

Constraints on the Theory of Vowel Height

Author(s): Frederick Parkinson

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Constraints on the theory of Vowel Height*

Frederick Parkinson
Ohio State University

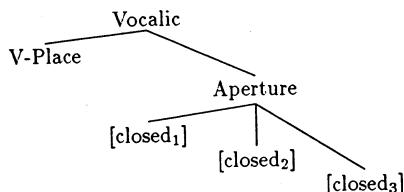
In this paper I propose a model of vowel height features which, while able to account for the full range of attested variation in vowel height phenomena found in the world's languages, is more constrained than existing models which incorrectly predict unattested patterns. This model is constrained in two ways: by the adoption of privative features which limits possible assimilation processes by ruling out partial lowerings, and by imposing an implicational relation on these features which prohibits all but a unique representation for any given vowel height.

Assumptions.

To constrain the model in the ways mentioned above, I propose that the theory of vowel height should include the following assumptions; (a) vowel height features are scalar, (b) vowel height features are privative, (c) vowel height is characterized by the feature [closed], and (d) an implicational relation is imposed on vowel height features.

I additionally assume that all assimilation is accomplished by spreading single elements from a universal feature geometry. Single terminal features may spread, or an organizing node may be spread which allows for constituents of features to assimilate. Following Clements (1989), I also assume that vowel features are organized as in (1) following Clements (1989), where vowel height features form an independent constituent, separate from vowel place. (See also Odden 1991, Clements and Hume to appear, Wiswall 1991, and Goad 1993 who motivate this separation.)

(1) Organization of Vowel Features.



Scalar vs. Multiple Features.

Throughout this paper I will compare the model proposed here to two widely accepted approaches to vowel height, that of Sagey (1986, 1990) and that of Clements (1989). Sagey characterizes vowel height with the features [high] and [low], an approach I refer to as the multiple feature model. Clements argues that the multiple feature account should be abandoned since it cannot account for 'stepwise' harmonies like that found in Nzebi.

(2) Nzebi (Guthrie 1968) 'stepwise' vowel raising. (Showing front vowels only.)

/-bis-i/	→	[bis]	'to refuse'	/-βoom-i/	→	[βuum]	'to breathe'
/-bet-i/	→	[bit]	'to carry'	/-kolən-i/	→	[kulin]	'to go down'
/-sueɪn-i/	→	[sueɪn]	'to hide oneself'	/-tɔɔd-i/	→	[tɔɔd]	'to arrive'
/-sal-i/	→	[sel]	'to work'	/-βaŋgən-i/	→	[βɛŋgin]	'to promise'

The examples in (2) illustrate Nzebi stepwise raising. The addition of the suffix /-i/ to verb stems raises the root vowel one 'step' so that /e/ surfaces as [i], /ɛ/ becomes [e], and /a/ raises to [ɛ].¹

(3) Nzebi assimilation within the Multiple Feature framework (Sagey 1990).

e ə o	→	i u	[-high]	→	[+high]
ε ə	→	e o	[-ATR]	→	[+ATR]
a	→	ε	[+low]	→	[-low]

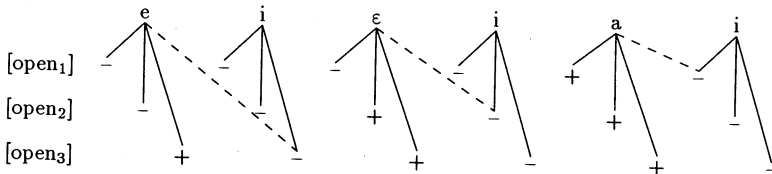
Clements (1991) argues that the multiple feature model should be abandoned since it cannot characterize the changes in (2) as a single process because each target requires that a different feature spread. He proposes that scalar features be adopted to account for Nzebi, specifying Nzebi vowels as in (4).

