Heads, dependents, and complexity in Shona vowel height harmony[*]

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Goal

- Analysis of the asymmetric Vowel Height Harmony (VHH) of Shona (Zimbabwe, Eastern Bantu) in terms of Head–Dependent Asymmetry (HDA; Dresher and van der Hulst 1998).

Overview

1. Asymmetric Vowel Height Harmony in Shona: the pattern
2. Complexity Head–Dependent Asymmetry
3. Asymmetric VHH as the result of HDA
   3.1 Identifying heads and dependents in Shona
   3.2 Deriving asymmetric VHH
4. The corresponding OT analysis
5. Conclusions

1 Shona VHH: The asymmetry

- Shona displays an asymmetric vowel height harmony typical of the Eastern Bantu languages (Hyman 1998, 1999).
- Shona has a surface five-vowel inventory (1)

  (1) [i, e, a, o, u]

- mid vowels [e] and [o] appear in the verbal extensions only if the root shows a mid vowel itself (height harmony)
- however, the pattern is asymmetric; root /o/ lowers both /i/ and /u/, but root /e/ lowers only /i/:

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(2) a. **o**-*verbal root*

$/o/_{root} \ldots /i/_{ext} \rightarrow [o]_{root} \ldots [e]_{ext}$
$/o/_{root} \ldots /u/_{ext} \rightarrow [o]_{root} \ldots [o]_{ext}$

b. **e**-*verbal root*

$/e/_{root} \ldots /i/_{ext} \rightarrow [e]_{root} \ldots [e]_{ext}$
$\boxed{/e/_{root} \ldots /u/_{ext}} \rightarrow \boxed{[e]_{root} \ldots [u]_{ext}}$

- The following data, illustrating the asymmetric VHH pattern of Shona, are from Beckman (1997).

  – $o_{root} \ldots i_{ext} \rightarrow [e]_{ext}$

(3)

RADICAL	EXTENSION	FV	
son 'sew'	+ ir APPL	+a	→ sonera
pot 'go round'	+ irir PERF	+a	→ poterera
tond 'face'	+ is CAUS	+a	→ tondesa
gon 'be able'	+ ik NEUTER	+a	→ goneka
polysyllabic root:	bover- 'collapse inwards'	*bovir-	

  – $o_{root} \ldots u_{ext} \rightarrow [o]_{ext}$

(4) no example of -uC- extensions (reversive) in Beckman

polysyllabic root:	tonhor- 'be cold'	*tonhur-
	nonok- 'dally, delay'	*nonuk-
	nonot- 'scold, abuse'	*nonut-
	korodok- 'itch (nostril)'	*koruduk-
	gobor- 'uproot'	*gobur-

  – $e_{root} \ldots i_{ext} \rightarrow [e]_{ext}$

(5)

RADICAL	EXTENSION	FV	
per 'end'	+ir APPL	+a FV	→ perera
chek 'cut'	+irir APPL	+a FV	→ chekerera
vereŋg 'count'	+ik NEUTER	+a FV	→ vereŋgeka
polysyllabic root:	chember- 'grow old'	*chembir-	

  – $\mathbf{e}_{root} \ldots \mathbf{u}_{ext}$

(6)

polysyllabic root:	svetuk- 'jump'	*svetok-
	serenuk- 'water'	*serenok-

POL.ROOT	EXTENSION	FV	
svetuk- 'jump'	+ir APPL	+a FV	→ svetukira

- Note that Beckman, in illustrating the asymmetry in (6), does not provide examples of -uC- extensions (cf. 4) and that she refers only to polysyllabic roots.[1]

[1] Polysyllabic roots: "The majority of verb roots in Shona are CVC in shape, but polysyllabic roots are not uncommon. Some polysyllabic roots reflect derived root+extension combinations from earlier stage of the language; such forms have been lexicalised to varying degrees in the synchronic grammar. Many other polysyllabic roots are unambiguously monomorphemic [...]" (Beckman 1997: 36, footnote 10).

- Thus, from the data provided by Beckman, especially the ones referring to the asymmetry between **o. . . u** → **o** in (4) and **e. . . u** in (6), it is not possible to deduce that the phenomenon is synchronically productive. One could have concluded that the asymmetry is indeed lexical.

