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Abstract. In the earliest work on tone languages, tones were treated as atomic units: High, Mid, Low, High Rising, etc. Universal tone features were introduced into phonological theory by Wang 1967 by analogy to the universal features commonly used in segmental phonology. The implicit claim was that features served the same functions in tonal phonology as in segmental phonology. However, with the advent of autosegmental phonology (Goldsmith 1976), much of the original motivation for tone features disappeared. Contour tones in many languages were reanalyzed as sequences of simple level tones, calling into question the need for tonal features such as [±falling]. Processes of tone copy such as L(ow) > H(igh) / __ H(igh) were reinterpreted as tone spreading instead of feature assimilation. At about the same time, a better understanding of downstep emerged which allowed many spurious tone levels to be eliminated. As a result, in spite of the vast amount of work on tone languages over the past thirty years, the number of phenomena that appear to require tone features has become significantly reduced, raising the issue whether the notion of tone features is at all useful. This paper first reviews the basic functions for which segmental features have been proposed, and then examines the evidence that tone features are needed to serve these or other functions in tone languages. The discussion focuses successively on level tones, contour tones, and register, building on examples from Africa and Asia. Our current evaluation of the evidence is that tone features, to the extent that they appear motivated at all, do not serve the same functions as segmental features.

1. INTRODUCTION

In this introduction, we review criteria that are commonly used in feature analysis in segmental phonology, and suggest that these criteria have not, in general, been successfully extended to tonal phonology.

Some important functions of features in segmental phonology are summarized in Table 1.[1]

function		example (segments)
distinctive	distinguish phonemes/tonemes	/p/ and /b/ are distinguished by [±voice]
componential	define correlations (sets distinguished by one feature)	[-voiced] p t c k [+voiced] b d ɟ g
classificatory	define natural classes (rule targets, rule contexts)	[-sonorant] sounds are devoiced word-finally
dynamic	define natural changes (such as assimilation)	obstruents become [+voiced] before [+voiced] consonants

Table 1. Some common functions of features in segmental phonology.

It is usually held, since the work of Jakobson et al. 1952, that one small set of features largely satisfies all functions. We have illustrated this point by using the feature [±voiced] in the examples above. It is also usually believed that each feature has a distinct phonetic definition at the articulatory or acoustic/auditory level, specific enough to distinguish it from all other features, but broad enough to accommodate observed variation within and across languages. In this sense features are both "concrete" and "abstract".

With very few exceptions, linguists have also maintained that features are universal, in the sense that the same features tend to recur across languages. Thus the feature [labial] is used distinctively to distinguish sounds like /p/ and /t/ in nearly all languages of the world. Such recurrence is explained by common characteristics of human physiology and audition.[2]

Although all the functions in Table 1 have been used in feature analysis at one time or another, the trend in more recent phonology has been to give priority to the last two functions: classificatory and dynamic. We will

accordingly give these functions special consideration here.

Feature theory as we understand it is concerned with the level of (categorial) phonology, in which feature contrasts are all-or-nothing, rather than gradient. Languages also have patterns of subphonemic assimilation or coarticulation which adjust values *within* given phonological categories. Such subphonemic variation does not fall within the classical functions of features as summarized in Table 1, and it should be obvious that any attempt to extend features into gradient phenomena runs a high risk of undermining other, more basic functions, such as distinctiveness.

Traditionally, rather high standards have been set for confirming proposed features or justifying new ones. The most widely-accepted features have been founded on careful study of evidence across many languages. Usual requirements on what counts as evidence for any proposed feature analysis include those in (1).

(1) a. *phonetic motivation*: processes cited in evidence for a feature are phonetically motivated.
b. *recurrence across languages*: crucial evidence for a feature must be found in several unrelated languages.
c. *formal simplicity*: the analyses supporting a given feature are formally and conceptually simple, avoiding multiple rules, brackets and braces, Greek letter variables, and the like.
d. *comprehensiveness*: analyses supporting a give feature cover all the data, not just an arbitrary subset.

Proposed segmental features that did not receive support from analyses meeting these standards have not generally survived (many examples can be cited from the literature).

The case for tone features, in general, has been much less convincing than for segmental features. One reason in that much earlier discussion was vitiated by an insufficient understanding of:
• "autosegmental" properties of tone: floating tones, compositive contour tones, toneless syllables, etc.
• downstep: for example, ¡H tones (downstepped High tones) being misinterpreted as M(id) tones
• intonational factors: downdrift, final lowering, overall "declination"

- contextual variation, e.g. H(igh) tones are often noncontrastively lower after M(id) or L(ow) tones

As a result, earlier analyses proposing assimilation rules must be reexamined with care. Our experience in the African domain is that most, if not all, do not involve formal assimilation processes at all.