(4) Nzebi vowel height in Clements (1991:36).

	iu	eəo	εə	a
open ₁	-	-	-	+
open ₂	-	-	+	+
open ₃	-	+	+	+

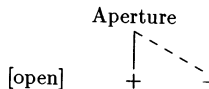
In Clements' analysis, [+] specifications for [open] indicate that a vowel is more open (ie. lower), and [-] specifications characterizes higher vowels. The vowel [a] is specified entirely by [+open], while [i] is characterized exclusively by [-open]. Note that scalar models do not require a stipulation to prohibit a single vowel from bearing the conflicting specifications of [+high] and [+low].²

(5) Spreading [-open].



As shown in (5), to account for step raising in Clements' approach, the trigger spreads a specification of [-open] for which the target vowel has a [+open] specification. In this way, *i* spreads its value of [-open₃] to /e/ to derive [i], spreads [-open₂] to /e/ to create [e], and [-open₁] to /a/ which then surfaces as [ε]. Clements formalizes this rule as in (6).

(6) Vowel Raising: A Structure Preserving process.



Since multiple feature models cannot account for the Nzebi facts, I follow Clements' suggestion, adopting scalar features.

Privative vs. Binary features.

I will now address the question of the privativity of vowel features, suggesting that privative features predict fewer types of assimilations. Binary systems predict that both values of a feature are active cross-linguistically (in essence, creating two features e.g. [+high] and [-high]), while privativity allows reference to only one feature value. For example, since it has been argued that no phonological process refers to [-labial], the privative feature [labial] has been adopted (see Selkirk 1993 and references therein).

I propose that privativity be adopted for height features as well, positing that [closed] characterize vowel height contrasts. Assuming the geometry in (1), two types of vowel height assimilations are possible; complete and partial height harmony. In complete height harmony, the Aperture node spreads to the target so that it is raised or lowered to the same height as the trigger. The adoption of a privative feature [closed] predicts that partial height harmony will *raise* the trigger.

(7) A prediction of this proposal.

All partial height assimilations *raise* the target to a height intermediate to it and the trigger.

These predictions are borne out by attested vowel height phenomena. While complete harmonies may raise or lower their targets, all partial harmonies crucially raise their targets.

Implementation.

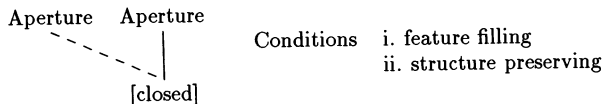
To illustrate how the model I am proposing can be implemented, I will present a brief analysis of three languages exhibiting height assimilations. First is Nzébi, which was discussed earlier. Nzébi vowels are specified in the model proposed here as in (8) where specifications for [closed] correspond to higher vowels. The lowest vowel, *a*, lacks a specification for [closed].³ The highest vowels, *i* and *u*, have three specifications for [closed].

(8) Nzébi vowel height in privative features.

	i	u	e	ɛ	o	ɔ	a
closed ₁	•		•		•		
closed ₂	•		•				
closed ₃	•						

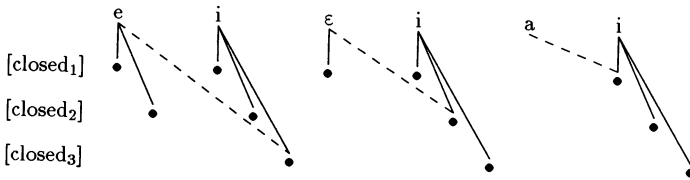
Nzébi step raising is accomplished by adding a value of [closed] to the target vowel so that /a/ gains a specification for [closed₁], /ɛ/, which is specified only for [closed₁], gains [closed₂], and /e/ assimilates for [closed₃]. Such spreading succeeds in raising the target one 'step.' Nzébi stepwise Raising is formalized as spreading a value of [closed] for which the target is not specified, as in (9).

(9) [closed] spreading: spread a value of [closed] for which the target is not specified.



A structure filling constraint is imposed which requires that a 'new' specification of [closed] be spread, and not a value for which the target is already specified. The structure preserving constraint prohibits spreading a value of [closed] when the target is not specified for all lower values of [closed].

(10) Nzébi Raising.



