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Neutral vowels in Lokaa harmony

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1. INTRODUCTION

This paper re-examines Lokaa¹ vowel harmony, providing details unavailable in previous work.² Most previous studies are for example limited to descriptions of harmony in bisyllabic nouns. Here I look at vowel co-occurrence in all types of nouns as well as in verbs. The article thus aims at a richer descriptive study of the harmony system. The central focus is the set of neutral vowels in Lokaa harmony, [i, u, ə, a]. By neutral I mean a segment which has no harmonic counterpart. Such segments are either transparent or opaque. Lokaa harmony is important in three crucial respects, typologically and theoretically. First, it is unusual to find a language which has both transparent and opaque vowels in its harmony, as Lokaa does.³ The high vowels [i, u] are transparent to harmony; the low vowel [a] is opaque, and the status of the mid vowel [ə] is indeterminate. Secondly, though Lokaa has an eight-vowel inventory the vowels [a] and [ə] have not completely “re-paired” (Bakovic 2000, 2003). They do not alternate at all in prefixes, as we find for example in the neighbouring language Igede (Bergman 1971; Armstrong 1983), or in Wolof (Ka 1994), which has an identical vowel system. Thirdly, the historic ATR contrast found in Benue-Congo high vowels (Stewart 1971; Williamson 1973) shows up when high vowel stems take mid-vowel prefixes, though the high vowels can only be [+ATR] on the surface. That is, the ATR merger of high vowels in Lokaa is not complete.

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¹Lokaa [lɔkɛə] (orthographic Lokaa) is a language of the Upper-Cross cluster within the Niger-Congo family. It is spoken by about half a million people in southeastern Nigeria.

²Earlier descriptions of the vowel harmony can be found in Iwara (1982, 1994, 1995), Runsewe (1988), and Akinlabi and Iwara (2004).

³Steinberger and Vago (1987) report that Bari, an eastern Nilotic language with a ten-vowel system, has both opaque and transparent vowels in its ATR harmony. Certain dialects of Yoruba, for example Ife, may also have both transparent and opaque vowels. Ola (2001, 2003) discusses the transparent status of high vowels in Ife Yoruba but is silent about the status of low vowels.

As van der Hulst and Smith (1986) note, languages which have ATR-harmony do not always have two fully symmetrical sets of vowels. However, the behaviour of the so-called neutral vowels varies from one language to another. Furthermore the number of vowels in an inventory is not a true predictor of the number of neutral vowels that a language has. In Standard Yoruba, a seven-vowel system, the neutral vowels include both high vowels [i, u] and the low vowel [a] (Archangeli and Pulleyblank 1989; Pulleyblank 2002). All three vowels are opaque. Wolof (Ka 1994) has an eight-vowel inventory, identical to that of Lokaa. However, it has two high vowels [i, u] which are neutral and transparent.

This article begins with a discussion of vocalic structure and vowel co-occurrence in nouns and verbs. In section 2, I discuss the domain of harmony and the status of compounds. Section 3 illustrates Lokaa harmony, using only non-high vowels. In section 4 I turn to the high vowels. Section 5 discusses high vowel transparency and its formal treatment. In section 6, I discuss the low vowel [a] and opacity.

Though Lokaa harmony is fairly complicated, I argue that a constraint-based analysis is possible, within O'Keefe's (2007) modified version of McCarthy's (2004) headed span theory. My preference for this theory arises from the fact that it accounts uniformly for both local and non-local harmonies, and it is able to account for both transparency and opacity in the same language. I will only use this model when discussing transparency and opacity to illustrate how it accounts for the phenomena. Within the headed span approach to harmony, this paper proposes that both co-occurrence constraints and ASSOCIATEHEAD are crucial because they play different roles. Co-occurrence constraints control the inventory, and the different rankings of the ASSOCIATEHEAD constraints indicate whether or not a feature will form part of a harmonic-span.

2. THE VOCALIC STRUCTURE AND BASIC HARMONY

Lokaa is an eight-vowel language with /i, u, e, o, ε, ɔ, ə, a/. The vowels appear to split into two harmonic ATR sets, as in (1).

(1) *Lokaa harmonic sets:*

[+ATR]	[−ATR]
i u	
e ə o	ε ɔ
	a

Assuming the classic definition of neutral vowels as stated above, there are four neutral vowels in (1), since there are four vowels that have no harmonic counterparts. The vowels [i, u, ə] have no [−ATR] counterparts, and the vowel [a] has no [+ATR] counterpart. In the next two sub-sections, I show the vowel distribution patterns of these in bisyllabic nouns and verbs, arranging them according to height: high, low, and mid. To highlight the severe restriction of vowel distribution in verb stems, I will present the vowel distribution in nouns and verbs differently. Merging verbs with nouns would hide this restriction.

2.1. Vowel distribution in nouns

Each of the eight vowels in (1) can occur as a stem vowel, and all vowels except [ə] can occur as a (noun) class prefix.⁴ The table in (2) shows the distribution of vowels in the prefix+noun stem domain. The presentation of the examples in (3) is based on the stem vowels.

(2) *Lokaa vowel co-occurrence in bisyllabic (prefix + stem) nouns:*

Prefix \ Stem	i	u	a	ɛ	ɔ	e	o	ə
i	✓	✓	✓	✓	✓	✓	✓	✓
u	✓	✓	✓	✓	✓	✓	✓	✓
a	✓	✓	✓	✓	✓	✓	✓	✓
ɛ	✓	✓	✓	✓	✓			
ɔ	✓	✓	✓	✓	✓			
e	✓	✓				✓	✓	✓
o	✓	✓				✓	✓	✓
ə								

(3) *Exemplification of vowel distribution in bisyllabic nouns (prefix + stem domain):*

High vowels: The high vowels noun stems permit both [+ATR] and [−ATR] prefix vowels (all vowels except [ə]).

a. [i] as stem vowel. Possible prefix vowels: [i, u, e, o, ɛ, ɔ, a]

lì-wí	‘basins of water’	lɛ-kpì	‘electric fish’
è-tí	‘stick’	lú-jí	‘food’
lò-wí	‘water’	yà-yì	‘blood’
ð-kpí	‘spitting cobra’		

b. [u] as stem vowel. Possible prefix vowels: [i, u, e, o, ɛ, ɔ, a]

ù-kù	‘cradle’	kè-yú	‘riches, wealth’
kì-kùl	‘box’	yò-yú	‘beauty’
è-pú	‘hip’	yà-tù	‘wine’
yò-nùŋ	‘salt’		

Low vowel [a]: The noun stems with low vowel [a] permit only [−ATR] non-high vowel prefixes, and disharmonic high vowel prefixes.

c. [a] as stem vowel. Possible prefix vowels: [i, u, ɛ, ɔ, a]

à-mà	‘holes’	lì-dà	‘folk tale’
é-tál	‘kite’	ú-kwá	‘canoe’
ð-kà	‘needle’		

Mid vowels: The noun stems with mid vowels permit only [+ATR] or [−ATR] mid vowel prefixes depending on their [ATR] specification, and disharmonic high or low vowel prefixes.

⁴See Iwara (1982, 2003) for a presentation of the 14 noun classes of Lokaa.

- d. [ɛ] as stem vowel. Possible prefix vowels: [i, u, ɛ, ɔ, a]
 è-tè ‘dagger’ kú-blènì ‘(sleeping) mat’
 ò-yè ‘funnel’ à-bé ‘breasts’
 yì-dé ‘sleep’
- e. [ɔ] as stem vowel. Possible prefix vowels: [i, u, ɛ, ɔ, a]
 kò-bó: ‘arm’ ú-kpòŋ ‘type of cocoyam’
 è-tó ‘house’ kà-wój ‘sky’
 yì-nòn ‘bird’
- f. [e] as stem vowel. Possible prefix vowels: [i, u, e, o, a]
 é-fém ‘crocodile’ kù-bém ‘lie’
 ò-bèlè ‘water pot’ à-tè ‘songs’
 í-kpé ‘lawsuit, case’
- g. [o] as stem vowel. Possible prefix vowels: [i, u, e, o, a]
 lò-tó ‘intestine’ í-tòm ‘shrine’
 è-tòm ‘life’ à-kó ‘wars’
 ú-kpò ‘towel’
- h. [ə] as stem vowel. Possible prefix vowels: [i, u, e, o, a]
 è-dól ‘louse’ kú-dḍèn ‘spirit’
 ò-dóm ‘man, male’ à-bḍ ‘pits’
 yí-tànḍ ‘antelope’

If we define a harmony “trigger” as a vowel that determines the harmonic quality of a neighbouring vowel and an “undergoer” as a vowel that alternates based on the harmonic quality of the trigger, then descriptively the emergent picture of vowel co-occurrence in Lokaa is as follows. Words consisting only of non-central mid vowels are completely harmonic: the prefix vowel must agree completely with the noun stem vowel in ATR. High vowels [i] and [u] can co-occur with any vowels either as prefix or as stem vowels. It appears therefore that high vowels neither trigger nor undergo harmony. On the surface high vowels may be disharmonic, when the stem vowel is [–ATR]. Finally, the low vowel [a] behaves differently as a stem vowel than as a prefix vowel. As a stem vowel only [–ATR] vowels (mid and low) and the non-undergoing high vowels can occur to its left as prefixes. In this sense it triggers harmony. As a prefix, however, it does not alternate (it is a non-undergoer), and it can co-occur with all eight stem vowels.

