

Voicing and Polarity in Luo

1 Introduction

Alderete (2001) cites voicing alternations in Luo plural formation as compelling evidence for transderivational antifaithfulness (TAF) constraints. In this paper, I show that a TAF analysis of Luo plural formation meets empirical problems, and argue for an alternative approach based on the interaction of faithfulness and markedness constraints in a containment-based version of Optimality Theory (van Oostendorp, 2006b). Building on this analysis, I develop a comprehensive account of other morphological constructions involving voicing changes in Luo and of the closely related process of manner alternations. The Luo data which have been taken as decisive evidence for a genuinely non-additive type of morphology turn out to be fully compatible with a conception of morphology which is broadly concatenative.

The paper is organized as follows: Section 2 discusses the Luo data as they have been generally received in the literature, and introduces the details of Alderete's analysis. In section 3, I develop a fuller picture of the data, and argue that the antifaithfulness approach makes predictions which are not borne out, but also fails to capture significant restrictions on voicing alternations. The formal framework assumed in this paper is introduced in section 4. An alternative analysis of the Luo data is developed in section 5, and extended to voicing alternations in possessive constructions in section 6 and to those in verbs in section 7. In section 8, I analyze manner alternations, and in section 9, I compare the overall analysis with alternative approaches to polarity phenomena in Luo. Section 10 discusses the repercussions of the analysis for the general theory of possible morphological operations.

2 Voicing Polarity in Luo

Luo is a Western-Nilotic language spoken in Kenya and parts of Uganda. Theoretical treatments of voicing polarity are usually based on data from Gregersen (1972) and Okoth-Okombo (1982), but the most comprehensive grammar of Kenya Luo is Tucker (1994)¹ which will be the primary source of my analysis here.

The type of data usually discussed in the literature on Luo voicing polarity is illustrated in (1) and (2). The pattern is found with the productive nominal plural affix **-e** and the lexically

¹This book has been edited by Chet Creider after Tucker's death. Page numbers without explicit source refer generally to Tucker's grammar.

restricted allomorph **-i**, where plural formation does not only involve affixation, but changing the voicing of the root-final consonant. If this is a voiced obstruent in the singular it turns voiced in the plural (1), and if it is voiceless in the singular it gets voiced in the corresponding plural form (2):

(1) **Voicing Exchange [-voiced] → [+voiced]**

- a. bat (sg.) bed-e (pl.) ‘arm’
- b. luθ (sg.) luð-e (pl.) ‘walking stick’
- c. arip (sg.) arib-e (pl.) ‘milky way’
- d. juok (sg.) juog-i (pl.) ‘arm’

(2) **Voicing Exchange [+voiced] → [-voiced]**

- a. kidi (sg.) kit-e (pl.) ‘stone’
- b. okebe (sg.) okep-e (pl.) ‘tin can’
- c. cogo (sg.) cok-e (pl.) ‘bone’

A straightforward brute-force attack to this phenomenon has been proposed in Gregersen (1972) who invokes the alpha-rule in (3) triggered by the morphological context plural:

(3) $\alpha\text{voice} \rightarrow -\alpha\text{voice}$

In a constraint-based framework such as Optimality Theory rules of this type cannot be formulated. In fact the Luo data seem to be highly problematic for OT which is basically restricted to faithfulness and markedness constraints. In contrast to this, the change from **d** to **t** in (3a) violates a faithfulness constraint (IDENT[voice]) and while devoicing of an obstruent reduces markedness, this does not explain why devoicing only happens in the plural, and not in the phonologically crucially identical singular form. Even if markedness constraints forcing devoicing could be restricted to the plural forms, this seems to be at odds with the fact that forms which have unvoiced obstruents in the singular voice them in the plural forms.

Alderete (2001) (the same analysis can also be found in Alderete, 1999) takes these problems as evidence that OT has to be complemented by a new constraint type, so-called Transderivational Antifaithfulness constraints which require that the output of a derived form and the output of its morphological base differ for a specific property. More specifically, Alderete assumes that for every faithfulness constraint such as IDENT [voice], there is a corresponding antifaithfulness constraint (here \neg IDENT[voice]):

(4) **Faithfulness and Anti-faithfulness for [voice]**

- a. IDENT[voice]
Corresponding segments agree in the feature [voice].

b. \neg IDENT[voice]

It is not the case that corresponding segments agree in the feature [voice].

The tableau in (5) shows how (4b) ranked above (4a) allows to derive voicing exchange in Luo. \neg IDENT[voice] requires to change the voicing of at least one segment which rules out the c.-candidates. However, additional voicing changes as in the b–candidates are blocked by IDENT[voice]:

(5) **Voicing Exchange in Luo as Antifaithfulness**

Base	Derivative	\neg IDENT[voice]	IDENT[voice]
i. /bat/	☞ a. bed-e		*
	b. ped-e		**!
	c. bet-e	*!	
ii. /cogo/	☞ a. cok-e		*
	b. jok-e		*!*
	c. cog-e	*!	

Additionally, other constraints not discussed in detail by Alderete are necessary to ensure that the voicing change occurs consistently in the last root consonant to block e.g. **pet-e**, which fares equally well as (i-a) since it differs from /bat/ by a voicing change in the initial stop.

Alderete claims further that, in contrast to faithfulness constraints, TAF constraints are in general morphologically triggered, i.e. every TAF constraint is restricted to specific morphological constructions which means in most cases particular affixes. Thus \neg IDENT[voice] is associated to the plural affixes **-i** and **-e**, but not to the third plural allomorph **-ni** which does not exhibit voicing exchange:

(6) **No Voicing Exchange with plural -ni**

- a. kombe (sg.) komb-ni (pl.) ‘hole in a tree’
- b. poko (sg.) pokni (pl.) ‘arm’

3 A fuller picture of the data

While Alderete’s analysis captures two important patterns in Luo plural formation, it predicts other types of alternations which are not or only marginally attested in the language, and excludes other patterns which are well-documented. First, there are no nouns following the hypothetical alternation in (7), where a noun ends in a voiced obstruent in the singular which becomes unvoiced in the plural:

- (7) *bad (sg.) bet-e (pl.)

In fact Tucker (p. 94) explicitly states that “the voiced consonants b, dh, d, g, y cannot occur in final position”. A second pattern which is predicted to occur regularly according to Alderete’s analysis are vowel-final roots which have a voiceless obstruent in the singular and a voiced one in the plural. This pattern is exemplified by the nouns in (8):

(8) **Vowel-final [-vc] → [+vc] Alternations**

- a. agoko (sg.) agog-e (pl.) ‘chest’ (p. 491)
- b. koti (sg.) kod-e (pl.) ‘coat’ (Okoth-Okombo, 1982:??)
- c. ongeti (sg.) ongede (pl.) ‘blanket’ (Okoth-Okombo, 1982:??)

However, the example in (8a) is the only example of this type in Tucker’s grammar. (8b) and (8c) are loanwords cited in Okoth-Okombo (1982).² Thus the status of this pattern is at most marginal in Luo. On the other hand, not all noun roots which take -e as their plural suffix have final consonants or obstruents which alternate for voicing. (9) contains cases with vowel-final, and (10) with consonant-final singular forms:

(9) **Vowel-final non-alternating roots with [-vc] obstruent**

- a. cupa (sg.) cup-e (pl.) ‘bottle’
- b. othitho (sg.) othit-e (pl.) ‘small thing’
- c. pata (sg.) pat-e (pl.) ‘hinge’
- d. okoco (sg.) okoc-e (pl.) ‘neck rest of sisal trunk’

(10) **Consonant-final non-alternating roots with [-vc] obstruent**

- a. ip (sg.) ip-e (pl.) ‘tail’
- b. ŋut (sg.) ŋut-e (pl.) ‘neck’
- c. lak (sg.) lek-e (pl.) ‘tooth’
- d. bath (sg.) bath-e/beth-e (pl.) ‘side’

In addition, there is at least one word with a voiced obstruent in the singular which gets not unvoiced in the plural:

- (11) ŋudi (sg.) ŋud-e (pl.) ‘neck of meat’

(12) summarizes the voicing alternation patterns found in Luo and to which degree they are documented in the data:

²See section 5.6 for a discussion on the relevance of loanwords for voicing polarity.

(12) Vicing Patterns in Luo

		singular	plural	
V-final	a.	[-voice]	[+voice]	well-attested
	b.	[-voice]	[-voice]	
	c.	[+voice]	[-voice]	marginal
	d.	[+voice]	[+voice]	
C-final	e.	[-voice]	[+voice]	well-attested
	f.	[-voice]	[-voice]	
	g.	[+voice]	[+voice]	not attested
	h.	[+voice]	[-voice]	

The analysis I propose reflects the differences in occurrence between these patterns by providing an analysis based on general phonological constraints for the well-attested patterns (12-a,b,e,f), while the marginal patterns (12-c,d) are derived by morphological particularities of the involved roots. In particular I propose that nouns which are underlyingly voiceless do never alternate which accounts for the vowel- and consonant-final roots which have a voiceless final obstruent in singular and plural (12-b,f). Thus alternating roots have all underlyingly a voiced final consonant. What happens with consonant-final roots (12-e) which are underlyingly voiced is straightforward final devoicing. Accordingly the noun **bat** has the underlying form **bad** which surfaces in the plural, while **d** is devoiced in word-final position to **t**. What causes final devoicing is a general constraint of Luo which allows voiced obstruents only if they are licensed by an immediately following (voiced) sonorant. Hence in vowel-final roots (12-a) such as **kidi**, the underlyingly voiced **d** surfaces as such since its voicing is licensed by the following **i**. In the plural, the root vowel, while deleted on the surface (**kidi-e** → **kide**), blocks licensing of **d** by suffixal **e** since licensing is not possible between segments which are underlyingly non-adjacent. This analysis will be developed in technical detail in the following two sections.

4 Preliminaries

4.1 Theoretical Framework

The version of OT I use here is a variant of the Coloured Containment version of Optimality Theory developed in Revithiadou (2007) and van Oostendorp (2006b). In particular, segments features and autosegmental links are never literally deleted in the output, and epenthetic material is distinguished from epenthetic structure by morphological colouring: Each morpheme has a unique color different from the colors of all other morphemes, and each non-epenthetic element in phonological structure wears the specific colour of its morpheme throughout the grammar which distinguishes it from epenthetic elements which are colour-less. In contrast to Revithiadou and van Oostendorp's approach which adapts Goldrick's (2000) tur-

bidity model, I will implement these intuitions in a more simple-minded way, where morphological colour implies morphological visibility and vice versa (hence epenthetic material is by definition morphologically invisible) and phonological entities are either phonetically visible or invisible resulting in a 2×2 typology of phonological visibility:

(13) **Typology of Phonological Visibility**

		morphologically visible	
		+	-
phonetically visible	+	realized underlying material	epenthetic material
	-	unrealized underlying material	

Output representations conform to the three unviolable wellformedness conditions in (14):

(14) **Unviolable Wellformedness Conditions on Phonetic Visibility**

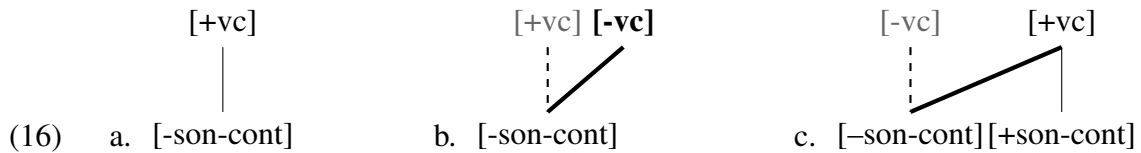
- a. Phonological objects are either morphologically or phonetically visible (or both)
- b. Phonetically visible links connect only phonetically visible structure
- c. Phonetic structure must be phonetically linked to higher phonetic structure (if there is any)

