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Tone: Is it Different?

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1.   Introduction

Except for a brief period in the late 1970s and early 1980s, tone has generally fallen outside the central concerns of theoretical phonology. During that period, the concepts and formalisms of Goldsmith's (1976a,b) autosegmental approach to tone provided the model to address other aspects of "non-linear phonology" including vowel harmony (Clements 1977, 1981), nasal harmony (Hyman 1982), and feature geometry (Clements 1985, Sagey 1986). In addition, autosegmental approaches to templatic morphology (McCarthy 1981), reduplication (Marantz 1982), and other aspects of "prosodic morphology" owed their inspiration to tone, which through the work of Pulleyblank (1986) provided important insights into the developing framework of lexical phonology and morphology (Kiparsky 1982, 1985; Mohanan 1986). Most generative work prior to and during this period had centered around African tone systems (Leben 1973a, Hyman & Schuh 1974, Goldsmith 1976, Clements & Ford 1979, Clements & Goldsmith's 1984), two notable exceptions being Haraguchi (1977) and Yip (1980), who dealt with the tonal dialectology of Japanese and Chinese, respectively. Finally, Pierrehumbert (1980) developed an influential autosegmental approach to intonation based on English, which was subsequently applied to Japanese (Beckman & Pierrehumbert 1986) and many other languages since. While the autosegmental legacy is still quite alive, tone has not contributed as centrally to subsequent theoretical innovations in phonology. In the case of optimality theory (Prince & Smolensky 1993, McCarthy 2002), there have been some interesting applications, e.g. Myers' (1997) treatment of the obligatory contour principle (OCP), but theoretical developments have largely been based either on segmental phonology or on stress, syllabification, reduplication and other aspects of prosodic phonology and morphology.

My goal in writing this chapter is twofold. First, I propose to cover some of the aforementioned contributions that tone has made to phonological theory. Second, I wish to show that there is still much more for phonologists and others to learn from tone. I suggest that linguists should be very concerned about tone, for at least three reasons:

(i) Tone systems are found in approximately 50% of the languages of the world. The greatest concentrations of "tone languages" are found in Sub-Saharan Africa, East and Southeast Asia, Southcentral Mexico, and parts of Amazonia and New Guinea. While we have had access to information about the first three areas for some time, comparatively little has been available on tone in Amazonia and New Guinea until recently. The emerging picture is that these tone sytems have interesting and diverse properties which complement the already varied African, Asian, and Mexican systems. The result is an extraordinary richness and a potential gold mine for future investigations.

(ii) The study of tone has influenced the history of phonology and promises to contribute further to our understanding of language in general, particular as concerns interface issues. For instance, some of the most detailed and influential studies concerning the syntax-phonology

interface have drawn from tonal alternations applying at the phrase level (Clements 1978, Chen 1987). More recently, several meetings have brought together scholars interested in the relation between tone, phrasal accent, and intonation, especially in the languages of Europe and East Asia (Germanic, Slavic, Basque, Chinese, Japanese, Korean etc.), areas covered in some detail by Gussenhoven (2004), among others. Three collections of note are van der Hulst (1999), Jun (2005), and Riad & Gussenhoven (2007). Cutting across the components of grammar, both abstract and instrumental research have been concerned with how focus and other aspects of information structure, often sometimes marked by stress or intonation, are realized when there is a competing tone system. Some of this work has shown that focus is not necessarily prosodically marked in certain languages with tone (Downing 2007).

(iii) Tone systems have properties which SURPASS segmental and metrical systems. In §6 I conclude that tone can do everything that segmental and metrical phonology can do, but that the reverse is not true. This is especially true of the long-distance effects that tone exhibits both within and across words, as when the tone of one word migrates several syllables or words to its right. Since some tonal phenomena have no segmental or stress analogues, anyone who is interested in the outer limits of what is possible in phonology would thus be well-served to understand how tone systems work.

Despite the widespread occurrence of tone in the world's language and the important contributions tone has already made to our understanding of phonology and its interfaces, the lack of familiarity of some scholars with tone has allowed certain old misconceptions to persist. The rest of the chapter is organized as follows. In §2, I begin by defining tone and characterizing these persistent misconceptions. In §3 I discuss the autosegmental insight to tone. The next section deals with the question of whether tone has different properties from other phonology, either quantitatively (§4.1) or qualitatively (§4.2). §5 takes us the issue of whether tone should sometimes be analyzed in accentual terms. Throughout the discussion focus will be on the question of what tone has to teach phonologists, and therefore crucially, whether there are phonological properties that are found only in tone systems. The conclusion in §6 summarizes the key points of the preceding sections, concluding that the capabilities of tone do surpass those of either segmental or metrical phonology.

2.   Defining tone: Three misconceptions

A logical place to begin is by raising an old, but most essential question, "What is tone?" How do we know if a language has tone? As given in (1), two early definitions of a language with tone is a language

(1)   a.   "... having significant, contrastive, but relative pitch on each syllable" (Pike 1948:3)
      b.   "... in which both pitch phonemes and segmental phonemes enter into the composition of at least some morphemes" (Welmers 1959:2)

While Pike originally saw tone as a contrastive feature on each syllable or other tone-bearing unit (TBU), Welmers' definition insists on the MORPHOLOGICAL nature of tone: tone is not a property of syllables, as expressed by Pike, but rather of morphemes. Welmers correctly pointed out that not all morphemes need to have a tone—some may be toneless. Similarly, not all morphemes need to have a TBU—they may be "tonal morphemes" (§2, §3). We will see that there is great advantage in approaching tone from this morphological perspective. However, it is

useful to update and slightly modify Welmers' definition as in (2). A language with tone is a language

(2)   "... in which an indication of pitch enters into the lexical realization of at least some morphemes." (Hyman 2001a:1368; Hyman 2006:229)

The above statement defines tone in terms of the morphemes which in turn are amalgamated to form words. Since word-level tones may be assigned by rule, "lexical realization" refers to the output of lexical phonology, not necessarily underlying representations. For example, it could be argued that the Somali noun roots in (3) are underlyingly toneless:

(3)   root   masculine   feminine
    a.   /inan/   ínan   'boy'   inán   'girl'
         /naʕas/   náʕas   'stupid man'   naʕás   'stupid woman'
         /goray/   góray   'male ostrich'   goráy   'female ostrich'
    b.   /darmaan/   darmáan   'colt'   darmaán   'filly'
         /ʕeesaan/   ʕeesáan   'young he-goat'   ʕeesaán   'young she-goat'
         /dameer/   daméer   'he-donkey'   dameér   'she-donkey'

For these nouns, the masculine morpheme assigns a high (H) tone (´) to the penultimate vowel, while the feminine morpheme assigns a H tone to the final vowel (Hyman 1981, Saeed 1999). Toneless vowels which follow a H are realized low (L), while vowels which precede a H tone are realized mid (M). The contrast in (3a) is thus between [H-L] vs. [M-H], while the contrast in (3b) is between [M-HL] vs. [M-MH], where the last long-vowel syllable is either falling or rising. Somali also illustrates the importance of the wording "indication of pitch" in the definition in (2), which is taken to mean tone features or any other analytical device whose only function is to characterize pitch. In the above analysis, a H tone is assigned to one of the last two vowels of the noun. Although an analyst may prefer to assign a diacritic accent (*) to the relevant vowel instead, the diacritic device would still be marking only H tone, which in fact may be entirely absent on a word, e.g. on both the subject noun and verb in the utterance *inan wáa dhaʕay* 'a boy fell'. The definition in (2) would thus include Somali, but would exclude languages where all indications of pitch are introduced post-lexically, i.e. at the phrase or utterance level.