- However, according to Fortune (1955, 1981), Shona has extensions of the type -uC-, as this list shows:

(7)

PASSIVE	-iw-	REPETITIVE	**-urur-**
NEUTER	-ik-	REVERSIVE	**-Vnur-**
APPLIED	-ir-	PERFECTIVE	-irir-
CAUSATIVE	-is-, -y-	INTENSIVE	-is-
EXTENSIVE	-ik-		

- The data found in Fortune (1955, 1981) reveal the synchronic nature of the entire process. Observe the repetitive forms in (8) and the reversive forms in (9):

(8) a. **o**-roots + *urur* (REPETITIVE):

radical	radical+*urur*
-r**o**nd- 'track'	-r**o**nd-**o**r**o**r- 'track thoroughly'
-dz**o**ng- 'sow'	-dz**o**ng-**o**r**o**r- 'resow'
-dz**o**k- 'come back'	-dz**o**k-**o**r**o**r- 'weed for the second time'

b. **e**-roots + *urur* (REPETITIVE):

radical	radical+*urur*
-s**e**nd- 'plane'	-s**e**nd-**u**r**u**r- 'replane'
-r**e**v- 'say'	-r**e**v-**u**r**u**r- 'confess'

c. non-harmonyzing roots + *urur* (REPETITIVE):

radical	radical+*urur*
-famb- 'walk'	-famb-urur- 'walk a second time'
-dzim- 'extinguish'	-dzim-urur- 'extinguish thoroughly'
-tuk- 'curse'	-tuk-urur- 'curse roundly'

(9) a. **o**-roots +*Vnur* (REVERSIVE):

radical	radical+*Vnur*
-r**o**y- 'bewitch'	-r**o**y-**onor**- 'unwitch'

b. **e**-roots+*Vnur* (REVERSIVE):

radical	radical+*Vnur*
-pf**e**k- 'dress'	-pf**e**k-**enur**- 'undress'

c. non-harmonizying roots+*Vnur* (REVERSIVE):

radical	radical+*Vnur*
-ch**a**t- 'marry'	-ch**a**t-**a**nur- 'divorce'
-p**i**ng- 'latch'	-p**i**ng-**i**nur- 'unlatch'
-s**u**ng- 'tie'	-s**u**ng-**u**nur- 'untie'

- In (8) while the mid round vowel **o** lowers the following high round vowels **u** in the repetitive extension (-urur-), the mid unround vowel **e** does not trigger the same process. In (9), the first vowel of the reversive extension (-Vnur-) appears to be underlyingly unmarked, since it systematically inherits the feature specification from the preceding root vowel. However, when the root vowel is the round mid **o**, the second vowel of the extension, which is round and high (**u**), lowers to **o**, whereas, when the root vowel is the unround mid **e**, the second vowel of the extension does not lower. The same pattern is found in the ideophones built from a verbal root and the repetitive extension -uru- (10) the reversive extension -Vnu- (11):

(10)

	radical	radical+*uru* (REPETITIVE)
VHH	-dz**o**k- 'come back'	dz**o**k-**oro** 'weeding a second time'
no VHH	-r**e**v- 'say'	r**e**v-**uru** 'confessing'
	-b**a**y- 'stab'	b**a**y-**u**ru 'stabbing again and again'
	-z**i**v- 'know'	z**i**v-**u**ru 'knowing a lot'

(11)

	radical	radical+*Vnu* (REVERSIVE)
VHH	-r**o**y- 'bewitch'	r**o**y-**ono** 'unwitching'
no VHH	-pf**e**k- 'dress'	pf**e**k-**enu** 'undressing'
	-k**a**t- 'coil'	k**a**t-**a**nu 'uncoiling'
	-p**i**ng- 'blok'	p**i**ng-**i**nu 'unlatching'
	-s**u**ng- 'tie'	s**u**ng-**u**nu 'untying'

2 Complexity Head–Dependent Asymmetry (HDA)

- Complexity Head–Dependent Asymmetry as defined by Dresher & van der Hulst (1998):
  - "Phonological representations have a layered constituent structure. Many, perhaps all, of these constituents contain elements which can be identified as heads" (Dresher & van der Hulst 1998: 317)
  - phonological heads "show the maximum complexity allowed by the grammar" (ibid.: 318).[2]
  - complexity Head–Dependent Asymmetry: "heads and dependents may be equally complex; but if there is an asymmetry, it will always be the head that is more complex than the dependent" (ibid.).