A second reason, bearing on more recent analysis, is that the best arguments for tone features have often not satisfied the requirements shown in (1). Feature analyses of tonal phenomena, on close examination, very often prove to be phonetically arbitrary; idiosyncratic to one language; complex (involving several rules, Greek-letter variables, abbreviatory devices, etc.); and/or noncomprehensive (i.e. based on an arbitrary selection of "cherry-picked" data).

A classic example in the early literature is Wang's celebrated analysis of the Xiamen tone circle (Wang 1967; see critiques by Stahlke 1977, Chen 2000, among others). Wang devised an extremely clever feature system which allowed the essentially idiosyncratic tone sandhi system of Xiamen to be described in a single (but highly contrived) rule in the style of Chomsky & Halle 1968, involving angled braces, Greek letter variables and whatnot. Unfortunately, the analysis violated criteria 1a-c, viz. phonetic motivation, recurrence across languages, and formal simplicity. As it had no solid crosslinguistic basis, it was quickly and widely abandoned.

The following question can and should be raised: when analyses not satisfying the criteria in (1) are eliminated, do there remain any convincing arguments for tone features?

2. THE TWO-FEATURE MODEL

Though there have been many proposals for tone feature sets since Wang's pioneering proposal (see Hyman 1973, Anderson 1978), recent work on this topic has converged on a model which we will term the Two-Feature Model.

In its essentials, and abstracting from differences in notation and terminology from one writer to another, the Two-Feature Model posits two tone features, one dividing the tone space into two primary registers (upper and lower, or high and low), and the other dividing each primary register

into secondary registers. The common core of many proposals since Yip 1980 and Clements 1983 [3] is shown in (2). This model applies straightfowardly to languages that contrast four level tones.

(2)		top	high	mid	low
	register	H	H	L	L
	subregister	h	l	h	l

We use the conventional terms "top", "high", "mid", and "low" for the four tones of the Two-Feature Model in order to facilitate comparison among languages in this paper. The model outlined in (2) analyses these four tones into two H-register tones, top and high, and two L-register tones, mid and low. Within each of these registers, the subregister features, as we will call them, divide tone into subregisters; thus the top and high tone levels are assigned to the higher and lower subregisters of the H register, and the mid and low tones are likewise assigned to the higher and lower subregisters of the L register.

The Two-Feature Model, like any model of tone features, makes a number of broad predictions. Thus:
• attested natural classes should be definable in terms of its features
• natural assimilation/dissimilation processes should be describable by a single feature change
• recurrent natural classes and assimilation/dissimilation processes which cannot be described by this model should be unattested (or should be independently explainable)

We add two qualifications. First, more developed versions of the Two-Feature Model have proposed various feature-geometric groupings of tone features. We will not discuss these here, as we are concerned with evidence for tone features as such, not for their possible groupings. Second, there exist various subtheories of the Two-Feature Model. Some of these, such as the claim that contour tones group under a single Tonal Node, have been developed with a view to modelling Asian tone systems (most prominently those of Chinese dialects), while others were proposed on the basis of observations about African languages. Again, we will not discuss these subtheories here except to the extent that they bear directly on evidence for tone features.

3. ASSIMILATION

As we have seen, much of the primary evidence for segmental features has come from assimilation processes in which a segment or class of segments acquires a feature of a neighboring segment or class of segments, becoming more like it, but not identical to it. (If it became identical to it we would be dealing with root node spreading or copying rather than feature spreading).

We draw a crucial distinction between (phonological) assimilation, which is category-changing, and phonetic assimilation or coarticulation, which is gradient. A rule by which a L tone acquires a higher contextual variant before H in a language with just two contrastive tone levels, L and H, is not phonological. In contrast, a rule L → M in a language having the contrastive tone levels L, M, and H is neutralizing and therefore demonstrably category-changing. As we are concerned here with phonological features, we will be focusing exclusively on phonological assimilation.[4]

Now when we look through the Africanist literature, an astonishing observation is the virtual absence of clear cases of phonological assimilation in the above sense. The vast number of processes described in the literature since the advent of autosegmental phonology involve shifts in the alignment between tones and their segmental bearing units. Processes of apparent tone assimilation such as L → H / __ H are described as tone spreading rather than feature assimilation.

