Word prosody II: Tone systems*

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1. Introduction: What is tone?

All languages use "tone" if what is meant is either pitch or the F0 variations that are unavoidable in spoken language. However, this is not what is generally meant when the term is used by phonologists. Instead, there is a major typological split between those languages that use tone to distinguish morphemes and words vs. those that do not. Found in large numbers of languages in Sub-Saharan Africa, East and Southeast Asia, parts of New Guinea, Mexico, the Northwest Amazon and elsewhere, tone can be used to distinguish lexical morphemes (e.g. noun and verb roots) or grammatical functions. Thus, in the following examples the same eight-way tonal contrast has a lexical function on nouns, but marks the indicated grammatical distinctions on the verb /ba/ 'come' in Iau [Lakes Plain; West Papua] (Bateman 1990:35-36):[1]

Tone	*Nouns*		*Verbs*		*Inflectional meaning*
H	bé	'father-in-law'	bá	'came'	*totality of action punctual*
M	bē	'fire'	bā	'has come'	*resultative durative*
HS	bé̋	'snake'	bá̋	'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	bè	'small eel'	bà	'come (process)'	*totality of action durative*
HLM	bē̂	'tree fern'	bā̂	'sticking, attached to'	*telic durative*

Table 1. Tonal contrasts in Iau

As the above monosyllabic examples make clear, tone can be a crucial exponent of morphemes, which may be distinguished only by tone. While Iau tone is hence densely paradigmatic, at the other end of the spectrum tone can be quite sparse and syntagmatic. This is the case in Chimwiini [Bantu; Somalia], where a single H tone contrasts with zero (Ø), is strictly grammatical (nouns and verbs are underlyingly toneless), and can occur only on the final or penultimate syllable of a phonological phrase (Kisseberth & Abasheikh 2011:1994):

(1) a. n-jile: n̪ɑmá 'I ate meat' n-jile ma-tu:ndá 'I ate fruit'
b. jile: n̪ɑmá 'you sg. ate meat' jile ma-tu:ndá 'you sg. ate fruit'

* We dedicate this chapter to the memory of our dear friend and colleague of over four decades, Russell G. Schuh, who loved tone as much as we do.

[1] In these examples and elsewhere H = high (˴), M = mid (˗), L = low (˵) and S = superhigh (˝). HS thus represents a contour which rises from high to superhigh tone.

c. jile: n̪ámɑ ‘s/he ate meat’ jile ma-tú:nda ‘s/he ate fruit’

As seen from the above examples, the H tone will occur phrase-finally in the past tense if the subject prefix on the verb is either first or second person. Otherwise the phonological phrase will receive a default penultimate H.

1.1. Tone as toneme vs. morphotoneme

Comparisons of Iau and Chimwiini, representing two extremes, reveal two different approaches to tonal contrasts, which are exemplified by two pioneers in the study of tone. For Kenneth Pike the presence of tone had to do with surface phonological contrasts. Hence, a language with tone is one “having significant, contrastive, but relative pitch on each syllable” (K. Pike 1948:3). For William E. Welmers, on the other hand, tone was seen to be an underlying property of morphemes. Hence, a tone language is one “... in which both pitch phonemes [read: features] and segmental phonemes enter into the composition of at least some morphemes.” (Welmers 1959: 2; 1973: 80) Since Pike conceptualized tone as relatively concrete surface contrasts, he assumed that every output syllable carries a tone (or tones), as in Iau. Welmers, on the other hand, emphasized that a tone system could have toneless tone-bearing units (TBUs), as well as toneless morphemes (e.g. toneless noun and verb roots in Chimwiini).

1.2. Tone as pitch vs. tone package

As indicated, the bare minimum to be considered a “tone language” is that pitch enters as a (contrastive) exponent of at least some morphemes. However, more than pitch can be involved in a tonal contrast. This is particularly clear in Chinese and Southeast Asian languages. As seen in Table 2, different phonation properties accompany the six-way tonal contrast in Hanoi Vietnamese (Kirby 2011:386):

name	*pitch level*	*contour*	*other features*	*example*	
Ngang	high-mid	level	laxness	ma	‘ghost’
Huyền	mid	falling	laxness, breathiness	mà	‘but, yet’
Sắc	high	rising	tenseness	má	‘cheek’
Nặng	low	falling	glottalization or tenseness	mạ	‘rice seedling’
Hỏi	low	falling	tenseness	mả	‘tomb’
Ngã	high	rising	glottalization	mã	‘code’

Table 2. Tonal contrasts in Vietnamese

In “stopped” syllables ending in /p, t, k/ the above six tones are neutralized to a binary contrast between a “checked” rising vs. low tone (*mát* ‘cool’, *mạt* ‘louse, bug’). In addition to glottalization, breathiness, and tense-laxness, different tones can have different durations. While one can expect falling and rising contour tones to take longer to execute, tone-specific durational differences are not always predictable on the basis of universal phonetics. Thus, of the four tones of Standard Mandarin, as spoken in isolation, level H tone I and HL falling tone IV tend to be shorter than rising tone II , which is shorter than low dipping tone III (Xu 1997:

67).[2]. Correlating with such complex phonetic realizations found in Chinese and SE Asia is the traditional view of areal specialists that contour tones should be interpreted as units and not sequences of individual level tones. The typological distinction seems therefore to be between tone as a "package" of features (necessarily including pitch) vs. tone as pitch alone (cf. Clements et al 2010:15). Especially prevalent in languages with monosyllabic words, the worldwide distribution can be characterized as the Sinosphere vs. the world. Outside of the Sinosphere (Matisoff 1999) phonations and non-universal timing differences between tones are much rarer. Where they do occur, e.g. in the Americas, they are generally independent of the tones, and tonal contours are readily decomposable into sequences of level tones (cf. §2.2 below).

1.3. Tone-bearing unit vs. tonal domain (mora, syllable, foot)

Another way tone systems can differ is in their choice of tone-bearing unit (TBU) and tonal domain. By TBU we mean the individual landing sites to which the tones anchor. Past literature has referred to vowels (or syllabic segments), to moras, or to syllables as the carriers of tone. Some languages count a bimoraic (heavy) syllable as two TBUs and a monomoraic (light) syllable as one. Such languages often allow HL or LH contours only on bimoraic syllables. Thus, in Jamsay [Dogon; Mali], bimoraic CV: syllables can be H, L, HL, or LH, while monomoraic CV syllables can only be H or L (Heath 2008:81). Other languages are indifferent to syllable weight and treat all syllables the same with respect to tone.

Another notion distinct from the TBU is the domain within which tones (or tonal melodies) are mapped. In Kukuya [Bantu; Republic of Congo], for example, the five tonal melodies /L, H, LH, HL, LHL/ are a property of the prosodic stem (Paulian 1975, Hyman 1987). Thus, in the following examples, the /LHL/ "melody" stretches out over the maximally trimoraic stem:

(2)	(ndɛ́)	bvǐ	'(s/he) falls'	
	(ndɛ́)	kàây	'(s/he) loses weight'	/kǎǐ/
	(ndɛ́)	pàlǐ	'(s/he) goes out'	
	(ndɛ́)	bàámì	'(s/he) wakes up'	
	(ndɛ́)	kàlə́gì	'(s/he) turns around'	

For some this has meant that the prosodic stem is the TBU. However, it is important to keep distinct the carrier of tone (mora, syllable) vs. the domain within which the tones or tonal sequences map. (Paulian refers to the latter as the "accentable unit" (unité accentogène) since the first or only syllable is said to be accented.) We might carry over this distinction and talk about TBU vs. tonal domain. While the distinction is usually clear, Pearce's (2013) study of Kera [Chadic; Chad, Cameroon] shows how the two notions can be confused: In this language tones are mapped by feet. Since it will often be the case that a foot takes one or another tone (or tone pattern), it is tempting to refer to the foot as the TBU. A similar situation arises in Tamang (Mazaudon & Michaud 2008), where there are four word-tone patterns (with phonations) which map over words. In languages that place a single "culminative" tone,

[2] Xu adds that these findings match results from earlier studies, citing Lin 1988. We thank Kristine Yu for locating these studies for us. See also Yu (2010:152) and references cited therein.

typically H, within a prosodic domain, as in Chimila [Chibchan; Columbia] (Malone 2006:34), the H is often described not only as a property of its TBU, but also of its domain. However, the distinction between TBU and tonal domain is clearer in most languages, and it is useful to keep them separate.

1.4. Tone vs. accent

The example of a single H per domain brings up the question of whether the H is (only) a tone or whether it is also an "accent". We saw such a case in Chimwiini with only one H tone per phonological phrase. One way to look at this H is from the perspective of the domain, the phonological phrase. In this case, since there can be only one H, the temptation is to regard the H as an "accent", as Kisseberth & Abasheikh (1974) refer to it. However, in (1), H is a strictly tonal exponent of the first/second vs. third person subject prefix. In this sense it satisfies the definition of tone, which is our only concern here. Although there are other cases where the tone vs. accent distinction becomes blurred, the goal is not to assign a name to the phenomenon, rather to understand strictly tonal properties. While there are very clear cases of tone such as Iau in Table 1 and of accent (e.g. stress in English), no language requires a third category called "pitch accent" or "tonal accent". Instead, there are languages with restricted, ultimately obligatory and culminative "one and only one H tone per domain", as in Kinga (Schadeberg 1973) and Nubi (Gussenhoven 2006). Between this and a system that freely combines Hs and Ls languages place a wide range of restrictions on tonal distributions.

1.5. Outline of what follows

The following sections

2. Phonological typology of tone by inventory

There are a number of ways to typologize tone systems by inventory. The first concerns the number of tones, which can be calculated in one of two ways: (i) the number of tone heights; (ii) the number of distinct tonal configurations including level and contour tones. Tone systems can also differ in whether they allow register effects such as downstep, by the various constraints they place on the distribution of their tones and whether the lack of tone (Ø) can function as a contrastive value. We take up each of these in this section.

2.1. Number of tones

In order to satisfy the definition of a tone language in §1, there must minimally be a binary contrast in pitch. In most cases this will be a contrast between the two level tones /H/ and /L/, as in Upriver Halkomelem [Salish; British Columbia] /qʷáːl/ 'mosquito' vs. /qʷàːl/ 'to speak' (Galloway 1991:3). As seen in (3)-(5), other languages contrast up to five tone heights:

(3) Three contrastive pitch heights in Sar [Central Sudanic; Chad] (Palayer 1970: vii)

a. high tone : ɓɔ́ ‘pity’
b. mid tone : ɓɔ̄ ‘entrust’
c. low tone : ɓɔ̀ ‘thick juice’

(4) Four contrastive pitch heights in Yaitepec Chatino [Zapotecan; Mexico] (McKaughan 1954: 27)

a. high tone : kṵ́ ‘I eat’ (̣ = nasalization)
b. upper-mid tone : kṵ̄ ‘I grind’
c. lower-mid tone : kṵ ‘sweet potato’
d. low tone : kṵ̀ ‘dove’

(5) Five levels: Shidong Kam [Tai-Kadai; China] (Edmondson & Gregerson 1992: 566)

a. highest tone : ʈa^{5} ‘cut down’
b. ↑ : ʈa^{4} ‘step over’
c. : ʈa^{3} ‘father’
d. : ʈa^{2} ‘eggplant’
e. lowest tone : ʈa^{1} ‘thorn’

As also seen, tones may be indicated by accents or numbers. An alternative IPA transcription of the five tone heights of Shidong Kam would thus be *ʈa̋, ʈá, ʈā, ʈà, ʈȁ*, where ˝ and ̏ represent a higher H and a lower L, respectively.

