Tongue root restriction and nominal morphological domains in Nata[*]

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Abstract: Within OT, vowel harmony is an assimilatory process where a particular feature is distributed throughout some domain such as a word, (Baković 2000, Archangeli and Pulleyblank 2002; McCarthy 2011 among others). In Nata, both derived and underived nouns exhibit right-to-left harmony asymmetry where roots demonstrate incompatible ways of agreeing with material occurring to the left of the noun (prefix and pre-prefixes). In particular, while non-deverbal nouns exhibit root faithfulness conditions, certain nominalizing suffixes in non-deverbal nouns present a case of dominant-recessive [ATR] vowel harmony (Baković 2000), which override root faithfulness conditions. I investigate these [ATR] harmony cases within the Optimality-Theoretic Account (Prince and Smolensky 1993) and report on how they compare with harmony in other Bantu languages.

Keywords: Nata, Bantu, vowel harmony, ATR, phonology

1 Introduction

Vowel harmony refers to restrictions on what vowels may occur with one another within a word or phrase (cf. Anderson 1980; Pulleyblank 2002). Within OT, (vowel) harmony is canonically an assimilatory process where a particular feature is distributed throughout some domain such as a word, (Baković 2000, Archangeli and Pulleyblank 2002; McCarthy 2011 among others). Nata, (E45, Guthrie: (1967–71)), a lacustrine Bantu language spoken in Northwest Tanzania, demonstrates an [ATR] vowel harmony situation where roots exhibits different ways of achieving harmony with prefixes. Crucially, Nata harmony motivates morphological domains such as root/stem and word, which restrict the domain of application of harmonic constraints (Beckman 1998; Archangeli and Pulleyblank 2002; Downing 2008 among others). The interaction between harmony and nominal morphological domains in Nata presents evidence for a morphology-phonology mapping (Akinlabi 1996; Beckman 1998; Archangeli and Pulleyblank 2002). Another aspect of Nata [ATR] harmony I bring to light is the variation of harmony situation across derived nouns versus underived nouns. Both derived and underived nouns clearly display right-to-left harmony asymmetry. Crucially, harmony in underived nouns pattern differently from that of derived nouns due to harmony triggered by suffixes. Particularly, while underived nouns exhibit root faithfulness conditions, certain nominalizing suffixes in derived nouns present a case of dominant-recessive [ATR] vowel harmony (Baković, 2000), which override root faithfulness conditions. The nature of these alternations motivates sequential markedness constraints discussed in the No-disagreement Account (Pulleyblank 2002) where such constraints are ranked above word positional faithfulness to prohibit disallowed vowel sequences. I show that the conflict between root faithfulness conditions and dominant-recessive harmony in Nata results from two phonological processes: dissimilation and assimilation. Since assimilation and dissimilation are opposing phonological processes, this cannot be accounted for by a single constraint ranking, hence two Co-phonologies are required.

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This paper is divided into 3 sections. In Section 1 I give a brief introduction of the inventory and the morphology of Nata nouns. In Section 2, I present the data, generalizations and OT constraint interactions. In Section 3 I conclude.

1.1 The phonology of Nata

Nata has 7 vowels in which one set of vowels is associated with a [+ATR] feature as in (1a) and the other one a [-ATR] as in (1b).

(1) a. Set I [+ATR] b. Set II [-ATR]

i	u	ɛ	ɔ
e	o	a	

In (1) only mid vowels are lexically contrastive for [ATR] value. That is, high vowels and the low vowel have no [ATR] counterparts[1].

1.2 The Nata noun morphology

For the analysis of Nata nominal [ATR] harmony, I claim that vowel harmony functions differently in different morphological domains. I adopt the morphological domain distinctions and/or terminology such as *root*, *stem*, *macrostem*, and *word* **(**Myers 1990, Mutaka and Hyman 1990, Downing 1997, Ngunga 2000, Archangeli and Pulleyblank 2002, Mudzingwa 2010). These constituents are schematically represented in (2), for underived nouns, and (3) for derived nouns.

(2) PPF $_{WD}$[PF [STEM[ROOT]]]

(3) PPF $_{WD}$[PF [MST(OM)[STEM[ROOT-(EXT)-FV]]]**]**

In (2), the nominal root in underived nouns is coextensive with the nominal stem; hence the labels 'stem' and 'root' can be used interchangeably (cf. Mudzingwa 2010). In (3), the Object Marker (OM), which marks the left edge of the Macrostem, is optional in some deverbal nouns. Where OM is absent in (3), the PF attaches directly to the stem, as in (2). In (3) the stem is formed of the VRoot and at least one suffix (for example the Extensional suffixes (EXTs) and/or the final vowel, which is also known as *the nominalizing suffix.* EXTs add a wide range of meanings to the verb root, such as applicative, intensive, reciprocal etc. I assume with Mutaka and Hyman (1990), Archangeli and Pulleyblank (2002), Visser (2008), and Gambarage (2012) that the pre-prefix (PPF), also known as the *augment* in Bantu attaches at the syntactic level, at the DP rather than a word. In the analysis of harmony I assume that PPFs are outside of the word domain. However, the analysis of PPFs will appear on a separate occasion. I will make references to PPF only where necessary[2]. These domains indicate the mapping between phonology and morphology where they specify the domains of application of harmonic constraints (Beckman 1998; Archangeli and Pulleyblank 2002).

[1] In this analysis I am assuming bivalence of features [±ATR]; contrastively an analysis assuming that features are monovalent [ATR or RTR] will achieve similar results.

[2] PPFs in Nata are argued to be weak determiners (Ds) (Gambarage 2012). In Nata, Class 5 nouns are not marked with overt PPFs, due to some prosodic evidence (i.e., word minimality condition).

2 Vowel harmony phonotactics and domains

I start with an argument that only two harmonic domains exist in Nata: the root/stem and the word. I argue that the vowel harmony phonotactics that hold within stems also hold within roots. Generally, I show that root/stem internal harmony is restricted to mid vowel sequences, and that such harmony phonotactics hold word-internally.