One apparent case of assimilation that has frequently been cited in the recent literature proves to be spurious. Yala, a Niger-Congo language spoken in Nigeria, has three distinctive tone levels: H(igh), M(id), and L(ow). This language has been described as having a phonological assimilation rule by which H tones are lowered to M after M or L (Bao 1999, Yip 2002, 2007, after Tsay 1994). According to the primary source for this language, Armstrong 1968, however, Yala has no such rule. Instead, Yala has a downstep system by which any tone downsteps a higher tone: M downsteps H, L downsteps H, and L downsteps M.

Downstep is non-neutralizing, so that e.g. a downstepped H remains higher than a M. Yala is typologically unusual, though not unique, in having a three-level tone system with downstep, but Armstrong's careful description leaves no doubt that the lowering phenomenon involves downstep and not

assimilation.[5]

Our search through the Africanist literature has turned up one possible example of an assimilation process. Unfortunately, all data comes from a single source, and it is possible that subsequent work on this language may yield different analyses. However, as it is the only example we have found to date, it is worth examining here.

Bariba (also known as Baatonu), a Niger-Congo language spoken in Benin (Welmers 1952), has four contrastive tone levels. We give these with their feature analysis under the Two-Feature Model in (3). (Tone labels "top", "high", "mid", and "low" are identical to those of Welmers, but we have converted his tonal diacritics into ours, as given in the last line.)

(3)　　　　　　　　top　high　mid　low
　　register　　　H　　H　　L　　L
　　subregister　　h　　l　　h　　l
　　　　　　　　　 ő　　á　　ā　　à

By a regular rule, "a series of one or more high tones at the end of a word becomes mid after low at the end of a sentence" (Welmers 1952, 87). In rule notation, this gives $H_1 \rightarrow M \: / \: L \underline{\quad} \:]_S$. Examples are given in (4a–b) (alternating words are underlined):

(4)　a.　ná　b̀ɔ̀rá　buā　'I broke a stick' (b̀ɔ̀rā 'a stick')
　　　b.　ná　bóó　wá　　'I saw a goat' / ná bìì wā 'I saw a child'

Example (4a) illustrates one condition on the rule: the target H tone of /b̀ɔ̀rá/ in 'I broke a stick' occurs after L, as required, but does not occur sentence-finally, and so it does not lower; in the second example ('a stick'), however, both conditions are satisfied, and H lowers to M. (4b) illustrates the other condition: the target H tone of /wá/ in 'I saw a goat' occurs sentence-finally, but does not occur after a L tone, and so it does not lower; in the second example ('I saw a child'), both conditions are satisfied, and the H tone lowers as expected.

Considering the formal analysis of this process, it is obvious that the Two-Feature Model provides no way of describing this assimilation as spreading. Consider the LH input sequence as analyzed into features in (5):

(5)   low   high]$_S$
        register   L   H
        subregister l   l

We cannot spread the L register feature from the L tone to the H tone, as this would change it to L, not M. Nor can we spread the l subregister feature from the L tone to the H tone, as this would change nothing (H would remain H).

Other analyses of the Bariba data are possible, and we briefly consider one here, in which what we have so far treated as a M tone is reanalyzed as a downstepped H tone.[6] There is one piece of evidence for this analysis: according to Welmers' data, there are no M-H sequences. (Welmers does not make this observation explicitly, so we cannot be sure whether such sequences could be found in other data, but for the sake of argument we will assume that this is an iron-clad rule.) We can see two straightforward interpretations for such a gap. One is that M is a downstepped H synchronically, in which case any H following it would necessarily be downstepped. The other is that M is synchronically M, as we have assumed up to now, but has evolved from an earlier stage in which M was !H (see Hyman 1993 and elsewhere for numerous examples of historical *!H > M shifts in West African languages). The absence of M-H sequences would then be a trace of the earlier status of M as a downstepped H.

Looking through Welmers' description, we have found no further evidence for synchronic downstep in the Bariba data. If Bariba were a true downstepping language, we would expect iterating downsteps, but these are not found in the language. Welmers presents no sequences corresponding to H !H !H, as we find pervasively in classic downstep systems; we would expect that if the second of two successive M tones were produced on a new contrastive lower level in some examples, Welmers would have commented on it. Also, M does not lower any other tone, notably the top tone. A downstep analysis would therefore have to be restricted by rather tight conditions. In contrast, if M is really M, the only statement needed is a constraint prohibiting M-H sequences, which accounts for all the facts.

We conclude that Bariba offers a significant *prima facie* challenge to the Two-Feature Model, while admitting that further work on this language is needed before any definitive conclusion can be drawn.

