Do Tones Have Features?

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ABSTRACT

Unless explicitly concerned with developing a system of features per se, most studies of tonal phonology refer to contrasting high, mid, low and contour tones as H, M, L, HL, LH (etc.), or with integers, rather than with features such as [±UPPER], [±RAISED]. Since this practice stands in marked contrast to vowel and consonant phonology, where features seem unavoidable, it is natural to ask whether this difference in practice is due simply to convenience or whether tones lend themselves less naturally to a featural interpretation than vowels and consonants. In this paper I suggest that this is indeed the case: while features sometimes facilitate a general and insightful account, there are inconsistencies, indeterminacies, and other reasons to doubt the value of tonal features (and tonal geometry). This then naturally leads to a more general question: Why should tone be different? In Hyman (in press), I provide evidence to suggest that tone is different in its capabilities: tone can do everything that segmental and accentual phonology can do, but the reverse is not true. I start by illustrating some examples to make this point then turn to the question of how this provides insight into the relative unimportance of featural analyses of tone. In this paper I also raise the question of why tone, which might seem like a good bet, is not a linguistic universal (as compared to consonants and vowels). I suggest that it is the relative autonomy and "non-integration" of tone that accounts for its versatile and unique properties. Since some tonal phenomena have no segmental or stress analogues, I argue that anyone who is interested in the outer limits of what is possible in phonology would be well-served to understand how tone systems work.

1. Introduction: Three questions about tone

In this paper I address the question of whether tones have features. Given that most phonologists accept either binary features or privative elements in their analyses of segmental systems, it may appear surprising that such a question needs to be asked at all. However, as I discuss in Hyman (in press) and below, tone has certain properties that appear to be unique within phonological systems. Hence, it could also be that featural analyses of tones are not necessary, even if they are well-founded in consonant and vowel phonology. Before considering whether tones have features, there are two prior questions about tone which will bear on my conclusion:

(1) Question #1: Why isn't tone universal?
Question #2: Is tone different?
Question #3: Do tones have features?

The first question is motivated by the fact that all languages exploit pitch in one way or another, so why not lexical or grammatical tone? It is generally assumed that somewhere around 40-50% of the world's currently spoken languages are tonal, although the distribution is highly areal, covering most of Subsaharan Africa and East and Southeast Asia, as well as significant parts of Mexico, the Northwest Amazon, and New Guinea. There would seem to be several advantages for universal tone: First, tone presents few, if any articulatory difficulties vs. consonants (which all languages have). Second, tone is acoustically (hence perceptually?) simple, F_0, vs. consonants and vowels. Third, tone is acquired early (Li and Thompson 1978, Demuth 2003), such that nativists may even want to claim that human infants are prewired for it. Thus, if all of the languages of the world had tone, we would have no problem "explaining" why this is. The more interesting question, to which I will return in §5, is why tone *isn't* universal.

The second question is whether tone is different. In Hyman (in press) I suggested that tone is like segmental phonology in every way—only "more so", in two different senses: (i) *Quantitatively* more so: tone does certain things more frequently, to a greater extent, or more obviously (i.e. in a more straightforward fashion) than segmental phonology; (ii) *Qualitatively* more so: tone can do everything segments and non-tonal prosodies can do, but segments and non-tonal prosodies cannot do everything tone can do. This "more so" property contrasts with the articulatory and perceptual simplicity referred to in the previous paragraph. As Myers and Tsay (2003: 105-6) put it, "...tonal phenomena have the advantages of being both phonologically quite intricate and yet phonetically relatively straightforward (i.e. involving primarily a single perceptual dimension, although laryngeal physiology is admittedly more complex)." There is so much more you can do with tone. For example, as seen in the Giryama [Kenya] forms in (2), the tones of one word may be realized quite distantly on another (Philippson 1998: 321):

(2) a. ku-tsol-a ki-revu 'to choose a beard' /-tsol-/ 'choose'
b, ku-on-a ki-révu 'to see a beard' /-ón-/ 'see'
H

In (2a) all of the TBUs are toneless, pronounced with L(ow) tone by default. In (2b), the H(igh) of the verb root /-ón-/ 'see' shifts long distance to the penult of the following word, which then ends with a H-L sequence. Put simply, segmental features and stress can't do this. They are typically word-bounded or interact only locally at the juncture of words. Thus, no language has been known to transfer the nasality of a vowel to the penult of the following word. Similarly, one word does not normally assign stress to the next. While tone is capable of a rich lexical life as well, it has an equal potential at the phrase level, where the local and long-distant interaction of tones can produce a high degree of opacity (differences between inputs and outputs) and analytic open-endedness.

In short, tone can do everything that segmental and accentual phonology can do, but the reverse is not true. Some of this may be due to the fact that tone systems can be extremely paradigmatic or syntagmatic, exclusively lexical or grammatical. Thus consider the eight tone patterns of Iau [Indonesia: Papua] in (3).

(3)	*Tone*	*Nouns*		*Verbs*		
	H	bé	'father-in-law'	bá	'came'	*totality of action punctual*
	M	bē	'fire'	bā	'has come'	*resultative durative*
	H↑H	bé↑´	'snake'	bá↑´	'might come'	*totality of action incompletive*
	LM	bè⁻	'path'	bà⁻	'came to get'	*resultative punctual*
	HL	bê	'thorn'	bâ	'came to end point'	*telic punctual*
	HM	bé⁻	'flower'	bá⁻	'still not at endpoint'	*telic incompletive*
	ML	bē`	'small eel'	bā`	'come (process)'	*totality of action durative*
	HLM	bê⁻	'tree fern'	bâ⁻	'sticking, attached to'	*telic durative*

As seen on the above monosyllables (where ↑´ = super-high tone), the same eight tones contrast paradigmatically on both word classes, although with a lexical function on nouns vs. a grammatical function on verbs (Bateman 1990: 35-36).

Compare this with the representative final vs. penultimate H tone in the Chimwiini [Somalia] paradigm in (4):

(4)

singular		*plural*	
n-ji:lé	'I ate'	chi-ji:lé	'we ate'
ji:lé	'you sg. ate'	ni-ji:lé	'you pl. ate'
jí:le	's/he ate'	wa-jí:le	'they ate'

The properties of Chimwiini are as follows (Kisseberth (2009): (i) there is grammatical tone only, i.e. no tonal contrasts on lexical morphemes such as noun stems or verb roots; (ii) H tone is limited to the last two moras; (iii) final H is morphologically conditioned, while penultimate H is the default; (iv) first and second person subjects condition final H vs. third person which takes the default penultimate H. As seen, the only difference between the second and third person singular [noun class 1] is tonal: *ji:lé* vs. *jí:le*. However, as seen now in (5), the final or penultimate H tone is a property of the phonological phrase:

(5)

a.	jile: n̪amá	'you sg. ate meat'	jile ma-tu:ndá	'you sg. ate fruit'
b.	jile: n̪áma	's/he ate meat'	jile ma-tú:nda	's/he ate fruit'

In fact, when there is wide focus, as in (6), each phonological phrase gets the appropriate final vs. penultimate H tone:

(6)

a.	Ø-wa-t̪ind̪il̪il̪e w-aaná] n̪amá] ka: chi-sú]	'you sg. cut for the children meat with a knife'
b.	Ø-wa-t̪ind̪il̪il̪e w-áana] n̪áma] ka: chí-su]	's/he cut for the children meat with a knife'

Although phrasally realized, the Chimwiini final vs. penultimate patterns reflect an original tonal difference on the subject prefixes. Thus, compare the following from the Cahi dialect of Kirimi (where ↓ = downstep):

(7)

a.	/ʊ-kʊ-túng-a/	→	ʊ-kʊ-túng-á	's/he is tying'
b.	/ú-kʊ-túng-a/	→	ú- kú-↓túng-á	'you sg. are tying'
			H H	

As seen, the second person subject prefix has a H tone, while the segmentally homophonous [noun class 1] third person singular subject prefix is toneless. This suggests the following implementation of the Chimwiini facts: (i) first and second person subject markers have an underlying /H/ tone; (ii) this H tone links to the last syllable of the phonological phrase; (iii) any phonological phrase lacking a H tone receives one on its penult. While tone is dense and paradigmatic in Iau, it is sparse and syntagmatic in Chimwiini—so much so that the question even arises as to what the final vs. penultimate H tone contrast is:

(8)

a.	morphology?	(a property of [+1st pers.] and [+2nd pers.] subject prefixes);
b.	phonology?	(property of the phonological phrase—H is semi-demarcative)
c.	syntax?	(property of the syntactic configurations which define the P-phrases)
d.	intonation?	(not likely that there would be a first/second person intonation)

Note also that since the final H tone targets the end of a *phonological* phrase, it is not like phrasal morphology, e.g. English *-'s*, which is restricted to the right edge of a syntactic noun phrase. Again, tone is different: there does not seem to be a segmental or metrical equivalent.

