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One-Step Tone Raising in Ali*

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1. Introduction

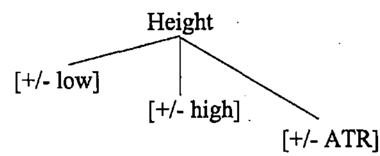
The Niger Congo language, Ali, provides support for a model of tone features in which there is a single feature for tone which may occur in multiple instantiations that differentiate between higher and lower tones. The Incremental Constriction model for vowel height proposed in Parkinson 1996 provides a feature organization in which a single feature is stacked hierarchically in such a way that one feature is the daughter of another. Using data from Monino 1987, I will show that an analogous model accounts very elegantly for a process of one-step tone raising in Ali in which a low (L) tone becomes mid (M) and a M tone becomes high (H). After showing the model's usefulness, I will discuss some problems it poses in providing a unified account of tonal behavior cross-linguistically.

The model of tone features that can account for the tone phenomenon found in Ali will be structurally analogous to a model of vowel height features, reflecting the similarities between vowel height and tone. For example, both tone and vowel height vary along a single phonetic dimension. Clements 1991 points toward this similarity when he states that of all the other features, only tone might function in a hierarchical manner like vowel height does. Another similarity is that both vowel

* I would like to thank David Odden for useful discussion of the ideas presented in this paper.

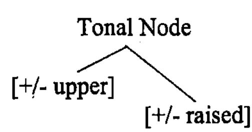
height and tone are subject to incremental raising. In addition, there is a parallel between how vowel height and tone features have traditionally been represented in feature geometry. Traditionally, notwithstanding the fact that there is a single phonetic dimension along which vowel height varies, a variety of different features, each of which is binary, has been used to represent that difference. For example, the model in Odden 1991, shown in (1), uses 3 different features to characterize vowel height: [+/- high], [+/- low] and [+/- ATR].

(1) Odden 1991 Vowel Height Model



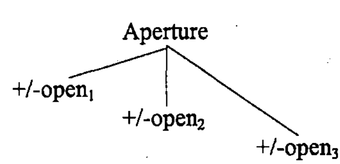
Analogously, traditional models of tone feature geometry rely on two or more different features to characterize tone differences. For example, the model proposed in Clark 1990, and shown in (2), specifies tone with two independent binary features, [upper register] and [raised pitch]. (For earlier models of tone features that Clark builds upon, cf. Clements 1981, Yip 1980, and Pulleyblank 1986.)

(2) Clark 1990 Model



Another type of model for vowel height feature geometry has been proposed in both Clements 1991 and Parkinson 1996. In these models, vowel height is specified by a single feature which is hierarchically organized. The Clements model is given in (3).

(3) Clements 1991 Vowel Height Model



Parkinson 1996 goes further in the direction of representing vowel height as a hierarchical feature. His tone feature, [closed] is privative and stacked, that is, [closed] features are arrayed in a recursive chain with one instance of [closed] dominating every other. Parkinson's Incremental Constriction model is illustrated in (4) for a high vowel.

(4) Height
    |
  [closed]
    |
  [closed]
    |
  [closed]

As shown in (5), successively higher vowels have successively more specifications of the vowel height feature [closed] in Parkinson's model.

(5)

	a	ε	e	i
closed		•	•	•
closed			•	•
closed				•

One of the justifications for the use of a single feature to specify vowel height is that a single feature represents a single phonological parameter, and this corresponds better to the single phonetic dimension across which vowel height varies. The use of multiple features with differing phonetic correlates, as in (1), obscures this property.

Because tone is similar to vowel height in this way, the use of multiple features to represent tones at different levels of pitch similarly obscures the unity of the phonetic dimension (ie. pitch) along which the difference occurs. The case for tone may actually be more striking since there are no definitions of [upper register] and [raised pitch] which even pretend to have different phonetic correlates. Clements 1991 points out that of all the other features, only tone might function in a hierarchical manner like vowel height does. Both Clements and Parkinson also justify their models based on the elegant treatment which the models provide for incremental vowel height assimilations. Although tone models with multiple features can account for such assimilations by extrinsic ordering of seemingly unrelated processes, only tone models with a single tone feature can account for such assimilations in a unified manner. The existence of incremental tone assimilations, as will be seen in Ali, therefore provides similar justification for an analogous model of tone.