More than a simple distinction of contrasting heights is sometimes needed based on the phonological behavior of the tones. While the most common three-height tonal contrast is /H, M, L/ (*á, ā, à*), where /M/ functions as quite distinct from /H/ and /L/, some tone systems some tone systems instead distinguish H and extra H (*a̋, á, à*) or L and extra L (*á, à, ȁ*). This occurs particularly when the top two or bottom two tones are phonologically related by rule. For example, in Engenni [Edoid; Nigeria], a /H/ tone is raised to what Thomas (1978:12) calls a “top” tone whenever followed by a L. Thus, /únwónì/ ‘mouth’ is realized [úwő́nì], where the second H is realized higher than the first. When the vowel carrying the L tone is elided before another vowel, the result is a surface contrast between H and superhigh: /únwónì + ólíló/ → [únwő́n ólíló] ‘mouth of a bottle’. This example illustrates that a tone system may distinguish fewer underlying contrastive tone heights than surface ones. A particularly dramatic case of this is Ngamambo [Bantoid; Cameroon], which although analyzed with /H, L/ (Hyman 1986a), presents a five-way H, M, ꜜM, L˚ , L contrast on the surface. (re L˚ see §2.2; re ꜜM see §2.3).

2.2. Contour tones

In addition to level tones, languages often have contour tones, where the pitch can be falling, rising, rising-falling, or falling-rising. Essentially what this means is that two or more tone heights are realized without interruption by a (supralaryngeal) consonant. Contours thus occur in all but the last Kukuya example in (2). As shown autosegmentally in (6a), the LHL sequence is realized on a single mora:

(6) a. bvî b. bàámì c. kàlágì

L H L LH L L H L

In (6b) the LH sequence is realized one-to-one on the first two moras. Both would be called contours in contrast with the L to H to L transitions in (6c) where each tone is linked to a CV mora. Thus, contours arise either when more than one tone links to the same TBU or when two or more tones link to successive vocalic moras. A third possible interpretation often assumed in the study of Chinese and SE Asian languages would treat the sequenced pitch gestures as a single unit, e.g. "low rising", "high falling". See Yip (1989, 2002:50-52) who shows, among other things, that contour tones sometimes behave as single units and provides a feature-geometric representation to distinguish them from the more common "tonal clusters" illustrated in (6a,b).

Note that the above refers to *phonological* contours. It is often the case that level tones also redundantly contour. It is very common for sequences of like tones to slightly rise or trail off in actual pronunciation. Even among closely related languages there can be differences. Within the Kuku-Chin branch of Tibeto-Burman, a prepausal L tone will abruptly fall in Kuki-Thaadow, e.g. *zààn* [˩] 'night'. This is the most common realization of a L tone before pause. In closely related Hakha Lai, however, L tone is realized with level pitch, e.g. *kòòm* [ˍ] 'corn'. Other languages can have a surface contrast between falling vs. level L. In most cases the level tone, represented with ˚, can be shown to be the result of the simplification of a final rising tone or of the effect of a "floating" H tone in the underlying representation, e.g. Bamileke-Dschang [Bantoid; Cameroon] /lə-tɔŋ´/ → *lətɔŋ˚* 'navel' vs. /lə-tɔŋ/ → *lətɔŋ* 'to reimburse' (Hyman & Tadadjeu 1976:91). Correspondingly, there are languages where /H/ (more rarely /M/) is realized as a falling contour before pause (and hence in isolation), e.g. Leggbó [Cross-River; Nigeria] /dzɔ́/ → [dzɔ̂] 'ten', Tɑngkhul Nɑgɑ [Tibeto-Burmɑn; NE Indiɑ] /sām/ → [sə̀m] 'hair'. In other cases contour tones arise by fusing unlike tones, either between words, as in the reduplication case in Etsako [Benue-Congo; Nigeria] (Elimelech 1978:45) in (7a), or by affixation of a grammatical tone, as in Tanacross [Athabaskan; Alaska] in (7b), where the possessive H + glottal stop suffix also conditions voicing (Holton 2005:254).

(7) a. ówà + ówà 'house' → ówŏwɑ̀ 'every house'
b. š-tš'òx + ´ʔ → š-tš'ŏɣʔ 'my quill'

In other cases input contours are simplified to level tones (see §3.2). In short, contours can be either underlying or derived.

2.3. Downstep and floating tones

The preceding section mentioned that L tones may be realized with a falling pitch, particularly alone or in a sequence before pause. Often attributed to a declination which can be suspended in certain intonations (e.g. questions), one also finds that alternating Hs and Ls usually undergo "downdrift", in which each H preceded by L is lowered, and with each lowered H establishing a terrace for further tones. Figure 1 illustrates this effect in the two-height system of Bole [Chadic; Nigeria] (Schuh, Gimba & Ritchart 2010:299):

mú gòjjún gùskínà ‘we bought burnt crust’
H L H L H L

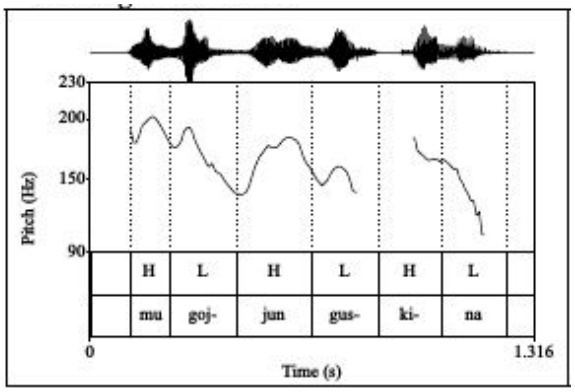


Figure 1. Downdrift in Bole

In a few two-height languages such downdrift is not observed. Thus, in Haya [Bantu; Tanzania] the Hs in the statement *bákàbónà kátò* ‘they saw Kato’ could all be played on one note on the piano (Hyman 1979a). In the terms of Welmers (1959, 1973) the H tones are “discrete” in Haya, but “terraced-level” in Bole. Each lowered H establishes a terrace for further tones.

Independent of whether a language has downdrift or not, it may also have non-automatic downsteps, marked by ˡ. The most common downstepped tone is ˡH, which usually contrasts with H only after another (ˡ)H, as in Aghem [Bantoid; Cameroon]. As seen in (8a), the two nouns ‘leg’ and ‘hand’ are both realized H-H in isolation (Hyman 2003: 154-155):

(8)	a.	kí-fé	‘leg’			kí-wó	‘hand’
		H H	[¯ ¯]			H H	[¯ ¯]
	b.	fé kín	‘this leg’			wó ˡkín	‘this hand’
		H H	[¯ ¯]			H L H	[¯ –]
	c.	fé kîa	‘your sg. leg’		b.	wó kìa	‘your sg. hand’
		H L	[¯ ¬]			H L L	[¯ _]

However, as seen in (8b,c) they have different effects on the tones that follow (the noun class prefix /kí-/ drops when these nouns are modified). When followed by /H/ tone /kín/ ‘this’ in (8b), ‘this leg’ is realized H-H, while ‘this hand’ is realized H-ˡH. As indicated lowering or downstepping of *kîn* is conditioned by an abstract floating L tone (which used to be on a lost second stem syllable; cf. Proto-Bantu **-bókò* ‘hand’). While this L has no TBU to be pronounced on its own, it has effected a “register lowering” on the H of the demonstrative. The same floating L tone blocks the H tone of /-wó `/ ‘hand’ from spreading onto the following L tone possessive pronoun /kìa/.

Although first and most extensively documented in African tone systems, downstepped H is found in New Guinea, e.g. Kairi [Trans New Guinea; Papua New Guinea] (Newman & Petterson 1990), Asia, e.g. Kuki-Thaadow [Tibeto-Burman; Myanmar, NE India] (Hyman 2010a), Mexico, e.g. Coatzospan Mixtec [Mixtecan] (E. Pike & Small 1974), and South America, e.g. Tatuyo [Tukanoan; Colombia] (Gomez-Imbert 1980). The most common source is the loss of a L tone between Hs, whether by loss of the TBU (as in the Aghem example in (8b)),

by simplifications of a contour tone in a HL-H or H-LH sequence, or by one of assimilation of a /H-L-H/ sequence to either H-H-ˡH or Hˡ-H-H, e.g. Igbo [Benue-Congo; Nigeria] /ócé/ 'chair' + /àtọ́/ 'three' → *ócé ˡátọ́* 'three chairs' (Welmers & Welmers 1969:317). Another source is the downstepping of a H that directly follows another H, as when Shambala [Bantu; Tanzania] /nwáná/ 'child' + /dú/ 'only' is realized *nwáná ˡdú* 'only a child' (Odden 1982:187).

Although H-ˡH and H-M sequences may sound similar—or even the same—there are two crucial differences between ˡH and M: First, ˡH establishes an upper ceiling on subsequent tones. If another H were added to a H-ˡH sequence, it would have to be realized on the same level as the H, i.e. H-ˡH-H [¯– –]. A true M tone does not impose this upper ceiling. Thus, if a H were added to a H-M sequence, the H-M-H sequence would be realized [¯– ¯], i.e. with the second H realized higher than the preceding M. The second difference is the downstepping can be iterative, producing H-ˡH-ˡH... sequences as in Igbo *ụ́ˡlọ́ ˡụ́fọ́dụ́* 'some houses' (Welmers & Welmers 1969:318). The number of downstepped Hs is logically unlimited. A third difference between ˡH and M is that ˡH does not usually contrast with H after L (or pause), whereas L-M and utterance-initial M are a common occurrence. An exception is found however in Bamileke-Dschang [Bantoid; Cameroon], where in addition to *làtòŋ* 'to reimburse' and *làtòŋ˚* 'navel', seen above, is the contrast between *làtɔ́ŋ* 'feather' and *làˡtɔ́ŋ* 'to call' (Hyman & Tadajdeu 1976:91).

While H is by far the most common downstepped tone, downstepped M and L also occur as contrastive tones. The five-way H, M, ˡM, L˚, L contrast of Ngamambo (Bantoid; Cameroon) referred to above is illustrated in (9) (Hyman 1986:123):

(9) a. ā-síŋ á rə́-kōn 'place of the beds'
b. ā-síŋ á rə́-ˡbɛ̄i 'place of the knives'
c. ā-síŋ á rə́-kìŋ˚ 'place of the pots'
d. ā-síŋ á rə́-bùm 'place of the bellies'

As seen, the contrasts on the second are H-M, H-ˡM, H-L˚ and H-L. The evidence that M is a downstepped M rather than an additional independent lower-mid tone is that any M tone that follows it is realized on the same pitch level. For downstepped ˡL, we return to Bamileke-Dschang which has contrasts such as the following (Hyman & Tadadjeu 1976:98):

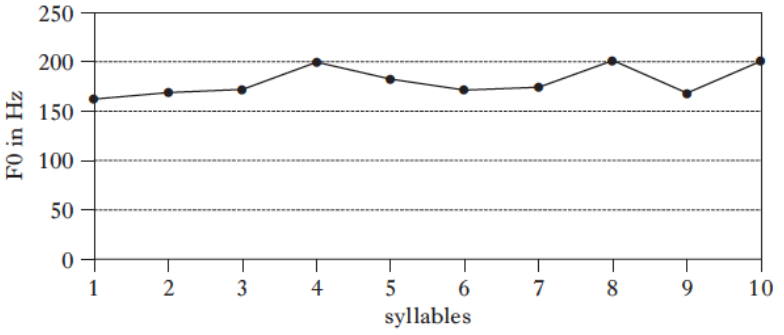
(10) a. èfɔ̀ nà 'chief of the animal'
b. ǹdzɑ̀ ˡnà 'axe of the animal'
c. ŋˡgyà nà 'house of the animal'

Again, an actual floating L is not required as the source of these particular downsteps. In some languages the simple juxtaposition of two (or more) phonological Hs may cause the second to downstep. Campbell (2016:148) shows that a H will cause an adjacent H or M to become downstepped in Zenzontepec Chatino [Zapotecan; Mexico], i.e. H + H → H-ˡH, H + M → H-ˡM.