I will later make the structure preserving constraint superfluous with the imposition of an implicational relation for [closed], but in the meantime, (9) ensures that the trigger *i* spread [closed₃] to /e/ since that vowel is already specified for [closed₁] and [closed₂]. /ε/ is specified for [closed₁] so the feature filling constraint prevents this feature from spreading, while the structure preserving constraint prevents [closed₃] from spreading, leaving only [closed₂] to spread. The structure preserving constraint allows only [closed₁] to spread to /a/.

Kimatuumbi (Odden 1991, to appear), which has the four phonological heights seen below, provides an example of complete height assimilation.

(11) Kimatuumbi vowels.

	i	ɥ	i	u	e	o	a
closed ₁	•	•	•	•	•	•	
closed ₂	•	•	•	•			
closed ₃	•	•					

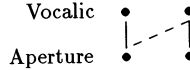
The harmony process exhibited in (12) where the height of the root is copied onto a suffix, is found in some form in many Bantu languages. In this case, the /i/ of the passive suffix surfaces with the same height as the stem initial vowel (/ɥ/ undergoes glide formation).

(12) The passive suffix /-ɪɥ-/ harmonizes with non-low vowels.

base	passive	gloss
asɪm-a	asɪm-ɪlw-a	'borrow'
kɥn-a	kɥn-ɪlw-a	'dance'
twiik-a	twiik-ilw-a	'lift a load'
uug-a	uug-ilw-a	'bathe'
keengeemb-a	keengeemb-elw-a	'uproot tubers'
bool-a	bool-elw-a	'tear bark off a tree'

Since the suffix vowel surfaces with height identical to the root, this process is a complete harmony in which the entire Aperture node is spread. Kimatuumbi Height Harmony is formalized as (13) where Aperture spreads from the root to the suffixal vowel.

(13) Kimatuumbi Harmony with Privative features: Spread Aperture.



Some languages exhibit both complete and partial height harmony. KiKuria⁴ (Odden 1992, pc), which has the vowels in (14), is one such example.

(14) KiKuria Vowels.

	iu	eo	ɛɔ	a
closed ₁	•	•	•	
closed ₂	•	•		
closed ₃	•			

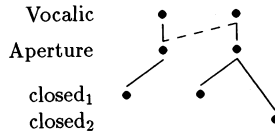
KiKuria has a complete lowering, as seen in the examples in (15). The applicative suffix, /era/, is lowered to [ɛra] after a root with a lower mid vowel.

(15) Complete Assimilation in KiKuria: /e o/ to [ɛ ɔ].

- | | | | | |
|----|---------------------|---|-------------------|--------------------------|
| a. | /u-gu-suraang-era/ | → | u-gu-suraang-era | 'to praise for' |
| | /o-go-taanggat-era/ | → | o-go-taanggat-era | 'to lead for' |
| | /o-ko-baamb-era/ | → | o-ko-baamb-era | 'to fit a drum head for' |
| | /o-ko-hoor-era/ | → | o-ko-hoor-era | 'to thresh for' |
| b. | /o-ko-rɔg-era/ | → | o-ko-rɔg-ɛra | 'to bewitch for' |
| | /o-ko-gɔɔg-era/ | → | o-ko-gɔɔg-ɛra | 'to slaughter for' |
| | /o-ko-sɔk-era/ | → | o-go-sɔk-ɛra | 'to poke for' |
| | /o-ko-tɛrɛk-era/ | → | o-go-tɛrɛk-ɛra | 'to brew for' |

Since the height of the target and the trigger are identical as a result of this process, Mid Vowel Lowering must be a complete harmony involving the spreading of the entire Aperture node as in (16).

(16) Mid Vowel Lowering: spread Aperture of [ɛ ɔ] to suffix.



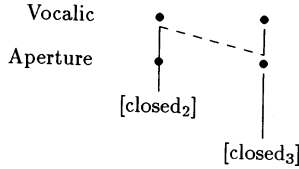
KiKuria also has a complete raising as seen in (17) where a high root vowel raises the prefix from /o/ to [i]. The first set of examples demonstrates that the noun class prefixes and the infinitive marker normally surface with mid vowels. The second group of forms illustrates that these prefixes are raised if the root vowel is high.

(17) Complete Raising: /e o/ to [i u].