- This constraint has been noticed in many phonological studies and referred to in different models:
  - in the framework of Government Phonology, Harris (1990: 274) formulates a *Complexity Condition*, "which allows for either a sloping or a level complexity differential between a governor and its governee."

[2]This generalization strongly resembles what has been observed and claimed about (psycholinguistically and phonetically) prominent positions (Steriade 1993 among others), and therefore we associate the notion of prominence with the property of being a head.

- Steriade (1995: 158-166) refers to indirect licensing (e.g., Guaraní nasal harmony): marked segments or features must be licensed via association to a prominent position.
- indirect licensing works also for Bantu VHH, as pointed out by Hyman (1998): mid vowels can surface in the (prosodically weak) extensions iff licensed by the (prosodically strong) root, i.e. if harmony takes place.

- In OT, complexity HDA is the rationale behind the subset of faithfulness constraints known as POSITIONAL FAITHFULNESS constraints:
  - Padgett (1995) and Lombardi (1996) posit positional faithfulness constraints that are motivated by perceptual facilitation
  - Beckman's (1998) positional faithfulness constraints mandate preservation of underlying phonemic contrast in prominent positions
- Note, however, that POSITIONAL FAITHFULNESS constraints belong to the paradigmatic dimension only: a prominent position preserves constrast well, and is therefore better able to sustain complexity than a non-prominent position, but no syntagmatic requirements are made on the relative complexity of the prominent and non-prominent positions within a single form.
- HDA, as formulated by Dresher & van der Hulst and by Harris, on the other hand, operates also on the syntagmatic dimension: it explicitly refers to the relation between positions. (For another approach to syntagmatic asymmetries, compare Steriade's (1995) indirect licensing.)
  - Aside: Generating syntagmatic asymmetries in OT
    The POSITIONAL FAITHFULNESS metaconstraint **Root Faith** $\gg$ **Affix Faith** has syntagmatic effects when, as in McCarthy and Prince (1995), it is applied to cases in which the root is a base and the affix is a reduplicant. Since root and affix are derived from the same input, the paradigmatic asymmetry between them will (frequently) surface as a syntagmatic asymmetry within a given form. (See Alderete (2001) for further discussion.)
- We define complexity on the segmental level such that the more dependents a segment has, the more complex it is (Dresher & van der Hulst 1993, 1998, Rice & Avery 1993, Dyck 1995)

3 Asymmetric VHH as HDA requirement

> Claim
> The asymmetry in the VHH pattern of Shona arises from a syntagmatic complexity HDA requirement

3.1 Shona heads and dependents

The head–dependent relation between the root and the extension can be detected:

- lexically: The verbal root contributes the core lexical-conceptual information about the verbal stem and the extensions modify it with respect to argument structure.

- morphologically: The verbal root is the base and the extensions are derivational suffixes.
- phonologically:
  - prosody: Assuming that the prosodic trough (τ) is a general characteristic of Bantu languages (Hyman 1998), the root and the final vowel morpheme are the strong prosodic peripheries (prosodic heads), and the extension(s) in between the weak dependent(s).
  - tones: Verbal extensions do not possess their own lexical tonal specification; rather, they inherit it from the root (lexical H tone) (Myers 1990: 157-158).

(12) a. ku-téng-á
INF-ROOT-FV
'to buy'

b. ku-téng-és-á
INF-ROOT-CAUS-FV
'to sell'

c. ku-téng-és-ér-á
INF-ROOT-CAUS-APPL-FV
'to sell to'

d. ku-téng-és-ér-án-á
INF-ROOT-CAUS-APPL-RECIP-FV
'to sell to each other'

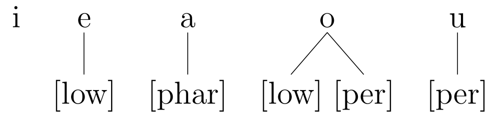
3.2 The analysis

- minimally specified vowel inventory for both root and extensions (compatible with the Continuous Dichotomy Hypothesis of Dresher, Piggott, and Rice (1994)).[3]
- as shown in (13), we follow Uffman (2001) in considering the vowel /a/ to be distinguished from the rest of the inventory not by a height feature [low], but by a place feature [pharyngeal] (or [radical], Clements & Hume 1995, Hume 1996).
- the specification of [pharyngeal] takes scope (*sensu* Dresher 1998) over all other feature specifications: this predicts the exclusion of /a/ from the vowel harmony process.
- /e/ and /o/ are specified for [low].
- /o/ and /u/ are specified for [peripheral] (Rice 1995, 2002; D'Arcy 2003):

(13) a.

