Coda Constraints on Tone

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1. Introduction

One of the major concerns within both syllabic and CV frameworks concerns onset-coda asymmetries: While some languages don't have phonetic codas at all, others restrict codas to a small subset of the contrasts found in onset position. Still others allow only one or two coda consonants, for example, the velar nasal and/or glottal stop, which in turn may be disallowed in onset position. In addition to these restrictions, codas are known to participate in "rime constraints", i.e. cases where only specific vowel + consonant combinations are allowed. An example of this is the Fe'fe' dialect of Bamileke in which only front [a] can occur before coda [t] and only [ɛ] can occur before coda [n] (Hyman 1972). In this paper I am interested in coda constraints on tone: In numerous Southeast Asian languages the presence of a stop coda places important constraints on which tones can appear on the rime. Thus, as will be seen below, in Kuki-Thaadow, only /L/ tone can occur in monosyllabic words that end in /p/ or /t/ (and historical **k*, which has become glottal stop). In the following sections I first present the issues, with illustration of reported cases of coda-tone restrictions from the literature and my own work. Since such coda-tone constraints are most prevalent in East and Southeast Asian languages, it is likely that the historical account of tonogenesis from final lost consonants plays a major role in explaining the limited or absence of contrasts on "stopped" or "checked" syllables. As such diachronic sources have been widely discussed (Haudricourt 1954, Matisoff 1973, Mazaudon 1979, Svantesson 1989, Kingston 2004), my emphasis will be on the synchronic consequences, specifically on how to interpret the tonal restrictions that are found with such codas. Although my emphasis will not be on a formal analysis, it will be evident that the coda-tone restrictions lend themselves quite naturally to a structural licensing account which is familiar from other aspects of syllable or CV structure (Ito 1986, Goldsmith 1990, Kaye 1990, Charette 1990, Harris 1994 etc.).[1]

2. The issues

We can begin by asking the general question of what phonetic effects codas can have on tone. As a short answer, we can consider that laryngeal consonants such as *-h*, *-ʔ*, *-N^{ʔ}*, *-L^{ʔ}*, *-G^{ʔ}* can generate tone diachronically ("tonogenesis") and/or restrict the number and nature of tonal contrasts in synchronic systems.[2] Thus consider the different tonal contrasts found in CV vs. CVʔ syllables in Lahu (Lolo-Burmese), where 5 = the highest pitch and 1 = the lowest:

[1] In this paper I will continue to refer to codas as such, well-aware that the facts presented here replicate many of the concerns of strictly CV or ON frameworks (Lowenstamm 1996, Scheer 2004). An earlier version of this paper was presented at the Workshop on Segments and Tone held in Amsterdam, June 7-8, 2007.

[2] Here and in what follows I shall rely on the following abbreviations: C = any consonant, V = any vowel, VV = long vowel or diphthong, T = stop (typically voiceless), R = sonorant, N = nasal, L = liquid, G = glide. As is customary, H, M, and L stand for high, mid and low tone, respectively.

(1)

	Matisoff (2003, pers. comm.)					Matisoff (1988)						
CV :	53	35	33	21	11	54	45	33	21	11		
CV? :	54			21							4	2

As seen in the two slightly different representations in (1), five tones contrast on "smooth" CV syllables, while only two contrast on "stopped" CV? syllables. This raises two questions. The first how to interpret the glottal stop: Is it a full consonant, a feature of the vowel, or a feature of the tones with which it coocurs? Matisoff (2003: 209) takes this last position:

> "Lahu syllables have a very simple structure, consisting of only an (optional) initial consonant and a vowel and a tone. There are no syllables with final consonants, since glottal stop -? is best regarded as a tonal feature."

The second question is how to interpret the two tones that occur in CV? syllables. In the first interpretation I have aligned and thereby identfied 54? and 21? with the 53 and 21 shapes that occur in CV syllables, especially as it is not surprising for a glottal stop to raise pitch, e.g. /53?/ → 54?. In the second interpretation 4? and 2? are treated as a separate subsystem, not identified with any of the other tones. Since glottal stops are known to shorten a preceding vowel, we could, however, alternatively start with /54?/ and /21?/ as the underlying forms which become surface 4? and 2? as a result of vowel shortening.[3]

That CV? syllables are particularly inhospitable to contour tones is clearly seen in the following tonal contrasts found in San Martin Itunyoso Trique (Mixtecan) (Dicanio 2008):s

(2)

	Level Tones				*Falling Tones*			*Rising Tones*	
CV	1	2	3	4	43	32	31		
CV?	1	2	3	4					
CVh	1	2	3	4				13	45

As seen, four tone heights contrast on smooth, glottal-final and breathy-final syllables, symbolized as CV, CV? and CVh. On the other hand, falling tones can be licensed only by CV and rising tones only by CVh. Again, we have the ambiguous question of how to interpret the final laryngeal gestures: are they coda consonants, properties of the vowel, or properties of the tones?

