Tone, Phonation, and Intonation Register

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This paper explores the relationship between three different kinds of register, and tries to assess whether they are phonologically one and the same, or whether we must distinguish between them. The three kinds of register that will be discussed here are :

a. tonal register, dividing the pitch of the voice into 2 ranges, called [+upper] register and [-upper] register.

b. phonation register, giving laryngeal characteristics such as murmur or creaky voice.

c. intonation register, determining the level on which a lexical tone is actually realized in an utterance.

I will investigate the properties of each in turn and conclude that they cannot all be reduced to a single feature.

1. Register as a tonal feature:

The model of tonal features I will present here is laid out in Yip (1980) and modified in Yip (1989).For useful discussion see also Pulleyblank (1986), whose terminology I adopt here), Hyman (1986, to appear) and others. Four level tones are given by the structures in (1), where the register feature [upper] divides the pitch range into two halves, and these are then further refined by the subsidiary feature [raised]; 5 denotes high pitch, 1 denotes low pitch, etc., and contour tones are shown by their starting and

ending points.[1]

(1)

[+upper]	[+upper]	[-upper]	[-upper]
|	|	|	|
[+raised]	[-raised]	[+raised]	[-raised]
55	44/33	33/22	11

Contour tones have a single specification for [upper], which dominates a sequence of two specifications for [raised] . This gives four possible contour tones, shown in (2); I have substituted the shorthand H, L for [+/- raised] respectively, and will continue this practice throughout the paper.

(2)

[+upper]	[+upper]	[-upper]	[-upper]
/ \	/ \	/ \	/ \
L H	H L	L H	H L
35	53	13	31

In general I will show tones in this form, as a complex of tonal features headed by [upper], which acts as a tonal root node and associates to the segmental tier. I will refer to [upper] as a tonal register feature, and L, H as the melodic features.

The evidence for a tonal register feature, [upper], comes from rules which delete the subsidiary L, H tones, but leave the register behind. Tones may then spread from a neighboring segment, and the result will be a surface tone whose level is a composite of the underlying register, and the neighboring tone.

1.1 Taiwanese:

My first example of this is drawn from Taiwanese; for a fuller discussion see Yip (1980:168-9) and references therein.

On sonorant-final syllables, Taiwanese has five citation tones which surface unchanged pre-pausally; in non-final position they are reduced to four, two of which are [+ upper] register (55, 53) and two of which are [-upper] register (21, 33). There is a third set of allotones which surface before the diminutive sufix a^{53}. This set has only two members,(55 and 33). The data is given in (3):

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[1] Hyman (1986, and to appear) uses the term register for the secondary feature, but I will use it consistently for the major division of the pitch range.

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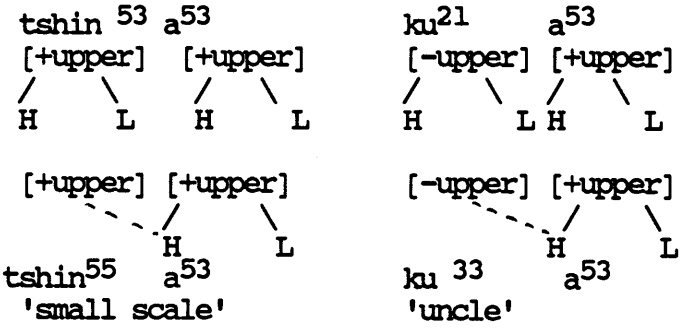
(3)

Citation:	53	21	33	13	55
Non-final:	55	53	21	33	
Before $\underline{a}^{53}$:	55		33		

It is this final set that is of interest here. The usual non-final forms are replaced by tones that retain their register, but lose all other contrasts of contour and height. Both [+upper] tones are now [+upper, H] (55), and both [-upper] tones are now [-upper, H] (33).This suggests that the subsidiary H, L tones have been deleted in this environment, leaving the register behind. The suffix which causes these changes, $\underline{a}^{53}$, is [+upper, HL], so the H tone that surfaces on the preceding syllable can be attributed to spreading leftwards from the suffix.

(4)



1.2 Suzhou:

My second example comes from the Wu dialect of Suzhou. (Shih (1986:72ff), data from Ye (1979). Suzhou has two registers, with three or four tones in each:

(5)

[+upper]	44	52	412	5
[-upper]	13	31		3

In compounds, initial syllables retain their citation tones. Medial syllables keep only their register; they lose their tones and become level, either [+upper] 44 or [-upper] 33. Final tones are neutralized still further. Again, then, tones delete but register remains intact.