    While it is possible to view the above Somali roots as underlyingly toneless, and the gender markers as tonal morphemes devoid of a TBU, the most common situation is for morphemes to consist of both segmental and tonal features. This is seen in the minimal pairs, triplets, quadruplets and quintuplets in (4)-(7) showing examples contrasting two, three, four, and five contrastive tone heights, respectively:

(4)   Two levels: Dadibi [Papua New Guinea] (MacDonald & MacDonald 1974:151)

      a.   L (low) tone   :   wà   'string bag'   nà   'shoulder'
      b.   H (high) tone :   wá   'edible greens'   ná   'aunt'

(5)   Three levels: Nupe [Nigeria] (Banfield 1914)

      a.   L (low) tone   :   bà   'to count'   wà   'to scratch'
      b.   M (mid) tone   :   bā   'to cut'   wā   'to extract'

c.   H (high) tone :   bá   'to be bitter'   wá   'to want'

(6)   Four levels: Chatino (Yaitepec) [Mexico] (McKaughan 1954:27)

L (low) tone   Lower mid tone   Higher mid tone   High (H) tone
kù̠   ku̠   kū̠   kú̠
'dove'   'sweet potato'   'I grind'   'I eat'

(7)   Five levels: Kam (Shidong) [China] (Edmondson & Gregerson 1992)

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

The contrasts in (7) show that it is sometimes difficult to give names and use accent marks for each tone level, in which case it is more practical to indicate pitch levels by numbers (5 = highest, 1 = lowest). In addition to such level tones, some languages also have contour tones which either rise, fall, or both. The best known such example is Standard Mandarin, whose four-way contrast is frequently exemplified by means of the minimal quadruplet in (8).

(8)   Tone I   (high level)   ma^{55} 'mother'
         Tone II   (rising)   ma^{35} 'hemp'
         Tone III   (falling-rising)   ma^{214} 'horse'
         Tone IV   (falling)   ma^{51} 'scold'

By exploiting other contours as well as differences in phonation, e.g. breathiness or glottalization, a language can have even more tonal contrasts on monosyllables, as in the following Trique (Itunyoso) [Mexico] examples (Dicanio 2006):

(9)   Level   Falling   Rising
         bbe^{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'

As many people do not speak a native language with tone, tonal contrasts such as the above can be quite unfamiliar to linguists and language learners alike:

> "Most language students, and even a shocking number of linguists, still seem to think of tone as a species of esoteric, inscrutable, and utterly unfortunate accretion characteristic of underprivileged languages—a sort of cancerous malignancy afflicting an otherwise normal linguistic organism. Since there is thought to be no cure—or even reliable diagnosis—for this regrettable malady, the usual treatment is to ignore it, in hope that it will go away of itself." (Welmers (1959:1)

In this chapter we are concerned with whether and, if so, how tone is different from other aspects of phonology. While few phonologists would like to be identified with the above caricature, which Welmers (1973:77) felt compelled to repeat fourteen years later, there are occasional indications that "a shocking number of linguists" feel that tone is different from segmental

phonology in rather dramatic ways. While we will conclude that there ARE important differences, let us first reject three rather extreme misconceptions about tone which are sometimes expressed:

(i) *Tone cannot be studied the same way as other phonological phenomena.* Upon encountering their first tonal experience, even seasoned field workers have asked me: "How can I tell how many tones my language has?" Each time this happens I am tempted to answer back with the rhetorical question: "How can you tell how many vowels your language has?" I have seen investigators try to discover the tonal categories by first eliciting long utterances, and then marking the relative pitch changes between syllables, as one might initially do when approaching intonation. At best, this complicates the task. As in the case of voicing, nasality, vowel length and other phonological contrasts, the normal technique is to first elicit individual words to determine the phonetic properties, and ultimately the phonemic contrasts. In the case of tone, this might then yield the tonal minimal pairs, triplets, quadruplets and quintuplets seen in (4)-(8) above. Other languages may offer fewer minimal pairs and/or require specific contexts or "frames" in which the full range of contrasts can be discerned. For example, as seen in (10), the largely monosyllabic words of Hakha Lai [Burma] are pronounced with either HL falling (ˆ) or level L (ˋ) tone in isolation (Hyman & VanBik 2004):

(10)   in isolation   after ka=   'my'

		in isolation		after ka=	
a.	hmâa	'wound'	ka hmâa		'my wound'
	lûŋ	'heart'	ka lûŋ		'my heart'
b.	kêe	'leg'	ka kĕe		'my leg'
	kôoy	'friend'	ka kŏoy		'my friend'
c.	sàa	'animal'	ka sàa		'my animal'
	kàl	'kidney'	ka kàl		'my kidney'

However, as seen in the forms on the right, the falling tone nouns split into two classes when following toneless proclitics such as ka= 'my': the nouns in (10a) remain HL, while those in (10b) are pronounced with a LH rising (ˇ) tone. The natural conclusion to draw is that Hakha Lai has three underlying tones, /HL, LH, L/, and a LH → HL rule that applies after pause (and in certain other environments—see Hyman & VanBik 2004).

Such observations do not make tone different from other aspects of phonology—one has but to think of the languages which merge segmental contrasts on words in isolation, e.g. the voicing contrast on German *Rat* 'advise' vs. *Rad* 'wheel'. In studying tone we need to be rigorous and comprehensive, just as we would have to be in attempting to analyze anything else. As we shall see, the issues that come up in the study of tone are quite complex, with more processes being available to tone, particularly at the phrase level, than to segmental phonology (cf. §4.2). However, since tones enter into "paradigmatic" contrasts very much like consonant and vowel features, we need not seek new methodologies. As Welmers (1959:9) put it: "The more information we acquire about even the most complex tone systems, the more encouragement we receive that we already have the equipment needed to handle them." In short, tone CAN be studied just like other aspects of phonology.

(ii) *Tone cannot mark certain things.* A second misconception is that tone is used only to mark certain things. Most of the examples in (4)-(10) illustrate the LEXICAL function of tone: Different monomorphemic nouns, verbs etc. differ only in tone. However, the Somali examples in (3) show that tone can also be implicated in grammar, i.e. it can have a MORPHOLOGICAL function. Further examples of morphological tone are seen in (11)-(13).

(11) Tone marking person in Zapotec (Macuiltianguis) [Mexico] (Broadwell 2000:7)

    a.   1st person: bè-xáttāʔ-yàʔ-nà 'I ironed it'   bè-gálláʔ-yàʔ-nà 'I hung it up'
    b.   3rd person: bè-xàttāʔ-nà-nà 'he ironed it'   bè-gàlláʔ-nà-nà 'he hung it up'

(12) Tone marking tense-aspect in Nambikuára [Brazil] (Kroeker 1977:129)

    a.   present: xyău-nàră 'he is staying'   săsǒ-nàră 'he is taking'
    b.   past: xyàu-nără 'he stayed'   săsô-nără 'he took'

(13) Tone marking negation in Igbo (Aboh) [Nigeria] (elicited by the author)

    a.   /ò jè kọ̀/   →   ò jè kọ̀ 'he is going'
    b.   /ó jè kọ̀/   →   ó jé kọ̀ 'he isn't going'   (H of subject /ó/ spreads onto /jè/)

In (11) we see that the 1st person Zapotec verbs begin with a H tone, while the 3rd person verbs begin with L. In (12) the only difference between the present and past tense is tonal in Nambiquára (where ˆ and ˇ mark HL falling and LH rising tones, respectively). Finally, in the Aboh dialect of Igbo, the only difference between the affirmative and negative utterances in (13) is the tone on the third person subject pronoun /o/ (whose H spreads onto /jè/ 'go' in the second example). It is thus clear that tone can have a grammatical function as well as a lexical one.

    The question is whether there are grammatical notions that tone cannot mark. At a recent annual conference in the US, a distinguished senior scholar presented a plenary talk at which, in passing, he proposed the following alleged universal: "No language uses tone to mark case." The Maasai [Kenya] data in (14), however, provide a rather clear counterexample to this claim (Tucker & Ole Mpaayei 1955:177-184):

(14)

		nominative	accusative	
	class I:	èlùkùnyá	èlúkúnyá	'head'
		èncùmàtá	èncúmátá	'horse'
	class II:	èndérònì	èndèrónì	'rat'
		ènkólòpà	ènkòlópà	'centipede'
	class III:	òlmérégèsh	òlmérègèsh	'ram'
		òlósówùàn	òlósòwùàn	'buffalo'
	class IV:	òmótònyî	òmótònyî	'bird'
		òsínkìrrî	òsínkìrrî	'fish'

In Maasai, native nouns usually consist of a gender prefix (masculine sg. *ol-*, feminine sg. *en-*) followed by a stem of one or more syllables. Except for class IV, nouns take different tones in nominative vs. accusative case. Although there are other complications, the four-syllable nouns which are cited show the following: In class I, the nominative has a single H on the last syllable, while the accusatives have one L followed by all H syllables. In class II, nouns have a single H which is realized on the first stem syllable in the nominative vs. the second stem syllable in the accusative. In class III, the nominative has a H tone on the first and second stem syllables, while the accusative has a H only on the first stem syllable.