The situation becomes considerably less ambiguous once we generalize to consider languages which restrict tonal contrasts in syllables which end in the oral stops /p, t, k/. In this case it is clearly the identity of the syllable coda consonant that fails to license a full inventory of tonal contrasts. In (3) I present a summary of several Tibeto-Burman languages and Chinese dialects that have exactly this property:[4]

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[3] All of this begs the question of whether the tonal integers might be amenable to an analysis such as /H/, /MH/, /M/, /ML/ and /L/.

[4] The sources are as follows: Bol (Namkung 1996), Maru (Okell 1989), Tangkhul Naga (personal notes), Trung (Namkung 1996), Jingpho (Qingxia & Diehl 2003), Karen (Jones 1961), Xiamen (Chen 1987), Cantonese (Yip 2002, Yu 2007). Note that Cantonese 5 tone occurs in CVT (short stopped) syllables, while 3 tone occurs in CV:T (long stopped) syllables.

(3)	*Language*	*classification*	*"smooth" syllables*	*stopped*	*ratio*	*codas*
	Bola	Lolo-Burmese	H, L, HL	H, HL	3:2	p t k ʔ m n ŋ
	Maru	Lolo-Burmese	H, M, L	H, L	3:2	p t k ʔ m n ŋ
	Tangkhul	Naga	H, M, L	M, L	3:2	p t k m n ŋ r w y
	Trung	Nungish	H, L, HL, LH	H	4:1	p t k ʔ m n ŋ l r
	Jingpho	Jingpho	H, M, L, HL	H, L	4:2	p t k ʔ m n ŋ
	Karen (Pa'o)	Karenic	H, M, L, HL	M, L	4:2	p t k ʔ m n ŋ
	Xiamen	Chinese	44, 24, 22, 21, 53	4, 32	5:2	p t k ʔ m n ŋ w y
	Cantonese	Chinese	53~55, 33, 22, 21, 35, 23	5, 4, 3	6:3	p t k m n ŋ w y

Almost all of the supralaryngeal stopped-syllable effects on tone have come from Chinese and Southeast Asia (Chen 2000:5). The question we face is whether these coda-tone limitations are attributable to Haudricourt's (1954) Southeast Asian type of tonogenesis or whether we should seek possibly universal effects which stop codas may have on the pitch of preceding vowels? If the latter possibility could be shown to hold true, we would face the problem of explaining why the allegedly universal effects of *-p, -t, -k* codas on tone is so rarely attested elsewhere in the world.

Assuming that their is a phonetic basis to the observed, restrictive properties of CVT, this may be due to one of two logical sources: (i) Stop codas may have an ACTIVE phonetic effect. In this case final stops trigger universal effects that result in the restricted tonal contrasts in CVT syllables. (ii) Stop codas may have a PASSIVE phonetic effect. In this case final stops block other the universal phonetic effects that other finals have on tone. Either way, the diachronic effect is to produce fewer tonal contrasts on stopped syllables. We thus arrive at the following two synchronic generalizations: (i) Stopped syllables can have the same or fewer tonal contrasts than smooth syllables, never more. (ii) Where fewer, the contrasts found on stopped syllables are a subset of those found on smooth syllables. While the first seems non-controversial, the second is often a matter of interpretation. To illustrate, in (3) it was suggested that Trung has a four-way /H, L, HL, LH/ contrast on smooth syllables, but a non-contrastive H on stopped syllables. This distribution is subject to the following three types of analysis:

(i) A SUBSET analysis: In this interpretation the tone(s) on stopped syllables can be identified with one or more tones found on smooth syllables, although with possibly different realizations (cf. for example Yip's (2002:174-5) account of Cantonese). In the Trung case, the four contrastive tones /H, L, HL, LH/ are recognized, where only /H/ occurs on stopped syllables.

(ii) A TWO-SYSTEM analysis: the tone(s) on stopped syllables form a separate tonal subsystem distinct from the tones on smooth syllables. This has been the approach taken by many specialists of Chinese and Southeast Asian languages. In this case Trung would be analyzed with five underlying tones: /H, L, HL, LH/ plus /Hq/, where /Hq/ is a stopped tone distinct from the /H/ that occurs on smooth syllables.

(iii) An UNDERSPECIFATION analysis (available if only one tone is allowed on stopped syllables): short-stopped syllables are toneless, akin to neutral tone phenomena in Chinese. This approach shares properties with each of the other two. As in the subset approach, four underlying tones /H, L, HL, LH/ would be set up for Trung. As in the two-system approach, stopped syllables would not carry any of these tones. However, rather than carrying a distinct

tone, they would be toneless, something which Weidert (1987:368) identifies as general in Tibeto-Burman:

> "...most TB languages known to date suggest a zero-tonology on stopped syllables for the reconstructable proto-stages of different divisions."

