǐq ‘woman-PRED’	LH àhtè-ně ‘woman-POSS’	HL àhtè-pô ‘woman-Q’
…HL(L)	LH àyàhtâ-mě ‘hair-IDENT’	LH nâh-săhq ‘taro-collecting’	HL nâh-pô ‘taro-Q’

TABLE 2. Underlying (UR) tones and tonal allomorphs for monosyllabic suffixes.

All of the stems ending in LH undergo rise simplification in the presence of a suffix. In isolation, ‘fish’ would be pronounced as *pǎh* but as *pàh* when suffixed. As we can see in this table, the contrast between /H/ and /LH/ suffixes (classes 1 and 3, respectively) is neutralized in all cases except when following class I nouns with final H or rising tone. /H/ and /HL/ suffixes (classes 1 and 2) are always distinct, and /LH/ and /HL/ suffixes are distinct except when following H-final class I nouns (with a floating L). The example *ápòkèh-kǎ* 'treetop-actor' is starred, since elsewhere Loving gives the citation form of 'treetop' with a final rise (*ápòkěh*) but in giving this example, he presented its citation form with final L. Regardless, the rising tone would simplify to L with the addition of the suffix.

Table 3 summarizes the behavior of disyllabic suffixes (Loving's classes 4–6).

	UR (LOVING'S TONAL CLASS)		
STEM ENDS IN	/H.H/ (CLASS 4)	/L.H/ (CLASS 5)	/H.L/ (CLASS 6)
…H	H.H òyétá-táté 'egg-DU'	L.LH (hypothesized ex.) *òyétá-tàhnsǎ* 'egg-similar'	H.L (hypothesized ex.) *póétáhq-pómò* 'pig-DUB'
…LH	H.H pàh-mátí 'fish-PL'	HL.LH pàh-tâhnsǎ 'fish-similar'	H.L pàh-póqpòq 'fish-DUB.CONJ'
…H(L)	L.LH tàhnú-tàtě 'flea-DU'	L.LH tàhnú-tàhnsǎ 'flea-similar'	H.L tàhnú-pómò 'flea-DUB'
…LH(L)	HL.LH ápòkèh-kâqkǎq 'treetop-CONJ'	HL.LH (hypothesized ex.) *ápòkèh-tâhnsǎ* 'treetop-similar'	H.L (hypothesized ex.) *ápòkèh-pómò* 'treetop-DUB'
…L(L)	L.H kàpàtà-tàtó 'bird-TRI'	L.H nàh-tàhnsá 'house-similar'	L.HL nàh-pòqpôq 'house-DUB.CONJ'
…HL(L)	L.H *nâh-màtí** 'taro-PL'	L.H (hypothesized ex.) *nâh-tàhnsá* 'house-similar'	L.HL nâh-pòqpôq 'taro-DUB.CONJ'

TABLE 3. Underlying tones and tonal allomorphs for disyllabic suffixes.

As with monosyllabic suffixes, the distinction between /H.H/ and /L.H/ is often neutralized, but in the case of disyllabic suffixes, they are distinct following class II H- and rising-final nouns. /H.L/ is always distinct. The example *nâh-màtí* 'taro-PL' is starred, since Loving writes the result of concatenating *nâh* 'taro' and the suffix as *nàh-màtí*, which I suspect to be a typo, since he does not describe a rule modifying HL to L on stems, and this form would mean 'many houses'.

Taken together with Loving's specified suffixes, all combinations of tonal melodies are attested on mono- and disyllabic suffixes. Table 4 summarizes these results and notes either Loving's suffix class or *sp* for 'specified'.

	MONOSYLLABIC	DISYLLABIC
L	✓ (sp)	✓ (sp)
H	✓ (1)	✓ (4)
LH	✓ (3)	✓ (5)
HL	✓ (2)	✓ (6)

TABLE 4. Inventory of tonal melodies on suffixes.

In the following subsections, I address each tonal melody in turn, showing how the allomorphs illustrated in Tables 2 and 3 result from competing tonotactic pressures. This discussion sets the stage for the constraint-based analysis, and forward cross-references to the constraint set in §4.1 are provided where relevant.

3.2. L-TONED SUFFIXES. Given the tonal phonology of Awa, it is no surprise that L-toned suffixes have no allomorphs, leading Loving to recognize their underlying L tone. The main avoided sequences are HLH and nonfinal rising tones. Since roots are already optimized to avoid the penalized HLH sequences (described in §2.2), there is no way that the addition of an L-toned suffix could create such a sequence. The only possible tonal modification to be made would be shifting the H portion of a root-final rising tone onto the suffix, a process I assume would take place but that Loving does not illustrate.

In terms of floating tones, I assume that floating L tones are merged with the L of the suffix in violation of UNIFORMITY (McCarthy & Prince 1995; see definition in 35) rather than associating two identical tones to the same suffix (in violation of *TWIN (cf. twin sister convention; Clements & Keyser 1983); see definition in 32). The autosegmental derivation is represented in 10.

(10) L-toned suffixes after stems

```
a. tahnu   -e    →   tahnu -e        'big flea'
   |  |     |        |  |   |
   L  H L1 L2        L  H   L1,2
b. nah -tapa     →   nah -tapa       'big house'
    |   |/            |    |/
    L L1 L2           L    L1,2
```

The floating tones have no audible effect.

3.3. H-TONED SUFFIXES. In contrast to L-toned suffixes, the addition of an H-toned suffix can create illicit tonal sequences, and the repairs are illuminating for understanding the tonology of Awa. First, after H-final stems with no floating tones, the underlying form of the suffix is allowed to surface. Even if the H is part of a final rise, it can simply delink and merge with the H of the suffix in violation of UNIFORMITY. These outcomes are illustrated in 11 with mono- and disyllabic suffixes.

(11) H-toned suffixes after H-final nouns (no floating tone)

```
a. poetahq  -me          [póétáhqmé]   'the pig'
    |//      |
    H        H
b. oyeta  -tate          [òyétátáté]   'eggs (dual)'
   | |/    |/
   L H     H
c. anowa  -teh    →   anowa  -teh    [ànôwàtéh]   'his mother and others'
   | |\/|   |         | |\/    |
   L HLH1  H2         L H L    H1,2
d. pah  -mati     →   pah  -mati     [pàhmátí]    'fish (plural)'
   /\    |/            |     |/
   L H1  H2            L     H1,2
```

Following L-final stems with a floating L tone, the floating L docks to the suffix, creating a rising tone on monosyllabic suffixes and L.H on disyllabic suffixes. This latter result requires delinking the suffixal H from the first syllable of the suffix (in violation of MAX(ASSOCIATION); see §4.1) in order to avoid creating a nonfinal rising tone (*NFR; see 26).

(12) H-toned suffixes after L-final nouns

```
a. ahte -miq      →   ahte  -miq        [àhtèmǐq]     'it is a woman'
   |/     |           |/     /\
   L  L   H           L      L H
b. kapata  -mati  →   kapata  -mati     [kàpàtàmàtí]  'many birds'
    |//      |/        |//     | |
    L  L     H         L       L H
```

These outcomes hold true of both level L-final nouns, like those in 12, and falling-final nouns where the resulting sequences HL.LH (as in *àyàtâ-mě* 'the hair') and HL.L.H (as in *nâh-màtí* 'many taros') obey the constraint *HLH due to the presence of two L association lines separating the H tones (see 29 for a formal definition of *HLH).