	[peripheral]		
i	u		
e	o	[low]	
a			[pharyngeal]

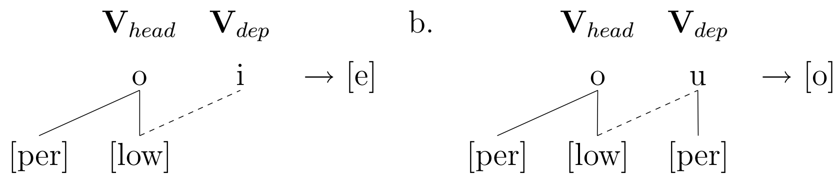
[3]There are two possible inventory speficications which produce the necessary asymmetry in markedness; we have not yet found the evidence needed to argue for either of them over the other. The alternative feature specifications are given in the appendix.

b. 

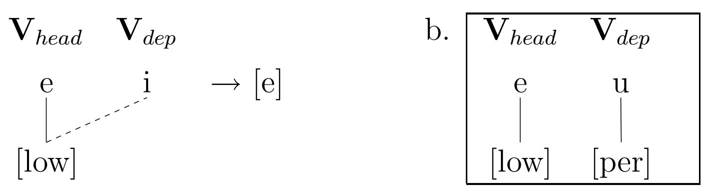
- According to the featural configuration in (13b), the vowel /o/ is the most complex one, being specified by two features, /i/ is the least complex (no feature specified), /e, a, u/ are of equal complexity (one feature each).

- recall that VHH is a lowering process due to the rightward (from root to extension, i.e. from head to dependent) spreading of the feature [low].

- in (14) we illustrate the lowering process as triggered by the root-vowel /o/:

(14) a. 

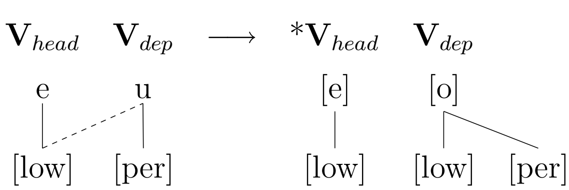
- in (15) the lowering process triggered by the root-vowel /e/:

(15) a. 

- The descriptive generalization which expresses the asymmetry between (14b) and (15b) can be stated as follows:

(16) [low] spreads onto a dependent V which is marked for [peripheral] if and only if the head V is also marked for [peripheral].

- We propose that the generalization in (16) can be captured in terms of complexity Head–Dependent Asymmetry, where the dependent V cannot be made more complex than the head V. In fact, if the [low] feature of the head V /e/ spread onto the dependent V /u/, the latter would show more complexity than its head:

(17) 

- The complexity HDA requirement exactly predicts that spreading of [low] will be blocked when it would create the configuration *[e . . . o], as in (15), and nowhere else.

4 Asymmetry and Optimality

Because it depends primarily on representations rather than rules, the HDA analysis of Shona VHH can in principle be adopted within either a rule-based or a constraint-based approach to phonology. One possible Optimality Theoretic version of this analysis employs correspondence constraints that refer separately to heads and to dependents. The relation between heads and dependents in this model is similar to the relation between bases and reduplicants in McCarthy and Prince (1995).

- Input–Head (IH) correspondence constraints mandate faithfulness of heads to inputs.
- Input–Dependent (ID) correspondence constraints mandate faithfulness of dependents to inputs.
- The greater tolerance for complexity in heads in general is encoded by the (universal) ranking of $\textsc{Max}_{\text{IH}}$ over $\textsc{Max}_{\text{ID}}$.
- Head–Dependent (HD) correspondence constraints encode more specific requirements on the relations between heads and dependents.