    While Maasai is rather clear on the issue of tone marking case, the proposal is all the more surprising as so much of the tonal discussion in the 1960s and 1970s concerned the analysis of the so-called associative tone in certain West African languages such as Igbo (see Williamson 1986 and references cited therein). One analysis is that the associative marker consists of a H

tonal morpheme which, as seen in the examples in (14), is assigned to the left in Central Igbo, but to the right in Aboh Igbo (Hyman & Schuh 1974:98-9):

(15) Central Igbo: àgbà   +   ´   +   èŋwè   →   àgbá   èŋwè   'jaw of monkey'
      Aboh Igbo: ẹ̀gbà   +   ´   +   èŋwè   →   ẹ̀gbà   éŋwè   'jaw of monkey'

In Igbo, the /L-L/ words *àgbà ~ ẹ̀gbà* 'jaw' and *èŋwè* 'monkey' are pronounced L-L in isolation. As seen, according to the dialect, an intervening H tonal morpheme is realized either on the preceding or following TBU in the associative construction. But what is this "associative morpheme" if not a genitive case marker? The more pressing question is why anyone would seek to limit the kinds of constructions or semantic notions that tone can mark. The failure here is to appreciate the full morphological nature of tone: If a tone can be a morpheme, then it can do anything that a morpheme can do. This follows from the fact that tonal morphemes most commonly derive historically from earlier segmental+tonal morphemes whose segments have been lost (cf. §3). Thus, anything that can be marked by a segmental+tonal morpheme, can also be marked by a tonal morpheme. In other words, "tonal morphology... exhibits essentially the same range of morphological properties as in all of segmental morphology" (Hyman & Leben 2000:588).

The alternative view, that tone is better suited to express certain ideas rather than others, has, however, occasionally also been expressed:

"In a tone language, tone is not a purely harmonic or musical element, it is the expression of a thought, of an idea; it belongs to the intellectual domain, such that we can formulate the following axiom: SEEK THE IDEA AND YOU WILL HAVE THE TONE." (Stoll 1955:5) (my translation, his emphasis)

Along these lines, Stoll suggests that H tone indicates "everything that is woman, female, feminine" while L tone indicates "everything that is masculine, male, man" (p.156). While certain languages occasionally exhibit indications of tonal iconicity (cf. Ratliff 1992), there is no reason for H vs. L tones to signify feminine and masculine any more than voiceless vs. voiced consonants (with which these tones often correlate, respectively). Once again, tone is not different from other phonological features.

(iii) *Tone is expendable*. The third misconception is that tone is somehow less essential in a language than other phonological features. This is seen in the way tones and tone systems are sometimes dealt with in the literature. First, many descriptive and pedagogical grammars do not analyze or present the tone system in any detail. Those that do may have a section on tone, but then elect not to transcribe tone in the rest of the study. Different excuses are variously provided: (i) the tones are not important because they do not have a heavy functional load (i.e. there are few minimal pairs); (ii) the tones are a typographical inconvenience (e.g. an accent mark gets in the way of marking nasalized vowels with a tilde); (iii) the tones have not yet been analyzed; (iv) in order to learn the tones you have to listen to a native speaker anyway; (v) native speakers prefer not to write the tones, etc. There are, of course, practical orthographies that do not mark tone, just as there are those which fail to mark all of the segmental contrasts. While there is a growing experimental literature on whether it is advantageous to readers if tone is marked, and if yes, when and how (see, for example, Bird 1999a,b), the minimal contrasts cited in the above numbered examples establish that tone is extremely important in many, if not most languages which have a tone system.

The view that tone is expendable is not limited to those designing practical orthographies. In general linguistic work, even phonologists commonly cite language data without indicating the tones. The most egregious cases occur when linguists REMOVE the tones from tone-marked examples cited from other sources, sometimes adding in a footnote that they have done so because "the tones are not relevant to the current study." Perhaps this is also encouraged by an awareness that stress, another prosodic property (which may be predictable or have a low functional load), is also often omitted from linguistic transcriptions, as it is from many practical orthographies. However, no other phonological feature is treated with such indifference as tone: contrastive voicing on consonants or contrastive rounding on vowels is never removed from original fully-marked examples because voicing/rounding "is not relevant to the current study." On the other hand, there are speech situations where the speakers themselves omit the segments in favor of the tones:

> "...when, for some physical reason, it is inconvenient for a Nambikuára to separate his teeth, he may still participate in a conversation by talking through closed teeth using tone as his principle means of communication." (Kroeker 1977:133-4)

The inherent importance of tone should therefore not be underestimated.

As I have tried to indicate, although the above three misconceptions are sometimes explicitly expressed, they are more frequently implicit in the way linguists go about doing their work. Whether overtly expressed or not, the evidence is that tone is thought of as something different from the rest of what phonologists—or linguists in general—study. The above misconceptions are both extreme and wrongheaded. However, the question still remains: Is tone significantly different from other aspects of phonology? For example, is tone more independent from other phonological features than these latter are from each other? Is tone capable of greater variability than other features? Are there special processes which are found only in tone systems? Or, as Leben (1973b:117) once put it:

> "Is tone such a special phenomenon that it must be viewed as a feature on morphemes or larger units in some languages, as a feature on syllables in others, and as a feature on segments in still others? If so, then there is something left to explain: namely, why tone, unlike any other linguistic entity we know anything about, is capable of this many different types of representation."

Such questions are taken up in the following sections.

3. The autosegmental insight

Over the past several decades there has been an exponential increase in the documentation, analysis, and theoretical understanding of tone systems from throughout the world. Numerous formal proposals have been made concerning tone features and feature geometry, register effects such as downstep, and the interaction between tone and stress (de Lacy 2002), among other issues. In addition, the treatment of globality issues in tone has led to the development of Optimal Domains Theory (Cassimjee & Kisseberth 1998). However, as mentioned in §1, the greatest impact of tone on phonological theory occurred in the 1970s when tone provided the model for autosegmental phonology (Goldsmith 1976a,b). As a preliminary to the question of

whether tone is "different", it is therefore appropriate to begin by considering the fundamental insight of autosegmental tonology, stated in (16).

(16) Tones are SEMI-AUTONOMOUS from the tone-bearing units on which they are realized.

This view constituted a reaction to the "segmental" approach of standard generative phonology (Chomsky & Halle 1968), which represented consonants and vowel segments in terms of a single matrix of binary distinctive features. For example, the vowel /a/ could be characterized by the vertical array of the binary feature values [-cons], [+back], [-round], and [+low], as in (17).

(17) a.   High tone [á]   b.   Rising tone [ǎ]

$$\begin{bmatrix} \text{-cons} \\ \text{+back} \\ \text{-round} \\ \text{+low} \\ \text{+HIGH} \end{bmatrix} \qquad\qquad \begin{bmatrix} \text{-cons} \\ \text{+back} \\ \text{-round} \\ \text{+low} \\ \text{+RISING} \end{bmatrix}$$

The question was how to represent the various level and contour tones in terms of features. An ad hoc response was to add tonal feature values to the segmental matrices in (17), e.g. [+HIGH] for H tone, [+RISING] for rising tone (the capitals being used so as not to confuse tonal and vowel height features). However, there are two problems with the representations in (17).