1.3 Cantonese:

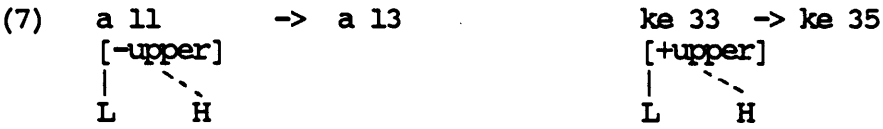
My last piece of evidence for the independence of register and melody comes from Cantonese. The data here come from Law (1989), although I depart from her on some elements of the analysis . Cantonese has six tones (a seventh, 53, is reported for some speakers): four level tones and two rising tones.

(6)

55	[+upper, H]	22	[-upper, H]
33	[+upper, L]	11	[-upper, L]
35	[+upper, LH]	13	[-upper, LH]

There are two utterance-final boundary tones, L and H, which have no register of their own. The effect of adding one of these, say the H tone, which has a "weakening" semantic flavor, is that it shows up with the underlying register of the preceding syllable, as shown in (7):

(7)



The facts in this section show that we must recognize tonal register as distinct from melody.

2. Register as a phonation feature:

The second type of register I shall be concerned with is closely related to, but distinct from, purely tonal register. Some languages show differences in voice quality in vowels, such as breathy voice (murmur) or creaky voice (laryngealized). Such phonation differences frequently affect the observed pitch of the syllable, and behave phonologically in ways similar to tone. Shanghai provides my first example.

2.1 Shanghai:

Shanghai contrasts murmured and plain syllables, with murmured syllables showing a lower pitch overall. The tonal inventory of Shanghai is as follows (data from Xu, Tang and Qian 1981, 1982, 1983):

(8) Clear: 53 24 55 Murmured: 13 13

The 13 tones occur only on syllables with voiced onsets accompanied by a murmured release, apparently a kind of breathy voice . Sherard (1972: 84-87) quotes Ladefoged in support of the view that the term "voiced aspiration" is not appropriate here, and we shall see that phonologically murmur and aspiration behave quite differently in Shanghai. Murmured release occurs on all and only voiced obstruents, but it is contrastive on sonorants, and the so-called "zero initial". Although murmured sonorants predominate, plain ones are reasonably common, at least among glide-initial and "zero-initial" syllables. Minimal pairs are given below, taken from Sherard (1972) and Zee and Maddieson(1980:67). h denotes murmur. y is a lower high front rounded vowel. @ is a mid central vowel with lip compression.

(9)

nyh@	'cow'	ny@	'to pinch'
lhyng	'order'	lyng	'carry'
wha?	'slippery'	wa?	'to pick'

Given this distribution of murmur, it cannot be predicted from voicing on the onset. However, voicing can be predicted from murmur: if the syllable is murmured, then the onset is voiced. There is no need for a distinctive feature [voice] underlyingly in Shanghai.

Shanghai, like the other Wu dialects, is known for its left-dominant tone sandhi. In polysyllabic words the tones of all but the first syllable are deleted, and the tone of the first syllable spreads over the rest of the utterance. See Zee and Maddieson 1980, Yip 1980, Duanmu 1988, for details. What is of interest here is the behavior of murmur. I will argue that murmur has a closer affinity to the tonal features of Shanghai than it does to the laryngeal properties of the onset. This is because it too deletes on non-initial syllables, whereas voicing and voiceless aspiration remain intact.

Sherard's thorough description states (p80) that the murmured onsets are always fully voiced, both initially and medially, and he contrasts this with other Wu dialects where they have been described as devoiced initially. He also says that medially the murmur is lost, and in support of this he cites neutralizations that take place between murmured and plain sonorants in non-initial position:[2]

(10)	the hu	'contraband'
	chOng hhu > chong hu	'(auto)accident'

We may thus analyze Shanghai as follows. (I am indebted to Duanmu (1988) for several aspects of this analysis; I differ from him in taking murmur to be tonal, rather than a property of the onset).

(i) On non-initial (i.e. unstressed) syllables, delete both tone and murmur.

(ii) Associate the remaining tone and murmur one-to-one, left-to-right, with the word (see Goldsmith 1976, Pulleyblank 1986 on universal association principles); the single specification for murmur will always surface on the first syllable. There may however be two tones (eg LH for the rising tones), and these will associate with the first two syllables.