The necessary constraints for Shona VHH are as follows:

$\textsc{Max}_{\text{IH}}$(F), $\textsc{Dep}_{\text{IH}}$(F):	These constraints, which mandate faithfulness in heads, are unviolated in the Shona forms in question. MAX(H): 'Every feature associated with a head vowel in the input must also be associated with that vowel in the output.' DEP(H): 'Every feature associated with a head vowel in the output must also be associated with that vowel in the input.'
$\textsc{Dep}_{\text{HD}}$(LOW):	'Every instance of the feature [Low] associated with a dependent vowel (in the output) must also be associated with the corresponding head vowel (in the output).' This constraint prevents low dependent vowels from following non-low stem vowels.
$\textsc{Max}_{\text{ID}}$(F):	'Every feature associated with a dependent vowel in the input must also be associated with that vowel in the output.' This constraint prevents deletion of features from being used as a strategy for satisfying the following two constraints.
$*D \supset H$:	'The features of a dependent vowel must not be a proper superset of the features of the corresponding head vowel.' This constraint encodes the relevant notion of complexity for the HDA found in Shona.
$\textsc{Max}_{\text{HD}}$(LOW):	This is the constraint that drives height harmony. It, too, can be stated in terms of correspondence theory: 'Every [Low] feature associated with a head vowel (in the output) must also be associated with its dependent (in the output).'
$\textsc{Dep}_{\text{ID}}$(F):	'Every feature associated with a dependent vowel in the output must also be associated with that vowel in the input.' This constraint is outranked by $\textsc{Max}_{\text{HD}}$(LOW), and so it can be violated in order to satisfy the harmony requirements.

The tableaux below show that, given the featural representations proposed for the derivational version of the analysis, these constraints will correctly generate the attested asymmetrical height harmony pattern: /o/ lowers both /i/ and /u/, but /e/ lowers only /i/.

(18) Head /o/ lowers dependent /i/ and /u/:
a. /o ... i/ → [o ... e]

o i Per Low	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
o i Per Low						*!	
☞ o e Per Low							*
u i Per Low (delinked)	*!						

b. /o ... u/ → [o ... o]

o u Per Low Per	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
o u Per Low Per						*!	
☞ o o Per Low Per							*
u u Per Low (delinked) Per	*!						

(19) Head /e/ lowers dependent /i/ but not /u/:
a. /e ... i/ → [e ... e]

e i Low	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
e i Low						*!	
☞ e e Low							*
i i Low (delinked)	*!						

b. /e . . . u/ → [e . . . u]

e u Low Per	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
☞ e u Low Per						*	
e o Low Per					*!		*
e e Low Per				*!			*
o o Low Per		*!					*
i u Low Per	*!				*		

(20) Underlying violations of *D ⊃ H surface faithfully unless the offending feature is [Low]:

a. /i . . . u/ → [i . . . u]

i u Per	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
☞ i u Per					*		
u u Per		*!					
i i Per				*!			

b. /i . . . e/ → [i . . . i]

i e Low	Mx$_{\text{IH}}$(F)	Dp$_{\text{IH}}$(F)	Dp$_{\text{HD}}$(Lo)	Mx$_{\text{ID}}$(F)	*D ⊃ H	Mx$_{\text{HD}}$(Lo)	Dp$_{\text{ID}}$(F)
i e Low			*!		*		
e e Low		*!					
☞ i i Low				*			

For dependent vowels that alternate between [i] (after head /i, u, a/) and [e] (after head /e, o/), either underlying /i/ or underlying /e/ will yield the attested surface forms in all environments. The actual underlying form must be selected by a version of Lexicon Optimization that takes alternations into account.

(21) ALTERNANT OPTIMIZATION (Inkelas 1994)
Given a grammar G and a set S = $\{S_1, S_2, \ldots S_i\}$ of surface phonetic forms for a morpheme M, suppose that there is a set of inputs I = $\{I_1, I_2, \ldots I_j\}$, each of whose members has a set of surface realizations equivalent to S. There is some $I_i \in I$ such that the mapping between I_i and the members of S is the most harmonic with respect to G, i.e. incurs the fewest marks for the highest ranked constraints. The learner should choose I_i as the underlying representation for M.

Alternant Optimization selects /i/ rather than /e/ for such alternating dependent vowels:

(22) Selecting the optimal underlying form for dependent [i ∼ e]

LEXICON OPTIMIZATION	DP_{HD}(LO)	MX_{ID}(F)	*D ⊃ H	MX_{HD}(LO)	DP_{ID}(F)
☞ /i/ → [i] /{i, u, a}__ → [e] /{e, o}__					*
/e/ → [i] /{i, u, a}__ → [e] /{e, o}__		*!			

