Positional faithfulness and feature co-occurrence constraints in the height harmony systems of five-vowel Bantu languages[*]

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1 Introduction

- Height harmony (HH) is an extremely common phenomenon within the Bantu languages (e.g. Clements 1991, Hyman 1999, 2003).
- Work has tended to focus on the most frequently found variety, namely "canonical" asymmetric HH (e.g. Moto 1989, Hyman 1991, Scullen 1992, Harris 1994, 1997, Steriade 1995, Mutaka 1995, Downing 2010).
- Indeed, this has been described as 'a classic phonology problem' (Downing & Mtenje 2017:75).

- In this talk, I will discuss the different patterns observed in five five-vowel Bantu languages:
  - Canonical HH in Shona (S.12); [1]
  - Non-canonical HH in S. Kongo (H.16a), Pende (L.11) and Lozi (K.21);
  - And no HH in Punu (B.43).

- First, I will give some background information for each of these languages.
- I will then introduce Beckman's (1997) analysis of HH in Shona, which makes use of positional faithfulness and feature co-occurrence constraints,
- Multiple linking of nodes is also used, which may allow for a reduction in the total number of tokens of a given autosegment or combinations of autosegments.

- Next, I will apply Beckman's approach to S. Kongo, Pende, Punu and Lozi.
- And show that this able to account for HH in S. Kongo and Pende.
- But that it is unable to be adapted to capture what is observed in Punu and Lozi.

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[1]Guthrie codes follow Maho (2009).

- S. Kongo and Pende are accounted for simply by reordering the constraints.
- However, when dealing with Punu, Beckman's analysis runs into a richness-of-the-base problem:
  - In order to reproduce the observed pattern, mid vowels in the input must be limited to root-initial syllables.
- And treatment of Lozi also poses problems:
  - Conflicting constraint rankings are required to fully account for this HH system.
- Beckman's analysis is therefore unable to account for the full variety seen in the HH systems of five-vowel Bantu languages.

2 Descriptive background

2.1 Some generalisations

- In general, HH in five-vowel Bantu languages—i.e. those with the vowel phoneme inventory /i u e o a/—shows the following properties:

- Lowering of vowels in verbal suffixes by preceding stem vowels.
  - Commonly affected suffixes are the causative, applicative, reversive and perfective.
  - High /i u/ are lowered to mid /e o/ by preceding mid vowels.

- Final vowels fall outside the domain of harmony.
  - Though there are Bantu languages, such as seven-vowel Koyo (C.24), where final /a/ may be raised (Hyman 1999:240).

- Low /a/ is opaque and neither triggers nor undergoes lowering, thus seemingly forming a natural class with high /i u/.
  - Though, as we shall see in §§2.2.4 and 4.3, this is not *entirely* true for Pende.

- HH is also usually asymmetric with regard to rounding (or backness).
  - /i/ is lowered after both /e o/ whereas /u/ is lowered only after /o/.
  - This asymmetry is not only common currently but it is also robust historically (Hyman 1999:238,245).

- Thus, for many languages, HH can, descriptively at least, be split into front (FHH) and back height harmony (BHH)

- This description of canonical HH is summarised in (1) below.

(1) *Canonical Bantu height harmony*

   a. Front height harmony: i ⟶ e / {e o} C_

   b. Back height harmony: u ⟶ o / o C_

2.2 The present subset

2.2.1 Overview

- The five example languages discussed in this talk are:
  - Shona, S. Kongo, Pende, Punu and Lozi.

- The systems found in these languages are summarised in Table 1 below.
  - Each left-hand column shows FHH contexts, the right-hand BHH contexts.
  - Bolding and underlining highlight instances where HH effects a change in vowel height.