(14a) captures the intuition that structure which is neither motivated by morphological nor by phonetic evidence is uninterpretable (and utterly useless). It follows that the fourth cell in (13) is empty, and the inventory of visible elements reduces to three possibilities: morphologically visible material which is phonetically (un-)visible and epenthetic material (phonetically visible material which is morphologically invisible). (15) illustrates the notation I adopt to indicate visibility. Material which is morphologically and phonetically visible is written in normal print, morphological material which is phonetically invisible appears shaded, and phonetic material which is morphologically invisible is written in boldface. Hence, all three strings in (15) are phonetically interpreted as [bete]. In (15a) this corresponds to underlying /bete/, while the input for (15b) is /bet/ (with epenthetic [e]), and (15c) shows underlying /betep/ with deleted /p/:³

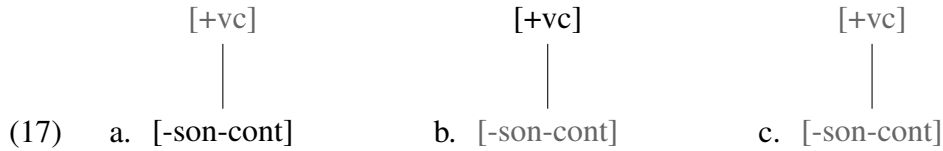
(15) a. b e t e b. b e t e c. b e t e p

Since for association lines, shading is difficult to read, I will replace it by dashed lines. In (16), a. shows an underlyingly voiced stop which is realized faithfully, (16b) is an underlyingly voiced stop under overt (possibly final) devoicing ([-vc] and its link are epenthetic), and (16c) shows a case where a stop assimilates to a following nasal:

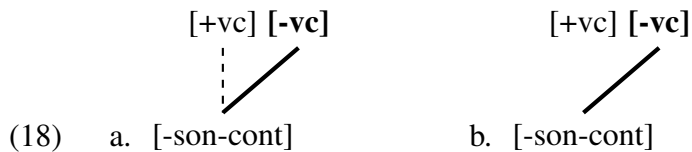
³The advantage of this notation is that it doesn't require any diacritics and can be combined with colouring wherever representation of morphological colouring is relevant and possible.



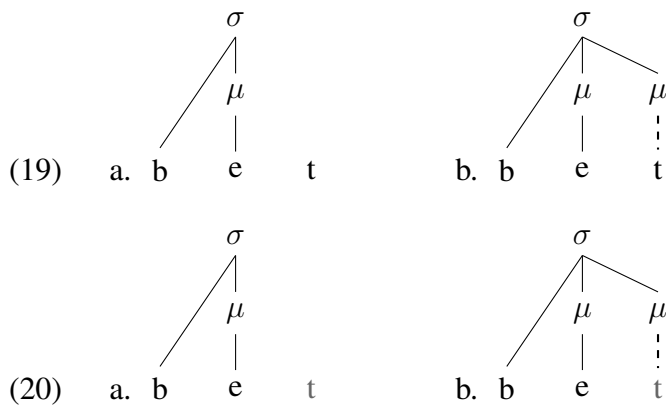
The condition in (14-b) bans configurations as in (17), where elements which are phonetically invisible are connected by a phonetically visible association line:



The condition in (14-c) corresponds to stray erasure (Steriade, 1982; Itô, 1988). It excludes floating features in surface representations since this would require either the representation in (18a) or (18b) which both violate (14-c).



The same condition also has the effect that “extrametrical” segments must be phonetically invisible since the structures in (19) are excluded, only the corresponding structures in (20) are possible:

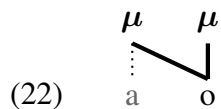


Let us finally see how the framework proposed here can capture cases of opacity which are the central motivation for the turbid version of Coloured Containment. An often cited case in point is the deletion of vowels under hiatus before another vowel in Luganda which leads to compensatory lengthening of the surviving vowel (Goldrick, 2000):

(21) **Compensatory Lengthening in Luganda**

- a. /ka + tiko/ → katiko ‘mushroom’
- b. /ka + oto/ → ko:to ‘fireplace (dim.)’
- c. /ka + ezi/ → ke:zi ‘moon (dim.)’

These data lead to an opacity problem for Correspondence Theory because the mora associated to the first vowel (**a** in (21b)) seems to reassociate to the second vowel (**o** in (21b)), but under Richness of the Base (Prince and Smolensky, 1993) nothing forces **a** to project a mora in the first place since constraints requiring vowels to associate to moras apply like any other OT-constraint to outputs, not to inputs. However if van Oostendorp (2006a:8) is right in assuming that “an association line is not a phonological object on a par with features and segments, but . . . rather describes a relation between two phonological objects”, association lines are exempt from the condition in (14-a) and there are association lines which are both morphologically and phonetically invisible. Assuming a constraint which requires that every vowel (whether phonetically visible or not) is associated to a phonetically visible mora⁴, an output structure as (22) results for (21b) (where a dotted line indicates a link which is phonetically and morphologically invisible):



The visibility of the association line which links the leftmost mora in (22) to **a** follows from the representation: Since the mora is epenthetic, the association line must be morphologically invisible. Since **a** is phonetically invisible, the association line must also be phonetically invisible by (14-b). Compensatory lengthening results from a requirement that phonetically visible moras must be linked to phonetically visible root nodes.

4.2 Constraints

The constraints I assume are fairly standard or motivated straightforwardly by empirical evidence, but the technical details of implementation are crucial for the analysis of voicing polarity in section 5. Following Wetzels and Mascaró (2001), I assume that feature Identity is captured by different identity constraints for [+voice] and [–voice] in the following format:

(23) **ID [+vc]:** Every segment which is morphologically associated with [+vc] is phonetically associated with [+vc]

(24) **ID [–vc]:** Every segment which is morphologically associated with [–vc] is phonetically associated with [–vc]

Note that these constraints do not penalize segments which are linked to different voicing features in input and output as long as the value of the feature is the same. In other words, they require linking to identical types, not to identical tokens.

⁴Strictly speaking the constraint must require that each vowel is linked to a mora which is not linked to another vowel by an association line of the same phonetic visibility status. This is necessary to avoid that **a** and **o** in ?? link to one and the same mora, but extends also to cases of two overt vowels which do generally not share moras.

Further, I follow Lombardi (1994, 1995) in assuming that final devoicing and a number of other processes involving voicing are triggered by a licensing condition on the feature [+voice] which I formulate as in (25). Incorporating a basic insight from Steriade (1997)⁵, (25) is not restricted to licensors and licensees which are in the same syllable, but requires only that both elements are phonetically adjacent and are linked to the same voicing feature:

- (25) **LICENSING CONSTRAINT (Lombardi, 1994, 1995; Steriade, 1997):**
 A [+vc] obstruent should be phonetically visible through an immediately following sonorant in the same voicing span.

I take the voicing of obstruents and right-adjacent nasals to be governed by the constraint in (26):

- (26) **(TN):** Obstruents and following nasals should be linked to the same voicing feature.

This accounts for example for cases where pre-nasal obstruents get voiced as in Tangale where underlying obstruents get voiced before the nasal-initial suffix **-no** (Kidda, 1993; Kenstowicz, 1994):

- (27) **Stop Voicing before nasals in Tangale**

‘N’	[lo:]	[bugat]	[tugat]	[aduk]	[kuluk]
‘the N’	[lo:-i]	[bugat-i]	[tugad-i]	[aduk-i]	[kulug-i]
‘my N’	[lo:-no]	[bugad-no]	[tugad-no]	[adug-no]	[kulug-no]
‘your N’	[lo:-go]	[bugat-ko]	[tugad-go]	[aduk-ko]	[kulug-do]
‘her N’	[lo:-do]	[bugat-to]	[tugad-do]	[aduk-to]	[kulug-do]
	‘meat’	‘window’	‘berry’	‘load’	‘harp’

While Luo does not exhibit voicing assimilation of this type, I will show in section 5 that (26) leads to the licensing of voiced obstruents before nasals which would otherwise be devoiced.

The last type of constraints we need for an analysis of Luo voicing polarity are constraints penalizing autosegmental spans which skip intervening elements. Besides the more familiar constraint in (28) which only counts skipping of phonetically realized elements,⁶ it is natural in a containment model of phonological representations that intervention effects of this type generalize to phonetically invisible elements. This intuition is captured by the constraint in (29):

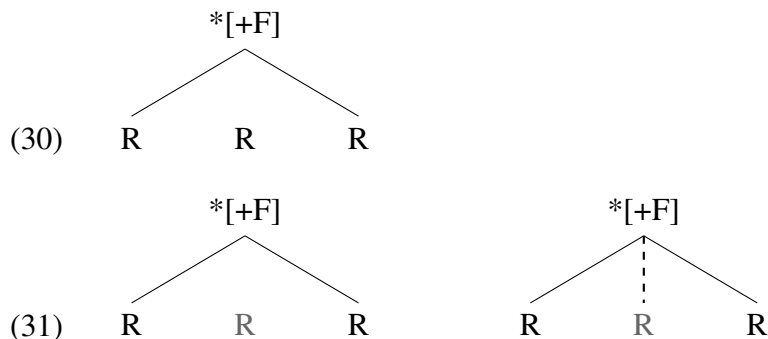
- (28) **NOSKIPPING-VIS:** Phonetically visible association spans
 should not skip phonetically visible elements

⁵Steriade shows that in Lithuanian voiced obstruents are only possible if they are followed by a sonorant even though both are separated by a syllable boundary. This follows from the licensing constraint as it is formulated here, but not from Lombardi’s original version.

⁶This constraint is often claimed to be inviolable (Archangeli & Puleyblank, ??), a point which is not crucial for the argumentation here.

(29) **NOSKIPPING:** Phonetically visible association spans should not skip elements

Thus the configuration in (30) violates both, (28) and (29), but the structures in (31) violate only (29):



Evidence for the generalized Noskipping constraint in (29) comes from assimilation data in different varieties of Dutch. Thus van Oostendorp (2004) observes that in Hellendoorn Dutch, nasal suffixes assimilate in place to preceding obstruents (32a,c). However, in past tense forms, where an intervening underlying obstruent (the past tense suffix) is deleted, no assimilation takes place (32b,d):

(32) **Blocking of Place Assimilation in Hellendoorn Dutch**

	Underlying	Surface
a. 'to work'	wɛrk-n	wɛrkŋ
b. 'we worked'	wɛrk-t-n	wɛrkŋ
c. 'to hope'	hop-n	hopŋ
d. 'we hoped'	hop-t-n	hopŋ

Similarly, in Aalst Dutch nasals regularly assimilate to following obstruents in place across word boundaries (33a), but fail to assimilate if the underlying representation contains an intervening schwa (the gender marker) (33b):

(33) **Blocking of Place Assimilation in Aalst Dutch**

	Underlying	Surface
a. 'handsome guy'	schoo/n/ ventje	schoo/ŋ/ ventje
b. 'beautiful woman'	schoo/nə/ vrouw	schoo/n/ vrouw

Assuming that nasal assimilation is triggered by a constraint which requires that nasals are associated to the same place features as preceding stops, written here simply as PA ('Place Assimilation'), the contrasts in (32) follow from higher ranked NOSKIPPING (abbreviated in

the following as NOSKIP) as shown in (34) and (35).⁷ The brackets in (34b) and (35b) indicate that the included segments are linked to the same place feature.

(34) **Input:** wɛrk-n, ‘to work’

	NOSKIP	PA
a. wɛrk-n		*!
☞ b. wɛr(k-ŋ)		

(35) **Input:** wɛrk-t-n, ‘we worked’

	NOSKIP	PA
☞ a. wɛrkt-n		*
b. wɛr(kt-ŋ)	*!	

The Aalst Dutch data can be captured by the same type of analysis.

⁷Note that t cannot be linked to the same place feature as k and the nasal since this would violate condition (14-b).

5 Voicing Alternations in Plural Forms

The constraints introduced in section 4.2 allow now a straightforward account for the basic patterns of voicing polarity in Luo.