The first problem stems from the inherent claim that tones are inseparable features on segments, whereas tones have considerable autonomy from their TBUs. As argued by Leben (1973a,b), some languages have a limited number of suprasegmental "tonal melodies" which must be abstracted away from the the TBUs on which they are realized. Although his example was Mende (cf. Leben 1978), I cite examples in (18) which illustrate the corresponding five tonal melodies of closely related Kpelle [Liberia] (Welmers 1962:86):

(18) a.   High throughout

pá   'come'   ɓóa   'knife'
láa   'lie down'   píli   'jump'

b.   Low throughout

kpòo   'padlock'   kpàki   'loom'
tònɔ   'chisel'   tòloŋ   'dove'

c.   High followed by low (low begins on the next vowel if there is one)

yɛ̂   'for you'   tôa   'pygmy antelope'
kpôŋ   'door'   kâli   'hoe'

d.   Mid throughout

kpɔŋ   'help'   sua   'animal'
see   'sit down'   kali   'snake'

e.   Mid with first vowel, then high followed by low

tɛɛ̂   'black duiker'   konâ   'mortar'
yuɔ̂   'axe'   kpanâŋ   'village'

In the above, I have adopted Welmers' practice of using only one tone mark per word (M is unmarked). He thus writes /kâli/ for what is pronounced [kálì] 'hoe', i.e. H-L. Second, there is no difficulty reducing Kpelle to an underlying two-level system: The M that occurs in the MHL melody in (18e) is straightforwardly analyzed as a L which is raised before H (cf. §4.2), and the "mid throughout" melody in (18d) is underlyingly /LH/, as is seen when two "mid throughout" words occur in sequence:
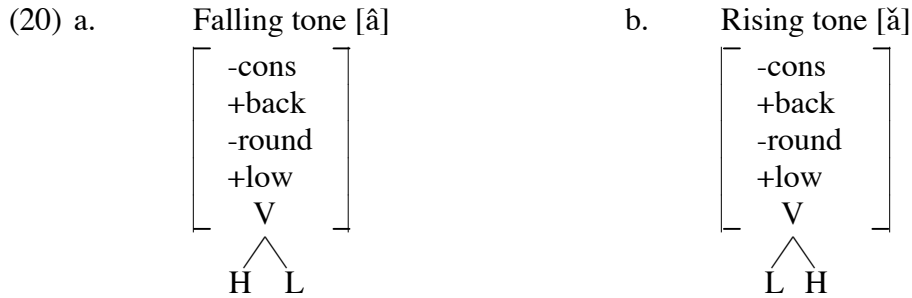
> "In mid-mid, for the dialect being described here, the first mid has a slightly rising allotone.... In some areas, the first mid is level, but the second mid begins a little higher and drops quickly to the level of the first. In still other areas, both phenomena occur: the first mid ends a little higher, and the second begins a little higher. In all cases, the conjunction of two mids is accompanied by an upward pressure." (Welmers 1962:87, note 2)

The important observation is that only five tone patterns (or "melodies") are possible independent of the number or nature of the TBUs: /H/, /L/, /HL/, /LH/, /LHL/. If, on the other hand, each TBU were capable of carrying an independent, underlying /H/, /L/, rising, or falling tone, we would expect 4 x 4 = 16 combinations on two TBUs, rather than the five that are observed. In this sense the tones are autonomous from the TBUs.

The second problem with (17) has to do with the representation of contour tones. Features such as [RISING] and [FALLING] encode a change within the segment which is not made explicit. In a two-level tone systems, a rising typically tone acts as if it is a sequence of L+H realized on a single TBU, while a falling tone acts as if it is a H+L sequence on a single TBU. We see this need in the following noun forms from Mende [Sierra Leone] (Leben 1978), which are arranged according to the same five tonal melodies as in Kpelle:

(19) | | | base noun | | + hu 'in' | + ma 'on' |
|---|---|---|---|---|---|
| a. | /H/ | kɔ́ | 'war' | kɔ́-hú | kɔ́-má |
| b. | /L/ | bɛ̀lɛ̀ | 'trousers' | bɛ̀lɛ̀-hù | bɛ̀lɛ̀-mà |
| c. | /HL/ | mbû | 'owl' | mbú-hù | mbú-mà |
| d. | /LH/ | mbǎ | 'rice' | mbà-hú | mbà-má |
| e. | /LHL/ | nyàhâ | 'woman' | nyàhá-hù | nyàhá-mà |

As seen, the two locative enclitics =hu and =ma take their tone according to the tone of the preceding noun. When the noun ends in a H or L, as in (19a,b), the enclitic takes the same tone. When the noun ends in a falling (HL) tone, as in (19c,e) or a rising tone, as in (19d), the two parts of the contour "split": the first part goes on the last syllable of the noun, while the second goes on the enclitic. We thus see that when there is an extra available syllable, a falling tone maps as a H-L sequence and a rising tone maps as a L-H sequence. This then provides the evidence that contours should not be characterzed by features such as [FALLING] and [RISING] but rather as sequenced level tone features, as in (20).

(20) a. Falling tone [â]   b. Rising tone [ǎ]

$$
\begin{bmatrix} \text{-cons} \\ \text{+back} \\ \text{-round} \\ \text{+low} \\ \text{V} \end{bmatrix}
$$
  H L

$$
\begin{bmatrix} \text{-cons} \\ \text{+back} \\ \text{-round} \\ \text{+low} \\ \text{V} \end{bmatrix}
$$
  L H

As proposed by Goldsmith (1976a,b), the H and L tones (or tone features) are represented on a separate tonal tier. Since they are both linked to the same TBU, the result is a contour tone. Other evidence that contours consist of two (occasionally more) independent tones linked to the same TBU can be cited from tone systems throughout the world. On the other hand, Yip (1989, 2002) argues that contour tones should be analyzed as units in certain Chinese dialects where the sequenced tone features appear to function as units. In such cases a rising tone would be represented roughly as in (21a), where the two tone features, L and H, are linked to a single tonal node.

(21) a. contour tone   b. tone cluster

   V   V   (TBU)
   | / \
   o   o o   (tonal node)
   / \ | |
   L H   L H
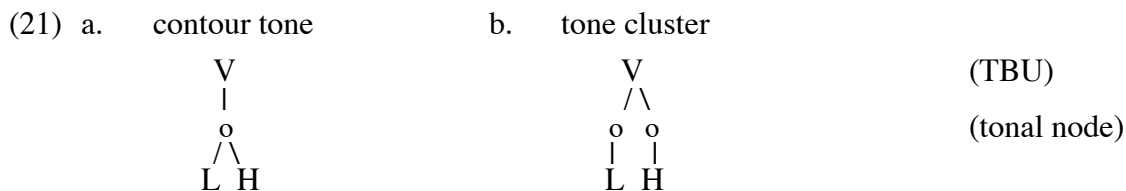
This is what Yip refers to as a true contour tone vs. the more common "tone cluster" representation in (21b), where each tone has its own tonal node.

  With such representations, we now understand the meaning of the "semi-autonomy of tone": Tones are on a separate tier, but they are linked to their TBUs by association lines. Originally the proposal was that there were two tiers, a segmental tier and a tonal tier, whereas further elaborations were proposed to capture (i) the feature geometry of segments (Clements 1985, Clements & Hume 1995); (ii) the feature geometry of tones (Bao 1999, Snider 1999, Yip 1995, 2002), and (iii) the moraic and syllabic structures which organize the segments and serve as the TBUs to which the tones link. All of this was made possible by the autosegmental insight that tones are semi-autonomous from their TBUs. Support for this position has come from three general observations:

  The first argument is that there is a NON-ISOMORPHISM between the two in the sense that the tones and TBUs do not necessarily synchronize: As we saw in (20) and (21), more than one tone can link to the same TBU, in which case we obtain a contour tone. The reverse, where one tone links to two TBUs is also possible. As a result, Kukuya [Congo] (Paulian 1975, Hyman 1987) contrasts two kinds of H-H words. As seen in (22a), both *má-bá* 'they are oil palms' and *wátá* 'bell' are pronounced H-H in medial utterance position:

(22) a. Medial   b. Prepausal

  má-bá wátá   má-bā wātā
   | | \ / | | \ /
   H H   H   H M   M
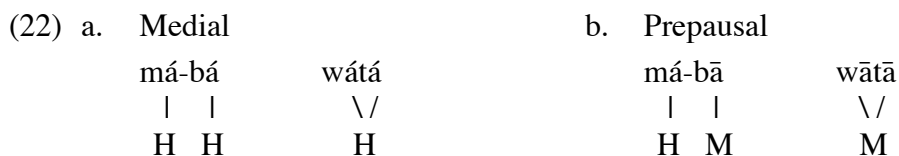
In (22b), however, the two words are realized differently before pause. As seen, there is a H → M rule which affects the last H feature before pause, not just the last H TBU. The contrasting representations in (22a), which had no equivalence in pre-autosegmental tonology, provide the structural difference that results in the surface opposition of H-M vs. M-M before pause. This difference largely correlates with a morphological difference: *má-bá* consists of two morphemes while *wátá* consists of one. In general, the double representation seen in *má-bá* is possible only when each H belongs to a different morpheme, while the branching representation of *wátá* is expected of single morphemes. There are exceptions in both directions, but in general the Obligatory Contour Principle (OCP) (Leben 1973a, Goldsmith 1976a) prohibits sequences of identical tonal features within the same morpheme.