This, then, brings us to the third question: Do tones have features? If yes, are they universal "in the sense that all languages define their speech sounds in terms of a small feature set"

(http://nickclements.free.fr/featuretheory.html)? If no, how do we talk about different tone height and contours and their laryngeal interactions? As Yip puts it:

> "A satisfactory feature system for tone must meet the familiar criteria of characterizing all and only the contrasts of natural language, the appropriate natural classes, and allowing for a natural statement of phonological rules and historical change. In looking at East Asian tone systems the main issues are these: (a) How many different tone levels must be represented? (b) Are contour tones single units or sequences of level tones? (c) What is the relationship between tonal features and other features, especially laryngeal features?" (Yip 1995: 477; cf. Yip 2002: 40-41)

These and other issues will be addressed in subsequent sections. In §2 I will outline the issues involved in responding to this question. In the following two sections we will look at whether features can capture tonal alternations which arise in multiple tone-height systems, first concerning tonal morphology (§3) and second concerning abstract tonal phonology (§4). The conclusion in §5 is that although tone features may be occasionally useful, they are not essential. I end by suggesting that the existence of tone features is not compelling because of their greater autonomy and unreliable intersection with each other and other features. This explains as well why tone is different and not universal.

2. Do tones have features?

In addressing the above question, the central issue of this paper, it should first be noted that there has been no shortage of proposals of tone features and tonal geometry. (See Anderson 1978, Bao 1999, Snider 1999, and Chen 2000: 96 for tone-feature catalogs.) However, there has been little agreement other than: (i) we would like to avoid features like [RISING] and [FALLING]; (ii) we ought in principle to distinguish natural classes of tones by features; (iii) we ought in principle to be able to capture the relation of tones to laryngeal features, e.g. voicing, breathiness, creakiness. However, at the same time, there has been a partial "disconnect" between tone features and tonal analysis: Tones are barely mentioned, if at all, in most theoretical and descriptive treatments of tone. Tone features are, of course, mentioned in a textbook on tone, but read on:

> "Although I have left unresolved many of the complex issues bearing on the choice of a feature system, in much of the rest of this book, it will not be necessary to look closely at the features of tone. Instead we will use just H, M, L, or tone integers, unless extra insights are to be gained by formulating the analysis in featural terms." (Yip 2002: 64)

In actual practice, unless a researcher is specifically working on tone features, s/he is likely to avoid them. Thus compare two recent books on Chinese tonology, Bao (1999) vs. Chen 2000). Bao is specifically interested in developing a model of tonal geometry and tone features, which thus pervade the book. Chen, on the other hand, is interested in a typology of tone sandhi rules and how they apply, hence almost totally avoids features, using Hs and Ls instead.

Since tone and vowel height are both phonetically scalar, it is not surprising that similar problems arise in feature analyses. For example, the respective coalescence of /a+i/ and /a+u/ to [e] and [o] is hard to describe if /a/ is [+low] and /i/ and /u/ are [+high], since the desired output is [-high, -low]. Similarly, the coalescence of a HL or LH contour to [M] is hard to describe if H = [+STIFF] and L = [+SLACK], since the desired output is [-STIFF, -SLACK]. Scalar chain shifts such as i → e → ɛ and H → M → L are notorious problems for any binary system. Still, phonologists do not hesitate to use binary height features for vowels, but often not for tones.

The problem of tone features is largely ignored in two-height systems, where there is little advantage to using, say, [±UPPER] over H and L. Instead, the issue concerns the nature of the H/L contrast, which can be privative and/or binary, as in (9).

(9) a. /H, L/ e.g. Baule, Bole, Mende, Nara, Falam, Kuki-Thaadow, Siane, Sko, Tanacross, Barasana
b. /H, Ø/ e.g. Afar, Chichewa, Kirundi, Ekoti, Kiwai, Tinputz, Una, Blackfoot, Navajo, Seneca
c. /L, Ø/ e.g. Malinke (Kita), Ruund, E. Cham, Galo, Kham, Dogrib, Tahltan, Bora, Miraña
d. /H, L, Ø/ e.g. Ga, Kinande, Margi, Sukuma, Tiriki, Munduruku, Puinave, Yagua

Another variant is to analyze level tones as /H/ vs. /Ø/, but contour tones as /HL/ and /LH/, as in Puinave: "L-tones are considered phonetic entities, which are therefore not specified lexically, except for the L-tones that are part of the contrastive contour tones" (Girón Higuita and Wetzels 2007).

Assuming the possibility of underspecification, similar analytical possibilities occur in three-height tone systems, as in (10).

(10) a. /H, M, L/ b. /H, Ø, L/ /Ø, M, L/ /H, M, Ø/ c. /H, M, L, Ø/

Beyond the above possibilities is the fact that in some systems M is a distinct third tone equally related to H and L, while in others M may be asymmetrically related to one of the tones. This produces output possibilities such as the following, where the ↑ and ↓ arrows represent raising and lowering, respectively:

(11) a. H, M, L	M is equally related to /H/ and /L/	e.g. Tangkhul Naga (pers. notes)
b. ↑H, H, L	M is a non-raised variant of /H/	e.g. Engenni (Thomas 1978)
c. H, ↓H, L	M is a lowered variant of /H/	e.g. Kom (Hyman 2005)
d. H, ↑L, L	M is a raised variant of /L/	e.g. Kpelle (Welmers 1962)
e. H, L, ↓L	M is a non-lowered variant of /L/	e.g. Ewe (Smith 1968, Stahlke 1971, Clements 1978)

While some languages have three underlying contrastive tone heights (11a), others derive the third height by the indicated process in (11b-e). As indicated in (12), both Kom and Ik have two underlying, but three surface tone heights:

(12) a. Kom /H, L/ L-H → L-M (→ M) (Hyman 2005)
b. Ik /H, L/ L-H → M-H (→ M) (Heine 1993)

Whereas Kom regularly lowers a H to M after L, Ik raises a L to M before H. Since the triggering tone may be lost, the M becomes surface-contrastive in both languages. Finally, M may derive from the simplification of a HL or LH contour tone, e.g. Babanki L-H͡L-H → L-M-H (Hyman 1979a: 23). The above possibilities arise independent of whether the raising or lowering process creates only one additional pitch level (as in the cited languages) or whether there can be multiple upsteps and downsteps. The above all assumes that tone features define pitch levels rather than pitch changes. In a pitch-change system such as Clark's (1978), the H, M and L tone heights could be represented as /↑/, /Ø/ and /↓/.

In principle, even more interpretations should be possible in systems with four or five surface-contrasting tone heights. Some such systems can be shown to derive from three (or even two) underlying tones, e.g. Ngamambo, whose four heights H, M, ↓M, L can be derived from /H/ and /L/ (Hyman 1986a).