When a floating L follows an H-toned stem, we find different results for monosyllabic and disyllabic suffixes. Following monosyllabic suffixes, the floating L tone is deleted, neutralizing the contrast between stems with a floating L and stems without. This is due to the fact that linking the floating L to the suffix, as in 12, would create a violation of *HLH and also a violation of the more specific and more powerful *H.LH (see 30). In Awa, we never find cases where the floating L links leftward to the stem (which could introduce a second association line and repair the *HLH violation), suggesting that a constraint NoTautomorphemicDocking (Wolf 2007; see 33 below) is powerful in the grammar. Thus, it is better to delete the floating L (Max(L)) than to create a *HLH/*H.LH violation or leave the L tone floating (*Float; see 31). With disyllabic H-toned suffixes, however, the floating L can link to both syllables, pushing the underlying H to the right edge. This allows the floating tone to be realized without creating a banned HLH sequence. Both results are shown in 13.

(13) H-toned suffixes after H-final nouns with floating L

```
a. tahnu   -me     →    tahnu  -me    [tàhnúmé]     'the flea'
   |   |    |           |   |    |
   L   H  L H           L   H    H
b. tahnu   -tate   →    tahnu  -tate  [tàhnútàtě]   'fleas (dual)'
   |   |    |/          |   |   |/|
   L   H  L H           L   H   LH
```

The same basic results are found for rising-final roots with a floating L: with monosyllabic suffixes, the floating L is deleted and the delinked H from the rising tone merges with the H of the suffix; with disyllabic suffixes, the floating L links to both syllables, creating L.LH, and the H links to the first syllable, yielding the ultimate result HL.LH.

(14) H-toned suffixes after rising-final nouns with floating L

```
a. apokeh   -me       →  apokeh  -me       [ápòkèhmé]       'it is a tree top'
   | |/|      |          | |/      |
   H L H1   L H2         H L       H1,2
b. apokeh  -kaqkaq    →  apokeh  -kaqkaq   [ápòkèhkâqkǎq]   'and a tree top'
   | |/|    |/           | |/     /\/\
   H L H   L H           H L     H  L  H
```

In summary, H-toned suffixes demonstrate that the floating L will link to the suffix provided no violation of *HLH is created. For disyllabic suffixes, this results in spreading the floating L to both syllables, while for monosyllabic suffixes, there is insufficient space, so the floating tone is deleted. The tonal allomorphs and environments are summarized in 25.

(15)

Monosyllabic	H	after all H-final nouns
	LH	after L-final nouns
Disyllabic	H.H	after H-final nouns with no floating L
	L.H	after L-final nouns
	L.LH	after H-final nouns with floating L
	HL.LH	after rising-final nouns with floating L

3.4. LH-toned suffixes. Underlying LH-toned suffixes share many of the allomorphs of H-toned suffixes. For example, following L-final stems with floating Ls, the two classes of suffixes are neutralized on the surface, both to LH (or L.H for disyllabic suffixes). Compare the examples in 16 with those in 12 above.

(16) LH-toned suffixes after L-final nouns

a. ahte -ne → ahte -ne [àhtèně] 'the woman's'
L L_1 L_2 H → L $L_{1,2}$ H

b. nah -tahnsa → nah -tahnsa [nàhtàhnsá] 'like a house'
L L_1 L_2 H → L $L_{1,2}$ H

The difference is that here, the floating L merges with underlying L of the suffix in violation of UNIFORMITY. In the case of the disyllabic suffix, an alternative to merging the tone would be to push the suffixal L over to the final syllable, creating an L.LH sequence on the suffix. However, Awa tends to avoid the creation of a rising tone unless it resolves a strong tonotactic constraint, such as an HLH violation, as seen in 13 and 14. I account for this effect with a constraint *RISE (formalized below in 27), which is necessarily weak since rising tones are attested both underlyingly and in derived forms.

Disyllabic LH-toned suffixes likewise mirror the behavior of their H-toned counterparts after H- and rising-final roots: here, a rising tone is created (L.LH after H-final roots and as HL.LH after rising-final roots), which resolves a potential HLH sequence. These melodies are found regardless of the presence of a floating L (which could either merge with L of the suffix or, as shown below, push the suffixal L over one syllable).

(17) LH-toned disyllabic suffixes after H-final nouns with floating L

a. tahnu -tahnsa → tahnu -tahnsa [tàhnútàhnsǎ] 'like a flea'
L H L_1 L_2 H → L H $L_{1,2}$ H

b. apokeh -tahnsa → apokeh -tahnsa [ápòkèhtâhnsǎ] 'like a tree top'
H L H L_1 L_2 H → H L H $L_{1,2}$ H

After H-final nouns with no floating tones, monosyllabic LH suffixes once again look identical on the surface to H-toned suffixes with the allomorph H, since retaining the L on the suffix would violate *HLH as well as *H.LH. When the suffix is disyllabic, however, there is enough room to spread the L to the second syllable, thus introducing two L association lines between the H tones.

(18) LH-toned suffixes after H-final nouns (with no floating L)

a. oyeta -taq → oyeta -taq [òyététáq] 'on the egg'
L H L H → L H H

b. oyeta -tahnsa → oyeta -tahnsa [òyétátàhnsǎ] 'like an egg'
L H L H → L H L H

As we can see, the amount of syllabic space available in the suffix along with the specific HLH sequence (H.LH vs. H.L.H) determines whether *HLH will be satisfied by tone deletion (18a) or spreading (18b).

The trickiest surface forms involving LH suffixes are found with monosyllabic suffixes after H-final words with a floating L tone. As after H-final nouns, H.LH sequences are created, but in order to resolve them in the same way, both the floating L as well as the L of the suffix would need to be deleted. Instead, we find that Awa trades the deletion of two Ls for the deletion of a single H, resulting in an L allomorph after level H-final nouns.

(19) LH-toned monosyllabic suffixes after H-final nouns with floating L

tahnu -ka → tahnu -ka [tàhnúkà] 'the flea did it'

L H L_1 L_2H → L H $L_{1,2}$

This is a case of COUNTING CUMULATIVITY (Jäger & Rosenbach 2006): L deletion is generally preferable to H deletion in Awa, as we have already seen above, but the deletion of two L tones is worse than deleting a single H. I return to this point in §4 below, where I compare the abilities of various frameworks to account for such effects.[8]

Here again, both monosyllabic and disyllabic LH-toned suffixes undergo modifications to avoid HLH sequences and to resolve nonfinal rising tones. If there is adequate space, as on disyllabic suffixes, all tones will be preserved, though the L of the suffix may spread or shift to the following syllable. On monosyllabic suffixes, a single L will delete if it resolves an H.LH sequence, but if two Ls would need to be deleted, an H will delete instead. These results are summarized in 20.

(20)	Monosyllabic	LH	after L-final nouns
		H	after H-final nouns without floating L
		L	after H-final nouns with floating L
	Disyllabic	L.H	after L-final nouns
		L.LH	after all H-final nouns
		HL.LH	after all rising-final nouns

3.5. HL-TONED SUFFIXES. Finally, HL-toned suffixes follow the same general patterns seen above, but when taken together with the LH-toned suffixes in the last subsection, they help motivate the presence of both general *HLH as well as specific *H.LH in the constraint set. I return to this point shortly.