It is of course possible, in fact likely, that Tibeto-Burman and other East and Southeast Asian languages differ from each other in this regard. In the following section I shall show that languages from the Kuki-Chin subbranch of Tibeto-Burman require a subset approach: their stopped tone is always identifiable with one of the underlying tones which contrast on smooth syllables.

3. Stopped tones in Kuki-Chin

As reconstructed by VanBik (2006), Proto-Kuki-Chin (PKC) contrasted four tones on smooth syllables, which have the following shapes: CVV, CV(V)N, CV(V)L, CV(V)G. The final nasals could be **m*, **n* or **ŋ*, the final liquids **l* or **r*, and the final glides *w and *y. Since it is hard to give phonetic values to the four proto tones, VanBik designated these as *t1, *t2, *t3 and *t4. Of these, only one (*t3) is reconstructed on short stopped syllables (CVT), which could end with **p*, **t*, **k*, **ʔ* or glottalized sonorants. Another tone (*t2) is reconstructed on long stopped syllables (CVVT), which could end with **p*, **t* or **k* (but not *ʔ or glottalized sonorants). The table in (4) shows the (underlying) tonal reflexes of VanBik's *t1-*t4 in the four Kuki-Chin languages which I have personally studied:

(4)

PKC	*Falam Lai*	*Hakha Lai*	*Thlantlang Lai*	*Kuki-Thaadow*	*Smooth σ's*	*CVT*	*CVVT*
*t1	H	HL	HL	HL	✓	*	*
*t2	HL	L	L	HL	✓	*	✓
*t3	L	LH	H	L	✓	✓	*
*t4	LH	HL	HL	H	✓	*	*

As seen, Falam contrasts four tones, while the others contrast only three. They also differ in how stopped tones are realized. The underlying tones of short and long stopped syllables are compared in (5), where I have added two more Kuki-Chin languages:

(5)

	Falam Lai	*Hakha Lai*	*Thlantlang Lai*	*Kuki-Thaadow*	*Tedim Chin*	*Mizo*
CVT	L	LH	H	L	HL	L
CVVT	HL	L	L	HL	LH	HL

There is an undeniable cross-linguistic tendency for short stopped syllables to be level tones (recall Trique CVʔ in (2)), which can be attributed to the tendency for vowels to be short in this position (Gordon 2001, Zhang 2002, 2004). However, the one tone on CVT is realized /LH/ in Hakha Lai and /HL/ in Tedim Chin. While it is logically possible to treat these as /H/, since /H/ does not otherwise exist in these languages, this would seriously detract from the major generalization of the Hakha Lai tonal system (cf. (14) below). What's more, it would fail to account for the contour tone on CVT in both Hakha Lai and Mizo. In an undoubtedly related

finding, Maddieson (2004:745) does however surprisingly indicate that Hakha Lai LH tone smooth syllables tend to be shorter than either HL or L syllables.

It is important to note that the tables in (4) and (5) concern underlying contrastive tone. Depending on the language one can get many more possibilities on the surface. Thus, in Thlantlang Lai, where CVT syllables can only be underlyingly /H/, four different tones can be observed on the surface:

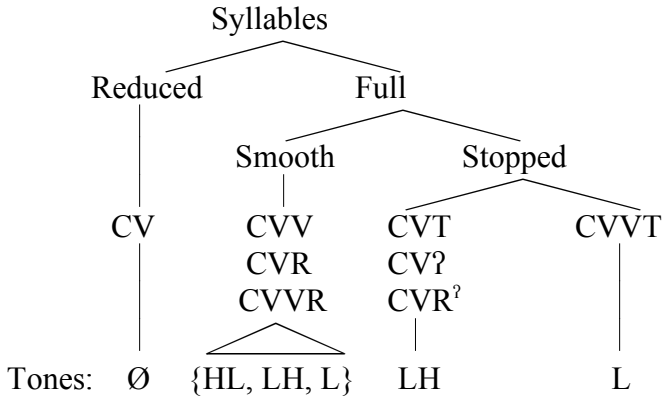
(6)	a.	HL :	vô̲k	'pig'	/H/	→ H̲L / __ ‖
		H :	vó̲k kêe	'pig's leg'	/H + H/	→ H̲-H
	b.	LH :	bòoy vǒ̲k	'chief's pig'	/L + H/	→ L-L̲H / __ ‖
		L :	bòoy vò̲k kêe	'chief's pig's leg'	/L + H + H/	→ L-L̲-H

The fact that HL and LH contours are possible is one argument that the underlying tone of CVT is /L/ rather than /Ø/. In the following subsections I will present arguments in favor of the subset hypothesis, organized as follows: (i) In Hakha Lai, CV syllables are demonstrably /Ø/ (toneless), while CVT syllables are distinctively not /Ø/, rather /LH/. (ii) In Kuki-Thaadow, CVT syllables are /L/, which cannot be interpreted as /Ø/. (iii) In Falam Lai, CVT syllables are /L/, not /Ø/ (as proposed by Osburne 1975).