4. INTERACTIONS BETWEEN NONADJACENT TONES

We have so far examined possible cases of interactions between adjacent tones. A particularly crucial question for the Two-Feature Model concerns the existence of interactions between *nonadjacent* tones. We show the Two-Feature Model again below:

	top	high	mid	low
register	H	H	L	L
subregister	h	l	h	l

This model predicts that certain nonadjacent tones may form natural classes and participate in natural assimilations. In a four-level system, *top* and *mid* share the feature *h* on their tone tier, and *high* and *low* the feature *l*. Thus, under the Two-Feature Model we expect to find interactions between top and mid tones, on the one hand, and between high and low tones, in the other, in both cases skipping the intermediate tone. A few apparent cases of such interactions were cited in the early 1980s, all from African languages, and have been cited as evidence for the Two-Feature Model, but no new examples have been found since, as far as we know. Reexamination of the original cases would seem to be called for.

A small number of African languages, including Ewe and Igede, have alternations between non-adjacent tone levels. We will examine Ewe here, as it has often been cited as offering evidence for the Two-Feature Model (Clements 1983, Odden 1995, Yip 2002). We will argue that while the alternations between nonadjacent tones in Ewe are genuine, they do not offer evidence for a feature analysis, either synchronically or historically.

The facts come from a rule of tone sandhi found in a variety of Ewe spoken in the town of Anyako, Ghana, as originally described by Clements 1977, 1978. While most varieties of Ewe have a surface three-level tone system, this variety has a fourth, extra-high level. We will call this the "top" level consistently with our usage elsewhere in this paper. These four levels are characterized in the Two-Feature Model in the same way as the other four-level systems discussed so far (see 2 above).

The tone process of interest was stated by Clements 1978 as follows. Whenever an expected M tone is flanked by H tones on either side, it is

replaced by a T(op) tone, which spreads to all flanking H tones except the very last. Examples are shown in (6).

(6)　　/ēkpé　+　mēgbé/　→　ēkpɛ̋ mɛ̋gbé

'stone'　　'behind'　　　'behind a stone'

/àtýíkē　　+　dýí/　→　àtýíkɛ̋ dýí

'medicine'　　'on'　　'on medicine'

/gā　　+　hǒmē　+　gɛ̋　　+　áɖé/　→　gà hòmɛ̋ gɛ̋ ɛ̋ɖé

'money'　　'sum'　　'large'　　INDEF　　'much money'

/nyɔ́nūví　+　á　+　wó　+　vá/　→ nyɔ́nɛ̋-ví ɛ̋ wő vá

'girl'　　　DEF　PL　'come'　'the girls came'

In the first example, the M tone of the second word /mēgbé/ 'behind' shifts to T since it is flanked by H tones. The second example shows that this sandhi process is not sensitive to the location of word boundaries (but see Clements 1978 for a discussion of syntactic conditions on this rule). In the third example, the targeted M tone is borne by the last syllable of /hǒmē/ 'sum'; this M tone meets the left-context condition since the rising tone on the first syllable of /hǒmē/ consists formally of the two level tones LH (see Clements 1978 for further evidence for the analysis of contour tones in Ewe into sequences of level tones). The fourth example shows the iteration of T spreading across tones to the right. This rule must be regarded as phonological since the Top, i.e. extra-high, tones created by this process contrast with surface high tones at the word level:

(7)　　/nú　　+　nyā　　+　lá/　　→　nű-nyɛ̋-lá

'thing'　　'wash'　　AGENT　　'washer(wo)man'

/nú　+　nyá　+　lá/　　→　nú-nyá-lá

'thing'　　'know'　　AGENT　　'sage, scholar'

In Clements' original analysis (1983), as recapitulated above, the tone-raising process involves two steps, both invoking tone features. First, the H register feature spreads from the H tones to the M tone, converting it into T. Second, the h subregister feature of the new T tone spreads to adjacent H tones, converting them into T tones (the last H tone is excluded from the

spreading domain). It is the first of these processes that is crucial, as it gives evidence for tone assimilation between nonadjacent tone levels – prime evidence for the Two-Feature Model.

The analysis we have just summarized is simple, but it raises a number of problems. First, there is no apparent phonetic motivation for this process: not only does it not phonologize any detectable natural phonetic trend, it renders the location of the original M tone unrecoverable. Second, no other phonologically-conditioned raising process of this type has come to light; this process appears to be unique to Anyako Ewe, and is thus idiosyncratic. Third, though the analysis involves two rules, there is in fact no evidence that two distinct processes are involved; neither of the hypothesised rules applies elsewhere in the language. (Top tones arising from other sources do not spread to H tones.) Thus, the rule seems arbitrary in almost every respect. Notably, it does not satisfy the first three criteria for feature analysis as outlined in (1).