2. An incremental tone model and the case of Ju/'hoasi

These considerations lead to the question of whether tone should be represented in the same way that vowel height is. Miller-Ockhuizen 1997 uses data from a Khoisan language, Ju/'hoasi, to justify a similar representation of tone. Sequences of tones in Ju/'hoasi words are no more than one step apart. As exemplified in (6), if the initial tone is L, the sequence is LH; if it is H, the sequence is HL; and if it is superlow (S^L), the sequence is S^LL. Since these tone sequences are predictable, Miller-Ockhuizen derives the second tone.

(6)	LH	gàʔḿ̩	'to hide'
	HL	dáʔàN	'fire'
	S^LL	jȁqʔò	'clean'

The significant advantage of the Incremental Constriction model in accounting for one-step vowel assimilations suggests that an analogous representation to deal with one-step tone assimilation would be useful. Miller-Ockhuizen provides the chart in (7) for Ju/'hoasi tone. The chart includes superhigh (S^H) although it is never found in word internal tone sequences.

(7)		S^L	L	H	S^H
	[Pitch]	•	•	•	•
	[Pitch]		•	•	•
	[Pitch]			•	•
	[Pitch]				•

The geometry assumed in Miller-Ockhuizen 1997 is presumably that in (8), where privative [pitch] features are stacked on a tonal node to represent the H tone.

(8)

Tonal Node
|
[pitch]
|
[pitch]
|
[pitch]

Ju/'hoasi provides an interesting case of one-step tone assimilation, but it is a case that involves no alternations. A stronger argument in support of a new theory of tone feature geometry could be made if it were based on alternating rather than nonalternating tones. When tone patterns are static it is difficult to ascertain their true import since they might simply reflect accidentally unified lexical patterns resulting from disparate historical processes. A pattern involving alternations, on the other hand, provides compelling evidence for a unified synchronic phenomenon. This kind of pattern is found in Ali, a three-toned Gbaya language spoken in the Central African Republic.

3. The incremental tone model and the case of Ali

The associative construction in Ali consists of at least two nouns, or a noun and pronoun, with the head noun to the left. Tone changes occur on the right edge of the left noun. A L on the head noun raises one step to M, a M raises one step to H, and H remains H, since there is no higher tone to raise to. For example, in (9a), the L of head noun *zù* 'head' raises to M in the construction *zū yérè* 'buffalo head'. The tone of the noun or pronoun to the right is irrelevant, as shown by second nouns with initial H, M and L tones. When the left noun is disyllabic, as in (9d) where *gbà̲là̲* → *gbā̲lā̲ yérè* 'buffalo bone', the tone on both syllables is affected. In three word constructions, such as *gbā̲lā̲ zū mī* 'my skull' (9e), tone raising is recursive. First, *gbà̲là̲* + *zù* becomes *gbā̲lā̲ zù*, and then *gbā̲lā̲ zù* + *mī* becomes *gbā̲lā̲ zū mī.*[1]

(9) L → M

a.	zù + ASSOC + yérè → zū yérè	'buffalo head'
b.	zù + ASSOC + tānā → zū tānā	'turtle head'
c.	zù + ASSOC + sàdî → zū sàdî	'animal head'
d.	gbà̲là̲ + ASSOC + yérè → gbā̲lā̲ yérè	'buffalo bone'
e.	gbà̲là̲ + ASSOC + zù + ASSOC + mī → gbā̲lā̲ zū mī	'my skull'
f.	gbà̲là̲ + ASSOC + yà → gbā̲lā̲ yà	'his bone'

Likewise, the M of a head noun raises one step to H, as in *nū* → *nú kpánà* 'jar mouth' (10a). When the left noun has two different lexical tones, as in *mbàā* → *mbàá mī* 'my mother' (10d), only the final tone is affected.