3.1. Stopped tones in Hakha Lai

The schema in (7) summarizes the syllable structures of Hakha Lai words and their tones:[5]

(7)



The syllable-structure generalizations are as follows: (i) Syllables require an onset and can be open or closed. (ii) Coda consonants can be voiceless stops, sonorants (R), or glottalized sonorants (R$^{?}$). (iii) Vowels are short before a glottal stop or glottalized sonorant coda. (iv) Underlying vowel length is contrastive only in syllables closed by a sonorant or voiceless stop. (v) Reduced CV syllables are toneless: they are either proclitics or derived by a rule of vowel-

[5] In Kuki-Chin languages words are largely monosyllabic. There are few affixes, while compounding is widespread. Besides Hakha Lai work co-authored with Kenneth VanBik, I would like to thank the following language consultants: Thien Haokip and Vei Ning (Kuki-Thaadow), Milan Za (Falam Lai), Bawi Lianmang (Thlantlang Lai).

shortening in context. The three contrastive tones on smooth syllables are illustrated after the toneless proclitic /ka=/ 'my' in (8).

(8)

	CVV		CVR		CVVR	
HL	ka hmâa	'my wound'	ka lûŋ	'my heart'	ka tlâaŋ	'my mountain'
	ka zûu	'my beer'	ka lâw	'my field'	ka râal	'my enemy'
LH	ka kěe	'my leg'	ka hrŏm	'my throat'	ka kŏoy	'my friend'
	ka ʔŏo	'my voice'	ka tsăl	'my forehead'	ka tsăan	'my time'
L	ka sàa	'my animal'	ka ràŋ	'my horse'	ka bòoy	'my chief, lord'
	ka hnìi	'my skirt'	ka kàl	'my kidney'	ka bòor	'my bunch'

Now consider the 3 x 3 tone patterns plotted in $Noun_1$-$Noun_2$ combinations after the toneless proclitic *ka*= 'my':

(9)

		HL		LH		L	
a.	HL	tlâaŋ	zùu	tlâaŋ	tsăan	tlaàŋ	sàa
b.	LH	thlăan	zûu	thlăan	tsâan	thlàan	sàa
c.	L	bòoy	zùu	bòoy	tsăan	bòoy	sàa
ka + 'my'		'mountain beer' 'grave beer' 'chief's beer'		'mountain time' 'grave time' 'chief's time'		'mountain animal' 'grave animal' 'chief's animal'	

Those tones which change are underlined. A schematic summary of the sequences which undergo tonal alternation is given in (10):

(11)

	HL	LH	L
HL	HL - L		
LH		LH - HL	L - L
L	L - L		

The rules that are needed are presented informally in (12).

(12) a. HL → L / { HL, L } __
b. LH → HL / LH __
c. LH → L / __ L

The question is: Why these rules? Compare in (13) the inputs which do not change vs. those which do:

(13)

Inputs which do not change	*Inputs which do change:*	*Outputs they change to:*
a. LH-HL	b. HL-HL	c. → HL-L
HL-LH	LH-LH	→ LH-HL
L-LH	LH-L	→ L-L
HL-L	L-HL	→ L-L
L-L		

As pointed out in Hyman & VanBik (2004), the inputs in (13b) are required to change in the output by the following tonal conspiracy: *The end-tone of one syllable should be the same as the beginning tone of the next.* In other words, tone levels should not change between syllables! As seen in (13c), the outputs directly repair the input violations of the following No Contour Principle (NOCP):

(14) No Contour Principle (NOCP) : * σ σ
| |
αH -αH

The reason for going into all of the above is that the tone rules in (12) provide direct evidence that CV—but not CVT—syllables are toneless. When occurring non-finally in certain constructions, a long-vowel /CVV/ syllable is shortened to CV. When this happens, the underlying contrast between /HL/, /LH/ and /L/ neutralizes by deletion of these tones, thereby bleeding the tone rules in (12). Thus, in the examples in (15), the input tones are allowed to surface without any change after a CV syllable:

(15)	*input*				*output*		*rule which fails to apply*		
a.	sàa	+	râal	→	sa râal	'animal's enemy'	L + HL	→	L-L
b.	fâa	+	pôoy	→	fa pôoy	'pregnant woman'	HL + HL	→	HL-L
c.	pŏo	+	kăaw	→	po kăaw	'gluttinous person '	LH + LH	→	LH-HL
d.	pŏo	+	kìl	→	po kìl	'stomach corner'	LH + L	→	L-L

What this means is that a syllable must have two moras to be a tone-bearing unit. Toneless CV syllables receive their pitch postlexically (cf. Hyman & VanBik 2005).