Shona		**S. Kongo**		**Pende**		**Punu**		**Lozi**	
i·i	i·u	i·i	i·u	i·i	i·u	i·i	i·u	i·i/e	i·u
u·i	u·u	u·i	u·u	u·i	u·u	u·i	u·u	u·i/e	u·u
e·e	e·u	**e·e**	**e·o**	**e·e**	e·u	e·i	e·u	e·i/e	e·u
o·e	**o·o**	**o·e**	**o·o**	**o·e**	**o·o**	o·i	o·u	o·i/e	**o·o**
a·i	a·u	a·i	a·u	**a·e**	a·u	a·i	a·u	a·i/e	a·u

Table 1: Height harmony systems in five-vowel Bantu languages

- The canonical pattern found in Shona is overwhelmingly the commonest in five-vowel Bantu languages (Hyman 1999:236–46).
- Few languages lack HH, as Punu does, or exhibit non-canonical HH, such as Pende and Lozi.
- The symmetric pattern displayed by S. Kongo is exceedingly rare among five-vowel Bantu languages, being limited to S. Kongo itself and closely related varieties (Hyman 1999:242).

- Incidentally, there are no (convincing) reported cases of a Bantu language with a “reverse Lozi” system, i.e. lacking BHH but having FHH (Hyman 1999:245).

2.2.2 Shona

- As reported in Beckman (1997) and elsewhere, Shona exhibits the canonical HH pattern for a five-vowel Bantu language.
- In FHH contexts, high unrounded /i/ is lowered to mid /e/ after both /e o/.
- This is illustrated below with examples using the applicative suffix. Data are from Fortune (1955; cited in Beckman 1997:10):

(2)	a.	-ip-ir-a	'to be evil for'
	b.	-svetuk-ir-a	'to jump in'
	c.	-per-**e**r-a	'to end in'
	d.	-son-**e**r-a	'to sew for'
	e.	-vav-ir-a	'to itch at'

- Whereas, in BHH contexts, high rounded /u/ is lowered to mid /o/ only after /o/ itself.
- This can be seen in the examples below from Dale (1999:165), which use the reversive suffix.

(3)	a.	-kiy-inur-a	'to unlock'
	b.	-sung-unur-a	'to untie'
	c.	-pet-enur-a	'to unfold'
	d.	-mon-on**o**r-a	'to uncoil'
	e.	-nam-anur-a	'to unstick'

- Thus, it can be seen that Shona exhibits canonical asymmetric HH.
- Many authors treat canonical HH as two distinct processes:
  - Moto (1989) on Chewa (N.31) states that triggers are only permitted to spread [-high] to targets specified as [-round, -low]—i.e. FHH—with the exception that [+round] triggers can only spread to targets specified as [+round, -low]—i.e. BHH.
  - Nevins (2010:130–3) on Kisa (E.32) and Shona separates FHH and BHH, with only BHH being parasitic on [+round].
- However, Beckman's (1997) approach does not require this division.

2.2.3 S. Kongo

- Of the current subset, S. Kongo is the only language that exhibits HH but does *not* exhibit any front–back asymmetry.
- High unrounded /i/ is lowered to mid /e/ after both /e o/.

- As seen with the applicative suffix (data from de Gheel 1652; cited in Hyman 1999:241):

(4)	a.	-sik-il-a	'soutenir, fortifier'
	b.	-vur-il-a	'surpasser, l'emporter'
	c.	-leng-**e**l-a	'dépérir, languir'
	d.	-somp-**e**l-a	's'attacher à'
	e.	-land-il-a	'suivre'

- In the same way, high rounded /u/ is lowered to mid /o/ after both /e o/.
- This is shown with the reversive suffix in the examples below (ibid.):

(5)	a.	-vil-ul-a	'mouvoir, remuer'
	b.	-bub-ul-a	'corrompre'
	c.	-lemb-**o**l-a	'barrer, effacer'
	d.	-tomb-**o**l-a	'faire monter'
	e.	-bang-ul-a	'faire violence'

2.2.4 Pende

- In Pende, however, there *is* a front–back asymmetry, but of a different kind to Shona.
- High unrounded /i/ lowers not only after /e o/ but also after /a/.
- As illustrated with the applicative suffix below (Niyonkuru 1978 in Hyman 1999:242).

