

NAWURI ATR HARMONY IN TYPOLOGICAL PERSPECTIVE

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Nawuri, a North Guang (Kwa) language of Ghana, has a nine-vowel system with cross-height ATR harmony of a sort found in many other African languages. This article has the twofold aim of describing in detail the behavior of the Nawuri ATR harmony system and of comparing this behavior with what has been reported in other African languages. Typologically widespread traits of Nawuri [ATR] harmony include acoustic overlap of high [-ATR] and mid [+ATR] vowels, high frequency of occurrence of [-ATR] vowels, neutrality of /a/, a greater extent of leftward than rightward [+ATR] spreading, and (a trait which may be a near-universal of nine-vowel systems) systematic dominance of [+ATR] over [-ATR] vowels. Among the more unusual traits displayed by Nawuri is superficial transparency of the low vowel /a/ to leftward [+ATR] spreading.

Le nawuri, une langue kwa du Ghana, possède un système vocalique de neuf voyelles avec harmonie vocalique [ATR] d'une sorte qui se trouve en des nombreuses langues africaines. Cette étude vise à deux buts: décrire le comportement du système harmonique en nawuri, et le comparer avec ce qui se trouve dans les autres langues africaines. Parmi les traits de l'harmonie en nawuri qui sont typologiquement fréquents, on trouve un rapprochement acoustique entre les voyelles fermées [-ATR] et les voyelles moyennes [+ATR], une fréquence d'occurrence élevée des voyelles [-ATR], la neutralité de la voyelle /a/, une plus grande tendance à l'assimilation anticipatoire, et la dominance systématique des voyelles [+ATR], ce dernier trait semblant être quasiment universel dans les langues de neuf voyelles. Cependant, le système harmonique du nawuri présente des autres traits typologiquement rares, y compris une apparition de la voyelle /a/ d'être transparent à l'assimilation anticipatoire [+ATR].

0. INTRODUCTION

Nawuri, a North Guang (Kwa, Tano) language spoken in eastern Ghana, has a nine-vowel system with cross-height ATR vowel harmony of the sort found in many other African languages. Notwithstanding the many similarities of this harmony system to better known cases such as Akan (Clements 1981, 1984, Stewart 1967), the Nawuri harmony system also diverges in interesting ways from more commonly reported patterns. For example, the low vowel /a/, though opaque (as in Akan) to rightward [+ATR] spreading, exhibits superficial transparency to leftward spreading in at least some cases.

This article¹ has the twofold aim of describing the behavior of the Nawuri ATR harmony system in detail and of comparing its behavior with what has been reported in other African languages, both those which are closely related and those which are less closely related. It will emerge that whereas some aspects of Nawuri ATR harmony are unusual, others are typologically common. It will moreover be suggested that one striking characteristic of Nawuri ATR harmony, the consistent dominance of [+ATR] vowels over [-ATR] vowels may be a nearly universal property of languages

¹ This article is based on speech data provided, over a period of several years, by many Nawuri people from the village of Kitare, to whom sincere thanks are due. I would especially like to thank Derrick Atta Kwame, Theresa Dapa, Sam Otu, Nicholas Imambu, and Pastor Adams Nwumele for producing the recordings on which the vowel formant measurements in this study are based. An earlier version of this article was presented at the 29th Colloquium on African Languages and Linguistics at Leiden University, 29 August – 1 September 1999, and benefited from comments by a number of people present on that occasion. I am grateful in particular to John Stewart and Tucker Childs for helpful discussion of a number of the issues raised in this article, and to Mike Cahill and a JWAL reviewer for helpful written comments on the article. Any shortcomings which remain are my own responsibility.

with the five-height vowel system found in Nawuri, though not of all other types of vowel inventories.

The data presented in this article are representative of the dialect of Nawuri spoken in the village of Kitare, located on the western shore of the Volta Lake, close to where it is joined by the Oti River. The examples are derived from my own field work, carried out primarily during the period 1985–1991. During much of that time my wife and I lived in Kitare, where we worked under the auspices of the Ghana Institute of Linguistics, Literacy and Bible Translation and the Summer Institute of Linguistics.

The article is organized as follows. Section 1 presents an overview of the Nawuri vowel system, describing the underlying inventory and some pervasive processes affecting the allophonic realization of vowels. Section 2 presents the ATR harmony sets, discusses their relative frequency, and illustrates the regular behavior of harmonizing affixes. In section 3 some aspects of the phonetics of Nawuri vowels are considered, in terms of both impressionistic observations and vowel formant measurements. The behavior of the low vowel /a/, an area in which nine-vowel systems are known to vary in interesting ways (cf. Bakovic 2000, Polgárdi 1998, Pulleyblank et al. 1995) is examined in some detail in section 4. Section 5 presents various forms of evidence that [+ATR] behaves as the phonologically active or dominant value in Nawuri, and considers the significance of this fact in light of what has been reported about [+ATR] or [-ATR] dominance in other African languages. It will be suggested that the manifestation in Nawuri of [+ATR] rather than [-ATR] dominance is not, as would be the claim of many phonological theories, an accidental property of the language. Rather, this behavior is intimately connected with the presence in the language of an underlying five-height vowel inventory, as has been claimed elsewhere (Goad 1993, Casali 1993, 1996, 1998). Section 6 discusses a further issue of theoretical relevance, the markedness status of the high [-ATR] vowels /ɪ/ and /ʊ/. It is proposed that these vowels do not exhibit the kinds of behavior in Nawuri (or, apparently, in a number of other languages) typically expected of marked vowels, a fact which may be at odds with the widely-held assumption (cf. Archangeli and Pulleyblank 1994, Calabrese 1995) that these vowels are highly marked by virtue of their articulatory properties. The article concludes with a brief summary in section 7.

1. THE NAWURI VOWEL SYSTEM

1.1 UNDERLYING INVENTORY

Nawuri has a system of nine vowel phonemes,² shown in (1), of a type found in many other Tano languages, including Abouré (Burmeister 1982), Ahanta (Ntummy 1997a, b), Akan (Berry 1957, Clements 1981, 1984, Stewart 1967), Anum (Obeng 1995), some dialects of Anyi (Retford 1971), Cherepon (Bransom 1981), Chumburung

² Sherwood (1982) recognized a tenth vowel phoneme, described as a “half-open central spread vowel” in her study of the Kpandai dialect of Nawuri. Although I agree that non-low central vowels clearly exist phonetically in both the Kpandai and Kitare dialect, I analyze all such vowels as arising through two pervasive allophonic processes discussed in §1.2.1 below: the centralization of underlying front vowels and the raising of /a/ (cf. §2.2.2).

(Hansford 1988, Snider 1985, 1989c), Eotile (Hérault 1982), Foodo (Plunkett 1991), Gichode (Lenwah 1979), Krachi (Dundaa 2000), Nkonya (Peacock and Lear 1997), Larteh (Banchi n.d.), and Nzema (Berry 1955).

- (1)
- | | |
|----------|----------|
| i | u |
| ɪ | ʊ |
| e | o |
| ɛ | ɔ |
| ɑ | |

A nine-vowel system of this type, with cross-height ATR harmony, has been reconstructed for Proto-Tano (Stewart 2000). This system is particularly pervasive in the Guang subfamily to which Nawuri belongs, being found in nearly all languages in this family. These facts will be important to keep in mind later in comparing the behavior of Nawuri ATR harmony at various points with that found in other languages, for it means that any patterns which Nawuri shares with other Tano (and especially with Guang) languages may be reflective simply of common inheritance. We shall see however that certain interesting patterns of [ATR] behavior shared by Nawuri and related Tano languages appear in languages from a wide variety of other families as well.

Unlike some other Guang languages, e.g. Larteh (Snider 1989b), Nawuri does not have phonemic vowel nasalization. Vowel length is however contrastive for each of the nine phonemic vowels in Nawuri. Examples of phonemic long vowels are given in (2) (word-medial position) and (3) (word-final position). Note that word-final phonemic long vowels (represented as double vowels throughout this article) are realized phonetically with a following glottal stop in pre-pausal position.