Now observe in (16) that the /LH/ of CVT and the /L/ of CVVT participate in tone rules:

(16) a. râal vŏk + hrŏm → râal vŏk hr̲ôm 'enemy's pig's throat'
HL LH LH HL LH HL

b. ka hnùuk + hmâa → ka hnùuk hm̲àa 'my breast wound'
L HL L L

It should be clear, therefore, that CVT and CVVT syllables do not function as toneless in Hakha Lai. A similar conclusion can be drawn from closely related Kuki-Thaadow.

3.2. Stopped tones in Kuki-Thaadow

As summarized above in (5), Kuki-Thaadow CVT syllables have /L/ tone, while CVVT syllables have /HL/.[6] One suggestive piece of evidence that /L/ might be analyzed as /Ø/ concerns the process of $stem_2$ formation in verbs, illustrated with CVN $stem_1$ verbs in (16).

[6] In this section CVT refers only to CVp and CVt syllables. Kuki-Thaadow has lost final **ʔ* (*CVʔ > CVV) and modified final glottalized sonorants. On the other hand it has developed new glottal stops from final **r* and **k* (see VanBik 2006). These changes complicate the distributional statements slightly, but not with respect to present-day CVp and CVt, which have /L/ tone.

(17)

	without denasalization				*with denasalization*			
stem$_1$ tone	*stem$_1$*	*stem$_2$*	#		*stem$_1$*	*stem$_2$*	#	
HL	kûm	kùm	30	‘descend’	dôm	dòp	7	‘lift w/hands’
	tân	tàn	29	‘cut’	bwôon	bwòt	1	‘wrestle’
	hlûŋ	hlùn	17	‘arrive’	hlêŋ	hlèʔ	1	‘exchange’
H	póm	pòm	37	‘accept’	túm	tùp	5	‘aim’
	khén	khèn	61	‘divide’	mán	màt	1	‘catch sth. in air’
	máŋ	màn	48	‘lose’	---	---	0	
L	nàm	nàm	3	‘kiss’	lùm	lùp	7	‘lie (down)’
	dòon	dòon	6	‘sprout’	sùn	sùt	9	‘stab’
	kèeŋ	kèeŋ	2	‘nude’	tàŋ	tàʔ	10	‘grind’

As seen, stem$_2$ formation may or may not denasalize a final nasal (a relic of original glottalization). In both cases /HL/, /H/ and /L/ stem$_1$ tones all merge as L.[7] There thus are two potential interpretations of how stem$_2$ is derived: (i) Tone → L; (ii) Tone → Ø.

To see which is correct, consider the 3 x 3 tone patterns plotted in Noun$_1$-Noun$_2$ combinations after the proclitic kà=/ká= ‘my’ (Hyman 2010).[8]

(18)

			HL		H		L	
a.	HL		lów	↓ûy	lów	zŏoŋ	lów	làam
b.	H		hláaŋ	ûy	hláaŋ	zóoŋ	hlàaŋ	lâam
c.	L		hùon	ûy	hùon	zŏoŋ	hùon	làam
	kà	+	‘field dog’		‘field monkey’		‘field dance’	
	kà	+	‘mountain dog’		‘mountain monkey’		‘mountain dance’	
	ká	+	‘garden dog’		‘garden monkey’		‘garden dance’	

A number of tonal alternations are noted in (18). Among these are the processes of L tone spreading (LTS) and H tone spreading (HTS) in (19), expressed in autosegmental terms in (20).

(19) a. hùon + zóoŋ → hùon zŏong ‘garden monkey’ (= LTS)
/L/ + /H/ L LH

b. hláaŋ + làam → hláaŋ lâam ‘mountain dance’ (= HTS)
/H/ /L/ H HL (as realized after H)

(20) a. hùon zŏoŋ ‘garden monkey’ b. hláaŋ lâam ‘mountain dance’

L H H L

[7] For an analysis of the syntactic and semantic conditions requiring stem2, see Cover (2012).

[8] Unlike Hakha Lai, pronominal proclitics carry a tone in Kuki-Thaadow. As seen next to the glosses in (18), *ka=* takes a polar tone: L before /HL/ and /H/, H before /L/. Since this the H of *ká=* doesn’t spread onto the following L, it may best be analyzed as /HL/. When /kà= hláaŋ làam/ ‘my mountain dance’ undergoes the tone spreading rules in (20) to become *kà= hlàaŋ lâam*, with *kà=* followed by L tone, the polar allomorphy is rendered opaque.