While downstep is clearly established in the literature, there are also occasional mentions of an opposite "upstep" phenomenon whereby H tones become successively higher. This is found particularly in Mexican tone languages. In Acatlán Mixtec (E. Pike & Wistrand 1974:83) where H and upstepped H contrast, upstep appears to be the reverse of downstep. In Peñoles Mixtec (Daly & Hyman 2007:182) a sequence of input Hs is realized level, but if preceded by a L, the H's will each go up in pitch, ultimately reaching the upper end of a speaker's pitch range. A number of other languages have what has been called "upsweep": A sequence of H tones

begins quite low and reaches an ultimately H pitch level. One such language is Baule [Kwa; Ivory Coast], studied by Creissels & Kouadio (1979), Leben & Ahoua (1997) and Creissels (2003). In the following Baule sentence (Leben & Ahoua 1997: 116), a continuous sequence of H TBUs is broken down into three phrases, each with a rising pattern:

bé nín wá blú dó bólí blú bwé blú
their mother child ten fetish goat ten nose ten
'the ten noses of the ten goats of the fetish of their ten brothers'



	bé	nín	wá	blú	dó	bó	lí	blú	bwé	blú
F0	162·3	168·9	172·1	199·7	182·5	171·4	174·3	201·4	168·4	200·8
std. dev.	3·3	4·1	3·3	5·8	20·8	1·8	3·4	5·0	1·3	5·0

Figure 2. Upsweep in Baule

Leben & Ahoua (1997:115) note that it is even possible to construct an all-H Baule sentence without internal phrasing, leading to a gradual rise across the whole sentence. For more on downstep, upstep, and upsweep, see Tucker (1981) and Leben (in press).

2.4. Underspecified tone and tonal markedness

In many tone languages one of the contrastive tone heights is best represented as the absence of tone. The simplest and most common case is a two-height system with an underlying contrast between /H/ and Ø. TBUs which do not have an underlying /H/ may acquire H or L by rule, the latter most often as a default tone. The primary argument for zeroing out a tone is that it is not "phonologically activated" in the sense of Clements (2001). In /H/ vs. Ø languages, phonological rules and distributions refer to H, but not to L. Representative languages include Chichewa [Bantu; Malawi] (Myers 1998), Tinputz [Oceanic; Papua New Guinea] (Hosteler & Hostetler 1975), Blackfoot [Algonquian; Montana, Alberta] (Stacy 2004) and Iquito [Zaparoan; Peru] (Michael 2011). Although less numerous, there also are languages which contrast /L/ vs. Ø, e.g. Malinke [Mande; Mali] (Creissels & Grégoire 1993), Ruwund [Bantu; DRC] (Nash 1992-4), Bora [Witotoan; Colombia, Peru] (Thiesen & Weber 2012:56) and a number of Athabaskan languages (Rice & Hargus 2005:11-17). While Galo [Tibeto-Burman; NE India] contrasts surface H and L, the latter with tense phonation (Post 2009:946), alternations such as the following suggests a /L/ vs. Ø contrast:

lák-	'arm/hand'	+	cə́ə-	'digit'	→	lákcə́ə	'finger'	(H + H → H)
lák-	'arm/hand'	+	cì-	'left'	→	làkcì	'left hand/arm'	(H + L → L)
lə-	'leg/foot'	+	cə́ə-	'digit'	→	ləcə̀ə	'toe'	(L + H → L)

lə̀-	'leg/foot'	+	cì-	'left'	→	lə̀cì	'left leg/foot'	(L + L → L)

Table 3. Tonal derivations in Galo (Post, p.947)

Although Post schematizes the patterns as in the last column, if H were treated as /Ø/, then the L feature would "spread" in both directions throughout the word (Post 2005:4). In other words L is the active tone, and H is default.

While there is only one activated tone in privative /H, Ø/ and /L, Ø/ systems, there are also tonal asymmetries in /H, L/ systems where both tones are activated. In this connection Hyman (2012) reports a systematic difference in how input Hs and Ls are treated in tone alternations in two closely related Tibeto-Burman languages [Myanmar, NE India]. In Kuki-Thaadow, every input /H/ is preserved in the output. In Hakha Lai, however, every input /L/ is preserved in the output, Thus, the disyllabic inputs /L-HL/ and /LH-L/ are both realized L-L in the output.

The asymmetric behavior of different tones becomes even more evident in languages with multiple tone heights. A common analysis in a three-height tone system is to treat the M tone as Ø, as originally proposed for Yoruba [Benue-Congo; Nigeria] (Pulleyblank 1986, Akinlabi 1985), where only the H and L tones are activated. However, Campbell (2016) has recently shown that Zenzontepec Chatino [Otomanguean; Mexico] has a /H, M, Ø/ system, where Ø TBUs assimilate to a preceding (activated) H or M, otherwise receive default L tone.

Finally there are /H, L, Ø/ systems where Ø does not represent a distinct tone height, rather a TBU with a third behavior. Thus in Margi [Chadic; Nigeria], roots and suffixes can have a fixed /H/ or /L/, or can have a third tone (Ø) that varies between H and L depending on the neighboring tone (Pulleyblank 1986:69-70).

2.5. Distributional constraints

We have already mentioned that tone is more dense in some tone systems than in others (cf. Gussenhoven 2004:35). At one end of the density scale are languages where all tonal contrasts are fully specified and realized in all positions. Assuming that the syllable is the TBU, a /H, L/ system would thus predict two possible contrasts on monosyllabic words, four contrasts on disyllabic words, eight contrasts on trisyllabic words, and so forth, as in Andoke [Isolate; Colombia] (Landaburu 1979:48). If the two tones were allowed to combine as HL and LH contours, there would be more possibilities. At the other extreme are systems such as Somali [Cushitic; Somalia] which, along with other restrictions, rarely allows more than one /H/ per word (Green & Morrison 2016). In between the extremes are systematic distributional constraints. Some of these have to do with the distribution of underlying tones, others with their surface realization. Either can be responsible for the absence of a logically possible combination of tones. In Tanimuca [Tukanoan; Colombia] (Keller 1999:77), for example, disyllabic words are limited to H-H, L-H and H-L, with *L-L non-occurring. The same requirement of at least one H is found on trisyllabic words (*L-L-L), but in addition, there are no words of the shape *H-L-L. (There are no monosyllabic words.) As mentioned in §1.3, Kukuya allows the five prosodic stem melodies /L, H, LH, HL, LHL/. Significantly, it is missing the possibility of a /HLH/ melody. Where /HLH/ sequences occur, they are frequently modified (Cahill 2007), e.g. to trisyllabic H-H-H, H-ꜜH-H or H-H-ꜜH. Languages also may restrict some or all tonal contrasts to the stressed syllable, as in the "Accent 1" vs. "Accent 2" in Swedish and Norwegian (Riad 1998, a.o.). More dramatic is a nine-way tonal contras in Itunyoso Trique

[Otomanguean; Mexico], realized only on the word-final (stressed) syllable (Dicanio 2008).

Both underlying and derived contour tones can also have strict distribution constraints. First, they can be restricted by syllable type. Heavy, especially long-vowel syllables support tonal contours better than syllables with shorter rimes or stop codas (Gordon 2001, Zhang 2004). In addition, tonal contours can be restricted to stressed syllables or to phrase-final or penultimate position. The following markedness scale is generally assumed (where R = rising, F = falling, and > means "more marked than"): RF, FR > R > F > H, L (cf. Yip 2002: 27-30).

Finally, contours can be restricted by what precedes or follows them: Some languages require that a contour be preceded or followed by a like tone height (e.g. L-LH, HL-L), while others prefer that the neighboring tone height be opposite (e.g. H-LH, HL-H) (Hyman 2007:14). The following table shows the distribution of LH rising tone with respect to the following tone in three closely related Kuki-Chin [Tibeto-Burman] languages:

	Hakha, Mizo	Falam	Kuki-Thaadow	articulation	perception
LH-L	*	√	*	more complex	more distinct
LH-H	√	*	*	less complex	less distinct

Table 4. LH Distribution in Four Kuki-Chin Languages

As seen, Hakha Lai and Mizo require the following tone to be H, while Falam requires it to be L. As indicated, there appears to be a conflict between articulatory vs. perceptual concerns. Dropping from LH to L represents a more complex gesture than staying on the same pitch level. On the other hand, a LH rising tone will be more distinct when followed by a drop to L. The reverse is true of LH-H. While keeping the same tonal gesture represents an articulatory advantage, the endpoint of a contour tends to become masked ("absorbed") into a following like tone. Hence, LH-H tends to become L-H. The same points apply to HL falling tones, concerning whether a language favors the same vs. different pitch level before or after the contour (see Hyman 2007:12-16). Since Kuki-Thaadow restricts contour tones to final position, neither *LH-L nor *LH-H is possible.

3. Phonological typology of tone by process

In some languages the input or underlying tonal contrasts are realized essentially the same in the surface phonology. Such is the case of Tangkhul Naga [Tibeto-Burman; NE India], which has no tonal morphology or tonal alternations; the /H/, /M/ and /L/ tones which contrast on lexical morphemes (*páay* 'defecate', *pāay* 'be cheap, able', *pàay* 'jump') do not change in the output. However, in many (perhaps most) tone systems, input tones can be modified by processes triggered by another tone, a boundary, or the grammar (morphology, syntax). In this section we consider the most common phonologically conditioned tone rules.

3.1. Vertical assimilation

Whenever tones of different heights occur in sequence, the pitch level of one or the other can be raised or lowered by what we are calling vertical assimilations. In a two-tone system, the interval of a /L-H/ sequence generally compresses, while a /H-L/ interval expands. In the /L-H/ case vertical assimilation can result in a third M tone height either by raising the L or lowering the M, or both, as in (11).

(11) a. /L-H/ → M-H e.g. Ik [Eastern Sudanic; Uganda] (Heine 1993:18)
b. /L-H/ → L-M e.g. Kom [Bantoid; Cameroon] (Hyman 2005:315-6)
c. /L-H/ → M-M e.g. Kpelle [Mande; Liberia] (Welmers 1962:86)

In case the conditioning tone is modified or deleted, an underlying /H, L/ system can develop a surface [H, M, L] contrast, as in Ik: /cèkí/ → *cēkí* → *cēk* 'woman' (Heine 1993:17).

Quite the opposite process affects a /H-L/ sequence, where the H can be raised to an extra-high level (or the L lowered to an extra-low). The case of Engenni was cited in §2.1 where a H is raised to a new "top" level before a L (Thomas 1978:12). Other cases include several Gurma languages [Togo; Ghana; Burkina Faso] (Rialland 1983:200, Snider 1998:81), Krachi [Kwa; Ghana] (Snider 1990:456), Kirimi (Hyman 1993:99) and Yoruba (Laniran & Clements 2003:230-1s). While only the H TBU immediately before the L is affected in Engenni, in other languages it can be a whole sequence of Hs, especially when the Hs are raised in anticipation of an upcoming downstep, which can be located several syllables away, as in Amo [Kainji; Nigeria] (Hyman 1979a:25n):

(12) a. kìté úkɔ́ɔ́mí fínáwà 'the place of the bed of the animal'
b. kì˖té úkɔ́ɔ́mí fíká˗lé 'the place of the bed of the monkey'

By expanding the /L-H/ interval of *kì˖té* 'place' in (12b) speakers create the tonal space for what can in principle be an unlimited number of ˗H pitch levels (cf. §2.3). Such anticipatory preplanning is extremely common, perhaps universal in languages with downstep (cf. Rialland 2001, Laniran & Clements 2003).

Vertical assimilations can occur in multi-height tone systems as well. Thus, Jamieson (1977:107) reports that all three non-low tones are raised before a low tone in four-height Chiquihuitlán Mazatec [Oto-Manguean; Mexico]. Less common are cases where the /H-L/ interval is compressed to [M-L] or [H-M], the latter occurring in the Kalenjin group of Nilotic [Kenya], e.g. Nandi /áy-wà/ → *áy-wā* 'axe' (Creider 1981:21) and Endo *tány* 'cow' + *àkà* 'another' → *tány ākā* 'another cow' (Zwarts 2004: 95). However, there are quite a number of cases where pitch levels are interpolated such that /H-L-L/ is realized H-M-L, as in Andoke [Isolate; Colombia] (Landaburu 1979:49). In three-height Noni [Bantoid; Cameroon], the /M/ tone is optionally lowered in both /H-M-L/ and /L-M-H/ sequences (Hyman 1981:6). In some cases the pitch adjustments create contours, e.g. /L-H/ is realized L-MH in Kunama [Nilo-Saharan; Eritrea] (Connell, Hayward & Ashkaba 2000:16) and /L-H/ and /H-L/ are realized L-MH and H-ML, respectively, in Mumuye [Adamawa; Nigeria] (Shimizu 1983:15-16). Finally, note that vertical assimilation can be conditioned by a boundary, as when one or more H TBUs are realized M before pause in Isoko and Urhobo [Benue-Congo; Nigeria] (Elugbe 1977:54-5).