5.1 Basic Analysis

I take consonant-final roots which exhibit a voiced obstruent in the singular, and a voiceless one in the plural as a straightforward case of final devoicing. In the singular, a voiced obstruent in word-final position violates the LICENSING CONSTRAINT. Since extending the voicing span of the obstruent to the left (indicated by the brackets in (36c)) would not remediate this situation, and other repair operations (especially deletion of the obstruent or insertion of a vowel after the obstruent) seem to be generally excluded in Luo, the only option is to devoice the final obstruent (recall that devoicing amounts technically to the structure of b. in (16)):

(36) **Input:** ar**ib**, ‘milky way’

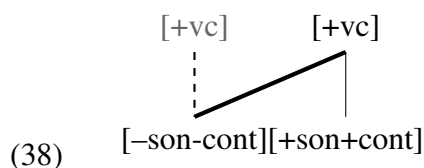
	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ a. ar ip					*
b. ar ib				*!	
c. ar (ib)				*!	

In plural forms, the root-final obstruent is followed by a vowel which opens the possibility to satisfy both LICENSING and ID [+vc] by forming a voicing span which comprises both the obstruent and the vowel (37a):

(37) **Input:** ar**ib**-e, ‘milky way (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ a. ar i (b-e)					
b. ar ip -e					*!
c. ar ib -e				*!	

The voicing span in (b-e) corresponds actually to the structure in (38), which requires relinking, but satisfies Id [-vc] since both sounds which link to [+vc] underlyingly do the same in the phonetically visible representation.



The same strategy of licensing a voiced obstruent by relinking it to the [+vc] feature of a following vowel applies in the singular forms of vowel-final roots with an underlyingly voiced

obstruent. Since nothing intervenes, voicing of the obstruent is licensed without complications by forming a [+vc] span with the following vowel:

(39) **Input:** kidi, ‘stone’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ki(di)					
kidi				*!	
kiti					*!

NO SKIPPING gets only relevant in the corresponding plural form where the stem-final vowel is deleted, hence phonetically invisible. Voicing of **d** cannot be licensed by **i** since the LICENSING CONDITION requires licensing by a phonetically visible segment. However to be licensed by **e**, **d** would have to be linked to the same voicing feature skipping **i**, (40a) which incurs a fatal NoSkip violation:

(40) **Input:** kidi-e, ‘stone (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
a. ki(di-e)			*!		
b. ki(di)-e				*!	
☞ c. kiti-e					*

Since the LICENSING CONSTRAINT only allows voiced obstruents before sonorants, but does not require voicing in this position, roots with final obstruents which are underlyingly voiceless remain voiceless in the output due to high-ranked Id [-vc]:

(41) **Input:** ip, ‘tail’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ip					
ib	*!			*	

(42) **Input:** ip-e, ‘tail (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ip-e					
i(b-e)	*!				
ib-e	*!			*	

The same holds if the voiceless obstruent is followed by a root-final vowel:

(43) **Input:** osi:ki, ‘stump’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ osi:ki					
osi:gi	*!			*	
osi:(gi)	*!				

(44) **Input:** osiki-e, ‘stump (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ osi:ki-e					
osi:gie	*!			*	
osi:(gie)	*!				

Summarizing, apparent polarity follows from a unique phonological source: Underlyingly voiced obstruents can only retain voicing if they are followed without intervention by a sonorant. For CVC roots this means devoicing in the singular since this results in a word-final obstruent. On the other hand, CVCV roots devoice in the plural because the deleted root-final vowel blocks licensing while voicing is stable in singular forms where it is licensed by the following vowel.

5.2 *The status of [y]*

For one sound, just the same voicing alternation discussed so far for obstruents seems to extend to a sonorant sound and to involve also a manner alternation. The segment transcribed [y] by Tucker is devoiced and hardened to [ç] in the singular of consonant-final roots, and the plural of vowel-final roots, hence exactly the same contexts where voiced obstruents devoice:

(45) **Stopping**

sg	pl	
tic	tiy-e	‘work’
ic	iy-e	‘belly’
biye	bic-e	‘white ant(s)’
ŋga:yɪ	ŋge:c-e	‘paddle’

Moreover, as Tucker notes, [y] never occurs in word-final position just as if it were an obstruent, and no similar pattern is found with vowel-final roots, i.e., there are no hypothetical alternations like **bice** ~ **biye**. All these facts follow naturally if that the sound transcribed as [y] is actually analysed as a voiced fricative, hence [j]⁸ and Luo systematically lacks the voiceless counterpart [ç] which I will exclude here simply by the ad-hoc constraint *ç. (46) shows

⁸A comparable case of an apparent approximant which behaves phonologically as a fricative is the [j] sound in German (cf. Eisenberg, 1998).

how this captures devoicing and stopping for the noun **ic**, ‘belly’. The analysis for **biye** is analogous:

(46) **Input:** ij-e, ‘belly’

	*ç	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ic						*
ij					*!	
iç	*!					*

5.3 Plurals in -ni

An apparent problem for a purely phonological account of voicing polarity is that it does not occur with nouns forming their plural by the affix **-ni**⁹ instead of **-e** or **-i** (cf. Alderete, 2001:210):¹⁰

(47) **Nouns forming the plural with -ni**

sg	pl	
go:go	go:gni	“lump of clay”
pe:do	pe:d-ni	“thorny Rambler”
aba:ja	abe:j-ni	“large spear”
oke:be	oke:bni	“rich man”
po:ko	po:k-ni	“gourd”
ŋga:to	ŋge:t-ni	“clog”
fu:ko	fu:k-ni	“mole”
kue:si	kue:s-ni	“pipe”

LICENSING CONSTRAINT and NO SKIP let expect that in a form such as **go:gni** (represented as go:goni) the medial **g** is devoiced since it cannot be licensed across **o** (“☞” indicates the empirically correct candidate which is suboptimal under the given ranking):

(48) **Input:** gogo-ni, ‘lump of clay (pl.)’

	NO SKIP	LC	ID [+vc]
☞ a. go(go-n)i	*!		
☞ b. goko-ni			*
c. gogo-ni		*!	

⁹According to Tucker (p.127) nouns which take **-ni** are much rarer than those with select **-e** or **-i**.

¹⁰Tucker (p.127) cites only 3 consonant-final roots which take **-ni**. All three end in sonorants and do not exhibit any voicing alternation.

However both constraints are dominated by (TN) which demands that **g** and **n** are linked to the same [+vc] feature even though this leads to a NoSkip violation. Since the configuration (go-n) satisfies the LICENSING CONSTRAINT (**g** and **n** are phonetically adjacent and in the same voicing span) voicing of **g** is retained:

(49) **Input:** gogo-ni, ‘lump of clay (pl.)’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ a. go(go-n)i			*		
b. gogo-ni		*!		*	
c. goko-ni		*!		*	*

In the corresponding singular form voicing is maintained as with other nouns with final voiced obstruent:

(50) **Input:** gogo, ‘lump of clay’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ g(ogo)					
gogo				*!	
goko					*!

Nouns with underlying voiceless obstruent keep voicelessness throughout singular and plural by the protection of undominated ID [-vc]:

(51) **Input:** poko, ‘gourd’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ poko					*
p(ogo)	*!				
pogo	*!			*	

(52) **Input:** poko-ni, ‘gourd’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ poko-ni		*			
pogo-ni	*!	*		*	
po(go-n)i	*!		*		

5.4 Nouns with empty suffixes

The account of nouns taking **-ni** extends straightforwardly to a class of nouns which contain what Tucker calls CV suffixes: final CV syllables which are dropped in plural forms:

(53) Nouns with CV Suffixes

sg	pl	
kedh-no	keth-e	“bile, gall bladder”
kog-no	ko:k-e	“nail, claw”
kud-ni	ku:t-e	“insect”
njok-la	njok-ni	“thread worm”
lihumb-lu	lihumb-ni	“backbone”

Since **-no**, **-ni** and **-la** seem not to have a clear meaning component and are not involved in productive affixation processes, I assume that they are semantically empty morphs (Inkelas and Zoll, 2005) which are lexically part of the nouns with which they appear, and are deleted in plural forms due to phonological constraints. For nouns with an underlying voiced obstruent and plural **-e** this results in ‘voicing polarity’ for the plural form since voicing of **g** cannot be licensed across the deleted empty suffix (here: **-no**):

(54) Input: kog-no, ‘nail,claw’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ ko(gn)o					
kog-no		*!		*	
kok-no		*!			*

(55) Input: kog-no-e, ‘nail,claw’

	ID [-vc]	(TN)	NO SKIP	LC	ID [+vc]
☞ kokno-e					*
k(ogno-e)			*!		
kogno-e				*!	

In a form like **njok-ni** voicelessness of the root-final obstruent is again retained due to high-ranked ID [-vc].

5.5 *The Deletion of noun-final material*

Let us now turn to the question why stem-final material (i.e., root-final vowels and empty CV-suffixes) is consistently deleted in plural forms. While deletion of a root-final vowel before suffixal **-e** or **-i** could be argued to follow from hiatus avoidance or more technically the constraint ONSET, this reasoning would not extend to **go:go/go:g.ni** where ***go:goni** would not involve any hiatus and deletion of root-final **o** results in more, not less NOCODA violations.

On the other hand the relevant deletion processes consistently result in stress on the penultimate syllable of the word.¹¹ Since stress in Luo nouns falls invariably on the single root vowel of a CVC root and the penultimate vowel of a polysyllabic, root, the only possibility to maintain penultimate stress position under affixation is to delete vocalic material.

Assuming that main stress in Luo involves binary trochaic feet, the deletion processes can then be derived from four constraints:¹²

(56) **Constraints governing stem-final deletion in plural forms**

FAITH STRESS	Underlyingly stressed syllables are also stressed in the output
ALLFTRT	The right edge of metrical feet is aligned to the right edge of the prosodic word
MAX _{RIGHT}	Avoid phonetically invisible segments at the the right edge of the prosodic word
AFFIX-INTEGRITY	Affixes should be fully realized or fully unrealized

MAX_{RIGHT} is a positional faithfulness constraint (Beckman, 1998) penalizing deletion at the right edge of the prosodic word. Note that MAX_{RIGHT} predicts for cases of multiple affixation that it is always the rightmost affix or affix vowel which is retained. AFFIX-INTEGRITY effects have long been noted in the literature on Bantu reduplication (Mutaka and Hyman, 1990; Downing, 1999, 2000) The constraint is violated by partially deleted affixes, but satisfied if all segments of an affix are retained or all segments of an affix are deleted. This is shown schematically in (57) for a hypothetical prefix **ba**:

¹¹Following Tucker I have not explicitly transcribed stress since it is usually indicated by vowel length.

¹²FAITH STRESS and ALLFTRT (Kager, 1999) are fairly standard.

(57) **Input:** ba-Base

	AFFIX-INTEGRITY
☞ a. ba-Base	
☞ b. ba-Base	
c. ba-Base	*!
d. ba-Base	*!

(58) shows that for the plural of **osiki**, ‘stump’ deletion of a vowel is inevitable to satisfy both FAITH STRESS and ALLFTRT leading to the elimination of (58c,d). That the stem vowel is deleted, and not the suffix vowel as in (58b) follows from MAX_{RIGHT}:

(58) **Input:** osíki-e, ‘stump (pl.)’

	FAITH STRESS	ALLFTRT	MAX _{RIGHT}	AFF-INT	MAX
☞ a. o.[sí.ki-e]					*
b. o.[sí.ki]-e			*!		*
c. o.[sí.ki]-e		*!			
d. o.si.[kí-e]	*!				

AFFIX-INTEGRITY gets decisive in plural forms with **-ni** where a candidate with deletion of stem **o** and affixal **n** (59b) would not violate MAX_{RIGHT}:

(59) **Input:** póko-ni, ‘gourd (pl.)’

	FAITH STRESS	ALLFTRT	MAX _{RIGHT}	AFF-INT	MAX
☞ a. [póko-ni]					*
b. [pó.koni]				*!	*
c. [pó.ko-ni]			*!		**
d. [póko]-ni		*!			
e. po.[kó-ni]	*!				

AFFIX-INTEGRITY also blocks partial deletion of the empty suffix for nouns such as **kóg-no**, ‘nail, claw’ (60b):

(60) **Input:** kóg-no-e, ‘nail, claw (pl.)’