Are other analyses of these data possible? We will consider one here, that draws on advances in our knowledge of West African tonal systems in both their synchronic and diachronic aspects. More recent work on tone systems has brought to light two common processes in West African languages. First, H tones commonly spread onto following L tone syllables, dislodging the L tone. This is a common source of downstep. Schematically, we can represent this process as H L H → H H $^!$ H. Second, by a common process of H Tone Raising, H tones are raised to T before lower tones. Thus we find   H → T / __ L   in Gurma (Rialland 1981) and Yoruba (Laniran & Clements 2003).

There is some evidence that such processes may have been at work in the Ewe-speaking domain. Clements 1977 observes that some speakers of western dialects of Ewe (a zone which includes Anyako Ewe) use nondistinctive downstep. Welmers 1973: 91 observes *distinctive* downstep in some dialects, and observes that the last H preceding a downstep + H sequence is "considerably raised".

Accordingly, we suggest a historical scenario in which original H M H sequences underwent the following changes:

(8)   processes   result
        introduction of nondistinctive downstep   H M $^!$H
        H spread, downstep becomes distinctive   H H $^!$H
        H raising before downstep, rendering it nondistinctive   H T $^!$H
        loss of downstep   H T H
        T spreads to all flanking H tones but the last   T T T

In this scenario, there would have been no historical stage in which M shifted directly to T. Any synchronic rule M $\rightarrow$ T would have to conflate two or three historical steps.

Inspired by this scenario, we suggest an alternative analysis in which M Raising is viewed as the "telescoped" product of several historical processes. In a first step, all consecutive H tones in the sandhi domain are collapsed into one; this is reminiscent of a cross-linguistic tendency commonly referred to as the Obligatory Contour Principle (see in particular Odden 1986, McCarthy 1986). The final H remains extraprosodic, perhaps as the result of a constraint prohibiting final T tones in the sandhi domain. Second, H M H sequences (where M is singly linked) are replaced by T: see Table 2.

nyɔ́nūví á wó vá | | | | | | H M H H H H	underlying representation

nyɔ́nūví   á wó vá
   | | \/ |
  H M   H
 (H)
	1. OCP(H), subject to extraprosodicity
	(no overt change)

nyɔ́nű vǐ   ǎ wő vá
    \/ |
    T
   (H)
	2. replacement of H M H by T

Table 2. A sample derivation of 'the girls came', illustrating the reanalysis of M Raising as the product of several historical processes.

This analysis is, for course, no more "natural" than the first. We have posited a rule of tone replacement, which has no phonetic motivation. However, it correctly describes the facts. Crucially, it does not rely on tone features at all.

Ewe is not the only African language which has been cited as offering evidence for interactions among nonadjacent tone levels. Perhaps the best-described of the remaining cases is Igede, an Idomoid (Benue-Congo, Niger-Congo) language spoken in Nigeria (see Bergman 1971, Bergman & Bergman 1984). We have carefully reviewed the arguments for interactions among nonadjacent tone levels in this language as given by Stahlke 1977 and find them unconvincing. In any case, no actual synchronic analysis of

this language has yet been proposed (Stahlke's analysis blends description and historical speculation). Such an analysis is a necessary prerequisite to any theoretical conclusions about features.

In sum, examining the evidence from natural assimilations and predicted natural classes of tones, the Two-Feature Model appears to receive little if any support from African languages. Confirming cases are vanishingly few, and the best-known of them (Ewe) can be given alternative analyses not requiring tone features. We have also described a potential disconfirming case (Bariba). Perhaps the most striking observation to emerge from this review is the astonishingly small number of clearly-attested assimilation processes of any kind. Whether this reflects a significant fact about West African tonology, or merely shows that we have not yet looked at enough data, remains to be seen.

5. REGISTER FEATURES IN ASIAN LANGUAGES

The concept of register has long been used in studies of Asian prosodic systems, with several distinct acceptations. Specialists agree that Asian prosodic systems give evidence of register at the diachronic level: the present-day tonal system of numerous Far Eastern languages results from a tonal split conditioned by the voicing feature of initials, that created a 'high' and a 'low' register (Haudricourt 1972). The question we will raise here is whether register features in the sense of the Two-Feature Model are motivated at the synchronic level. In view of a rather substantial literature on this topic, this question might seem presumptuous, were it not for our impression that much of the evidence cited in favor of register features suffers from the same shortcomings that we have discussed in the preceding sections in regard to African languages.