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[1] Underlining indicates nasalization.

(10) M → H

a.	nū + ASSOC + kpánà → nú kpánà	'jar mouth'
	nū + ASSOC + mī → nú mī	'my mouth'
	nū + ASSOC + sàdī → nú sàdī	'animal's mouth'
b.	sām + ASSOC + nū + ASSOC + mī → sám nú mī	'my mouth's saliva'
	sām + ASSOC + mī → sám mī	'my saliva'
	sām + ASSOC + yà → sám yà	'his saliva'
c.	sālā + ASSOC + lī + ASSOC + mī → sálá lí mī	'my eyelash'
	sālā + ASSOC + nɔ̄ɛ̄ → sálá nɔ̄ɛ̄	'bird feather'
	sālā + ASSOC + tɛ̀ → sálá tɛ̀	'body hair'
d.	mbàā + ASSOC + mī → mbàá mī	'my mother'
	mbàā + ASSOC + yà → mbàá yà	'his mother'

Adopting the incremental model proposed in Miller-Ockhuizen 1997, the tones of Ali can be specified as in (11), where L is unspecified[2], M has one specification and H has two specifications.

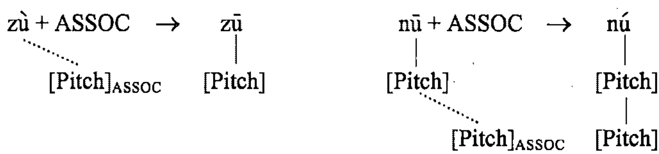
(11)

	L	M	H
[Pitch]		•	•
[Pitch]			•

The one-step tone raising can be accounted for in terms of an associative morpheme that consists of a floating [pitch] feature. In the associative construction, the associative morpheme is suffixed to the preceding noun. As illustrated in (12), when it docks to the final mora, it adds a specification of [pitch] causing the tone to raise by one step.

[2] This contrasts with Ju/'hoasi where Miller-Ockhuizen fully specifies all the tones. Although no extensive work has been done on Ali, my work on the closely related Suma language where L is unspecified leads me to suspect that L is unspecified for Ali as well. However, the choice between fully specifying L or leaving it unspecified has no significant consequence for this analysis.

(12) L → M   M → H



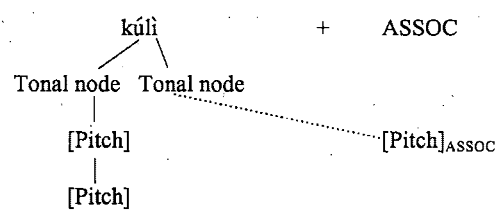
There is an additional process that results in a surface tone which has apparently been raised by more than one step in the associative construction. When a final L is preceded by a H, as in (13), we expect the L to raise to M, but it actually raises to H, due to a process conditioned by the preceding H. For example, when *kúlì* 'egg' and *kɔ̀rā* 'chicken' are combined in the associative construction, *kúlì* becomes *kúlí* rather than **kúlī*.

(13) HL → HH

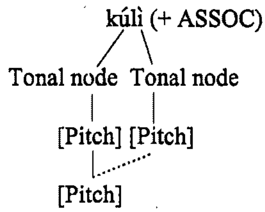
a.	kô + ASSOC + yérè → kó yérè	'female buffalo'	*kō̄
	kô + ASSOC + mī → kó mī	'my wife'	
	kô + ASSOC + dùà → kó dùà	'female goat'	
b.	kúlì + ASSOC + nɔ̄ɛ̄ → kúlí nɔ̄ɛ̄	'bird egg'	*kúlī
	kúlì + ASSOC + kɔ̀rā → kúlí kɔ̀rā	'chicken egg'	

Although the data in (13) reflect one-step raising at an intermediate stage, the surface tones are the result of a further spreading process that spreads a terminal pitch feature after the floating pitch feature has docked. The derivation would begin with the docking of the associative morpheme (14a), which produces an intermediate form with HM tones. Next, the terminal pitch feature from the preceding tonal node spreads once to the right (14b).