(6)	a.	-díg-íl-a	'bâtir pour'
	b.	-túng-íl-a	'vendre pour'
	c.	-bemb-**e**l-a	'abandonner pour'
	d.	-lómb-**é**l-a	'demander pour'
	e.	-sas-**e**l-a	'hacher pour'

- However, as in Shona and Lozi, /u/ only lowers after /o/.
- As observed with the reversive suffix (Gusimana 1972 in Hyman 1999:242):

(7)	a.	-shit-ul-a	'défaire (nœud)'
	b.	-vumb-ul-a	'déterrer'
	c.	-seng-ul-a	'absoudre'
	d.	-bóg-**ó**l-a	'briser'
	e.	-kál-úg-a	'gémir'

2.2.5 Punu

- Among Bantu languages, only five-vowel languages lack HH (Hyman 1999:239). [2]
- In these languages, 'the distribution of mid vowels is severely restricted' (ibid.).
- Punu is one such five-vowel Bantu language:
  - Mid /e o/ are only found root-initially (Kwenzi-Mikala 1980:8 in Hyman 1999:240).
  - Initial vowels therefore have no effect on the height of vowels in potential target suffixes.
  - Thus, suffixes such as the applicative and reversive are always realised with high vowels.
  - This is exemplified in (8) and (9) below (Blanchon 1995; cited in Hyman 1999:240).

(8)	a.	-kil-il-a	'repasser'
	b.	-sub-il-a	'uriner sur'
	c.	-ded-il-a	'obéir à'
	d.	-gol-il-a	'se frotter avec'
	e.	-gab-il-a	'distribuer à'

(9)	a.	-kip-ul-a	'découvrir'
	b.	-fung-ul-a	'révéler'
	c.	-tes-ul-a	'briser'
	d.	-dob-ul-a	'extraire, extirper'
	e.	-gab-ul-a	'séparer'

2.2.6 Lozi

- As in Shona and Pende, HH in Lozi is asymmetric.
- However, it is rather different from either as FHH is entirely absent.
- This is illustrated below with data from Jalla (1937) and Fortune (2001).
- There is no lowering of underlying high front vowels:

(10)	a.	-lif-is-a	'to fine'
	b.	-fuluh-is-a	'to help paddle'
	c.	-belek-is-a	'to give employment'
	d.	-fol-is-a	'to wait till sunset'
	e.	-bal-is-a	'to teach to read'

[2] A possible exception to this is seven-vowel Enya (D.14; see Hyman 1999:239, footnote 8).

- And no raising of underlying mid front vowels:

(11) a. -bih-el-a 'to report to'
b. -fuluh-el-a 'to paddle towards'
c. -fwek-el-a 'to land at, on'
d. -kolop-el-a 'to scrub (the floor) for'
e. -alaf-el-a 'to nurse for'

- But BHH in Lozi is the same as in Shona and Pende.
- That is, /u/ is lowered only after /o/ (ibid.):

(12) a. -bip-ulul-a 'to let fermented grain dry up'
b. -lut-ulul-a 'to unthatch'
c. -ez-ulul-a 'to do for the second time'
d. -bof-**o**l**o**l-a 'to outspan'
e. -amb-ulul-a 'to change one's mind'

- HH is therefore extremely restricted, effecting a change in vowel height in just one context.

3 Positional faithfulness, positional neutralisation and Shona vowel harmony

3.1 Preliminaries

- Beckman's (1997) analysis in Optimality Theory of canonical HH in Shona employs positional faithfulness and feature co-occurrence constraints.
- She argues against analyses using alignment constraints (Beckman 1997:26–33).

- The mid vowels /e o/ are seen as being more marked than peripheral /i u a/.
  - Cf. Moto (1989) and Harris's (1994) treatments of Chewa, where mid vowels are also considered more marked, but in terms of their number of features.
- In Beckman (1997), there is no featural underspecification for vowels, as can be seen below:

(13) a. /i/ = [+high, -low, -round, -back]
b. /u/ = [+high, -low, +round, +back]
c. /e/ = [-high, -low, -round, -back]
d. /o/ = [-high, -low, +round, +back]
e. /a/ = [-high, +low, -round, +back]

- The ranking of the relevant constraints in her analysis of Shona is as follows:

(14) Ident(rd), Ident(lo), Ident-σ_1(hi) » *RoLo » *Mid » *High » Ident(hi)

- And these constraints are unpacked below:

(15) a. Ident(rd)
Do not change values for the feature [±round] between input and output.

b. Ident(lo)
Do not change values for the feature [±low] between input and output.

c. Ident-σ_1(hi)
Do not change values for the feature [±high] between input and output for a segment in the root-initial syllable.

d. *RoLo
Segments should not be simultaneously specified as [+round] and [-high].

e. *Mid
Segments should not be simultaneously specified as [-high] and [-low].

f. *High
Segments should not be simultaneously specified as [+high] and [-low].

g. Ident(hi)
Do not change values for the feature [±high] between input and output.