Disyllabic suffixes are straightforward: floating L tones dock to the first syllable, pushing the H to the second syllable to avoid a nonfinal rise (21a), unless the L would create an HLH sequence. In this case, it is deleted (21b).

(21) Disyllabic HL-toned suffixes after floating L

a. nah -poqpoq → nah -poqpoq [nàhpòqpôq] 'and a house?'

L L H L → L L HL

b. tahnu -pomo → tahnu -pomo [tàhnúpómò] 'a flea?'

L HLH L → L H H L

Following H-final nouns with no floating L, the suffix surfaces faithfully, and following rising-final nouns, the H of the rise merges with the suffixal H.

Monosyllabic suffixes are unsurprisingly more complicated, given the smaller number of tone-bearing units (TBUs) to work with. After level L-final nouns (which carry a floating L), we find deletion of the floating tone, which is unable to link to the suffix (given Awa's firm limit of two tones per TBU). After a rising-final noun, the H of the rise merges with the suffixal H.

[8] Loving does not give an example of an LH monosyllabic suffix after a rising-final noun with a floating L, but the grammar predicts a similar single H-tone deletion (in this case, the H of the rise) rather than the deletion of two L tones.

(22) Monosyllabic HL-toned suffixes after L- and rising-final nouns

a. ahte -po → ahte -po [àhtèpô] 'is it a woman?'
|/ /\ → |/ /\
L L H L → L H L

b. anowa -seq → anowa -seq [ànôwàsêq] 'and his mother'
| |\/| /\ → | |\| /\
L HLH$_1$ H$_2$ L → L H L H$_{1,2}$L

If an H-final noun carries a floating L, it is similarly deleted, but here, we find the effects of the tonotactic constraint *H.HL (formalized in 28 below). Rather than delete the H tone of the suffix, it undergoes literal tonal absorption and merges with the H of the stem, the only case we find of leftward tonal movement in Awa (which violates Anchor-L; see 34 below). This result is shown in 23 both with and without a floating tone.[9]

(23) Monosyllabic HL-toned suffixes after H-final nouns

a. tahnu -po → tahnu -po [tàhnúpò] 'is it a flea?'
| | /\ → | | |
L H$_1$ L H$_2$ L → L H$_{1,2}$ L

b. poetahq -po → poetahq -po [póétáhqpò] 'is it a pig?'
\|/ /\ → \|/ |
H$_1$ H$_2$ L → H$_{1,2}$ L

After an HL-final noun, we find the one case in Awa where an HLH sequence is tolerated: the floating L is deleted, but both falling tones are retained.

(24) Monosyllabic HL-toned suffix after falling-final noun

nah -po [nâhpô] 'is it a taro?'
/\ /\
H L ~~L~~ H L

The question here is: why is this HLH sequence retained with only deletion of the floating L, whereas the one in 19 is resolved by deleting an H tone? Upon closer inspection, the two situations differ in one regard: the example in 19 would involve the HLH sequence H.LH, whereas the HLH sequence in 24 is HL.H(L); in other words, the former is an HLH sequence with a rising tone, and the latter is not. This looks to be a case of ganging between *HLH and the weaker constraint *Rise, but in fact, simple cumulativity between these two constraints cannot capture the Awa data patterns since the violations of the two constraints must be local in order to be heavily penalized, as in local constraint conjunction (Smolensky 1993, 2006, Baković 2000, Itô & Mester 2003). For this reason, I include a specific markedness constraint *H.LH in addition to *HLH, with violations of the former able to motivate tone deletion, while violations of the latter can only motivate shifting or spreading of tones. Since the tonal density is very high in the case of 24, no tonal movement is possible and hence the HL.HL sequence is retained. See §4.3 and §5 below for further discussion and illustrative tableaux.

The allomorphs of HL-toned suffixes are summarized in 25.

(25)	Monosyllabic	HL	after L-toned nouns
		L	after all H-toned nouns
	Disyllabic	H.L	after all H-toned nouns
		L.HL	after L-toned nouns

3.6. Local summary. We have seen that all one- and two-tone melodies are attested in Awa on both mono- and disyllabic suffixes. Alternations are driven by the need to

[9] I assume the floating tone is deleted rather than merged with the suffixal L, since that would violate an otherwise unviolated Linearity constraint.

dock a floating tone and by tonotactic constraints: avoidance of nonfinal rise, H.HL, and HLH sequences, wherein H.LH is worse than HL.H.

There is likewise a logic to the repairs: floating tones cannot dock to the root, leftward spreading of tones is avoided, and tones will merge if they can rather than deleting; if tones must be deleted, it is better to delete L than H (though deleting two Ls is worse than deleting a single H). Finally, rising tones are not created unless they are necessary to avoid violating a tonotactic constraint.

While each of these generalizations is straightforward and typologically natural on its own, the ways in which they interact to produce the surface forms in Awa are quite complex. In the next section, I show that constraint ranking, as in OT, fails to account for the data patterns, even when allowing for local constraint conjunction. The data are successfully modeled in harmonic grammar, which employs weighted rather than ranked constraints, provided the specific constraint *H.LH is included in the constraint set; simple cumulativity of *HLH and *Rise cannot capture the data.

4. Model comparison. This section lays out issues in the evaluation metric for Awa. I first discuss the basic elements required in the constraint set, then turn to questions of how the relative strengths of constraints should be encoded (ranking, weighting, and the permissibility of constraint conjunction).

4.1. Constraint set. The last two sections of the article have informally introduced many of the constraints needed for the analysis of Awa tonology. In this section, I formally define all of the constraints before turning to models of constraint interaction.

Following standard OT procedure, we can divide Awa's constraints into markedness and faithfulness constraints. All of the tonotactic constraints that motivate tonal alternations in the suffixes are markedness constraints. First, we saw the undominated constraint *NonFinalRise (*NFR).

(26) *NonFinalRise: Assign a violation for every rising tone in phrase-medial position.

This constraint is formulated for the phrase level, since Loving reports decontouring of rising tones before a following word in the same phrase, but it follows that words in isolation would constitute their own phrase for the purposes of this constraint, and thus any nonfinal rising tone would be penalized. This constraint is a more specific version of the constraint *Rise, which penalizes any rising tone in any position.

(27) *Rise: Assign a violation for every rising tone.

Though not powerful on its own, *Rise is important for its interactions with *HLH below. Both constraints fall into line with the findings of Zhang (2004), who argues that rising tones require the most effort and the longest time to articulate. This makes them most natural in final position, where syllables may be inherently longer due to final lengthening.

The other undominated tonotactic constraint is *H.HL, a constraint motivating tonal absorption (Hyman & Schuh 1974, Hyman 2007a).

(28) *H.HL: Assign a violation for every H tone immediately followed by a falling tone.

I assume this constraint would apply equally to two separate H autosegments, one on the H-toned syllable and one as part of the HL contour, as well as to a single H autosegment linked to both TBUs; the pitch contour being avoided is an H-to-L transition that does not occur at the syllable boundary after an H-toned syllable. We have no evidence of this constraint or any others besides *NFR being operative at the phrase level, and thus I assume it is word-bounded.

The markedness constraint *HLH is responsible for many of the suffixal alternations. As stated in §2.2, a constraint like *HLH has been proposed elsewhere in the literature (Cahill 2007, Hyman 2010, and earlier as *Trough in Yip 2002), but the formulation of the constraint in Awa is unique in that it penalizes specifically a configuration with just a single L association line separating the two H tones.