- (2)
- | | | |
|--------------------|---------------|------------------------------------|
| a. [ɔ̀lɪ̀n'dzɪ́ɪʔ] | (/aliidziɪ/) | (devotee of a certain fetish cult) |
| b. [bɪ̀tɛ́ʔ] | (/bɪɪtɪ/) | to pull |
| c. [gɪ̀kɛ̀lɪ̀nʔ] | (/gi-keelii/) | kapok tree |
| d. [bɛ̀ɛ̀rɛ̀ɛ̀ʔ] | (/bɛɛrɛɛ/) | to respect |
| e. [sà̀lɛ́ʔ] | (/saalɪ/) | to insult |
| f. [dʒ̀ɔ̀tɛ́ʔ] | (/dʒɔɔtɪ/) | spoon |
| g. [gɪ̀pò̀lɪ́ʔ] | (/gi-poolii/) | (type of tree) |
| h. [fù̀tɛ́ʔ] | (/fɔutɪ/) | to breathe |
| i. [kú̀úriʔ] | (/kuuri/) | pig |
- (3)
- | | | |
|----------------|-------------|-------------|
| a. [bìʔ] | (/bii/) | to be black |
| b. [kìʔ] | (/kii/) | to look |
| c. [ɔ̀fù̀lɛ́ʔ] | (/ɑ-fulee/) | money |
| d. [gɪ̀bɛ́ʔ] | (/gi-bɛɛ/) | butterfly |
| e. [tà̀ʔ] | (/taa/) | to take |
| f. [dɔ̀ʔ] | (/dɔɔ/) | farm |
| g. [lò̀ʔ] | (/loo/) | to enter |
| h. [lù̀ʔ] | (/luu/) | to weave |

This glottal stop does not appear when the word-final long vowels are followed by another word within the same phonological phrase, as in the examples below.

- (4) a. [kìì mò] look at him/her
 b. [tàà dèèbí] take the knife

The contrast between long and short vowels in Nawuri is limited to word-medial and word-final position. Word-initially, all vowels are phonologically short (as diagnosed for example by their tone-bearing behavior), although they tend to be longer in duration than utterance-medial short vowels.

1.2 ALLOPHONIC VARIATION IN VOWEL PHONEMES

1.2.1 Centralization and raising

As in most other North Guang languages (Snider 1989a,b), short front vowels /i/, /ɪ/, /e/, /ɛ/ have centralized allophones which occur word-medially between consonants. Short /a/ is raised to [ʌ] in the same environment:

- (5) /i/ → [i]
 /ɪ/ → [ĩ] / C__C
 /e/ → [ɛ̃]
 /ɛ/ → [ʌ]
 ↑
 /a/

Examples of these allophones are given below. Note that centralization of front vowels and raising of /a/ apply both in closed syllables, as in (6), and open syllables as in (7). (The relevant vowels in these examples are underlined.)

- (6) a. /o-liŋ/ [ólíŋ] root
 b. /tɪŋ/ [tĩŋ] to cut
 c. /o-feŋ/ [òféŋ] scent
 d. /daŋ/ [dʌŋ] to grow
- (7) a. /biti/ [bítì] to want
 b. /kɪti/ [kítè'] lizard
 c. /dekereke/ [dákáráké] chameleon
 d. /tasi/ [tʌsé'] to peck

Centralization and raising also apply across morpheme boundaries, as in (8), and word boundaries, as in (9):

- (8) a. /a-dzi-tɔ/ [ádʒítɔ] food
 b. /ɔ-sali-pu/ [òsálípú] carver
 c. /le-wu/ [lěw] death
 d. /tʃɛ-minɛɛ/ [tʃʌmìnɛé?] friend (cf. [tʃɛ] 'help')
 e. /ɔ-sola-pu/ [òsólápú] person who carries
- (9) a. /a-ɲaŋ-bi gi-lifa/ [àɲàmbígílfá] one hundred nails
 (cf. [àɲàmbí] 'nails' in isolation)
 b. /a-bite gu-du/ [àbítégúdú] ten girls
 (cf. [àbíté] 'girls' in isolation)

- c. /t̥ m-fii/ [t̥m̥fiiʔ] sit here
(cf. [t̥] ‘to sit’ in isolation)
- d. /s̥a bamu/ [s̥abámú] give them
(cf. [s̥a] ‘to give’ in isolation)

Centralization and raising do not however apply to word-initial vowels when preceded by a word-final consonant:

- (10) a. [isáŋ ʔlíŋ ʔmó] the roots remain (*[isaŋ iliŋ])
b. [isáŋ ʔkíŋ ʔmó] the fish remain (*[isaŋ ikíŋ])

Centralization affects only *short* front vowels. Long vowels do not centralize interconsonantly, as is evident from the examples shown previously in (2).

Although centralization and raising can be viewed as kinds of reduction processes, it is important to emphasize that centralization does not neutralize the underlying oppositions among front vowels; all four central allophones are phonetically distinct, although the differences between [i] and [ĩ] and (perhaps to a lesser extent) between [ĩ] and [ə] are not always easy to hear.

Contrast between (short) /ɛ/ and /a/ is however neutralized word-medially, since both vowels are realized as [ʌ] in this context. This means that it is not necessarily possible to tell whether a non-alternating word-medial [ʌ] derives underlyingly from /ɛ/ or /a/. This indeterminacy is reflected to some extent in the spelling practices of native speakers. Although there seems to be a general tendency to favor representing non-alternating word-medial [ʌ]’s as /a/, the author has observed many cases in which the same word has been variously spelled using either *ɛ* or *a* to represent an instance of word-medial [ʌ]. For purposes of this article, these ambiguous vowels will consistently be represented in underlying forms as /a/, which corresponds to the conventions of the present orthography.

1.2.2 Realization of /a/ in [+ATR] contexts

Word-initially, the vowel /a/ has an allophone, transcribed throughout this article as [a̠], that occurs to the left of syllables with [+ATR] vowels. It is both somewhat higher in auditory quality and has a voice quality (see §3.1.1 below) more characteristic of [+ATR] vowels. Examples are shown in (11).

- (11) /a/ before [-ATR] vowels /a/ before [+ATR] vowels
- a. [â-sá] three c. [â-nû] five
- b. [â-pó] two d. [â-síjé] six

This same quality change also affects word-medial instances of long /aa/ which occur to the left of a [+ATR] syllable. There is a slight but noticeable difference for example between the instances of /aa/ in the words in (13), which precede [+ATR] vowels, and those in (12), which precede [-ATR] vowels. As in the case of the words in (11), the difference involves a slight auditory raising and characteristically [+ATR] voice quality (see below) in instances of /aa/ that are followed by [+ATR] vowels.

- (12) a. [kááléʔ] (/kaali/) shirt
b. [kààpó] to show
- (13) a. [kààké] (type of dance)

b. [nǝ̀ǝ̀mùùʔ] deaf/dumb person

Word-medial *short /a/* is also affected by a [+ATR] vowel in the following syllable. In this case, however, the change is phonetically much more noticeable and is not purely allophonic, but serves to neutralize an underlying contrast. The change in question can be seen to result from combined effects of two independent processes: raising of short /a/ interconsonantly, and leftward spreading of [+ATR]. As noted above, interconsonantal short /a/ is generally realized phonetically as a raised ([-ATR]) central vowel [ʌ].

(14) a. [bǎ] to come
b. [ǝ̀-bʌ́ mʉ́] when he/she came

However, when a following syllable contains a [+ATR] vowel, this underlying short interconsonantal /a/ is realized as [ǝ] (which, it will be recalled, is also the centralized interconsonantal allophone of /e/). This is exemplified in (15c,d) below, where the underlying low vowels of the roots /bʌ/ 'to come' and /pʌŋ/ 'arrow' (illustrated in their more usual phonetic realizations in (15a,b)) surface as mid central [+ATR] [ǝ] when followed by morphemes with [+ATR] vowels.

(15) a. [bǎ] to come
b. [ǝ̀-pʌ́ŋ] arrows
c. [bǎ ʔ gǝ̀-wú] come home (COMPLETIVE)
d. [ǝ̀-pʌ́ŋm-bí] nails (lit. 'small arrows')

The realization of /a/ as [ǝ] in this context can be attributed to the combined effect of raising of /a/ to [ʌ] interconsonantly, as in (14b), and an independent and pervasive process of leftward [+ATR] spreading, which is described in some detail in §5.1 below. That is, /a/ becomes [-low] as a result of raising and [+ATR] via leftward [+ATR] spreading, the net result being a [-low, +ATR] vowel, [ǝ].

Since both /a/ and /e/ are realized as [ǝ] in the context C__C [+ATR], contrast between these vowels is neutralized in this environment. Consequently, word-medial instances of [ǝ] are often ambiguous as to their underlying source, being potentially derivable either from /e/, by centralization, or from /a/, by raising and [+ATR] spreading.^{3,4}

As far as I have observed, the phonetic realization of /a/ (whether short or long) is not affected by the presence of a [+ATR] vowel in a *preceding* syllable. This is consistent with a very general tendency in Nawuri, which we shall see exemplified at various points below, for leftward spreading of [+ATR] to take place more readily than rightward spreading.

³ In frameworks making use of underspecification, these ambiguous [ǝ] vowels might of course be represented alternatively as unspecified for the features that distinguish /a/ from /e/.