2.2. Vowel distribution in verbs

The vast majority of verbs in Lokaa are monosyllabic. The most common monosyllabic verb shapes are CV, CV: and CVC. Lokaa has consonant clusters, so the onset can be a cluster ([bló:] ‘come from’), but there are no complex codas. Furthermore, closed syllables can occur with long vowels ([kpǎ:l] ‘gather’). Finally, the second position in a cluster is restricted to non-nasal sonorants, and codas are restricted to sonorants. All verbs are consonant-initial.

2.2.1. Monosyllabic verbs

As in noun stems, all eight vowels can occur in monosyllabic verbs, as the following examples show. The table in (4) illustrates only the most common shapes.

(4) *Vowel occurrence in monosyllabic verbs:*

CV Verbs	CV: Verbs	CVC verbs
fí ‘foam’	fí: ‘kill’	píl ‘break’
wú ‘pound’	wú: ‘be full’	mǔŋ ‘give to drink’
kpé ‘learn’	tě: ‘sing’	yěl ‘call’
	dé: ‘buy’	kěŋ ‘sift’
dó ‘tidy up’	dó: ‘be satisfied’	tól ‘trace’
kó ‘trim to shape’	kó: ‘ignore (someone)’	póm ‘go early’
kó ‘see’	kǒ: ‘give’	kóm ‘pierce’
tá ‘shoot’	tá: ‘investigate, dig up’	báj ‘coax’

2.2.2. *Bisyllabic verbs*

Bisyllabic verbs are mostly CVCV in shape. In these verbs, the second vowel position V_2 is restricted to the three vowels [i], [a], and [ə]: that is, one high vowel, one low vowel, and one mid vowel. When V_2 is [i], all vowels can occur as V_1 . When V_2 is [a], only the high vowels [i, u] and the [–ATR] mid vowels can occur as V_1 . Finally, when V_2 is [ə], only the [+ATR] vowels can occur as V_1 . This vowel distribution is illustrated in the table in (5) and is exemplified in (6).

(5) *Vowel co-occurrence in bisyllabic verbs:*

$V_1 \backslash V_2$	i	u	a	ə	e	o	ɛ	ɔ
i	✓?		✓	✓				
u	✓		✓	✓				
a	✓		✓					
ə	✓			✓				
e	✓			✓				
o	✓			✓				
ɛ	✓		✓					
ɔ	✓		✓					

(6) a. Final [i]. If V_2 is [i], the stem initial vowel can be any of the eight vowels:

túmí ‘dot’	yémí ‘awaken’
dəlí ‘take, pick, choose’	kóbí ‘fetch’
yéní ‘have’	tàlí ‘pull’
kóŋŋí ‘be eerie’	

b. Final [a]. If V_2 is [a], the stem initial vowel can be [–ATR] vowels [a, ɛ, ɔ], or the high vowels [i, u].

tíká ‘shift’	nòná ‘cook’
lú:wá ‘push’	pàná ‘touch’
mé:ná ‘bend’	

- c. Final [ə]. If V₂ is [ə], the stem initial vowel can be [+ATR] vowels [ə, e, o], or the high vowels [i, u].
- | | | | |
|-------|------------|--------|---------------------|
| fùkó | ‘count’ | kpé:nó | ‘watch over, guard’ |
| wì:yó | ‘blow’ | tómó | ‘push’ |
| yòmó | ‘lie down’ | | |

In summary, the following co-occurrence generalizations hold across bisyllabic nouns and verbs:

(7) *Vowel co-occurrence in bisyllabic nouns and verbs:*

- a. [ə] cannot occur as a prefix vowel in nouns, and the mid vowels [e, o, ε, ɔ] don’t occur as V₁ in verbs.
- b. If V₂ is a high vowel, V₁ can be any vowel.
- c. If V₂ is [a], V₁ can be a [−ATR] vowel [a, ε, ɔ], or a high vowel [i, u].
- d. If V₂ is [ə], V₁ can be a [+ATR] vowel [e, o], or a high vowel [i, u]. In addition, V₁ can also be [a] in nouns or [ə] in verbs.

In addition, the following two generalizations also hold in nouns:

- (7) e. If V₂ is a [−ATR] mid vowel [ε, ɔ], then V₁ can be a [−ATR] mid vowel [ε, ɔ], a high vowel [i, u], or the low vowel [a].
- f. If V₂ is a [+ATR] mid vowel [e, o], then V₁ can be a [+ATR] mid vowel [e, o], a high vowel [i, u], or the low vowel [a].

2.2.3. *On vowel restriction in bisyllabic verbs*

For completeness, I now digress to compare the above restricted vowel distribution in verbs with what has been reported for a closely related language, Leggbo, especially in relation to the facts in (7d–f).

The first obvious generalization from the table in (5) is that the second vowel of the verb cannot be a non-central mid vowel ([e, o, ε, ɔ]). This is very much unlike Leggbo. Hyman and Udoh (2002:4) and Hyman et al. (2002:6) propose that Leggbo bisyllabic “verbs consist of a CVC (or CVVC) root plus a suffix”, either /-i/ as in (8a), which can occur after all V₁ vowels, or /-a/ which assimilates to a preceding mid vowel, as in (8b).

(8) *Analysis of CVCV verbs as /CVC-i/ and /CVC-a/ (including CVVCV):*

- a. /CVC-i/
 - V₁ can be any vowel
- b. /CVC-a/
 - /CiC-a/, /CuC-a/, /CaC-a/ (no change)
 - /CeC-a/ → [CeC-e]
 - /CoC-a/ → [CoC-o]
 - /CεC-a/ → [CεC-ε]
 - /CɔC-a/ → [CɔC-ɔ]

They observe further that the underlying V_2 /-i/ and /-a/ are thus frozen lexical suffixes found only on some verbs. Though both languages may have historically had a CVC verb root, Lokaa does not have the type of assimilation postulated in Leggbo. In fact Lokaa lacks bisyllabic verbs in which the two vowels are mid non-central vowels, as in (9).⁵

(9) *Bisyllabic verb patterns absent from Lokaa (but present in Leggbo):*

*[CeCe] *[CɛCɛ]
*[CoCo] *[CɔCɔ]

While Leggbo assimilates final [a] to a preceding mid vowel (resulting in six final vowels [i, a, e, o, ɛ, ɔ]), Lokaa maintains [i], [a], and [ə] as final vowels. Therefore the Leggbo analysis does not carry over to Lokaa.

A second possible inference from the table in (5) is that the final schwa [ə] is the [+ATR] equivalent of /a/. The surface vowel distribution patterns appear to suggest an alternation between [a] and [ə] in bisyllabic verbs. This is because only [+ATR] vowels may precede [ə]. The [a]/[ə] alternation idea again follows from an assumption that the verb stem consists of a CVC root followed by final vowel, which is a suffix, as has been persuasively argued for Leggbo by Hyman and Udoh (2002) and Hyman et al. (2002). The argument might take the form that Lokaa's final vowels are /i/ and /a/, and the final [a] assimilates to the preceding mid vowels in [ATR], resulting in [a] or [ə]. However, there is hardly any additional support for an [a]/[ə] alternation in the synchronic phonology of Lokaa.

The assumption that a "suffix" [a] assimilates to a preceding mid vowel in [ATR] implies that suffixes constitute a domain of harmony in Lokaa. This is not borne out by Lokaa facts, as I will now show.

Iwara (1982, personal communication) points out that "Lokaa has very few elements that would pass as suffixes". Interestingly, however, in none of these so-called suffixes is there an alternation. We begin with the specific case of [a] in nouns. The vowel [a] sometimes occurs as a suffix marking third-person pronoun in nouns of kinship as in (10a), or as postposition to mark "for/of" as in (10b). In neither case does it alternate.

(10) *Suffix-like element [a]:*

a. [a] as third person

ò-dóm	'man'	[òdómá]	'her husband'	*[òdómó]
yà-ně̃n	'woman'	[yànèná]	'his wife'	
wě̃n	'child'	[wèn-á]	'his/her child'	

b. [a] used as postposition to mark 'for/of'

è-tó	'house'	[è:tóá] or	'for the house'	
		[è:tówá]		
wǒ:l	'body'	[à:wò:lá]	'for the body'	*[à:wò:l-ó]

⁵The only type of bisyllabic verbs with identical mid non-central vowels in Lokaa are those derived from reduplicating monosyllabic verbs as follows:

bé:	'stand'	bé:bé:	'keep standing'
mé	'do a roof mat'	mémé	'keep doing roof mats'
yó	'look for'	yóyó	'keep looking for'

li-kò:l	‘forest’	[likó:lá]	‘for the forest’	*[likó:lə]
/lè-ból-kòl/	[lèbó:kòl]		‘wrist (lit. neck of hand)’	
/lè-ból-kòl-á/	[lèbó:kò:lá]		‘of a wrist’	*[lèbó:kò:lə]
/è-ból-jów/	[èbójów]		‘royal necklace (lit. rope of neck)’	
/è-ból-jów-á/	[èbójówá]		‘of a royal necklace’	*[èbójówə]

2.2.3.1. *Enclitics.* The third-person singular takes the form of the enclitic [é] in Lokaa. It may have an onset, which varies depending on the class of the noun. The following examples show that it does not alternate at all in ATR value. The same non-alternation is observed in Leggbo enclitics (Hyman and Udoh 2002).