- Note that this analysis does not use, for example, alignment constraints.
- Rather, harmony is a result of the interaction of positional faithfulness and marked feature combinations.
- Indeed, to Krämer (2003:66), this analysis appeals because, not only does it 'impl[y] a typology of vowel harmony' but also because the constraints used are independently motivated.

- Finally, a further key detail in Beckman's analysis is that, where possible, adjacent vowels may share Aperture or VPlace nodes.
- Thus, certain sequences of segments are assigned fewer violations than if their nodes were not shared (because there are fewer tokens of certain autosegments).
- It is this minimisation of the number of autosegment tokens which, along with the constraint ranking, is able to account for *asymmetric* HH.

3.2 Walkthrough

- Firstly, undominated IDENT(rd) entirely prohibits changes to the feature [±round].

- Similarly, IDENT(lo) prevents alterations to [±low].

- This prevents raising of /a/ in any position.
- As a result, harmony fails to apply across an intervening low /a/.

(16)

	/CoCaCiC/	IDENT(lo)	*MID	*HIGH	IDENT(hi)
☞	a. C o C a C i C [-lo] [-hi] [+lo] [-hi] [-lo] [+hi]		*	*	
	b. C o C a C e C Aperture Aperture Aperture [-lo] [-hi] [+lo] [-lo]		**!		*
	c. C o C e C e C Aperture [-lo] [-hi]	*!	*		*

- Since high-ranking IDENT-σ_1(hi) prevents changes from being made to [±high] in initial syllables, any such alterations must be made to the right.
- Harmony therefore appears to propagate rightwards (as seen in the example tableaux below).
- Mid /e o/ are able to surface in initial syllables because IDENT-σ_1(hi) dominates *MID.

(17)

	/CeC/	IDENT-σ_1(hi)	*MID	*HIGH	IDENT(hi)
☞	a. C e C [-lo] [-hi]		*		
	b. C i C [-lo] [+hi]	*!		*	*

- And they surface in non-initial syllables following other mid vowels thanks to multiple linking and the fact that both *Mid and *High outrank Ident(hi).

(18)

	/CeCiC/	Ident-σ_1(hi)	*Mid	*High	Ident(hi)
	a. C e C i C [-lo] [-hi] [-lo] [+hi]		*	*!	
☞	b. C e C e C Aperture [-lo] [-hi]		*		*
	c. C e C e C [-lo] [-hi] [-lo] [-hi]		**!		*
	d. C i C i C Aperture [-lo] [+hi]	*!		*	*

- But they are prevented from surfacing after high /i u/ for the same combination of reasons.

(19)

	/CiCeC/	Ident-σ_1(hi)	*Mid	*High	Ident(hi)
	a. C i C e C [-lo] [+hi] [-lo] [-hi]		*	*!	
☞	b. C i C i C Aperture [-lo] [+hi]			*	*
	c. C i C i C [-lo] [+hi] [-lo] [+hi]			**!	*
	d. C e C e C Aperture [-lo] [-hi]	*!	*		*

- Ranking *Mid above *High means that [i] rather than [e] surfaces after [a].
- Beckman states that this as an ‘emergence of the unmarked effect (McCarthy & Prince 1994)’.

(20)

	/CaCiC/	*Mid	*High	Ident(hi)
	a. C a C e C [+lo] [-hi] [-lo] [-hi]	*!		*
☞	b. C a C i C [+lo] [-hi] [-lo] [+hi]		*	

- *RoLo (= *[+round, -high]) militates against [o] surfacing.
- In support of this constraint, Beckman (1997:24) cites Kaun (1995:144; see also Kaun 2004).
- It is this that prevents the inputs /e·u/ or /e·o/ from surfacing as [e·o] because the multiple linking needed to avoid excessive violations is not possible in this instance.