⁴ This indeterminacy is also reflected to some extent in native speaker spelling practices: a word like [gǝ-wu] 'home' (in which the first morpheme is a singular noun class prefix realized as [gǝ-] with [+ATR] roots and as [gʌ-] with [-ATR] roots) has been spelled variously as *gawu* or *gewu*. However, there seems to be a fairly strong general preference for spelling *non-alternating* instances of [ǝ], as in a monomorphemic word like [dǝkǝrǝkǝ] 'chameleon' as *e*, a practice which is adopted in this article, somewhat arbitrarily, in showing underlying forms.

(morpheme-internal) vowel harmony at all. Comparative evidence involving numbers in other North Guang languages suggests the possibility that the word ‘seven’ was also historically a compound, though it is less clear whether it can be analyzed as such synchronically. This leaves the word [dʒoonɔ] ‘dog’ as perhaps the only clear exception to morpheme-internal vowel harmony. It is interesting to note that cognate forms of this word in related North Guang languages are harmonic, although the particular vowels found in the word vary somewhat.⁵ It is also of interest that the vowel /o/ is virtually absent immediately following nasal consonants in Nawuri, which makes it tempting to speculate that there may have been a sound change historically of /o/ to /ɔ/ in this context.

The low vowel /a/ is neutral in the sense that it can co-occur in roots with both [–ATR] and [+ATR] vowels, a behavior which is common, though by no means universal, in languages with this nine-vowel system.⁶ The neutral behavior of /a/ will be discussed in some detail below. Among other things, the neutrality of this vowel will be seen to exhibit an interesting asymmetry which complicates its diagnosis in terms of the familiar division of neutral vowels into the subcategories of transparent and opaque neutral elements (Hulst and Smith 1986). While /a/ is clearly opaque with respect to rightward [+ATR] spreading, it frequently appears to be transparent with respect to leftward [+ATR] spreading. It will be suggested below, however, that this transparency to leftward spreading is only apparent, and that in all such cases the vowel /a/ has in reality itself become [+ATR] (with slight but detectable phonetic consequences), allowing the feature [+ATR] to spread still further leftward without skipping any vowels.

As in many languages with five-height nine- or ten-vowel systems, e.g. Chumburung (Cahill 1991, Hansford 1988), Dagaari (Cahill 1991), Godie (Marchese 1983), Kɔnni (Cahill 1991), Wali (Cahill 1991), Gichode (Lenwah 1979), Igbira (Scholz 1976), Igede (Armstrong 1985), Lobiri (Audrey Joslin, personal communication), and Puguli (Kevin Warfel, personal communication), words with [–ATR] vowels are more numerous than words with [+ATR] vowels. A computer search of 1238 noun and verb roots in my lexical database revealed the following breakdown of [+ATR] and [–ATR] roots:

(19)	a. roots with [+ATR] vowels only:	327	(26.4%)
	b. roots with [–ATR] vowels only:	802	(64.8%)
	c. roots with /a/ and one or more [+ATR] vowels:	109	(8.8%) ⁷

The relative percentages of each of the nine individual vowels in this count are given below. Note that root occurrences of the vowels /e/ and /o/ are rare in Akan also.

⁵ Cognate forms for ‘dog’ in related North Guang languages, from Snider (1989a), are as follows: [dʒono] (Chumburung, Gichode), [dʒoro] (Krachi), [dʒɔnɔ] (Gonja).

⁶ Exceptions include the Gur languages Kɔnni (Cahill 1996, 1999), Puguli (Kevin Warfel, personal communication), and Sisaala (Regina Blass, personal communication), in which /a/ generally does not occur in words with [+ATR] vowels.

⁷ Some of these are probably compounds historically.

(20)	ɑ	31.8%
	ɪ	15.9%
	i	13.4%
	u	9.1%
	ɔ	7.7%
	ɛ	6.6%
	ʊ	5.9%
	e	5.1%
	o	4.6%

The statistical preponderance of [-ATR] vowels is even greater in text material, a fact which is undoubtedly due to a much greater frequency of [-ATR] than [+ATR] vowels in grammatical morphemes and function words, many of which frequently occur in positions where they need not harmonize for [ATR] with a neighboring lexical morpheme, especially in careful speech. A computer count of [+ATR] and [-ATR] words in a corpus of narrative text (approximately twenty-one single-spaced pages) revealed the latter to be roughly four times as frequent as the former (even if words in which [+ATR] vowels combine with the [-ATR] vowel /ɑ/ are added exclusively to the [+ATR] total). The relative percentages of occurrence of each individual vowel in the text corpus are given in (21).

(21)	ɑ	30.4%
	ɪ	23.5%
	ʊ	10.1%
	ɔ	8.1%
	i	7.4%
	ɛ	7.0%
	u	5.2%
	e	4.9%
	o	3.5%

Perhaps the most notable aspect of these figures, relative to the lexical frequencies in (20), is the much higher frequency of the vowel /ʊ/ in text material, a fact which seems clearly related to its frequent occurrence in grammatical morphemes.

2.2 HARMONIZING AFFIXES

Like most languages with ATR harmony, Nawuri has a variety of affixes which harmonize with a root in their value of [ATR]. In this section the behavior of some of these affixes is illustrated, beginning with a singular noun class prefix that alternates between [o] and [ɔ]:

(22)	Singular noun class prefix /o-/ ~ /ɔ-/	
a.	ò-bú	room
b.	ó-líṅ	([ólíṅ]) root
c.	ò-gèè	([ògèè?]) valley
d.	ó-bó	hole
e.	ó-fé	rope
f.	ò-kpá	path

Roots which take this /o-/ ~ /ɔ-/ singular prefix usually form their plurals with a noun class prefix /i-/ ~ /ɪ-/, whose behavior is illustrated in (23):

- (23) Plural noun class prefix /i-/ ~ /ɪ-/
 a. **ì-bú** rooms
 b. **í-líṅ** ([ílíṅ]) roots
 c. **ì-gèè** ([ìgèèʔ]) valleys
 d. **í-bó** holes
 e. **í-fé** ropes
 f. **ì-kpá** paths

Another harmonizing (singular) noun class prefix takes the form [gə] with [+ATR] nouns and [gɛ] with [-ATR] nouns.⁸ Examples of this prefix are shown in (24). (The plural prefix that generally corresponds to this singular class, a homorganic syllabic nasal consonant, is irrelevant to ATR harmony will not be illustrated here.)

- (24) a. [gə-bɛʔ] child
 b. [gə-sú] year
 c. [gə-dzɛɛʔ] sand
 d. [gɛ-ké] day
 e. [gɛ-kóká] salary
 f. [gɛ-tú] spoon

The final noun class prefix that displays harmonic alternations in Nawuri is a singular noun class prefix with four allomorphs, /gi/ ([gɪ]), /gɪ/ ([gĩ]), /gu/, and /gʊ/, whose selection is determined by roundness harmony as well as ATR harmony, as shown below.⁹

- (25) /gi-/ occurs with [+ATR] roots when the first root vowel is non-round:

- a. **gì-nsí** ([gìnsí]) eye
 b. **gì-kpéṅ** ([gìkpéṅ]) (type of bean)
 c. **gì-gbíṅ** ([gìgbíṅ]) cheek

/gɪ-/ occurs with [-ATR] roots when the first root vowel is non-round:

- d. **gì-báá** ([gìbááʔ]) hand
 e. **gí-fé** ([gífé]) medicine
 f. **gì-bííʔ** ([gìbííʔ]) hill

⁸ Recall from §1.2 above that [ə] is the phonetic realization of both /e/ and /a/ interconsonantly when followed by a [+ATR] syllable, while [ɛ] is the phonetic realization of both /e/ and /a/ interconsonantly in non-[+ATR] contexts. Hence the underlying form of this prefix could be analyzed either as /gə/, a prefix with allomorphs /ge/ (in [+ATR] contexts) and /gɛ/ (in [-ATR] contexts); or as some less fully specified morpheme, e.g. the consonant /g/ plus a vowel specified only as [-high, -round]. No attempt is made here to decide among these various possibilities; what is relevant for our present purposes is simply that the prefix clearly harmonizes for [ATR] with a following noun root.

⁹ The distribution rules presented for the prefix allomorphs in (25) are slightly oversimplified in that they ignore one important fact about roundness harmony, which is that harmony may be blocked by a root-initial labial consonant. (See Casali 1995a for details).