3.2. Horizontal assimilation

Whereas vertical assimilations involve an upward or downward adjustment in pitch range, horizontal assimilations involve cases where a tone extends to a neighboring TBU. Better known as "tone spreading", the most common cases involve perseverative assimilations where the first tone spreads into a following TBU. In horizontal assimilations there is a tendency for a tone to last too long rather than start too early (Hyman & Schuh 1974:87-90), as schematized in (13).

(13) a. *Natural*

L-H → L-LH
H-L → H-HL
(perseverative)

b. *Unnatural*

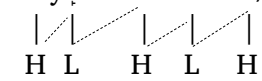
L-H → LH-H
H-L → HL-L
(anticipatory)

In (14a) L tone spreading (LTS) and H tone spreading (HTS) create a contour tone on the next syllable, which may however simplify by subsequent processes, as in the case of HTS in Adioukrou [Kwa; Ivory Coast] in (14c) below (Hérault 1978:11):

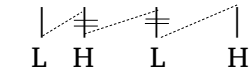
(14) a. /jɔ́w + à/ → jɔ́w â 'the woman'
b. /tʃǎn + à/ → tʃǎn â 'the goat'
c. /má + dʒěn/ → má dʒẽn 'type of pestle' (→ [má dʒéˈń])

LTS occurs less frequently (and often with more restrictions) than HTS, e.g. applying in Nandi [Nilotic; Kenya] only if the H TBU has a long vowel: /lạ̀:k-wḛ́:t/ → *lạ̀:k-wḛ́:t* 'child' (Creider 1981:21). Many languages have both HTS and LTS which potentially interact with each other in longer utterances. In (15a) we see that HTS and LTS creates successive contour tones in Yoruba [Benue-Congo; Nigeria] (Laniran & Clements 2003:207). In Kuki-Thaadow [Tibeto-Burman; NE India, Myanmar] in (15b) the expected contours are however simplified, since the language allows contours only on the final syllable (Hyman 2010a).

(15) a. /máyọ̀ mí rà wé/ [máyộ mǐ râ wě] 'Mayomi bought books'



b. /kàzóoŋ lìen thúm/ [kà zòoŋ líen thǔm] 'my three big monkeys'



In languages with a M tone, spreading most likely occurs between Hs and Ls, where the interval is greater than between M and either H or L. However, Gwari [Benue-Congo; Nigeria] not only has HTS and LTS of the sort illustrated in (15), but also /M-L/ is realized M-ML, e.g. /ōzà/ → *ōzâ* 'person'. We thus expect tone spreading to follow a hierarchy of likely occurrence, HTS > LTS > MTS, where HTS is most common and MTS quite rare.

While the above examples involve an interaction between H and L tones, spreading can also occur in privative systems. In /H/ vs. Ø systems, H tone often spreads over multiple TBUs, as in Yaqui [Uto-Aztecan; Mexico] /téeka/ → *tééká* 'sky', /tá-tase/ → *tá-tásé* 'is coughing' (Demers, Escalante & Jelinek 1999:40). In both Bagiro [Central Sudanic; Democratic Republic of Congo] (Boyeldieu 1995:134) and Zenzontepec Chatino [Otomanguean; Mexico] (Campbell

2016:147), a H tone will spread through any number of Ø (or L) TBUs until reaching either pause or a H or M tone, which will be downstepped.

(16) a. ta tāká tzaka nkwítza ‘there already was a child’
M H H (already exist one child)
[tà tāká tzáká ˈnkwítzá] (Campbell 2016:148)

In other languages HTS can be restricted from applying onto a L (or Ø) TBU which is followed by another H. Thus, in Chibemba [Bantu; Zambia], /bá-la-kak-a/ ‘they tie up’ is realized *bá-lá-kàk-à*, with HTS from the subject prefix /bá-/ onto the following tense marker, while /bá-la-súm-a/ ‘they bite’ is realized *bá-là-súm-á*. As seen, the /H/ of /bá-/ cannot spread, because it would bump into the H of /-súm-/, an Obligatory Contour Principle (OCP) violation (Goldsmith 1976a,b). (The /H/ of the verb root /-súm-/ does however spread onto the final inflectional suffix /-a/.)

3.2. Contour simplification

We have already seen in some of the examples that a common process is contour tone simplification. As was shown in Table 4, languages frequently limit the distribution of contour tones, requiring that their beginning or end points be preceded or followed by a like or unlike tone height. The Kuki-Thaadow example in (15b) shows another tendency, which is to restrict contour tones to the final syllable of a phrase or utterance. A major motivator of contour simplification is the general articulatory principle of minimizing the number of ups and downs, a potential problem which becomes particularly acute when a contour is surrounded by unlike tone heights. Thus the L-HL-H input sequence shows the following realizations in the indicated Grassfields Bantu languages [Bantoid; Cameroon] (Hyman 2010b:71):

Language	*Output*	*Process*	
Mankon	L-H-ˈH	H-upstep	Leroy (1979)
Babanki	L-M-H	HL-fusion	Hyman (1979b)
Babadjou	L-H-ˈH	H-downstep	(notes)
Yemba (Dschang)	L-H-H	HL-fusion + H-downstep	Hyman & Tadadjeu (1976)
Kom	L-M-M	H-lowering	Hyman (2005)
Aghem	L-H-H	L-deletion	Hyman (1986b)

Table 5. Different Contour Simplification of L-HL-H Sequence

As seen, contour simplifications can produce a new surface-contrastive tone, e.g. the M in Babanki, which results from the simplification of the HL resulting from *n*-deletion (Akumbu 2016):

(17) a. kə̀-bán + ə̀-kɔ́m → kə̀-bā: kɔ́m ‘my fufucorn’
b. kə̀-ŋkón + ə̀-kɔ́m → kə̀-ŋkɔ̄: kɔ́m ‘my fool’

Similarly, to minimize ups and downs, an input H-LH-L sequence is subject to multiple modifications in the output.

A second motivation for contour simplification is perceptual. A common change is tone absorption (Hyman & Schuh 1974:90). whereby the input sequences LH-H and HL-L are simplified to L-H and H-L, respectively. In these cases the endpoint of the contour has been masked by the following like tone height. Thus, in Lango [Nilotic; Uganda], a HL falling tone derived by HTS is simplified to H: /dɔ́g gwènò/ (mouth + chicken) → *dɔ́g gwênò* → *dɔ́g gwénò* 'chicken's mouth' (Noonan 1992:51). Another common change is LH-L → L-HL, which occurs in Lango (p.53), Isthmus Zapotec [Otomanguean; Mexico] (Mock 1988:214), and elsewhere. In this case the more marked LH rising tone is avoided, and a less marked HL falling tone results.

3.3. Dissimilation and polarity

The tone processes discussed above are all either assimilatory or represent simplifications of contours and other "ups and downs". As in segmental phonology, there are processes that are dissimilatory in nature. In Munduruku [Tupi; Brazil], a L tone becomes H after /L/: /è + dìŋ/ (tobacco + smoke) → *è-díŋ* 'tobacco smoke' (Picanço 2005:312). Picanço analyses Munduruku with a /H, L, Ø/ contrast, where Ø will receive a default L unless affected by dissimilation: /L/ conditions the above dissimilation, while Ø does not. However, both /L/ and Ø undergo the change to H after /L/. Besides tone levels, contours dissimilate, as when Hakha Lai [Tibeto-Burman; Myanmar, NE India] LH rising tone becomes falling HL after another LH rising tone: /ka kǒoy hrǒm/ → *ka kǒoy hrôm* 'my friend's throat' (Hyman & VanBik 2004:832). Similar "contour metatheses" occur in various Chinese dialects, e.g. Pingyao hai^{35} + bing^{35} → hai^{53} bing^{35} 'become ill' (Chen 2000:15). Even disyllabic sequences can dissimilate. Thus in Cuicateco [Otomanguean; Mexico], a sequence of /M-L/ + /M-L/ becomes L-M + M-L: /ntōʔò/ 'all' + /ʔīnù/ 'three' → *ntòʔō ʔīnù* 'all three' (Needham & Davis 1946:145).

In some cases where it is not desirable to start with an underlying tone, a morpheme may receive the opposite "polar" tone to what precedes or follows. In Eastern Kayah Li (Karen) [Tibeto-Burman; Myanmar], which distinguishes /H, M, L/, prefixes contrast in tone before a M root: *ʔì-lū* 'the Kayah New Year festival' vs. *ʔí-vī* 'to whistle'. However, prefixes are H- before /L/ and L- before H: *ʔí-lò* 'to plant (seeds)', *ʔì-khré* 'to winnow' (Solnit 2003:625). In many analyses morphemes with polar tone are analyzed as underlyingly toneless, receiving their tone by context. This is so for Margi [Chadic; Nigeria], discussed at considerable length by Pulleyblank (1986:203-214), as well as Fuliiru [Bantu; Democratic Republic of Congo], which contrasts /H/, /L/ and /Ø/ verb roots, the last behaving like /H/ or /L/ verb roots in different parts of the paradigm (Van Otterloo 2014:386).

4. Grammatical tone

In this section we consider grammatical functions of tone. While tone is (almost) completely lexical in many languages, e.g. most Chinese, there are other languages where tone is largely grammatical, e.g. marking morphological classes, morphological processes, and ultimately syntactic configurations as well as semantic and pragmatic functions such as negation and focus. For example, in the Igboid language Aboh [Benue-Congo; Nigeria], the difference between affirmative and negative can be solely tonal: *ò jè kò* 's/he is going' vs. *ó jé kò* 's/he is not going'. Grammatical functions of tone are as varied as grammar itself. From the above

examples we see that tone can function alone as a morpheme. It follows therefore that if tone can be a morpheme, it can do everything that a (segmental) morpheme can do, e.g. mark singular/plural, case, person, tense-aspect, and of course negation (Hyman & Leben 2000:588). On the other hand, tone vastly surpasses segmental phonology in encoding syntactically dependent prosodic domains (cf. §4.6).

4.1. Lexical vs. morphological tone

It is clear that tone can be a property of either lexical morphemes (nouns, verb roots etc.) or grammatical morphemes (prefixes, suffixes, clitics etc.). In this sense most tone languages are similar: tones can contrast on content morphemes or on pronouns, demonstratives etc. which mark grammatical distinctions. There may of course be generalizations concerning the distribution of tones by word class. For example, in Mpi [Tibeto-Burman; Thailand], nouns contrast /H, M, L/ (*sí* 'four', *sī* 'a color', *sì* 'blood') while verbs contrast /MH, LM, HL/ (*sǐ* 'to roll', *sǐ̀* 'to be putrid', *sî* 'to die') (Matisoff 1978). However, grammatical tone does not usually refer to tonal contrasts on segmental morphemes, e.g. the H and L tones of the subject pronouns *à* 'I', *ò* 'he', *á* 'she' in Kalabari [Ijoid; Nigeria] (Jenewari 1977:258-9). In such cases the tone is clearly linked to its TBU and not assigned by a grammatical process. In this section grammatical tone will refer to cases where tone is either the sole exponent of morphology, or where morphology introduces tonal exponents that are realized independent of any segmental morpheme that may accompany the tone.