(29) *HLH: Assign a violation for every sequence HLH in which only a single L association line separates the two H tones.

This constraint penalizes the specific surface sequences H.LH, HL.H, and H.L.H. In addition to this general *HLH constraint, the data motivate a more specific *H.LH constraint penalizing HLH sequences involving a rising tone.

(30) *H.LH: Assign a violation for every sequence H.LH.

This constraint could be viewed as the local conjunction of *HLH and *Rise, an option I return to in §4.3 below. Alternatively, we could see this constraint as related to *H.HL: Awa disprefers H tones followed by contour tones. Violations of *H.LH are a subset of the violations of general *HLH.

The last two markedness constraints relate to floating tones, either directly or indirectly. First, the markedness constraint *Float penalizes floating tones in the output.

(31) *Float: Assign a violation for every unassociated tone in the output.

This constraint is unviolated by winning candidates in Awa. Finally, floating tones cannot be associated to the same TBU as another L tone without merging, due to a constraint *Twin.

(32) *Twin: Assign a violation for every TBU associated to two identical tones.

This can be seen as related to the twin sister convention (Clements & Keyser 1983).

Transitioning to faithfulness constraints, we begin with a constraint that straddles the definition between markedness (purely determinable by surface form) and faithfulness (requiring identity between input and output). The constraint NoTautomorphemicDocking (NoTauMorDoc/NoTMD; Wolf 2007) captures the generalization that floating tones are not allowed to dock onto the morpheme that introduced them (in Awa, the root).

(33) NoTautomorphemicDocking: Assign a violation for every floating tone in the input linked in the output to the morpheme that introduced it.

This constraint is like markedness in that it evaluates a surface configuration but is like faithfulness in that it requires reference to both the input and the output.

The effect of NoTauMorDoc is similar to that of another faithfulness constraint, Anchor-L (Anch-L; McCarthy & Prince 1995, Myers 1997), which penalizes leftward tone spreading or shifting by requiring faithfulness to the left edge of a tonal domain.

(34) Anchor-L: For every tone in the input T whose leftmost association in the input is to a syllable S, assign a violation if the leftmost association in the output is to the left of S.

The only situation in which this constraint is violated in Awa involves an H tone merging with another H to its left in order to resolve an H.HL sequence.

Tone mergers of this sort violate the faithfulness constraint Uniformity (Unif; McCarthy & Prince 1995).

(35) Uniformity: Assign a violation for every tonal autosegment in the output that has two corresponding autosegments in the input.

This is not a very powerful constraint in Awa, as we find mergers of both H tones and L tones, particularly involving the association of floating tones or the H portion of an erstwhile final rise.

The rest of the faithfulness constraints are of the families Max and Dep: Max(L), which penalizes deletion of L autosegments, and corresponding Max(H) for H autosegments, along with Max(A), which penalizes the deletion of association lines present in the input but not the output, and Dep(A), which penalizes association lines present in the output but not the input.[10]

The interaction of these atomic constraints is able to capture the tonology of Awa suffixes.

4.2. Traditional optimality theory. In §3, I pointed out cases of cumulativity involved in the tonology of Awa suffixes, where multiple violations of weaker constraints combine to overpower a more powerful constraint. Jäger and Rosenbach (2006) identify two types of cumulativity, counting cumulativity and ganging-up cumulativity. In the former, two or more violations of a single weaker constraint overpower a single violation of a more powerful constraint. In the latter, violations of two or more weaker constraints conspire to overpower a single more powerful constraint. As I demonstrate below, both forms of cumulativity are problematic for traditional OT, by which I mean parallel, strict ranking OT.

In Awa, L deletion is preferable to H deletion in satisfying tonotactic constraints. We can see this in 18, where the HLH sequence that would be created by suffixation of an LH-toned suffix triggers the deletion of the L tone, even though deleting the H of the suffix would likewise satisfy the markedness constraint. This tells us that in Awa, Max(H) ≫ Max(L), shown in the following mini tableau.

(36) OT tableau for *òyétá-táq* 'on the egg'

oyeta -taq | / /\\ L H LH	*HLH	Max(H)	Max(L)
a. oyeta -taq | / /\\ L H L H	*!		
b. oyeta -taq | / | L H L		*!	
☞ c. oyeta -taq | / | L H H			*

The ranking of *HLH and Max(H) are indeterminate here. With strict ranking in OT, it would not matter how many times Max(L) is violated; so long as the higher-ranked *HLH or Max(H) is violated, candidate (c) will win.

[10] I make the assumption in this article that merging two tones in violation of Uniformity does not incur a violation of Dep(A), even when one of those merged tones is a floating tone that had no association underlyingly. I treat the association line as the link between a tonal target and a TBU, and in the case of merged tones, this link was already present underlyingly; merging the floating tone simply adds more material to the tonal target. A referee suggests an alternative view, in which the association lines are essentially association pairs (T, V). In a configuration (L_1) L_2 H, where L_1 is a floating tone, the input association (L_2, V_i), linking L_2 to a vowel V_i, is distinct from the output association ($L_{1,2}$, V_i), where $L_{1,2}$ represents the merger of the floating tone and the underlyingly associated tone. The debate could in principle be empirical: which approach better captures the data? The current case provides no way to distinguish the two; the final harmonic grammar model works just as well assuming that the merged tone does violate Dep(A) for associating to its new TBU. The weight of Uniformity simply goes down a little, since all Uniformity-violating candidates would likewise incur a violation of Dep(A).

This strict ranking cannot capture the counting cumulativity found in Awa, first seen in 19. In this case, we find the deletion of a single H tone to resolve an HLH sequence rather than the deletion of two L tones (assuming undominated *FLOAT). As the following mini tableau shows, however, traditional OT predicts the wrong result.

(37) OT tableau for *tàhnú-kà* 'the flea did it'

tahnu -ka L H L_1 L_2H	*HLH	MAX(H)	MAX(L)
a. tahnu -ka L H L_1 L_2H	*!		
☹ b. tahnu -ka L H $L_{1,2}$		*!	
☞ c. tahnu -ka L H H			**

Given strict ranking, there is no number of violations of MAX(L) that could overpower MAX(H).

Ganging-up cumulativity is also problematic for strict ranking for the same reason: if candidate X violates a higher-ranked constraint that candidate Y does not, it does not matter how many lower-ranked constraints candidate Y violates; candidate X has already been ruled out. In Awa, we see ganging-up effects in the form *nâh-pô* 'is it a taro?'. We saw above that *HLH outranks MAX(L), since L tones can be deleted to avoid an HLH sequence. We also know that MAX(L) must outrank the general markedness constraint *RISE, since we find roots and suffixes with rising tones (i.e. the L does not delete in this case to turn them into H tones). Nevertheless, this ranking of *HLH ≫ MAX(L) ≫ *RISE predicts the unattested output **nâh-pǒ*.