Returning to the question of CVT tone, the examples in (21) show that it cannot be toneless. Instead, its /L/ tone both triggers LTS and undergoes HTS, e.g. /khùt/ 'hand':

(21) a. khùt nŭŋ 'back of hand'
L H

b. gúol khût 'friend's hand'
H L (as realized after H)

Recall that the question concerning $stem_2$ formation was whether the neutralized tone is L or Ø. The examples in (22) show that the L from $stem_2$ also triggers LTS and undergoes HTS:

(22) a. /sùu/ → /sùʔ/ 'pound' ($stem_2$)
sùʔ thĭeŋ 'clean up'
L H
(pound + clean)

b. /khòom/ → /khòp/ 'gather, collect' ($stem_2$)
súm khôp 'money collecting
H L (as realized after H)
(money + collect)

Even if $stem_2$ formation is viewed as a "reduction" process, there can be no question that the resulting neutralized tone is L, not Ø. Our final case comes from Falam.

3.3. Stopped tones in Falam Lai

Whereas Hakha Lai and Kuki-Thaadow have only three underlying tones, four tones contrast in Falam. The following examples are from my elicitations (Osburne 1975 reports only three contrasting tones in her study of the Zahao dialect):

(23) a.	H	páa	'mushroom'	lám	'road'
b.	HL	sâa	'animal'	thlûak	'brain'
c.	LH	zŭu	'bear'	tlăaŋ	'mountain'
d.	L	kèe	'leg'	sèer	'lemon'

The following table represents the tonal alternations involving syllables other than CV and CVT:

(24)

		H	HL	LH	L
a.	H	H- H	H- HL	H- LH	H- L
b.	HL	HL- H	HL- HL	HL- LH	HL- L
c.	LH	L- H	L- HL	L- H	LH- L
d.	L	L- H	L- HL	L- LH	L- L

As seen, only /LH/ tone changes. The rules proposed by Osburne (1975) are as follows:

(25) a. LH → L / ___ {H, HL}
e.g. tlăaŋ + lám → tlàaŋ lám 'mountain road'
tlăaŋ + thlûak → tlàaŋ thlûak 'mountain brains'

b. LH + LH → LH-H → L-H
   e.g. tlǎaŋ + zǔu → tlǎaŋ zúu → tlàaŋ zúu ‘mountain bear’

c. LH + L → no change
   e.g. tlǎaŋ + sèer → tlǎaŋ sèer ‘mountain lemon’ (*tlàaŋ sêer, *tlàaŋ séer)

As seen in (25a), the H endpoint of a /LH/ tone is “absorbed” into a following /H/ or /HL/. In Osburne’s analysis in (25b), the second of a sequence of /LH/ tones first simplifies to H, which then triggers the same absorption process. Of crucial note in (25c) is that /LH/ normally does not change when followed by a /L/.

However, /LH/ does change when the following L syllable has either the shape CV or CVT:

(26) a. tlǎaŋ + sàrìʔ → tlàaŋ sárìʔ ‘seven mountains’

b. tlǎaŋ + vòk → tlàaŋ vók ‘mountain pig’
   tlǎaŋ + khàt → tlàaŋ khát ‘one mountain’

c. lám + khàt → no change ‘one road’
   lám + sàrìʔ → no change ‘seven roads’

In (26a) it would appear that the H of /LH/ spreads onto the following CV syllable [sà], delinking its L and also feeding absorption (LH-H → L-H). The same appears to happen in (26b), where the following L syllable is CVT. Finally, note in (26c) that it is only /LH/ tone which does this, not /H/.

The question is how to account for the fact that /LH/ will send its H onto a following L CV or CVT syllable, but not onto any other shape L tone syllable. Osburne’s answer is that these two syllable shapes are not /L/, but rather /Ø/. An alternative interpretation is that both CV and CVT consist of a single mora vs. all other syllable shapes, which are bimoraic. Viewed this way, the rule can be informally presented as in (27), where L̆ stands for a monomoraic or “short” L:

(27) LH + L̆ → L-H

While much of the attention in the literature has been focused on the need for a rising tone to appear on a hospitable tone-bearing unit, e.g. a syllable whose the vowel is long and/or the coda is a sonorant (Gordon 2001, Zhang 2002, 2004), Falam seems to be telling us something different: A LH rising tone can be realized before L only when the L tone syllable has sufficient weight, specifically bimoricity. That is, a LH tone places a weight constraint on the landing site of a subsequent drop to L. This correlates with the fact that languages may place constraints on which tones can preceding or follow contour tones, whether rising, falling, or more complex (Hyman 2007:12-15).