4.2. Tonal morphemes

The most straightforward type of grammatical tone is where the tone is the only exponent of a morphological distinction. Typically called a "tonal morpheme", its position can sometimes be established within a string of (segmental) morphemes. For example, the subject H tone of Yoruba [Benue-Congo; Nigeria] occurs exactly between the subject and verb: *ọ̄mọ̄* + ˊ+ *lọ̄* → *ọ̄mọ́ lọ̄* 'the child went' (Akinlabi & Liberman 2000:35). Similarly, the H genitive ("associative") marker of Igbo [Benue-Congo; Nigeria], often translatable as 'of', can be located between the two nouns in /àlà/ 'land' + ˊ + /ìgbò/ 'Igbo' → *àlá ìgbò* 'Igboland' (Emenanjo 1987:36). Such tonal morphemes can have any shape (L, M, etc.) and can even occur in sequences. In Jamsay [Dogon; Mali] some nouns acquire a L tonal morpheme functioning as a locative suffix (Heath 2008:283-4):

noun		*tonal locative*	
búró	'pond'	búrò	'in the pond'
ójú	'road'	ójù	'on the road'
ní:	'water'	nî:	'in water'
nùmó	'hand'	nùmô:	'in the hand (of)'
gǰ:	'granary'	gǰ̃:	'in the granary'

Table 6. Locative L suffix in Jamsay

Although length is contrastive in Jamsay, in the last three examples additional final length automatically occurs to accommodate the contour tone (Heath 2008:124). In other cases there

can be ambiguity as to whether the tone is accompanied by a TBU devoid of segmental features. The following examples show that there is a L associative tone in Gokana [Cross-River; Nigeria] (which shows up, however, only if the first word ends in a M tone) (Hyman 1985:24):

(18)	a.	mīī	'blood'	mīì nɛ̄n	'person's blood'
	b.	mɛ̄n	'neck'	mɛ̄ǹ nɛ̄n	'person's neck'
	c.	tɔ̄	'house'	tɔ̄ɔ̀ nɛ̄n	'person's house'

In (18a) we see that the long vowel has become a ML falling tone, which is independently attested in the language (*kōò* 'horn', *kāà* 'spider'). The derived ML tone in (18b) is however not otherwise found on CVC syllables in the language. Interestingly, in (18c) the CV noun lengthens its vowel, suggesting either that the L tonal morpheme has a TBU of its own, or that lengthening automatically occurs so that the L can link. (The same TBU may allow the final /n/ to take the L tone in (18b).) The above example shows that a tonal morpheme can be accompanied by other effects, in this case length.

In other cases it is harder to analyze morphological tones as items to be arranged in a sequence with segmental morphemes. Instead, individual H or L tones may be assigned to various positions within a paradigm. In the /H/ vs. Ø language Kikuria [Bantu; Kenya], there is no lexical tone contrast on verb roots. Instead, different inflectional features assign a H tone to either the first, second, third, or fourth mora of the verb stem. In the examples in Table 7, the stem is bracketed and the mora receiving the H is underlined. As also seen, this H then spreads to penultimate vowel (Marlo, Mwita & Paster 2014:279)

μ1	ntoo-[kóóndókóra]	'indeed we have already uncovered'	*untimed past anterior*
μ2	ntooɣa[koóndókóóye	'indeed we have been uncovering'	*hodiernal past progressive anterior focused*
μ3	ntore-[koondókóra]	'we will uncover (then)'	*remote future focused*
μ4	tora-[koondokóra]	'we are about to uncover'	*inceptive*

Table 7. H tone stem patterns in Kikuria

4.3. Replacive tone

In other cases a morphological process may assign a "replacive" tone or tonal schema. In the following examples from Kalabari [Ijoid; Nigeria], a LH "melody" replaces the contrastive verb tones in deriving the corresponding intransitive verb (Harry & Hyman 2014:650):

transitive			*intransitive*		
kán	H	'tear, demolish'	kàán	LH	'tear, be demolished'
kɔ̀n	L	'judge'	kɔ̀ɔ́n	LH	'be judged'
ányá	H-H	'spread'	ànyá	L-H	'be spread'
ɗìmà	L-L	'change'	ɗîmá	L-H	'change'
sá$^{\downarrow}$kí	H-$^{\downarrow}$H	'begin'	sàkí	L-H	'begin'
kíkímà	H-H-L	'hide, cover'	kìkìmá	L-L-H	'be hidden, covered'
pákìrí	H-L-H	'answer'	pàkìrí	L-L-H	'be answered'
gbóló$^{\downarrow}$má	H-H-$^{\downarrow}$H	'join, mix up'	gbòlòmá	L-L-H	'be joined, mixed up'

Table 8. Detransitivizing LH Replacive Tone in Kalabari

As seen, the LH melody is realized as a LH rising tone (with vowel lengthening) on monosyllables, L-H on two syllables, and L-L-H on trisyllabic verbs. In (19), denominal adjectives are derived via replacive H tone in Chalcatongo Mixtec [Otomanguean; Mexico] (Hinton et al 1991:154; Macaulay 1996:64), while deadjectival verbs are derived via replacive L in Lulubo [Central Sudanic; South Sudan] (Andersen 1987:51)

(19)	a.	Chalcatongo Mixtec	bīkò	'cloud'	→	bíkó	'cloudy'
			tɑ̄nɑ̀	'medicine'	→	táná	'medicinal'
			sòʔò	'ear'	→	sóʔó	'deaf'
			žūù	'rock'	→	žúú	'solid, hard'
	b.	Lulubo	ōsú	'good'	→	òsù	'become good'
			ɑ̀kēlí	'red'	→	àkèlì	'become red'
			álí	'deep'	→	àlì	'become deep'

(For cases of replacive tone conditioned by phrasal domains see §4.6.)

4.4. Inflectional tonology

The above examples show that tone can directly mark derivational processes (to which we return in §4.5). It may also mark inflectional morphology, specifically morphosyntactic features such as person, number, gender, tense, aspect etc. Thus, in Ronga [Nilo-Saharan; Chad, Central African Republic] certain nouns mark their plural by assigning a H tone: *tàù* 'flour' (pl. *táú*), *ndòbó* 'meat' (pl. *ndóbó*) (Nougayrol 1989:27). A similar H tone plural effect occurs on possessive determiners in Kunama [Nilo-Saharan [Eritrea] (Connell, Hayward & Ashkaba 2000:17):

	singular	plural
1st person (exclusive)	-àaŋ	-áaŋ
2nd person	-èy	-éy
3rd person	-ìy	-íy
1st person (inclusive)		-íŋ

Table 9. Possessive Determiners in Kunama

As seen, the segmental morphs mark person, while the tones mark number (L for singular, H for plural). Similar alternations due to number are seen in the following noun class 9/10 examples from Noni [Bantoid; Cameroon] (Hyman 1981:10):

	stem tone	singular		plural			alternation
(i)	/L/	jòm	/ˋ + jòm/	jə̀m	/ˊ + jòm/	‘antelope’	L vs. ML
(ii)	/LH/	bìè	/ˋ + bìé/	bíé	/ˊ + bìé/	‘fish’	L vs. H
(iii)	/HL/	bìē	/ˋ + bíè/	bīē	/ˊ + bíè/	‘goat’	LM vs. M
(iv)	/H/	bwě	/ˋ + bwé/	bwé	/ˊ + bwé/	‘dog’	LH vs. H

Table 10. Noni Singular/Plural Alternations in Noun Class 9/10

As indicated, from a two-height system Noni developed a H, M, L surface contrast, where most occurrences of *H became M. The main exception is the plural of ‘fish’: In this case the expected HLH sequence simplified to H. A similar situation arises in Day [Adamawa; Chad] in the marking of aspect (Nougayrol 1979:161). Although the language contrasts surface H, M, and L we again recognize inputs /H/ and /L/ in Table 11.

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

Table 11. Day Completive/Incompletive Aspect Alternations

As seen, when the completive H- prefix combines with the H tone verb ‘put on, wear’, the result is a H tone. Similarly, when the incompletive L- prefix combines with the L tone verb ‘drink’, the result is a L tone. Both H + L and L + H result in M tone *yūū*, which can either mean ‘put on, wear’ (incompletive) or ‘drink’ (completive).

While the above cases allow us to factor out the individual tonal contribution of each morpheme (an affix and a root), such a segmentation may be difficult or impossible in other cases. Recall from Table 1 the inflected verb forms that were seen in Iau, which can be summarized as follows:

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

Table 12. Iau Verb Tones

Although Iau verbs lend themselves to a paradigmatic display by plotting the above morphosyntactic features, the portmanteau tonal melodies do not appear to be further segmentable into single tones or features. Of course one can look for patterns of the sort that telic forms begin H and have either a L, a M or both tones after them, but these would not be predictive.

Inflectional tonology may also produce scalar effects. In Gban [Mande; Ivory Coast], a language with 4 tone heights (4 = highest, 1 = lowest), there are systematic effects on inflected subject markers conditioned by person and tense (Zheltov 2005:24). As seen in Table

13, first and second persons are one degree higher than third, and past tense is two degrees lower than present:

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

Table 13. Inflected Subject Markers in Gban

Although there are different ways to implement such a paradigm, the above shows how the tonal reflexes can be nicely modeled with the features [upper] and [raised]. Such an analysis is not possible in contiguous Guébie [Kru; Ivory Coast], where (i) each of the tone heights 1-4 goes down one level in the imperfective; (ii) just in case the imperfective is already 1, the tone height of the preceding subject is raised by one level instead; (iii) just in case the subject is already 4, it raises to a superhigh 5 level, the only such occurrence in the language (Sande 2016).

4.5. Compounding

In §4.3 we observed a number of cases where tone was the only reflex of a derivational process, e.g. changing word class. Languages which have (almost) no morphology may however show traces of earlier derivational processes as in the following falling tone nominalizations in Standard Mandarin: *shán* 'to fan' → *shân* 'fan' (n.), *lǐan* 'to connect' → *lîan* 'chain', *shù*(ˊ) 'to count' → *shû* 'number' (Wang 1972:489). Both in Chinese and other tone languages tones can be modified in compounding. Thus in Shanghainese compounds, all but the tone of the first word reduce to a default L, as in (20a) (Zee 1987; cf. Selkirk & Shen 1990).

(20) a. ɕɪŋ + vəŋ → ɕɪŋ vəŋ 'news' < ɕîŋ 'new' (HL)
HL LH H L

ɕɪŋ + vəŋ + tɕia → ɕɪŋ vəŋ tɕia 'news reporting circle'
HL LH MH H L L

ɕɪŋ + ɕɪŋ + vəŋ + tɕi + tsɛ → ɕɪŋ ɕɪŋ vəŋ tɕi tsɛ 'new news reporter'
HL HL LH MH MH H L L L L

b. kʰʌʔ + sɤ → kʰʌʔ sɤ 'to cough'
MH MH M H

kʰʌʔ + sɤ + dã → kʰʌʔ sɤ dã 'cough drops'
MH MH LH M H L

kʰʌʔ + sɤ + jʌʔ + sɻ + bɪŋ → kʰʌʔ sɤ jʌʔ sɻ bɪŋ 'cough tonic bottle'
MH MH LH MH LH M H L L L

The examples in (20b) show that when the first tone is a contour, here MH, its tones map to the first two syllables, any remaining syllables receiving a default L.

It is very common for elements of a compound to undergo tonal modifications. This happens also in Barasana [Tukanoan; Colombia], which contrasts H-H, H-L, L-H and L-HL on disyllabic words. In the following examples, ~ marks nasality, a prosodic property of morphemes (Gomez-Imbert & Kenstowicz 2000:433-4):

(21)	a.	H-L + H-L	→	H-L + L-L	~újù ~kùbà	'kind of fish stew'	(~kúbà 'stew')
		H-L + L-H	→	H-L + L-L	~kíî jècè	'peccary (sp.)'	(jècé 'peccary')
		H-L + L-HL	→	H-L + L-L	héè rìkà	'tree fruits (in ritual)'	(rìká` 'fruits')
		H-H + H-L	→	H-H + H-H	~ɨ́dé ~bídí	'bird (sp.)'	(~bídì 'bird')
	b.						
		H-H + L-H	→	H-H + H-H	~kóbé cótɨ́	'metal cooking pot'	(còtɨ́ 'cooking pot')
		H-H + L-HL	→	H-H + H-H	héá ~gɨ́tá-á	'flint stone'	(~gɨ̀tá-à 'stone-CL')

As seen in (21a), if the first member of the compound ends L, the second member of the compound will be L-L. In (21b), however, where the first member ends H, the second member is realized H-H. It is reasonable to assume that the tones of the second member have been deleted, followed either by the spreading of the final H or L of the first member.