2.1 The root or stem harmonic domain: underived nouns

Roots and stems in underived nouns are co-extensive and therefore they exhibit similar harmony alternations. First, high vowels are advanced and a low vowel is retracted always. Additionally, roots/stems do not alternate in either tongue height or [ATR] features. Crucially, root/stem internal [ATR] harmony is restricted to mid vowel sequences; hence mid vowels with different tongue root qualities are disallowed: ***e..ɛ, *ɛ..e, *e..ɔ, *ɔ..e, *o..ɛ, *ɛ..o, *o..ɔ,** and ***ɔ..o**. Other than these vowel sequences, vowels within roots may appear advanced (4), retracted (5), or both advanced and retracted, (6). Throughout, domains are marked with square brackets for exposition. High tone is marked and low tone is unmarked, but I assume that tone does not affect harmony.

(4) a. C8 e-βé-[tore] 'cucumbers'.
b. C3 o-mo-[ríɣo] 'load'

(5) a. C6 a-má-[saahɛ] 'blood'
b. C8 o-βú-[sɛra] 'porridge'

(6) a. C3 e-me-[kéra] 'wild fruits'
b. C7 o-mo-[súkɔ] 'pocket'
c. C3 a-ma-[sɔ́hi] 'sisal'

2.1.1 Constraint interaction

To ensure that high vowels are advanced and a low vowel is retracted in Nata, Archangeli and Pulleyblank's (1994) universal grounded conditions in (7) are crucial. The constraint in (7a) prefers [+HI] vowels be associated articulatorily with tongue root advancement, and the one in (7b) prefers that a [+LO] vowel be associated with tongue root retraction.

(7) a. *+HI/-ATR: If [+HI] then not [-ATR]

b. *+LO/+ATR: If +LOW then not [+ATR]

Within Optimality Theory (Prince and Smolensky, 1993), the grounded constraints potentially conflict with featural faithfulness constraints like (8).

(8) IDENT-IO[ATR]$_{ROOT}$: Within a root, let X be a segment in the input and Y be a correspondent of X in the output. If X is [αATR], then Y is [αATR] (McCarthy and Prince, 1995, Beckman 1998).

To prohibit retracted high vowels and an advanced low vowel in the Nata grammar, the grounded markedness conditions in (7) must be ranked above root faithfulness, (9).

(9) *+HI/-ATR, *+LO/-ATR >> IDENT-IO[ATR]$_{ROOT}$

The effect of imposing such conditions is that a [-ATR] high vowel will incur a violation mark on (7a), while [+ATR] high advanced vowels will remain unscathed. Also, a [+ATR] low vowel will violate constraint (7b) while a [-ATR] low vowel will satisfy this condition.

2.2 The root or stem harmonic domain: derived nouns

Derived noun roots/stems pattern differently with respect to the nominalizing suffixes, as we shall see in 2.2.1. However, some generalizations for underived noun roots/stems also hold for derived noun roots: high vowels are advanced in all cases and a low vowel is always retracted. Stem/root internal harmony is restricted to mid vowels only; thus mid vowels with different [ATR] qualities are not allowed. Vowels within roots may appear advanced (10a), retracted (10b), or both advanced and retracted vowels, (10c–d).

(10)	a.	C1	o-mó-[siker-i]	'enterer'	from *sikera*	'enter'
	b.	C7	e-ɣi-[tɔ́ɔ́ndɔɔr-i]	'pair of tongs'	from *tɔ́ɔndɔra*	'sort out'
	c.	C14	o-βo-[sínɔɔr-i]	'bed wetting'	from *sínɔɔra*	'pee'
	d.	C15	a-βa-[ráɣor-i]	'healers'	from *ráɣora*	'heal'

Since these cases are not different from those found in underived nouns, the constraint ranking proposed for underived noun roots can account for the derived noun root cases as well.

2.2.1 Stem harmony with suffixes

Harmony with nominalizing suffixes is of particular interest. First, recall the morphology of derived noun stems in (3), […[…STEM[ROOT[(EXT)-FV]]]]. The nominalizing suffixes, which are part of stems, are either [-ATR] mid vowel [ɔ] or high vowels [i, u]. The suffix (**ɔ**) can co-occur with any vowel within a stem, except [+ATR] mid vowels, (11). [+ATR] mid vowels [e,o] in roots appear as [-ATR] before the suffix [ɔ] (see examples (11d), (13)), as well as in forms where a low vowel intervenes between roots and [ɔ], (14). High vowel suffixes can co-occur with any vowel (12). Note that here too a low vowel is retracted in all cases and high vowels are always advanced.

		Verb	**Gloss**	**CL**	**PPF-PF-[ROOT-NOMN]s**	
(11)	a.	ɣana	'tell a story'	C6	a-má-[ɣan-**ɔ**]	'stories'
	b.	tɔ́ɔsa	'abuse'	C3	o-mú-[tɔɔs-**ɔ**]	'an abuse'
	c.	súuŋga	'ascend'	C11	o-ro-[súuŋg-**ɔ**]	'hanger'
	d.	iɣóta	'sated'	C3	o-mw-[iɣɔ́t-**ɔ**]	'satisfaction'
(12)	a.	sɛ́ka	'lough'	C1	o-mú-[sɛk-**i**]	'laugher'
	b.	sɔ́ɔha	'be greedy'	C14	o-βu-[sɔ́ɔh-**u**]	'greediness
	c.	tuka	'dig'	C1	o-mo-[tuk-**i**]	'digger'
	d.	saβa	'beg'	C1	o-mu-[[saβ-**i**]	'beggar'
(13)	a.	tóoŋga	'piece through'	C3	ɔ-mɔ́-[tɔɔŋg-**ɔ**]	'string'
	b.	méra	'swallow'	C7	ɛ-kɛ́-[mɛr-**ɔ**]	'throat'