- | | | | |
|---------------|---|-------------|-------------------|
| /egesaka/ | → | egesaka | 'stream' |
| /okogɛɛca/ | → | okogɛɛca | 'to chop' |
| /omomura/ | → | umumura | 'young man' |
| /omoriisya/ | → | umuriisya | 'boy' |
| /eketuumbe/ | → | igitumbe | 'stool' |
| /okosiika/ | → | ukusiika | 'to close a door' |
| /okohiingira/ | → | ukuhiingira | 'to shave' |

Since the target and trigger surface with identical heights, this process is formalized in (18), where Aperture spreads from the high root vowel to the prefix.

- (18) Mid Vowel Raising: prefixal /e o/ completely assimilate for height to [i u].



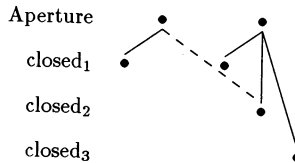
KiKuria also has a partial harmony whereby lower mid vowels in a root are raised to upper mid vowels before a high vowel. In the examples in (19), the trigger is the causative suffix /i/ which undergoes an independent rule of Glide Formation.

- (19) Partial Harmony: Raising of ϵ and ɔ .

plain infinitive	causative	gloss
okorɔga	okorogya	'bewitch'
okogɔɔga	okoroogya	'slaughter'
okosɔka	ogosokya	'poke'
okogesa	okogesya	'harvest'
okoseensa	ogoseensya	'winnow'
okoteema	ogoteemya	'hunt mushrooms'

Since the target does not completely assimilate to the trigger, this is a process in which only a single feature is spreading. Therefore, Low Vowel Raising is formalized as in (20) where [closed₂] spreads from [i u] to / ϵ ɔ /.

- (20) Low Vowel Raising: spread [closed] from [i u] to / ϵ ɔ / in root.



The three languages discussed thus far are consistent with the prediction made in (7), that all partial assimilations are raisings.

Implicational Relation among vowel height features.

To further constrain this model of vowel height, an implicational relation is imposed upon height features as in (21).

- (21) An Implicational Model for [closed].

$$[\text{closed}_3] \rightarrow [\text{closed}_2] \rightarrow [\text{closed}_1]$$

Clements (1989) discusses an implicational relation among height features, but abandons it in some cases. Kinande is one such example, where he provides the specifications in (22) which reflect that the parenthesized vowels are derived in Kinande.

(22) Height in Kinande (Clements 1991:44): implication suspended for derived height.

	iy	iu	(eɔ)	e o	(ʌ)	a
open ₁	-	-	-	-	+	+
open ₂	-	-	+	+	+	+
open ₃	-	+	-	+	-	+

Halle (1959) argues that phonological representations should not be burdened with making such distinctions. In addition, suspending the implicational relation to differentiate derived from underlying inventories allows for a proliferation of representations as below, where a four height system may have 54 possible representations.

(23) Six (of the 54) representations of four heights without an implication relation.

	a.			b.			c.					
	iu	eo	ɛɔ	a	iu	eo	ɛɔ	a	iu	eo	ɛɔ	a
closed ₁	•	•	•		•	•	•		•	•		
closed ₂	•	•			•				•		•	
closed ₃	•				•	•			•			

	d.			e.			f.					
	iu	eo	ɛɔ	a	iu	eo	ɛɔ	a	iu	eo	ɛɔ	a
closed ₁	•	•			•				•			
closed ₂	•				•	•			•	•	•	
closed ₃	•	•	•		•	•	•		•	•		

With the implicational relation enforced, only the representation in (23.a) is permitted. As seen in (24), multiple feature models are not exempt from this problem since a two height system allows for four representations.

(24) Representations of two heights with Multiple Features.

	iu	a	iu	a	iu	a	iu	a
high	+	-			+			-
low			-	+		+		-

To limit a height system to a unique representation, I propose that (21) is in effect cross-linguistically.⁵

Cross-height Harmony and Pseudo Cross-height Harmonies.