(38) OT tableau for *nâh-pô* 'is it a taro?'

nah -po H L L H L	*FLOAT	*HLH	MAX(L)	*RISE	DEP(A)	MAX(A)
a. nah -po H L L H L	*!	*				
☹ b. nah -po H L H L		*!	*			
☞ c. nah -po H L L H			*	*	*	*

The ranking of *HLH above MAX(L) (and all other weaker constraints) means that the grammar will rule out the actually attested surface form, candidate (b). In Awa, this form wins due to the combined penalties of MAX(L) and *RISE (in addition to DEP(A) and MAX(A), depending on the exact model); in other words, an L should not be deleted if it creates a rising tone.

We might argue that it is not *HLH that motivates tone deletion in 36 and 37, but rather the more specific *H.LH; the ranking *H.LH ≫ MAX(L) ≫ *HLH could then account for the lack of deletion in 38. However, in other forms, like *tàhnú-pómò* 'a flea?', it is better to delete the floating L of the stem than to create an H.L.H sequence.

(39) OT tableau for *tàhnú-pómò* 'a flea?'

tahnu -pomo L H L H L	*HLH	Max(H)	Max(L)
☞ a. tahnu -pomo L H H L			*
b. tahnu -pomo L H L H L	*!		
c. tahnu -pomo L L H L		*!	

The last case of ganging-up cumulativity is more complex, in that it involves multiple low-ranked constraints ganging up against a higher-ranked constraint. The form in question is one of Loving's complex specified suffixes after an H-final noun, *òyétá-tàpîtǎ* 'an egg?'. The attested surface candidate is fully faithful but violates *HLH. Given that *HLH dominates Max(L), and Max(L) dominates low-ranked Uniformity (as well as faithfulness constraints on association lines), the expected winner is **òyétá-tàpìtá*. The following tableau illustrates this problematic case.

(40) OT tableau for *òyétá-tàpîtǎ* 'an egg?'

oyeta -tapita L H LH_1LH_2	*HLH	Max(L)	Dep(A)	Max(A)	Unif
☹ a. oyeta -tapita L H LH_1LH_2	*!				
☞ b. oyeta -tapita L H L $H_{1,2}$		*	*	***	*

Even though candidate (a) incurs only a single violation of any constraint while candidate (b) incurs six, it still loses since *HLH outranks the other constraints in the tableau.

4.3. Local conjunction. The standard method for capturing cumulativity in OT is local conjunction (LC; Smolensky 1993, Baković 2000, Moreton & Smolensky 2002, Itô & Mester 2003, Smolensky 2006), wherein two constraints can combine into a single conjoined constraint that is violated if and only if both atomic constraints are violated. The locality condition on conjunction states that both atomic constraints must be violated in the same domain δ (segment, morpheme, etc.).

The cumulativity effects in Awa can be accounted for using conjoined constraints with varying degrees of success. First, the counting cumulativity seen in 37 above can be captured using self-conjunction (Itô & Mester 1998) of Max(L).

(41) $[\text{Max}(L)^2]_\omega$: Assign a violation if two (or more) L tones are deleted within the domain of the word.

The crucial ranking here would be $[\text{Max}(L)^2]_\omega \gg$ Max(H) $\gg$ Max(L), capturing the fact that deleting a single H is worse than a single L but better than deleting two Ls. One potentially problematic aspect of this constraint is its broad domain: not a syllable (the

TBU in Awa), not even a morpheme, but the word as a whole, since the crucial cases involve the deletion of a floating L tone in addition to the L of a suffix.

The ganging-up cumulativity case in 38 can also be accounted for using local conjunction, this time in the narrow domain of the syllable. The constraints involved are Max(L) and *Rise, and their local conjunction ($[\text{Max(L)\&*Rise}]_\sigma$) captures the idea that an L tone should not be deleted from a TBU if a rising tone is created in its place.[11] With the ranking $[\text{Max(L)\&*Rise}]_\sigma$ ≫ *HLH ≫ Max(L), we are able to rule out the unattested surface form in 38; *HLH can still outrank Max(L), since the deletion of multiple L tones to alleviate the HLH sequence would violate the self-conjoined constraint $[\text{Max(L)}^2]_\omega$. However, Moreton and Smolensky (2002) argue that this type of conjunction, that is, of markedness with Max, is impossible and unattested, since the domain of Max necessarily includes the input and the domain of markedness is only the surface. If we take this to be true, then local conjunction would fail to account for the cumulativity effects in this case.

As discussed in §2.2, HLH sequences are generally dispreferred in Awa, but the specific sequence H.LH is always avoided, even if it means deleting an H tone as in 37. Section 4.1 introduced a specific markedness constraint *H.LH penalizing this sequence (which is also penalized by more general *HLH), but this constraint could easily be viewed as the local conjunction of *Rise and *HLH: an HLH sequence involving a rising tone. If this conjunction *HLH&*Rise outranked Max(H), it could motivate H-tone deletion in a form like *tàhnú-kà* ‘the flea did it’, while the general *HLH would not, as illustrated in the following tableaux.

(42) a. OT-LC tableau for *tàhnú-kà* ‘the flea did it’

tahnu -ka L H L_1 L_2H	*HLH& *Rise	Max(H)	Max(L)	*HLH
a. tahnu -ka L H L_1 L_2H	*!			*
b. tahnu -ka L H $L_{1,2}$		*!		
☞ c. tahnu -ka L H H			**	

b. OT-LC tableau for *nâh-pô* ‘is it a taro?’

nah -po H L L H L	Max(L) &*Rise	*HLH& *Rise	Max(H)	Max(L)	*HLH
☞ a. nah -po H L H L				*	*
b. nah -po H L L H	*!			*	*
c. nah -po H L $L_{1,2}$			*!		

[11] The creation of the rising tone requires the addition of an association line from another L tone, which would also violate Dep(A) for that TBU; it is not clear whether it poses a substantial conceptual problem for local conjunction to omit this step from the conjoined constraint.

The domain of this conjunction must be strictly local, coextensive with the HLH sequence and not the entire word, since winning candidate *òyétá-tàpîtǎ* 'an egg?' would independently violate *HLH and *Rise but does not contain an H.LH sequence. I discuss this point further in the next subsection.

While local conjunction appears to provide a solution to many of the cumulativity issues in Awa (albeit with a dubious conjunction of markedness and Max), the last case discussed above surrounding 40, *òyétá-tàpîtǎ* 'an egg?', remains troublesome due to the fact that the ganging involves multiple lower-ranked constraints; local conjunction, as standardly practiced, involves two. I tested all possible two-way conjunctions in OT Help (Staubs et al. 2010) with no success. No ranking could be found that would choose the attested surface form as the winner. Although there is nothing in the architecture of local conjunction precluding the conjunction of multiple constraints, allowing it would further undermine the restrictiveness of the theory and open the door for many more unnatural conjunctions of unrelated constraints.

In sum, the inclusion of conjoined constraints brings us closer to modeling Awa tonology, but here too issues arise, both in obeying locality conditions on conjunction and in the need for conjoined constraints with more than two conjuncts.

4.4. Harmonic grammar. In harmonic grammar (HG; Legendre et al. 1990, Smolensky & Legendre 2006), most of these cumulativity effects discussed so far come for free given the use of constraint weighting rather than ranking. Constraints are assigned real number weights; the more powerful the constraint, the larger the weight. For every candidate, the number of violations of a constraint is translated into a negative integer, which is multiplied by the constraint's weight. These numbers are summed across the constraint set, and the resulting number is known as a candidate's harmony (*H*); the candidate with the greatest harmony (i.e. closest to 0) wins. Given this evaluation metric, it is clear that both counting and ganging-up cumulativity can be accounted for without recourse to constraint conjunction (Potts et al. 2010, Pater 2016). These outcomes are schematized in 43.