	FAITH STRESS	ALLFTRT	MAX _{RIGHT}	AFF-INT	MAX
☞ a. [kóg.g-no-e]					**
b. [kóg-no-e]				*!	*
c. [kóg-no]-e			*!		*
d. [kóg-no]-e		*!			
e. kog-[nó-e]	*!				

5.6 Exceptions and Suppletion

While the analysis so far captures the overwhelming majority of noun plurals which display (and do not display) voicing changes, there is a handful of exceptions. In this section, I will show that the phonological behaviour of these exceptional nouns follows straightforwardly if they are analyzed as cases of morphological suppletion.

The first case of this type is the noun **nudi** for which Tucker reports that it retains voicing in the plural (cf. (11) repeated as (61)):

(61) η udi (sg.) η ude (pl.) ‘neck of meat’

The analysis developed here seems to predict incorrectly devoicing of **d** instead (☛ indicates the technically suboptimal, but empirically correct candidate):

(62) **Input:** η udi-e, ‘necks of meat (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☛ a. η u(di-e)			*!		
☞ b. η uti-e					*
c. η udi-e				*!	

However, this result depends on the assumption that **nudi** is a morphologically regularly decomposable noun. Now Luo as virtually any other inflecting language has suppletive stem allomorphs for a small number of roots. Thus in (63a-c), the plural is formed without further affixation by a suppletive root. In (63d), **-i** can be analysed as a plural suffix, but **pi:r** remains as a suppletive allomorph of **pa:kɔ**. In (63e) and (63f) singular and plural stems are clearly related, but no other root in the language shows a change of **l** to **t** or from **r** to **nd**, so these seem to be also suppletive roots combining with the regular plural suffix **-e**:

(63) **Suppletive Stem Allomorphs**

sg	pl	
a. dha:kɔ	mo:n	‘woman’
b. dha:la	mier	‘village’
c. dhra:ŋ	dho:k	‘cow’
d. pa:kɔ	pi:r-i	‘girl’
e. lɛl	liet-e	‘anthill, grave’
f. we:r	we:nd-e	‘song’

Crucially while there are cases where suppletive allomorphs bear no resemblance to each other, there are also forms where suppletive morphs still show a certain similarity to each other. All we have to do to derive the behaviour of **nudi** is to assume that it is suppletive in the same

way as the roots in (63), vizibly that it has a suppletive plural allomorph which lacks the final **i** (**ɲud**) in contrast to the vowel-final singular allomorph (**ɲudi**). As a consequence the suppletive allomorph retains voicing since licensing is not blocked by an intervening deleted vowel:

(64) **Input:** ɲud-e, ‘necks of meat (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ɲu(d-e)					
ɲute					*!
ɲud-e				*!	

CVCV roots which exhibit voicing change from voiceless (singular) to (voiced) in the plural pose a similar problem. Okoth-Okombo (1982) cites two cases of this type (65a-b), and there is a single example from Tucker’s grammar (65c):

(65) **CVCV with [-vc] → [+vc] change**

- a. koti (sg.) kode (pl.), ‘coat’
- b. ongeti (sg.) ongede (pl.) ‘blanket’
- c. agoko (sg.) agoge (pl.) ‘chest’

Again an analysis invoking listing of suppletive allomorphs (**koti** for the singular, and **kod** for the plural) makes the correct predictions:¹³

(66) **Input:** koti, ‘coats (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
ko(di)	*!				
kodi	*!			*	
☞ koti					

(67) **Input:** kod-e, ‘coats (pl.)’

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
☞ ko(d-e)					
kote					*!
kod-e				*!	

The loanword examples in (65) together with the regularly patterning loanwords in (68) are taken by Okoth-Okombo (1982:54) as decisive evidence for a non-phonological analysis of voicing polarity.

¹³This type of alternation could also be derived under the assumption that the singular is a ‘singulative’ derived from the plural by affixation of **-e** and subsequent deletion of root-final **e**. This alternative is not completely implausible given the broad distribution of singulative morphology in other Western-Nilotic languages as in Shilluk (Gilley, 1992:62).

(68) **Regularly Patterning Loanwords**

- | | sg | pl | |
|----|-----------|-----------|-------------------|
| a. | ɔk | ɔg-e | ‘chalk’ (English) |
| b. | buk | bug-e | ‘book’ (English) |

A loanword such as **book** so the argument goes, has necessarily an underlying form ending in a voiceless obstruent since speakers of Luo never hear an English input with a voiced obstruent such as **buge**. However as recent experimental work shows, integration of non-words into a language often leads to underlying forms not directly evident in the source. Thus Ernestus and Baayen (2003) show that in Dutch, a language with final devoicing speakers confronted experimentally with non-words ending in a voiceless obstruent often reanalyze these as ending underlyingly in the corresponding voiced obstruent based on the lexical frequency of similar words in the language. Similarly Nevins and Vaux (2006) report results from Turkish, another language showing final devoicing, that speakers frequently infer underlying forms with voiced final obstruents from inputs with final voiceless obstruents, both with non-word and in loanword adaptation, again based on lexical frequency and a number of other factors such as syllable number. As Dutch and Turkish Luo has also loanwords which show no voicing alternation:

(69) **Luo Loanwords without Voicing Alternation**

- | | sg | pl | |
|----|-----------|-----------|--------------------|
| a. | cu:pa | cu:p-e | ‘bottle’ (Swahili) |
| b. | pa:ta | pa:t-e | ‘hinge’ (Swahili) |

Thus loanword adaptation does not seem to set Luo apart from other languages with regular final devoicing and is perfectly compatible with an approach where voicing polarity derives from the phonological licensing of voicing. Given the empirical facts it seems to be the case that under any analysis some nouns must be treated as exceptions. Crucially, the analysis proposed here minimizes the number of nouns which require exceptional treatment and implements this in a way which requires nothing else than the well established device of morpheme suppletion.

6 Voicing Mutation in Possessive Forms

Apparent voicing polarity also appears in a second place in the Luo noun paradigm, namely in specific noun forms in which head nouns appear in possessor and related constructions. I will call these forms “nominal possessor forms”. (70) shows two illustrative cases in appropriate contexts. (71) and (72) contain additional examples:

(70) Possessive Constructions with Nominal Possessor Forms

Bare Root	ki·di		‘a stone’
	stone		
Possession Form	kit	gôt	‘a stone from a hill’
	stone	hill	
Bare Root	o·t		‘a nest’
	nest		
Possession Form	od	winyó	‘a bird’s nest’
	nest	bird	

(71) Nominal Possessor Forms

- a. yath (root) yadh (poss.) ‘palm’
- b. kuot (root) kuod (poss.) ‘shield’
- c. tic (root) tij (poss.) ‘work’

(72) Nominal Possessor Forms

- a. udi (root) ut (poss.) ‘bird’
- b. tigo (root) tik (poss.) ‘neck’
- c. kitabu (root) kitap (poss.) ‘book’

Nominal possessor forms seem to provide direct counterevidence to the assumption that polarity is partially triggered by word-final devoicing since in forms like [od] no devoicing happens. In fact Alderete (2001:207) cites them as additional evidence against a phonological account of Luo voicing alternations. I will show here that the nominal possessor forms are a straightforward case of morphological opacity: the voiced stop in [od] is licensed in a morphologically related (possessor) form from which [od] is derived, and exceptional maintainance of the voiced stop is due to faithfulness to the morphological input. Since the argument requires to take into account the full array of possession morphology in the language, subsection 6.1 gives an overview of the morphosyntactic system of possession marking in Luo and subsection 6.2 provides a phonological analysis of the apparent polarity data.

6.1 Possession Marking in Luo

Besides the nominal possessor forms exemplified in (70) (named the “high-tension” construction by Tucker), Luo exhibits a second pattern for marking possession by a noun which Tucker calls the “low-tension” construction. (73) shows the noun **co-go** in both constructions. Crucially, stem-final vowels are lost in high-tension forms, but retained in low-tension forms, and low-tension forms do not exhibit any voicing (or other alternations) of the stem-final consonant:

(73) **Low-tension and high-tension nominal possessor forms** (p. 202)

- a. *gagi nyathi*
cowry shell(s) child
‘the child’s cowry shell(s)’ (high tension construction)
- b. *gak nyathi*
cowry shell(s) child
‘the child’s cowry shell(s) (low tension construction)’

While for many nouns such as **gagi** both constructions seem to be interchangeable with respect to use and meaning, for many others only one of both is available, and in a third substantial group of nouns low-tension and high-tension nominal possessor forms convey different meanings:

(74) **Low-tension and high-tension nominal possessor forms** (p. 199)

- a. *cogo guok (low tension)*
bone dog
‘the dog’s bone’
- b. *cok dhiaŋ (high tension)*
bone cow
‘a cow bone’

Corresponding to the two nominal possessor constructions which are restricted to full-NP possessors there are two paradigms of forms which are used for pronominal (overt or zero) possessors. In these forms which I will call “pronominal possessor forms”, the noun bears agreement affixes which agree in person and number with the pronoun (75), where the suffixes partially differ in the high- and the low-tension variant. As with nominal possessor forms, the low tension forms retain the stem-final vowel and exhibit no consonant alternation, while the high-tension variant exhibits the alternation pattern familiar from noun plurals:

(75) **Pronominal Possessive Forms:** ga-gi, cowry shell(s)

a. **high tension**

	sg	pl
1	ga·k-a	ga·k-wa
2	ga·k-i	ga·k-u
3	ga·k-e	ga·k-gi

b. **low tension**

	sg	pl
1	ga·gi-na	ga·gi-wa
2	ga·gi-ni	ga·gi-u
3	ga·gi-ne	ga·gi-gi

(76) and (77) show that both well-documented patterns of voicing (non-)alternation are documented here:¹⁴

(76) **Pronominal Possessive Forms with consistent final voiceless stop**¹⁵

a. mo·ko, ‘affluence’

	sg	pl
1	mo·k-a	mo·k-wa
2	mo·k-i	mo·k-u
3	mo·k-e	mo·k-gi

b. i·t, ‘ear’

	sg	pl
1	i·t-a	i·t-wa
2	i·t-i	i·t-u
3	i·t-e	i·t-gi

(77) **Pronominal Possessive Forms with Voicing Alternation**

a. ki·di, ‘stone’

	sg	pl
1	ki·t-a	ki·t-wa
2	ki·t-i	ki·t-u
3	ki·t-e	ki·t-gi

b. ot, ‘house’

	sg	pl
1	od-a	od-wa
2	od-i	od-u
3	od-e	od-gi

Crucially, also the (high-tension) pronominal possessor forms exhibit polarity, but in a way which is completely compatible with the analysis of noun plurals in section 5. Roots ending in a voiceless stop retain voicelessness throughout according to high-ranked IDENT [-vc] (76). Vowel-final roots with an underlyingly voiced stop undergo devoicing in the possessive forms since voicing in the obstruent cannot be licensed across the phonetically invisible (deleted) final vowel (77a). Consonant-final roots with a final voiced obstruent maintain voicing because voicing is licensed by a following vowel or glide. Note that in **od-gi** there is a voicing span covering both obstruents and the vowel (o(dgi)), hence the vowel licenses voicing in both stops.

¹⁴Of course corresponding paradigms exist for high-tension nominal possessor forms. The only native irregular root is again **agoko**, which voices in possessor forms.

¹⁵The plural forms of **i·t**, ‘ears’ are constructed according to the description of Tucker, where only the singular forms are given.