While it is sometimes possible to argue that the four (~ five) tone heights form "natural classes" (see below), equally common are cases such as in (13) where such evidence is weak or lacking:

(13) a. Five levels: Kam (Shidong) [China] (Edmondson and Gregerson 1992) (5=highest, L=lowest)

ʈa^{11}	ʈa^{22}	ʈa^{33}	ʈa^{44}	ʈa^{55}
'thorn'	'eggplant'	'father'	'step over'	'cut down'

b. Four level + five contour tones in Itunyoso Trique [Mexico] (Dicanio 2008)

Level		*Falling*		*Rising*	
ββe^{4}	'hair'	li^{43}	'small'	yãh^{45}	'wax'
nne^{3}	'plough (n.)'	nne^{32}	'water'	yah^{13}	'dust'
nne^{2}	'to tell lie'	nne^{31}	'meat'		
nne^{1}	'naked'				

Where multiple contrasting tone heights join into natural classes the assumption is that they share a feature. For this purpose numerous tone-feature proposals have appeared in the literature, among which those in the following table, based on Chen (2000: 96), where 5 = the highest and 1 = the lowest pitch:

(14)

			5 (=H)	4	3 (=M)	2	1 (=L)
a.	Halle and	STIFF	+		-		-
	Stevens (1971)	SLACK	-		-		+
b.	Yip (1980)	UPPER	+	+		-	-
		HIGH	+	-		+	-
c.	Clements (1983)	ROW 1	h	h		l	l
		ROW 2	h	l		h	l
d.	Bao (1999)	STIFF	+	+		-	-
		SLACK	-	+		-	+
# < 455 lgs. with n tone heights:			12	26	140	367	

As seen in the top row, linguists often identify the tone heights with integers, as it is not even clear what to call the tones. Thus, in a four-height system, the middle two tones are sometimes called "raised mid" and "mid", sometimes "mid" and "lowered mid". There also is no agreement on which accents to use to indicate these two tones: While, [ā] unambigously indicates M tone in a three-height systems, in a four-height system it sometimes indicates the lower of the two M tones, sometimes the higher. The numbers in the bottom line of (14) indicate how many tone systems I have catalogued out of 545 with five, four, three and two underlying tone heights. As seen, systems with more than three heights are relatively rare as compared with two- and three-height systems.

For the purpose of discussion let us assume the following feature system, with Pulleyblank's (1986: 125) replacement of Yip's HIGH with RAISED:

(15) Yip/Pulleyblank tone feature system (M = a "lower-mid" tone)

	H	M	M	L
UPPER	+	+	-	-
RAISED	+	-	+	-
	4	3	2	1

The natural classes captured by such a system are the following:

(16)

[+UPPER]	[-UPPER]	[+RAISED]	[-RAISED]
H, M	M, L	H, M	M, L
4, 3	2, 1	4, 2	3, 1

The interesting groupings are those captured by [±RAISED], since the tone heights 4,2 and 3,1 are not contiguous. While such pairings are sometimes observed (see Gban in §3), there are problems inherent in this and the other feature proposals in (14):

(17) a. 5-height systems: no way to characterize a fifth contrasting tone height
b. 4-height systems: no way to characterize the inner two tone heights (3,2) as a natural class
c. 3-height systems: potential ambiguity between two kinds of mid tones (3 vs. 2)

Prior to the establishment of the feature system in (15), when features such as [HIGH] and [LOW] were in currency, the general response to the problem in (17a) was propose a third feature such as MID (Wang 1967), to expand the inventory in the mid range, or EXTREME (Maddieson 1971) which, expanding the inventory at the top and bottom, has the dubious property of grouping 1,5 as a natural class. Concerning the problem in (17b), either a [-EXTREME] specification, like [+MID], could group together the 3,2 tones in a four-height system. However, such features have not gained currency and appear almost as ad hoc as [αUPPER, -αRAISED]). Given that there are only five contrasting levels, the argument for three binary tone features is considerably weakened if there is no principled way to pare the eight logical feature combinations down to five height values. Of course, there is always the possibility that the same tone height might have different feature values in different tone systems, which brings us to the problem in (17c): The M tone in a three-height system can be either [+UPPER, -RAISED] or [-UPPER, +RAISED], an issue which is taken up in §3 and §4 below. All of these problems raise the question of how abstract the tonal representations should be allowed to be: A scalar pitch system with 2, 3, 4 or 5 values would be much more concrete, hence arguably the more natural solution were it not for the general acceptance of binary features or privative "elements" in segmental phonology and elsewhere, e.g. in morphology (Corbett and Baerman 2006).

In the following two sections we will take a close look at how the features in (15) fare in the analysis of selected three-height tone systems. §3 is concerned with tonal morphology and §4 with "abstract" tonal phonology. Both involve the potential featural ambiguity of phonetically identical M tones as [+UPPER, -RAISED] and [-UPPER, +RAISED], even in the same language. Although Bao (1999: 186) sees the dual representation of M as a virtue of the theory, we shall see that such tone features do not always yield a revealing account of M tone properties.

3. Tonal morphology and M tone

In this section we will examine how the tone features in (15) account for tonal morphology. Focus will be on tonal marking on verbs. One argument for tone features would be that they can function independently as tonal morphemes, e.g. marking the inflectional features of tense, aspect, mood, polarity, person and number. We begin with two four-level tone systems whose inflectional tones tell two quite different stories. The first is Iau, whose eight tone patterns in (3) were seen in to be lexical on nouns, but morphologically determined on verbs, as in (18).

(18)

	telic	*totality of action*	*resultative*
punctual	HL	H	LM
durative	HLM	ML	M
incompletive	HM	H↑H	

Although Iau verbs lend themselves to a paradigmatic display by morpheme features, the portmanteau tonal melodies do not appear to be further segmentable into single tones or features.

A quite different situation is found in the subject pronoun tones in Gban [Ivory Coast], as reported by Zheltov (2005: 24):

(19)

	present		*past*		
	sg.	*pl.*	*sg.*	*pl.*	
1st pers.	ĩ^{2}	u^{2}	ĩ^{4}	u^{4}	[+upper]
2nd pers.	εε^{2}	aa^{2}	εε^{4}	aa^{4}	
3rd pers.	ɛ^{1}	ɔ^{1}	ɛ^{3}	ɔ^{3}	[-upper]
	[-raised]		[+raised]		

In the present tense, third person subject pronouns are marked by a 1 tone (=lowest), while first and second person pronouns have a 2 tone. In the past tense, each tone is two levels higher: third persons receive 3 tone, while first and second persons have 4 tone. In this case tone features work like a charm: As indicated, first/second persons can be assumed to be marked by [+UPPER] and third person by [-UPPER]. These pronouns receive a [-RAISED] specification in the present tense vs. a [+RAISED] specification in the past tense. (The same result would be achieved if we were to reverse [UPPER] and [RAISED] to mark tense and person, respectively.)

It is cases like Gban which motivate Yip's (1980) original proposal, based on tonal bifurcation in East and Southeast Asia: If [±UPPER] represents the original tonal opposition, often attributable to a laryngeal distinction in syllable finals, [±RAISED] can potentially modify the original contrast and provide the four-way opposition (which does not always produce four tone levels in the Asian cases). As (19) demonstrates, the same historical development has produced a four-height system whose natural classes include 1,2 (present tense), 3,4 (past tense), 1,3 (first and second person) and 2,4 (third person). Although Gban is a Mande language, similar four-level systems are found in other subgroups of Niger-Congo, e.g. in Igede [Nigeria; Benue-Congo] (Stahlke 1977: 5) and Wobe [Liberia; Kru] (Singler 1984).

Given the neatness of the Gban example, let us now consider how the features [UPPER] and [RAISED] function as tonal morphemes in three-height systems. A number of languages have the tonal properties in (20).