There is additional evidence that contour tones are restricted to bimoraic syllables in Falam. As in the Kuki-Chin languages, CVV syllables shorten to CV in context. When they do, the following tonal changes are observed:

(28)	a.	páa	'mushroom'	→	pá	ràay	'mushroom disease'	H	→	H
	b.	zŭu	'bear'	→	zú	ràay	'bear disease'	LH	→	H
	c.	sâa	'animal'	→	sà	ràay	'animal disease'	HL	→	L
	d.	kèe	'leg'	→	kè	ràay	'leg disease'	L	→	L

As seen, derived CV can be phonetically H or L, depending on the end tone of the input: both /H/ and /LH/ are realized H, while /HL/ and /L/ are both realized L.[9] Significantly when this happens, the H which results from either /H/ or /LH/ is free to spread onto a following CV or CVC syllable:

(29)	a.	páa + sàrìʔ	→	pá	sárìʔ	'seven mushrooms'
		páa + khàt	→	pá	khát	'one mushroom'
	b.	zŭu + sàrìʔ	→	zú	sárìʔ	'seven bears'
		zŭu + khàt	→	zú	khát	'one bear'

What we see, therefore, is that Falam prohibits three of the four combinations of "short H" followed by "short L" across a word boundary:

(30)	a.	LH	##	LH	→	L-H	*vs.*	b.	H̆	##	LH	→	no change
		LH	##	L̆	→	L-H̆							
		H̆	##	L̆	→	H-H̆							

By "short" I mean a H or L which is linked to a single mora, either because it is on a CV or CVT syllable, or because it is part of a contour on a bimoraic syllable. If I am right in identifying the constraint *H̆ ## L̆ as motivating the three changes in (30a), I do not have an explanation as to why (30b) does not change to H-H.

In summary, what we can conclude about Falam and Kuki-Chin more generally is that while CVT may sometimes have the same properties as CV, it is definitely not toneless. Rather, the underlying tone of CVT is always identical to one of the contrasting tones on smooth syllables. As we have also seen, it may acquire other tonal shapes by rule, just as smooth syllables do. Although not illustrated here, the same is true of the one underlying tone of CVVT syllables, which also may acquire different tonal shapes by rule.

4. Other cases

While the preceding discussion has focused on the restriction of tone in stopped syllables in a number of synchronic systems in Southeast Asia, the more general question is what recurring effects codas can have on tone. This concerns not just their presence vs. absence, and the difference between stops and sonorants, but specifically their phonetic features. Codas

[9] Given what we know about contour simplification from other languages, I would instead have expected the first tone to have remained, rather than the second. My hypothesis is that LH and HL represent "bifurcations" of an earlier *H vs. *L contrast conditioned by an original voicing or phonation contrast. Monomoraic CV and CVT syllables would not have had sufficient weight to undergo this bifurcation. Thus, the outputs in (28) may be retentions rather the result of contour simplification. Whether open syllables should be reconstructed as *CV or *CVV is another question. What is important is that the CV vs. CVV contrast would have had to predate tonal bifurcation, if this hypothesis is correct.

involving phonation gestures (constricted/spread glottis) can raise/lower pitch. A phonetic coda glottal stop is expected to raise pitch, but especially shorten the preceding vowel, which may then not be able to manifest all of the tonal contrasts in the language. Finally, coda voicing is not expected to affect pitch as it does in onsets (Hombert 1978).[10]

Still, there are some intriguing synchronic and/or diachronic effects reported in the literature. A rather unusual case of tonogenesis dependent on coda voicing has been reported in Las Norias Piman (Shaul 2006). As illustrated in the closely related Tohono O'odham forms in (31), the proto language contrasted voicing in codas:

(31)

	'defecate'	'clay'	'stomach'	'road'
Tohono O'odham	bi:t	bid	vo:k	vo:g
Las Norias Piman	pí:t	pî:t	vó:k	vô:k

However, in Las Norias Piman, syllables which ended in a proto voiceless stop have H tone, while those which ended in a proto voiced stop have a HL falling tone. Is the latter due to the pitch-lowering effect that voiced obstruents normally only have on a following vowel, or could the difference be due to intrinsic length differences between voiceless vs. voiced codas?

A striking parallel involving apparent tonal bifurcation dependent on coda voicing is found in Hup, a Maku language (Epps 2008). As seen in (32), /H/ is realized H if the coda consonant is voiceless, HL if it is voiced (or if there is no coda):

(32) a. /cúk/ → [čúk˚] 'tool handle'
b. /cúg/ → [čûgŋ] 'hummingbird'
c. /jˀá/ → [čâ̰:] 'black'

Again, the expected shorter duration of the vowel in CVT syllables may have prevented the otherwise natural realization of /H/ as HL. Such a situation is reported in the Chadic language Bade, where HL becomes H in syllables closed by a voiceless obstruent (Schuh 2002). Less straightforward is the realization of /LH + L/ in Kakua (Cathcart 1979:24, 28). If the first syllable is CV or ends in a voiced coda, the realization will be M-H, where the H of the rising tone has apparently spread to the next syllable. If the first syllable ends in a voiceless coda, the realization will instead be MH-L. In this case the voiceless consonant appears to have blocked H tone spreading, exactly the opposite of what would normally be expected (Hyman & Schuh 1974:107-8).