(21)

	/CeCuC/	Ident(rd)	*RoLo	*Mid	*High
☞	a. C e C u C Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]			*	
	b. C e C o C Aperture [rd] [-lo] [-hi]		*!	*	
	c. C e C e C Aperture [-lo] [-hi]	*!		*	
	d. C e C i C Aperture Aperture [-lo] [-hi] [-lo] [+hi]	*!		*	*

- However, this *is* possible with the inputs /o·u/ or /o·o/.
- And so the above inputs result in the height-harmonic output [o·o].

(22)

	/CoCuC/	Ident(rd)	*RoLo	*Mid	*High	Ident(hi)
	a. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*	*!	
☞	b. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*		*
	c. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**		*
	d. C o C i C Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]	*!	*	*	*	

4 Expanding the scope of Beckman's approach

4.1 Introduction

- In this section, I apply Beckman's (1997) work to:
  - S. Kongo—symmetric HH;
  - Pende—asymmetric HH with lowering after /a/ in FHH;
  - Punu—no HH and mid vowels only root-initially;
  - And Lozi—only BHH and only after /o/.

- The feature specifications for all vowels are the same as in (13).
- And the same stipulations on multiple linking apply.

- As previously mentioned, S. Kongo (§4.2) and Pende (§4.3) pose no problems.
- Punu (§4.4) and Lozi (§4.5) , however, do.

4.2 S. Kongo

- Beckman's analysis of Shona is easily adapted to S. Kongo's symmetric HH system.
- This is accounted for by simply demoting *RoLo from a high- to a low-ranking position:

(23) Ident(rd), Ident(lo), Ident-σ_1(hi) » *Mid » *High » Ident(hi) » <u>***RoLo**</u>

- This allows an input of /e·u/ or /e·o/ to surface as height-harmonic [e·o].

(24)

	/CeCuC/	Ident(rd)	*Mid	*High	*RoLo
	a. C e C u C VPlace VPlace Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]		*	*!	
☞	b. C e C o C VPlace VPlace Aperture [rd] [-lo] [-hi]		*		*

- While all other outcomes remain the same as in Shona.
- For example, the inputs /o·u/ or /o·o/ both surface as height-harmonic [o·o].

(25)

	/CoCuC/	IDENT(rd)	*MID	*HIGH	*ROLO
	a. C o C u C VPlace VPlace Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*!	
☞	b. C o C o C VPlace Ap [rd] [-lo] [-hi]		*		*

- Similarly, /i/ is lowered after both /e o/.
- And, mid /e o/ are not permitted to surface after high /i u/.

4.3 Pende

- Pende also does not pose any problems.
- Firstly, as for Shona, ranking of *MID and *HIGH above IDENT(hi) means that the inputs /o·u/ and /o·o/ surface as [o·o].

(26)

	/CoCuC/	IDENT-σ_1(hi)	*ROLO	*MID	*HIGH	IDENT(hi)
	a. C o C u C VPlace VPlace Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*	*!	
☞	b. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*		*

- But *RoLo prevents /e·u/ from surfacing as [e·o], yielding [e·u] instead.

(27)

/CeCuC/	Ident-σ_1(hi)	*RoLo	*Mid	*High	Ident(hi)
☞ a. C e C u C Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]			*	*	
b. C e C o C Aperture [rd] [-lo] [-hi]		*!	*		*

- The added wrinkle that /a·i/ surfaces as [a·e] is dealt with thus:
  - Ranking *High above *Mid ensures that the sequence /a·i/ surfaces as [a·e].

(28)

/CaCiC/	Ident-σ_1(hi)	*RoLo	*High	*Mid	Ident(hi)
a. C a C i C [+lo] [-hi] [-lo] [+hi]			*!		
☞ b. C a C e C [+lo] [-hi] [-lo] [-hi]				*	*

  - And /a·u/ is prevented from surfacing as [a·o] by high-ranking *RoLo.
  - The observed output of [a·u] is therefore predicted.

(29)

/CaCuC/	Ident-σ_1(hi)	*RoLo	*High	*Mid	Ident(hi)
☞ a. C a C u C Ap [rd] Ap [+lo] [-hi] [-lo] [+hi]			*		
b. C a C o C Ap [rd] Ap [+lo] [-hi] [-lo] [-hi]		*!		*	*

  - Recall that for Shona, *High above *Mid are ranked the opposite way round.

- Note that having *High outrank *Mid does not cause problems elsewhere:
  - For example, /i·e/ still surfaces as [i·i] thanks to multiple linking.