(iii) Associate excess tones with the final syllable

(iv) Remaining syllables surface as 33 by default, with a

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[2] Duanmu (1988) discusses an apparently different dialect, in which initial onsets are devoiced, and medially murmur is retained. He argues that in this dialect murmur is a property of the onset, and not of the tone.

drop on the final syllable to 31.

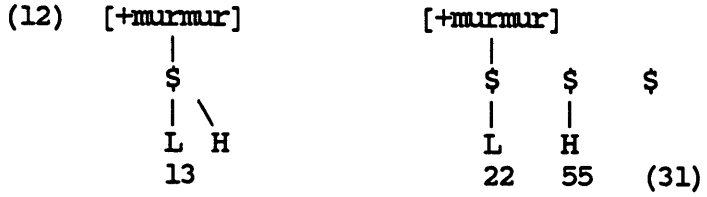
Note that there is no spreading in Shanghai, either of tone or of murmur; the effect of spreading results from association of up to two tones with a polysyllabic domain. Murmur appears to be fixed on the onset syllable solely because there is only one remaining specification for murmur.

As an illustration, consider the patterns of tones 2 and 3 on different numbers of syllables.[3]

(11)	Clear:	24		Murmur:	13
	T2	33 44		T3	22 44
		33 55 31			22 55 31
		33 55 33 31			22 55 33 31
		33 55 33 ..33 31			22 55 33 .. 33 31

Both tones are LH, but T3 is also [+murmur]. On monosyllables [murmur] affects the entire syllable with which it is associated, and the entire LH rise is lower. On polysyllables, [+murmur] is associated only with the first syllable, which it lowers, so that we get 22 versus 33 on the first syllable. On the second syllable, the H is unaffected by murmur, so both tones rise to 5. Below I show the representations for the murmured tone on one and on three syllables; the final syllable gets its tones by default.

(12)



So far I have talked of "murmur" and used a feature [+murmur], and I have argued that this feature is tonal rather than being a property of the onset. The implication is that the feature, whatever it is, belongs with the other tonal features in the feature geometry, and not with the laryngeal features. I am assuming a model of feature geometry along the lines of Clements (1985), Sagey (1986). There are three main candidates for what "murmur" is:

(i) A laryngeal feature(s), maybe the complex [voice, +s.g.].

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[3] Note that the tone digits may be spuriously precise, in that what is crucial about 13 versus 24 is that both are rising, but one is higher than the other; and that T3 is lower than T2 throughout on one syllable, but on two or more syllables the first syllable is always lower, and the second syllable is always the same.

(ii) A tonal feature, maybe [-upper]
(iii) A feature with affinities to both tonal and laryngeal nodes.

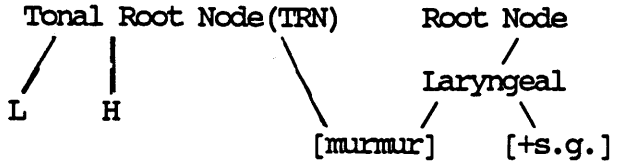
(i) is the least plausible of these. Its advantage is that it alone directly explains the fact that "murmur" conditions onset voicing. However, it makes the deletion of murmur in non-initial syllables impossible to explain. To see this, note that deletion affects both tone and murmur, but NOT voicing, or aspiration on voiceless onsets. If murmur is voiced aspiration, this generalization clearly cannot be captured.

(ii), that murmur and [-upper] are one and the same, was essentially the position taken in Yip (1980). It directly explains the deletion of both tone and murmur, and the failure to affect voicing and aspiration, but leaves two problems. First, there is no obvious reason why [-upper] (murmur) should condition onset voicing. In other tone languages, such as Cantonese, this is not the case. Second, it fails to distinguish between the phonetic realization of [-upper] in Shanghai as both lowered pitch and murmur, and [-upper] in Taiwanese or Cantonese as just lowered pitch.

Both these problems are part of a more general issue: what is the relationship between laryngeal features and tonal features? On the one hand they can be quite independent from one another, as in most African tone languages, or in Cantonese; on the other hand there is a clear historical relationship (see Kingston and Solnit 1988, and refs cited therein), and even a synchronic one in some cases. Shanghai is an instance of this split personality: murmur occupies the middle ground. It deletes like tone, but unlike laryngeal features; it conditions voicing on the onset in obstruents, as if it were itself laryngeal.