(11) *Monosyllabic verbs:*

tĩ:	‘step on’	tě:	‘step on him’
kpě:	‘sell’	kpè:ké	‘sell it’
wó:	‘find/search for’	wó:ké	‘find/search for it’
yǒ:	‘weave’	yò:ké	‘weave it’
kǎ:	‘give’	kǎ:ké	‘give him’
dǒ:	‘mix’	dò:ké	‘mix it’
dě:	‘greet, call’	dè:ké	‘greet him’
dé:	‘buy’	dé:ké	‘buy it’
tá	‘shoot’	té:	‘shoot him’
dú	‘beat’	dùwé	‘beat him’

(12) *Bisyllabic verbs:*

tàlí	‘pull’	tàlé:	‘pull him’
tólí	‘return’	tólé:	‘return it’
dàlí	‘take’	dàlé:	‘take him’
bò:lí	‘peel (with hand)’	bò:lé	‘peel it’
yémí	‘awaken’	yémé:	‘awaken him’
dìbó	‘catch’	dìbé:	‘catch him’
tómó	‘push’	tómé:	‘push him’
dénnó	‘beg’	dénné:	‘beg him’
blámá	‘hug’	blámé:	‘hug him’
máná	‘hold’	máné:	‘hold him’
nòná	‘cook’	nònáké	‘cook it’
kówá	‘peel (with knife)’	kówáké	‘peel it’

The second-person singular enclitic [ó] patterns the same way. I cite only the relevant mid-vowel cases here.

(13) kpé	‘teach’	ó kpô:	‘he taught you’
wó:	‘search for’	ó wóyô:	‘he searched for you’
tò:lí	‘follow’	ó tò:lô	‘he followed you’
dénnó	‘beg’	ó dénnô:	‘he begged you’

Two conclusions can be drawn from the above examples. First, suffixes in general do not harmonize for ATR in Lokaa; specifically, the vowel [a] in suffix position does not alternate. The second point is that suffixes and enclitics are outside the domain of harmony. I will therefore regard the V₂ ([i], [a], and [ə]) in the bisyllabic

verbs as frozen parts of the verb stem which no longer behave as suffixes, even if they were suffixes historically. Therefore synchronically, I do not regard final [a] and [ə] as alternating in the second vowel V_2 of bisyllabic verbs; rather, they determine the ATR value of the first (preceding) vowel V_1 . This position accounts for all of the data so far presented in verbs, and as we shall see it is also consistent with the behaviour of final vowels in trisyllabic nouns. In the rest of this paper I will pay attention to stems and prefixal and proclitic elements only.⁶

I now turn to the details of Lokaa harmony.

3. DOMAIN OF HARMONY

In Lokaa, the domain of harmony is the Prosodic Word (PrWd), which consists of a stem (see Bakovic 2000, 2003; Pulleyblank 2002) and a preceding clitic or affix. This domain covers, in a noun, both the stem and its prefix, and in a verb, a prefix (or pronoun clitic) and its radical (monosyllabic or bisyllabic). The forms in (14a,b) and (14c) illustrate the “clitic plus verb” domains, and those in (15) show the “prefix plus noun stem” forms.

(14) *Third-person pronoun before [+ATR] and [-ATR] verb stems:*

- a. ð-nèn ímàà ó-kóó b́é k̀è
 man the he-saw them has
 ‘The man has seen them.’
- b. ð-nèn ímàà ó-kràà lè-k̀òì
 he-beat drum
 ‘The man beat a drum.’
- c. é tóó ‘it had’ é d́óó ‘it slept’
 ó mléé ‘he entered’ ó m̀èè ‘he swallowed’

(15) *Noun class prefixes plus noun stems:*

- | | | | |
|---------|---------------|----------|----------|
| é-fém | ‘crocodile’ | è-tè | ‘dagger’ |
| ò-tèm | ‘Igbo trader’ | ò-yè | ‘funnel’ |
| k̀ò-póó | ‘cup’ | k̀ò-b́óó | ‘hand’ |

In (14a,b) the instructive examples are the forms *ó-kóó* ‘he-saw’ as compared to *ó-kràà* ‘he-beat’. The form of the third-person proclitic varies depending on the ATR specification of the vowel of the verb stem. The same is true of the examples in (14c). If we take these examples of clitic+verb stem with those of class prefix+noun stem in (15), it is clear that the domain of harmony can be characterized as the PrWd.

⁶Note that we cannot assume that “alternating” a/ə receive tone from verb melodies and so are suffixes, whereas enclitics have underlying (H) tones and therefore fall outside the domain of harmony. As Iwara et al. (2003) note, Lokaa verbs can be split into two tone groups, those of H stem (first syllable) and those with L stem. Therefore, all isolation monosyllabic verbs are H or LH, and all isolation bisyllabic verbs are HH or LH. Suffix-like elements are always H, and tonal evidence cannot determine that the final vowels in (6b) and (6c) are suffixes and part of the harmony domain, and those in (10)–(12) are enclitics and therefore outside the harmony domain.

The proposal that the harmony domain is a PrWd is further supported by the fact that this is also the domain of a “tonal complex” in Lokaa, as argued in Akinlabi and Liberman (2006).

3.1. Compounds

Compounds may juxtapose two or more noun stems with vowels from different harmonic sets; for this reason, they appear to be outside the domain of harmony. It is useful to note the following points:

- (i) Compounds are head-final. In a compound of two nouns, the second noun stem determines the nominal class of the entire compound by dictating the shape of nominal prefix.
- (ii) However, it is the first noun stem that determines the harmonic class of that prefix (Iwara 2003; Hyman 2004).

The following examples show compounds formed with nouns from different nominal classes and different harmonic sets. The prefixes are underlined to show that the compound belongs to the (noun) class of the second noun.⁷

- | | | |
|---------|---|---|
| (16) a. | <u>lè</u> -bóó-kpà ‘climbing rope’
kè-bóó + <u>lè</u> -kpà
rope bag | <u>lè</u> -kpè-kòòl ‘leopard’s neck’
è-kpè + <u>lè</u> -kòòl
leopard neck |
| b. | <u>kó</u> -dám-bóó ‘right hand’
ò-dám + <u>kò</u> -bóó
man hand | <u>è</u> -bóól-jóú ‘royal necklace’
ò-bóól + <u>è</u> -jóú
chief rope |
| c. | <u>lè</u> -kó-táá ‘war boulder’
lè-kó + <u>lè</u> -táá
war stone | <u>lè</u> -nòmà-bè ‘deep seat’
kè-nòmà + <u>lè</u> -bè
seat hole |

Using the last example, lè-nòmà-bè ‘deep seat’, as illustration, I propose that nominal compounds have a nested structure consisting of a PrWd within a PrWd, and that the prefix is phonologically closer to the first noun. This structure can be represented as in (17).

- (17) [[lè-nòmà]_{WD} bə]_{WD}

If the domain of vowel harmony is the PrWd, then we must conclude that the vowel of the first stem is opaque to harmony. This is completely expected if the domain of harmony is the first (lower) PrWd, and if the second stem falls outside the harmony domain. All of the compound forms in (16) illustrate this point. Note that in each case, the (initial) vowel of the first noun stem is a mid vowel, which triggers and undergoes harmony. A formal account of the above forms is the same as that for the forms in (15) above and (18) below, except that the second stem constitutes a harmonic domain by itself.

⁷But see Runsewe (1988), who regards the first stems as “infixd”.

4. MID VOWELS

The Lokaa harmonic sets in (1) can be illustrated with non-central mid vowels, which have harmonic counterparts in each set. For reasons of clarity, I focus on non-high vowels in this section. High vowels are discussed in section 5 and the low vowel [a] in section 6. In the nouns in (18), stems with [+ATR] vowels take only [+ATR] noun-class prefixes, and stems with [−ATR] vowels take [−ATR] prefixes.⁸

(18) *Stems and noun class prefixes:*

[+ATR] roots		[−ATR] roots	
lè-kó	‘war’	lè-dè	‘greeting’
lò-tè	‘song’	lò- tɛ́	‘giant ant’
é- kòdò	‘friendship’	é-kò	‘cloth’
ò-dám	‘man, male’	ò-dáj	‘fufu’

In these examples, the nouns in each row belong to the same noun class, and the vowel quality difference in the class prefix is completely a function of the ATR specification of the stem vowel. These data are straightforward and can be easily accounted for by assuming the supremacy of constraints enforcing agreement of ATR features within the PrWd domain, which includes the prefix-stem structure in (18).

It is necessary to adapt the idea of “stem control” (Van der Hulst and Weijer 1995; McCarthy and Prince 1995; Bakovic 2000) to account for the fact that affixes harmonize with stems. This achieves the directionality effect in stem-controlled harmonies. The stem control faithfulness constraint is stated in (19).

(19) FAITHSTEM(ATR):

If an input segment x_1 is in the stem, has value $[\alpha\text{ATR}]$, and it has an output correspondent x_0 , x_0 will have value $[\alpha\text{ATR}]$.

In single PrWds with only mid vowels, there can only be one harmonic span. Moreover, the fact that the affix (mid) vowel rather than the stem (mid) vowel alternates implies the dominance of (or faithfulness to) the ATR specification of the stem vowel through FAITHSTEM(ATR). Everything else is secondary.

5. HIGH VOWELS

The Lokaa vowel system reveals an asymmetry commonly found in ATR harmony systems: high vowels have no [−ATR] counterparts. Therefore some [−ATR] stems take high vowel prefixes, which are invariant in their ATR specification. However, it is clear that Lokaa used to have the $[\pm\text{ATR}]$ distinction in high vowels, which was present in Benue Congo (Stewart 1971; Williamson 1983). This historical fact is revealed by the varied behaviour of high vowels in noun stems. However, all high vowels (prefix or stem) are now [+ATR].

⁸A long vowel is transcribed throughout as a sequence of identical vowels; tones are indicated with the usual diacritics.

5.1. Disharmonic high vowel prefixes

The forms in (20) show that high vowel prefixes are invariably [+ATR] before [+ATR] stems (first column), as well as before [-ATR] stems (third column).