(30)

	/CiCeC/	Ident-σ_1(hi)	*RoLo	*High	*Mid	Ident(hi)
☞	a. C i C i C Aperture [-lo] [+hi]			*		*
	b. C i C e C [-lo] [+hi] [-lo] [-hi]			*	*!	*

– Likewise, /e·i/ surfaces as height-harmonic [e·e].

(31)

	/CeCiC/	Ident-σ_1(hi)	*RoLo	*High	*Mid	Ident(hi)
☞	a. C e C e C Aperture [-lo] [-hi]				*	*
	b. C e C i C [-lo] [-hi] [-lo] [+hi]			*!	*	

- The constraint ranking for Pende is therefore:

(32) Ident(rd), Ident(lo), Ident-σ_1(hi) » *RoLo » **<u>*High</u>** » *Mid » Ident(hi)

4.4 Punu

- It also appears that the constraint ranking is also relatively easily adapted for Punu.
- A lack of HH can be derived by placing Ident(hi) between *Mid and *High:

(33) Ident(rd), Ident(lo), Ident-σ_1(hi) » *RoLo » *Mid » **<u>Ident(hi)</u>** » *High

- This does not produce lowering of non-initial high vowels by initial mid vowels in the input.

(34)

	/CeCiC/	Ident-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
	a. C e C e C [-lo] [-hi] [-lo] [-hi]			**!	*	
☞	b. C e C i C [-lo] [-hi] [-lo] [+hi]			*		*
	c. C e C e C Aperture [-lo] [-hi]			*	*!	

(35)

	/CoCuC/	Ident-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
	a. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**	*	
☞	b. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*		*
	c. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*	*!	

- However, this arrangement requires limiting mid vowels in the input to initial syllables.
- Otherwise, non-initial mid vowels surface following initial mid vowels.
- The height-harmonic outputs are incorrectly preferred because of multiple linking.
  - In the tableaux below:

    💣 designates a candidate which is incorrectly selected as a winner;

    ☹ designates an actual surface form which incorrectly loses.

(36)

	/CeCeC/	Ident-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
	a. C e C e C [-lo] [-hi] [-lo] [-hi]			**!		
☹	b. C e C i C [-lo] [-hi] [-lo] [+hi]			*	*!	*
💣	c. C e C e C Aperture [-lo] [-hi]			*		

(37)

	/CoCoC/	IDENT-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
	a. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**		
☹	b. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*	*!	*
💣	c. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*		

- In reality, as noted in §2.2.5, mid vowels in Punu are restricted to root-initial position.
- This problem is one created by multiple linking, which is necessary to account for Shona.

4.5 Lozi

- The system found in Lozi poses even more of a challenge.
- The surface sequence [e·o] is disallowed.
- Thus, *RoLo must rank higher than *High.

(38)

	/CeCuC/	IDENT-σ_1(hi)	*RoLo	*Mid	*High
☞	a. C e C u C Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]			*	*
	b. C e C o C Aperture [rd] [-lo] [-hi]		*!	*	

(39)

	/CeCoC/	IDENT-σ_1(hi)	*RoLo	*Mid	*High
☞	a. C e C u C Ap [rd] Ap [-lo] [-hi] [-lo] [+hi]			*	*
	b. C e C o C Aperture [rd] [-lo] [-hi]		*!	*	

- And, since lowering is lacking in all but one context, namely /o·u/, Ident(hi) should rank higher than *High.
- (40) and (41) below show that ranking Ident(hi) over *High prevents lowering in FHH contexts.
- Firstly, a height-disharmonic input remains so in the output.

(40)

	/CeCiC/	Ident-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
☞	a. C e C i C [-lo] [-hi] [-lo] [+hi]			*		*
	b. C e C e C Aperture [-lo] [-hi]			*	*!	

- And this produces the correct output when given a harmonic input.

(41)

	/CeCeC/	Ident-σ_1(hi)	*RoLo	*Mid	Ident(hi)	*High
	a. C e C i C [-lo] [-hi] [-lo] [+hi]			*	*!	*
☞	b. C e C e C Aperture [-lo] [-hi]			*		

- However, looking at BHH, for /o·u/ to surface as [o·o] rather than [o·u], Ident(hi) paradoxically needs to be ranked lower than *High.