The second argument for the semi-autonomy of tones from their TBUs concerns STABILITY EFFECTS. When a TBU is deleted, its tone is not necessarily deleted, but may either be relinked to another TBU, or it may "float" and have an effect on other tones. Both possibilities can be observed in Twi [Ghana] (Schachter & Fromkin 1968) in (23).

(23) a. /me ɔ-bo/   'my stone'   b. mê   bó   c. mé   ↓bó
          | | | |\ | | |
          H   L   H   H L H   H   L H

The input in (23a) consists of a /H-L-H/ sequence. When the historical L tone prefix /ɔ-/ is deleted, there are two options: In (23b), as indicated by the dotted association line, some speakers reassociate the L to the H tone pronoun /mé/ 'my' to form a HL falling tone. The more common option in (23c), however, is for the L to stay afloat and cause a lowering or "phonemic" DOWNSTEP of the following H of the root /bó/ 'stone'. Since the deletion of a vowel does not require the deletion of its tone, we have a strong validation of the decision to represent the tone on its own tier.

The derivation of a contour tone or downstep from the loss of a TBU is very common. Another example of the latter comes from Bamileke-Dschang [Cameroon] (Tadadjeu 1974):

(24) a. séŋ è séŋ   'the bird of the bird'   →   séŋ   ↓séŋ
         H   L H   H   L   H
     b. séŋ ↓séŋ ↓séŋ ↓séŋ ↓séŋ   'the bird of the bird of the bird of the bird....'
         H   L H L H L H L H

In very deliberate speech, the input associative (genitive) marker /è/ 'of' is pronounced as a L tone [è]. When the vowel is deleted, however, the stable L tone produces a downstep on the possessor. The artificial, but grammatical, sequence in (24b) shows that the downstep effect is iterative: each floating L tone conditions a successive drop on the following H.

The Bamileke-Dschang example leads naturally into the third argument for the semi-autonomy of tones from their TBUs, the possibility of ZERO REPRESENTATION: a morpheme can consist solely of a tone without a TBU and without segmental features. Tonal morphemes of course derive from full syllables which have deleted. At a point where future Bamileke-Dschang speakers can no longer pronounce the /è/ in (24a), they will have derived a L associative tonal morpheme, much like the H associative tonal morpheme that was seen in Igbo in (15).

While a tone can be a morpheme until itself, other floating tones can be lexical. Such a situation obtains in Peñoles Mixtec [Mexico], whose TBUs show an underlying contrast between /H/, /L/ and /Ø/ (Daly & Hyman 2007):

(25) a.   /kɨtɨ/   'animal'   b.   kɨtɨ   ditó   'uncle's animal'
           /nǰuši `/   'chicken'   nǰuši d̠ɨtó   'uncle's chicken'

Both of the nouns in (25a) are toneless, pronounced identically with a low falling contour before pause or a L tone. However, as seen in (25b), the realization of /ditó/ 'uncle' is different after the two nouns. In the case of 'uncle's animal', the three toneless TBUs are pronounced on a level mid pitch. In the case of 'uncle's chicken', the floating L of 'chicken' links to the first syllable of 'uncle' and the two toneless TBUs of *nǰuši* continue to be pronounced with a low falling contour. As seen in the underlying forms in (25a), nouns such as /nǰuši `/ 'chicken' have a floating L tone after them (which derives from the loss of Proto-Mixtec final glottal stop (Longacre 1957, Dürr 1987)).

While the effects of lexical floating tones can be discerned in tone systems from all parts of the world, they are particularly common in Mexico and West Africa. Besides Peñoles, other Mixtec languages show the effects of a lexical floating L, e.g. Atatláhuca (Mak 1953), a lexical floating H, e.g. Chalcatongo (Hinton et al 1991), San Miguel el Grande (Pike 1948, Goldsmith 1990:20-27), or both, e.g. Acatlán (Pike & Wistrand 1974), Jacaltepec (Bradley 1970), Magdalena Peñasco (Hollenbach 2004). Within Africa, the Grassfields Bantu languages are particularly well known for their complex floating tone systems (Voorhoeve 1970, Hyman & Tadadjeu 1976). In Aghem [Cameroon] (Hyman 1979a), although the two nouns *kɨ́-fú* 'rat' and *kɨ́-wó* 'hand' are pronounced identically as H-H in isolation, they have different effects on the tone that follows:

(26) a.   kɨ́-fú   kɨ́-mɔ̰̀   'one rat'   b.   fú   kɨ́n   'this rat'
           | |ˏˏˏˏˊˊ ‡ | . | |
           H H́   L L   H   H

           kɨ́-wó   kɨ̀-mɔ̰̀   'one hand'   wó   ↓kɨ́n   'this hand'
           | | | | | |
           H H L   L L   H L   H

As indicated by the dotted line in (26a), the H tone of the root *-fú* spreads onto prefix of the numeral 'one' (pronounced *kɨ̀-mɔ̰̀* in isolation), whose L tone then delinks. The H tone of the root *-wó* 'hand', however, does not spread. This is because it is followed by a floating L which belonged to a historically lost second syllable (cf. Proto-Bantu *-*bókò* 'hand'). While much of the older work on Mixtec languages would have simply divided up H-H nouns into an arbitrary class A vs. class B, the floating L analysis has the advantage that it naturally accounts for the additional difference observed in (26b). Here the demonstrative *kɨ́n* 'this' (which conditions the deletion of the noun class prefix *kɨ́-*) is realized H after *fú* 'rat', but as a downstepped H after *wó* 'hand'. As we saw in (23) and (24), a floating L frequently conditions downstep, as it does in Aghem. The floating L of /kɨ́-wó `/ is thus not circular: It blocks H tone spreading onto a follow L AND conditions downstep on a following H, something which would not be naturally captured by a class A/B diacritic account.

It should be clear from the foregoing that the autosegmental representations, which express the traditional intuition of the semi-autonomy of tone, provide a more explanatory analysis in many cases. This does not mean that all tonal phenomena will have the properties illustrated in the preceding paragraphs. In some languages, when a vowel is deleted, its tone shows a stability effect, as above, while in others, e.g. Shilluk (Gilley 1992:164), the tone is deleted with the vowel. In addition, some languages may not distinguish intra- vs. heteromorphemic representations as in (22a). Worse yet, they may violate the OCP and show contrasts WITHIN morphemes. Odden (1982, 1986), for example, argues that in Shambala *nyóká* 'snake' has one

doubly linked H tone vs. *ngó˩tó* 'sheep', which, in violation of the OCP, has two underlying H tone features, the first causing the second to downstep. Similar issues arise concerning underlying L tone in Dioula (Odienné) [Ivory Coast] (Braconnier 1982):

(27) a. before pause   b. before H
          sὲbὲ   sὲbέ   'paper'
          tùrù   túrú   'oil'
          kàràkà   kàràká   'bed'
          sùmàrà   sùmárá   'soumbala' (a spice)

As seen in (27a), the four monomorphemic nouns are pronounced all L before pause. When followed by a H, as in (27b), both the bisyllabic and trisyllabic nouns show two patterns: either one or two L tone syllables become H. The analysis may depend on how the rule is formulated. If the rule is as in (28a), the observed differences can be represented in one of two ways:

(28) a. L   →   H /   {//, L} __ H

      b. sɛbɛ   turu   karaka   sumara
          | | V   V | | V
          L L   L   L L   L   L

      c. sɛbɛ   turu   karaka   sumara
          | V | V
          L   L   L   L

In (28b) a noun may have one vs. two L tone features, where only the L feature which precedes the H is raised to H. Depending on one's theoretical assumptions, this analysis potentially has two problems: (i) the forms with two Ls violate the OCP intramorphemically; (ii) the rule in (28a) is formulated as a feature-changing rule rather than a tone-spreading rule—which is the most common way to express tonal assimilations (§4.1). In response to the first problem we might instead propose the representational differences in (28c). As seen, there is now only one /L/, linked either to one or two TBUs. As also seen, this /L/ can be preceded by one or more toneless TBUs. The idea here is that the raising rule affects only those TBUs that are prelinked to the /L/.