/gu-/ occurs with [+ATR] roots when the first root vowel is round:

- g. **gù-núh** meat
 h. **gú-jú** guinea corn
 i. **gú-dzó** yam

/gu-/ occurs with [-ATR] roots when the first root vowel is round:

- j. **gú-sú** ear
 k. **gú-tó** thing
 l. **gú-tù** ([gútù?]) shooting

Subject pronoun prefixes containing non-low vowels also regularly harmonize for [ATR] in Nawuri; some of these are illustrated below:

- (26) Third person singular animate completive subject pronoun /o-/ ~ /ɔ-/
- a. **ò-séélí** he/she played
 b. **ò-díí** ([òdíí?]) he/she climbed
 c. **ò-dzî** he/she ate
 d. **ò-táálí** he/she was able
 e. **ò-nátí** ([ònáté']) he/she walked
 f. **ò-wíílí** ([òwíílé']) he/she crawled
- (27) Third person singular animate incompletive subject pronoun /e-/ ~ /ɛ-/
- a. **è-séé'lí** he/she is playing
 b. **è-gbésì** ([ègbásì]) he/she is barking
 c. **è-tfú'lá** he/she agrees
 d. **è-táásì** ([ètáásè']) he/she is asking
 e. **è-ηmá'sí** ([è-ηmá'sé']) he/she is laughing
 f. **è-wíí'lí** ([èwíí'lé']) he/she is crawling
- (28) Third person singular inanimate/abstract subject pronoun /i-/ ~ /ɪ-/
- a. **ì-júúlí** it is cold
 b. **ì-bò-dzá** it is hot
 c. **ì-dágáà** ([ìdágáà?]) it is necessary
 d. **ì-bò-síj** ([ìbòsíj]) it is difficult
- (29) Second person inanimate incompletive subject pronoun [fu] ~ [fʊ]
- a. **fù-díí** ([fù-díí?]) you rode
 b. **fù-kpé** you went
 c. **fù-wú** you saw
 d. **fù-tè** you sat
 e. **fù-lówí** ([fù-lówé']) you finished

Other prefixal morphemes which harmonize for [ATR] in Nawuri include a third person plural incompletive subject pronoun prefix /bee-/ ~ /bɛɛ-/, an incompletive prefix (used with noun phrase subjects) /i-/ ~ /ɪ-/, a negative incompletive marker /mee-/ ~ /mɛɛ-/, and the verbal auxiliaries /tee-/ ~ /tɛɛ-/ (a kind of perfective) and /pii-/ ~ /piɪ-/ (analyzable as a suppletive allomorph of /tee-/ ~ /tɛɛ-/ in negation contexts).

Although the vast majority of harmonizing affixes in Nawuri are prefixes, there is one clear case of a productive harmonizing suffix in the language. This is an agentive suffix which alternates harmonically between /pu-/ and /pɔ-/:

- (30) a. ò-ɲì-pù ([òɲìpù]) expert
 b. ò-tìrì-pù ([òtìrìpù]) pauper
 c. ò-léwú-pú ([òléwúpú]) dead person
 d. ɛ-dǎǎ-pô farmer
 e. ò-kúáǎ-pô teacher
 f. ò-lóú-pú weaver

3. PHONETIC VOWEL QUALITY

3.1 IMPRESSIONISTIC OBSERVATIONS

3.1.1 Voice quality

Many languages with cross-height ATR harmony have been reported to exhibit a noticeable voice quality difference between the [+ATR] and [-ATR] vowels. A number of different labels have been commonly used to describe the difference. Voice quality terms frequently used to describe [+ATR] vowels include “deep”, “hollow”, and “breathy”. [-ATR] vowels have been characterized by terms such as “bright”, “choked”, and “creaky”. While voice quality distinctions of these types have undoubtedly been reported more commonly in Nilo-Saharan languages, they have also been noted in a number of West African Niger-Congo languages, including Nzema and Ahanta (Berry 1955), Akan (Berry 1952, as cited in Stewart 1967), Abua (Ward 1937, as cited in Stewart 1967), Degema (Fulop et al. 1998), and Yoruba (Armstrong 1985).

In Nawuri, voice quality differences are consistently correlated with the two harmony sets. The difference in quality is, to be sure, not so striking that it cannot go unnoticed; I had been working with the language for a couple years before I became aware of it. Once I became sensitive to the distinction, however, I found that it proved to be a very useful cue in distinguishing pairs of vowels (chiefly /ɪ/ and /e/ and /ʊ/ and /o/) which are otherwise often difficult to tell apart due to the fact that they are so similar in perceptual height.

Although the terms “breathy” and “creaky” are fairly apt descriptions of the impressionistic quality of the [+ATR] and [-ATR] vowels respectively, there is no reason to believe (as these terms might appear to suggest, and as may in fact be the case in some other languages) that different glottal phonation mechanisms are involved in the production of the two sets. That is, it is not assumed that the [+ATR] vowels are articulated with a marked spread glottis mechanism as in true breathy voice, or that the [-ATR] vowels are laryngealized. Rather, it is assumed (based both on a priori plausibility and my own attempts at imitation) that the articulatory difference primarily involves, as in Akan (Lindau 1987, Painter 1973, Stewart 1967, Tiede 1996) an advancing of the tongue root (leading to greater pharyngeal cavity volume) with the [+ATR] set as against a retraction of the tongue root (leading to a constricted pharyngeal cavity) with the [-ATR] set of vowels.

3.1.2 [ATR] and tenseness

It has often been noted (cf. Hall et al. 1975, Hall and Yokwe 1981, Odden 1983, Stewart 1967, Tiede 1996) that the [+/-ATR] distinction in African ATR harmony languages can be qualitatively quite different from the *tense* vs. *lax* distinction found in English and some other European languages. This is certainly the case in Nawuri. Among other things, the [-ATR] vowels are not perceptibly shorter than the [+ATR] vowels (as is the case with the English lax vowels relative to their tense counterparts), nor do the [+ATR] vowels have the diphthongal qualities that the tense vowels exhibit in many dialects of English (e.g. /e/ in Nawuri is not realized, as it commonly is in English, as [eⁱ] or [e^l]). Based on what is known about the behavior of ATR harmony languages, this is hardly surprising.

A further claim that has sometimes been made in comparing [ATR] distinctions in African languages with the tense/lax distinction of European languages, is that it is the [-ATR] vowels and not the [+ATR] vowels which involve the greater degree of muscular tension in their production, even though the former have generally been designated as *lax* and the latter as *tense* in descriptions of African languages which use these labels rather than [ATR]:

It is well-known to those who have worked on West-African languages that the correlation of 'tense' with 'close' and 'lax' with 'open' is often at variance with the actual phonetic facts—specifically that so-called 'open' vowels are frequently articulated with a greater degree of muscular tension than the so-called 'close' vowels (cf. Stewart 1971:199). (Hall et al. 1974:242)

Although this claim has been made fairly frequently (cf. Rottland 1980, Stewart 1971, Tucker 1975, and, with respect to Kru, Marchese 1983), it does not however represent a unanimous viewpoint among linguists who have worked on nine- or ten-vowel ATR harmony languages. A number of descriptions of individual languages state or strongly imply that the [+ATR] vowels are articulated with more tension than the [-ATR] vowels. Among these are Reh (1996) on Anywak (Western Nilotic), Parker (1985) on Baka (Central Sudanic), Bonvini (1974) on Kasem (Gur), and Ourso (1989a) on Lama (Gur).

It is not clear to what extent these rather different reports reflect genuine cross-linguistic variation, and to what extent they are indicative simply of different subjective impressions on the part of different observers. It is not inconceivable that to some extent different researchers are paying attention to different aspects of the relevant articulatory gestures in forming their impressionistic judgments. Since a number of different muscles are involved in the production of (both [+ATR] and [-ATR]) vowels (cf. Lindau et al. 1972), it is possible that the different sets involve tension in different locations. It is perhaps interesting in this connection that one of the comparatively few instrumental articulatory studies that touches on this question, Tiede's (1996) MRI study of Akan, suggests that both [+ATR] and [-ATR] vowels in Akan may involve (different types of) muscular tension in the pharyngeal cavity.

Although it is not clear that yet another subjective opinion on the issue is going to shed much light on this picture, I will note here, for what it is worth, my impression that the [+ATR] vowels are articulated with a considerable degree of tension in

Nawuri; in fact, they seem to me to involve significantly more tension than the tense vowels of English. The [–ATR] vowels do not strike me as involving a particularly great amount of tension, although I do suspect that the tongue root is typically more retracted than in the corresponding lax vowels of English, and if so there is presumably muscular tension involved in actively retracting the tongue root. Although it seems to me that this tension is in general less striking than that which accompanies the [+ATR] vowels (whose production seems to involve, for many speakers, a fairly extreme alteration of the vocal tract), I also note that there are some speakers for whom the choked/creaky quality of the [–ATR] vowels is more noticeable (with the hollow/breathy quality of the [+ATR] vowels perhaps somewhat less striking) than for others, and I would speculate that these speakers retract the tongue root to a greater degree in pronouncing [–ATR] vowels, which might be presumed to involve a greater degree of tension.

The foregoing remarks are subjective and speculative and should naturally be taken with caution. Ultimately, we might hope that more reliable information based on instrumental techniques will be available for more ATR harmony languages. Pending the availability of such information, however, I have felt it important to note my impression that Nawuri does not conform to the widespread view that the [–ATR] vowels involve more tension in their production than the [+ATR] vowels.