(20) a. noun stems contrast /H/, /M/ and /L/ lexically
b. verb roots contrast only two levels lexically—but are realized with all three levels when inflectional features are spelled out

Again, it is the assignment of verb tones which is of interest. The relevant tone systems fall into two types, which are discussed in the following two subsections.

3.1. Type I: H/M vs. M/L verb tones

In the first, represented by Day [Chad] (Nougayrol 1979), the two verb classes have the higher/lower variants H/M vs. M/L:

(21) a.

		/yuu/ [+u] ‘put on, wear’	/yuu/ [-u] ‘drink’
completive	[+r]	yúú	yūu
incompletive	[-r]	yūū	yùù

b.

		/yuu, H/ ‘put on, wear’	/yuu, M/ ‘drink’
completive		yúú	yūu
incompletive	L-	yūū	yùù

c.

		/yuu/ [+2] ‘put on, wear’	/yuu/ [+1] ‘drink’
completive		yúú [+2]	yūū [+1]
incompletive	[-1]	yūū [+1]	yùù [Ø]

In (21a) the lexical contrast is assumed to be [±UPPER], while the (in)completive aspect assigns [±RAISED]. This produces a situation where both [+UPPER, -RAISED] and [-UPPER, +RAISED] define phonetically identical M tones. The question is how one might account for the above facts without features. (21b) posits a lexical contrast etween /H/ and /M/. The completive aspect is unmarked, while the incompletive aspect has a /L/ prefix which combines with the lexical tone of the verb. The resulting LH and LM contours would then have to simplify to M and L, respectively. Since contours are rare in the language (Nougayrol 1979: 68), this is not problematic. A corresponding scalar solution is sketched in (21c), where it is assumed that the /H/ and /M/ verbs have values of [+2] and [+1], respectively. As seen, completive aspect is unmarked, while incompletive aspect contributes a value of [-1]. When the integers combine, there are again two sources of [+1] M tone and one source each of [+2] H and [Ø] L tone.

While all three analyses capture the limited data in (21), the question is how they fare when the verb is bi- or trisyllabic. The regular tone patterns are schematized in (22).

(22)

	σ			σ–σ				σ–σ–σ
completive	M	H	HL	H-M	H-L	M-M	M-L	H-H-L
incompletive	L	M	ML	M-M	M-L	L-M	L-ML	M-M-L

As seen, bi-syllabic verbs must end M or L. (The final contour of L-ML will be discussed shortly.) The one regular trisyllabic pattern shows that it is only the last syllable that is affected, with inflectional [±RAISED] targeting the H-H ~ M-M on the first two syllables. Let us, therefore, add to the analysis in (21a) that the final syllable is [-UPPER] and contrastively prespecified for [±RAISED]. This produces the feature specifications in (23).

(23) underlying

	σ–σ		σ–σ		σ–σ		σ–σ	
UPPER	+	-	+	-	-	-	-	-
RAISED		+		-		+		-

completive

	H-M		H-L		M-M		M-L	
UPPER	+	-	+	-	-	-	-	-
RAISED	+	+	+	-	+	+	+	-

incompletive

	M-M		M-L		L-M		*L-L	
UPPER	+	-	+	-	-	-	-	-
RAISED	-	+	-	-	-	+	-	-

correct: L-ML

As seen, all of the tones come out correctly except for the bottom right hand form, where completive M-L is predicted to alternate with L-L rather than the correct L-ML. The /H, M, L/ analysis in (21b) is better

equipped to get the right output. Recall that in this analysis that verb roots are /H/ vs. /M/. When the incompletive L is prefixed to M-M and M-L inputs, we obtain the intermediate representations LM-M and LM-L. The LM-M becomes L-M by delinking the M from the first syllable. Assuming that the same happens in the second case, all that needs to be said is that the delinked M reassociates to the second syllable to produce the ML contour.

Since there is no input M in either the featural or scalar analyses, one might attempt to provide one by fully specifying verb roots, with a [+UPPER, +RAISED] /H/ verb becoming [+UPPER, -RAISED] M in the incompletive. (There would no longer be any need for a completive [+RAISED] prefix.) However, this still does not solve the problem. Since the M-L verb would have a [-UPPER, +RAISED] specification on its first syllable, the [-RAISED] incompletive prefix would only change the value of [RAISED], not delink it. We therefore would have to propose that the incompletive prefix is fully specified as [-UPPER, +RAISED]. What this does is make the analysis exactly identical to the /H, M, L/ analysis in (21b), where there was no need to refer to features at all. The same is true of the scalar analysis, where the [-1] incompletive prefix would have to contour with the [+1] M, as if it were a real tone, not a pitch-change feature. We conclude that there is no advantage of a featural analysis of tone in Day—or in Gokana [Nigeria] which has a similar system (Hyman 1985).

3.2. Type 2: H/L vs. M verb tones

There is a second type of system where nouns have a three-way lexical contrast between H, M and L and verbs a two-way contrast. While in the type 1 languages the two-way contrast is identifiable as a relatively higher vs. lower verb tone, in type 2 one verb class alternates between H and L, while the other is a non-alternating M. First documented in Bamileke-Fe'fe' (Hyman 1976), consider the H~L alternations on the first (= root) syllable of verbs in Leggbó (Hyman, Narrog, Paster and Udoh 2002), where the second tone is suffixal:

(24)

	MCA/ORA		*SRA*		*NEG*	
Root tone:	/L/	/M/	/L/	/M/	/L/	/M/
Perf./Prog.	H-M	M-M	L-M	M-M	H-M	M-M
Habitual	L-L	M-L	L-L	M-L	H-M	M-M
Irrealis	L-L	M-L	L-L	M-L	L-L	M-L

(MCA: main clause affirmative; SRA, ORA: subj./obj. relative affirmative)

Unless we adopt an ad hoc feature such as MID or EXTREME, there is no synchronic reason why H and L should alternate to the exclusion of M. Paster's (2003) solution is to propose that L is the underspecfied tone in Leggbó such that H or L prefixes can be assigned to it. A M root would resist these prefixal tones since it is specified. The solution has some appeal as Leggbó has only a few LH and HL tonal contours, hence little need to prespecify L tone. However, it cannot work for Bamileke-Fe'fe', which has numerous LM contours and floating L tones. While Hyman (1976) provided an abstract analysis involving floating H tones on both sides of the L, the alternative is to simply accept the arbitrariness of the H/L alternations, which represent morphological processes of "replacive" tone. In this respect they no more need to have a featural account than the replacive tone sandhi of Southern Min dialects, e.g. Xiamen 24, 44 → 22 → 21 → 53 → 44 (Chen 1987). Type 2 systems thus provide even less evidence for tone features than type 1.

4. Tonal phonology and M tone

While the previous section sought evidence for features from the behavior of tonal morphemes which are assigned to verb forms, in this section we shall seek purely phonological evidence for features in three-

height tone systems. Since the systems in (14b-d) provide four distinct feature configurations they also make the prediction that a three-height system could have two phonologically contrasting tones which are phonetically identical, as summarized in (25)

(25) a. /4/ and /3/ could be two kinds of phonetic H tone
b. /3/ and /2/ could be two kinds of phonetic M tone
c. /2/ and /1/ could be two kinds of phonetic L tone

In the following subsections we shall consider Villa Alta Yatzachi Zapotec, which represents (25c), and Kagwe (Dida), which represents (25b). The question will be whether tone features can be helpful in accounting for such behaviors.