Given privative features, this results in a preference for the less marked vowel (/i/ rather than /e/) in alternating forms.

The approach taken here is, in both its derivational and its optimality theoretic forms, very much based on formal complexity. This contrasts with the more substantive constraints proposed by Beckman (1997, 1998), which penalize mid vowels in general and [o] in particular.

(23) Beckman's constraints:

*MID ≫ *HIGH ≫ IDENT(HI):	[–high, –low] vowels are more marked than [+high, –low] vowels.
IDENT(RD) ≫ *ROLO ≫ IDENT(HI):	Round non-high vowels are marked, and will be repaired by raising rather than by unrounding.

For Beckman, the marked status of [o] is encoded in the constraints rather than in the representations. Her *ROLO predicts that [o] will be cross-linguistically dispreferred; this may be true, but it is not made to follow from anything inherent in the formal structure of her analysis. In the approach pursued here, the e/o asymmetry follows from general properties of marked and unmarked features.

One unresolved problem with the OT version of the present analysis: Underlying /e ... o/ is predicted to surface faithfully. The apparent absence of underlying dependent /o/ is so far unexplained.

Conclusions

- In Shona, HDA requirements apply both to the underlying root and extension vowel inventories and to the process of height harmony.
- Given contrastive specification, the relevant notion of complexity is straightforwardly derivable from the featural representations.

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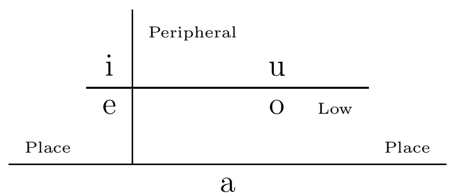
Appendix: The alternative inventory configuration

There is another way in which the Shona vowel inventory can be specified underlyingly that yields the same markedness asymmetry, with /o/ being the most complex vowel of the system.

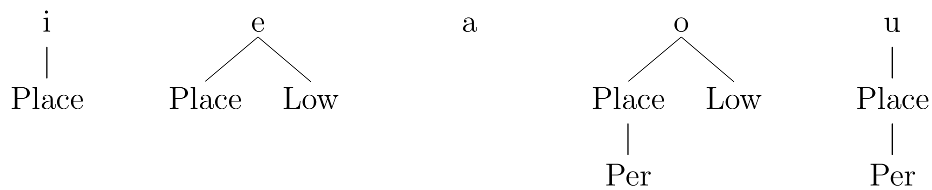
The alternative is outlined in (24). (24a) provides the relevant feature specification hierarchy; (24b) illustrates the inventory configuration; and (24c) provides the feature specification for each of the vowels:

(24) a. Place ≫ Peripheral, Low

b.

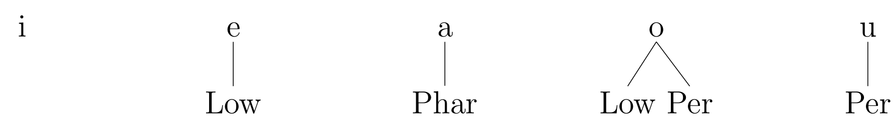


c.



In this set of feature specifications, /a/ is represented as a placeless vowel, while the four vowels that participate in the height harmony system bear Place nodes.[4] As in the feature specifications in (13), repeated in (25), this has the effect of excluding /a/ from the symmetrical four-vowel subinventory in which harmony operates. Also common to the two sets of representations is the fact that the features of /o/ are a proper superset of the features of /e/.

(25)



- According to (24c), /a/ is the unspecified segment of the inventory, whereas according to (25) it is /i/.
- /o/ is the most complex in both systems.
- /i/, /u/ and /a/ are equally complex in (25), while in (24) /e/ and /u/ are equally complex, being specified for two features, and /i/, having one specification, is simpler than /e/ and /u/ but more complex than /a/.

We hope to find evidence that will allow us to choose between the two alternatives.

[4] This is similar to Balcaen's (1998) treatment of non-harmonizing [a] in Aka, although in Aka this [a] contrasts with another [a] that does trigger harmony. According to Balcaen, the non-harmonizing [a] (=/ʌ/) is underlyingly non-low, while the harmonizing [a] (= /a/) is underlyingly low.