Finally pronominal possessor forms follow the corresponding nominal possessor form in exhibiting gaps and in conveying (partially) different meanings as illustrated in (78), where for both high tension forms the possessor is animate while it is inanimate for the high-tension forms:

(78) **Low-tension and high-tension nominal possessor forms** (p. 199)

- a. *mbala ruoth* (*low tension*)
scar chief
'the chief's scar'
- b. *mband lweny* (*high tension*)
scar battle
'a battle scar'
- c. *mbala-ne* (*low tension*)
scar-3sg
'his scar'
- d. *mband-e* (*high tension*)
scar-3sg
'its scar'

6.2 *Polarity in Possession Marking as Opacity*

Returning to (high-tension) nominal possessor forms we note that they truncate so that the final syllable is consistently closed (mo·ko ⇒ mok, kidi ⇒ kit). It is a non-trivial question from which morphological base these truncations are derived, but there are two obvious possibilities. First they might be derived directly from the root, and second they might be truncated from the corresponding pronominal possessor forms. Thus **od** in **od winyó** (cf (70)) would be derived as follows:

(79) **Derivation of od, 'house' (nominal possessor form)**

- Root:** od
- Affixation:** od-a
- Truncation:** od

That nominal possessors trigger agreement in the possessed noun just as nominal possessors is typologically rather unspectacular. Such a pattern is found for example in Hungarian:

(80) **Possessive Agreement in Hungarian**

- a. *a ház*
the house
'the house'

- b. *a(z) ö ház-a*
 the (s)he house
 ‘his/her house-3sg’
- c. *a tanár ház-3sg*
 the teacher house
 ‘the teacher’s house’

Hence what would be special about Luo under a derivation as in (79) would only be the fact that nominal possession is additionally marked by truncation of the possessed noun. Evidence for this analysis comes from irregular nouns which show unpredictable consonant changes in nominal possessor forms. Crucially the same changes can be observed in pronominal possessor forms suggesting that both types of possession marking derive from the same morphological base:

(81) **Consonant Changes in Irregular Nouns**

Root	Plural	Pron. Poss	Nom.Poss.	
í·p	í·p·e	í·w·ê	íw	‘tail’
mo	mó·dh·î	mór·ê	mór	‘oil,fat’
rawe·ra	rawé·r·ê	rawe·cé	rawec	‘boy’

Now just as irregular consonant changes of pronominal possessor transfer to nominal possessor forms, so does the phonologically derived (non-)voicing of root-final consonants. Nominal possessor forms is hence comparable to standard cases of phonological opacity under truncation. To take just one such case consider the well-known alternation between [æ] and [ɑ] in many dialects of English, where [æ] cannot appear as the nucleus of a syllable closed by [r] (Kahn, 1980; Benua, 1995):

(82) **English [æ] ≈ [ɑ] Alternation (Benua, 1995:78)**

a.	map	[mæp]	b.	mar	[mɑr]
	carry	[kæ.ri]		car	[kɑr]
	Harry	[hæ.ri]		hard	[hɑrd]
	Larry	[læ.ri]		lark	[lɑrk]

Hypocoristics which involve truncation to a single syllable show a systematic exception to this restriction. If the [æ] alternant is phonologically motivated in the base (e.g. [hæ.ri]) this is transferred to the truncated form even if the latter ends up in a syllable closed by [r] (e.g. [hær]) thus violating the otherwise exceptional restriction against [æɾ] syllables:

(83) **English Hypocoristics (Benua, 1995:79)**

Harry	[hæ.ri]	Har	[hær]
Larry	[læ.ri]	Lar	[lær]
Sarah	[sæ.rə]	Sar	[sær]

In the literature there are currently two types of approaches to opacity of this type: Benua (1995) proposes specific output-output constraints which require identity between the output of the morphological base and the output of the truncated form and thus enforce for the English a vowel quality of the base onto the truncated form which is excluded in non-truncated forms by a high-ranked markedness constraint. On the other hand, Inkelas and Zoll (2005) argue that such effects are due to different cophonologies: the cophonology associated with roots and untruncated words suppresses marked phonological structure by the high ranking of the corresponding markedness constraint while the cophonology linked to truncation ranks the relevant faithfulness higher which leads to emergence of marked structure in truncation.

While both approaches are consistent with the Luo truncation data, only a cophonology account is consistent with the containment-based analysis proposed for the basic polarity facts.

I will assume here along the lines of Stratal OT (Kiparsky, 2000; Bermúdez-Otero, 2007) that Luo has three cophonologies, a stem-level phonology (which will become relevant for voicing alternations in verbs), a word-level phonology linked to noun plurals and pronominal possessor forms, and a phrase-level phonology which applies in nominal possessor truncation. Crucially, voicing alternations are triggered transparently at the word level where the LICENSING CONSTRAINT is ranked above IDENT [+vc]. Truncation applies at the phrase level probably in connection with the fact that (high-tension) nominal possessor forms are obligatorily followed by a head noun syntactically to which they seem to be prosodically adjoined which becomes evident by the fact that they are never stressed. (Tucker, 1994; Bye, 2006). At the same time the phrase level shows ranking of IDENT [+vc] above LICENSING CONSTRAINT so that voiced obstruents which are licensed at the word level remain voiced at the phrase level even when truncation removes the licensing sonorant resulting in straightforward intralevel opacity. This is illustrated here by the nominal possessor form **od**. At the word level, the

underlying voicing of the root **od** is retained since it is immediately followed by **e**:

(84) **Input:** od-e, 'his house' (Word Phonology)

	ID [-vc]	NO SKIP	LIC	ID [+vc]
☞ a. o(d-e)				
b. od-e				*!
c. od-e			*!	

The output of the word level (84)- **ode** - gets the input of the phrase level where specific constraints here abbreviated as TRUNC achieve deletion of the final **e**. Nonetheless the voicing of word-final **d** is retained to satisfy high-ranked IDENT [+vc]:

(85) **Input:** o(d-e), 'his house' (Phrase Phonology)

	TRUNC	ID [-vc]	ID [+vc]	NO SKIP	LIC
☞ a. ode					*
b. ote			*!		
c. o(d-e)	*!				

Apparent polarity emerges because in the bare singular root **od**, **d** devoices regularly to **t** resulting in the citation form **ot**. For a bisyllabic root with a voiced obstruent such as **kidi**, devoicing of the nominal possessor form happens at the word level (86), and is then propagated to the phrase level by high-ranked IDENT [-vc], again inducing a voicing exchange with respect to the citation form:

(86) **Input:** kidi-e, 'his stone' (Word Cophonology)

	ID [-vc]	(TN)	NO SKIP	LIC	ID [+vc]
a. ki(di-e)			*!		
b. ki(di)-e				*!	
☞ c. kiti-e					*

(87) **Input:** kit-e, 'his stone' (Phrase Cophonology)

	TRUNC	ID [-vc]	ID [+vc]	NO SKIP	LIC
☞ a. kit					
b. kid		*!			*

7 Voicing Alternations in Verbs

Transitive verbs in Luo show similar alternations as nouns, but with interesting differences and complications. While transitive verbs are generally vowel-final (ending in *o* or *ɔ* according to the [ATR]-specification of the root) they allow the formation of a verbal noun which truncates the final vowel and shows the familiar pattern of devoicing (canonical transitive forms are called here ‘applicatives’ according to the terminology used in most studies on Nilotic and in Tucker’s grammar):

(88) Voicing Alternations in Verbs

Applicative		verbal noun	
ca:bɔ	‘disorganize’	ca:p	‘disorder’
ri:do	‘to tear’	ri:t	‘act of tearing’
muogo	‘dig deep, burrow’	muok	‘digging’
gɔ:jo	‘to ‘hit, beat’	gɔ:c	‘a blow/beat’

Besides vowel-final transitive verbs there are also intransitive verbs ending in *o/ɔ* (89) and a great number of intransitive verbs which are consonant-final (90):

(89) Intransitive Vowel-final Forms

nndo	‘to sleep’
gi:ro	‘to gallop’
yɔ:kɔ	‘to trot’
co:po	‘to arrive’

(90) Intransitive Consonant-final Forms

cɔr	‘to groan’
ŋɔ:l	‘to be lame’
muo:l	‘to be gloomy’

Many of the consonant-final intransitive verbs have corresponding transitive verbs which differ only by the presence of final [*o/ɔ*]. As with the verbal nouns obstruents which are voiced in the applicative are unvoiced in the intransitive (91), voiceless obstruents remain voiceless throughout:

(91) Verbs with three variants (voiced obstruent in the applicative)

Intransitive		Applicative	Qualitative	
nyo:c	‘to be weak’	nyo:jo	nyo:co	‘to weaken’
ciɛk	‘to get ripe’	ciɛgɔ	cieko	‘to ripen’
bo:th	‘to be insipid’	bo:dho	bo:tho	‘to make insipid’
kuot	‘to swell’	kuodo	kuoto	‘To cause to swell’

Intransitive forms and verbal nouns are often identical, but differ in their semantics: intransitive verbs mostly denote stative-like predicates, while verbal nouns retain the implicit transitivity of applicative forms. Phonologically, intransitive verbs allow final [w] and disallow final nasal compounds while verbal nouns exhibit stopping of final [w] and allow freely for nasal compounds. These facts are discussed in detail in section 8. At this point it is only important that intransitive forms are bare roots while verbal nouns are distinct formations derived from applicative forms.

Finally there are so-called qualitative verb forms, i.e. antipassive forms which license a non-overt object, in which voiced obstruents turn voiceless and [y] is affected by the familiar type of palatalization:

(92) **Voicing Alternations in Verbs**

Applicative		Qualitative	
pogo cam	‘divide the grain’	po:ko	‘to make a division’
ludhə ɲa:tə	to maltreat someone	lu:tho	‘to maltreat in general’
kado təl	‘to plait a rope’	ke:to	‘to plait in general’
kabə ɲatə	‘to hold someone tightly’	ke:po	‘to be rough in handling’

Note again the subtle morphosemantic difference: an ‘intransitive’ verb denotes an activity which is inherently intransitive, an applicative denotes the same kind of action as the corresponding applicative with the sole difference that the object must not be overtly expressed. This difference becomes clear if we look at the qualitative forms corresponding to the pairs in (91):

(93) **Verbs with three variants (voiced obstruent in the applicative)**

Intransitive		Applicative	Qualitative	
nyo:c	‘to be weak’	nyo:jo	nyo:co	‘to weaken’
ciɛk	‘to get ripe’	ciɛgo	cieko	‘to ripen’
bo:th	‘to be insipid’	bo:dho	bo:tho	‘to make insipid’
kuot	‘to swell’	kuodo	kuoto	‘To cause to swell’

Qualitative formation is accompanied by a number of other changes in the verb root which do not seem to interfere with the voicing alternation, but serve to morphologically distinguish the forms: [–ATR] roots change their vowels into [+ATR], [a] turns into [e], and the final stem vowel is lengthened:

(94) **Consistent Voiceless Obstruents in Qualitative Formation**

bupo ji	‘to hit with a large soft object’	bu:po	‘to do this kind of hitting’
lutho la:w	‘to dip a cloth’	lu:tho	‘to dip in general’
keto piny	‘to put down’	ke:to	‘to put in general’
roco ɣato	‘to frustrate a person’	ro:co	‘to be frustrating’
pəkɔ rabwɔn	‘to peel a potato’	po:ko	‘to do the peeling’

7.1 *Basic Analysis*

Morphosyntactically and semantically it is obvious that in the standard case applicative verbs are derived from intransitive verbs while verbal nouns and qualitative verbs are derived from applicative forms. I will assume that the formation of applicative forms from bare (intransitive) roots is stem-level affixation¹⁶ while qualitative and verbal noun formation happens at the word level. More concretely I will assume that both qualitative and verbal noun formation are preceded by a more general morphological operation which achieves morphosyntactic intransitivization and is phonologically realized by the floating features [-cont-appr] triggering stopping of the glide [w] (see section 8 for a detailed analysis). Moreover I take the final round vowel in qualitative forms as a distinct suffix from the word-final vowel in applicatives. The applicative suffix is **-O**, i.e. a back round mid vowel without ATR-specification which assimilates to the [ATR]-value of its base while the qualitative suffix is **-o** a back round mid [+ATR] vowel which triggers [ATR]-harmony in the base (the base turns consistently [+ATR]). Since qualitative forms are derived from applicative forms, they exhibit affixation of both suffixes leading to deletion of the applicative marker.