Reduction or loss of tone on certain member(s) of a compound is quite widespread. A quite different resolution is reached in compounding in many Mande languages. Known as "compacité tonale" in the French literature, the process applies to compounds and to certain derivational processes (Creissels 1998). The following Bambara [Mali] examples from Green (2013:4) illustrate compacité tonale in compounds (22a), noun + adjective (22b) and noun + derivational suffix combinations (22c).

(22)	a.	jàrá lion	+	wòló skin	→	jàrà-wóló	'lion skin'
		jàkúmá cat	+	wòló skin	→	jàkùmà-wóló	'cat skin'
	b	jàkúmá cat	+	wárá wild	→	jàkùmà-wárá	'feral cat'
		jìgí hope	+	-ntan neg.	→	jìgì-ntán	'hopeless'

If the first word has a LH melody, the full compound is realized LH with the H on the final constituent and the L on preceding ones, as first formulated to our knowledge by Woo (1969:33-34), with an acknowledgement to Charles S. Bird for help with the data (see also Leben 1973:128, Courtenay 1974:311). This is seen particularly clearly in more complex examples (Green 2013:9):

(23)	a.	fàlí donkey	+	bálá upon	+	yɛ̀lɛ́n climb	→	fàlì-bàlà-yɛ́lɛ́n	'ride a donkey'

b.	nún	+	kɔ̀rɔ́	+	síí	→	nún-kɔ́rɔ́-síí	'moustache'
	nose		under		hair			

4.6. Phrase-level tonology

It is commonly observed that tones have the potential for considerable mobility and mutual interaction at a distance. This is seen particularly dramatically in their behavior at the phrase level. As an example, Giryama [Bantu; Kenya] contrasts /H/ vs. Ø. In (22a) all of the morphemes are toneless, and all of the TBUs are pronounced with default L pitch. In (22b), however, where only the subject prefix /á-/ differs, its /H/ is realized on the penultimate mora of the phrase (Volk 2011:17):

(24)

a. All L tone	b. H tone on penultimate mora	
'I want ...'	'he/she wants ...'	
ni-na-maal-a	a-na-maál-a	
ni-na-mal-a ku-guul-a	a-na-mal-a ku-guúl-a	'... to buy'
ni-na-mal-a ku-gul-a ŋguuwo	a-na-mal-a ku-gul-a ŋguúwo	'... to buy clothes'
	╪ H	

No other phonological property is capable of such a long distance effect. Less dramatic are the many tone rules and tone sandhi which apply between words (again, much richer than what is found in segmental phonology). In Kuki-Thaadow (Hyman 2010a) and the Chatino languages (Cruz 2011, Campbell 2014, McIntosh 2015, Sullivant 2015, Villard 2015) the tonal processes apply throughout the clause, blocked only by a sentence boundary or pause. In other languages they are subject to applying within certain prosodic domains which in turn are defined by the syntax.

A good example of the latter occurs in Xiamen [Chinese]. Known as the Southern Min Tone Circle, when followed by another tone, each of the five contrasting tones is replaced by a different paired tone according to the schema 24, 44 → 22 → 21 → 53 → 44. Thus, in the following example (Chen 1987:113), only the last tone remains unchanged:

(25)

	#	yi	kiong-kiong	kio	gua	ke	k'uah	puah	tiam-tsing	ku	ts'eq	#	
		44	24	24	21	53	44	21	21	53	44	53	32
→		22	22	22	53	44	22	53	53	44	22	44	

The above changes take place only within what Chen calls a "tone group", a phrasal prosodic domain determined by the syntax (cf. Selkirk 1986, 2011). While most of the tonal processes discussed in §3 were shown to be natural phonological rules, Xiamen also shows that such "tone sandhi" can also involve quite arbitrary replacive tone.

Cases involving tone and syntactically defined prosodic domains are common, early examples being Chimwiini (Kisseberth & Abasheikh 1974, 2011), Ewe (Clements 1978), and several additional languages described in Clements & Goldsmith (1984), Zwicky & Kaisse (1984) and Inkelas & Zec (1990). Many of these studies show that the left or right edge of a prosodic domain can be marked by a boundary tone. A clear example comes from Kinande

[Bantu; Democratic Republic of Congo]. As seen in (26a), the underlyingly toneless noun 'shoe' is realized with default L tone when followed by the adjective 'heavy' (Hyman 1990):

(26) a. èkìryàtù kìrı́tò 'a heavy shoe' (p.113)
b. èkìryàtú] kìkâwâ 'a shoe is falling' (p.115)
H%
c. èkìryátù]] 'shoe' (p.117)
H% L//

(Although not transcribed above, Kinande declarative intonation also exhibits phrase-penultimate vowel-lengthening (Mutaka 2014:104), hence [kìrı́:tò] 'heavy'.) (26b) shows that the subject is marked off as a separate phonological phrase (PhP) from the verb that follows. As indicated, the right edge of the subject PhP is marked by a H% boundary tone, realized on the final vowel of 'shoe'. In (24c) the PhP H% is followed by a declarative intonational boundary L//, resulting in a final H-L sequence on the noun. Had this been a question, the interrogative boundary tone H// would have occurred instead, hence *èkìryátó́* 'a shoe?' In fact, the H-L found on the underlyingly toneless adjective /ki-rı̩to/ is also from the same H% L// boundary tone sequence (cf. the H% H// sequence in *èkìryàtù kìrı́tó*? 'a heavy shoe?').

These last examples show not only that there is a distinction between word-level tones and boundary tones, but also that intonational tones can involve the same H and L elements that distinguish morphemes in the lexicon. While L// and H// are easily sequenced in the string in Kinande, intonational tones may be superimposed or replacive. Thus, compare Luganda [Bantu; Uganda] *òmùpákàsì* 'a porter' vs. *òmùpákā́sì* 'a porter?', where a superhigh (˝) tone has replaced the first L of a H-L transition. In other cases the register or intervals are affected. In some instances intonational effects can merge tonal contrasts which words in isolation therefore do not distinguish. Although Coreguaje [Tukanoan; Colombia] CVCV nouns distinguish underlying /H-H/, /H-L/, /L-L/ and /L-H/, they all merge as H-L under question intonation (Gralow 1985:3). Other languages keep the intonational melodies separate. Thus, in Mazahua [Otomanguean; Mexico] word-level tone contrasts are on pre-final syllables, while the final syllables are reserved for contrastive "intonemes", which E. Pike (1951:101) identifies as in Table 12.

Intoneme	Meaning	Intoneme	Meaning
L%	'colorless finality'	MH%	'surprise'
H%	'is that what you said/mean?'	ML%	'anger, disgust'
M%	'something is expected to follow'	H:L%	'calling, shouting'

Table 12. Final "Intonemes" in Mazahua

More generally, the tonal elements illustrated here for word-level tonology, accent, and phrasal tonology play a key role in intonation. This is true in non-tone languages as well as in tone languages, as one can gather from Gussenhoven (2004) and chapter 4 of this volume (Intonation: The mainstream model). The behavior of tones in lexical tone systems has provided inspiration for the analysis of intonation in tone languages and non-tone languages alike. This tradition reaches back at least as far as Liberman (1975) and Pierrehumbert (1980), as traced by Gussenhoven (2004), among others, and as evidenced in many current analyses of intonation in

specific languages, including those compiled in Jun (2005, 2014) and Downing & Rialland (2017).

5. Further issues

As a coda to this survey of some general as well as some unusual properties of tone systems we return to cases where tones are accompanied by laryngeal gesture such as breathiness and glottalization. Even if analyzed as final /-h/ and /-ʔ/, the laryngeal gestures can affect the distribution of tones, as in Itunyoso Trique [Otomanguean; Mexico] (Dicanio 2016:231).

Tone	Open syllable		Coda /h/		Coda /ʔ/	
/4/	yũ^{4}	‘earthquake’	yãh^{4}	‘dirt’	niʔ^{4}	‘see.1dual’
/3/	yṹ^{3}	‘palm leaf’	yãh^{3}	‘paper’	tsiʔ^{3}	‘pulque’
/2/	ũ^{2}	‘nine’	tah^{2}	‘delicious’	ttʃiʔ^{2}	‘ten’
/1/	yṹ^{1}	‘loose’	yãh^{1}	‘naked’	tsiʔ^{1}	‘sweet’
/45/			toh^{45}	‘forehead’		
/13/	yo^{13}	‘fast (adj.)’	toh^{13}	‘a little’		
/43/	ra^{43}	‘want’	nnãh^{43}	‘mother!’		
/32/	rã^{32}	‘durable’	nnãh^{32}	‘cigarette’		
/31/	rã̰^{31}	‘lightning’				

Table 13. Tonal Distributions in Itunyoso Trique

As seen, the high rising tone /45/ only occurs on CVh syllables, while only the four level tones occur on CVʔ syllables. “Stopped” syllables typically have fewer contrasts than “smooth” syllables in Chinese and Southeast Asian languages in general.

Such interactions between consonant types, syllable structure, and phonation relate play an important role in tonogenesis and subsequent tonal splits (Haudricourt 1961, Matisoff 1973, Kingston 2011). A common pattern is for each of the two contrasting /H/ and /L/ tones to further “bifurcate” into two distinct heights each, conditioned by the voicing of the onset consonant. This likely accounts for the four-way contrast in Gban in Table 11. Once a language has at least a binary H vs. L contrast, the tones themselves can also interact to produce further tone heights as well, e.g. the M of Ik and Kom in (11). While a featural analysis was provided for Gban, whether (or to what extent) tone features are needed in the phonology of tone has been recently questioned (Clements, Michaud & Patin 2010, Hyman 2010b). These and other issues remain to be resolved in the coming years.

References

Akinlabi, Akinbiyi (1985) *Tonal underspecification and Yoruba ton*e. Doctoral dissertation, University of Ibadan.

Akinlabi, Akinbiyi and Liberman, Mark (2000) ‘The tonal phonology of Yoruba clitcs’. In Birgit Gerlach and Grijzenhout (eds) *Clitics in phonology, morphology and syntax*, 31-62. Amsterdam/Philadelphia: John Benjamins.

Akumbu, Pius (2016) ‘A featural analysis of mid and downstepped high tone in Babanki’. Paper presented at the 47th Annual Conference on African Linguistics, March 23-26, 2016, University of California, Berkeley. To appear in proceedings.

Andersen, Torben (1987) 'An outline of Lulubo phonology'. *Studies in African Linguistics* 18.39-65.

Bateman, Janet (1990) 'Iau segmental and tonal phonology'. *Miscellaneous studies of Indonesian and other languages* 10.29-42.

Boyeldieu, Pascal (1995) 'Modifications tonales et limites syntaxiques en bagiro (language "Sara" de la République Centrafricaine)', pp. 131-145. In Robert Nicholaï and Franz Rottland (eds) *Cinquième Colloque de Linguistique Nilo-Saharienne/Fifth Nilo-Saharan Linguistics Colloquium*. Nice: 24-29 Août 1992. Köln: Rüdiger Köppe Verlag.

Brend, Ruth M. (ed) (1974) *Advances in tagmemics*. North-Holland Linguistic Series, 9. Amsterdam: North-Holland.

Cahill, Mike (2007) 'More universals of tone'. Ms. SIL International. https://www.sil.org/resources/publications/entry/7816

Campbell, Eric (2014) *Aspects of the phonology and morphology of Zenzontepec Chatino, a Zapotecan language of Oaxaca*, Mexico. Doctoral dissertation, University of Texas, Austin.

Campbell, Eric (2016) 'Tone and inflection in Zenzontepec Chatino'. In Enrique L. Palancar and Jean Léo Léonard (eds) *Tone and inflection*, 141-162. Berlin and /Boston: Walter de Gruyter.