(14)	a.	hétee**r**a	'overtake'	C3	ɔ-mɔ́-[hɛtɛɛr-an-**ɔ**]	'a wake'
	b.	hoora	'beat'	C3	ɔ-mɔ́-[hɔɔr-an-**ɔ**]	'pounding'

The following observations are crucial to the analysis of stems in (11–14): First, roots with [+ATR] mid vowels assimilate to the [-ATR] value of the suffix [ɔ], which seems to be underlyingly specified as [-ATR], (11d), (13). This may suggest that the [-ATR] value of mid vowels is a dominant value (cf. Casali 2003, Hume 2011). High vowel suffixes do not spread their [+ATR] feature to roots, (12). Crucially, a low vowel seems to be transparent to the propagation of the [-ATR] feature of the nominalizer [-ɔ] in (14). It is not plausible to assume that a low vowel (of the applicative morpheme (-an-)) spreads a [-ATR] feature leftward in (14), as the same effect is observed even where a low vowel is absent, (13). Moreover, verbs in (14) show clearly that a low does not trigger retrogressive harmony. This presents further evidence that mid vowel harmony occurring in stems takes the root as its domain, and hence applies to both root and stem material.

2.2.2 Accounting for suffix harmony in stems

To enforce Nata harmony for stem cases in (11–14), one needs to prohibit disagreeing sequences of mid vowels. My analysis follows the spirit of the No-disagreement account, Pulleyblank (2002), who proposes sequential markedness constraints to prohibit disharmony. To account for the [+ATR] mid vowels which seem to assimilate to [-ATR] mid vowel suffix, ID[+ATR]$_{WORD}$ and ID[-ATR]$_{WORD}$ needs to be invoked. For the analysis of Nata the constraints in (15) are crucial[3].

(15) a. *[-HI, +ATR]C$_0$[-LO, -ATR]$_{WORD}$: Ignoring consonants, within a word, a [-ATR] non-low vowel may not immediately be preceded by a [+ATR] non-high vowel.

b. *[-LO, -ATR]C$_0$[-HI,+ATR]$_{WORD}$: Ignoring consonants, within a word, a [-ATR] non-low vowel may not be followed by a [+ATR] non-high vowel.

(16) a. IDENT-IO[-ATR]$_{WORD}$: Let X be a segment in the input and Y be a correspondent of X in the output. If X is [-ATR], then Y is [-ATR], (ID[-A]$_{WD}$) (cf. McCarthy & Prince, 1995).

b. IDENT-IO[+ATR]$_{WORD}$: Let X be a segment in the input and Y be a correspondent of X in the output. If X is [+ATR], then Y is [+ATR], (ID[+A]$_{WD}$) (cf. McCarthy & Prince, 1995).

The constraints in (15) and (16a) are undominated, hence are ranked above faithfulness to [+ATR] value, (16b). ID[+ATR]$_{RT}$ must be ranked below ID[-ATR], because [+ATR] value of root mid vowels assimilate to the [ɔ] suffix. The ranking in (17) is illustrated in tableau (18) with *ɛ-kɛ́-mɛr-ɔ* 'throat'. Violations are counted within the respective domain (eg. the domain in brackets).

(17) GROUNDED, MID VOWEL HARMONY, ID[-A]$_{WD}$ >> ID[A]$_{RT}$ >>ID[+A]$_{WD}$

[3] In the No-disagreement Account, Pulleyblank uses sequential markedness constraints with different levels of proximity: close, intermediate, distal proximity (Suzuki 2000), for instance, *[+ATR][-ATR], *[+ATR]C$_0$[-ATR], *[-ATR]∞[+ATR] respectively. Given the nature of the Nata harmony, constraints that are formulated more generally and are not restricted to mid vowel sequences will overapply, hence will end up being ranked very low.

(18) *ɛ-ké-mɛr-ɔ* ‘throat’ from *méra* ‘swallow’.

/-mer-ɔ/	*[-HI, +A] [-LO, -A]$_{WD}$	*[-LO, -A] [-HI,+A]$_{WD}$	ID[-A]	ID[A]$_{RT}$	ID[+A]
a. ɛ-kɛ́-[mer-ɔ]	*!				
b. ɛ-kɛ́-[mɛr-ɔ] ☜				*	*
c. ɛ-kɛ́-[mer-o]			*!		*

This ranking correctly selects (b) as the winner despite its violation on ID[ATR]$_{RT}$. Candidate (a) fatally violates mid vowel harmony for stems. Stems/roots with both retracted mid vowels and high vowels are not problematic for this ranking. The [-ATR] value cannot be changed, hence (c) is out. Now, take stem cases with both [+ATR] and [-ATR] value such as o-βo-[sínɔɔr-i] ‘bed wetting’.

(19) o-βo-[sínɔɔr-i] ‘bed wetting’ from *sínɔɔra* ‘pee’.

/[sínɔɔr]-i /	*HI/-ATR	*[-HI, +A][-LO, -A]$_{WD}$	*[-LO, -A][-HI,+A]$_{WD}$	ID[ATR]$_{RT}$
a. o-βo-[sínɔɔr-i] ☜				
b. o-βo-[sínoor-i]				*!
c. o-βo-[sınɔɔr-ı]	*!*			

Candidate (c) is penalized by the grounded constraint that prohibits high vowel retraction. High vowels never spread their [ATR] value; hence (b) is out of the race for violating faithfulness as it changed the [ATR] value in the root. It is important to restrict sequential constraints to mid vowel sequences only as harmonic constraints that are formulated more generally would rule out cases with retracted mid vowels and high vowels as (a).

2.2.3 Harmony with extensional suffixes

The stem is comprised of a verbal root and the extensions such as applicative extensions *-er- or -ɛr,* or intensive extensions *-er-er-* or *-ɛr-ɛr-*. Roots with [-ATR] mid vowels select for [-ATR] extensional suffixes (20), and roots with [+ATR] vowels select for [+ATR] extensional suffixes (21). Surprisingly, a low vowel selects for the [+ATR] extensions suffixes, (22). Apparently, the nominalizing suffixes [i], (20) or [u] as in (12) do not affect the [-ATR] value of extensions or roots.