(14) a.



b.

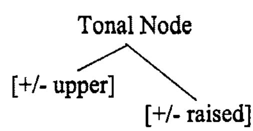


The use of an incremental model makes possible a unified analysis of one-step tone raising in Ali which allows for a straightforward characterization of the associative morpheme as a floating pitch feature.

4. Problems for a traditional tone model in accounting for Ali

An analysis of the same data using a traditional model of feature geometry presents several problems. Clark's 1990 model, given in (2) and repeated in (15), specifies tone with two independent binary features, [upper] and [raised].

(15) Clark 1990 Model



Using this model, we need to know what the specifications of tone in a three-tone language would be. In a four-tone language, and assuming full specification at some point in the grammar, the actual specification falls out of the model. But in a three-tone language, there is some uncertainty over the tone specifications. There are at least four possibilities, as shown in (16), and the choice between them depends on what the actual tone alternations in a language are. Thus, in some three-tone languages, we expect to find L specified as [-upper, -raised], while in others, it would be specified as [-upper, +raised]. The same is true for M and H. In some languages, M would be [-upper, +raised], while in others, it would be [+upper, -raised]. In some languages, H would be [+upper, -raised], while in others, it would be [+upper, +raised]. However, no matter which featural assumptions are made, a unified analysis of one-step raising cannot be developed using the traditional tone model.

(16)

		L	M	H
(a)	Upper	-	-	+
	Raised	-	+	+
(b)	Upper	-	+	+
	Raised	-	-	+
(c)	Upper	-	-	+
	Raised	-	+	-
(d)	Upper	-	+	+
	Raised	+	-	+

With a tone system as in (16a) in which L is [-upper, -raised]; M is [-upper, +raised] and H is [+upper, +raised], the feature changes given in (17a) would be necessary in order to account for the tone alternations in the associative construction of Ali. Where L becomes M, [-raised] changes to [+raised] and where M becomes H, [-upper] changes to [+upper]. Thus, a different feature change is required for each tone change and there is no way to unify the process. In addition, the feature changes have to be ordered in a counterfeeding order to avoid changing a L to M and then subsequently to H. Thus, M must first change to H; then L must change to M.

(17b-d) give the same information as (17a) but in relation to the other possible feature specifications given in (16). Note that these changes only account for the one-step raising itself and not for the additional spreading process that results in the final step of the derivation, ie. HM → HH.

(17) a. $_{L}$[-up, -rai] → [-up, +rai]$_{M}$ [-rai] → [+rai]
$_{M}$[-up, +rai] → [+up, +rai]$_{H}$ [-up] → [+up] (counterfeeding)

b. $_{L}$[-up, -rai] → [+up, -rai]$_{M}$ [-up] → [+up]
$_{M}$[+up, -rai] → [+up, +rai]$_{H}$ [-rai] → [+rai] (counterfeeding)

c. $_{L}$[-up, -rai] → [-up, +rai]$_{M}$ [-rai] → [+rai]
$_{M}$[-up, +rai] → [+up, -rai]$_{H}$ [+rai] → [-rai]
[-up] → [+up] (counterfeeding)

d. $_{L}$[-up, +rai] → [+up, -rai]$_{M}$ [+rai] → [-rai]
[-up] → [+up]
$_{M}$[+up, -rai] → [+up, +rai]$_{H}$ [-rai] → [+rai] (counterfeeding)

The problem with this analysis is that the generalization that tones are raised one step is completely lost. The processes by which [raised] and [upper] features are changed show no evidence of even being related. Nor can we give a representation of the associative morpheme that allows the surface forms to fall out naturally. Instead we must rely on arbitrary tone changes to characterize the associative construction.