(20) *Disharmonic high vowel prefixes:*

í-kpé	‘lawsuit’	ì-tàŋ	‘hat’
li-tè	‘songs’	yì-dé	‘sleep/dream’
kú-té	‘musical instrument’	kú-bààŋ	‘door’
li-tó	‘intestines’	li-wàá	‘leaves’
		yì-tò	‘he-goat’

The standard Optimality Theoretic (OT) approach to this phenomenon, named “harmonic non-pairing” by Bakovic (2003), is the use of co-occurrence or “grounding” constraints (Archangeli and Pulleyblank 1994). The constraint *[+HI, -ATR] (Archangeli and Pulleyblank 1994; Calabrese 1995; Bakovic 2003) in (21) says that high vowels “prefer” not to be [-ATR].

(21) *[+HI, -ATR]:

An output segment is not simultaneously specified for [+HI] and [-ATR].

Disharmonic high vowel prefixes occur because *[+HI, -ATR] is inviolable in Lokaa, and therefore dominates the constraints enforcing harmony.

As seen from the above examples, alteration of the [+ATR] value of a high vowel prefix is disallowed. The question is: does the high vowel belong in the same harmonic span as the [-ATR] mid vowel? The proposal here is that they do. Support for this position is that high vowels are transparent to harmony, as I show in section 6.

5.2. Disharmonic mid vowel prefixes

Mid vowel prefixes are ordinarily harmonic, usually agreeing with the ATR value of the stem vowel, as seen in the examples in (18). The interesting issue that arises is that certain high vowel stems may take [-ATR] mid vowel prefixes, which are disharmonic. This section argues that high vowels may be [+ATR] or [-ATR] in the input, but crucially must be [+ATR] on the surface because of undominated *[+HI, -ATR] (21). However, the input [-ATR] specification of the relevant vowels remains floating on the surface, and is not deleted. The floating [-ATR] represents the incomplete fusion of historic [-ATR] high vowels with [+ATR] ones. This essentially represents postulating a ten-vowel underlying structure for Lokaa.⁹

Before turning to the exceptional cases of high vowels in stems, it is important to establish what happens in the majority of cases. In most Lokaa nouns, stems with high vowels take [+ATR] class prefixes, while stems with non-high [-ATR] vowels take the [-ATR] class prefixes, as in (22).

⁹See Hyman (2003) for a comparable high vowel case and analysis in Kalɔŋ; and Hoffmann (1973) and Omamor (1988) for comparable mid vowel cases in Okpe and Uvwie respectively. See also Runsewe (1988) for a comparable solution to the Lokaa data.

(22) *Prefix alternation before high vowel stems and [−ATR] mid vowel stems.*

	High vowel	Non-high [−ATR] vowel
a. Class 3 singular [le/ɛ]:	lè-tú ‘head’	lè-mà ‘hole’
b. Class 5 singular [ke/kɛ]:	kè-tí ‘tree’	ké-kòòl ‘noise’
c. Class 6 plural [ye/yɛ]:	yè-tí ‘trees’	yé-kòòl ‘noises’
d. Class 11 singular [ko/kɔ]:	kò-wú ‘settlement’	kò-bóó ‘hand’
e. Class 13 [lo/lɔ]:	lò-wí ‘water’	lò-té ‘ant’

However, some high vowel stems (in 23) take [−ATR] class prefixes, as do the [−ATR] mid vowel stems in (22).

(23)	[+ATR] (harmonic) prefixes	[−ATR] (disharmonic) prefixes
	lè-tú ‘head’	lé kpì ‘electric fish’
	kò-wú ‘settlement’	kò-kpì ‘women’s native pad’
	kè-tí ‘tree’	kè-yú ‘riches’
	ó-tì ‘ankle bell’	ò-kpí ‘viper’
	yò-jí ‘palm tree’	yò-yú ‘beauty’

There are two possible analyses of the disharmonic data in (23). The first approach is to assume that the [−ATR] values of the mid vowel prefixes are not determined by the high vowel stems, and so the prefixes are underlyingly [−ATR]. The second possibility is to say that the [−ATR] values of the prefixes are, in fact, determined by the following high vowel stems, though they themselves are not [−ATR] on the surface. Evidence from compounds suggests that the second approach is the correct one. If these high vowel stems are placed in compounds, they still trigger [−ATR] prefixes for the entire compound.

(24) a.	ò-kpí ‘viper’	lè-tú ‘head’	lè-kpí-tú ‘viper’s head’
cf:	è-kpí ‘rat’	lè-tú ‘head’	lè-kpí-tú ‘rat’s head’
b.	kè-yú ‘riches’	è-tó ‘family/house’	è-yú-tó ‘rich man’s family’
cf:	lé-dù ‘trash’	è-tó ‘family/house’	é-dù-tó ‘trash-house’
c.	lò-wí ‘water’	kè-wáà ‘drinking’	kè-wí-wáà ‘water drinking’

Several points are in order here. First, note that as shown in the compounds in (16), the stem that is closest to the prefix determines its ATR specification. Thus it makes sense to assume that *ò-kpí* ‘viper’ and *è-kpí* ‘rat’ in (24a) trigger different ATR prefixes. This explains why *lè-kpí-tú* ‘viper’s head’ retains a [−ATR] prefix while *lè-kpí-tú* ‘rat’s head’ has a [+ATR] prefix. Otherwise it is odd that the last stem [-tú] ‘head’ in both compounds selects different ATR specifications for different compounds. Secondly, as shown in the examples in (16) above, compounds are opaque to ATR propagation. Therefore, the [−ATR] specification of the prefix in forms such as *è-yú-tó* ‘rich man’s family’ in (24b) cannot be from the last [−ATR] vowel (i.e., the second stem). The second stem vowel [-tó] is “outside” the domain of harmony triggered by the first stem vowel, as we have shown. Finally, if the [−ATR] vowel of the prefix in this form were from the last stem vowel [-tó], there would be no

explanation for the [+ATR] prefix in forms such as [é-dù-tó] ‘trash-house’, which has the same final stem.¹⁰

I propose therefore that the disharmonic high vowel stems in (23) have an input [−ATR] feature. Though the high vowels themselves are [+ATR] on the surface, their input [−ATR] remains floating. They do not re-associate because *[+HI, −ATR] is high ranked and inviolable in Lokaa. I propose that the prefixes of these stems harmonize with the floating [−ATR] of the stems, satisfying all higher ranked constraints calling for ATR agreement. But the stems themselves violate a constraint against having a floating feature on the surface and a constraint against feature ([+ATR]) insertion. In addition, we must also assume that the floating [−ATR] cannot be deleted from stems.

Without a [−ATR] specification of the input, it is impossible for the prefix to surface as [−ATR], since the [ATR] value of the mid vowel prefix is completely predictable from that of the stem. Given the high ranking of both *[+HI, −ATR] and FAITHSTEM(ATR), the floating ATR can be neither deleted nor phonetically realized as part of the stem high vowel. However, note that ATR can be deleted in prefixes, as the mid vowel forms show.¹¹

The essential claim of this sub-section has been that cases of apparent disharmony involving mid vowel prefixes and high vowel stems are really not disharmony because the stem has a surface floating [−ATR] autosegment, proof of which are the compounds in (24). Otherwise it is not clear what the mid vowel prefixes are harmonizing with. As seen in the forms in (24), even when the prefix is supplied by another ([+ATR]) stem that is further away, the high vowel stem still turns the prefix to [−ATR].¹²

The issue that arises here is the phonetic status of the high vowel of the stem. Is the [−ATR] realized as part of the high vowel? The answer here is that it is not.

¹⁰A reviewer has contested the proposal that the compounds in (24) support the hypothesis that [−ATR] values of the prefixes are determined by the following high vowel stems, proposing instead that the [−ATR] prefixes in (23)–(24) can be assumed to be underlyingly [−ATR]. The only way such an argument can go through is to assume that [−ATR] is assigned to the prefix “positions”, and not to the prefix segments themselves. Note that in (24a), for example, it is a complete mystery why the class prefix [lè-] for *lè-tú* ‘head’ alternates between [−ATR] and [+ATR] in the compounds *lè-kpí-tú* ‘viper’s head’ and *lè-kpí-tú* ‘rat’s head’ but not in isolation. This is unnecessary if the alternation comes from the stems for ‘viper’ and ‘rat’.

¹¹Furthermore, we must assume that [ATR] is also deletable from high vowel prefixes, given the class prefix selection in *yí-kilíkílí* ‘weaverbird’ and *yó-kilíkílí* ‘weaverbirds’. Under the analysis proposed here, the reduplicated stem [-kilíkílí] has an underlying [−ATR] [ɪ], hence the selection plural prefix [yó-], but [−ATR] is deleted in the singular prefix.

¹²For the sake of completeness, note that it is impossible to derive (24a) without assuming a stem with [−ATR], given that mid vowel prefixes always harmonize with the stem. This may seem to be like imposing an input, but this is not the case. The only claim is that only inputs with a [−ATR] surface this way, while inputs with [+ATR] surface with [+ATR] prefixes. Given Richness of the Base (Prince and Smolensky 2004), we must consider both types of stem inputs. The alternative position — assuming that the prefixes themselves are [−ATR] — collapses in the face of the data in (24), where [ATR] specification of the prefix must be assumed to come from the stem.