PPF-PF-OM-[ROOT-EXT(S)- NMLZ

(20)	a.	tɛma	C1	o-mo-tu-[tɛm-**ɛr**-i]	‘a person who beats for us’
	b.	βɔha	C1	o-mo-tu-[βɔh-**ɛr-ɛr**-i]	‘a person who ties repeatedly for us’
(21)	a.	tuma	C1	o-mó-to-[tum-**er**-i]	‘a person who sews for us’
	b.	βooka	C1	o-mó-[βook-**er-er**-i]	‘a person who never plans ahead’

(22) a. sama C1 o-mó-tu-[sam-**er**-i] ‘a person who taste things for us’
b. ɣamba C1 o-mú-[ɣamb-**er**-**er**-i] ‘slacker’/’jobless person’

Similar to [+ATR] mid vowels, stems with the nominalizing suffix [i] follow from the analysis that a [+ATR] feature is a dormant value in Nata. This accounts for the fact that [+ATR] vowels in the suffixes cannot extend their features either to extensions or to roots as in (20). As we shall see below, the Nata data, in fact, appeals for an analysis where a [+ATR] value is default and a [-ATR] feature is the dominant value (cf. Casali 2003 and references therein). Thus, it is plausible to posit that the extensions in (20) surfaced with a [-ATR] value in order to satisfy mid vowel harmony. I argue that the [+ATR] extensions occurring after [+ATR] mid and high vowels in (21) receive their [+ATR] value by default feature assignment. Nata data suggest that only [-ATR] mid vowels spread their [ATR] value, the property not found in a low vowel. The reason for this may be that a low vowel does not have [ATR] counterpart. This accounts for the data in (22) in which [a] fails to spread its feature to the extensions yielding prefixes with a default [+ATR] value.

2.2.3.1 Accounting for extensions harmony

Before I propose the analysis of extensions, let me recapitulate that, in Nata, only two vowels can occur in the extensions: either [**ɛ**] or [e]. The constraint ranking for the OT analysis must be one that allows extensions with a retracted vowel, [ɛr], to follow stems with [-ATR] mid vowels, and extensions with a default value, [er**],** to occur elsewhere. The constraints in (23) are crucial.

(23) a. *[-ATR]: No [-ATR] feature (cf. Leitch 1997).
b. *[+ATR]: No [+ATR] feature (cf. Leitch 1997).
c. ID[ATR]$_{RT}$ >> *[-ATR]>> ID[ATR]$_{ST}$ >>*[+ATR]

To achieve desirable results on default values one needs to rank featural prohibition markedness *[-ATR] above faithfulness for stems, (23c). Crucially, *[+ATR] must be ranked very low. These cases do not involve changing [ATR] features in roots hence ID[ATR]$_{RT}$ can be ranked above *[-ATR]. Now take cases such as in (21) and (22) where extensions appear with a default value. I demonstrate how this ranking works in tableaux (24–25). Assume /er/ is our input.

(24) o-mó-to-tum-er-i (20a)

/-tum-er-i/	ID[A]$_{RT}$	*[-ATR]	ID[+ATR]$_{ST}$	*[+ATR]
a. o-mó-to-[tum-ɛr-i]		*!	*	**
b. o-mó-to-[tum-er-i] ☜				***

(25) o-mó-tu-[sam-**er**-i]. Assume the extension is /ɛr/ is the input.

/-sam-ɛr-i/	ID[A]$_{RT}$	*[-ATR]	ID[+ATR]$_{ST}$	*[+ATR]
a. o-mó-tu-[sam-**ɛr**-i]		*!*		*
b. o-mó-tu-[sam-**er**-i] ☜		*	*	**

Extensions with [-ATR] non-low vowels in such stems as (20) are not default values. In tableau (26), the constraint for mid vowel harmony phonotactics rules out candidate such (a). Note that our winner violates *[-ATR] once but this has no harm compared to (a) with two fatal violations.

(26) o-mo-tu–[tɛm-**ɛr**-i] (20a)

/-tɛm-er-i/	*[-LO, -A][-HI,+A]$_{WD}$	ID[A]$_{RT}$	*[-ATR]	ID[+ATR]$_{ST}$	*[+ATR]
a. o-mo-tu-[tɛm-**er**-i]	*!		*	*	**
b. o-mo-tu-[tɛm-**ɛr**-i] ☜			**		*
c. o-mo-tu-[tem-**er**-i]		*!			***

2.3 Harmony with prefixes: word level harmony

Harmony between prefixes (PFs) and nominal roots or verbal roots is different in several respects from the one occurring in roots/stems. First, note that while it is possible to find [+ATR] mid vowels preceding a low vowel (eCa, oCa) within both underived noun roots/stems, (27) and derived noun roots/stems, (28), mid vowel PFs cannot precede roots beginning with a low vowel.

(27) a. C3 o-[mo-k**e**r**a**] ‘tail’.
b. C11 o-[ro-ɣ**o**m**a**] ‘wound’ (usu. found on a head).

(28) a. C15 tenani (V) o-[ɣo-t**e**n**a**n-i] ‘putting Xs diagonal to each other’.
b. C6 hóoŋga (V) a-[βá-hooŋg-**e**r-**a**n-i] ‘people who sieve for each other’

Recall our generalization in Section 2.1 that mid vowel with different [ATR] values cannot occur within the stem or root. Here, we encounter another instance where sequences such as eCa and oCa are only possible outside roots/stems but not within roots or stems. This clearly indicates that a word is a distinct domain from the stem/root. I claim that this characterization is crucial in the formal account of vowels in roots and stems.

Furthermore, if roots begin with a low vowel, prefixes consistently surface as high vowels and never advanced non-high vowels, (29–30).