Proposals of underlying /H, L, Ø/ systems go back at least to Pulleyblank's (1986) treatment of Margi [Nigeria], which realizes /Ø/ as [H] or [L] and Yoruba [Nigeria], which realizes /Ø/ as [M] (cf. Akinlabi 1985). If /L/ contrasts with /Ø/ in Dioula, still another alternative is to propose the underlying representations as in (29a), where the nouns end in one or more toneless syllable:

(29) a. sɛbɛ   turu   karaka   sumara
          | V |
          L   L   L

      b. {//, L} $\underline{\sigma}^n$ # σ
                            `- - _ _ |
                                   `H

With these representations, the tonal assimilation rule can be reformulated as an anticipatory spreading rule, as in (29b), where the underlined $\underline{\sigma}^n$ represents one or more toneless TBUs.

Which one of the above is the most satisfactory account of the facts can be determined only by an in depth analysis of Dioula d'Odienné, which is not an isolated case: We face similar analytic choices in Acatlán Mixtec [Mexico] (Pike & Wistrand 1974), where some L-L words become H-L, others H-H after what is most naturally analyzed as a floating H tone. Such representational issues pervade tonological analysis, perhaps even more than in the analysis of segmental systems.

4.   Is tone different?

With the semi-autonomy of tone now firmly established, we turn to the question of whether tone is different from the rest of phonology. In her textbook on tone, Yip (2002:65) observes the following possible differences between tone and segmental phonology:

(30)   "Tone differs from many other phonological features in the following ways, rarely or never observed in more familiar consonant or vocalic features:

   a.   Mobility: Movement away from point of origin
   b.   Stability: Survival after loss of original host segment
   c.   One-to-many: A single tonal feature shared by two or more segments
   d.   Many-to-one: Multiple tonal features surfacing on a single host segment
   e.   Toneless segments: Potentially tone-bearing segments that never acquire phonological tone"

As seen, Yip's summary essentially recapitulates the autosegmental nature of tone, such that tone would seem to have more semi-autonomy than consonant or vowel features. We might therefore say that *tone is like segmental phonology in every way—only more so!* The phrase "only more so" can have two meanings: (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 cannot do everything tone can do. In fact, both of these characterizations are correct, as we shall see in the following two subsections.

4.1. Quantitative differences between tonal and nontonal phonology

In this section I discuss the following properties of tones, as they apply within the word domain: spreading, local shifts, non-local shifts, plateauing and polarity. Each of these are frequently attested in tone systems, but only the first is robustly attested in segmental phonology. I begin with the most common tonal process, tone spreading, whose properties are summarized in (31).

(31) Horizontal assimilation (or tone spreading) (Hyman 1975:223)

   a.   Natural   b.   Unnatural
      L-H → L-LH   L-H → LH-H
      H-L → H-HL   H-L → HL-L
       (perseverative)   (anticipatory)

As seen, the term "horizontal assimilation" refer to cases where a full tone spreads onto a neighboring TBU. (Register effects or "vertical assimilations" are discussed in §4.2). As is well known, even when there is no tone spreading, tonal targets tend to be reached late within their TBU: "Late realization of tonal targets has been demonstrated both for languages in which tones are lexical... and for those in which they are intonational..." (Kingston 2003:86). As a consequence, phonological tone spreading tends to be perseverative, and where anticipatory, spreading is much rarer and has a quite different character (Hyman 2007b). This stands in marked contrast to what is usually said about segmental assimilations:

> "In regular conditioned sound changes, the conditioning factor is far more frequently a sound which follows than one which precedes." (Greenberg 1957:90)

> "I examined 365 segmental assimilatory rules culled from 60 languages... documented in the Stanford Phonology Archive. 195 of these rules involved anticipatory assimilation of a segment to a following segment. 89 of these involved the perseverative assimilation of a segment to a preceding segment.... The conclusion must be that segmental assimilation is generally anticipatory...." (Javkin 1979:75-76)

As seen in (32a), alternating sequences of input Hs and Ls undergo both H tone spreading (HTS) and L tone spreading (LTS) in Yoruba (Laniran & Clements 2003:207):

(32) a. /máyò mírà wé/   [máyǫ̀ mǐ râ wě]   'Mayomi bought books'

         H L H L H

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

         L H   L   H

Since phrase-internal contour tones are permitted in Yoruba, the result is a sequence of falling and rising tones. This contrasts with the situation in (32b) from Kuki-Thaadow [NE India, Burma] (Hyman 2007c). Since this language does not allow phrase-internal contours, LTS and HTS condition delinking of the original tone except on the final syllable. The result is a bounded tone SHIFT: both the first H and the second L in the input in (32b) are realized only on the following TBU.

A similar relation between tone spreading and shifting is seen in the closely related Nguni Bantu languages in (33), where the processes are unbounded:

(33) a. Ndebele   b. Zulu
         ú-kú-hlek-a   u-kú-hlek-a   'to laugh'
         ú-kú-hlék-is-a   u-ku-hlék-is-a   'to amuse (make laugh)'
         ú-kú-hlék-ís-an-a   u-ku-hlek-ís-an-a   'to amuse each other'

In (33a) the underlying (underlined) H tone of the initial prefix /ú-/ spreads up to the antepenult in Ndebele [Zimbabwe] (Sibanda 2004). The result is a H tone sequence spanning several syllables. However, as seen in (33b), the same H tone SHIFTS to the antepenultimate syllable in Zulu [South Africa] (Downing 1990:265). In this case unbounded spreading + delinking has produced unbounded tone shift. Ndebele, thus, represents the older situation.

We can assume that both bounded and unbounded spreading have analogues in segmental phonology, where the most natural comparison is with processes such as vowel harmony. However, while it is very common for an underlying tone to shift several syllables to another position within the word (or onto a subsequent word, as will be seen in §4.2), there are very few cases reported where a segmental feature has this property. One such case in progress comes from Makonde [Mozambique] (Liphola 1999, 2001). As seen in (34), a process of vowel height harmony converts the applicative suffix /-il-/ to [-el-] after the mid root vowels /e/ and /o/:

(34)   underlying   VH-harmony   V-lengthening V-reduction
   a.   /ku-pet-il-a/   →   ku-pet-el-a   →   ku-pet-eel-a ~ ku-pateela   'to separate for'
   b.   /ku-pot-il-a/   →   ku-pot-el-a   →   ku-pot-eel-a ~ ku-pateela   'to twist for'

While the height harmony process is widespread in Bantu, as is phrase-penultimate vowel lengthening, Makonde appears unique in allowing /e/ and /o/ to reduce to [a] in pre-penultimate position. As seen, both inputs are potentially realized as *ku-pat-eel-a*, which suggests a local shift of the mid vowel height feature to the right. The additional examples in (35) show that the shift is potentially unbounded:

(35) a.   'to not reach a full size for'   b.   'to cough for'
          /ku-pelivilil-il-a/   /ku-kolumul-il-a/
          ku-pelevelel-eel-a   ku-kolomol-eel-a   (no vowel reduction)
          ku-palevelel-eel-a   ku-kalomol-eel-a   (one application)
          ku-palavelel-eel-a   ku-kalamol-eel-a   (two applications)
          ku-palavalel-eel-a   ku-kalamal-eel-a   (three applications)
          ku-palavalal-eel-a   (four applications)

As seen, mid-vowel reduction to [a] follows vowel harmony and applies optionally to any number of mid vowels that precede the penult. The major constraint is that if an [e] or [o] is not reduced, it is not possible for another mid vowel to its right to be reduced (**ku-pelavelel-eel-a*, **ku-kolomal-eel-a*). This suggests either that reduction applies left-to-right or that there is a no-gapping constraint against the mid height feature (Archangeli & Pulleyblank 1994). As seen, the last variants of (35a,b) have the same property as the H tone shift in Zulu: In *ku-palavalal-eel-a* and *ku-kalamal-eel-a*, the mid feature originates in the underlined root vowel, but shifts several syllables to the penult. Although such segmental shifts are extremely rare (I do not know of another such case), Makonde shows that it is possible. Hence, the difference between tone, which frequently shifts, and segmental features, which rarely shift, is a quantitative one in this case.