There is still another way of approaching this phenomenon in a traditional model, as illustrated by the features in (18). It is possible (though not desirable) to allow two separate specifications for a M tone, either of which would result in the same phonetic output. M might be specified as either [-upper, +raised] or as [+upper, -raised]. Thus, there would be two phonetically identical but featurally distinct M's in a single language.

(18)

	L	M	M	H
Upper	-	-	+	+
Raised	-	+	-	+

Under this assumption, the one-step raising is merely a change of [-raised] to [+raised], as illustrated in (19).

(19) $_{L}$[-up, -rai] → [-up, +rai]$_{M}$ [-rai] → [+rai]
$_{M}$[+up, -rai] → [+up, +rai]$_{H}$

In order to justify such an approach, we need to have some other evidence for two independent M tones. That is, there is nothing inherently wrong with the notion that a language might have two phonetically identical but featurally distinct M tones. It is simply that without some kind of independent phonological or phonetic evidence for two M tones, an analysis like that in (18) is excessively abstract.

5. Problems for an incremental model in accounting for Ewe

One-step raising provides support for an incremental model of tone, but there are problems with such a model if we are committed to the notion of a feature geometry which is invariant across languages. Although the incremental model is far superior to the traditional model in Ali, the incremental model simply does not account for tone processes in some other languages. A clear example comes from the Ewe language. There is a process in the Anlo dialect of Ewe described in Clements 1976 whereby M becomes S^H between two H's. Data is given in (20). Note that there is also a process of S^H spread.

(20) Anlo Ewe (Clements 1978) M → S^H / H __ H

wó nɔ̄ví → wő nɔ̋ví

àtyí + mēgbé → àtyí mḗgbé 'behind a tree'

mē + ātyíkē dzrá-gé → m'àtyíkḗ dzrấ-gé 'I'm going to sell medicine'

mē + kpé + flē-gé → mè kpḗ flḗ-gé 'I'm going to buy a stone'

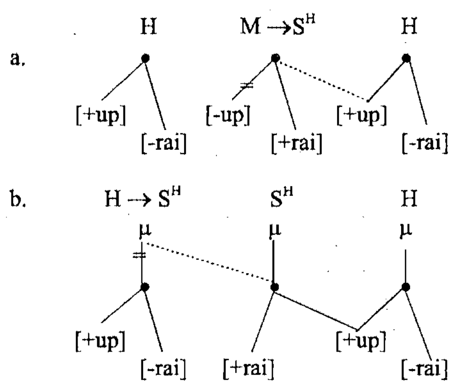
In the traditional model of tone feature geometry, the feature specifications will be as in (21), where L is specified as [-upper, -raised], M is [-upper, +raised], H is [+upper, -raised], and S^H is [+upper, +raised]. Since Anlo Ewe has four tones, there is no ambiguity about the specifications.

(21)

	Upper Register	Raised Pitch
L	-	-
M	-	+
H	+	-
S^H	+	+

The analysis of the change from M to S^H, shown in (22a), is straightforward using the traditional tone feature model. The H's specification for [+upper] spreads to the M where the [-upper] specification is delinked. Thus, the M changes from [-upper, +raised] to [+upper, +raised], ie. to a S^H. S^H spread, shown in (22b), involves the spread of the entire tonal node.

(22)

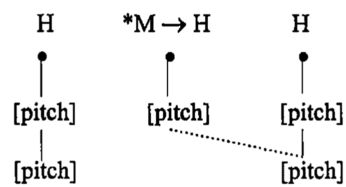


This data poses serious problems for an incremental model of tone features. The tones would be specified as in (23), where L has no [pitch] specification, M has one specification, H has two specifications and S^H has three. A change from M to S^H would entail a change from a single [pitch] specification to three [pitch] specifications.

(23)	L	M	H	S^H
[Pitch]		•	•	•
[Pitch]			•	•
[Pitch]				•

Using the incremental model, there is only one pitch feature that can spread, and that would change the M to H rather than S^H.