(29) a. C1 o-[**mu**-kári] *o-[**mó**-kári] ‘woman’
b. C11 o-[**rú**-**β**aru] *o-[**ró**-**β**aru] ‘ribs’

(30) a. C1 o-[**mú**-ɣan-i *o-[**mó**-ɣan-i] ‘story teller’
b. C1 o-[**mú**-raɣor-i] *o-[**mó**-raɣor-i] ‘healer’

In addition to the harmony we saw above, [+ATR] mid vowel prefixes cannot also immediately precede roots beginning with a [-ATR] mid vowel. Thus, prefixes are high if the first syllable of the root contains a [-ATR] mid vowel as in (31), and are [+ATR] non-high vowels where roots start with a [+ATR] value as in (32).

(31) a. C14 o-[**βu**-sɔ́ɔhu] *o-[**βo**-sɔ́ɔhu] ‘greediness’
b. C7 e-[**ki**-γérɔ] *e-[**ke**-γérɔ] ‘thing’

(32) a. C1 o-[**mó**-sukɔ] *o-[**mú**-sukɔ] ‘pocket’
b. C4. o-[**me**-kéra] *e-[**mi**-kéra] ‘tails’

In derived nouns, too, the first syllable of the root with a [-ATR] vowel can only be preceded with prefixes with high vowels (33); but where roots do not start with a [-ATR] vowel, prefixes appear with [+ATR] mid vowels, (34).

(33) a. C7 e-[βi-rɛɛŋgɛ] *e-[βe-rɛɛŋgɛ] ‘feet’
b. C1 o-[**mu**-sɔ́ɔh-u] *o-[**mó**-sɔ́ɔh]-u ‘greedy person'

(34) a. C1 o-[**mó**-rem-i] *o-[**mu**-rem-i] ‘farmer’
b. C7 e-[**ke**-ríβ-ɔ] *e-[**ki**-ríβ-ɔ] ‘lid’

Recall that within roots/stems mid vowels with different tongue root qualities cannot co-occur but at the word level such sequences are tolerated when are not adjacent, (35).

(35) a. C1 o-[**mó**-sukɔ] * o-[**mú**-sukɔ] ‘pocket’
b. C7 e-[**ke**-ríβ-ɔ] *e-[**ki**-ríβ-ɔ] ‘lid’

As we shall see below, except for some derived nouns, which involve assimilatory cases, in Nata, there are no underived nouns with [-ATR] mid vowel PFs[5]. For that matter, sequences such as ***C**ɔ**-[C**V..]**, *C**ɛ**-[CV..], *C**ɔ**-[C**V..], ***C**ɛ**-[C**V..] are not found.

2.3.1 Accounting for prefix dissimilation harmony

To account for prefixes that dissimilate before a low vowel in roots, I assume that there is a constraint such as the one in (36) which prohibits [+ATR] mid vowel prefixes to immediately precede roots starting with a low vowel. Recall that such a constraint does not hold in stem/root internal harmony hence provides evidence for the instantiation of the word domain. I maintain that a [-ATR] value is an active value while the [+ATR] value is a default. I refer to the process that forces mid vowel PFs surface as high vowels before [-ATR] roots initial syllables as “prefix dissimilation” (see also Higgins 2011 similar process in Ikoma – a sister language to Nata). Based on the fact that underived noun roots/stems do not alternate in both tongue height and [ATR] values, it is plausible to consider root faithfulness constraints, IDENT[HEIGHT]$_{ROOT}$, and IDENT[ATR]$_{ROOT}$. In addition to the grounded constraints, featural prohibition markedness, and

[5] There are a few forms in underived nouns as exemplifies in (i)a–b in which prefixes appear with a [-ATR] mid vowel before a [-ATR] root initial syllable. Such forms seem to be originated from verbs but their source verbs are not known. This makes sense to me as such patterns are common in derived nouns where there is leftward spreading of the [-ATR] feature of the nominalizing suffix. I treat these two forms as exceptional, unless further evidence is presented.

(i) a. C3 ɔ-mɔ́-[rɔr]-ɔ ‘fire’ (probably from *rora* ‘bitter’ or *rori* ‘whistle’).
b. C7 ɛ-βɛ-[sɛ́ɣ]-ɔ ‘miracles’ (probably from *iseγa* ‘turn into something magically’

stem mid-vowel harmonic constraints defined above, the following constraints are crucial for the analysis of Nata harmony at the word domain:

(36) *[+ATR, -HI]C_0 [+LO]: Ignoring consonants, A mid vowel may not immediately precede a low vowel.

(37) IDENT[HEIGHT]$_{WORD}$: Within the word, If an input segment is [αhigh] then its output correspondent is [αhigh], (ID[HE]$_{WD}$), (Adopted from Baković, 2000, Pulleyblank 2002).

Mid vowel harmonic constraints introduced in (15) above are undominated as they are not violable within the word. Ranking *[+ATR], below *[-ATR] but above ID[ATR]$_{WORD}$ may rule out undesirable candidates with retracted non-low vowels who may otherwise surface as false winners. We know that due to prefix dissimilation, ID[HEIGHT]$_{WD}$ is violable, and hence needs to be ranked low, possibly below ID[ATR]$_{WD}$. The ranking of ID[ATR]$_{RT}$ with respect to *[-ATR] can be maintained. The ranking for dissimilatory cases is given in (38).

(38) MID. V. HARMONY, GROUNDED >> ID[ATR]$_{RT}$>> *[-ATR]>>ID[+ATR]$_{WD}$ >> ID[HE]$_{WD}$

Consider cases with prefix dissimilation in (29) and (31) repeated in (29') and (31'), respectively:

(29')	a.	C1	o-[**mu**-kári]	*o-[**mó**-kári]	'woman'
	b.	C11	o-[**rú**-**β**aru]	*o-[**ró**-**β**aru]	'ribs'
(31)	a.	C14	o-[**βu**-sɔ́ɔhu]	*o-[**βo**-sɔ́ɔhu]	'greediness'
	b.	C7	e-[**ki**-γέrɔ]	*e-[**ke**-γέrɔ]	'thing'

Because of richness of the base mid vowel PFs may be advanced or retracted underlyingly. I illustrate that candidates with retracted prefixes or default prefixes cannot be optimal in prefix dissimilation contexts. Assume in tableau (39) the prefix in (40a) o-**βu**-sɔ́ɔhu is /βo/. Because of space, I collapse IDENT[-ATR] and IDENT[+ATR] into ID[ATR]$_{WD}$.