To help organize the discussion, we begin by proposing a simple typology of East Asian tone languages, inspired by the work of A.-G. Haudricourt 1954, 1972, M. Mazaudon 1977, 1978, M. Ferlus 1979, 1998, E. Pulleyblank 1978, and others. This is shown in Table 3.

	voicing contrast among initials?	distinctive phonation registers?	distinctive tone registers?	examples
Type 1	+	−	−	Early Middle Chinese (reconstructed)
Type 2	−	+	−	Zhenhai
Type 3	−	−	+	Cantonese (see below)
Type 4	−	−	−	most Mandarin dialects; Vietnamese; Tamang

Table 3. A simple typology of East Asian tone languages, recognizing 4 principal types.

Each "type" is defined by the questions at the top of the table. The first question is: Is there a voiced/voiceless contrast among initials? In certain East Asian languages, mostly reconstructed, a distinctive voicing contrast is postulated in initials (e.g. [d] vs. [t], [n] vs. [n̥]). This contrast transphonologized to a suprasegmental contrast in the history of most languages; it is preserved in some archaic languages (e.g. some dialects of Khmou). The second question is: are there distinctive phonation registers? By "phonation register" we mean a contrast between two phonation types, such as breathy voice, creaky voice, and so on. Phonation registers usually include pitch distinctions: in particular, in languages for which reliable information is available, breathy voice always entails lowered pitch, especially at the beginning of the vowel. Various terms have been proposed for distinctive phonation types, including "growl" (Rose 1989, 1990). Phonetically, phonation register is often distributed over the initial and the rhyme. In this sense, phonation register can usually be best viewed as a "package" comprising a variety of phonatory, pitch, and other properties, and it may sometimes be difficult to determine which of these, if any, is the most basic in a linguistic or perceptual sense. The third question is: are there distinctive tone registers? The putative category of languages with two distinctive tone registers consists of languages that allow at least some of their tones to be grouped into two sets (high vs. low register), such that any tone in the high register is realized with higher pitch than its counterpart(s) in the low register. In languages with distinctive tone registers, any phonatory differences between a high-register tone and its low-register counterpart must be hypothesized to be derivative (redundant with the register contrast).

The typology set out in Table 3 is synchronic, not diachronic, and is not intended to be exhaustive. Further types and subtypes can be proposed, and some languages lie ambiguously on the border between two types. Interestingly, however, successive types in this table are often found to constitute successive stages in historical evolutions. Also, since voicing contrasts are typically lost as tone registers become distinctive, there is no direct relation between consonant voicing and tone; this fact explains the absence of a further type with a voicing contrast and distinctive tone registers.

It should be noted that only type 3 languages as defined above can offer crucial evidence for a phonologically active tone register feature. Such evidence could not, of course, come from Type 1, 2 or 4 languages, which lack (synchronic) tone registers by definition.

In our experience, clear-cut examples of type 3 languages – "pure" tone register languages – are not easy to come by. Some alleged type 3 languages prove, on closer study, to be phonation register languages. In others, the proposed registers are historical and are no longer clearly separated at the synchronic level. Most East Asian languages remain poorly described at the phonetic level, so that the typological status of many cannot yet be determined. The small number of clear-cut type 3 languages may be due in part to insufficient documentation, but it could also be due to the historical instability of this type of system, as suggested by Mazaudon 1988.[7] The defining properties of type 3 languages are the following:

1.   no voicing contrast in initials
2.   no phonation register
3.   distinctive high vs. low tone registers, as schematized below:

	melodic type 1	melodic type 2	melodic type 3	etc.
high register	Ta	Ta	Ta	…
low register	Tb	Tb	Tb	…

In each column, Ta is realized with higher pitch than Tb

(some tones may be unpaired).

As a candidate type 3 language we will examine Cantonese, a member of

the Yue dialect group spoken in southern mainland China. This language is a prima facie example of a type 3 language as it has no voicing contrast in initials, only marginal phonation effects at best, and a plausible organization into well-defined tone registers. Our main source of data is Hashimoto-Yue 1972, except that following Chen 2000 and other sources, we adopt the standard tone values given in the *Hanyu Fangyin Zihui*, 2nd ed. (1989).

There are several ways of pairing off Cantonese tones into registers in such as way as to satisfy the model of a type 3 tone language. The standard pairings, based on Middle Chinese (i.e. etymological) categories, are shown in (9).

(9)	I	II	III	IVai	IVaii
high register	[53]~[55]	[35]	[44]	[5q]	[4q]
low register	[21]~[22]	[24]	[33]		[3q]

The [53]~[55] variants are conditioned by individual and morphosyntactic variables (Hashimoto-Yue 1972: 178–180, who considers the high falling variant [53] as underlying). Of course, this particular set of pairings has no analytical priority over any other in a purely synchronic analysis. The implicit assumption is that these are the most likely to form the basis of synchronic constraints and alternations. These pairings (as well as the alternatives) satisfy our third criterion for a Type 3 language. However, we have been unable to find any phonetic studies that confirm the pitch values above, which are partly conventional.