(43) a.

/input/	C_1 3	C_2 2	*H*
a. candidate1	−1	0	−3
☞ b. candidate2	0	−1	−2

b.

/input/	C_1 3	C_2 2	*H*
☞ a. candidate1	−1	0	−3
b. candidate2	0	−2	−4

c.

/input/	C_1 3	C_2 2	C_3 2	*H*
☞ a. candidate1	−1	0	0	−3
b. candidate2	0	−1	−1	−4

The tableau in 43a recreates the effects of OT ranking by assigning C_1 a larger weight than that of C_2. The result is that candidate1, which violates C_1, has a harmony of −3, worse than the harmony of −2 of candidate2, which violates C_2. In 43b, however, we see that two violations of C_2 results in -2×2 (the weight of C_2), which overpowers the stronger constraint C_1. Similarly, in 43c, candidate2's single violations of two weaker constraints sum up to a harmony worse than that of candidate1, which violates only the stronger constraint.

To model the Awa data and derive the full set of constraint weights, tableaux indicating violations and winners were fed into OT Help (Staubs et al. 2010). Interestingly, despite the ease with which HG handles cumulativity, the algorithm failed to find a solution without the inclusion of the specific constraint *H.LH. In other words, basic cumulativity of *HLH and *Rise failed to capture the data patterns. Reviewing the predicted winners for all tableaux by hand showed that the issue arose for the forms *nâh-pô* (see 38) and *òyétá-tàpîtă* (see 40), particularly given the behavior of *tàhnú-kà* (see 37). These are the only two forms in the language to retain HLH sequences rather than to delete a tone, either H or L. In order for *tàhnú-kà* to prefer a single H deletion to either an HLH sequence or the deletion of two L tones, the grammar assigned the following constraint weights to the pertinent constraints.

(44) Max(H) 25
*HLH 18
Max(L) 17
*Rise 9

We can explore some key predictions of these constraint weights, both correct and incorrect, in a comparative tableau.

(45) Comparative tableau for problematic cases in HG

weights		25	18	17	9	7
input	winner ~ loser	Max(H)	*HLH	Max(L)	*Rise	Anch-L
oyeta -taq L H LH	oyeta -taq ~ oyeta -taq L H H L H L	W		L		
tahnu -ka L H L_1 L_2H	tahnu -ka ~ tahnu -ka L H $L_{1,2}$ L H H	L		W (× 2)		
idem	tahnu -ka ~ tahnu -ka L H $L_{1,2}$ L H $L_{1,2}$H	L	W		W	
nah -po H L L_1 H L_2	nah -po ~ nah -po H L H L_2 H L $L_{1,2}$	W	L	L		
idem	nah -po ~ nah -po H L H L_2 H L L_1 H		L		W	
oyeta -tapita L H LH LH	oyeta -tapita ~ oyeta -tapita L H LH LH L H LH LH		L			W

For each input, I compare the attested winner (i.e. the actual surface form) and one losing candidate. Under each constraint is a W if that constraint favors the winner (by being violated by the loser) and an L if that constraint favors the loser (by being violated by the winner); if both candidates violate the constraint equally, the penalties cancel each other out and nothing is marked. We know that the model is predicting the correct winner if the sum of the constraint weights marked W is greater than the sum of the constraint weights marked L.

First, for *òyétá-táq* 'on the egg', we see a W under Max(H), since this constraint favors the winning candidate, and an L under Max(L), since this constraint favors the losing candidate; the correct winner is predicted, since the sum of W violations is 25 and the sum of L violations is 17. These weights capture the effects of counting cumulativity, as shown for the first winner ~ loser pair for *tàhnú-kà* 'the flea did it'. Here Max(H) favors the loser and Max(L) favors the winner, but since there are two violations of Max(L), this results in a sum of 34 for the W violations, outweighing the 25 of Max(H). Given the weight of *HLH alone, we might predict that it would be better to keep the HLH sequence (merging the underlying floating tone with the suffix to avoid a violation of *Float); this candidate is contrasted with winning *tàhnú-kà* in the next row of the tableau. As we can see, this HLH sequence involves a rising tone, and thus violates both *HLH and *Rise, for a sum of 27, once again outweighing the more powerful constraint Max(H)—a case of ganging-up cumulativity.

The problem is that these weights predict the unattested form *nâh-pò* as the output form for the underlying form in 38, with the floating L merged into the L of the suffix after the deletion of the suffixal H. This is due to the fact that the actual attested surface form must delete its floating L (since tautomorphemic docking is banned), resulting in the combined penalty of *HLH and Max(L) for a summed weight of 35, a larger weight than that of Max(H). A second output candidate was a close contender, namely *nâh-pǒ*, in which the suffixal L was deleted and the floating tone linked in its place. In this case, rather than violating *HLH and Max(L) like the attested winner, the candidate violates *Rise and Max(L); the two violations of Max(L) cancel each other out, leaving the remaining loser-preferring constraint *HLH with a larger weight than the winner-preferring *Rise.

The other problematic case is *òyétá-tàpîtǎ*, where the grammar predicts instead an output candidate in which the L of the suffix spreads leftward onto the stem in violation of Anchor-L, which does not have a large weight in the current grammar (being, as it is, violated in forms with tonal absorption to avoid H.HL sequences). Here, we get a hint at the issue: the cumulativity ruling out the attested winner is *HLH and *Rise, precisely the cumulativity purported to be responsible for the differing behavior of H deletion in *tàhnú-kà* vs. *nâh-pô*. In reality, though, the kind of cumulativity we want for *HLH and *Rise is local: in the case of *tàhnú-kà*, the cumulativity arises from the configuration H.LH, whereas in *òyétá-tàpîtǎ*, the HLH sequence is H.L.H and the rising tone is two TBUs away.[12]

This result is somewhat surprising, given Pater's (2016) assertion that locality conditions on cumulativity like those proposed by Łubowicz (2005) emerge naturally from the HG framework. In the case of Awa tonotactic constraints, this is not the case. Two solutions, at least, are available here. The first, and the one employed in the analysis here, is to simply propose the specific constraint *H.LH, parallel in format to *H.HL and standing in a stringency relation with *HLH. This constraint penalizes the configuration targeted by the local conjunction of *HLH and *Rise without explicitly making

[12] One might wonder whether the problems in the model could be solved by relativizing Anchor-L for L and H tones, since the motivation for the former spreading left would be to introduce another association line and alleviate HLH, and the motivation for the latter would be to resolve an H.HL sequence. I tried such a model, which did indeed account for *òyétá-tàpîtǎ*, but the problems with *nâh-pô* remained. I believe this is due to the fact that in order for the cumulativity of *HLH and *Rise to be powerful enough to motivate tone deletion in, for example, *tàhnú-kà*, *HLH has to have a fairly large weight independently, since *Rise cannot be given too much weight. This combination of a larger weight for *HLH and a small weight for *Rise predicts *nâh-pǒ* as the winner.

reference to either constraint. The other possibility is to allow the inclusion of conjoined constraints in a weighted constraint model. In fact, this has been proposed by Green and Davis (2014) and Shih (2016) to account for cases of so-called 'superadditivity', where the penalty incurred by violating two constraints is greater than the sum of their cumulative penalties. As Shih (2016) argues, this is analogous to interaction terms in a statistical model, where weighted constraints are the parameters. In the case of Awa, constraint conjunction would account for locality rather than superadditivity. In practical terms, *H.LH and *HLH&*Rise function entirely the same: for every sequence H.LH, *H.LH or *HLH&*Rise will be violated in addition to *HLH and *Rise. The choice between the two approaches is ultimately a theoretical one: if we include conjoined constraints in HG, is the payoff in explanatory power worth the loss of restrictiveness in the model? I leave this as an open question and adopt *H.LH here, acknowledging that the model behaves identically either way.