Clements proposes that his model of vowel height can account for cross-height harmony, providing an analysis of Kinande. In fact, I will show that Kinande exhibits height harmony, but is different from real cross-height harmony systems such as those found in Akan (Lindau 1975) and DhoLuo (Jacobson 1978). Kinande has the vowels presented in (25), following Hyman (1988).⁶

(25) Kinande (Hyman 1988) Vowels.

	iy	iu	ɛɔ	eo	a
closed ₁	•	•	•	•	
closed ₂	•	•	•		
closed ₃	•	•			
closed ₄	•				

The examples in (26) illustrate that Kinande exhibits complete height harmony in some suffixes like that discussed above in Kimatuumbi. Here, the applicative suffix harmonizes for height to the root vowel.

(26) Height Harmony in Kinande (cf. Bantu, e.g. Kimatuumbi).

erilimira	'exterminate for'	erihukira	'cook for'
erilimira	'cultivate for'	erihumira	'beat for'
erihekera	'carry for'	eribohera	'tie for'

The examples in (27.a) show that super-high [i̟] contrast with [i u], while the forms in (27.b) illustrate that this contrast is neutralized in some suffixal environments such as the perfective.

(27) Kinande Vowel Alternations: [i̟] trigger raising.

a. Contrast between [i̟] and [i u], but not for mid vowels.

erilima	'to exterminate'	erihuka	'to cook'
erilima	'to cultivate'	erihuma	'to beat'

b. Contrast between high and superhigh is neutralized in some context

mɔtwakilimire	'we exterminated it'	mɔtwakihukire	'we cooked it'
mɔtwakilimire	'we cultivated it'	mɔtwakihumire	'we beat it'

c. [e o] are raised to [ɛ ɔ] when followed by superhigh suffixes.

eriheka	'to carry'	mɔtwakihɛkire	'we carried it'
eriboha	'to tie'	mɔtwakibɔhire	'we tied it'

d. Agentive suffix neutralizes high vowels, and raises mid vowels.

omulimi	'exterminator'	omulimi	'farmer'
omuhɛki	'porter'	omuhɔhi	'one who ties'

The forms in (27.c-d) show that the mid vowels /e o/ are raised to [ɛ ɔ] when followed by the perfective or agentive suffixes. While the fact that /e/ raises to [ɛ] and /i/ raises to [i̟] resembles a cross height harmony, in fact these assimilations are familiar height assimilations. In a true cross-height assimilation, one feature distinguishes /i̟/ from /i u/ as well as /e o/ from /ɛ ɔ/, while another contrasts high vowels and mid vowels.

This is not so in Kinande since the feature that distinguishes /i̟/ from /i u/ also distinguishes the high vowels from /e o/. This is seen in the harmony displayed in (26) where the feature that distinguishes /i̟/ from /i/ forms a constituent with the feature distinguishing /i/ from /e/ since both are assimilating in (26). This model can account for height harmony (like Kinande), but real cross-height harmonies (like Akan) require further study.

Another language which exhibits a partial raising similar to that in Kinande is Gitonga (Odden pc), which has the vowels specified in (28) where [e o] are derived from /ɛ ɔ/.

(28) Gitonga vowels.

	i	u	e	o	ɛ	ɔ	a
closed ₁	•	•	•	•	•	•	
closed ₂	•		•				
closed ₃	•						

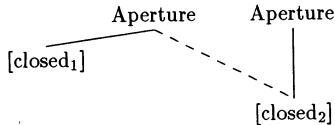
In Gitonga, like Kinande, the high vowels raise mid vowels in the root in various contexts including the locative as shown in (29).

(29) Gitonga: /ε ɔ/ are raised by locative suffix.

root	gloss	'In X'	'Where the X are'
sombɔ	clothes	somboni	sombotunu
gilatɔ	shoe	gilatoni	gilatotunu
gipetɔ	circle	gipetoni	gipetotunu
ndzεve	ear	ndzeveni	ndzevetunu

This process raises the root vowel to a height intermediate to it and the triggering high vowel, and so must be a partial harmony. This harmony is formalized as in (30) where the [closed₂] of a high vowel spreads to a lower mid vowel, which is any vowel specified only for [closed₁].

(30) Gitonga Mid Vowel Raising.



The partial harmonies of Gitonga and Kinande are different only in the number of heights affected by the harmony; Gitonga has one, and Kinande two.