4.1. Two kinds of L tone in Villa Alta Yatzachi Zapotec

According to Pike (1948), Villa Alta Yatzachi Zapotec [Mexico] has three surface tones, H, M, and L, as well as HM and MH contours on monosyllabic words. However, there are two kinds of L tones: those which remain L in context vs. those which alternate with M. Pike refers to these as class A vs. class B, respectively. In (26), these are identified as L_a and L_b:

(26) a. $L_b \rightarrow M \;/\; \_\_ \{M, H\}$
b. L_a : bìa ‘cactus’ bìa gōlī ‘old cactus’
L_b : bìa ‘animal’ bīa gōlī ‘old animal’

Rule (26a) says that class B L tones are raised to M before a M or H tone. As seen in (26b), there are actual minimal pairs, i.e. words which are phonetically identical in isolation but which have different behaviors in the raising context. Assuming that we do not want to identify the two L tones by means of a diacritic, as Pike does, there are two possible featural strategies we might attempt. The first in (27a) is to fully specify L_b as [-UPPER, +RAISED], a lower-mid (M̲) tone, featurally distinct from both M and L:

(27) a. *L_b is fully specified as /M̲/*

	H	M	L_b	L
UPPER	+	+	-	-
RAISED	+	-	+	-

b. *L_b is underspecified for [RAISED]*

	H	M	L_b	L
UPPER	+	-	-	-
RAISED	+	+		-

The second strategy in (27b) is to underspecify L_b for exactly the feature that alternates, namely [RAISED]. This makes L_b featurally non-distinct from both /M/ and /L/. The rules needed under each analysis are formulated in (28).

(28) a. if L_b is fully specified as [-UPPER, +RAISED]
[-UPPER, +RAISED] → [-RAISED] / __ [-UPPER, -RAISED]
b. if L_b is underspecified for [RAISED]
[o RAISED] → [α RAISED] / __ [α RAISED]

In (28a) the lower-mid tone becomes L when followed by L. Since the lowering has to occur also before pause, we would have to assume a prepausal L% boundary tone. In (28b), the underspecified [RAISED] feature acquires the same value as what follows it, thereby becoming [+RAISED] before H and M, but [-raised] before L(%). Except for the dubious use of the alpha notation, both analyses seem reasonable up to this point.

Now consider a second process where the H of the second part of a compound is lowered to M after both L_a and L_b:

(29) a. /dè-/ (L_a) 'denominalizer' + /zíẓ/ 'sweet' → dèzīẓ 'a sweet'
b. /nìs/ (L_b) 'water' + yíʔ 'fire' → nīsyīʔ 'kerosene'

Assuming this is assimilation rather than reduction (perhaps questionable), the rules would be as follows:

(30) a. if L_b is fully specified as fourth tone [-UPPER, +RAISED]
[+UPPER] → [-RAISED] / [-UPPER] # __
b. if L_b is underspecified for [RAISED]
[+UPPER] → [-UPPER] / { [-UPPER, {-RAISED, o RAISED}] # __

Each of the above rules has a problem. In (30a), the change of feature value is not explicitly formalized as an assimilation, e.g. by spreading of a feature. Instead, [+UPPER] changes to [-RAISED] after [-UPPER]. The rule in (30b) can be expressed as the spreading of a preceding [-UPPER], but requires the awkward disjunction in the environment so that M tone, which is [-UPPER, +RAISED], does not condition the rule. Note that one cannot first fill in [o RAISED] as [-RAISED], since, as seen in (29b), [o RAISED] becomes [+RAISED] by the rule in (28b). It is thus not obvious that features are helpful in distinguishing the two kinds of L tone in this language.

4.2. Two kinds of M tone in Kagwe (Dida)

The problem is even more acute in Kagwe (Dida) [Ivory Coast], which has two types of M tone (Koopman and Sportiche 1982): /M/ (class A) alternates between M and H, while /M/ (class B) remains M. The rule in question is formulated in (31a).

(31) a. M_a → H / M_a __ otherwise M_a → M (= M_b)

b. M_a :	lē	'spear'	mànā	lé	'this spear'
	jō	'child'	mànā	jó	'this child'
c. M_b :	kpʌ̄	'bench'	mànā	kpʌ̄	'this bank'
	lɔ̄	'elephants'	mànā	lɔ̄	'these elephants'

As indicated, M_a becomes H after another M_a. Alternations are seen after the L-M_a word *mànā* 'this/these' in (31b). M_b tones do not change after *mànā* in (31c).

As in the case of Zapotec L_b, two possible underlying representations of M_a are considered in (32).

(32)

a. *M_a is fully specified as /M/*

	H	M_a	M_b	L
UPPER	+	+	-	-
RAISED	+	-	+	-

b. *M_a is underspecified for [UPPER]*

	H	M_a	M_b	L
UPPER	+		-	-
RAISED	+	+	+	-

In (32a), M_a is fully specified as M vs. phonetically identical M_b, which has the features of a lower-mid. In (32b), M_a is underspecified for the feature which alternates, namely [UPPER], hence is non-distinct from both /H/ and /M_b/. The rules needed under each of these analyses are formulated in (33).

(33) a. M_a is fully specified as [+UPPER, -RAISED]

[+UPPER, -RAISED] → [+RAISED] / [+UPPER, -RAISED] __

b. M_a is underspecified for [UPPER]

[o UPPER] → [+UPPER] / [o UPPER] __
[o UPPER] → [-UPPER]

In (33a), the raising rule appears to be dissimilatory, perhaps an OCP effect? The question here is why the language would not permit a succession of abstract [+UPPER, -RAISED] tones, at the same time allowing phonetically identical [M-M] sequences from three other sources: /M_a-M_b/, /M_b-M_a/, /M_b-M_b/. The rule would make sense only if Kagwe has an output condition *[+UPPER, -RAISED], with all remaining such tones converting to [-UPPER, +RAISED]. However, this would be a very abstract analysis indeed. The rule in (33b) is even more suspect: Why should [o UPPER] become [+UPPER] only if preceded by another [o UPPER]?

While Koopman and Sportiche (1982) do point out that other Dida dialects have four contrasting tone heights as suggested by the matrix in (32a), there are other possible analyses of M_a. One is to treat M_a as /M/ and M_b as /Ø/. The dissimilation rule would thus become M → H / M __. Even better is to represent M_a either as a MH contour tone, as in (34a), or as a M tone followed by a floating H, as in (34b).

(34) a. M_a as a contour b. M_a as M + floating H c. M_a → H as plateauing

If M_a is analyzed as M followed by floating H, as in (34b), the "raising" rule can be formulated as a common case of H tone plateauing, as in (34c). In fact, one might even attempt such an interpretation of Villa Alta Yatzachi Zapotec L_b, which could be a L followed (preceded?) by a floating M. What this means is that featural analyses may in some cases be denecessitated by the availability of contour representations and floating tones. Both of the representations in (34a,b) at least give a principled reason why M_a becomes H after another M_a.

4.3. Lowered or downstepped M tone?

In the preceding two subsections we have considered two three-height tone systems which have two classes of phonetically identical tones: L_a vs. L_b in Villa Alta Yatzachi Zapotec and M_a vs. M_b in Kagwe. While these L_b and M_a alternate with M and H, respectively, the output system still remains one of three tone heights. A slightly different situation is found in Jibu [Nigeria] (Van Dyken 1974: 89), whose "class 1" vs. "class 2" M tone properties are summarized and exemplified in (35).

(35) a. "a class 2 mid tone is lowered when it follows a class 1 mid tone."

tī ↓wa̱n žà 'he is buying cloth' (tī = M_1, wa̱n = M_2)

b. "both a class 1 mid tone and a class 2 mid tone are lowered when they follow a lowered mid tone."

kū sā ↓bāi bū 'he made bad thing' (kū, sā, bū = M_1, bāi = M_2)

As indicated, Jibu appears to have a surface four-height system with the need to distinguish between two types of "M" tone. Since it is M_2 which undergoes lowering, it seems appropriate to analyze it as involving a L+M sequence in one of the ways in (36).