Chen, Matthew Y. (1987) 'The syntax of Xiamen tone sandhi'. *Phonology [Yearbook]* 4.109-149.

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.

Clements, G. N. (2001) 'Representational economy in constraint-based phonology'. In T. Alan Hall (ed),.), *Distinctive feature theory*, 71-146. Berlin: Mouton de Gruyter.

Clements, G. N. and Goldsmith, John (1984) (eds) *Autosegmental studies in Bantu tone.* Dordrecht: Foris.

Clements, G. N., Michaud, Alexis and Patin, Cédric (2010) 'Do we need tone features?' In John A. Goldsmith, Elizabeth Hume and Leo Wetzels (eds) *Tones and features: Phonetic and phonological perspectives*, 3-24. Berlin and Boston: de Gruyter Mouton.

Connell, Bruce A., Hayward, Richard A., and Ashkaba, John Abraha (2000) 'Observations on Kunama tone'. *Studies in African Linguistics* 29.1-41.

Courtenay, Karen (1974) 'On the nature of the Bambara tone system'. *Studies in African Linguistics* 5.303-323.

Creider, Chet A. (1981) 'The tonal system of Proto-Kalenjin'. In Thilo C. Schadebertg and M. Lionel Bender (eds) *Proceedings of the First Nilo-Saharan Linguistics Colloquium*, 19-39. Dordrecht: Foris Pubs.

Creissels, Denis (1988) *Le système tonal du bambara standard*. Grenoble: Centre de Linguistique AfricaineAfricaines et de l'Université Stendhal.

Creissels, Denis (2003) 'Some remarks on tonal processes at utterance boundaries'. In Rose-Juliet Anyanwu (ed), *Stress and tone—The African experience. Frankfurter Afrikianistische Blätter* 15.49-58.

Creissels, Denis and Grégoire, Claire (1993) 'La notion de ton marqué dans l'analyse d'une oppositon tonale binaire: Le cas du Mandingue. Journal of African Languages and Linguistics 14.107-154.

Creissels, Denis and Kouadio, N'Guessan (1979) Les tons du baoulé (parler de la région de Toumodi)'. Abidjan: Institut de Linguistique Appliquée, Université d'Abidjan.

Cruz, Emiliana (2011) *Phonology, tone and the functions of tone in San Juan Quiahije Chatino*. Doctoral dissertation, University of Texas, Austin.

Daly, John P. and Hyman, Larry M. (2007) 'On the representation of tone in Peñoles Mixtec'. *International Journal of American Linguistics* 73.162-207.

Demers, Richard, Escalante, Fernando, and Jelinek, Eloise (1999) 'Prominence in Yaqui words'. *International Journal of American Linguistics* 65.40-55.

Dicanio, Christian (2008) *The phonetics and phonology of San Martin Itunyoso Trique*. Doctoral dissertation, University of California, Berkeley.

Dicanio, Christian (2016) 'Tone classes in Itunyoso Triqui person morphology' In Enrique L. Palancar and Jean Léo Léonard (eds) *Tone and inflection*, 225-266. Berlin and Boston: de Gruyter Mouton.

Downing, Laura J. and Rialland, Annie (eds) (2017) *Intonation in African tone languages*. Berlin and Boston: de Gruyter Mouton.

Edmondson, Jerold A., and Kenneth J. Gregerson (1992) On five-level tone systems. In S. J. J. Hwang & W. R. Merrifield (eds) *Language in Context: Essays for Robert E. Longacre*: 555-576. Dallas: SIL.

Elimelech, Baruch (1978) *A tonal grammar of Etsako.* Berkeley and Los Angeles: University of California Press.

Elugbe, Ben Ohi (1977) 'Some implications of low tone raising in southwestern Edo'. *Studies in African Linguistics*, Supplement 7, 53-62.

Emenanjo, E. Nolue (1987) *Elements of Modern Igbo grammar*. Ibadan, Nigeria: University Press Limited.

Galloway, Brent Douglas. (1993) *A grammar of Upriver Halkomelem*. Berkeley and Los Angeles: University of California Press.

Goldsmith, John A. (1976a) *Autosegmental phonology*. Doctoral dissertation, MIT. New York: Garland Press, 1978.

Goldsmith, John A. (1976b) An overview of autosegmental phonology. *Linguistic Analysis* 2. 23–68.

Gomez-Imbert, Elsa (1980) 'La faille tonale en tatuyo'. Communication présentée aux Journées de Tonologie LP 3-121 du CNRS.

Gomez-Imbert, Elsa, and Kenstowicz, Michael (2000) 'Barasana tone and accent.' *International Journal of American Linguistics* 66, no. 4: 419-463.

Gordon, Matthew (2001) 'A typology of contour tone restrictions'. *Studies in Language* 25.405–444.

Gralow, Frances L. (1985) 'Coreguaje: Tone, stress and intonation'. In Ruth M. Brend (ed), *From phonology to discourse: Studies in six Colombian languages*, 3-11. Lang. Data, Amerindian Series No. 9. Dallas: SIL.

Green, Christopher R. (2013) 'Formalizing the prosodic word domain in Bambara tonology'. Journal of West African Languages 40.3-20.

Green, Christopher R. and Michelle E. Morrison (2016) 'Somali wordhood and its relationship to prosodic structure'. *Morphology* 26.3-32.

Gussenhoven, Carlos (2004) *The phonology of tone and intonation.* Cambridge University Press.

Gussenhoven, Carlos (2006) 'Between stress and tone in Nubi word prosody'. *Phonology* 23.193-223.

Harry, Otelemate and Hyman, Larry M. (2014) 'Phrasal construction tonology'. *Studies in Language* 38.649-689.

Haudricourt, André Georges (1961) 'Bipartition et tripartion des systèmes de tons dans quelques langues de'Extrême-Orient'. *Bulletin de la Société de Linguistique de Paris* 56.163-180.
Heath, Jeffrey (2005) *Tondi Songway Kiini (Songhay, Mali)*. Stanford: C.S.L.I.
Heath, Jeffrey (2008) *A grammar of Jamsay*. Berlin: Mouton de Gruyter.
Heine, Bernd (1993) *Ik dictionary*. Köln: Rüdiger Köppe Verlag.
Hérault, G. (1978) *Élements de grammaire adioukrou.* Abidjan: Institut de Linguistique Appliquée.
Hinton, Leanne, Buckley, Gene, Kramer, Mary, and Meacham, Michael (199) 'Preliminary analysis of Chalcatongo Mixtec tone'. *Occasional Papers on Linguistics* 16.147-155.
Holton, Gary (2005) 'Pitch, tone, and intonation in Tanacross'. In Sharon Hargus and Keren Rice (eds) *Athabaskan prosody*, 249-275. Amsterdam/Philadelphia: John Benjamins.
Hostetler, Roman and Hostetler, Carolyn (1975) 'A tentative description of Tinputz phonology'. Phonologies of five Austronesian languages. *Workpapers in Papua New Guinea Languages* 13.5-44.
Hyman, Larry M. (1979a) 'A reanalysis of tonal downstep'. *Journal of African Languages and Linguistics* 1.9-29.
Hyman, Larry M. (1979b) 'Tonology of the Babanki noun'. *Studies in African Linguistics* 10.159-178.
Hyman, Larry M. (1981) *Noni grammatical structure*. Southern California Occasional Papers in Linguistics 9. Los Angeles: Department of Linguistics, University of Southern California.
Hyman, Larry M. (1985) *A theory of phonological weight.* Dordrecht: Foris. (Reprinted 2003, Stanford: C.S.L.I.).
Hyman, Larry M. (1986a) 'The representation of multiple tone heights'. In K. Bogers, H. van der Hulst, and M. Mous (eds) *The phonological representation of suprasegmentals*. Dordrecht: Foris. 109-152.
Hyman, Larry M. (1986b) 'Downstep deletion in Aghem'. In David Odden (ed) *Current approaches to African linguistics*, vol. 4, 209-222. Dordrecht: Foris Publications.
Hyman, Larry M. (1987) 'Prosodic domains in Kukuya'. *Natural Language and Linguistic Theory* 5.311-333.
Hyman, Larry M. (1990) 'Boundary tonology and the prosodic hierarchy'. In Inkelas and Zec, 109-125.
Hyman, Larry M. (1993) 'Register tones and tonal geometry'. In Keith Snider and Harry van der Hulst (eds) *The phonology of tone: the representation of tonal register*, 75-108. The Hague: Mouton de Gruyter.
Hyman, Larry M. (2003) 'African languages and phonological theory'. *GLOT International* Vol. 7, No. 6, 153-163.
Hyman, Larry M. (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.
Hyman, Larry M. (2007) 'Universals of tone rules: 30 years later'. In Tomas Riad and Carlos Gussenhoven (eds) *Tones and tunes: Studies in word and sentence prosody*, 1-34. Berlin: Mouton de Gruyter.

Hyman, Larry M. (2010a) 'Kuki-Thaadow: An African tone system in Southeast Asia.' In Franck Floricic (ed) *Essais de typologie et de linguistique générale*, 31-51. Lyon, France: Les Presses de l'Ecole Normale Supérieure.

Hyman, Larry M. (2010b) 'Do tones have features?' In John A. Goldsmith, Elizabeth Hume, and Leo Wetzels (eds) *Tones and features: Phonetic and phonological perspectives*, 50-80. Berlin and Boston: de Gruyter Mouton.

Hyman, Larry M. (2012) 'Markedness, faithfulness, and two-height tone systems'. In *Proceedings from the Montreal-Ottawa-Toronto (MOT) Phonology Workshop 2011: Phonology in the 21st Century: In Honour of Glyne Piggott.* McGill Working Papers in Linguistics 22(1), 1-13.

Hyman, Larry M. and Leben, William R. (2000) 'Suprasegmental processes'. In G. Booij, C. Lehmann, and J. Mugdan (eds) *A handbook on inflection and word formation*, 587-594. Berlin: de Gruyter.

Hyman, Larry M. and Schuh, Russell G. (1974) 'Universals of tone rules: Evidence from West Africa'. *Linguistic Inquiry* 5.81-115.

Hyman, Larry M. and Tadadjeu, Maurice (1976) 'Floating tones in Mbam-Nkam'. In Larry M. Hyman (ed), *Studies in Bantu tonology*, 58-111. Southern California Occasional Papers in Linguistics 3. Los Angeles: University of Southern California.

Hyman, Larry M. and Kenneth VanBik (2004) 'Directional rule application and output problems in Hakha Lai tone'. *Language and Linguistics* 5.821-861.

Inkelas, Sharon and Zec, Draga (eds) (1990) *The phonology-syntax connection*. Stanford: C.S.L.I.

Jamieson, Allan R. (1977) 'Chiquihuitlán tone'. In William R. Merrifield (ed) *Studies in Otomanguean phonology*, 107-135. Summer Institute of Linguistics Publications in Linguistics, 54. Dallas: S.I.L. and the University of Texas at Arlington.

Jenewari, Charles Ezekiel William (1977) *Studies in Kalabari syntax*. Doctoral dissertation, University of Ibadan, Nigeria.

Jun, Sun-Ah (2005) (ed) *Prosodic typology: the phonology of intonation and phrasing*. Oxford: Oxford University Press.

Jun, Sun-Ah (2014) (ed) *Prosodic typology II: the phonology of intonation and phrasing.* Oxford: Oxford University Press.

Keller, Natalia Eraso (1999) 'Cambios tonales en la palabra verbal de la lengua tanimuca'. *Congresso de Lingüística Amerindia y Criolla*, 72-95. Memorias. Lenguas Aborígenes de Colombia.

Kingston, John (2011) 'Tonogenesis'. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume, and Keren Rice (eds) *Blackwell Companion to Phonology*, vol. 4, 2304-2334. Oxford: Blackwell Publishing.

Kirby, James P. (2011) 'Vietnamese (Hanoi Vietnamese)'. *Journal of the International Phonetic Association* 41.382-392.