5. Analysis.

5.1. Constraints and weights. The tonological grammar of Awa consists of the following constraints and weights, listed in descending order from most to least powerful.

(46)

Max(H)	24
NoTauMorDoc	22
Float	15
*H.HL	15
Max(L)	14
*H.LH	13
*Twin	9
HLH	9
Anchor-L	9
*NFR	6
*Rise	5
Dep(A)	3
Uniformity	3
Max(A)	2

We can infer some of the patterns and cumulativity effects discussed in the preceding sections by looking at the constraint weights alone. First, it is clear that H deletion is more heavily penalized than L deletion (Max(H)'s weight of 24 > Max(L)'s weight of 14), but the deletion of two L tones violates Max(L) twice and hence can outweigh Max(H). Second, *HLH on its own cannot motivate tone deletion, since its weight of 9 is less than the weight of both Max(H) and Max(L). Regular cumulativity between *HLH and *Rise creates a combined weight of 14, equal to Max(L), but provided the deleted L tone is linked (i.e. not floating) in the input, then the additional weight of Max(A) leaves tone deletion a more penalized outcome than retaining the HLH sequence. With the addition of the specific constraint *H.LH into the model, however, H.LH sequences will receive a minimum penalty of 27 (13 + 9 + 5), which gives them the strength to overpower even the most powerful constraint Max(H).

5.2. Illustrative tableaux. This section illustrates how the final HG analysis is able to capture the data patterns, focusing on the cases presented in the comparative tableau in 45. The full set of tableaux is available in the online supplemental materials.[13]

[13] The online supplements can be accessed at http://muse.jhu.edu/journals/language/v092/92.1.mcpherson01.html.

The first tableau is for the form *òyétá-táq* 'on the egg', in which an L is deleted from the monosyllabic LH suffix to resolve an H.LH sequence. Here and elsewhere, constraints that are unviolated by the constructions in question are omitted in the interest of space.

(47) HG tableau for *òyétá-táq* 'on the egg'

WEIGHTS	24	14	13	9	9	5	3	2	
INPUT: oyeta -taq | |/ /\\ L H L H	MAX(H)	MAX(L)	*H.LH	*HLH	ANCH-L	*RISE	DEP(A)	MAX(A)	*H*
☞ a. oyeta -taq | |/ | L H H	0	−1	0	0	0	0	0	−1	−16
b. oyeta -taq | |/\\/\\ L H L H	0	0	0	0	−1	−1	−1	0	−17
c. oyeta -taq | |/ | L H L	−1	0	0	0	0	0	0	−1	−26
d. oyeta -taq | |/ /\\ L H L H	0	0	−1	−1	0	−1	0	0	−27

The winning candidate (a) has a harmony of −16, from a combination of penalties from MAX(L) and MAX(A). This shows that the simple cumulativity of *HLH and *RISE could not motivate the deletion, since their combined weight is only 14. The specific constraint *H.LH contributes its weight of 13, ruling out faithful form (d). Candidate (b) preserves all of the underlying tones, but spreading the suffixal L leftward to alleviate the H.LH sequence incurs violations of ANCHOR-L (−9) and Dep(A) (−3) while still retaining a rising tone not found in candidate (a) (−5). Finally, in candidate (c) we see that H-tone deletion is not motivated in this form due to the large weight of MAX(H). These results are easy enough to capture even in OT, as tableau 36 showed.

Next, we consider *tàhnú-kà* 'the flea did it', discussed in 19, 37, and 45. This form involves a monosyllabic /LH/ suffix after an H-final noun with a floating L tone. The following tableau illustrates the cumulativity effects that allow an H tone to be deleted, despite MAX(H)'s large weight.

(48) HG tableau for *tàhnú-kà* 'the flea did it'

WEIGHTS	24	22	15	14	13	9	9	9	5	3	3	2	
INPUT: tahnu ka | | /\\ L H L L H	MAX(H)	NOTMD	*FLOAT	MAX(L)	*H.LH	*HLH	*TWIN	ANCH-L	*RISE	DEP(A)	UNIF	MAX(A)	*H*
☞ a. tahnu ka | | | L H $L_{1,2}$	−1	0	0	0	0	0	0	0	0	0	−1	−1	−29
b. tahnu ka | /\\ /\\ L H L L H	0	−1	0	0	0	0	0	0	−1	−1	0	0	−30
c. tahnu ka | | /\\ L H $L_{1,2}$ H	0	0	0	0	−1	−1	0	0	−1	0	−1	0	−30

(Tableau continues)

(Tableau continued)

WEIGHTS	24	22	15	14	13	9	9	9	5	3	3	2	
INPUT: tahnu ka L HL LH	MAX(H)	NOTMD	*FLOAT	MAX(L)	*H.LH	*HLH	*TWIN	ANCH-L	*RISE	DEP(A)	UNIF	MAX(A)	*H*
d. tahnu ka L H H	0	0	0	−2	0	0	0	0	0	0	0	−1	−30
e. tahnu ka L HLH	0	0	0	−1	0	0	0	−1	−1	−1	0	0	−31
f. tahnu ka L HLL	−1	0	0	0	0	0	−1	0	0	−1	0	−1	−38
g. tahnu ka L HLLH	0	0	−1	0	−1	−1	0	0	−1	0	0	0	−42

Winning candidate (a) incurs a violation of MAX(H), the most powerful constraint in the constraint set, which blocked H deletion in the last tableau; the fact that H deletion is possible here is due to the cumulative effects of weaker constraints for all other candidates. Candidate (b), for instance, is ruled out by −22 from the tautomorphemic docking of the floating tone in addition to −5 from the presence of a rising tone. Candidates (c) and (g) show the effects of *H.LH along with *HLH and *RISE: no tones are deleted, but the combined weights of *HLH, *RISE, and *H.LH give these forms a lower harmony score than the winning candidate with H deletion. Candidate (d) displays the effects of counting cumulativity, with two violations of MAX(L) outweighing the winning candidate's violation of MAX(H). Candidate (e) is ruled out from the combined weights of MAX(L), ANCHOR-L (from the suffixal L spreading leftward onto the stem), and *RISE, while candidate (f) shares much of its violations profile with the winning candidate (a) but does not merge the two L tones, thus violating *TWIN.

When an HLH sequence does not involve a rising tone, it can be retained, as shown in the following tableau for *nâh-pô* 'is it a taro?'. This example likewise shows the other possible circumstances for tone deletion in Awa, namely high tonal density and the heavy penalty assigned for tautomorphemic docking.

(49) HG tableau for *nâh-pô* 'is it a taro?'