3.1.3 Auditory height of high [–ATR] vowels

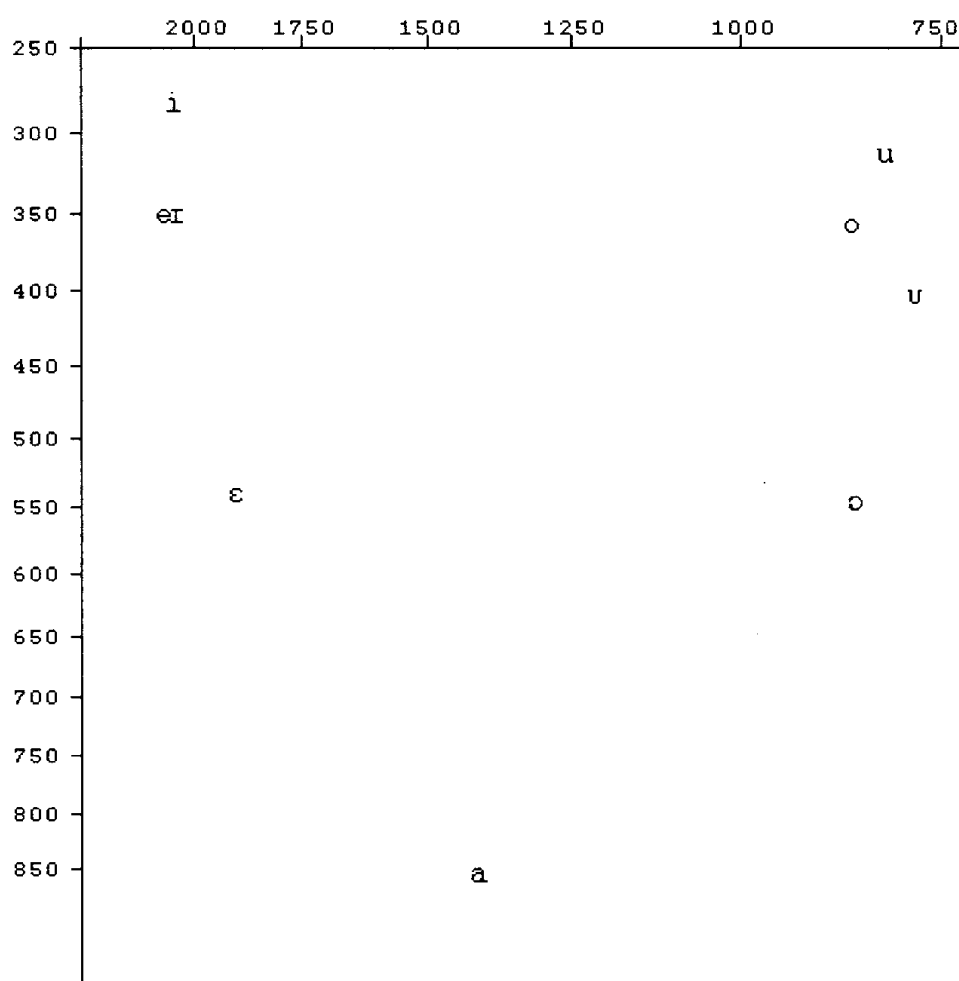
It is very commonly (perhaps typically) the case in five-height languages with ATR harmony that the high [–ATR] (height 2) vowels [ɪ] and [ʊ] are auditorily close to one of the adjacent heights. In some languages, e.g. Koromfe (Gur: Rennison 1986) and Kalenjin (Southern Nilotic: Tucker 1964), these vowels are most easily confused with the height 1 vowels /i/ and /u/, while in others, including Akan (Hess 1992), Budu (Bantu: Koehler 1995), Igbira (Nupoid: Scholz 1976), they are impressionistically closer to the height 3 vowels /e/ and /o/.¹⁰

It is the latter situation which generally exists in Nawuri and other Guang languages (Snider 1989b). The vowel [ɪ] in a word like [lɪʔ] ‘to come from’ sounds quite similar to the vowel [e] in a word like [ɔ̄fɪlɛ̀ɛ̀ʔ] ‘money’, while the vowel [ʊ] in [lòʊʔ] ‘to weave’ sounds quite close to the vowel [o] in [lòóʔ] ‘to enter’. It should be noted however that while the [ɪ] is quite similar to [e] and [ʊ] to [o], there is no question here of complete auditory merger (as has been claimed for example in the case of Okpe (Hoffman 1973, Pulleyblank 1986—but see Omamor 1988) and contemplated (though ultimately rejected) as a hypothesis for Akan by Hess (1992). In particular, the words [lòʊʔ] ‘to weave’ and [lòóʔ] ‘to enter’ are not homophonous; the vowel of each word can be reliably identified even when the word is pronounced in complete isolation, so as to eliminate any possible clues from harmony or other contextual information. This is despite the fact that, as we shall see in the section which follows, the first and second formant values of these vowels tend to coincide quite closely in the speech of some speakers.

¹⁰ Some other languages, e.g. Akposso (Anderson 1999) and Kɔnni (Mike Cahill, personal communication) are reported to show an interesting front-back asymmetry, such that whereas the front vowel /i/ is auditorily closer to (e.g. is more easily confused with) /i/ than /e/, the back vowel /u/ is closer to /o/ than to /u/.

3.2 FORMANT MEASUREMENTS

Average formant values for the nine long vowel phonemes in Nawuri are plotted in (31). The measurements were carried out on a set of words, four for each vowel, recorded by four different adult male speakers.¹¹ In each case, the vowel whose formants were measured occurred in a word-final /CV:/ ([CV:ʔ]) syllable. The actual words recorded in this study are shown in the appendix. For each speaker, average F₁ and F₂ values were obtained for each vowel. These speaker-specific values for each vowel were then averaged together to give the overall speaker-independent values plotted below.

(31) Vowel formant plot — F₁ (vertical axis) vs. F₂ (horizontal axis)

This type of pattern, in which the mid [+ATR] vowels /eɔ/ are acoustically as high as or higher than the high [-ATR] vowels /iʊ/ has been noted in some other nine-vowel languages, e.g. Okrika Ijo (Lindau and Ladefoged 1986). It is interesting to note however that this *height reversal* pattern does not hold in exactly the same way for all speakers. Individual speakers in fact exhibit considerable variation in the relative

¹¹ Formant measurements were made using the spectrogram-with-formants and spectrum ("snapshot") displays of the SIL WinCECIL speech analysis software program. Measurements were generally taken at a steady-state portion near the center of the vowel, except in the case of tokens involving allophonic diphthongal realizations of /eɛ/ as [ʔe] or /ee/ as [ʔe] (cf. §1.2.3 above), for which a point closer to the end of the vowel was generally selected.

spacing of the two sets of vowels. Average F_1 values for the high [-ATR] and mid [+ATR] vowels for each of the four individual speakers are shown below.¹²

(32)	<i>Speaker 1</i>	<i>Speaker 2</i>	<i>Speaker 3</i>	<i>Speaker 4</i>
	/ɪ/ $F_1 = 335$	$F_1 = 378$	$F_1 = 365$	$F_1 = 330$
	/e/ $F_1 = 390$	$F_1 = 318$	$F_1 = 370$	$F_1 = 325$
	/ʊ/ $F_1 = 435$	$F_1 = 440$	$F_1 = 388$	$F_1 = 353$
	/o/ $F_1 = 345$	$F_1 = 353$	$F_1 = 400$	$F_1 = 328$

Only speaker 4 shows a pattern that appears fairly similar (as far as the relative heights of /ɪ/ and /e/ and of /ʊ/ and /o/ are concerned) to the overall average in (31), in which /e/ and /ɪ/ have very similar acoustic heights while /o/ is higher than /ʊ/. Speaker 1 departs from this pattern with respect to the front vowels, in that /ɪ/ is higher than /e/. For speaker 2, on the other hand, it is /e/ which is higher than /ɪ/. With respect to the back vowels, both speaker 1 and speaker 2 conform to the average pattern in which /o/ is higher than /ʊ/. Speaker 3 departs however from this back vowel pattern, his speech showing a close coincidence of F_1 values both for the front vowels /ɪ/ and /e/ and the back vowels /ʊ/ and /o/.

The fact that individual Nawuri speakers show considerable variation (such that no two of the four speakers exhibit exactly the same pattern) in the acoustic spacing of the high [-ATR] and mid [+ATR] vowels suggests that the relative heights of these sets of vowels is a fairly low-level characteristic of individual speech and not a systematic property of the sound system of Nawuri. There has been no indication that this difference among speakers is correlated with any differences in the phonological patterning of their speech.