Tswana (Cole 1955) has six vowel heights and exhibits the partial harmony seen in Kinande and Gitonga. The two heights [i u] and [e o] are derived in Tswana. Cole provides a detailed phonetic characterization of the vowels which have the phonological specifications in (31).

(31) Specification of Tswana Vowel height.

	iy	iu	ɪʊ	eo	ɛɔ	a
closed ₁	•	•	•	•	•	
closed ₂	•	•	•	•		
closed ₃	•	•	•			
closed ₄	•	•				
closed ₅	•					

The agentive suffix /-i/ raises root vowels as seen in the first set of examples in (32). The second group illustrates the same raising in the locative, which may be derived from historical *ni.

(32) Raising I ʊ before agentive [i].

lɪɸa	'to pay'	muliɸi	'payer'
ruka	'to sew'	muruki	'tailor'
tɸuma	'hunt'	mutɸumi	'hunter'
mustpili	'journey'	musipiliŋ	locative
butlh ɔku	'pain, bitterness'	butlhukuŋ	locative
stmi	'whip'	simiŋ	locative
muthɔ	'person'	muthuŋ	locative
kuku	'fowl'	kukuŋ	locative

The mid vowels [ɛ ɔ] also are raised before high vowels as seen in the examples in (33).

(33) Raising /ɛ ɔ/

reka	'to buy'	mureki	'buyer'
loa	'bewitch'	muloj	'witch'
bola	'rot'	siboaɣ	'rotten thing'
ema	'stand'	kiemi	'I am standing'
bona	'see'	xaktboni	'I do not see'
ɛpa	'dig'	epulula	'dig out'
bɔfa	'tie'	bofulula	'untie'

This process is stated as spreading [closed] from the highest vowel to any other vowel specified for [closed] (which excludes /a/). There are a number of reasons to exclude the possibility that this process is a matter of phonetic implementation, including the existence of forms like those in (34).

(34) Foreign words as exceptions.

sikolo	}	>	Africaans <i>skool</i>
sikole			
sikwele			
dʒoko	}	>	English <i>yoke</i>
dʒokwe			
boro	>	Africaans <i>boor</i> 'drill'	

These examples illustrate that the higher, 'derived' vowels do exist in loanwords independently of a trigger suggesting that these allophones are not restricted to environments in which the tongue is raised in anticipation of a following high vowel target. This discussion shows that the model proposed here is able to account for even elaborate height inventories like that of Tswana.

Conclusion.

We have seen that the proposal described here constrains the theory of vowel height by assuming that vowel height is characterized by scalar values of the privative feature [closed]. Assuming scalar features allows for a straightforward account of 'stepwise' raisings, such as is found in Nzebi, and structurally prohibits the simultaneous specification of [high] and [low] for a single vowel which requires a separate stipulation in other models. Assuming privative features predicts fewer types of partial assimilations, since only one value may spread. Positing that the height feature is [closed] correctly predicts that all partial height assimilations will raise the target vowel. Imposing an implicational relation on values of [closed] limits the characterization of a vowel system to a unique representation, and eliminates the need to separately invoke a structure preserving constraint.

Notes.

* I owe many thanks to Kevin Cohen, Sussane Gahl, Rebecca Herman, Kathleen Hubbard, Beth Hume, Keith Johnson, Nasiombe Mutonyi, and David Odden whose feedback contributed greatly to this paper. Inconsistencies, errors, etc. are all my own.

1. See Guthrie for motivation of the suffix /-i/ which does not surface phonetically.
2. See Archangeli and Pulleyblank (1994), and Goad (1993) *inter alia* for other means of ruling out *[+high] [+low].
3. While *a* lacks a specification for [closed], it is necessary that it have an Aperture node to allow for complete assimilations to this height.
4. KiKuria exhibits two complete lowerings, a complete raising, and a partial raising. For the interaction of these four processes, see Odden (1992).
5. See Parkinson (1994) for a discussion of why geometric dominance of height features is not tenable.
6. Hyman describes a variety of Kinande that does not crucially differ from that in Valinande (1984) and Clements (1991).

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