Turning to anticipatory processes, we first note that bounded right-to-left tone spreading is extremely rare. As schematized in (36a), Inkelas & Zec (1988:230-1) analyze Belgrade Serbian with a rule that spreads a H onto a pretonic mora, illustrated in the examples in (36b).

(36) a.   μ   μ   b.   /papríka/   →   pápríka   'pepper'
           ` ` | /raazlíka/   →   raázlíka   'difference'
               H   /ne-ráadnik/ →   né-ráadnik   'non-worker'

Within Bantu, anticipatory local shift is also rare, but does occur in Kinande (Mutaka 1994):

(37) a.   e-ri-tﯠm-a/   →   e-rí-tum-a...   'to send'
      b.   /e-ri-na-tﯠm-a/   →   e-ri-ná-tum-a... 'to send indeed'

It should be noted, however, that anticipatory spreading and shifting are quite different from their perseverative counterparts (Philippson 1991:180, Hyman 2007b). Whereas the latter were said to derive from the phonetic tendency for tonal targets to be realized late, there is no corresponding phonetic tendency to realize tonal targets early. Instead, the above examples appear to have the property of anticipating prominent tones, in particular a /H/ tone which is opposed to /Ø/. Except as a phrasal property (§4.2), unbounded tone spreading is also rare, and unbounded anticipatory tone shifting even more so. In some cases tonal anticipation is restricted to applying from a weak final to strong penultimate syllable, e.g. Chichewa /pez-á/ → *peézá ~ peéza* 'find!' (Kanerva 1989). This, then, suggests two different motivations for tones to spread and shift: the phonetic perseverative tendency and the attraction of a tone to a metrically strong position. We should thus expect more unbounded perseverative (vs. anticipatory) spreading/shifting to a metrically syllable, since such processes are doubly motivated.

If segmental features show more favor to anticipatory assimilation than tone, we should expect more anticipatory spreading and shifting. The numerous harmonies known as Umlaut or metaphony fall into this category, as in the case of Servigliano Italian reported by Walker (2005:918):

(38) a.   verd-ó   'very green (m.sg.)   vird-ú   'very green (m.pl.)'
      b.   kommonek-á   'to communicate'   kummunik-ímo 'we communicate'

As seen, the mid vowels of the roots seen in (38a) assimilate in height to the high vowel of the following suffix in (38b). While most anticipatory cases involve suffix triggers, Esimbi [Cameroon] has a rather curious vowel height shift from root to prefix (Stallcup 1980, Hyman 1988), exemplified in (39).

(39) a.   /u-ri/ → u-ri 'to eat'   /u-mu/ → u-mu 'to drink'
      b.   /u-se/ → o-si 'to laugh'   /u-kŏ/ → o-kǐ 'to beg'   /u-mo/ → o-mu 'to go up'
      c.   /u-yɛ/ → ɔ-yi 'to wear'   /ú-tǎ/ → ɔ́-tǐ 'to leave' /ú-mɔ/ → ɔ́-mu 'to sit'

The verbs in (39) consist of a verb root preceded by the infinitive prefix /u-/, which is specified only for rounding. As seen, the height feature of the root transfers to the prefix. This produces the minimal triplet involving the phonetic root [mu]. Stallcup (1980) hypothesizes that the prefix became accented, thereby driving an anticipatory vowel height harmony. Subsequently, root vowels reduced to [+high], which, if unmarked for height, can be characterized as delinking. Given the relatively small number of cases, it is not clear if anticipatory shifting favors segmental vs. tonal features.

Another process which is distinctly tonal is H tone plateauing. A number of tone systems prohibit *H-L-H or *H-Ø-H sequences (Cahill 2007), which Yip (2002:137) refers to as *TROUGH. A common repair is for the non-H TBU(s) to be raised, such that a H tone plateau is created. In some languages, the process is limited to a single L TBU wedged between Hs, e.g. Kihunde (Goldsmith 1990:36) and Mamaindé [Brazil], about which Eberhard (2007:297) writes "The heart of the tone sandhi issue in Mamaindé verbs resolves around sequences of HLH. There seems to be some sort of restriction against any HLH sequences in certain contexts (across the

verbstem/affix boundary). When this illegal sequence occurs, the intermediate L is always delinked." In other languages, e.g. Amahuaca [Peru] (Russell & Russell 1959:152) and Luganda (Stevick 1969, Hyman et al 1987) multiple TBUs may undergo plateauing. The Luganda example in (40a) establishes that there is a H to L pitch drop on the last two syllables when the subject prefix is toneless /a-/ '3rd sg (class1)':

(40) a. a-a-tu-gul-ir-a   →   a-a-tu-gul-ír-à   'the one who buys it for us'
                | |
               H L

      b. a-ba-tu-gul-ir-a   →   a-bá-tú-gúl-ír-à   'the ones who buy it for us'
           | | | | |
           H   H L   H ------- H

In (40b), where the subject prefix is H tone /bá-/ '3rd pl (class 2)', the result is a H plateau of four TBUs (cf. also §4.2). The crucial point is that the two H tones can "see each other" at some distance. In fact, in some cases the plateauing process between Hs requires the deletion of one or more L features, which contrast with Ø (cf. (52)).

While such unbounded plateauing effects are quite common in tone, the question is whether comparable phenomena exist within segmental phonology. I know of only one example, mid vowel height plateauing in Yaka [Bantu; D.R.C.], illustrated in (41) (Hyman 1998).

(41)		root + a	root gloss	applicative	causative	perfective	URs
a.		kik-a	'obstruct'	kik-il-a	kik-is-a	kik-idi	/kik-ile/
		kul-a	'chase s.o.'	kud-il-a	kud-is-a	kud-idi	/kud-ile/
		kas-a	'bind'	kas-il-a	kas-is-a	kas-idi	/kas-ile/
b.		keb-a	'pay attention to'	keb-il-a	keb-is-a	keb-ele	/keb-ile/
		sol-a	'clear bush'	sod-il-a	sol-is-a	sol-ele	/sol-ile/

In (41a) we see that the applicative, causative and perfective suffixes all have the high vowel [i] when the root vowel is /i/, /u/ or /a/. In (41b), the causative and applicative are seen still to be -il- and -is- after the mid root vowels /e/ and /o/. Yaka would therefore appear to be lacking the widespread Bantu perseverative vowel height harmony process exemplified in Makonde in (34). However, the perfective suffix does show an alternation: *-idi* after /i, u, a/ vs. *-ele* after /e, o/. (The consonant alternation is due to a process whereby l → d before [i].) Why, then, should the harmony process be restricted to the perfective suffix, which often escapes height harmony in other Bantu languages? A number of arguments are presented in Hyman (1998) that the correct underlying representation of this suffix is /-ile/, as it is pronounced in many other Bantu languages. The harmony process thus targets high vowels which occur between two mid vowels. The forms in (42) show that mid vowel height plateauing applies to any number of high vowels which occur between mid vowels:

(42)		root + iC + a	stem gloss	perfective	URs
a.		yed-ik-a	'taste'	yel-ek-ele	/yel-ik-ile/
		kos-ik-a	'add'	kos-ek-ele	/kos-ik-ile/
		yek-uk-a	'be separated'	yek-ok-ele	/yek-uk-ile/
		tob-uk-a	'be pierced'	tob-ok-ele	/tob-uk-ile/

b.	bet-idik-a	'lower'	bet-elek-ele	/bet-ilik-ile/
	kel-umuk-a	'turn around'	k<u>e</u>l-omok-el<u>e</u>	/kel-umuk-ile/
			M --------- M

Mid height plateauing represents a response to the precariousness of word-final /e/, which must either spread to another post-root vowel or be peripheralized to [i]. Thus, unlike most other Bantu languages, Yaka does not allow bisyllabic noun stems of the form CVCe (where V = any vowel). While H tone plateauing is quite frequent, the Yaka process is quite unique. It does, however, show that segmental plateauing is possible, however rare.