The high vowel is [+ATR] on the surface, but there remains an unassociated [−ATR] autosegment. (See Akinlabi 1996 and Zoll 1996 for discussions of subsegmental units.) The idea therefore is that the high vowel of the stem behaves “transparently” to the floating [−ATR] autosegment. That the high vowel in this case is transparent is not surprising, as high vowels are in general transparent to any [−ATR] which is part of a following non-high vowel, as I discuss in detail in the next section.

6. HIGH VOWEL TRANSPARENCY

Section 5 showed that high vowels [i] and [u] are disharmonic in both prefixes and stems, because of co-occurrence constraints against high, [−ATR] vowels. This is however not the only characteristic of high vowels in Lokaa harmony. Though the high vowels themselves do not undergo harmony (they don’t alternate), they are transparent to [−ATR] propagation when they occur as the first vowel of a bisyllabic or trisyllabic stem.¹³

(25) *Bisyllabic noun stems with [+ATR] and [−ATR] class prefixes:*

a.	è-sisòŋ	‘smoke’		*è-sisòŋ
	kò-fíyà	‘brain’		*kò-fíyà
	lè-jìmà	‘matriclan’		*lè-jìmà
	ó-yínó	‘story’		*ó-yínó
b.	è-sísòŋ	‘housefly’		*è-sísòŋ
	kè-títàŋ	‘raffia bamboo splinter’		*kè-títàŋ
	lò-títàŋ	‘rib’		*lò-títàŋ
	ó-tú:má	‘need’		*ó-tú:má
	è-nínòŋ	‘finger’		*è-nínòŋ

(26) *Nouns derived from bisyllabic verb stems:*

a.	fúkó	‘count’	kó-fúkó	‘counting’	*kó-fúkó
	túkó	‘run’	kè-túkò	‘running’	*kè-túkò
	wì:yó	‘blow’	kè-wì:yó	‘blowing’	*kè-wì:yó
	fì:lá	‘jump’	é-fì:là	‘high jump’	*é-fì:là
b.	fúká	‘gather’	kò-fúkà	‘gathering (people)’	*kò-fúkà
	fúká	‘gather’	kè-fúkà	‘gathering (things)’	*kè-fúkà
	lú:wá	‘push’	kò-lú:wà	‘pushing’	*kò-lú:wà
	tíká	‘shift’	kò-tíkà	‘shifting’	*kò-tíkà
	yìká	‘put down’	kò-yìkà	‘putting (a load) down’	*kò-yìkà

(27) *Bisyllabic verb stems with proclitics:*

a.	yó ðibè	‘we caught’
	yópíká	‘we polished’
b.	yó kúdó	‘it split’
	yómù:là	‘it dissolved’

¹³It might be proposed that the stems in these cases have floating [−ATR] like those discussed in section 5. While there is no way to disprove such an argument, because there is already a following [−ATR] vowel, under such an account it would be purely accidental that the prefix is [+ATR] only when the stem high vowel is followed by a [+ATR] vowel, and [−ATR] only when the stem high vowel is followed by a [−ATR] vowel, and never otherwise.

(28) *Trisyllabic noun stems with two high vowels:*

é-kpilífbà	‘species of cocoyam’	*é-kpilífbà
ké-kílikà	‘kind of plant’	*ké-kílikà

In section 1, I argued that the final vowels of bisyllabic verbs in (26) and (27) are not suffixes, but synchronically part of an unanalyzable fused stem. Since final vowels of noun stems cannot be analyzed as suffixes, only this assumption can account for the uniform way in which final vowels of both these verbs and nouns (in 25) trigger harmony in prefixes and proclitics.

The examples in (25a) show that it is impossible to have a [−ATR] mid vowel prefix when the second stem syllable has a [+ATR] vowel, and (25b) shows that it is impossible to have a [+ATR] mid vowel prefix when the second vowel is [−ATR]. The near minimal pair of è-sísòŋ ‘smoke’ and è-sísòŋ ‘housefly’ is especially telling. The surface ATR specification of the prefixes of derived nouns in (26) cannot be explained unless the high vowels are transparent, since the verbs from which they are derived do not have these prefixes (compare *fúkó* ‘count’ and *fúká* ‘gather’). The forms in (27) show proclitic ATR alternation depending on whether the second vowel of the verb stem is [+ATR] or [−ATR]. Finally the forms in (28) show two transparent high vowels in a trisyllabic stem.¹⁴

So far, I have introduced two constraints: FAITHSTEM(ATR), which protects stem vowels from changing, and *[+HI, −ATR], which prevents a [−ATR] high vowel from occurring on the surface. These constraints are now generally employed in constraints-based analysis of harmony. However, in order to account for transparency and opacity within the same language, I turn to Headed Span Theory (McCarthy 2004). I provide a broad summary in section 6.1, though I only employ the insights provided into transparency and opacity in my analysis.

6.1. Headed Span Theory analysis

McCarthy’s (2004) Headed Span Theory is a theory of both local and non-local feature assimilation. McCarthy proposes that the segments of a word are exhaustively parsed into spans for each distinctive feature.¹⁵ Each span of the feature [F] has a head segment, and it is the head segment’s value for [F] that determines the pronunciation of the other segments in the span. A featural *span* is defined as a constituent whose terminal nodes are segments in a contiguous string.

McCarthy posits four constraint types:

- (i) A markedness constraint that is violated by adjacent [F]-spans. This constraint replaces the ALIGN or AGREE constraints of other theories of spreading.
- (ii) Faithfulness constraints requiring input [α F] segments to head [α F] spans in the output. They are Span Theory’s alternative to IDENT.

¹⁴Recent works (Garos 1996; Ní Chiosáin and Padgett 2001; Rose and Walker 2004; Benus 2005; and others) have proposed that all assimilation is local. Therefore, there cannot be any transparent vowels in harmony. Archangeli and Pulleyblank (2006) present interesting counterexamples to this claim.

¹⁵Some features are also shared by Cole and Kisseberth’s (1994) Optimal Domains Theory.

- (iii) Markedness constraints requiring certain segment types to head spans with a particular [F]-value. These constraints are essentially feature co-occurrence restrictions.
- (iv) Markedness constraints requiring the head segment to lie at a particular edge of a span. These constraints produce directionality effects similar to ALIGN.

Three of the above types of constraints are stated in (29), with an informal explanation of the role of each. The fourth type (iv) is not used in the discussion of Lokaa harmony here.

(29) *Harmony Constraints* (McCarthy 2004):

- a. *A-SPAN(F)
Assign one violation mark for every pair of adjacent spans of the feature [F].
(Explanation: *Prefers having just one [F]-span per domain. Forces harmony.*)
- b. FAITHHEADSPAN(α F)
If an input segment x_1 is [α F] and it has an output correspondent x_0 , x_0 will head a [α F] span.¹⁶
(Explanation: *Equivalent of IDENT.*)
- c. HEAD([β G, γ H, ...], [α F])
Every [β G, γ H, ...] heads a [α F] span.
(Explanation: *All (classes of) segments are capable of heading some F-assimilation span.*)

I use only the following ATR-specific formulations of the constraints in (29) here.

(30) *ATR-specific headed span constraints:*

- a. *A-SPAN(ATR): No adjacent ATR spans.
- b. HEAD([-HI], [+ATR]): Nonhigh vowels head [+ATR] spans.
- c. HEAD([-HI], [-ATR]): Nonhigh vowels head [-ATR] spans.

In addition, the faithfulness role of FAITHHEADSPAN(α F) will be performed by FAITHSTEM(ATR), as defined in (19), repeated here as (30d) for convenience.

(30) FAITHSTEM(ATR):

- d. If an input segment x_1 is in the stem, has value [α ATR], and it has an output correspondent x_0 , x_0 will have value [α ATR].

Using the constraint FAITHSTEM(ATR) for basic harmony in place of FAITHHEADSPAN(α F) raises a question about how the stem heads a span, since FAITHSTEM(ATR) only helps to preserve the ATR value of the stem. When combined with *A-SPAN(ATR), which disallows adjacent ATR spans, it performs this role indirectly. If the segments in a span must share ATR, and if the ATR value of the stem cannot change, it implies that the ATR value of the prefix will change if it is different. I assume this comment to be sufficient and move to the real task at hand.

¹⁶O'Keefe (2007) notes that FAITHHEADSPAN(α F) is a conjunction of markedness (*head a span of value α F*) and faithfulness (*preserve values of α F*). I do not use this constraint here. Instead, its faithfulness role is performed by FAITHSTEM(ATR) (30d).

In its standard form stated above, Headed Span theory requires every segment within a domain to agree in the harmonizing feature. Thus, within McCarthy’s original proposal it is impossible to have a transparent segment—that is, a segment which is neither a head nor associated with a head. O’Keefe (2007) proposes that the requirement for every segment to agree with the harmonizing feature within the domain (a headed feature span) must be violable. That is, segments within the headed feature span do not have to agree with the feature defining this domain. He proposes that forms with transparent vowels should be analyzed as belonging to a single span with the head but violating the constraint requiring them to associate to a feature of the head.

O’Keefe proposes the constraint family, ASSOCIATEHEAD, which requires that segments share a specific feature of the head of the [F]-span in which they are located. A violation of this constraint while still remaining in the [F]-span implies transparency. The constraint is defined as in (31), and the ATR instantiation of it is defined as in (32).

(31) ASSOCIATEHEAD([βG, γH, . . .], [αF]):

Every [βG, γH, . . .] must share the value of the head of the [F]-span in which it is located.

In this particular instantiation, I will simply assume that all vowels must share the [F]-span value of the head, without separating the vowels according to height, unless this becomes crucial.

(32) ASSOCIATEHEAD([ATR]):

Every vowel must share the value of the head of the ATR span in which it is located.