(36) a. M_2 as a contour

b. M_2 as floating L + linked M

What is crucial in this process is that M_2 establishes a new (lower) M level to which all subsequent M tones assimilate. Thus, in (35b), M_1 *bū* is realized on the same level as the preceding tone of ˡ*bāi* and not higher. The prediction of the [UPPER] and [RAISED] tone features is that the inner two tones of a four-height system should not be systematically related, since they bear opposite values of both features. In fact in every case I know where M assimilates to M after another M, the latter can be interpreted as a non-iteratively downstepped ˡM, as in Jibu, Gwari, Gokana, Ngamambo etc. (Hyman 1979a, 1986a), and possibly Bariba, the example which Clements, Michaud and Patin (2009) cite. This observation raises the question of whether iterative ˡH, ˡM, and ˡL downsteps should be captured by a feature system vs. an independent register node or tier (cf. the same question concerning the relation between vowel height and ATR (Clements 1991)).

In summary, while M tones should provide unambiguous evidence for features, instead questions arise due to their phonological properties (recall (11)). For every case where tone features appear to be useful, or at least usable, there is another case where they either don't provide any insight or run into difficulties. Why this may be so is the issue with which I conclude in §5.

§5. Conclusion

From the preceding sections we conclude that the case for tonal features is not particularly strong. This is revealed both from the specific examples that have been examined as well as the widespread practice of referring to tones in terms of H, M, L or integers. Let us now revise and reorder the questions that were raised in (1) and ask:

(37) a. Why is tone different?
b. Why is the case for tone features so weak?
c. Why isn't tone universal?

It turns out that the answer to all three questions is the same: Tone is different because of its greater diversity and autonomy compared to segmental phonology. Because of its diversity tone is hard to reduce to a single set of features that will do all tricks. Because of its autonomy, feature systems that have been proposed, even those which relate tones to laryngeal gestures, are not reliable except perhaps at the phonetic level. Given that tone is so diverse and so poorly "gridded in" with the rest of phonology, it is not a good candidate for universality. Let us consider the two notions of diversity and autonomy a bit further.

In the preceding sections we have caught only a glimpse of the extraordinary diversity of tone systems. Languages may treat tone as privative, /H, Ø/, equipollent, /H, L/, or both, /H, L, Ø/. Given that F_0, the primary phonetic correlate of tone, is scalar, the question is whether some systems treat tone as "gradual":

> "*Gradual* oppositions are oppositions in which the members are characterized by various degrees or graduations of the same property. For example: the opposition between two different degrees of aperture in vowels... or between various degrees of tonality.... Gradual oppositions are relatively rare and not as important as privative oppositions." (Trubetzkoy 1939 [1969]: 75)

Because of the phonetically gradient nature of tone, the use of integers to represent tone heights has some appeal. Speakers are capable of distinguishing up to five tone heights and all of the pitch changes between them, whether as contours within a single syllable or as steps up and down between syllables. Preserving the pitch changes between syllables sometimes has interesting effects in tonal alternations. As seen in (37a), in the Leggbó 'N_1 of N_2' construction, if the second noun has a L prefix, it will be raised to M (the genitive marker /ā/ is optionally deleted):

(37)									
	a.	L-L	→	M-L	gè-bòò	'squirrel'	:	lídzīl ā gēbòò	'food of squirrel'
					lì-gwàl	'leaf'	:	īzù ā līgwàl	'odor of leaf'
	b.	L-M	→	M-H	lì-zōl	'bird'	:	gèmmà ā līzól	'beak' (mouth of bird)
					gè-dī	'palm'	:	ànààn ā gēdí	'palm oil'
	c.	L-M-M	→	L-H-M	gè-kɔ̄mɔ̄	'disease'	:	ìzɛ̀ī ā gēkɔ́mɔ̄	'cause of disease'
					è-kāālā	'European'	:	èttɔ̄ ā ēkáālā	'house of European'
	d.	M-M	→	M-M	ē-ppyā	'market'	:	lèdzìl ā ēppyā	'day of market'
		H-M	→	H-M	lí-dzīl	'food'	:	ēvvén ā lídzīl	'place of food'

As seen in (37b), if N_2 has a L prefix and a M stem-initial syllable, the L-M sequence will become M-H. It is as if the raising process were one of upstep, $^{\uparrow}$/L-M/, designed to preserve the step up between the L and M syllables of the input. The fact that only the first syllable of a M-M stem is affected in (37c) is neatly accounted for by Steriade (2009): Although the output preserves the pitch change of /L-M/, there is no requirement to preserve the *lack* of a pitch change of a /M-M/ input. The examples in (37d) show that there is no change if the N_2 has a M or H prefix.

To appreciate further how some tone systems care about such "syntagmatic faithfulness", consider the realization of /L-HL-H/ in the following Grassfields Bantu languages [Cameroon]:

(38)	*Language*	*Output*	*Process*	*Reference*
a.	Mankon	L-H-$^{\uparrow}$H	H-upstep	Leroy (1979)
b.	Babanki	L-M-H	HL-fusion	Hyman (1979b)
c.	Babadjou	L-H-$^{\downarrow}$H	H-downstep	(personal notes)
d.	Dschang	L-$^{\downarrow}$H-H	HL-fusion+downstep	Hyman and Tadadjeu (1976)
e.	Kom	L-M-M	H-lowering	Hyman (2005)
f.	Aghem	L-H-H	L-deletion	Hyman (1986b)

While all four languages simplify the HL input, thereby minimizing the number of ups and downs (Hyman 1979a: 24) and all preserve a trace of both the H and the L, they make different choices as to what to preserve in terms of the syntagmatic relations. The upstep in Mankon is similar to what was seen in Leggbó: when the L of HL-H delinks, the rise to the next tone is preserved by means of upstepping the following H. Similarly, the step up is preserved in Babanki, this time by fusing the HL to a M tone. While the H-$^{\downarrow}$H in Babadjou realizes the drop that should have occurred between the two Hs, there is no pitch change between the second and third syllables in Bamileke-Dschang and Kom, which unambigously encode the lost L, or in Aghem, which shows no trace of the L at all.

Having established some of the extraordinary diversity of tone systems, let us now address the issue of autonomy. Tone, of course, was the original autosegmental property (Goldsmith 1976), and there is no problem demonstrating the advantages of representing tone on a tier separate both from its TBU and from the segmental features. Although tones require segments in order to be pronounced, I would argue that tones are not reliably integrated into a system of articulatory or acoustic features the way consonants and vowels are. For example, [+high, -low] not only defines a class of high vowels, /i, ü, ɯ, u/, with F_1 and F_2 defining a two-dimension "gridded" vowel space, but also a systematic intersection with palatal and velar

consonants (Chomsky and Halle 1968). [+UPPER, -RAISED], on the other hand, only defines a H tone, not a class of tones. We might therefore switch to [+STIFF, -SLACK] (Halle and Stevens 1971) to relate H tone to voiceless obstruents and implosives and L tone to voiced and breathy voiced onbstruents. While intersections of tones with laryngeal features or phonation types (aspiration, breathiness, glottalization, voicing) appear to provide evidence that tone features are "gridded in", note first that [±STIFF, ±SLACK] define only three possibilities, whereas there can be up to five contrasting tone heights. More importantly, tone-laryngeal interactions are notoriously unreliable. As has been long known from diachronic studies in Southeast Asia and Athabaskan, the same laryngeal source can correspond diachronically to either H or L (see the various papers in Hargus and Rice 2005). Within Southern Bantu, so-called depressor consonants are not necessarily voiced (Schachter 1976, Traill 1990, Downing 2009). Even implosives, long held to be "pitch raisers", show inconsistent tonal correspondences (Tang 2008). A particularly striking anti-phonetic case comes from Skou [Indonesia: Papua], where "there are no words with a L tone melody in which any syllable has a voiced stop onset" (Donohue 2004:87). This is reminiscent of Newman's (1974:14) description of Kanakuru verbs, which are H-L after voiced obstruents, L-H after voiceless obstruents and implosives, and contrastively H-L vs. L-H when sonorant-initial.