(24)



Thus, one step up in tone raising is possible, as seen previously. It is also possible to spread the entire tonal node, but that too would result in a H. What seems to be impossible is to use spreading to raise a tone to a pitch higher than the surrounding tones. Clearly, one could always posit a rule by which two specifications of [pitch] are inserted, but the insertion is unmotivated. Therefore, the incremental model fails to provide a satisfactory account of the Anlo Ewe data, while the traditional model allows for a tone change that involves raising two tone steps simply by spreading register.

6. Problems for an incremental model in accounting for Kikamba

Another case that deserves mention comes from the Bantu language, Kikamba. As elegantly argued in Roberts-Kohno 1997, tone alternations in Kikamba provide evidence for yet another tone feature, [extreme], which 'characterizes tones at the periphery of the tonal space'. Kikamba has four surface tones: S^L, L, H and S^H, shown in (25).

(25)	S^L (`)	kokonà	'to hit'
	L (unmarked)	nɔ̋ɔtɔ̋konɛ	'that we may hit'
	H (´)	toi̋kaakoná	'we will not hit'
	S^H (˝)	koya̋	'to eat'

The highest (S^H) and lowest (S^L) tones pattern together in various tonal alternations. As it happens, S^H is derived from a combination of S^L and H. Roberts-Kohno 1997 demonstrates this by illustrating the behavior of S^L phrasally. S^L is the phrase-final tone in a phrase with an assertive verb, as in *nétónáa-koni.ɛ̀* 'we hit (recent past)'. But if a verb stem has a final H, the phrase-final tone surfaces as S^H, as in *néwáá-ta̋la̋* 'he just counted (immediate past). Evidence that this S^H is a combination of S^L and H comes when the phrase is extended by adding a modifier after the verb. In *néwáá-tála maiò* 'he just counted bananas', the phrasal S^L now surfaces on the phrase-final mora, and there is a H (but no S^H) remaining on the verb stem.

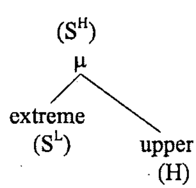
Roberts-Kohno postulates a tone feature system as in (26), where the tone feature [extreme] is added to the traditional feature [upper]. (The feature [raised] is irrelevant in Kikamba.) Tones are postulated to be underspecified in Kikamba such that S^L is specified simply as [extreme]; H is specified as [upper]; L is unspecified; and S^H is specified as [extreme] and [upper].

(26)

	extreme	upper register
S^L	•	
L		
H		•
S^H	•	•

The derivation of S^H is shown in (27) as the combination of a S^L and a H on the same tonal node.

(27)

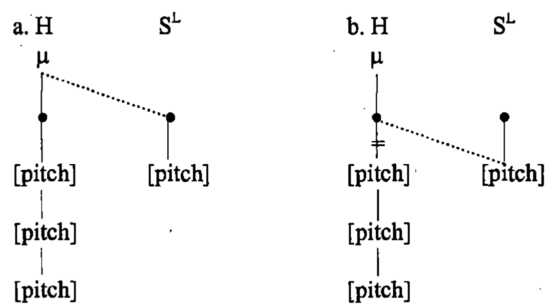


If we try to get a comparable result using the incremental model, once again we run into problems. We can specify the tone features as in (28) where S^L has one [pitch] feature and S^H has four.

(28)	S^L	L	H	S^H
[Pitch]	•	•	•	•
[Pitch]		•	•	•
[Pitch]			•	•
[Pitch]				•

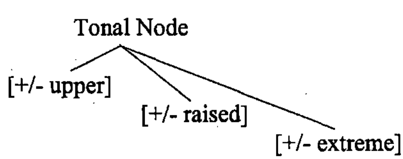
If S^L and H are combined as in (29a), the result is a contour tone, a fall from H to S^L. If the tone features combine as in (29b), the original specification for H must be deleted and the result is S^L. As in Ewe, it is impossible to get a tone with a higher pitch than the surrounding tones in a process of tone assimilation, and pitch insertion is unmotivated.