This is illustrated in (95) for different forms based on the root **ciɛg**. The bare intransitive root **ciɛg** undergoes final devoicing at the word level just as noun roots. In the applicative form affixation of **-O** is followed by vowel harmony. Since the voicing of **g** is licensed by the suffix vowel without intervention it is retained at the word level. The qualitative form undergoes a three-way affixation: **-O** at the stem level, intransitivizing [-cont-appr] and **-o** at the word level. Deletion of the applicative suffix vowel now happens exactly as the deletion of stem-final vowels in nouns: To preserve the stress pattern of the stem (**ciɛg-ɔ**), one of the vowels must be deleted, and MAX_{RIGHT} ensures that the rightmost vowel is retained. The deleted vowel intervenes between the obstruent (**g**) and its potential licenser, which leads to devoicing under the word-level phonology:

¹⁶Independent phonological evidence for this assumption is discussed in section ??

(95) Derivation for different forms of *cieko*

		Intransitive	Applicative	Qualitative
Root		ciɛg	ciɛg	ciɛg
Stem	Appl. Affixation	—	ciɛg-O	ciɛg-O
	Phonology	—	ciɛg-ɔ	ciɛg-ɔ
Word	Intransitivization	—	—	ciɛgɔ-[-cont-appr]
	Qual. Affixation	—	—	ciɛgɔ-[-cont-appr]-[-low]o
	Phonology	ciɛk	—	ciɛkɔɔ

(96) shows the derivation for a verbal noun. At the stem stratum there is no difference to the corresponding qualitative form. Intransitivization is for both without overt phonological effect. However truncation leaves the obstruent in word-final position where it cannot be licensed and consequently devoices:

(96) Derivation for different forms of *kad*

		Verbal Noun	Qualitative
Root		kad	kad
Stem	Appl. Affixation	kad-O	kad-O
	Phonology	kadɔ	kadɔ
Word	Intransitivization	kadɔ-[-cont-appr]	kadɔ-[-cont-appr]
	Qual. Affixation	—	kadɔ-[-cont-appr]-[-low]o
	Truncation	kadɔ	—
	Phonology	katɔ	ketɔɔ

Crucially all voicing alternation in verbs follow from the same mechanisms as employed for the analysis of nouns: At the word level obstruents devoice when they occur in word-final position or are separated from a following sonorant by a phonetically invisible intervenor.

7.2 Opacity in Imperative Forms

??

8 Manner Alternations

Apart from voicing alternations, Luo exhibits manner alternations which also result in cases of apparent polarity. The first such case involves the sound transcribed [y] by Tucker which has been analysed as the voiced fricative [j] in section 5.2. The second case of apparent manner polarity involves [w] and [p]. Thus in (97a,b) the [w] of the singular root is hardened to [p] in the plural, while in (97c) the plural form lenites the [p] of the singular to [w]:

(97) Apparent Manner Polarity involving [w] and [p]

	sg	pl	
a.	ba:wo	ba:pe	‘plank’
b.	la:w	le:pe	‘cloth’
c.	le:p	le:we	‘tongue’

As in the case of voicing the impression of polarity here is highly delusive. While [w] regularly turns into [p] before the plural suffixes **-e** and **-i**, the change of [p] to [w] is only marginally attested. In fact, **le:p**, the only example of a consonant-final noun root showing this alternation has the alternative form **le:pe** without lenition, and Luo has no vowel-final roots with the same consonant change. Anyway, assuming a polarity rule which changes [w] to [p] in plural forms would lead to immediate problems for the roots in final [p] which do not alternate (e.g. **i:p** (sg.), **i:pe** (pl.), ‘tail’) or show only a voicing change (e.g. **ari:p** (sg.) **ari:b-e** (pl.), ‘Milky Way’) as discussed in section 5.

Thus it is safe to conclude that the plural form in (97c) is another case of a (optional) suppletive allomorph restricted to the context of the plural suffix. In the remainder of this section, I will show that the hardening of [w] to [p] in (97a,b) is due to more general consonant mutation patterns which are triggered by the association of floating features to specific affixes providing further evidence that (97) is not a true case of polarity. The complete analysis of the mutation data which partially also involve changes in voicing complements the discussion in the preceding sections and gives rise to a complete account of voicing alternations in Luo.

8.1 Stopping in Nouns

Apart from stopping [w] to [p] Luo shows a number of other manner changes in nouns. Thus in noun plurals with **-e** and **-i**, nasals and the lateral /l/ turn into homorganic prenasalised stops. [r] is replaced by [c]. (98) shows these alternations for consonant-final, and (99) for vowel-final nouns:

(98) Class Alternations in Consonant-Final Nouns

	sg	pl	
a.	um	umbe	‘fork’
	te:n	te:nde	‘neck rest’
	pi:p	pi:pje	‘country’
	wa:ŋ	wa:ŋge	‘eye’
b.	bul	bunde	‘drum’
c.	bɔr	bɔce	‘ulcer’
	ɔr	ɔce	‘brother-in-law’

(99) Class Alternations in Vowel-Final Nouns

	sg	pl	
a.	ya:mɔ	yembe	‘wind’
	pi:nɔ	pi:nde	‘wasp’
	ɲi:p	ɲi:pje	‘iron’
	lɔ:ŋɔ	lɔ:ŋge	‘hernia’
b.	hɔ:la	hɔ:nde	‘wax’
c.	ga:ra	ge: ce	‘leg bell’
	ga:ri	ge: ce	‘vehicle’

The following tables summarize all changes found in nouns and verbs:

(100) Consonant-final Nouns

sg	pl	
[p,t,c,k]	[b,d,j,g]	Polarity
[c]	[j]	
[m,n,ɲ,ŋ]	[mb,nd,ɲj,ŋg]	Mutation
[l]	[nd]	
[r]	[c]	
[w]	[p]	

Vowel-final Nouns

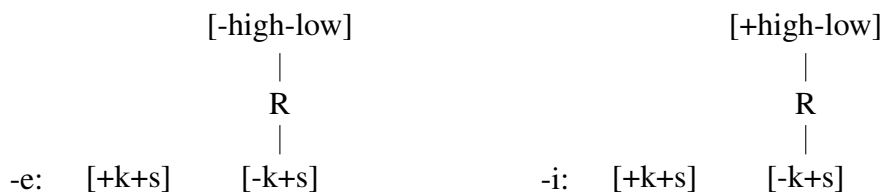
sg	pl	
[b,d,g,j]	[p,t,c,k]	Polarity
[j]	[c]	
[m,n,ɲ,ŋ]	[mb,nd,ɲj,ŋg]	Mutation
[l]	[nd]	
[r]	[c]	
[w]	[p]	

Strikingly, and in contrast to the voicing alternations, there is no difference between consonant-final and vowel-final roots. In both the alternations converge roughly in inserting a stop or stop

quality in the pre-suffix position. I will argue that these cases follow from morphological mutation, i.e. incomplete phonological structure morphologically associated to the suffixes **-e** and **-i** which associates to place features of the noun root.

More concretely, the suffixes **-e** and **-i** contain a bare obstruent root node ([+konsonant -sonorant], abbreviated in the following as [+k-s]) not associated to other features of place voice and manner. I will loosely refer to this node as a ‘floating root node’ even though an unassociated root node is technically not floating, but the complement of a floating feature¹⁷ Hence the full representations for **-e** and **-i** are roughly as follows:

(101) **Full Representations for -e and -i**



Mutation happens now basically to preserve root nodes and if it is not possible to realize two consonantal root nodes between two vowels to optimize sonority sequencing between onsets and syllable nuclei. Under the assumption that Luo does not allow segments without place nodes (???) (i.e. glottal sounds) word-internally and that insertion of place nodes is blocked, [+k-s] can only be pronounced if it links to the place node of the preceding (root-final) consonant.¹⁸ (102) shows the crucial constraints which implement this analysis

(102) **Constraints governing Manner Mutation**

DEP PLACE	Don't insert place nodes
SHARE PLACE	Place can only be shared between root nodes of a nasal and a following homorganic stop
MAX C	Input root nodes of consonants should be retained in the output
SONORITYSEQUENCING	Avoid sonorants as onsets
IDENT MAN	Don't change the values of the features [kontinuant], [konsonant], [sonorant]

The resulting candidates are fairly transparent as autosegmental representations, but place-consuming. To avoid excessive blow-up of the tableaux, I will abbreviate the candidates as in (103). Note that the autosegmental representations here are also already simplified: Vowels

¹⁷Alternatively one could assume following Padgett (1995) and Wolf (2005a,b) that [kons] and [son] are generally independent from the (basically empty) root node. [+kons] and [-son] could then be analyzed as truly floating features. For the current analysis both assumptions seem to work in principle, but the representation chosen here leads to significant simplification of structures and computation.

¹⁸Obviously it is also impossible that the bare root node links to a place feature which is underlyingly associated to a vowel. I leave it open here by which (high-ranked) constraint this option is ruled out.

and consonants not involved into the mutation process are replaced by the corresponding IPA-symbols. (103a) shows the input for **umbe**, the plural of **um**, ‘fork’, where the floating class node is indicated by **C**. (103b) is the correct output, both the nasal and the floating root node are associated to the place feature of the nasal (LAB). In (103c) the bare root node also links to LAB, but the root node of the nasal itself and the features associated to it are deleted. (103d) shows how association of the floating root node to place is achieved by insertion of an epenthetic place node. I assume that the unmarked place feature in Luo is coronal resulting in [c]¹⁹ In (103e) the bare root node is straightforwardly deleted.

(103) **Abbreviations For Autosegmental Representations In Candidates**

a. um-Ce	<p style="text-align: center;">LAB</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k+s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[-cont]</p>
b. um-be	<p style="text-align: center;">LAB</p> <p style="text-align: center;"> /</p> <p style="text-align: center;">[+k+s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[-cont] [-cont]</p>
c. u-pe	<p style="text-align: center;">LAB</p> <p style="text-align: center;"> /</p> <p style="text-align: center;">⋮ [+k+s] [+k-s] e</p> <p style="text-align: center;">⋮ </p> <p style="text-align: center;">[-cont] [-cont]</p>
d. um-ce	<p style="text-align: center;">LAB KOR</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k+s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[-cont] [-cont]</p>
e. um-e	<p style="text-align: center;">LAB</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k+s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[-cont]</p>

Although structures as in (103b-e) are suboptimal for roots with final nasals similar configurations become optimal with other types of sounds. The tableau in (104) shows these candidates in the derivation of the plural form **um-be** where a nasal turns into a prenasalized stop. Insertion of a place node (104d) is banned by undominated DEP PLC, and deletion of either root

¹⁹Section 8.4 provides additional evidence that [c] represents the unmarked place specification for a stop in Luo.

node is excluded by MAX C. Both root nodes can be retained (104a) satisfying MAX C since the place sharing of the nasal and the floating class node does not violate SHARE PLC and no change of manner features (and consequent violation of ID MAN) is necessary to produce this configuration:

(104) **Input:** umCe, ‘forks (pl.)’

	DEP PLC	SHARE PLC	ID MAN	MAX C	SON SEQ
☞ a. u[m-b]e					
b. u-pe				*!	
c. um-e				*!	*
d. um-ce	*!				

Crucially, the same holds for roots ending in **l**. Since **l** is [-continuant] and [+consonant+sonorant] just as the corresponding nasal, nasalizing **l** is tolerated to satisfy MAX C:²⁰

(105) **Input:** bul-Ce, ‘drums (pl.)’

	DEP PLC	SHARE PLC	ID MAN	MAX C	SON SEQ
☞ a. bu[n-d]e					
b. bu-te				*!	
c. bul-e				*!	*
d. bul-de		*!			
e. bul-ce	*!				

For roots ending in the trill [r] or the approximant [w], turning the final consonant into a nasal is not an option, since they are specified [+cont] and nasalization would require to change this to [-cont] violating ID MAN. One of the class nodes has to be sacrificed, and SON SEQ favors realization of the floating [+kons-son] linked to the [CORONAL] place feature of [r] (or [LABIAL]/[DORSAL] of [w]):

(106) **Input:** bur-Ce, ‘hole (pl.)’

	DEP PLC	SHARE PLC	ID MAN	MAX C	SON SEQ
☞ a. bu-ce				*	
b. bur-e				*	*!
c. bu[n-d]e			*!		
e. bur-ce	*!				