While [UPPER] and [RAISED] and the comparable systems in (14c,d) were designed to mirror diachronic, laryngeally-induced tonal bifurcations in Chinese and elsewhere, the synchronic reflexes may involve a level vs. contour contrast, rather than producing a four-height tonal system:

(39) a. Thakali (Hari 1971: 26)

	level	*falling*
tense	H	HL
lax	L	LHL

b. Grebo (based on Newman 1986: 178)

	level	*rising*
[+RAISED]	M	MH
[-RAISED]	L	LM

Starting with a /H/ vs. /HL/ contrast in Thakali [Nepal], a lower ("lax") register adds an initial L feature which converts /H/ to L, but combines with the HL to produce a LHL contour tone. However, as Mazaudon and Michaud (2008: 253-4) point out for closely related Tamang, the 2 x 2 pairings are not always obvious. The same can be said about Chinese, where Bao's (1999) tone sandhi analyses in terms of two sets of features {H, L} and {h, l}, as well as {hl} and {lh} contours, lend themselves to alternative interpretation and "do not come without complication" (Hyman 2003: 281).

In fact, it is not clear that diachronic developments inevitably lead to the positing of tone features. Mazaudon (1988: 1) argues that tones do not change by shared features, rather "each tone follows its own path." I.e. *Jeder Ton hat seine eigene Geschichte*. As in the present paper, she finds little value in analyzing tones in terms of features:

> "It seems to me that tones are simply *different* from segments and should be treated differently in the phonology.... My best present proposal would be that tones do not break up into features until the phonetic level, and that consequently these 'features' (which I propose to call 'parameters' to distinguish them clearly from *distinctive* features) are inaccessible to the phonology." (Mazaudon 1988: 7)

Nowhere is this clearer than in those systems where one tone is arbitrarily replaced by another. As mentioned above, in non-phrase-final position in Xiamen every tone is replaced by an alternate tone, as follows: 24, 44 → 22 → 21 → 53 → 44 (Chen 1987). Despite attempts, any featural analysis of such scales is hopeless. Mortensen (2006) cites a number of other tone chains which are quite abstract and diverge significantly from following a phonetic scale such as L → M → H. I would argue that tone is capable of greater abstractness than segmental phonology—or, at least, that comparable abstract analyses are better supported in tone than elsewhere. This has to do with the greater extractability of pitch and tonal patterns than segmental distributions: Thus, the Xiamen "tone circle" is clearly productive, while the

synchronic status of the Great English Vowel Shift is more controversial. The greater autonomy and extractability of tone are also responsible for its more extensive activity at the phrase level, as seen in morphophonemic alternations in Chinese, Otomanguean, African and other tone systems.

In short, tone is the most isolable gesture-based phonological property. This property is undoubtedly related to the fact that pitch also provides the best, if not universal expression of intonation, marking whole clauses and utterances. However, lexical, post-lexical, and intonational tones cannot be pronounced by themselves, unlike vowels and most consonants whose features may produce pronounceable segments of themselves. In fact, Harris and Lindsey (1995) and Harris (2004) have developed a "minimalist" approach to segmental features where no representation is unpronounceable. It is hard to see how this could be extended to tone, since a pitch feature cannot be pronounced by itself. While one might think that this would force tone to become inextricably tied to segments, just the reverse is true: Tone is highly independent (autosegmental) and free to enter into abstract relationships including many which defy a featural interpretation. Of course tone is not alone in having these properties. Length and metrical stress, two other non-featural prosodic properties, also show high autonomy. However, neither vowel nor consonant length has the complexity of tone, as contrasts are normally limited to two values, long vs. short. While stress is both complex and abstract like tone, it is typically (definitionally?) word bound. We thus return to the initial observation: Tone can do everything that non-tonal phonology can do, but not vice-versa. While some languages require every word to have a H tone, like word-stress, no language requires every word to have a stop or a high vowel. Thus, if tones consists of features, they are the only features that can be obligatorily required of a word. To conclude, there seems to be little advantage to treating tones other than the way that most tonologists treat them: as privative elements that are related to each other through their relative and scalar phonetic properties (cf. Mazaudon above). It thus may make most sense to adopt the integer system even for two-height systems: /H, L/ = /2, 1/, /H, M, L/ = /3, 2, 1/, and so forth.

References

Anderson, Stephen R.
1978. Tone features. In Victoria Fromkin (ed.), *Tone: A Linguistic Survey*, 133-175. New York: Academic Press.
Bao, Zhiming.
1999. *The Structure of Tone*. New York and Oxford: Oxford University Press.
Chen, Matthew.
1987. The syntax of Xiamen tone sandhi. *Phonology [Yearbook]* 4.109-149.
2000. *Tone Sandhi*. Cambridge University Press.
Clark, Mary M.
1978. *A dynamic treatment of tone with special attention to the tonal system of Igbo*. Bloomington: IULC.
Clements, G. N.
1978. Tone and syntax in Ewe. In Donna Jo Napoli (ed.), *Elements of Tone, Stress and Intonation*, 21-99. Washington, D.C.: Georgetown University Press.
1983. The hierarchical representation of tone features. In Ivan R. Dihoff (ed.), *Current Approaches to African Linguistics* (vol. 1), 145-176. Dordrecht: Foris.
1991. Vowel height assimilation in Bantu languages. *Proceedings of the Seventeenth Annual Meeting of the Berkeley Linguistics Society*, Special Session on African Language Structures, 25-64.
2005. The role of features in phonological inventories. Presented at Journée "Les géometries de traits/Feature geometries", Université de Paris 8 and Fédération Typologie et Universaux en Linguistique (TUL), Paris, 3 December 2005 (powerpoint in English).
Clements, G. N., Alexis Michaud and Cédric Patin.
2009. Do we need tone features? Paper presented at the Symposium on Tones and Features, University of Chicago Paris Center, June 18-19, 2009.
Corbett, Greville G. and Matthew Baerman.

2006. Prologomena to a typology of morphological features. *Morphology* 16.231-246.
Demuth, Katherine.
2003. The acquisition of Bantu languages. In Derek Nurse and Gérard Philippson (eds.), *The Bantu Languages*, 209-222. London: Routledge.
Donohue, Mark.
2004. *A grammar of the Skou Language of New Guinea*. Ms. National University of Singapore. http://rspas.anu.edu.au/~donohue/Skou/index.html
Downing, Laura J.
2009. On pitch lowering not linked to voicing: Nguni and Shona group depressors. In Michael Kenstowicz (ed.), *Data and Theory: Papers in Phonology in Celebration of Charles W. Kisseberth. Language Sciences* 31.179-198.
Girón Higuita, J.M. and W. Leo Wetzels.
2007. Tone in Wãnsöhöt (Puinave), Colombia'. In W. Leo Wetzels (ed.), *Language Endangerment and Endangered Languages: Linguistic and Anthropological Studies with Special Emphasis on the Languages and Cultures of the Andean-Amazonian Border Area*, 129-156. Leiden: CNWS.
Goldsmith, John.
1976. *Autosegmental phonology*. Doctoral dissertation. Massachusetts Institute of Technology.
Halle, Morris and Kenneth Stevens.
1971. A note on laryngeal features. *Quarterly Progress Report* 101.198-213. Research Laboratory of Electronics, MIT.
Hargus, Sharon and Keren Rice (eds.).
2005. *Athabaskan Prosody*. Amsterdam: John Benjamins.
Hari, Maria.
1971. *A guide to Thakali tone. Part II to Guide to Tone in Nepal*. Tribhvan University, Kathmandu: SIL.
Harris, John.
2004. Release the captive coda: the foot as a domain of phonetic interpretation. In J. Local, R. Ogden and R. Temple (eds.), *Phonetic Interpretation: Papers in Laboratory Phonology* 6, 103-129. Cambridge: Cambridge University Press.
Harris, John and Geoffrey Lindsey.
1995. The elements of phonological representation. In Jacques Durand and Francis Katamba (eds.), *Frontiers of Phonology: Atoms, Structures, Derivations*, 34-79. Harlow, Essex: Longman.
Heine, Bernd.
1993. *Ik Dictionary*. Köln: Rüdiger Köppe Verlag.
Hyman, Larry M.
1976. D'où vient le ton haut du bamileke-fe'fe'? In Larry M. Hyman, Leon C. Jacobson and Russell G. Schuh (eds.), *Papers in African linguistics in Honor of Wm. E. Welmers*, 123-134. *Studies in African Linguistics*, Supplement 6. Los Angeles: University of California, Los Angeles.
1979a. A reanalysis of tonal downstep. *Journal of African Languages and Linguistics* 1.9-29.
1979b. Tonology of the Babanki noun. *Studies in African linguistics* 10.159-178
1985. *A Theory of Phonological Weight*. Dordrecht: Foris Publications.
1986a. The representation of multiple tone heights. In K. Bogers, H. van der Hulst, and M. Mous (eds.), *The Phonological Representation of Suprasegmentals*, 109-152. Dordrecht: Foris.
1986b. Downstep deletion in Aghem. In David Odden (ed.), *Current Approaches to African Linguistics*, vol. 4, 209-222. Dordrecht: Foris Publications.
2003. Review of Bao, Zhiming. 1999. *The Structure of Tone*. New York and Oxford. Oxford University Press. *Linguistic Typology* 7.279-285.
2005. Initial vowel and prefix tone in Kom: Related to the Bantu Augment? In Koen Bostoen and Jacky Maniacky (eds.), *Studies in African Comparative Linguistics with Special Focus on Bantu and Mande: Essays in Honour of Y. Bastin and C. Grégoire, 313-341.* Köln: Rüdiger Köppe Verlag.
In press. Tone: is it different? To appear in John Goldsmith, Jason Riggle and Alan Yu (eds.), *The Handbook of Phonological Theory*, 2nd Edition. Blackwell.