With this constraint, cases of transparency can then be analyzed as single spans. The ranking argument for Lokaa high vowel transparency is shown in (33), using a form such as [è-sísòŋ] ‘housefly’. The relevant tableau is in (34). Transparent vowels are in square brackets within the [F]-span.

(33) *Ranking arguments for a transparent form:*

*A-SPAN >> ASSOCIATEHEAD([ATR])

(è[sí]sòŋ) vs. *(è[sí](sòŋ))

*[+HI, -ATR] >> ASSOCIATEHEAD([ATR])

(è[sí]sòŋ) vs. *(è[sí]sòŋ)

FAITHSTEM(ATR) >> ASSOCIATEHEAD([ATR])

(è[sí]sòŋ) vs. *(è[sí]sòŋ)

(34) è-sísòŋ ‘housefly’ *e-sisòŋ

	-sísòŋ	*[+HI, -ATR]	FAITHSTEM (ATR)	*A-SPAN	ASSOCIATEHEAD ([ATR])
a.	(è[sí](sòŋ))			*!	
b.	(è[sí]sòŋ)	*!			
c.	è[sí]sòŋ		*!		
d.	 (è[sí]sòŋ)				*

If the root vowels cannot be changed, and if high vowels do not alternate, then the only choice left for them is to be either transparent to [−ATR] or opaque. In (34) the opaque candidate (a) loses because of a violation of *A-SPAN, the fully harmonic candidate (b) loses because of *[+HI, −ATR], and candidate (c) loses because the stem vowel has been changed.

(35) *Ranking for high vowel transparency:*

*[+HI, −ATR], FAITHSTEM(ATR) >> *A-SPAN >> ASSOCIATEHEAD([ATR]).

As expected, high vowels are not transparent in compounds. This is so because the second stem falls outside the domain of harmony, as argued in section 3.1. Note that in (36) the forms *kè-kú* ‘bend’ and *è-tó* ‘house’ have [−ATR] prefixes in isolation. If the high vowels were transparent in the compounds we expect the prefixes to retain the [−ATR] specifications. (Recall from section 3 that the second stem determines the prefix, but the first stem determines its harmonic specification.)

- | | | | | | | |
|------|----|-------|---|-------|---|---------------|
| (36) | a. | è-tí | + | kè-kú | → | kè-tí-kú |
| | | stick | | bend | | walking stick |
| | b. | lé-dù | + | è-tó | → | é-dù-tó |
| | | trash | | house | | trash house |

In summary, high vowel transparency may be seen in two types of forms in Lokaa: first, when a floating [−ATR] survives in a stem with a [−ATR] high vowel, as in (23) and (24) and second, when a [−ATR] vowel follows a high vowel in a bi-syllabic form or longer, as in (25)–(28). The difference between these two is that in the forms in (23) the [−ATR] feature remains unassociated on the surface in the stem, whereas in (25)–(28), it is part of a non-high vowel. Therefore, all of the “disharmonic” forms in (23) violate ASSOCIATEHEAD([ATR]), since they are formally regarded here as “transparent” forms.

7. THE LOW VOWEL [a]

In this section, I turn to two features of the low vowel [a], namely its characteristics as a disharmonic prefix vowel and as an opaque stem vowel. The first characteristic is linked to the constraint forbidding the feature [+ATR] from co-occurring with the feature [+LO], and the second characteristic is linked to the fact that [a] must share the value of the head of the [F]-span in which it is located. In addition, the section proposes that co-occurrence constraints and ASSOCIATEHEAD constraints play different roles in harmony; both are crucial in accounting for harmony within the headed span approach.

7.1. Disharmonic [a] in prefixes

As a stem vowel the low vowel [a] triggers [−ATR] harmony. Only fully harmonic mid vowel prefixes (i.e., [−ATR]) can occur before it (in addition to the disharmonic high vowel prefixes discussed in section 4.1). The three [+ATR] mid vowels [e, ə, o] cannot occur before [a].

(37) [a] as a stem vowel:

è-fà	‘power’	kò-káà	‘crab’
é-káàŋ	‘dispute’	lè-mà	‘hole’
ò-dáj	‘fufu’	ké-kpán	‘overnight’
yò-pàá	‘pieces’		

However, as a prefix vowel, [a] can be disharmonic with the stem vowel. In Lokaa, [a] can occur as a prefix to any following vowel stem vowel. Our interest here is in the [+ATR] stem vowels:

(38) [a] as prefix:

Nouns		Verbs	
à-tè	‘songs’	á-tèì	‘you are singing’
à-tòò	‘loads’	á-tóówóí	‘you are carrying’
à-fíí	‘bush mangoes’	á-yéní	‘you had’
à-bò	‘holes’	yá-tóó	‘they carried’

As with the non-alternating high vowels, the standard OT approach to non-alternating low vowels is the use of co-occurrence or “grounding” constraints (Archangeli and Pulleyblank 1994). The relevant constraint here is *[+LO, +ATR]. The idea behind (39) is, again, that low vowels “prefer” not to be [+ATR].

(39) *[+LO, +ATR] (Archangeli and Pulleyblank 1994; Bakovic 2003):

An output segment is not simultaneously specified as [+LO] and [+ATR].

Taking *[+LO, +ATR] with the constraints enforcing harmony, *A-SPAN and FAITHSTEM(ATR), disharmonic low vowel prefixes can be accounted for with the constraint ranking: *[+LO, +ATR], FAITHSTEM(ATR) >> *A-SPAN. This ranking says that harmony — that is, belonging to one headed span — can be dispensed with in favour of retaining the ATR value of the root and not having a [+ATR] low vowel. The following tableau illustrates the derivation of à-tè ‘songs’.

(40) à-tè ‘songs’:

		*[+LO, +ATR]	FAITHSTEM (ATR)	*A-SPAN
a.	à-tè (à)(tè)			*
b.	(ætè)	*!		
c.	(àtè)		*!	

This tableau shows that we cannot change the ATR value of the root vowel or that of [a], in order to achieve a single harmonic span. However, it says nothing about changing the height of [a], so that it is no longer low, and then making it harmonic. To rule out such a possibility, we must assume that changing the height of a (disharmonic) vowel is disallowed in Lokaa. This must be true for both the high vowels as well as for the low vowel [a]. To achieve this, the IDENT constraints (*Input and Output specifications of vowel height features must be identical*) for both [HI] and [LO] (ID-HI, and ID-LO) must dominate *A-SPAN. The tableau in (41) shows this.¹⁷

¹⁷I am grateful to a CJL reviewer for pointing this out.

(41) *à-tè* ‘songs’

		*[+LO, +ATR]	FAITHSTEM (ATR)	ID-HI, ID-LO	*A-SPAN
a.	à-tè (à)(tè)				*
b.	(ètè)	*!			
c.	(àtè)		*!		
d.	(òtè)			*!	

In the tableaux in (40)–(41), *[+LO, +ATR] is used to prevent [a] from assimilating in ATR, just as *[+HI, –ATR] was used to prevent high vowels from assimilating in ATR. However, in anticipation of the analysis of its “opacity” (van der Hulst and Smith 1986:235) I assume here that it does not form part of the same span as the stem vowel. For example, a candidate like (*àtè*) will beat every other one on this tableau (41). Only the (high) ranking of ASSOCIATEHEAD([+LO], [ATR]), introduced immediately below, can rule it out.

The account given above of the non-alternation of [a] sets the stage for the analysis of its opacity, to which we now turn.

7.2. Low vowel opacity

The preceding section shows that the low vowel [a] is disharmonic in prefixes in that it does not alternate. It can be prefixed to either a [–ATR] stem or a [+ATR] stem. I accounted for this behaviour with the co-occurrence constraint *[+LO, +ATR], which requires that low vowels not be [+ATR]. This behaviour parallels that of high vowels in prefixes. Unlike high vowels, however, [a] is not transparent in stems. There are two issues that any analysis must account for. First, [a] does not alternate with [ə] in stems or prefixes even though both vowels occur in the system.¹⁸

- (42) è-bààm ‘glue’
 ò-bóó ‘ghost’
 á-kpòn ‘clump of raffia palm’

Secondly, [a] blocks [+ATR] propagation: nonhigh vowels occurring before [a] can only be [–ATR] in the prefix+stem domain, even if the second vowel of the stem is [+ATR].

- (43) è-kàpóŋ ‘pepper’
 ké-táàkpóò ‘grasshopper’
 è-bládàl ‘tick’
 ké-plákòn ‘afternoon’

One interesting feature of Lokaa is that, although it has an eight-vowel system, [a] has not “re-paired” with [ə] (Bakovic 2000, 2003). In a symmetrical eight-vowel system such as Wolof’s (Ka 1994) or a ten-vowel system such as Igede’s (Armstrong 1983) [a] normally pairs with [ə]. But Lokaa has an asymmetrical eight-vowel system

¹⁸See the appendix for a discussion the absence of [ə] in prefixes; this section focuses on [a] opacity.

in which [a] and [ə] are unpaired. This results in a system in which [a] and [ə] are neutral (in addition to the high vowels). Bakovic (2003:15) defines harmonic pairing as follows:

(44) *Harmonic pairing:*

A vowel *x* in a language *L* with a harmonic feature [$\pm hf$] is harmonically paired iff there is another vowel *y* in *L*'s inventory and *y* differs from *x* only in terms of [$\pm hf$].

The Lokaa vowel [a] differs from [ə] in both the harmonic feature [$\pm ATR$], as well as the feature [LO]. Re-pairing apparently results in a shift: [ə] is classified as a [+LO] vowel, as in Igede (Armstrong 1983), or the entire vocalic system is split into high versus non-high, as in Wolof (Ka 1994; O'Keefe 2007). Neither of these has yet taken place in Lokaa.¹⁹ The two vowels [a] and [ə] remain unpaired, hence the non-alternation.