(iii) This leaves us with the third possibility: murmur is a feature which partakes of both laryneal and tonal characteristics. I propose to capture this directly as shown below, by making "murmur" a dependent of both the tonal and the laryngeal nodes. Underlyingly, it is tonal, but it attaches to the laryngeal node as well, and in the process causes obstruent voicing .[4]

(13)



[4] On tonal root nodes, see Archangeli and Pulleyblank (1986), Hyman (1986), Yip (1989).

In non-initial position the tonal root node and its contents, including [murmur], delete; since obstruents remain voiced, this deletion must follow the default rule that determines voicing.

(14) (i) [murmur] -> [voice]
(ii) TRN -> Ø , contents delete too

The deletion of [murmur] is an automatic consequence of the deletion of the Tonal Root Node if we assume that it is required to be doubly dependent; in other words, it is only properly licensed if both superordinate nodes are present.

This proposal is a radical departure from standard notions of feature geometry in that [murmur] does not have a unique constituency. I would suggest , though, that it may be a useful way to think about the kind of interim stage we find in Shanghai, where an ertswhile segmental laryngeal feature is becoming tonal, but has not yet completed the transition and severed all ties to its host laryngeal node.

2.2 Tibetan: [5]

Tibetan is of interest because it resembles Shanghai in having a doubly-dependent feature, [murmur], but whereas in Shanghai the Tonal Root Node deletes, taking murmur and tone with it, in Tibetan the Laryngeal node deletes, taking murmur, voicing and aspiration with it. In other words, murmur is only licensed if both its superordinate nodes are present; if either one deletes, it disappears too.

On long V[+son] syllables, non-falling tones contrast with falling tones in both Lhasa and Tsang dialects. Non-falling syllables rise phonetically, but may be level phonologically. Hari (1979) finds this contrast on short syllables too, but the other reports disagree. There is also a high/low register difference, giving four tones, as shown below:

(15)	Level/Rise		Falling	
High	phüü 54	'offer'	phee 52	'come'
Low	thee 13	'mule'	thuu 131	'six'

The digits are for comparison with other sources only; they are not a close match to F_0 values.

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[5] The Tibetan data comes from Dawson 1980, Ossorio 1982, Mazaudon 1977, Kjellin 1975, 1976; Shih 1986. I would particularly like to thank Scott Meredith for useful discussion. Hari (1979) disagrees with the other sources on a number of points; I have taken the other sources as the basis for my discussion.

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The high/low register contrast is limited to sonorants and voiceless aspirates (including fricatives). Voiced obstruents are always low; plain voiceless stops are always high:

(16)

High		Low	
ma 54	'wound'	ma 13	'mother'
tha 54	'end'	tha 13	'now'
sa 54	'place'	sa 13	'eat'
see 52	'know'	see 131	'three days from now'
see 54	'crystal'	soo 13	'deceit,pretense'

The high/low contrast is accompanied on monosyllables by a " phonation register" difference (Ossorio (1982:88):

(17) High register: "tense":
- glottal stop on vowel-initial syllables
- strong aspiration
- plain stops and affricates sometimes slightly aspirated
- pharyngealization of checked syllables

Low register:
- absence of above
- Always/sometimes breathy

Having surveyed the basic facts, now I turn to the behavior of tone and register in compounds. In compounds, the first syllable loses its level/falling contrast (neutralized in favor of level); it keeps the high/low register contrast:

(18) If the first syllable is:

a. H level:	cen 54	'eye,pol'	cencu 54 54	'tear, pol'
H fall:	tshoa 52	'meeting'	tshoakang 54 54	'meeting hall'
b. L level:	maa 13	'butter'	maarin 13 54	'price paid for butter'
L Fall:	tee 131	'rice'	teeŸing 13 54	'rice field'

Since the level/fall contrast is restricted to long syllables, the TBU must be the mora; tonal contrasts will thus be captured as given below:

(19)

Level/Rising	Falling	Short Syllables:
m m	m m	m
|	|	|
H	H	H

On the first syllable of compounds, then, the tone (H) deletes. Everything else remains intact.

The second syllable loses the high/low register contrast,

neutralized to high; it keeps the level/falling contrast:

(20) If the second syllable is:

a. H level:	ngee 54	'bad,evil'	tshingee 54 54	'bad language'
L level:	ming 13	'name'	chöömíng 54 54	'name given by monks'
b. H fall:	nii 52	'two'	cunñii 54 52	'twelve'
L fall:	rii 131	'nationality'	phorii 13 52	'Tibetan race'

The second syllable also loses the "phonation register" contrast, and any aspiration and voicing contrasts on the onset; medial onsets are all more or less plain voiced.