Other tonal interactions involve stop vs. sonorant finals without clear phonetic motivation. Michailovsky (1975), for instance, reports that Khaling verb roots have H tone if stop-final, but L tone if sonorant-final:

(33)

	root	***1st singular***		***infinitive***
a.	/wæp/	wǽb-u	'I scoop out'	wǽm-næ
b.	/wæm/	wæ̀m-u	'I stick in'	wæ̀m-næ

[10] This conclusion is confirmed by the recent survey by Hyslop, Brunelle & Pittayaporn (2012). Note that Maran's (1971) claim to the contrary in Jingpho has been challenged by Matisoff (1973); see also Mazaudon (1977:67-76).

Michailovsky (1975:211) further points out that open syllable verb roots also have L tone, indicating that stop codas "are opposed to all other finals, which give rise to the low tone." (Michailovsky 1975:211). He offers the following possible phonetic motivation involving erstwhile concomitant glottalization:[11]

> "What remains to be understood is the phonetic motivation behind the development of a high tone from final stops, since stops per se have not been observed to have a phonetic pitch-raising effect. The best clue to a possible motivation may be provided by Hayu... and some other Kiranti languages, in which final stops... are invariably pronounced unexploded and with a simultaneously articulated glottal stop. If Khaling final stops were once pronounced with a simultaneous glottal stop, then the high pitch that has arisen on the preceding vowels could be traced to the influence of this glottal component." (Michailovsky 1975:214)

Finally, the perhaps most impressive involvement of codas in tonogenesis in Southeast Asia is fond in U (Mon-Khmer) (Svantesson 1988). In the following table, T = stop, R = sonorant, I = high vowels, and A = non-high vowels:

(34)	*CVT, *CVs	*CVVT, *CVVs	*CVR	*TVVR	*RV, *RVVR	*CVh	*TI	*TA
	H	LH	L	H	HL	HL	H	L

As seen, the tones that have developed on CVT and CVVT syllables are in every case different from those which arose on the corresponding sonorant syllables CVR, TVVR, and RVVR. I suspect that there are other cases of coda-induced tonogenesis or tonal distributions and processes conditioned by, or at least corresponding to different coda types.

5. Summary

I began this paper by asking why final stops have limiting effects on tonal contrasts. The cases we have considered suggest two separate reasons: (i) Assuming that tonogenesis arises from the gradual transphonologization of phonation as tone (see Thurgood 2002, 2006, among others), stops do not generally pass on tonogenetic phonation gestures to preceding vowels. (ii) Stops have a shortening effect on the preceding vowel, hence fewer tonal contrasts are tolerated: "The lack or paucity of tonal discriminations in stopped syllables is usually explained by referring to the difficulty in modulating pitch below a minimal temporal stretch" (Weidert 1987:368). But this would not directly account for a language like Tangkhul Naga, which allows /H, M, L/ on all syllables except CVT and CVVT. The following summarizes the number of entries of each tone with each syllable type:[12]

[11] Another possibility is that the L on CVR syllables derives from an earlier contour tone, which was disallowed on CVT syllables.

[12] These figures are based on a lexicon collected in a field methods class at UC Berkeley in 2002-3. Our thanks to Khan Lolly who served as language consultant.

(35)

	H	M	L	*totals*
CV	29	31	52	112
CVV	18	22	33	73
CVR	44	49	43	136
CVVR	15	16	14	45
CVT	(1)	25	50	76
CVVT	Ø	5	2	7
totals:	107	148	194	449

As seen, with one exception, CVT and CVVT cannot carry H tone. They, however, do contrast /M/ and /H/. Since the history of these tones is not known, we can only hypothesize that stopped syllables once were limited to a single tone, the difference between M and L later deriving on the basis of a contrast in the initials.

Recall that there have been at least three different interpretations of languages which allow multiple tonal contrasts on "smooth" syllables (open syllables or syllables which end in a sonorant coda): (i) the stopped syllable tones are a subset of the smooth syllable tones; (ii) the stopped syllable tones are a separate system not equatable with the smooth syllable tones (= the intuition of many Southeast Asian specialists); (iii) the stopped syllable tones fall outside the system (i.e. such syllables have /Ø/ tone in languages where there is no contrast at all). In this study I sorted out the above and other issues and argued that the first interpretation is the correct one. Synchronically this means that smooth syllables can license a full range of tonal contrasts, while stopped syllables can license only a subset—often only one—of the same tones. Although this survey has included glottal stop, the codas that we have been most interested in are /p, t, k/. While we can conclude that there is no need to talk about the concept of a stopped tone with respect to supralaryngeal stop codas, there still is the problem of interpreting glottal and breathy phonations which typically cooccur with fewer, and often different tonal contrasts from their modal counterparts. These phonations may indeed form part of a tonal package in a way that *-p*, *-t* and *-k* do not.

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