(39) o-βo-sɔɔhu 'greediness' (31a)

/o-βo-sɔɔhu/	*[-HI,+ATR]C_0 [-LO, -ATR]	ID[A]$_{RT}$	*[-ATR]	ID[ATR]$_{WD}$	ID[HE]$_{WD}$
a. ɔ-[βɔ-sɔ́ɔh-u]			*!*	*	
b. o-[βu-sɔ́ɔh-u] ☜			*		*
c. o-[βo-sɔɔh-u]	*!		*		
d. o-[βo-sooh-u]		*!			

If we had a retracted prefix as the input, (b) would still win. The only difference is that the winner candidate (b) and candidate (c) would both incur a violation on ID[ATR]$_{WD}$. This case shows clearly that [-ATR] value in roots never spread leftward as PFs are not [-ATR] value.

This ranking disfavours any candidate with non-low [-ATR] value in the affix at the expense of harmony. For cases involving PF dissimilation before roots beginning with a low vowel, the

constraint, *[+ATR, -HI]C_0[+LO] introduced in (36) needs to be ranked above both *[-ATR] and ID[ATR]$_{WD}$ for correct results. The reason is that, as we shall see below, such a constraint is violable in stems. I illustrate this ranking in tableau (40) using (29')b *o-ru-[ßaru]* 'rib'. Assume that the PF is [-ATR] non-low vowel.

(40) o-ru-βaru 'rib'

/-ro-βaru/	ID[ATR]$_{RT}$	*[+A, -HI]C_0[+LO]	*[-ATR]	ID[A]$_{WD}$	ID[HE]$_{WD}$
a. o-[**rɔ́**-βaru]			*!*	*	
b. o-[**rú**-βaru] ☜			*		*
c. o-[**ró**-βaru]		*!	*		

In tableau (40) the winner violates the last two constraints but this does not make it worse than candidate (a), which violates featural prohibition and candidate (b) which violates harmony.

Cases involving default prefixes presented in (41) are not problematic and straightforwardly follow from the analysis of the default affixes we proposed in 2.2.3.1. That is, we should maintain ranking *[-ATR] above word faithfulness. As I will argue in detail in 2.4, there is no need to posit for different ranking (by re-ranking ID[HE]$_{WD}$) while PFs are [+ATR] in both PF dissimilation and in default PF cases. Cases in (41) require that *[-ATR] be ranked appropriately to prohibit prefix retraction. However, there is no motivation to re-rank ID[HE]$_{WD}$ as the winning candidate always satisfy this constraint.

(41) a. C1 o-[**mó**-sukɔ] *o-[**mú**-sukɔ] 'pocket'
b. C4. e-[**me**-kéra] *e-[**mi**-kéra] 'tails'
c . C7 e-[**ke**-ríβ-ɔ] *e-[**ki**-ríβ-ɔ] 'lid'

I demonstrate this case using (41a) o-**mó**-sukɔ 'pocket'.

(42) C1 o-**mó**-sukɔ 'pocket' (41a)

/mo-sukɔ/	MV HARMONY/ GROUNDED	ID[A]$_{RT}$	*[-ATR]	ID[+A]$_{WD}$	ID[HE]$_{WD}$
a. o-[mo-sukɔ] ☜			*		
b. ɔ-[mɔ-sukɔ]			*!*	*	
c. o-[mu-sukɔ]			*		*!
d. o-[mo-suko]		*!			

The winner, candidate (a), has one violation against featural prohibition markedness which is actually violated by all except (d) who is rules out for changing the [ATR] value in the root. Candidate (c) violates ID[HE]$_{WD}$ who is left in the last column hence (a) is declared a winner.

2.3.2 Accounting for retrogressive harmony cases

We now turn to PF cases involving retrogressive harmony, (43)–(44) repeated partially from (13)–(14) above. These cases require ID[HE]$_{WD}$ to be undominated in order to rule out candidates with high vowel prefixes. Note also that in these examples only [+ATR] non-high vowels assimilate to the suffix [ɔ]. This follows from the analysis of the dominant [-ATR] value in Nata. Although it is clear that prefix dissimilation occurs where roots begin with a [-ATR] value, (31) and (33), it is not clear to me why prefix dissimilation is not attested in cases where the suffix [ɔ] triggers retrogressive assimilation to roots as in (43)–(44). If you recall roots beginning with a [-ATR] vowel forced PF raising if cases like (31'). I do not have a concrete answer to this problem. This situation necessitates a separate Co-phonology, Orgun (1996), Inkelas (1998). This is because ID[HE]$_{WD}$, which was ranked very low in dissimilatory cases, needs to be undominated in these cases order to prohibit PF dissimilation.

(43)	a.	C3	ɔ -[mɔ́-hɛt-ɔ]	'strap'	from *héta*	'pass'
	b.	C7	ɛ-[kɛ́-mɛr-ɔ]	'throat'	from *méra*	'swallow'
(44)	a.	C3	ɔ-[mɔ́-hɛtɛɛr-an-ɔ]	'a wake'	from *hétee**r**a*	'overtake'
	b.	C3	ɔ-[mɔ́-hɔɔr]-an-ɔ]	'pounding'	from *hoora*	'beat'

In Nata the vowel [**ɛ**] does not feature as the nominalizing suffixes. However, verbs ending with the subjunctive mood morpheme [**ɛ**], appear to trigger harmony in the same way as the suffix [**ɔ**], (45). This provides further evidence that the [-ATR] value is systematically dominant in Nata.