(42)

	/CoCuC/	Ident-σ_1(hi)	*RoLo	*Mid	*High	Ident(hi)
	a. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**		*
	b. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*	*!	
☞	c. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*		*

- As seen in (43) below, swapping round IDENT(hi) and *HIGH results in the incorrect output with the input sequence /o·u/:

(43)

	/CoCuC/	IDENT-σ_1(hi)	*RoLo	*MID	IDENT(hi)	*HIGH
	a. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**	*	
💣	b. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*		*
☹	c. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*	*!	

- Though it does not alter an already height-harmonic input of /o·o/.

(44)

	/CoCoC/	IDENT-σ_1(hi)	*RoLo	*MID	IDENT(hi)	*HIGH
	a. C o C o C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [-hi]		**!	**		
	b. C o C u C Ap [rd] Ap [rd] [-lo] [-hi] [-lo] [+hi]		*	*	*!	*
☞	c. C o C o C VPlace Ap [rd] [-lo] [-hi]		*	*		

- The two conflicting constraint rankings are:

(45) a. IDENT(rd), IDENT(lo), IDENT-σ_1(hi) » *RoLo » *MID » **IDENT(hi)** » *HIGH

b. IDENT(rd), IDENT(lo), IDENT-σ_1(hi) » *RoLo » *MID » *HIGH » **IDENT(hi)**

5 Conclusion

- I presented Beckman's (1997) analysis of HH in Shona.
- And applied this work to HH in four further five-vowel Bantu languages.
  - This encounters no problems for S. Kongo and Pende.
  - But does for Punu and Lozi.
  - However, these two cases do not have common problematic areas.
  - Nevertheless, Beckman's analysis of canonical asymmetric HH in Shona is unable to be adapted to cover the complete subset of HH dealt with here.
  - And is therefore not readily generalisable to the Bantu languages as a whole.
- Future work will:
  - Aim to find a solution applicable to all cases covered here;
  - As well other five-vowel languages not yet discussed;
  - And expand further to include seven-vowel languages (see Appendix).

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Appendix: Seven-vowel Bantu languages

- Beckman's (1997) analysis appears to be generally applicable to seven-vowel languages.
- A(n incomplete) sample of such HH systems is provided in Table 2 below.

Kikuyu		**Nyamwezi**		**Kinga**		**Matumbi**		**Ndendeuli**		**Mongo-Nkundo**	
i·e	i·o	i·ɪ	i·ʊ	i·i	i·u	i·i	i·u	i·i	i·u	i·e	i·o
u·e	u·o	u·ɪ	u·ʊ	u·i	u·u	u·i	u·u	u·i	u·u	u·e	u·o
e·e	e·o	ɪ·ɪ	ɪ·ʊ	ɪ·ɪ	ɪ·ʊ	ɪ·ɪ	ɪ·ʊ	**e·e**	e·u	e·e	e·o
o·e	o·o	ʊ·ɪ	ʊ·ʊ	ʊ·ɪ	ʊ·ʊ	ʊ·ɪ	ʊ·ʊ	**o·e**	**o·o**	o·e	o·o
ɛ·ɛ	ɛ·o	**e·e**	e·ʊ	**ɛ·ɛ**	ɛ·ʊ	**ɛ·ɛ**	ɛ·u	**ɛ·ɛ**	ɛ·u	**ɛ·ɛ**	**ɛ·ɔ**
ɔ·ɛ	**ɔ·ɔ**	**o·e**	**o·o**	**ɔ·ɛ**	**ɔ·ɔ**	**ɔ·ɛ**	**ɔ·ɔ**	**ɛ·ɛ**	**ɔ·ɔ**	**ɔ·ɛ**	**ɔ·ɔ**
a·e	a·o	a·ɪ	a·ʊ	a·ɪ	a·ʊ	a·i	a·u	a·i	a·u	a·e	a·o

Table 2: Height harmony systems in seven-vowel Bantu languages

- It seems that the most immediate problem the current constraint set would encounter is that, in Kikuyu, [o] (= [+round, -high]) is found as the default harmonic back vowel in a system which is also asymmetric.
- Might this require that *RoLo = *[+round, -high] be replaced by a similar constraint such as *RoLax = *[+round, -ATR]?