Kisseberth, Charles W. and Abasheikh, Mohammad Imam (1974) 'Vowel length in ChiMwi:ni: A case study of the role of grammar in phonology'. In A. Bruck et al (eds) *Papers from the Parasession on Natural Phonology*, 193-209. Chicago Linguistic Society.

Kisseberth, Charles W. and Abasheikh, Mohammad Imam (2011) 'Chimwiini phonological phrasing revisited'. *Lingua* 121.1987-2013.

Landaburu, J. (1979) *La langue des Andoke, Amazonie colombienne*. Paris: C.N.R.S.

Laniran, Yetundo O. and Clements, G. N. (2003) 'Downstep and high raising: interacting factors in Yoruba tone production'. *Journal of Phonetics* 31.203–250.

Leben, William R. (1973) *Suprasegmental phonology*. Doctoral dissertation, MIT. New York, Garland, 1980.
Leben, William R. and Ahoua, Firmin (1997) 'Prosodic domains in Baule'. *Phonology* 25.113-132.
Leben, William R. (in press) The nature(s) of downstep. In Firmin Ahoua (ed) *Proceedings from SLAO/1er Colloque International, Humboldt Kolleg.* Abidjan, 2014. .
Leroy, Jacqueline (1979) 'A la recherche de tons perdus'. *Journal of African Languages and Linguistics* 1.55-71.
Liberman, Mark Y. (1975) *The intonational system of English.* Doctoral dissertation, MIT.
Lin, M. (1988) 'Putonghua shengdiao de shengxue texing he zhijue zhengzhao'. [Perceptual cues for tones in Standard Chinese] *Zhongguo Yuwen* [*Chinese Linguistics*], 204.182-193.
Macaulay, Monica (1996) *A grammar of Chalcatongo Mixtec*. Berkeley and Los Angeles: University of California Press.
Malone, Terry (2006) 'Tone and syllable structure in Chimila'. *International Journal of American Linguistics* 72.1-58.
Marlo, Michael R., Mwita, Leonard Chacha, and Paster, Mary (2014) 'Kuria tone melodies'. *Africana Linguistica* 20.277-294.
Matisoff, James A. (1973) 'Tonogenesis in Southeast Asia'. In Larry M. Hyman, *Consonant types and tone*, 71-95. Southern California Occasional Papers in Linguistics 3. Los Angeles: University of Southern California.
Matisoff, James A. (1978) *Mpi and Lolo-Burmese microlinguistics*. Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.
Matisoff, James A. (1999) 'Tibeto-Burman tonology in areal context. In *Proceedings of the Symposium: Cross-linguistic studies of tonal phenomena: Tonogenesis, typology and related topics.* ILCAA.
Mazaudon, Martine and Michaud, Alexis (2008) 'Tonal contrasts and initial consonants: a case study of Tamang, a "missing link" in tonogenesis'. *Phonetica* 65.231-256.
McIntosh, Justin Daniel (2015) *Aspects of phonology and morphology of Teotepec Eastern Chatino*. Doctoral dissertation, University of Texas, Austin.
Michael, Lev (2011) 'The interaction of tone and stress in the prosodic system of Iquito (Zaparoan, Peru)'. *Amerindia* 35.53-74.
Mock, Carol (1988) 'Pitch accent and stress in Isthmus Zapotec'. In Harry van der Hulst and Norval Smith (eds) *Autosegmental studies on pitch accent*, 197-223. Dordrecht: Foris.
Mutaka, Ngessimo M. (2014) 'Penultimate lengthening and stress in Kinande'. *International Journal of Language Studies* 8.109-124.
Nash, Jay A. (1992-1994) 'UnderlyingUndelrying low tones in Ruwund'. *Studies in African Linguistics* 23.223-278.
Myers, Scott (1998) 'Surface underspecification of tone in Chichewa'. *Phonology* 15.367-391.
Needham, Doris and Davis, Marjorie (1946) 'Cuicateco phonology'. *International Journal of American Linguistics* 12.139-146.
Newman, John and Petterson, Robert G. (1990) 'The tones of Kairi'. *Oceanic Linguistics* 29.1, 49-76.
Noonan, Michael (1992) *A grammar of Lango*. Berlin: Mouton de Gruyter.
Nougayrol, Pierre (1979) *Le day de bouna (Tchad). I. Élements de description linguistique*. Paris: S.E.L.A.F.

Nougayrol, Pierre (1989) *La langue des Aiki dits Rounga.* Paris: Librairie Orientaliste Paul Geunthner.
Odden, David (1982) 'Tonal phenomena in Kishambaa'. *Studies in African Linguistics* 13.177-208.
Paulian, Christiane (1975) *Le kukuya: langue teke du Congo*. S.E.L.A.F.: Paris.
Pearce, Mary (2013) *The interaction of tone with voicing and foot structure: Evidence from Kera phonetics and phonology*. Stanford Monographs in African Languages. CSLI: Stanford, CA.
Picanço, Gessiane Lobato (2005) *Mundurukú: Phonetics, phonology, synchrony, diachrony*. Doctoral dissertation, University of British Columbia.
Pierrehumbert, Janet B. (1980) The phonology and phonetics of English intonation. Doctoral dissertation, MIT.
Pike, Eunice V. (1951) 'Tonemic-intonemic correlation in Mazahua (Otomi)'. *International Journal of American Linguistics* 17.37-41. Reprinted in Ruth M. Brend (ed) *Studies in tone and intonation*, 100-107. Basel: S. Karger, 1975.
Pike, Eunice V. and Small, Priscilla (1974) 'Downstepping terrace tone in Coatzospan Mixtec'. In Brend (ed), 105-34.
Pike, Eunice V. and Wistrand, Kent (1974) 'Step-up terrace tone in Acatlán Mixtec (Mexico)'. In Brend (ed), 81-104.\
Pike, Kenneth L. (1948) Tone languages. Ann Arbor, MI: U. of Michigan Press.
Post, Mark (2005) Handout, Sino-Tibetan Group Talk, May 25, 2005, La Trobe University.
Post, Mark (2009) 'The phonology and grammar of Galo "words": A case study in benign disunity'. *Studies in Language* 33.931-971.
Pulleyblank, Douglas (1986) *Tone in lexical phonology*. Dordrecht: D. Reidel.
Riad, Tomas (1998) 'Towards a Scandinavian accent typology'. In Wolfgang Kehrein and Richard Weise (eds) *Phonology and morphology of the Germanic languages*, 77-112. Tübingen: May Niemeyer Verlag.
Rialland, Annie (1983) 'Le système tonal du moba comparé à celui du gurma'. In J. Kaye et al (eds) *Current approaches to African linguistics* (vol. 2), 217–234. Dordrecht: Foris.
Rialland, Annie (2001) 'Anticipatory raising in downstep realization: evidence for preplanning in tone production'. In Shigeki Kaji (ed) *Cross-linguistics studies of tonal phenomenon: Tonogenesis, typology, and related topics,* 301-322. Tokyo: Institute for the Study of Languages and Cultures of Asia and Africa.
Rice, Keren and Hargus, Sharon (2005) 'Introduction. In Sharon Hargus and Keren Rice (eds) *Athabaskan prosody*, 1-45. Amsterdam/Philadelphia: John Benjamins.
Sande, Hannah (2016) 'Process morphology in a realizational theory'. Paper presented at the 47th Meeting of the North East Linguistic Society, University of Massachusetts, Amherst, October 14-16, 2016.
Schadeberg, Thilo C. (1973) 'Kinga: a restricted tone language'. *Studies in African Linguistics* 4.23-48.
Schuh, Russell G., Gimba, Alhaji Maina, and Ritchart, Amanda (2010) 'Bole intonation'. *Working Papers in Phonetics* 108, 226-248. Los Angeles: Department of Linguistics, UCLA.
Selkirk, Elisabeth (1986) 'On derived domains in sentence phonology'. *Phonology [Yearbook]* 3.371-405.
Selkirk, Elisabeth and Shen, Tong (1990) 'Prosodic domains in Shanghai Chinese'. In Inkelas and Zec, 313-337.
Shimizu, Kiyoshi (1983) *The Zing dialect of Mumuye.* Hambrug: Helmut Buske Verlag.

Snider, Keith L. (1990) 'Tonal upstep in Krachi: Evidence for a register tier'. *Language* 66.453-474.
Snider, Keith L. (1998) 'Phonetic realisation of downstep in Bimoba'. *Phonology* 15.77-101.
Solnit, David. 'Eastern Kayah Li'. In Graham Thurgood and Randy J. LaPolla (eds) *The Sino-Tibetan languages*, 623-631. London and New York: Routledge.
Stacy, Elizabeth (2004) 'Phonological aspects of Blackfoot prominence'. MA Thesis, U. Alberta.
Sullivant, John Ryan (2015) *The phonology and inflectional morphology of Chá?knyá, Tataltepec de Valdés Chatino, a Zapotecan language*. Doctoral dissertation, University of Texas, Austin.
Thiesen, Wesley and Weber, David (2012) *A grammar of Bora, with special attention to tone*. Dallas: SIL International.
Thomas, Elaine (1978) *A grammatical description of the Engenni language*. University of Texas, Arlington: Summer Institute of Linguistics.
Tucker, Archibald Norman (1981) 'The conceptions downdrift, upsweep, downstep, upstep, uphitch in African languages'. In H. Jungraithmayr and D. Miehe (eds) *Berliner afrikanistische Vorträge*, XXI, 223-224. Berlin: Deutscher Orientalistentage.
Van Otterloo, Karen (2014) 'Tonal melodies in the Kifuliiru verbal system'. *Africana Linguistica* 20:385-403.
Villard, Stéphanie (2015) *The phonology and morphology of Zacatepec Eastern Chatino*. Doctoral dissertation, University of Texas, Austin.
Volk, Erez (201) '*Mijikenda tonology*. Doctoral dissertation. Tel Aviv University.
Wang, William S.-Y. (1972. 'The many uses of Fo'. In A. Valdman (ed), *Papers in linguistics and phonetics dedicated to the memory of Pierre Delattre*, 487-503. The Hague: Mouton.
Welmers, William E. (1959) 'Tonemics, morphotonemics, and tonal morphemes'. *General Linguistics* 4.1-9.
Welmers, William E. (1962) 'The phonology of Kpelle'. *Journal of African Languages* 1.69-93.
Welmers, William E. (1973) *African language structures*. Berkeley and Los Angeles: University of California Press.
Welmers, William E. and Welmers, Beatrice F. (1969) 'Noun modifiers in Igbo'. *International Journal of American Linguistics* 35.315-322.
Woo, Nancy H. (1969) *Prosody and phonology*. Doctoral dissertation, M.I.T. Indiana University Linguistics Club mimeo.
Xu, Yi (1997) 'Contextual tonal variations in Mandarin.' *Journal of Phonetics* 25,1. 61-83.
Yip, Moira (1989) 'Contour tones'. *Phonology* 6.149-174.
Yip, Moira (2002) *Tone*. Cambridge University Press.
Yu, Alan C. L. (2010) 'Tonal effects on perceived vowel duration'. In C. Fougeron, B. Kühnert, M. D'Imperio, and N. Vallée (eds) Laboratory phonology 10, 151-168. Berlin: Mouton de Gruyter.
Zee, Eric (1987) 'Tone demonstration: Shanghai noun compound tone patterns'. Handout. Hyman/Leben course at LSA Summer Institute, Stanford University.
Zhang, Jie (2004) 'The role of contrast-specific and language-specific phonetics in contour tone distribution'. In Bruce Hayes, Robert Kirchner, and Donca Steriade (eds) *Phonetically-based phonology*, 157-19. Cambridge University Press.
Zheltov, Alexander (2005) 'Le système des marqueurs de personnes en gban: Morphème syncrétique ou syncrétisme des morphèmes'. *Mandenkan* 41.23-28.
Zwarts, Joost (2004) 'The phonology of Endo: A Southern Nilotic language of Kenya'. Munich: LINCOM Europa.

Zwicky, Arnold M. and Kaisse, Ellen M. (eds) (1987) 'Syntactic conditions on phonological rules'. *Phonology Yearbook* 4.1-263.