			?FOC-2sg-3sg-buy-Apl-M[6]	
(45)	a.	ɣora 'buy'	n-ɔɔ-mɔ-ɣɔ́r-ɛr-ɛ	'just buy for him/her'
	b.	tena 'cut'	n-ɔɔ-mɔ-tɛ́n-ɛr-ɛ	'just cut for him/her'

If we apply the ranking for dissimilation cases to retrogressive assimilation cases such as in (43)–(44), ID[+ATR] would conspire with ID[ATR]$_{RT}$ against the correct winner who appear to have two violations on ID[+ATR], as demonstrated in tableau (46).

[6] The grammatical function of the formative *n* indicated as FOC is not clear Francis (2013) shows that the nasal is ambiguous between being a Focus marker and a modal marker. I use FOC as a provisional label.

(46) o-mɔ́-hɛt-ɔ ‘trap’ from héta ‘pass’

/o-mo-het-ɔ/	*[+A,-HI]C_0[-A,-LO]/ *[-A,-LO]C_0[+A,-HI]	ID[-A]	ID[A]$_{RT}$	ID[+A]	ID[HE]
a. o-mó-[hɛt]-ɔ	*!		*	*	
b. o-mɔ́-[hɛt]-ɔ ☹			*	*!*	
c. o-mó-[het]-o		*!		*	
d. o-mú-[hɛt]-ɔ ☚			*	*	*
e. o-mú-[het]-o		*!			*
f. o-mo-[het]-ɔ	*!				

To correctly account for retrogressive harmony IDENT[+ATR] prohibits spreading of a [-ATR] feature from the root to PFs; hence works similarly to DEP[-ATR] (cf. Leitch 1997; also Higgins 2011). Thus, this constraint must be ranked very low because of unfaithfulness of some [+ATR] values. ID[HE] must be undominated to prevent prefix dissimilation in the place of default prefixes or in assimilatory cases. Since [-ATR] mid vowels never trade their [-ATR] feature, I have no evidence for ranking ID[-ATR] with respect to ID[HE]$_{WD}$. However, as we shall see below, ID[ATR]$_{RT}$ needs to be ranked below ID[-ATR] because of instances of the unfaithfulness of [+ATR] mid vowels in derived noun roots/stems. IDENT[ATR]$_{RT}$ needs to outrank IDENT[+ATR] since faithfulness to roots is more important than faithfulness to affixes (i.e., in extensions). The master ranking for assimilation cases is as shown in (47) followed by its illustration in tableau (48).

(47) GROUNDED, MID VOWEL HARMONY, ID[HE]$_{WD}$, ID[-ATR] >> ID[ATR]$_{RT}$ >> ID[+ATR][7].
Now observe the case that the first co-phonology left unresolved in tableau (46).

(48) ɔ-mɔ́-[hɛt-ɔ] ‘trap’ from héta ‘pass’

/mo-het-ɔ/	*[-HI,+A]C_0[-LO, -A]	ID[HE]$_{WD}$	ID[-A]$_{WD}$	ID[A]$_{RT}$	ID[+A]$_{WD}$
a. o-[mó-hɛt-ɔ]	*!			*	*
b. o-[mɔ́-hɛt-ɔ] ☚				*	***
c. o-[mó-het-o]			*!		*
d. o-[mú-hɛt-ɔ]		*!		*!	**
e. o-[mú-het-o]		*!	*		*
f. o-[mo-het-ɔ]	*!			*	

[7] I do not have reason to invoke constraints such as *[-ATR] or *[+ATR] for retrogressive harmony as such constraints are irrelevant here.

In (48) the promoted ID[HE] rules out (d) which assumes PF dissimilation. This gives us desirable results as (48b) wins over (48d). This ranking is also crucial for cases involving transparency of a low vowel in stems. A low vowel allows the propagation of the [-ATR] feature from the nominalizer as in (44)[8]. Note that the harmonic constraint that prohibits an advanced mid vowel to follow a low vowel, *[+A, -HI]C_0[+LO] is ranked appropriately low as eCa vowel sequences are tolerated in stems e.g. *o-mo-kera* 'tail'. I illustrate this ranking using *ɔ-mɔ́-[hɛtɛɛr]-an-ɔ* 'a wake' from *héteera* 'overtake' in tableau (49).

(49) *ɔ-[mɔ́-hɛtɛɛr-an-ɔ]* 'a wake' (44a)

/o-*mo-heteer-an-ɔ/*	*[+A,-HI]C_0[-A,-LO],	ID[HE]$_{WD}$	ID[-A]$_{WD}$	*[+A,-HI][+LO]	ID[A]$_{RT}$
a. o-[mó-hɛtɛɛr-an-**ɔ**]	*!				**
b. o-[mɔ́-hɛtɛɛr-an-**ɔ**] ☜					**
c. o-[mó-heteer-an-**o**]			*!		
d. o-[mó-heteer-an-**ɔ**]				*!	
e. o-[mú-hɛtɛɛr-an-**ɔ**]		*!			

Candidate (d) loses the race as she fatally violates the constraint that bans the co-occurances of mid vowels with different [ATR] values. Candidate (c) is out due to changing the suffix [ATR] value for unknown course.

2.4 Harmony with object markers

In derived nouns with object marking present, OMs surface as a high vowel if they immediately precede a [-ATR] vowel of the verbal root as in (50), but surface as [+ATR] mid vowel if they precede roots beginning with a [+ATR] value as shown in (51).

(50) a. C1 o-mo-**tú**-[tɛm]-ɛr-i 'a person who beats on our behalf'
b. C1 o-mó-**tú**-[sam]-er-i 'a person who tastes things for us'

(51) a. C1 o-mo-**tó**-[tum]-er-i 'a person who sews for us'
b. C1 o-mo-**tó**-[ɣor]-er-i 'a person who buys for us'

Unlike in roots and stems, OMs do not allow the (**e…**a/o…a) vowel sequence. I argue that in Nata the OM itself is not part of the stem (smaller stem) but of the larger stem, hence the Macrostem (Mudzingwa 2010). Note also that roots with [-ATR] value do not affect PFs on the left of OMs, as PFs and PPFs are not locally adjacent to roots. Further, nouns may be formed without OMs. Since height alternation is triggered by the root [-ATR] value as I argued above, this analysis predicts that, if OMs is omitted, PFs which are [+ATR] mid vowels in (50) will dissimilate to high vowels, but PFs in (51) will retain a [+ATR] feature in roots beginning with [+ATR] value. This is exactly what happens in (52) and (53).