Let me assume, as in Shanghai, that [murmur] is a feature dominated by both laryngeal and tonal nodes. This directly explains the relationship to voicing and phonation, and to pitch. On the second syllable, the Laryngeal node deletes, taking [murmur] with it. All laryngeal and phonation contrasts disappear, but the tonal contrast of level/falling is retained. The result of deleting [murmur] is that syllables surface as high register by default, showing clearly that [murmur] is the marked feature, even in the case of sonorants.

As in Shanghai, I have suggested that it is possible for a single feature to be dominated by both laryngeal and tonal nodes, and that this directly captures languages in an intermediate stage between contrasts being born by onset consonants, and a truly tonal language. A crucial difference between Shanghai and Tibetan is that in Shanghai the Tonal Root Node deletes, whereas in Tibetan the Laryngeal node deletes. In both cases murmur is consequently lost.

I have argued for a tonal register feature, [upper], and a phonation register feature, [murmur], which may be dominated by both laryngeal and tonal nodes.[6] I now turn to intonation register and its relationship to the entities discussed in the preceding sections.

3. Register as an Intonation Feature:

If intonation involves the manipulation of the tonal register feature [upper], what kind of phenomena would we observe? Setting aside temporarily the phonetic implementation of register, we might find rules which insert and spread [+upper], and rules

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[6] It is also true that tone and phonation register may co-exist. See discussion on Mpi and other cases in Maddieson (1979), and references cited therein.

which insert and spread [-upper]. In a language which has a lexical contrast in [+/-upper], rules like this would neutralize the contrast: one set of tones would be unaffected, but the other set would merge with them. In a language without a lexical contrast, addition of some value of [upper] would create a distinction where none existed before. The latter situation pertains in non-tonal languages, like English, where intonation typically introduces contrastive pitch to the system. However, there is no way of telling what tonal feature is involved in such systems, since it interacts with no others and creates only a 2-way contrast.

We thus need to look at a language with lexical tone, and study its interaction with intonation. The most common reported effects of intonation on tones are:

(21)

(i) all tones raise (lower) somewhat
(ii) the pitch range expands (contracts), with high tones raising and low tones lowering

Neither of these effects can be described as a phonological rule operating on [upper]; however, they can be understood as phonetic implementation rules (Liberman and Pierrehumbert (1984), Pierrehumbert (1980), Pierrehumbert and Beckman (to appear)) governing the realization of tone. The most interesting work for our purposes is that of Shih (1987), on Mandarin Chinese, who studies the interaction of lexical tones and intonation, and argues that there are phonetic implementation rules, or scaling rules, which have the effects of (21). In particular, (21i) resets the reference line (" an abstract line that corresponds to the mid pitch range") higher, raising all tones. (21ii) "scales tonal targets away from the reference line".

There is however, a recent paper which argues that intonation may involve the phonological manipulation of register, and it is to that I now turn. I shall conclude that this "register" is different in two crucial ways from the tonal register discussed in section 1, and that a single feature, say [upper], cannot be used to account for both sets of facts.

3.1 Hausa

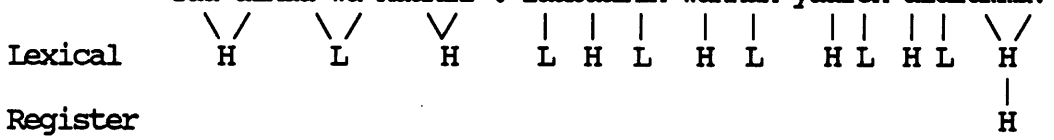
Inkelas, Leben and Cobler (1987) argue that Hausa Yes-No Question intonation can be understood as the addition and spreading of a H Register tone; that downdrift involves the insertion and spreading of a L Register tone, and that emphasis involves the addition of a H register tone. Hausa already has two lexical tones, and the register tones are superimposed on this system, so that a H tone with H register attached surfaces as extra-high, and a L tone with L register attached surfaces as

downdrifted L. In my summary of their account I use H and L register tones, following their terminology; later I will discuss the relationship between these entities and [+/-upper].