In particular, there is no indication that the heavy overlap of formant values for of /ɪ/ and /e/ and/or /ʊ/ and /o/ in the speech of some speakers corresponds to any kind of auditory merger of these vowels. As indicated earlier, all of the vowels remain auditorily distinct, even apart from contextual cues, as when monosyllabic words are pronounced in isolation. It thus appears to be the case in Nawuri, as has been suggested for a number of other ATR harmony languages, that some property other than sheer acoustic height, as indicated by F_1 values, is being exploited by listeners to distinguish the relevant pairs of vowels. Exactly what this property is remains to some extent unknown, although several studies (cf. Fulop et al. 1998, Hess 1992) have revealed promising possibilities. It seems reasonable to suppose, however, that this acoustic property is related somehow to the impressionistic voice quality difference between the [+ATR] and [-ATR] vowels in the language.

¹² A fifth speaker from Kitare, an adult woman, also participated in the recording session along with the four men whose average formant values are listed in (32). Although formant measurements for her vowels are not included in the overall averages on which the plot in (31) is based (in order to avoid possible skewing effects due to differences in male and female vocal tract sizes), it may be noted that her general pattern, as far as the relative height of /ɪʊ/ and /eʊ/ is concerned, appears to be most similar to that of Speaker 2. That is, /e/ is higher than /ɪ/, while /o/ is higher than /ʊ/.

4. LOW VOWEL BEHAVIOR

The low vowel /a/, phonetically [-ATR], is *neutral* in that it can occur in roots with [+ATR] as well as [-ATR] vowels. Examples of the latter case are shown in (33), while examples of the former case are shown in (34).

(33) /a/ in roots with [-ATR] vowels

- a. **kààpú** to show
- b. **sùlá** to carry
- c. **kítá** to catch
- d. **sààlí** to insult
- e. **tóómáà** neighbor
- f. **làpé** plate
- g. **gà-tjààpéè** (type of fish)
- h. **sàgá** hang

(34) /a/ in roots with [+ATR] vowels

- a. **bààrî** to embrace
- b. **bùsàà** yam slices
- c. **dààmú** controversy
- d. **kíná** to refuse
- e. **gì-díílàà** (type of grass)
- f. **pùlá** to bury
- g. **tíí'jááà'kóó** hornbill¹³
- h. **kààké** (type of dance)

Although /a/ can co-occur with [+ATR] vowels, it is worth noting that roots in which it co-occurs with the mid [+ATR] vowels /e/ or /o/, as in (34g,h), are very rare in my data. Roots in which it co-occurs with the high vowels /i/ or /u/ on the other hand, as in (34a–g), are not uncommon.

Vowels which are neutral in harmony systems, in that they can co-occur with vowels of either harmony set, have been found to exhibit two quite different types of behavior (Hulst and Smith 1986). In some cases, neutral vowels behave *transparently*, in the sense that vowels on either side of the neutral vowels will consistently harmonize with each other, just as though the neutral vowel were not there. In the case of interest to us here, transparent behavior of a low vowel /a/ in an ATR harmony system would entail that a harmonizing affix which is separated from a [+ATR] root vowel by an instance of the vowel /a/ would surface in a [+ATR] form, in agreement with this root vowel, despite the presence of the intervening /a/ (which is phonetically a [-ATR] vowel). This state of affairs is shown schematically in (35a) (for a prefix) and (35b) for a suffix). (Italic *i* is here used to stand for a [+ATR] vowel of any quality. The schema arbitrarily assumes a V prefix and a CV suffix, although the exact number and morphological affiliation of intervening consonants is irrelevant to the operation of ATR harmony in Nawuri, as in most other ATR harmony languages.)

¹³ It is extremely rare to find a long vowel in a closed syllable in Nawuri. This, combined with the rare tone pattern involving downsteps on successive syllables and the fact that three syllable noun roots are generally rare, strongly suggests that (34g) may have been a compound at least historically. I can see no way of decomposing it synchronically however.

- (35) a. *i* [_{root} C **a** C *i* ...
 b. ... *i* C **a** [_{root}] C *i*

In other cases, neutral vowels behave *opaquely*, in that they prevent a vowel which is further from the root than the opaque vowel from agreeing with the root in their value of the harmonic feature. Where the vowel /**a**/ is opaque to ATR harmony, we expect that a harmonizing affix will surface in a [-ATR] form when /**a**/ intervenes between the affix and a [+ATR] root vowel. This is schematized in (36), where italic *I* is used to stand for a [-ATR] vowel of any quality and italic *i* is once again used to represent a [+ATR] vowel of any quality.

- (36) a. *I* [_{root} C **a** C *i* ...
 b. ... *i* C **a** [_{root}] C *I*

In most ATR harmony languages in which the vowel /**a**/ is neutral, it behaves opaquely rather than transparently. Languages in which /**a**/ is opaque include Akan (Kwa, Tano: Clements 1981), LuGungu (Bantu: Kutsch Lojenga 1999), Didinga (Surma: De Jong 1999), Kalabari Ijo (Ijoid: Akinlabi 1997), Klao (Kru: Singler 1983), Mayogo (Ubangi: McCord 1989), Otuho (Eastern Nilotic: Dick Watson, personal communication), Tem (Gur: Tchagbale 1976), and Toposa (Eastern Nilotic: Schröder and Schröder 1987). There are however a few ATR harmony languages in which /**a**/ is reported to behave transparently. The cases I am aware of are Bila (Bantu: Kutsch Lojenga 1994a), Budu (Bantu: Koehler 1995, Kutsch Lojenga 1994b), Kinande (Bantu: Mutaka 1995), Talinga-Bwisi (Bantu: Paluku 1998), and Ngiti (Central Sudanic: Kutsch Lojenga 1994c).¹⁴ The case of Kinande has however been disputed, as will be discussed in more detail below.

In situations involving the rightward spreading of [+ATR] onto a suffix, the vowel /**a**/ clearly behaves opaquely in Nawuri, just as it does in the well-known case of Akan (Clements 1981, Hulst and Smith 1986). A harmonizing suffix which is separated from a [+ATR] root vowel by an intervening /**a**/ will surface in its [-ATR] form rather than its [+ATR] form, in agreement with the [-ATR] quality of the /**a**/ rather than the [+ATR] quality of the vowel on the opposite side of /**a**/. This behavior is exhibited by the agentive suffix [pɔ] ~ [pu]. With roots that do not involve the low vowel /**a**/, this suffix harmonizes for [ATR] in the familiar way that we would expect, surfacing as [pɔ] following [-ATR] roots and as [pu] following [+ATR] roots, as illustrated previously in the examples in (30). Where however the low vowel intervenes between a [+ATR] root vowel and the agentive suffix, [+ATR] agreement between these two elements is blocked, the suffix surfacing in its [-ATR] form:

- (37) ò-kúláá-¹pó widow (*ò-kúláá-¹pú)

¹⁴ In specifying genetic affiliations of languages throughout the remainder of this article, only one language family is generally listed for each language, at a relatively intermediate level in its family tree. (In the case of Niger-Congo languages, these frequently correspond to families to which chapters are devoted in Bendor-Samuel (1989).) In the case however of languages that are quite closely related to Nawuri in virtue of their membership in the Tano subfamily of Kwa or even the Guang subgroup within Tano, these more specific affiliations are shown as well.

Situations involving leftward agreement between a root and a prefix are less straightforward. There are many examples in my data where /**a**/ appears superficially to be transparent rather than opaque in cases where it intervenes between a [+ATR] root vowel to its right and a harmonizing prefix to its left. A few such examples are shown in (38).

- (38) a. [gù-bwààrúú?] water yam
 b. [gè-nààwùrì] Nawuri
 c. [ò-dáá'nóbíísí] (type of yam)
 d. [gì-tààkùrì] anthill

Cases where /**a**/ behaves transparently to [ATR] spreading are of some theoretical interest, as a number of recent phonological theories (e.g. Archangeli and Pulleyblank 1994, Hulst and Smith 1986, Polgárdi 1998) predict that this behavior should not occur. Such theories must accordingly account for apparent cases of transparency of /**a**/ to [+ATR] spreading by some other means. Generally this has been done by proposing that the vowel /**a**/ in such cases only appears to be transparent; in fact it undergoes [+ATR] spreading so as to become [+ATR]. Thus in their analysis of Kinande, Archangeli and Pulleyblank (1994) follow Hyman (1989) in claiming that, in those instances in Kinande where /**a**/ appears to show transparency, it actually undergoes [+ATR] spreading from a following vowel, becoming itself [+ATR] before transmitting this feature value in turn to a preceding vowel. Whatever phonetic difference exists however between the resulting [+ATR] variant of /**a**/ and its usual [-ATR] realization is assumed to be too slight to be readily detected in most contexts.