I now turn to the second point, [a] opacity, using the same assumptions as for disharmony. I derive the opacity of [a] essentially by ranking *[+LO, +ATR] and FAITHSTEM(ATR) over *A-SPAN. However, this is not enough to derive opacity. As Van der Hulst and Smith (1986:238) note, opaque segments are “blockers, non-undergoers and spreaders” (see also Clements and Sezer 1982). This ranking only achieves the “non-undergoing” nature of [a].

Within Span Theory the blocking and spreading characteristics of [a] require it to share the harmonic value of the head of the span and to head its own span. Both of these requirements must be superior to that of forming a single span with a head that has a different ATR value (O'Keefe 2007). These requirements are enforced by appropriate rankings of the constraints ASSOCIATEHEAD([+LO], [ATR]) and HEAD([+LO], [−ATR]), stated in (45) (see also 31 and 32).

(45) ASSOCIATEHEAD([+LO], [ATR]):

Every low vowel must share the value of the head of the ATR span in which it is located.

HEAD([+LO], [−ATR]):

Low vowels head [−ATR] spans.

To achieve [a] opacity, both of the constraints in (45) must also dominate *A-SPAN. The next tableau shows the derivation of [è-kàpóóŋ] ‘pepper’. Though the tableau in (46) does not show a crucial ranking of ASSOCIATEHEAD([+LO], [ATR]) and *A-SPAN, a close examination shows that this ranking alone achieves [a] opacity.

¹⁹See Iwara (1994:14), who notes that a shift is under way, not as re-analysis but as merger. Iwara (p.c.) notes that the younger generation of Lokaa speakers often substitute [ə] or [a] for stem [ə], as seen in [ùmó]/[ùmó] ‘place name’.

(46) è-kàpóóŋ ‘pepper’

	*[+LO, +ATR]	ASSOCIATEHEAD ([+LO], [ATR])	HEAD ([+LO, [−ATR])	*A-SPAN
a. (èkàpóóŋ)	*!			
b. (èkàpóóŋ)			*!	
c. (èk[à]póóŋ)		*!	*	
d. $\mathbb{E}^{\text{span}}(\text{èk}\hat{\text{a}})(\text{póóŋ})$				*

The combined ranking of the constraints for overall harmony, high vowel transparency, and low vowel opacity is presented in (47).

(47) *Low vowel opacity dominates high vowel transparency:*²⁰

*[+LO, +ATR], ASSOCIATEHEAD([+LO], [ATR]), HEAD([+LO], [−ATR]),
FAITHSTEM(ATR), *[+HI, −ATR] >> *A-SPAN >> ASSOCIATEHEAD([ATR]).

In summary, the analysis presented above and the ranking in (47) show that there is a crucial difference between co-occurrence constraints and ASSOCIATEHEAD constraints. The co-occurrence constraints control the inventory, and the different rankings of the ASSOCIATEHEAD constraints indicate whether segments will form part of an [F]-span or not.

I have derived the difference between opacity and transparency as a difference between (the ranking of) the *specific* versus the *general*. In this case, when the general ASSOCIATEHEAD constraint is ranked low (below *A-SPAN), high vowels are transparent (34); however when the specific ASSOCIATEHEAD([+LO], [ATR]) is ranked higher (above *A-SPAN), [a] is opaque (46).

This concludes the discussion of transparency and opacity in Lokaa. In the next section I present some of the typological predictions of the above constraint system.

7.3. Some typological predictions

To facilitate understanding of the predicted typology, I split the constraints into the interacting classes of constraints in section 7.3.1: harmony constraints, stem control, co-occurrence, and transparency.

7.3.1. Assimilation constraints (McCarthy 2004)

Recall from section 6.1 that there are four basic harmony (assimilation)-driving constraints, three of which are used here. I describe their functions informally.

(i) Harmony constraints (from 29):

- *A-SPAN(F)

Prefers having just one [F]-span per domain. Drives assimilation of a feature. Its effect is to force assimilation (or harmony).

²⁰The full ranking must be *[+LO, +ATR], ASSOCIATEHEAD([+LO], [ATR]), HEAD([+LO], [−ATR]), *[+HI, −ATR], FAITHSTEM(ATR) >> *A-SPAN, >> ASSOCIATEHEAD([ATR]), FAITHHEAD(+ATR), FAITHHEAD(−ATR), HEAD([+HI], [±ATR]).

- FAITHHEADSPAN(α F)

Equivalent of IDENT. Prevents feature change and insists on a feature heading its span. For example, a [-ATR] segment remains so and heads a [-ATR] span.

- HEAD($[\beta$ G, γ H, ...], [α F])

All (classes of) segments are capable of heading some F-assimilation span. Takes each class of segments separately to head spans of another feature. For example, low vowels head [-ATR] spans. The effect of this family is to be able to separate the strengths of different classes of segments in heading assimilation spans.

(ii) Stem control (Van der Hulst and Weijer 1995; McCarthy and Prince 1995; Bakovic 2000) (from 19)

- FAITHSTEM(ATR)

Harmony derives from stem vowels. (Replaces FAITHHEADSPAN(α F) in this analysis.)

(iii) Co-occurrence constraints (Archangeli and Pulleyblank 1994; Calabrese 1995; Bakovic 2003) (from 21, 39)

This family regulates which segments a language allows on the surface.

- *[+HI, -ATR]

Depending on ranking, the high [-ATR] vowel [ɪ] is forbidden.

- [+LO, +ATR]

Depending on ranking, the low [+ATR] vowel [æ] is forbidden.

(iv) Transparency (O'Keefe 2007) (from 31)

- ASSOCIATEHEAD($[\beta$ G, γ H, ...], [α F])

Depending on ranking, this family regulates transparency/opacity.

7.3.2. Ranking combinations

Some predicted combinations of the above constraint families include the following. Not all rankings are crucial; I exemplify only the crucial rankings.

(i) Harmony with stem control

*A-SPAN(F), ASSOCIATEHEAD($[\beta$ G, γ H, ...], [α F]), FAITHSTEM(ATR)
>> HEAD($[\beta$ G, γ H, ...], [α F])

Implications: The stem controls the value of a feature or features in a span. This means input values of non-stem segments can change.

Example: Degema (Elugbe 1984; Kari 1995, 1997)

(ii) No harmony

HEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), FAITHHEADSPAN(αF) \gg *A-SPAN(F)

Implications: Every segment heads its own span and is associated with the span. There are several spans.

Example: English

(iii) Harmony with transparency

{*A-SPAN(F), SOME CO-OCCURRENCE}, \gg ASSOCIATEHEAD($[\alpha F]$)

Implications: Vowels within a span share a feature or features. Certain feature combinations indicated by the co-occurrence constraint are not permitted. But the offending segment must be part of the span.

Example: Wolof (Ka 1994)

(iv) Harmony with opacity

{SOME HEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), SOME ASSOCIATEHEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), SOME CO-OCCURRENCE, FAITHHEADSPAN(αF)} \gg *A-SPAN(F)
 \gg {SOME HEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$)}

Implications: Some segments head spans (e.g., low vowels head [-ATR] spans). Segments are associated with their own spans. Co-occurrence constraints make changing them impossible, and they create their own spans. The other segments form single harmonic spans.

Example: Akan (Dolphyne 1988), Standard Yoruba (Archangeli and Pulleyblank 1989)

(v) Harmony with transparency and opacity

{SOME HEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), SOME ASSOCIATEHEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), SOME CO-OCCURRENCE}, FAITHHEADSPAN(αF) \gg
 *A-SPAN(F) \gg

{SOME HEAD($[\beta G, \gamma H, \dots]$, $[\alpha F]$), ASSOCIATEHEAD($[\alpha F]$)}

Implications: Some segments head spans (e.g., low vowels head [-ATR] spans). Segments are associated with their own spans. Co-occurrence constraints make changing them impossible, and they create their own spans. Other segments form single harmonic spans, with yet other segments that must not be changed (transparent segments such as high vowels).

Example: Lokaa, as described here.

The Lokaa typology makes an interesting prediction: when a language (with harmony) has both transparency and opacity, opacity will trump transparency. This is because the specific ASSOCIATEHEAD constraint (for opacity) must be ranked higher than the general ASSOCIATEHEAD constraint (for transparency), and *A-SPAN(F) will fall between them. This prediction remains to be confirmed in other languages that may have the pattern.

8. CONCLUSION

Unlike many languages with [ATR] harmony, Lokaa has four unpaired vowels — [i, u, ə, a]; [i, u] are transparent while [a] is opaque. The basic aim of this paper was to describe the phenomenon of high vowel transparency and low vowel opacity in Lokaa [ATR] harmony. In addition, the incomplete merger of the historic [+ATR] and [−ATR] high vowels is now manifest in two forms of high vowel transparency: one in which a high vowel is transparent to a floating [−ATR], and another in which a high vowel is transparent to a following [−ATR] vowel. Lokaa also has an interesting interaction between vowel harmony and another vowel distributional restriction, based on markedness.

A theory of harmony must be able to accommodate these varied phenomena in a single language. I have shown that McCarthy's (2004) Headed Span Theory, along with the extensions proposed by O'Keefe (2007), does this. I have also shown that co-occurrence constraints play different roles in harmony than ASSOCIATEHEAD constraints. Co-occurrence constraints control the inventory, and the different rankings of the ASSOCIATEHEAD constraints indicate whether or not they will form part of a feature-span.