The last process to be considered in this subsection is polarity. Although having a number of manifestations, the best known case of tonal polarity occurs when an affix or clitic takes the oppositive tone of its base or host. An example of this occurs in Margi [Nigeria] (Pulleyblank 1986:203):

(42) a. hɔ̀gyì gʉ́   'you are a Higi'

b. màrgyí gʉ̀   'you are a Margi'

As seen, the subject clitic /gʉ/ 'you sg.' takes the opposite or polar value of the tone that precedes it: H after a L tone vs. L after a H. Note that in such cases, which are quite frequent, despite different possible solutions, it is often difficult to assign a unique underlying tone to the polar morphemes. The same point applies to cases of polar boundary tones: /H/ and /L/ are realized as LH and HL utterance-initially in Ticuna [Colombia] (Montes-Rodrigues 1995) and as HL and LH utterance-finally in Thlantlang Lai [Burma] (Hyman 2007a:14). In these languages the boundary tone is polar to the adjacent lexical tone.

Since it would be arbitrary to propose a specific underlying tone in the above cases, tonal polarity differs from tonal (or segmental) dissimilation, where one of two identical specified features dissimilates (Hyman & Schuh 1974:100). Thus, the unusual and mysterious low vowel dissimilation /CaCa/ → CeCa in Woleian and Marshallese and /CaCa/ → CiCa in Ere (Blust 1996) do not seem parallel. However, it is not out of the question that certain apparent polar effects owe their existence to an historical dissimilatory process. Consider for example the following alternating H tone pattern in Kirundi (Goldsmith & Sabimana 1986):

(43)	-sab- 'ask for'	-báz- 'ask (question)'	
a.	ku-sab-a	ku-báz-a	'to ask' (infinitive)
	ku-bi-sab-a	ku-bí-baz-a	-bi- 'them'
b.	ku-bí-mu-sáb-a	ku-bí-mu-báz-a	-mu- '(to) him'
	ku-bí-mu-kú-sab-ir-a	ku-bí-mu-kú-bar-iz-a	-ku- '(for) you'
	ku-há-bi-mú-ku-sáb-ir-a	ku-há-bi-mú-ku-bár-iz-a	-ha- 'there'
	'to ask him (for) them for you there'		

Ignoring the infinitive prefix ku- we see that up to three H tones may appear from the tone span that includes the object prefixes and the verb root. While Goldsmith & Sabimana account for the alternating H-L pattern is in metrical terms, another way to conceptualize the pattern is to assume an earlier H tone plateau (as Furere & Rialland 1983 report for closely related Kinyarwanda), to which a left-to-right H-H → H-Ø dissimilatory process subsequently applied. Either way, what

makes the Kirundi facts interesting are the forms in the left column of (43a). When a toneless verb root occurs with one or no object prefix, the whole infinitive is toneless (vs. the corresponding forms involving a H verb root). However, as soon as a second object prefix is added in (43b), we obtain not one H, but two. It would seem that as soon as one H is introduced by the morphology, it must be alternated within the tone span. While the Kirundi facts are reminiscent of alternating stress, I am unaware of any parallel case where a segmental feature is assigned on an alternating basis.

In this section we have examined several tonal phenomena as they apply roughly within the word domain. In each case it was suggested that the tonal process is more natural and frequent than its segmental analogue. One way to look at this is to say that tone is less restricted than segmental phonology. This interpretation receives support from a common restriction in segmental phonology which seems rarely to apply to tone: root control (Clements 1981). Whereas many harmony processes involve the assimilation of (underspecified) affixes to segmental features of the root, even word-level tonal assimilations seem largely to apply across-the-board. To take just one example, it has been oft noted that prefixes rarely, if ever, condition vowel harmony on a following root (Hall & Hall 1980:227n). However, it is quite commonplace for the tone of a prefix to spread onto the following root, as seen in the Aghem examples in (44):

(44) a.   HTS: /kí-kɔ̀ɔ/   →   kí-kɔ̂ɔ   'cutlass'
      b.   LTS: /kì-téɛ/   →   kì-tɛ̌ɛ   'cricket'

It would appear that the perseverative tendency for tonal targets to be realized late overrides any counteracting tendency for prefixal tones to assimilate to roots. Since segmental assimilations were said to have an apparent anticipatory bias, we make the following statistical prediction: Roots will tend to assimilate to the tones of prefixes, but to the segmental features of suffixes. While we should not expect this prediction to be without exception, I believe that the asymmetry is quite real (Hyman 2002).

4.2. Qualitative differences between tonal and nontonal phonology

In the preceding section, the comparison of tonal to segmental processes was largely limited to the word domain. In this section we will consider tonal properties that apply across words. As will seen, once we do so, the differences become more pronounced. We begin by considering "register effects" and then move on to discuss long-distance processes that apply at the phrase level.

In §4.1 it was said that tones tend to perseverate in "horizontal" assimilations. This is true only if we are looking at full tone assimilation. A second possibility is for tones to undergo "vertical assimilation" or register adjustments. In this case, the asymmetries are quite different, as summarized below:

(45)   Compression   Polarization

a. Input:	Anticipatory	Perseverative	b. Input:	Anticipatory	Perseverative
L-H	M-H	L-M	L-H	? ↓L-H	? L-↑H
H-L	? M-L	? H-M	H-L	↑H-L	H-↓L

As seen in (45a), either tone of a /L-H/ input can undergo a pitch register adjustment and ultimately become a third level tone: the L may be raised to M, the H may be lowered to M, or as we saw in Kpelle in (18d), both may apply in which case /L-H/ is realized [M-M]. The result is tonal COMPRESSION: the difference in the interval between the two output tones becomes smaller than in the input. An input /H-L/ does not show this effect. As indicated by the question marks, it is quite unusual for the H to be lowered or the L to be raised. In fact, as seen in (45b), the opposite effect of POLARIZATION is observed: /H-L/ (but not /L-H/) may undergo raising of the H or lowering of the L. The raising process is seen in the Engenni [Nigeria] example in (46a) (Thomas 1974:12):

(46) a. /únwónì/ 'mouth'   b. /únwónì + ólíló/ 'mouth of a bottle'
          ↓   ↓
        [únwő̋nì]   [únwő̋n ólíló]

In Thomas' analysis a single H TBU is raised to a "top" or superhigh (˝) tone before a L. In (46b) the L tone vowel /ì/ is elided, but still has the raising effect on the preceding tone. The result is a surface contrast between the H and superhigh tone.

H tone raising before L is a quite widespread phenomenon, also occurring for example in Kirimi (Cahi) [Tanzania] (Hyman 1993), (Edopi [Indonesia (Papua)] (Kim 1996), and Chinantec (Lealao) [Mexico] (Rupp 1990). Tesfaye & Wedekind (1990:360) report that in Shinasha [Ethiopia] a H-L drop is realized "with about four semitones" while a L-H rise "is realized as a pitch increase of only two, sometimes three semitones." The question is whether there is a physiological reason for such differences or whether H-raising is a strategy for maximizing the tonal space—or both? Many languages have "downdrift" or "non-phonemic" downstep whereby the second H of a H-L-H sequence is realized on a lower pitch than the first. If there are enough transitions from H to L to H, Hs which are late in the utterance may become quite low. Since it increases the tonal space, raising a H before a L could thus be useful as a counterforce to processes which lower tones.

Some support for this interpretation is obtained from languages which raise H tone in anticipation of a contrastive downstep ($^{\downarrow}$H). In languages which contrast H-H vs. H-$^{\downarrow}$H there can be multiple downsteps within an utterance, with each $^{\downarrow}$H being produced at a lower pitch level than the previous H. Starting at a higher level could thus be quite useful. In this context consider the following pairs of examples from Amo [Nigeria] (Hyman 1979b:25) and Luganda (personal notes with Francis Katamba):

(47) Non-local H $\rightarrow$ $^{\uparrow}$H in anticipation of (long-distant) phonemic downstep

    a. kìté úkɔ́ɔ́mí fínáwà   'the place of the bed of the animal'
        kì$^{\uparrow}$té úkɔ́ɔ́mí fíká$^{\downarrow}$lé   'the place of the bed of the monkey'

    b. à-bá-síb-á kígùùndú   'the ones who tie up Kigundu'
        tè-$^{\uparrow}$bá-síb-á $^{\downarrow}$kígùùndú 'they do not tie up Kigundu'

In each pair the second utterance contains a $^{\downarrow}$H which is lacking in the first. As indicated, but not usually transcribed, a sequence of Hs is quite audibly raised in anticipation of the downstep. Thus, between the first and second syllables, there is a step up of [+1] in the examples lacking a $^{\downarrow}$H vs. [+2] in the examples having a later $^{\downarrow}$H. While the raising of H before L appears to be