The crucial question for our purposes is whether or not Cantonese "activates" register distinctions in its phonology. That is, is there evidence for a feature such as [±high register] in Cantonese in the form of rules, alternations, etc.? Contrary to some statements in the literature, Cantonese has a rather rich system of tonal substitutions and tone sandhi, and two of these phenomena are particularly relevant to this question.

Cantonese tonal phonology is well known for its system of "changed" tones. According to this system, some words, mostly nouns, are produced with the changed tones 35 or (less productively) 55, instead of their basic lexical tones. This shift is usually associated with an added component of meaning, such as 'familiar' or 'opposite' (Hashimoto-Yue 1972: 93–98). Some examples are shown in (10).

(10) replacement by 35:　　　　　replacement by 55:

魚　ўy:^{21} → ўy:^{35} 'fish'　　　　　阿姨 A:^{44} ïi:^{21} → A:^{44} ïi:^{55} 'aunt'

李　leĭ^{23} → leĭ^{35} 'plum'　　　　　長 tsʰœŋ^{21} 'long' → tsʰœŋ^{55} 'short'

緞　ty:n^{22} → ty:n^{35} 'satin'　　　　　遠 ўy:n^{23} 'far' → ўy:n^{55} 'near'

計　keĭ^{33} → keĭ^{35} 'trick'　　　　　衫 sA:m^{53} → sA:m^{55} 'clothes'

A feature-based analysis of the changed tones is possible, but requires a complex analysis with otherwise unmotivated "housekeeping" rules (see Bao 1999: 121–127, for an example).
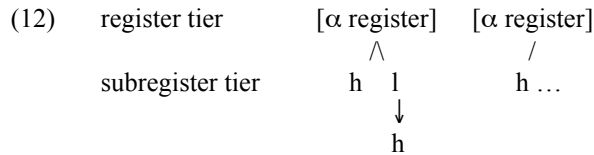
A more interesting source of evidence for a register feature comes from a regular rule of tone sandhi which Hashimoto-Yue describes as follows (1972: 112): "a falling tone becomes a level tone if followed by another tone that begins at the same level, whether the latter is level or falling". She states the following rules:

(11)　53　→　55　/　__　53/55/5
　　　21　→　22　/　__　21/22

Some examples follow:

应该　ĭŋ^{53} kɔ:i^{53} → ĭŋ^{55} kɔ:i^{53} 'should, must'

麻油　mA:^{21} ĭɐŭ^{21} → mA:^{22} ĭɐŭ^{21} 'sesame oil'

Let us consider the analysis of these alternations. A rather simple analysis is possible under the Two-Feature Model, if we allow Greek-letter variables or an equivalent formal device to express the identity of two feature values, as in (12):

(12)   register tier   [α register]   [α register]
                                    /\   /
         subregister tier   h   l   h …
                                    ↓
                                    h

This rule states that the low component of a falling tone shifts to high, provided it is followed by a tone beginning with a high component and that both tones belong to the same register. This analysis makes crucial use of both register features and subregister features, assigned to separate tiers. It correctly describes both cases.

A notable aspect of this rule, however, is that it describes alternations among variants of the same tone. That is, as we saw in (11), [53] and [55] are variants of the same tone, as are [21] and [22]. The rules are therefore "subphonemic", raising the question whether they are phonological in the strict sense – that is, category-changing rules – or gradient phonetic rules. In the latter case, they would not constitute evidence for tone features, since features belong to the phonological level (see our introductory discussion). To make a clear case for a phonological alternation we would need a set of alternations between contrastive tones, such as [53] ~ [35] and [21] ~ [24]. Thus, in spite of the rather elegant analysis that can be obtained under the Two-Feature Model, these facts do not make a clear-cut case for features.

We know of no other alternations that support a feature-based analysis of Cantonese tones. However, certain static constraints described by Hashimoto-Yue (110–111) are most simply stated in terms of a low register feature, and possibly in terms of the level/contour distinction, if [53] and [21] are taken to be underlying[8] (Roman numerals refer to the categories in (9)):

- unaspirated initials do not occur in syllables with the low-register I and II tones ("contour" tones?)

- aspirated (voiceless) initials do not occur in syllables with the low-register III and IV tones ("level" tones?)