(29)



The Kikamba data suggests that the traditional feature model should be modified, as in (30), to reflect the existence of the tone feature [extreme].

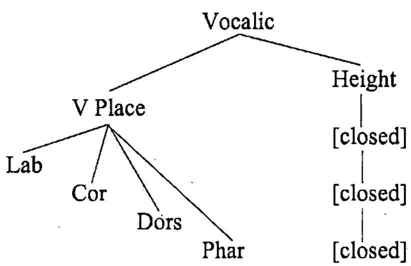
(30)



7. An invariant tone feature model

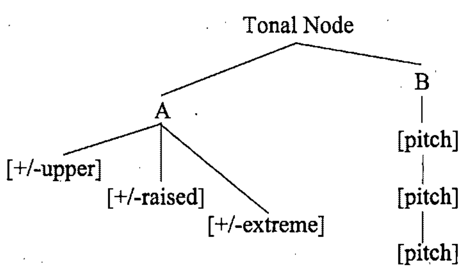
The problem then is that if some languages are accounted for with the incremental model and other languages require the traditional model or the modified traditional model, do we have to give up the notion of a model that is valid for every tone language? One way we could retain a more universal model is suggested by vowel feature geometry. As shown in Parkinson's adaptation (1996) of the Clements & Hume 1995 vowel feature model in (31), in addition to the stacked height features for vowels, we have a separate branch with place features.

(31)



A similar structure could be postulated for tone, as in (32). In this model, both the modified traditional model and the incremental model are combined.

(32)



This is a possible resolution of the problem, despite the fact that the new model overgenerates possible representations of tone. That is, it looks as if a single language could have a H tone specified in terms of stacked pitch features, as well as a H tone specified in terms of [upper, raised, extreme], as well as a H tone specified in terms of both. There is also a sense in which both parts of the tone feature model in (32) represent the same phonetic dimension, ie. the tonal space, and differ only in the manner in which they divide up that space. However, the idea that the same surface event may have different underlying representations is not in itself a particularly controversial one. This can be illustrated with respect to M tone, a phonological entity that has been specified differently in different languages. A M tone is specified as [+upper, -raised] in Bradshaw 1995 for Suma, and as [-upper, +raised] in Pulleyblank 1986 for Yoruba and Yala. Likewise, the contrast between the vowels *ε* and *e* is described in terms of vowel height in a language like Gbanu (Bradshaw 1996) but it is described in terms of the feature [ATR] in a language like Igbo. The alternative to using a model as in (32) is to propose that the feature geometry of tone is not invariant, but changes from language to language, and this would be far more controversial than the problems posed by the model presented here.

8. Conclusions

In this paper, I have shown that a model of tone using privative stacked features provides a better account of one-step tone raising in Ali than the traditional model which uses binary register and pitch features. But if the goal is to have a unified theory of tone features that accounts for tone crosslinguistically, the incremental model by itself does not fare very well. Some tone phenomena are not well suited to such a theory--and the same can be said about the traditional model. Even with modifications, the traditional model does not provide a satisfactory account of some tone phenomena. If we combine the theories into a new theory in which both stacked features and register and tone features are available, we can maintain a model of feature geometry that is invariant across languages. This is a desirable result, but one that is mitigated by the overenriched nature of the model presented here.

In using a combined model, we recognize that different languages may exhibit different patterns of tonal behavior. Just as we might not want to analyze the same vowel contrast in terms of the same features, we might not want to analyze tonal contrasts in terms of the same features in different languages. For example, the difference between [e] and [ε] might be captured in terms of vowel height features in one language and in terms of a place distinction or an ATR distinction in another, as argued by Parkinson 1997 and Clements 1991 respectively. Similarly tone contrasts in Ali might be best captured in terms of stacked [pitch] features, while tone contrasts in Ewe might be best captured in terms of independent [upper] and [raised] features.

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