Whatever the case may be in Kinande and other languages in which /**a**/ has been reported to be transparent, I believe it is precisely this state of affairs that underlies cases of superficial transparency of /**a**/ to leftward [+ATR] spreading in Nawuri. As noted in §1.2.2 above, the vowel /**aa**/ has a [+ATR] variant (slightly raised and having an overall “hollow” voice quality characteristic of [+ATR] vowels in the language) that occurs to the left of syllables with [+ATR] vowels. Although the auditory difference between this allophone and the more usual phonetic realization of /**aa**/ is relatively slight, it is nevertheless discernible. In keeping with this, the forms in (38) could be more narrowly transcribed as in (39), where [q̣q̣] is used to represent the presumed [+ATR] variant of /**aa**/.¹⁵

¹⁵ As added confirmation that the phonetic realization of /**aa**/ in the words in (39) does in fact differ from its usual realization in non-[+ATR] contexts, formant measurements were made of the [q̣q̣]'s in the three words (39a,b,d) in a tape-recorded word list produced by an adult male speaker of the Kitare dialect in 1988. (The word [ò-dáá'nóbíísí] in (39c) unfortunately does not occur in the word list or elsewhere in the recordings I have available.) The resulting values (each being the average for three repetitions on the tape of each word) are as follows: (39a) — F₁ = 520 hz, F₂ = 1350 hz; (39b) — F₁ = 530 hz, F₂ = 1540 hz; (39d) — F₁ = 580 hz, F₂ = 1510 hz. These measurements may be compared with the following additional formant measurements made for /**aa**/ in some words of relatively similar structure on the same tape, all of which contain only [-ATR] vowels: [bààwùlè'] 'lover' — F₁ = 790 hz, F₂ = 1330 hz; [láákúú?] (expression of sympathy) — F₁ = 760 hz, F₂ = 1350 hz; [ìb'áárè'] 'God' — F₁ = 770 hz, F₂ = 1340 hz; [láátíp'èè?] 'afternoon' — F₁ = 720 hz, F₂ = 1470 hz; [gì-bààfòh] 'half' — F₁ = 710, F₂ = 1260. From these measurements, it appears that the instances of /**aa**/ which occur in the words in (39) are acoustically raised (and in two cases somewhat fronted, though this effect is to my ears less perceptible) relative to instances of word-medial /**aa**/ in [-ATR] words.

- (39) a. [gù-bwààrúú?] water yam
 b. [gè-nààwùrì] Nawuri
 c. [ò-dáá'nóbíísí] (type of yam)
 d. [gì-tààkùrì] anthill

Having become [+ATR] (i.e. [aa]) under the influence of the following [+ATR] syllable, the underlying /aa/ is able to further transmit this acquired [+ATR] quality to a vowel to its left. Under this analysis, there is thus no question of transparency; rather, /aa/ simply undergoes the harmony process, albeit at an allophonic level.

It is interesting to compare this *pseudo-transparent* behavior of /a/ with respect to leftward [+ATR] spreading in Nawuri, with that of the corresponding low vowel /a/ in the related (and much better known) Tano language Akan. As in Nawuri, the vowel /a/ in Akan has an allophonic [+ATR] realization when it occurs to the left of a [+ATR] vowel (Dolphyne 1988, Clements 1981), e.g. /kari/ 'to weigh' is realized as [kari]. In contrast to the situation in Nawuri, however, this [+ATR] allophone of /a/ does not transmit its [+ATR] specification further to the left. Thus a form /ɔ-kari-i/ 'he weighed it' is realized as [ɔkarii] and not *[okarii]. The Akan situation, in which [+ATR] spreading is unable to proceed further to the left of an underlying /a/, would appear to represent the more typical situation in Tano (and in nine-vowel languages more generally). I am not aware, at any rate, of other Tano languages that have been reported to display the more extensive leftward spreading pattern found in Nawuri, although several such languages (Ahanta: Ntummy 1997a,b; Anum: Obeng 1995; Chumburung: Snider 1989a,c; Krachi: Snider 1989a; Gichode: Snider 1989a; Gonja: Snider 1989a) have been reported as having a [+ATR] allophone of /a/ to the left of [+ATR] vowels.¹⁶

Alongside cases like those in (38) in which a prefix surfaces in a [+ATR] form when separated from a [+ATR] root by the vowel /aa/, there are also a few (apparently) morphologically simple stems in which /aa/ is flanked by two [+ATR] syllables:

- (40) a. tí'máálóǵǵòǵ) praying mantis
 b. gè-tíínáàníí fairy
 c. dààdíímáàdí human being

In these cases too, we might plausibly assume that the instances of /aa/ have become [+ATR] ([aa]) on the surface.

In all of the examples in (38) and (40), the relevant instance of /a/ is long, i.e. /aa/. Where short /a/ occurs in this same context, the regular processes of raising and leftward [+ATR] spreading discussed in §1.2.2 above would cause it to be realized as [ə]. As noted in that section, non-alternating instances of [ə] are ambiguous as to their underlying source, being derivable either from /e/ via centralization or from /a/ via raising and [+ATR] spreading. Whatever their underlying source, such [ə]s do not in any case serve as a barrier to leftward [+ATR] spreading, as the examples in (41) illustrate.

¹⁶ A possible exception to this involves two words in Chumburung, [bare] 'to be sufficient' and [bware] 'to be good' which unexpectedly take [+ATR] forms of harmonizing proclitics (Hansford 1988:141).

- (41) a. [gə̀-sám'bí] woman of middle to old age
 b. [gə̀-də̀rɪbí] coin
 c. [gí-bəsí] egg
 d. [gí-kálóbí] rib

In these examples, the initial CV syllables are the same harmonizing singular noun class prefixes illustrated previously in (24) and (25). The fact that the prefixes surface in their [+ATR] allomorphs in all four examples shows that the non-alternating [ə̀] vowels in the root-initial syllables allow (perhaps not surprisingly) for the leftward transmission of [+ATR] to the prefix.

There are also instances of alternating [ə̀] which are known on morphological grounds to derive from interconsonantal /a/, as in examples like (15c), /ba/ 'to come' + /gə̀wu/ 'home' → [bá'gə̀wú] 'come home'. In these cases also, [+ATR] clearly propagates leftward beyond the vowel /a/ in some cases, although the possibility of such spreading seems to depend in part on speech style, so that spreading need not take place in careful speech. Thus for example the initial round vowel in a phrase like [ɔ̀bá'gə̀wú] 'he/she came home' may fluctuate between [o] and [ɔ̀] (being realized in many instances, presumably, as a vowel intermediate in quality between these two extremes).

5. [+ATR] PHONOLOGICAL ACTIVITY

5.1 MANIFESTATIONS OF [+ATR] ACTIVITY IN NAWURI

In contrast to the *dominant* or asymmetric harmony systems found in East African Nilo-Saharan languages, e.g. Didinga (Odden 1983), Sabaot (Larsen 1984, Kutsch Lojenga 1986), Lotuko (Hall et al. 1974), Nandi (Lodge 1995, Local and Lodge 1996, Tucker 1964), Otuho (Coates 1985), Pákot (Tucker 1964), Toposa (Schröder and Schröder 1987), West African Niger-Congo languages have usually been characterized as having symmetric, *root-controlled* harmony. Whereas in dominant harmony systems one value of [ATR] must, by definition, be asymmetrically dominant, in a purely root-controlled system there is no inherent necessity that one value of [ATR] should be active in a way that the other is not. Logically, it is entirely possible to have a root-controlled harmony system in which the two harmony sets behave symmetrically, i.e. in which neither value of [ATR] is clearly dominant over the other (cf. Aoki 1968:143, Hulst and Weijer 1995:504). Many individual West African languages have moreover been described as being symmetrical in precisely this sense.

Nevertheless, a large number of Niger-Congo languages with root-controlled ATR harmony systems do not display this prototypically expected symmetry, but rather show clear evidence that one or the other value of [ATR] is in some identifiable sense dominant. In Nawuri, as in many other nine-vowel languages, e.g. Anum (Kwa, Tano, Guang: Obeng 1995), Kɔ̀nni (Gur: Cahill 1996), Ebira (Nupoid: Scholz 1976), Izi (Igbooid: Meier et al. 1975), and Vata (Kru: Kaye 1982), it is the [+ATR] set which is dominant: [-ATR] vowels frequently assimilate to [+ATR] vowels, but [+ATR] vowels never assimilate to [-ATR] vowels. [+ATR] dominance in Nawuri manifests itself in two ways: spreading of [+ATR] in various contexts, and systematic preservation of [+ATR] in preference to [-ATR] under vowel coalescence (fusion).