- zero-initial syllables do not occur with low-register tones

These constraints, which are clearly phonological, might be taken as evidence for a low-register feature. However, static constraints have never

carried the same weight in feature analysis as patterns of alternation, the question being whether they are actually internalized as phonological rules by native speakers.

We conclude that Cantonese does not offer a thoroughly convincing case for tone features. The interest of looking at these facts is that Cantonese represents one of the best candidates for a type 3 language that we have found.

We have also surveyed the literature on tone features in other Asian languages. Up to now, we have found that arguments for tone features typically suffer from difficulties which make arguments for a register feature less than fully convincing:

• evidence is often cited from what are actually Type 2 or 4 languages
• very many analyses do not satisfy the criteria for feature analysis outlined in (1)

One reason for these difficulties, in the Chinese domain at least, is the long history of phonetic evolution that has tended to destroy the original phonetic basis of the tone classes. This has frequently led to synchronically unintelligible tone systems. As Matthew Chen has put it, the "vast assortment of tonal alternations… defy classification and description let alone explanation. As one examines one Chinese dialect after another, one is left with the baffling impression of random and arbitrary substitution of one tone for another without any apparent articulatory, perceptual, or functional motivation" (Chen 2000, 81–82).

The near-absence of simple, phonetically motivated processes which can be used to motivate tone features contrasts with the wealth of convincing crosslinguistic data justifying most *segmental* features. This may be the reason why most tonologists, whether traditionalist or autosegmentalist, have made little use of (universal) features in their analyses. As Moira Yip has tellingly observed, "Most work on tonal phonology skirts the issue of the features" (Yip 2007, 234).

6. WHY IS TONE DIFFERENT?

Why is it that tones do not lend themselves as readily to feature analysis as segments?

We suggest that the answer may lie in the monodimensional nature of level tones:

– *segments* are defined along many intersecting phonetic parameters (voicing, nasality, etc.); such free combinability of multiple properties may be the condition *sine qua non* for a successful feature analysis

– *tone levels* (and combinations thereof) are defined along a single parameter, F0; there is no acoustic (nor as yet, articulatory) evidence for intersecting phonetic dimensions in F0-based tone systems

The latter problem does not arise in phonation-tone register systems, in which phonation contrasts are often multidimensional involving several phonetic parameters (voicing, breathy voice, relative F0, vowel quality, etc.), and can usually be identified with independently-required segmental features.

Given the monodimensional nature of level tones, it is difficult to see how a *universal* tone feature analysis could "emerge" from exposure to the data. Unless "wired-in" by "Universal Grammar", tone features must be based on observed patterns of alternation, which, as we have seen, are typically random and arbitrary across languages. In contrast, patterns based on segmental features, such as homorganic place assimilation, voicing assimilation, etc., frequently recur across languages (see Mielke 2008 for a description of recurrent patterns drawn from a database of 628 language varieties).

Conclusion

We have argued that the primitive unit in tonal analysis may be the simple tone level, as is assumed in much description work. Tone levels can be directly interpreted in the phonetics, without the mediation of features (Laniran & Clements 2003). Tone levels are themselves grouped into scales. (The issue whether *all* tone systems can be analyzed in terms of levels and scales is left open here.)

Although this paper has argued against universal tone features, it has not argued against *language-particular* tone features, which are motivated in some languages. We propose as a null hypothesis (for tones as for segments) that features are not assumed unless there is positive evidence for them. (For proposed language-particular features in Vietnamese, involving several phonetic dimensions, see Brunelle 2009.)

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[1] Another theoretically important function, namely *bounding* (defining the maximum number of contrasts), will not be discussed here.

[2] Some linguists have maintained that features are innate in some (usually vaguely-defined) sense. However, recurrence across languages does not entail innateness, which is an independent hypothesis; for example, some current work is exploring the view that features can be developed out of experience. This issue is peripheral to the questions dealt with in this paper and will not be discussed further here.

[3] Yip 1980 originally proposed two binary features called [±upper register] and [±raised]. However, since the development of feature-geometrical versions of this model (Bao 1999, Chen 2000, and others), these have tended to be replaced by H and L, or h and l.

[4] In a broader sense of the term "phonology", any rule, categorial or gradient, which is language-specific might be regarded as phonological. This indeed was the view of Chomsky & Halle 1968, though it is less commonly adopted today.

[5] The facts of Yala are summarized in Anderson 1978 and Clements 1983.

[6] We are indebted to Larry Hyman for e-mail correspondence on this question.

[7] Mazaudon's Stage B languages correspond approximately to our type 3 languages.

[8] However, we have not seen convincing evidence for taking either of the alternating tones [53]~[55] or [21]~[22] as basic.