WEIGHTS	24	22	15	14	9	5	3	3	2	
INPUT: nah po H L_1 L_2 H L_3	MAX(H)	NOTMD	*FLOAT	MAX(L)	*HLH	*RISE	DEP(A)	UNIF	MAX(A)	*H*
☞ a. nah po H L_1 H L_3	0	0	0	−1	−1	0	0	0	0	−23
b. nah po H L_1 L_2 H L_3	0	0	−1	0	−1	0	0	0	0	−24
c. nah po H L_1 L_2 H	0	0	0	−1	0	−1	−1	0	−1	−24

(Tableau continues)

(Tableau continued)

WEIGHTS	24	22	15	14	9	5	3	3	2	
INPUT: nah po; H L_1 L_2 H L_3	MAX(H)	NOTMD	*FLOAT	MAX(L)	*HLH	*RISE	DEP(A)	UNIF	MAX(A)	*H*
d. nah po; H L_1 $L_{2,3}$	−1	0	0	0	0	0	0	−1	−1	−29
e. nah po; H $L_{1,2}$ H L_3	0	−1	0	0	−1	0	0	−1	0	−34
f. nah po; L_1 H L_3	−1	0	0	−1	0	0	0	0	−1	−40

As we can see, there is no way, given five tones and two TBUs, to realize all of the tones without either leaving an L floating in violation of *FLOAT (candidate b) or merging the floating L with the L of the stem in violation of NOTAUMORDOC (candidate e); both of these constraints carry a larger weight than MAX(L), so deleting the floating L as in winning candidate (a) is preferable. Candidate (c) likewise deletes an L tone, but this time the L of the suffix, which allows the floating tone to dock. While this alleviates the violation of *HLH, the cumulative penalties of *RISE, DEP(A), and MAX(A) outweigh this violation. The deletion of an H tone, as in candidates (d) and (f), automatically incurs a larger penalty than the overall penalty of the winning candidate.

Finally, the form *òyétá-tàpîtǎ* 'an egg?' is similar to the last form in its high tonal density and retention of an HLH sequence, but this form also demonstrates the fact that basic cumulativity of *HLH and *RISE cannot motivate tone deletion: only the local constraint *H.LH can do so, as in 47 and 48. The following is a partial tableau for the form (most penalized candidates are omitted in the interest of space).

(50) HG tableau for *òyétá-tàpîtǎ* 'an egg?'

WEIGHTS	24	14	9	9	5	3	3	2	
INPUT: oyeta -tapita; L H L H_1 L H_2	MAX(H)	MAX(L)	*HLH	ANCH-L	*RISE	DEP(A)	UNIF	MAX(A)	*H*
☞ a. oyeta -tapita; L H L H_1 L H_2	0	0	−1	0	−1	0	0	0	−14
b. oyeta -tapita; L H L H_1 L H_2	0	0	0	−1	−1	−1	0	0	−17
c. oyeta -tapita; L H L $H_{1,2}$	0	−1	0	0	0	−1	−1	−3	−26
d. oyeta -tapita; L H L H_1 H_2	0	−1	−1	0	0	0	0	−2	−27
e. oyeta -tapita; L H L L H_2	−1	0	0	0	−1	0	0	−1	−31

The winning candidate preserves the underlying HLH sequence, though crucially the configuration is H.L.H and not the extra-penalized H.LH. Any attempt to alleviate this sequence is suboptimal. Candidate (b) alleviates the HLH sequence by spreading the L of the suffix leftward onto the stem, but this violates ANCHOR-L and also crucially DEP(A); ANCHOR-L and *HLH have the same weight, and so it is the small weight of DEP(A) here that acts as the tie breaker. Candidate (c) alleviates HLH by deleting a suffixal L and merging the two remaining H tones. As we can see from the weights, the basic cumulativity of *HLH and *RISE (14) equals the weight of MAX(L), making all further constraint violations of candidate (c) (UNIFORMITY, MAX(A), etc.) fatal. Candidate (d) likewise deletes an L but also fails to alleviate HLH. Finally, candidate (e) is ruled out because of its deletion of an H tone, which cannot be motivated by the pattern of violations for this form.

For the full version of this tableau plus tableaux for all other forms presented in this article, see the online supplemental materials.

6. CONCLUSION. This article has offered a reanalysis of the Awa tone facts first described in Loving 1973. First, I have shown that the distinction between class I and class II nouns can be reduced to tonal structure: class I nouns carry a floating L, while class II nouns do not. Second, I have shown that the six supposedly toneless classes of noun suffixes actually carry underlying tone; the classes simply represent differences in underlying tone and syllable count (i.e. monosyllabic H suffixes, class 1, pattern differently from disyllabic H suffixes, class 4). The varying surface forms of each 'suffix class' are the result of tonal adjustments to satisfy the tonotactic demands of the language. The suffixes Loving identified as carrying underlying tone are those that either do not create tonotactic violations when added to a stem (i.e. the L-toned suffixes) or those with such high tonal density that no repair is more optimal.

One interesting result of this work is that Loving's meticulous documentation of the tone system leads directly to a specified analysis consistent with typologically natural tonal demands, a few of which are summarized in the following table.

(51)	TONOTACTIC	TYPOLOGICAL SUPPORT	CONSTRAINT(S)
	Tonal absorption	Hyman & Schuh 1974	*H.HL
	Restrictions on rising tones	Zhang 2004	*RISE *NONFINALRISE
	HLH ban	Cahill 2007	*HLH
	Ban on surface floating tone	Myers 2007	*FLOAT
	No tautomorphemic docking	Wolf 2007	NOTAUMORDOC
	Rightward spreading	Hyman & Schuh 1974	ANCHOR-L
	No identical tones on same TBU	Clements & Keyser 1983	*TWIN

Nevertheless, some aspects of the analysis are specific to Awa. Perhaps most important is the exact definition of *HLH. Though the original formulation of this constraint refers to any sequence of the three tones, Awa appears to be sensitive either to the AUTOSEGMENTAL distance between the two H tones, or to the syllabic affiliation of the L tone: a configuration with a single L association line separating the two H tones is penalized, but two L association lines are acceptable, placing the L tone on two syllables. Surprisingly, this means that an H.L.H sequence is ruled out but an HL.LH sequence is allowed, despite the fact that the former most likely allots more milliseconds to the L-toned portion.[14]

[14] This is an empirical question that could be tested in Awa and other languages to see whether there is phonetic grounding for the autosegmental tonotactics.

This article has also demonstrated that while the constraint set required to account for Awa tonology is relatively natural from a typological standpoint, the constraint interactions that give rise to the surface patterns are far from simple. Traditional optimality theory with strict ranking will not work, due to the necessity of cumulativity and ganging in constraint evaluation. OT with local conjunction gets closer, but certain necessary conjunctions are not strictly local or require the conjunction of multiple low-ranked constraints. Even harmonic grammar, whose use of weighted constraints captures most cases of cumulativity with no difficulty, fails to automatically capture the intuitive local cumulativity of *HLH and *Rise. The addition of the specific local constraint *H.LH (which could equally be seen as the local conjunction of *HLH&*Rise) results in a model capable of accounting for the range of alternations.

Finally, this article aims to explore what we can learn when applying modern reanalysis to older descriptive work. Though the data set is small for Awa, Loving's careful description of the patterns leads to a principled analysis in which all morphemes carry underlying tone. Future work on the tonology of Awa will prove or disprove the account I have offered here; Awa promises to be interesting either way.

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