APPENDIX: THE STATUS OF [ə]

This appendix presents the characteristics of [ə], its patterning as a mid vowel, its distribution within stems, and its bearing on the question of positional neutralization and harmony. Finally, the absence of [ə] in prefixes is discussed.

A.1 Harmony and the distribution of the vowel [ə]

The right-to-left distribution of [ə], in bisyllabic words, appears to be governed by vowel harmony, while the left-to-right distribution is governed by positional privilege (faithfulness) and markedness considerations.

As shown above, noun class prefixes and proclitics harmonize with noun stems and verbs stems respectively in their ATR specification, if they are mid vowels. The same distribution is true of the first vowel of an underived bisyllabic noun stem or verb stem, where the harmonic restrictions also hold (except that [ə] cannot be preceded by [a] in verb stems (6c)).

As a stem vowel, [ə] patterns like any other mid vowel. Since it is an ATR head (trigger), the vowels that can occur to its left are the same ones that can occur to the left of any other [+ATR] mid vowel, namely: [i, u, e, o, ə, a]. These are the expected [+ATR] mid vowels [e, o] (A1a), the [+ATR] high vowels [i, u] (A1b), the disharmonic [a] (A1c), or another [ə] (A1d).

(A1) *Vowel distribution before [ə]:*

a. [ə] preceded by mid vowels [e, o]

pè:yó	'learn'	*pè:yó
é-pléló	'mud shelf'	*é-pléló
yómə	'lie down'	*yómə
kówə	'show'	*kówə

- b. [ə] preceded by high vowels [i, u]
 pí:mə́ ‘inspect’ túkə́ ‘run’
 ðibə́ ‘catch’ kúwə́ ‘squat’
- c. [ə] preceded by [a]
 ɛ-bládəl ‘tick’
- d. [ə] preceded by another [ə]
 kpənə́ ‘cover’
 səkə́ ‘put aside’ (save money)

Given these forms, we can assume that any vowel can precede [ə], subject to vowel harmony and with a restriction that the [ə] must head a harmonic span like any other mid vowel. The rest of the ATR analysis follows that proposed above for mid vowels.²¹

However, the left-to-right distribution of [ə] is more severely restricted. The vowel following [ə] can only be [i] or else another [ə]. The following bisyllabic verb and noun stems illustrate the distribution.

(A2) *Vowel distribution after [ə]:*

- a. [ə] followed by [i]
 dəlí ‘take’
 kəbí ‘spoil’
 ló-wənì ‘space’
- b. [ə] followed by another [ə]
 təmə́ ‘push’
 kpənə́ ‘cover’
 kɛ-təmmə́ ‘willow’

Notice that the restriction after [ə] is not carried over to [i], because [i] can be preceded by any other vowel in the language. The restriction is on [ə] only. Harmonically, nothing interesting occurs here, since both vowels are [+ATR]. The left-to-right vowel distribution involving [ə] is dependent on markedness. [ə] must be followed by a less marked vowel [i],²² or a vowel of equivalent markedness [ə] (a copy of itself).

The conundrum here is that the left-to-right distribution of [ə] (and not any other vowel) appears to be controlled by markedness, supporting the positional markedness hypothesis of Beckman (1997) and others. However, harmony occurs in a right-to-left directionality, with [ə] also heading harmonic spans like any other mid vowel. Since positional privilege and markedness have been linked to vowel harmony (Beckman 1997), the question is whether the right edge has any privileges, or whether harmony is just directional (McCarthy 2004; Archangeli and Pulleyblank 2006; Hyman, to appear). As Lokaa data clearly shows, vowel distribution is often intertwined with vowel harmony, but they can be separated (see Archangeli and Pulleyblank (2006) for a similar point). Vowel distribution is often subject to positional privileges,

²¹Note that the distribution in (A1) cannot be analysed as vowel reduction because: (i) [ə] contrasts in with every other vowel in the language; (ii) it can be long or short like any other vowel in Lokaa; (iii) its occurrence is not restricted to any syllable type; (iv) the lone vowel of a monosyllabic noun stem can be [ə]; and (v) bisyllabic verb stems can have [ə] in both syllables.

²²There is extensive literature on the unmarked nature of [i]. See, for example, Pulleyblank (1988), DeLacy (2002). But note that some researchers, for example Hume (2006), have proposed that both values of a feature can be marked in different languages.

but vowel harmony is subject to directionality. When both occur together, this distinction is often masked, as we see in Shona (Beckman 1997).

A.2 Transparent or opaque?

The final question to be addressed here is the status of [ə] as a neutral vowel, and the related issue of its non-occurrence in class prefixes.

The absence of [ə] in class prefixes cannot be blamed on a constraint such as *PREFIX-[ə]. This is because [ə] appears in other prefixal elements and clitics. The following examples show the genitive marker. In all of the examples the clitic consists of [Cə], a consonant whose quality is determined by the class of the head noun (N₁) and [ə]. (Examples from Akinlabi and Liberman 2006.)

- (A3) a. LH + HH
 /lètú jə́ éfé́m/ → [lètú jè:fé́m] / [lètú jə́ éfé́m]
 head crocodile crocodile's head
- b. LL + HH
 /ɔ̀fɛ̀ kə́ éfé́m/ → [kɔ̀fɛ̀ kéfé́m] / [kɔ̀mè kə́ éfé́m]
 leg crocodile crocodile's leg
- (A4) a. LH + HL
 /lètú jə́ kétòm/ → [lètú jə́ ké:tòm]
 head lizard lizard's head
- b. LL + HL
 /ɛ̀mà jə́ kétòm/ → [ɛ̀mà yə́ ké:tòm]
 mouth lizard lizard's mouth
- (A5) a. LH + LH LH + HHL
 /kèkáw sɔ́ kə̀bɔ́/ → [kèkáw sɔ́ kə̀bɔ́]
 bone hand/arm hand bone
- b. HH + LH LH + HHL
 /úkwá wá ɔ̀:ɔ́/ → [úkwá wá:ɔ̀] / [úkwá wá ɔ̀:ɔ́]
 canoe chief chief's canoe
- c. LH + LH LH + HHL
 /ètú yá ɔ̀:ɔ́/ → [ètú yá:ɔ̀] / [ètú yá ɔ̀:ɔ́]
 house chief chief's house

Although the first noun determines the consonantal quality of the genitive marker, it cliticizes with the second noun. There are two kinds of evidence to support this. First, if the second noun is vowel-initial then the genitival [Cə́] optionally assimilates completely to the initial vowel of the noun. This is exemplified in (A3) and (A5b, c). Secondly, and more importantly, the genitival [Cə́] forms a tonal domain with the second noun (Akinlabi and Liberman 2006). The genitive marker [Cə́] is High toned. When the second noun begins with a High tone as in (A3) and (A4), nothing happens (or the two High tones fuse if N_s is vowel initial). However, if N_s has an initial Low tone, then the expected HLH output of the genitive marker becomes HHL (the LH of the second noun becomes HL). This happens regardless of whether N_s is consonant-initial or vowel-initial, as seen in (A5). Akinlabi and Liberman (2006) propose that the domain of this process is the Prosodic Word—the domain of vowel harmony in Lokaa. Finally, and of significance to the problem here, the vowel [ə́] of the genitive marker does not alternate when the noun has [–ATR] vowels, as the examples in (A5) show. The same non-alternation is observed in the item that Iwara (1982) calls a “relator”, in (A6).

(A6) *Relative Clauses (H-tone CV “relator”)*:

- a. HH noun: *éyóŋ*
 [yìsòwá f_éyóŋ ò:dèi] / [yìsòwá f_ó é:yóŋ ò:dèi] ‘the pot that Eyong bought’
- b. HL noun: *úbì*
 [yìsòwá f_ú:bì ò:dèi] / [yìsòwá f_ó ú:bì ò:dèi] ‘the pot that Ubi bought’
- c. LH nouns: *ìsu* and *òbòl*
 [yìsòwá f_ìsù ò:dèi] / [yìsòwá f_ó ìsù ò:dèi] ‘the pot that Isu bought’
 [yìsòwá f_òbòl ò:dèi] / [yìsòwá f_ó òbòl ò:dèi] ‘the pot that the chief bought’

The above examples may be analyzed in two ways. First, it may be the case that the genitive marker and the relative clause marker fall outside the domain of harmony. It may also be the case that [ó] simply does not alternate. The preceding facts are enough to rule out the constraint *PREFIX-[ə]. Instead I propose a co-occurrence constraint *[ə], which forbids combining [ə] with [-ATR] on the surface.

Neutral vowels are often either transparent to harmony, as in the case of Lokaa high vowels, or opaque to harmony, as demonstrated in the case of [a]. Is [ə] transparent or opaque? We have seen that [ə] triggers harmony (i.e., it is a spreader). The above forms show [ə] to be a non-undergoer. But is [ə] also a blocker?

The left-to-right distribution discussed in the preceding section prevents any definite answer to this question. As noted, [ə] is followed only by [i] or another [ə]. To test the transparency or opacity of [ə], it needs to be followed by a [-ATR] vowel and be preceded by a prefix or clitic. There is only one item that suggests [ə] opacity.²³

(A7) *yè-tálókpà* ‘domestic animal’

Since this is the only underived form showing as [ə] a blocker, I must conclude that the status of [ə] is indeterminate.

²³There appear to be no forms with a floating [-ATR] [i] following a [ə]. This gap may suggest that [ə] is opaque, on the interpretation that these forms exist and that [ə] is simply preventing [-ATR] harmony. [ə] occurs as a prefix vowel in a few examples, but the stem vowel must be [ə].

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