Hyman, Larry M., Heiko Narrog, Mary Paster, and Imelda Udoh.
2002. Leggbó verb inflection: A semantic and phonological particle analysis. *Proceedings of the 28th Annual Berkeley Linguistic Society Meeting*, 399-410.
Hyman, Larry M. and Maurice Tadadjeu.
1976. Floating tones in Mbam-Nkam. In Larry M. Hyman (ed.), *Studies in Bantu Tonology*, 57-111. Southern California Occasional Papers in Linguistics 3. Los Angeles: University of Southern California.
Kisseberth, Charles W.
2009. The theory of prosodic phrasing: the Chimwiini evidence. Paper presented at the 40th Annual Conference on African Linguistics, University of Illinois, Urbana-Champaign, April 9-11, 2009.
Koopman, Hilda and Dominique Sportiche.
1982. Le ton abstrait du kagwe. In Jonathan Kaye, Hilda Koopman and Dominique Sportiche (eds.), *Projet sur les Langues Kru*, 46-59. Montreal: UQAM.
Li, Charles N. and Sandra A. Thompson.
1977. The acquisition of tone in Mandarin-Speaking Children. *Journal of Child Language* 4.185-199.
Maddieson, Ian.
1971. The inventory of features. In Ian Maddieson (ed.), *Tone in Generative Phonology*, 3-18. *Research Notes* 3. Department of Linguistics and Nigerian Languages, University of Ibadan.
Mazaudon, Martine.
1988. An historical argument against tone features. Paper presented at the Annual Meeting of the Linguistic Society of America, New Orleans.
2003. Tamang. In Thurgood, Graham and Randy J. LaPolla. *The Sino-Tibetan Languages*, 291-314. London and New York: Routledge.
Mazaudon, Martine and Alexis Michaud.
2008. Tonal contrasts and initial consonants: A case study of Tamang, a "missing link" in tonogenesis. *Phonetica* 65.231-256.
Mortensen, David R.
2006. *Logical and substantive scales in phonology.* Doctoral dissertation. University of California, Berkeley.
Myers, James and Jane Tsay.
2003. A formal functional model of tone. *Language and Linguistics* 4.105-138.
Newman, Paul.
1974. *The Kanakuru Grammar*. Leeds: Institute of Modern English Language Studies, University of Leeds, in association with the West African Linguistic Society, 1974.
1986. Contour tones as phonemic primes in Grebo. In Koen Bogers, Harry van der Hulst, and Maarten Mous (eds.), *The Phonological Representation of Suprasegmentals*, 175-193. Dordrecht: Foris.
Nougayrol, Pierre.
1979. Le day de bouna (Tschad). I. *Eléments de Description Linguistique*. Paris: SELAF.
Paster, Mary.
2003. Tone specification in Leggbo. In John M. Mugane (ed.), *Linguistic Description: Typology and Representation of African Languages. Trends in African Linguistics* 8.139-150.
Pike, Eunice Victoria.
1948. Problems in Zapotec tone analysis. *IJAL* 14.161-170. Reprinted in Ruth M. Brend (ed.), *Studies in Tone and Intonation*, 84-99. Basel: S. Karger.
Pulleyblank, Douglas.
1986. *Tone in Lexical Phonology*. Dordrecht: D. Reidel.
Schachter, Paul.
1976. An unnatural class of consonants in Siswati. In Larry M. Hyman, Leon C. Jacobson and Russell G. Schuh (eds.), *Papers in African linguistics in Honor of Wm. E. Welmers, 211-220. Studies in African Linguistics*, Supplement 6.
Singler, John Victor.
1984. On the underlying representation of contour tones in Wobe. *Studies in African Linguistics* 15.59-75.

Smith, Neil.
1968. Tone in Ewe. Quarterly Progress Report No. 88, 290-304. Cambridge, MA: MIT Research Laboratory of Electronics. Reprinted (1973) in Eric E. Fudge (ed.), *Phonology*. London: Penguin.
Snider, Keith.
1999. *The geometry and features of tone*. Dallas: Summer Institute of Linguistics.
Stahlke, Herbert.
1971. The noun prefix in Ewe. *Studies in African Linguistics*, Supplement 2, 141-159.
1977. Some problems with binary features for tone. *International Journal of American Linguistics* 43.1-10.
Steriade, Donca.
2009. Contour correspondence: tonal and segmental evidence. Paper presented at Tones and Features: A Symposium to Honor Nick Clements Paris, June 18-19, 2009.
Thomas, Elaine.
1978. *A Grammatical Description of the Engenni Language*. University of Texas at Arlington: Summer Institute of Linguistics.
Traill, Anthony.
1990. Depression without depressors. *South African Journal of African Languages* 10.166–172.
Trubetzkoy, N.S.
1939 [1969]. *Principles of Phonology*. Translated by Christiane A. M. Baltaxe. Berkeley: University of California Press.
van Dyken, Julia.
1974. In John Bendor-Samuel (ed.), *Ten Nigerian Tone Systems*, 87-92. *Studies in Nigerian Languages*, 4. Jos and Kano: Institute of Linguistics and Centre for the Study of Nigerian Languages.
Wang, William S.-Y.
1967. Phonological features for tone. *International Journal of American Linguistic*s 33.93-105.
Welmers, William E.
1962. The phonology of Kpelle. *Journal of African Languages* 1.69-93.
1973. *African Language Structures*. Berkeley and Los Angeles: University of California Press.
Yip, Moira.
1980. *The tonal phonology of Chinese*. Doctoral dissertation, M.I.T.
1995. Tone in East Asian Languages. In John Goldsmith (ed.), *Handbook of Phonological Theory*, 476-494. Oxford: Basil Blackwell.
2002. *Tone*. Cambridge University Press.
Zheltov, Alexander.
2005. Le système des marqueurs de personnes en gban: Morphème syncrétique ou syncrétisme des morphèmes. *Mandenkan* 41.23-28.