²⁰The faithfulness constraints violated by changing **l** into **n** must be located below MAX C to guarantee this effect.

For stop-final nouns such as **ip**, the proposed constraint ranking introduced so far predicts a tie between deletion of the floating class node (107a) and deletion of the class node for the underlying **p** (with relinking of its place node) since both candidates fare equally well for MAX C and SON-SEQ, even though both candidates are phonetically identical. (107d,e) are eliminated for exactly the same reasons as (106d,e), but (107c) is excluded due to changing [-sonorant] (p) into [+sonorant]:

(107) **Input:** ip-Ce, ‘planks (pl.)’

	DEP PLC	SHARE PLC	ID MAN	MAX C	SON SEQ
☞ a. ip-e				*	
☞ b. i-pe				*	
c. i[m-b]e			*!		
d. ip-pe		*!			
e. ip-ce	*!				

The question whether the root node of the noun or the root node of the affix is retained gets empirically relevant in the case of nouns ending in voiceless fricatives, where no stopping occurs:

(108) **Nouns ending in Voiceless Fricatives**

sg	pl	
nus	sus-e	‘half’
sa:f	sa:f-e	‘sub-chief’
dirisa	diris-e	‘window’
ofifo	ofif-e	‘spoilt cotton’

Plausibly, the winning candidate has the structure in (109a). Hence we must exclude forms where the floating root node is retained and is linked to the [+cont] of the stem vowel (109b) or to an epenthetic [-cont] (109c) or [+cont] (109d):

(109) **Abbreviations For Autosegmental Representations In Candidates**

a. nus-e	<p style="text-align: center;">COR</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k-s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+cont]</p>
b. nu-s-e	<p style="text-align: center;">COR</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k-s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+cont]</p>
c. nu-se	<p style="text-align: center;">COR</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k-s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+cont] [+cont]</p>
d. nu-te	<p style="text-align: center;">COR</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+k-s] [+k-s] e</p> <p style="text-align: center;"> </p> <p style="text-align: center;">[+cont] [-cont]</p>

This can be achieved by the following three constraints:

(110) **Constraints**

- *SPREAD [cont] Instances of the feature [cont] morphologically linked to root node R should not link to any R' , $R \neq R'$
- DEP [cont] Instances of the feature [cont] should be morphologically visible
- *[+cont-son] Obstruents should be [-cont] (Avoid fricatives)

(111) **Input:** nus-Ce, 'halfs (pl.)'

	SON SEQ	*SPREAD [CONT]	DEP [CONT]	*[+CONT-SON]
☞ a. nus-e				*
b. nu-s-e		*!		*
c. nu-se			*!	*
d. nu-te			*!	

This ranking is also responsible for the fact that for nouns ending in the glide [w] mutation does not lead to a fricative by linking the [-cont] of [w] to the floating root node

(112) **Input:** η ew-Ce, ‘pegs (pl.)’

	SON SEQ	*SPREAD [CONT]	DEP [CONT]	*[+CONT-SON]
a. η ew-e	*!			
b. η e-f-e		*!		*
c. η e-fe			*	*!
☞ d. η e-pe			*	

Let us finally address the question why the stops created by mutation are consistently voiceless even when the corresponding root consonant is voiced as in the case of η ew ~ η ep-e. Basically instead of spreading the [+voice] feature of the affixal vowel to floating [+k-s], the latter is associated to an epenthetic [-voice] since this does neither violate Id [-vc] nor Id [+vc] and due to the preference for voiceless obstruents (*[-son +vc] = Kager’s Voiced Obstruent Prohibition):

(113) **Input:** η ew-Ce, ‘pegs (pl.)’

	ID [-VC]	ID [+VC]	*[-SON+VC]
☞ c. η e-(be)			
d. η e-pe			*!

8.2 *Stopping in Verbs*

Although verbs show exactly the same voicing alternations as nouns, they lack most of the manner alternations found in the nominal paradigm which provides strong evidence that manner alternations in Luo are mutation, i.e. morphologically, not phonologically conditioned. The only manner alternation pattern in verbs not related to the licensing of voicing is the hardening of [w] to [p] in qualitative formation (114), and the formation of verbal nouns (115).

(114) **Manner Alternations in Verbs: Qualitative Formation**

kawɔ pɛ:sa	‘to accept money’	ke:po	‘to accept in general’
buwo nyathɪ	‘to bully a child’	bu:po	‘to act in a bullying’
to:wo	‘to discolour’	to:po	‘to discolour something’

(115) **Manner Alternations in Verbs: Verbal Nouns**

hɛ:wɔ	‘to beat/excel’	hɛ:p	‘ability to excel’
cwowo	‘to inject’	cwo:p	‘injection’ (p. 98)
ŋa: wo	‘to hang up’	ŋa:p	‘hanging up’ (p. 100)

Crucially, this pattern cannot be related to a general phonological process since word-final [w] in bare nouns and in the infinitive of intransitive roots is well-documented:

(116) **Free Forms with final [w]**

- a. ŋew ‘peg’
- b. la:w ‘cloth’
- c. to:w ‘to be discoloured’
- d. cie:w ‘to wake up’

I conclude that the change of [w] to [p] is another instance of a mutation process triggered by floating features, in this case the features [-cont][-appr] associated with morphological intransitivization. What happens then in a stopping root such as **he:wo**, ‘to beat, excel’ (with the verbal noun **he:p**) is that a new root node is inserted to realize either feature according to the constraint *RealizeMorpheme* and without violation of *IDENT MAN*. As soon as it gets necessary to have an epenthetic root node, this will include [-cont][-appr] and assume unmarked structure hence result in a voiceless stop. (117) shows the relevant candidates as autosegmental representations which are evaluated in (118):

(117) Candidates

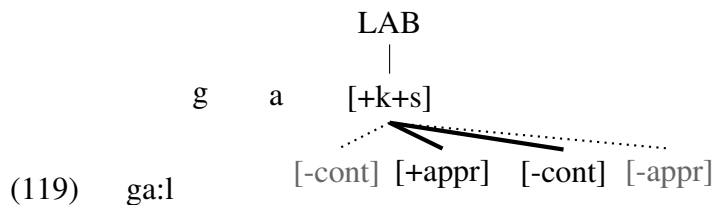
a. he:w	
b. he:l?	
c. he:r?	
d. he:m	
e. he:p	

(117a) violates REALIZEMORPHEME since no part of the intransitivizing affix is phonetically visible in the output. In (117b,c,d) the final root node of the noun is partially relinked to one or two of the floating features, but this is excluded by ID MAN. The only option is to insert an epenthetic root node and to link it to the floating features (117e) (Inserting a root node *and* a place node is ruled out by DEP PLC which is ranked higher than ID MAN, cf. section??):

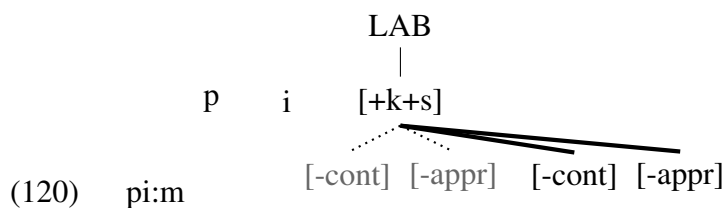
(118) **Input:** he:wo + [-cont][-appr], ‘excel’

	ID MAN	REALMORPH	DEP RT
a. he:w		*!	
b. he:l?	*!		
c. he:r?	*!		
d. he:m	*!*		
☞ e. he:p			*

Now [w] is the only true approximant in Luo. All other consonants in the language are either [-cont] or [-appr] to begin with. This means that they can vacuously link to one of the floating features without overt mutation. For example in **ga:l** the final [l] is specified as [+k-s][-cont] [+appr]. The optimal output is depicted in (119), where the root node of the noun-final consonant links to the floating [-cont] feature:



This candidate satisfies REALIZEMORPHEME since the floating [-cont] gets phonetically visible, but is also perfect for ID MAN because the root node is linked to exactly the same types of features phonetically as morphologically. Finally, (119) outranks any candidate involving an epenthetic root node since it does obviate a violation of Dep Rt. Similarly for **pi:m**:



8.3 Restrictions on prenasalized stops

Prenasalized stops exhibit a general restriction which seems to be tightly connected to the nature of manner alternations. Vizibly no non-derived noun and no intransitive verb end in a nasal compound, while verbal nouns are freely allowed to do so:

(121) Verbal Nouns ending in Nasal Compounds

Applicative		Verbal Noun	
wɪ:mbɔ	to 'take animals to temporal grazing'	wɪ:mb	'act of grazing animals'
lɔ:ndhɔ	'to persuade'	lɔ:ndh	'persuasion'
puonjo	'to teach'	puonj	'teaching'
kr:ŋgɔ	'to kill with a spell'	kr:ŋg	'spell killing'

This difference follows straightforwardly if the following constraint is ranked above all relevant manner faithfulness constraints at the stem level:

(122) *NC]_{PWord}: No nasal compound at the right edge of a phonological word.

As a consequence a putative intransitive root such as **pamb** would be transformed at the stem cycle into **pam** before any further affixes could be attached. On the other hand **wɪ:mbɔ** is licit

at the root level. Truncation for the verbal noun only applies at the word level where (122) is ranked low, and has no effect.

8.4 Consonant Insertion in Nouns and Verbs

A final alternation pattern not discussed so far appears with monosyllabic nouns which are vowel-final in the singular, but show [c] (123a) or [j] (123b) root-finally in plural forms:

(123) Monosyllabic Vowel-final Noun Roots

	sg	pl	
a.	si	si:c-e	‘pullet’
	ge	ge:c-e	‘second hole in board game’
	cwa	cwa:c-e	‘tamarind’
b.	bwε	bwε:c-e/bwε:j-e	‘jackal’
	kɔ	kɔ:j-e	‘churn’
	pu	pu:j-e	‘buttock’

Similarly there are intransitive verb roots which are monosyllabic and vowel-final which correspond to disyllabic applicative forms with rot-final [j]:

(124) Monosyllabic Vowel-final Verb Roots

	Intransitive	Applicative	
	kε	kεj-ɔ	‘to disperse’
	ɲa	ɲa :j-ɔ	‘to multiply, be prolific/to proloferate’
	po	po:j-ɔ	‘to be surprised/to startle’
	yie	yie:j-ɔ	‘to agree/to agree with’

What seems to happen here is (partial) insertion to avoid a hiatus (i.e., an ONSET violation) and unnecessary deletion of a consonantal root node. For nouns I assume that [c] corresponds to the empty root node morphologically affiliated to the plural suffix which associates to an epenthetic place feature, unmarked [CORONAL]. In contrast to manner alternations in consonant-final nouns, the empty root node cannot link to any other morphologically licensed place feature since it is non-adjacent to the only other consonant in the word (NO-SKIPPING-VIS is basically undominated in Luo). The resulting sound is a stop because both a fricative (125b) and a stop (125a) require insertion of a value for [continuant], but stops are the unmarked obstruents, which follows from *[+cont-son] independently motivated for mutation:²¹

²¹Luo tolerates ONSET violations in vowel-initial nouns such as **um**, ‘fork’ similar to Tashlhiyt Berber, where Onset violations are exceptionally licit in phrase-initial position (Prince and Smolensky, 1993). I assume that this pattern of facts follows from positional faithfulness: DEP_{First} is ranked above ONSET in Luo blocking epenthesis word-initially.

(125) **Input:** si-Ce, ‘pullets (pl.)’

	ONS	FAITH STRESS	DEP PLC	ID MAN	MAX C	DEP [CONT]	*[+CONT-SON]
☞ a. si-ce			*			*	
b. si-je			*			*	*!
c. s-e		*!			*		
d. si-e	*!				*		

While [c] seems to be the most frequent realization of the emerging intervocalic consonant, as (127) shows also [j]. I assume that this is triggered by a floating [+continuant] associated lexically to specific roots such as **ko**. Basically linking the floating class node of the plural suffix (via an epenthetic root node) to the floating [+continuant] of the root is preferred because it avoids a DEP KONT violation, and DEP KONT is ranked higher than *[+cont-son]. Note that linking of the floating [+cont] to the bare root node is not a violation of *SPREAD [cont] since [+cont] is not morphologically linked to any other root node:

(126) **Input:** kɔ[+kont]-Ce, ‘churns (pl.)’