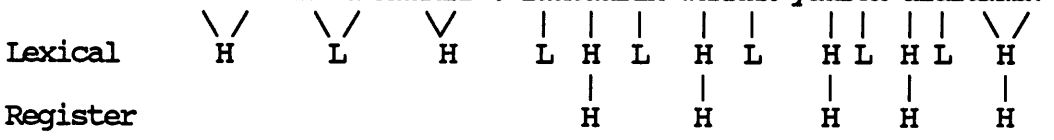
Hausa has downdrift, a process whereby all tones are lowered following a L tone. Inkelas, Leben and Cobler analyze this as the addition of a register L to all lexical L tones, followed by rightward spreading of the register L to a following H tone. They say (p4,ms) "a register tone shifts the register, so that it affects not only the tone it is associated with, but all the remaining tones in the phrase as well". Thus downdrift involves only local spreading, but the effect perpetuates itself across the phrase.

In Yes-No questions, there are three effects of interest:
(i) downdrift is suspended in the final intonational phrase
(ii) phrase-final H become extra-high
(iii) boundary L becomes raised L
These three effects are attributed to the addition of a register H, which associates to the final H of a question, and spreads iteratively leftward.[7] Its presence on H tones blocks the spreading rightward of register L's that would usually cause downdrift, accounting for (i) above. The extra-high and raised-low tones in (ii) and (iii) are the direct interpretations of lexical H and L associated with H register. An example is given below; % marks the Intonational Phrase boundary:

(22) (Inkelas, Leben and Cobler (10))



Copying of Register:



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[7] Actually, ILC have to state this rule as a copying rule, because they wish to leave the intervening L's free to accept a L register tone. The resulting alternation of H and L register resets the register repetitively back to its original position, resulting in the perceived level effect.

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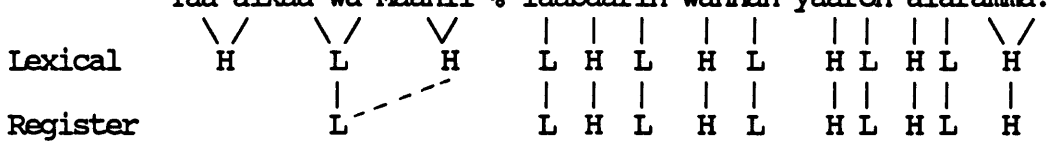
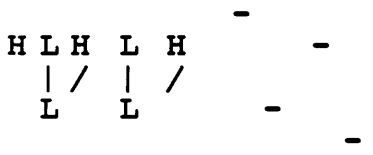
Downdrift Insertion and Spreading:



Now let us consider whether we can equate H and L register tones with [+/-upper].[9] There are two striking differences that suggest we cannot.

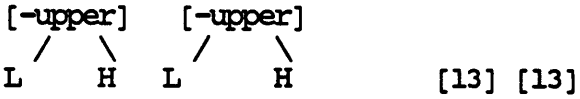
(i) Inkelas, Leben and Cobler's register tones reset the register permanently, but [+/-upper] , like Hause lexical tones, do not. In Hausa, a sequence of LHLH gets a register L on each L, and these spread to the following H's. The result is that the register is reset lower twice, giving downdrift:

(23)



In Chinese languages, a comparable sequence would be two low register rising tones, and each of these would have essentially the same register, with no successive lowering: [10]

(24)



(ii) There is some connection between lexical and register tones in Hausa, such that lexical L's get L register (in downdrift) and lexical H's get H register (both in questions and in emphasis). There is no such general connection between [+upper] and H, and [-upper] and L , in East Asian languages. Cantonese, for example, has all four possible combinations underlyingly. Because of this connection, in Hausa the effect of register is in some sense to expand the pitch range, raising H's and lowering L's

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[9] ILC themselves consider their proposal to be in the spirit of Yip (1980) and Hyman (1986), but although it is, I think, rather close to Hyman's concept of register, it is rather different from that of Yip (1980).

[10] See for example Shih's (1987:10) data on Mandarin sequences of two higher register rising tones, tone 2.If [+upper] reset the register permanently, we would expect updrift here; instead the two syllables are almost identical, each starting at about 216Hz and ending at about 250Hz.

(although the spreading of downdrift does lower H's too). (See also Clements (1989), who argues that ILC's register tier is superfluous.) It seems unavoidable to conclude that Inkelas, Leben and Cobler's register tones are not the same creature as the feature [upper] needed for East Asian languages.

5. Conclusion:

I have shown that it is necessary to recognize a tonal register feature, [upper], and that laryngeal features may doubly attach under laryngeal and tonal nodes to create what I have referred to as phonation register. I have also shown that intonation register, if phonological at all, cannot involve the same feature as tonal register.

Acknowledgements
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