[8] This OT analysis cannot tell why in retrogressive harmony prefixes harmonize with the root material instead of being realized as high vowels since both strategies would satisfy mid vowel harmony. This case will be investigated in Gambarage and Pulleyblank (in prep).

(52) a. C1 o-[**mu**-tém-i] ‘a person who beats’
b. C1 o-[**mú**-sam-i] ‘a person who taste things’

(53) a. C1 o-[**mó**-tum-i] ‘a tailor’
b. C1 o-[**mó**-ɣor-i] ‘a buyer’

It is clear that OMs and PFs behave in the same way with respect to the vowel of the root initial syllable they co-occur with (i.e. they both either dissimilate or acquire default values). This suggests that OMs and PFs can be analyzed by similar constraint rankings. Since retrogressive assimilation is not possible in derived nouns with OMs, I argue that there is no need to posit different ranking for OMs. The ranking we postulated for PFs dissimilation in (38), repeated in (38’), can account for both OM dissimilation in (50) and cases involving default OMs and PFs in (51). I illustrate these cases in tableaux (53) and (54).

(38’) MID. V. HARMONY, GROUNDED >> ID[ATR]$_{RT}$>> *[-ATR]>>ID[+ATR]$_{WD}$ >> ID[HE]$_{WD}$

(53) *o*-mo-tú-tɛm-ɛr-i (51a)

mo-to-[tɛm]-er-i	*[HI,+A]C_0 [-LO, -A]	ID[ATR]$_{RT}$	*[-ATR]	ID[+A]$_{WD}$	ID[HE]$_{WD}$
a. o-[mu-tú-tɛm-ɛr-i]			**	*	*!*
b. o-[mo-tú-tɛm-ɛr-i] ☜			**	*	*
c. o-[mo-to-tɛm-ɛr-i]	*!		**	*	
d. o-[mɔ-tú-tɛm-ɛr-i]			**!*	*	*

(54) o-mo-tó-tum-er-i

/mo-tó-tum-er-i/	*[HI,+A]C_0 [-LO, -A]	ID[ATR]$_{RT}$	*[-ATR]	ID[+A]$_{WD}$	ID[HE]$_{WD}$
a. o-[mu-tú-tum-er-i]					*!*
b. o-[mo-to-tum-er-i] ☜					
c. o-[mu-tɔ-tum-er-i]	*!		*!	*	*
d. o-[mɔ-tɔ-tum-er-i]			*!*	**	

In both tableaux each candidate (a) has two violations against ID[HEIGHT] because of OM and PF dissimilation. In fact, In tableau (54), there is no reason to rank ID[HE]$_{WD}$ very low as this constraint is inviolable here. However, I do not have any motivation to posit different ranking for the same morpheme (OM). Since cases involving PF dissimilation and default prefixes are accounted for by similar ranking, it seems clear that the second Co-Phonology is enforced by retrogressive harmony, where the suffix [ɔ] takes the words as its domain. Note also that the constraint such as *[-ATR] works well for both of these cases but such constraint would be ranked very low for cases involving retrogressive harmony discussed in 2.3.2.

3 Conclusion

This paper presented cases of both root faithfulness and suffix-controlled vowel harmony, which interact with morphological domains. One interesting case is the one where the [-ATR] feature is a dominant, spreading leftward from the nominalizing suffix (**ɔ**) in derived nouns across the board (if not blocked by high vowels). This process overrides root faithfulness conditions and affects [+ATR] mid vowels to the left of the nominal domain. Based on the analysis of Nata harmony presented in this work, I submit that the [-ATR] feature is the systematic dominant value while the [+ATR] value is the default. Nata is consistent with the System-Dependent [ATR] Dominance Hypothesis (Casali, 2003: 356) which argues that 'the dominant [ATR] value in a language is strongly correlated with underlying inventory structure and that the [-ATR] value is regularly dominant in languages where [ATR] is contrastive only for non-high vowels'. I have argued that within OT, Nata harmony can be studied within two separate Co-phonologies: one accounting for assimilation cases and the other for default feature assignment and prefixes dissimilation[9]

Conversely, the application of Co-phonologies in linguistic studies is equated to lack of a unified account. Co-phonologies proposed in this paper raise the question of learnability. Particularly, if harmony alternations are treated as two separate grammars, how do Nata learners learn or generalize such alternations? Recently, Archangeli and Pulleyblank (in prep), proposed that allomorphs (phonological alternations) can be studied within "the Lexical Allomorphy Account" or "Emergent Grammar" without invoking Co-phonologies. Crucial ideas of the emergent grammar include: allomorphs are learned and that allomorph selection is governed by phonotactics conditions. If this account was applied to Nata one must expect to have nouns and verb roots selecting for affixes with particular phonological properties i.e., roots beginning with [-ATR] would select for high vowel prefixes, while roots beginning with [+ATR] value would be treated as non-selectional roots, hence they can be assigned a default prefix. The author's plan for future research is to employ the *emergent grammar* and see whether or not is an absolute solution to a unified account of Nata harmony.

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[9] In this paper I have not discussed accounts such as AGREE (cf. Baković 2000), SPREAD (cf. Walker 1998) or SHARE (cf. McCarthy 2004). It is obvious that it is not possible to have a unified account using such models due to the fact that [-ATR] mid vowels do not assimilate to high vowels which are always advanced and can occur to the left or right of any vowel. However, a thorough investigation of Nata [ATR] using such accounts would require a separate paper.

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