	ONS	FAITH STRESS	DEP PLC	ID MAN	MAX C	*SPREAD [CONT]	DEP [CONT]	*[+CONT-SON]
a. kɔ-ce			*				*!	
☞ b. kɔ-je			*					*
c. k-e		*!			*			
d. kɔ-e	*!				*			

The analysis for verbs is similar. While the applicative suffix does not provide an empty root node, this also epenthesized here to avoid violation of ONSET and FAITH STRESS. Crucially DEP C must be ranked below these constraints.

(127) **Input:** po-[+kont]o, ‘to be surprised’

	ONS	FAITH STRESS	DEP C	DEP PLC
☞ a. po-je				*
b. p-e		*!		
c. po-e	*!			

That the epenthetic consonant is almost always [j] follows under the assumption that the applicative suffix is associated with a floating [-kont]. That the the consonant is an obstruent is due to SON-SEQ. To avoid a DEP C violation the epenthetic segment links to the available instance of the feature [cont] resulting in a fricative.

8.5 Exceptional Patterns

As with simple voicing alternations there are some exceptional cases, namely nouns and verbs where stopping exceptionally applies, fails to apply, or where destopping seems to take place. Thus the noun **le:p**, ‘tongue’ with the regular plural **le:p-e** has an alternative plural with a glide **le:w-e**. The intransitive form of the verb **to:wo**, ‘discolour’ has the irregularly stopped form **to:p** in addition to the regular **to:w**. Moreover in a handful of cases, root-final nasals do not turn into prenasalized stops:

(128) Root-final nasals failing to undergo stopping

sg	pl	
ɔmin	ɔmin-ε	‘brother’
pa:n	pa:n-e/pe:n-e/pa:nj-e/pe:nj-e	‘mortar’
ɔmbɔ:nj	ɔmbɔ:nj-ε/ɔmbɔ:njg-ε	‘ankle’

Again there are very few cases and even these are almost exclusively variants of forms which behave completely regularly according to the analysis proposed here. As the cases discussed in section 5.6 they can be captured as cases of morphemic suppletion. Thus assuming that the root **to:w** has **to:p** as a special allomorph for its intransitive form predicts that this will surface just as **to:p** since intransitive verbs do not undergo any alternations besides regular final devoicing. For the non-stopping forms in (128), it is not the root showing suppletion, but the suffix. Instead of the regular ending **-[+cons -son] e**, these items bear the suffix **-e** which is homonymous apart from lacking the floating root node. Mutation in the corresponding plural forms is suppressed trivially because there is no floating structure triggering mutation. Note that this case is completely analog to exceptional allomorphy involving **-[+cons-son] i**. Both affixes are phonologically very similar to **-[+cons -son] e**, and for both affixes the nouns which take it must be lexically listed in some form. Logically, we also expect cases where affix **and** root involve suppletion of this type and in fact this possibility seems to be instantiated by the plural **le:w-e**. **le:w** has to be listed as a suppletive allomorph of **le:p** in the context of a plural suffix, but at the same time the suffix must be **-e** not **-[+cons -son] e** since we would otherwise get stopping triggered by the floating root node. Finally suppletion analyses are also straightforward for marginal cases where monosyllabic vowel-final roots alternate with consonants other than [c] and [j], for example **pi** (sg.), **pig-e** (pl.), ‘water’ or **u** (sg.) **u:p-e** (pl.), ‘puff ader’.

9 Previous Analyses

In this section I discuss previous approaches to Luo voicing polarity which seek to eliminate an explicit stipulation of polarity or feature exchange. Analyses embracing the assumption that Luo has genuine feature polarity are summarized in section 2.

9.1 Stonham (1994)

Stonham (1994) provides the earliest attempt to reduce the Luo data to more standard means of morphological exponence. He claims that Luo number inflection has only one morphophonological rule which consistently triggers voicing of root-final obstruents. Under the assumption that nouns can be either inherently singular or plural in their basic form, and that obstruent voicing serves to indicate the marked (non-inherent) value of number for each noun, this rule is formulated as in (129):

(129) $C \rightarrow [+voiced] / _ (V) \# [+marked\ number]$

Unfortunately this analysis is at odds with the affixal morphology of number marking in the language. First, Luo has a substantial number of nouns which are consonant-final in the singular, and form the plural by adding the affix **-e** with or without additional change in voicing (e.g. *ip,ip-e* and *arip arip-e*). Under Stonham's approach we would expect nouns which exhibit mirror-image affixation, i.e. consonant-final plural nouns with corresponding singular forms showing an additional **-e**. However Luo seems to systematically lack such a pattern. Second, plural affixes in Luo are restricted to three allomorphs, **-e**, **-i**, and **-ni**, while singular forms may end in any vowel:

(130) **Final Vowels of Singular Nouns**

<i>kidi</i>	'stone'
<i>kombe</i>	hole in tree
<i>udo</i>	'ostrich'
<i>cu:la</i>	'island'
<i>bu:ju</i>	'mole'

This asymmetry in the distribution of noun-final vowels follows naturally if singulars are always basic and plurals always derived, but remains a mystery under Stonham's approach. However probably the most serious problem for his analysis is the fact that there is no apparent semantic motivation which distinguishes basic singular and basic plural nouns. Thus the proposal in effect requires to mark a huge percentage of the noun vocabulary as underlyingly plural with the sole motivation to trigger the rule in (129). Finally, as noted in Baerman (2007:38) it is hard to see how an approach in terms of number markedness would extend voicing polarity in possessive marking.

9.2 Wolf (2005a,b)

Wolf (2005a,b) argues in a general discussion of mutation phenomena that Luo voicing polarity derives from allomorphy of floating features:²² thus the nominal possessive morpheme com-

²²Wolf's proposal recapitulates an earlier unpublished analysis by de Lacy (2002) with differences in detail which are irrelevant to the Luo data.

prises two lexically listed allomorphs consisting of floating features, [+voiced] and [-voiced]. The constraint MAXFLT requires that one of the floating features is realized in the output. The central constraint however is NOVACDOCK which requires that association of a floating feature to a segment *S* is marked if *S* was already associated to a (different token of) the same value of the same feature underlyingly. Given the allomorphs for nominal possession marking NOVACDOCK will always favor docking of the allomorph specifying the opposite voicing value. This is illustrated for the noun **bat** in (131):

(131) **Input:** $\text{bat}_{[+vc]_1} + \{ [+vc]_2, [-vc]_3 \}$

	MAXFLT	NOVACDOCK	IDENT [VC]
a. $\text{bad}_{[-vc]_3}$			*
b. $\text{bat}_{[+vc]_{1,2}}$		*!	
c. $\text{bat}_{[+vc]_2}$		*!	
d. $\text{bat}_{[+vc]_1}$	*!		

The central problem with Wolfs's analysis is that it implies roughly the same possibilities as an antifaithfulness analysis, especially it also predicts counter to fact that there should not be noun roots which do not show voicing alternations. Moreover the analysis would also work in a putative language Luo' where voicing polarity appears regardless of syllable structure, i.e. a language without final devoicing where all roots are consonant-final would still be able to exhibit the same type of polarity as Luo. It seems that such languages do not exist, and if the approach in this paper is on the right track it cannot exist for principled reasons.

9.3 Trommer (2006) and Pulleyblank (2006)

Trommer (2006) assumes that final obstruents in Luo noun roots are underlyingly either voiced, unvoiced or unspecified for voicing. Voicing polarity in consonant-final roots then amounts basically to final devoicing, while vowel-final roots show the three way-contrast of voicing distribution exemplified in (132):

(132) Voicing Distributions in obstruents of vowel-final roots

	sg	pl	
a. Singular unvoiced - Plural unvoiced:	osi:ki	osi:k-e	‘small thing’
b. Singular voiced - Plural unvoiced:	kidi	kit-e	‘stone’
c. Singular voiced - Plural voiced:	ɲu:di	ɲu:d-e	‘neck of meat’

While the obstruents in (132a) and (132c) are analysed as underlyingly unvoiced and voiced respectively which is retained on the surface *e* by high-ranked faithfulness constraints, the alternating obstruent in (132b) is taken to be underlyingly unspecified for [+/-voice]. In the singular, the value [+voice] for **d** is provided by intervocalic voicing through a voicing span comprising (idi). However, in the plural this process is blocked by a constraint against spans crossing morpheme boundaries, leading to insertion of the unmarked voicing value for the obstruent, hence [-voiced]. Pulleyblank (2006) provides a similar analysis of voicing polarity with a different approach the sensitivity of voicing to morpheme boundaries, and an extension to the alternation between nasals and prenasalized stops (e.g. kuon, kuond-e, ‘bread’) which also relies on a three-way contrast using underspecification. Apart from the controversial status of underspecification in current phonological theory and their restricted empirical coverage omitting a substantial part of the involved manner alternations, these analyses have only one substantial problem which however seems to be lethal: the pattern in (132b) is absolutely marginal in Luo, it occurs only as a variant of a single noun (alternatively the plural form is **ɲu:d-ni**).

9.4 Baerman (2007)

9.5 Bye (2006)

The squib by Bye (2006) is the most elaborate recent reanalysis of the Luo data. Bye departs from a unary feature system where voiceless stops are [stop]_{C-manner}, voiced stops and glides unspecified for C-manner, nasals [nasal]_{C-manner}, and prenasalized stops [stop,nasal]_{C-manner} (Morén, 2003) with details of voicing supplied in the phonetic component. In this system stopping of glides and devoicing can be unified to insertion of [stop]_{C-manner}, while voicing implies deletion of [stop]_{C-manner}. Word-final devoicing and stopping is now derived from the constraint in (133) which requires that consonants at the right edge of a phonological phrase are specified as C-Manner [stop]:

(133) STOP: If C]_{PhP}, then C-Manner [stop]

Similarly nasal alternations as in **ti:m** (sg.) **ti:mb-e** (pl.), ‘act, deed’ follow from a constraint against prenasalized stops in phrase-final position leading to neutralization of nasals and prenasalized stops in most word-final positions.

Devoicing of obstruents in vowel-final noun roots is analyzed purely morphologically: the plural affixes **-e** and **-i** have each two allomorphs, one selecting vowel-final roots and inducing devoicing and stopping, and a default affix (effectively restricted to consonant-final roots) which fails to do so.

While the unification of devoicing and fortition in Bye’s analysis is elegant and theoretically attractive it faces both conceptual and empirical problems: Capturing devoicing in plural forms by multiple semi-identical allomorphs seems to amount to the hidden formulation of an arbitrary morpholexical rule which changes the voicing of root final consonants. This type of stipulation misses the generalization that devoicing happens regularly throughout the language whenever an obstruent is not followed by an appropriate licensensor. Practically double allomorphs have to be assumed not only for the two plural suffixes, but also for all high-tension possessive suffixes, the demonstrative marker (??), and the qualitative suffix. Empirically Bye’s analysis predicts that [w] cannot occur phrase-finally, and that prenasalized stops are impossible at the end of a phrase. The first prediction is wrong, while the second one holds only for non-derived stems. Moreover the claim that only vowel-final noun roots undergo fortition is contradicted by consonant-final roots ending in [r], [w] and [l] which regularly undergo fortition in the plural (e.g. **ŋe:w** (sg.) **ŋe:p-e** (pl.), ‘peg’; **bɔ:r** (sg.) **bɔ:c-e**, ‘ulcer’ **bu:l** (sg.) **bu:nd-e**, ‘drum’). Similarly it remains unexplained why monosyllabic nasal-final roots which do not undergo stopping in the plural are only marginally attested. All these observations follow straightforwardly if fortition and devoicing are separated along the lines proposed in this paper.

10 Consequences for Phonological Theory

Voicing polarity in Luo is of central importance for the general analysis of (apparent) featural exchange processes because

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