As far as spreading is concerned, the mere observation that some morpheme(s) show alternations between [–ATR] and [+ATR] forms, with the former surfacing in [–ATR] contexts and the latter in [+ATR] contexts, need not in and of itself reveal anything about which value of [ATR] is present underlyingly, and hence actively involved in spreading. Consider in this regard the numerous affixes, illustrated previously in §2.2, which regularly harmonize for [ATR] with the nearest vowel of the root to which they are attached. In general, these affixes never occur in Nawuri apart from a [+ATR] or [–ATR] root with which they agree in their [ATR] value.¹⁷ This being the case, there is no direct evidence which would allow us to diagnose one value of [ATR] as the basic or underlying one in such an affix, and the other as the value received via assimilation to the root. There is thus no basis, as far as these examples are concerned, for assuming that one value of [ATR] is dominant and the other recessive. Within an underspecification analysis, for example, one could account for the harmonization of these affixes by assuming either that [+ATR] is underlyingly specified, with [–ATR] serving as the default value, or that [–ATR] is underlyingly specified, with [+ATR] serving as the default value.

In order for [ATR] spreading or assimilation to serve as a diagnostic for which value is actively spreading, it is necessary to know what the basic, unassimilated (hence presumably underlying) form of an affected morpheme is. While the behavior of regular and symmetric affix harmonization provides no such knowledge in Nawuri, there are other kinds of assimilation involving [ATR] in which the unassimilated form of affected morphemes is discernible. These include the manifestation of [+ATR] allophones of the vowel /a/, [ATR] assimilation across word boundaries, assimilation within compounds, and, perhaps, assimilation of root vowels before a dominant suffix. Crucially, in all such cases the relevant vowels are seen to surface in [–ATR] forms in contexts not involving assimilation. This argues that [+ATR] should be regarded as the active or dominant value of [ATR] in Nawuri, since it is underlying [–ATR] vowels which assimilate to [+ATR] vowels rather than vice versa.

We will consider first the relevance of the [+ATR] allophone [a̠] of the vowel /a/, described in §1.2.2 above, which occurs to the left of syllables containing [+ATR] vowels. The fact that the [+ATR] allophone surfaces only before [+ATR] vowels, while the [–ATR] allophone [a] surfaces in all other contexts, including contexts where no other vowels occur (e.g. in cases where words of the form /Ca/ are pronounced in isolation), indicates that the [–ATR] allophone [a] is the basic or underlying one. The [+ATR] allophone can thus be analyzed as arising through assimilation to a following [+ATR] vowel, and consequently the feature value [+ATR] must be regarded as phonologically active.

¹⁷ A possible exception is the harmonizing second person singular subject pronoun [fɪ] ~ [fũ], illustrated previously in (29), which has an obviously related form [fó] that is used as a (second person singular) object or possessive pronoun and can also occur in isolation, e.g. as a one-word answer to a question. Note however that the tone of this independent form is also different from that of the harmonizing subject pronoun. Thus, although it is clear that the subject and free pronouns are related, it is not obvious that their underlying forms must be identical in every respect, e.g. it might be argued, within some phonological frameworks, that the independent form of the pronoun has an underlying [–ATR] specification, while the harmonizing subject pronoun is inherently unspecified for [ATR].

The feature [+ATR] also frequently spreads across word boundaries, causing one or more underlying [-ATR] syllables to become [+ATR] on the surface, as in the examples in (42).

- (42) a. /ɔ-sɪ wija/ → [òsúwíjâ] person whose
3s-father owner father is living
- b. /ɪ-sɪ ɪ-bu o-bu-to/ → [ísííbòòbùtò] sand is in the
NC-sand INCMPL-be NC-room-in room
- c. /ɛ-kɔɔli a-fulee/ → [èkóó'íq̣àfùlèè?] he is collecting
PROG-he.receive NC-money money

Note in example (42a) that the underlying vowel /ɪ/, in addition to becoming [+ATR], has also become round through an independent process (Casali 1995a) which rounds a high front vowel that precedes a round consonant (in this case /w/) or vowel. In (42b) the underlying vowel /ɔ/ is deleted before the vowel /o/ (with compensatory lengthening of the latter) through another regular process in the language (Casali 1988, 1995b); the vowel /ɪ/ in (42c) is elided by the same process. Note also that (42c) is another apparent case of /a/ behaving transparently, in that vowels to its left have become [+ATR]. Here again, it is assumed that the vowel /a/ actually undergoes [+ATR] spreading in this case, becoming itself [+ATR], but that the auditory consequences of this change are relatively slight.

The extent of leftward postlexical [+ATR] spreading is variable and dependent on rate or style of speech. My impression is that assimilation is in many such cases only partial, resulting in a vowel of intermediate quality. In casual speech, however, cases of [+ATR] spreading over several syllables as in the above examples are not uncommon. As there is no indication that leftward [+ATR] spreading is limited to any specifiable number of syllables, I assume that the process is unbounded, although its effect may tend to diminish with distance from the triggering [+ATR] morpheme, as has been claimed for Akan (Clements 1981).

Limited rightward spreading of [+ATR] also occurs in Nawuri. It is optional and speech-rate dependent, often failing to apply except in very rapid or casual speech. In contrast to leftward [+ATR] spreading, rightward spreading affects only a single syllable to the right of the trigger, and the target vowel must be high. Some examples are shown below.

- (43) a. /a-fuu footɪ-sa/ → [áfúú'fúútísâ] air for breathing
NC-air breathe-ADJ
- b. /gi-buu tuu-sa/ → [gìbúúútúùsà] a stone for throwing
NC-stone throw-ADJ

[+ATR] spreading in compounds is illustrated in (44). Note that (44a) involves rightward spreading of [+ATR], while (44b) involves leftward spreading.

- (44) a. /ga-tʃu-tuu/ → [gàtʃútúù?] water throwing
cf. j̣-tʃú 'water', ṭùò ([ṭùòʔ]) 'to throw' (a funeral rite)
- b. /ɔ-dɪ-bojii-pu/ → [òdìbójípû] gossip
cf. gá-dí ([gádé']) 'village', ḅójí ([ḅójʔ]) 'to break'

In contrast to the situation that exists with harmonizing affixes, [ATR] spreading both across word boundaries and between roots in a compound is asymmetric; whereas vowels that are normally [-ATR] frequently become [+ATR] under the influence of neighboring [+ATR] vowels, vowels that are underlyingly [+ATR] never assimilate to [-ATR] vowels. The value [+ATR] may thus be regarded as the dominant or active one as far as these assimilation contexts are concerned.

It can also be argued that Nawuri exhibits limited [+ATR] spreading from a dominant affix, a diminutive suffix */-bi/*. This morpheme is presumably a grammaticization of a noun root */bi/* 'seed' (sg. [gí-bí], pl. [ǫ́-bí]) which still exists in the language. In cases where this morpheme occurs with a [-ATR] root, the [+ATR] value of the suffix generally spreads onto at least the immediately preceding root syllable, causing it to become [+ATR] phonetically. This is illustrated by the examples in (45).¹⁸

- (45) a. */ga-buŋ-bi/* [gàbùmbí] stream
 NC-stream-DIM
- b. */ga-ta-lɔ-bi/* [gàtòlòbí] small pot for local beer
 NC-beer-pot-DIM
- c. */ga-wɛ-bi/* [gàwábí] small calabash
 NC-calabash-DIM
- d. */ɔ-fɔli-bi/* [òfólíbí] small crop bed
 NC-crop.bed-DIM

Alternatively, it might be argued that */bi/* continues to function as a noun root in these examples and not a suffix, in which case the examples in (45) would simply represent further instances of the [+ATR] spreading in compounds illustrated in (44). The analysis as a diminutive suffix may however be slightly preferable in view of the facts that, firstly, combinations involving */bi/* are extremely common and productive; and that, secondly, the original meaning of 'seed' or 'child' has largely eroded to give the fairly consistent meaning of small size that it has at present. In either case, what is important for our purposes is simply that these examples provide a further illustration of the consistent dominance of [+ATR].

A final type of [+ATR] dominance in Nawuri involves vowel coalescence, i.e. cases in which two adjacent underlying vowels fuse to form a third vowel whose quality is intermediate between the two originals. In Nawuri, coalescence occurs across word boundaries and applies only in cases where V_1 is [-high] and V_2 is [+high] /i/ or /ɪ/ (Casali 1995b). (The other high vowels, /u/ and /ʊ/, do not occur word-initially in Nawuri.) The result of coalescence is always a long mid vowel that

¹⁸ As with leftward [+ATR] spreading across word boundaries in Nawuri, the extent of leftward [+ATR] spreading from the suffix */-bi/* appears to be rather variable. Although the */ga-/* noun class prefix is transcribed in my phonetic database as [gɔ] for all three of the forms in (45a-c), this prefix clearly has a more [+ATR] voice quality (closer to, and perhaps not distinct from, the [gɔ] variant of the prefix that normally occurs with [+ATR] roots, as in [gɔ-bii?] 'child') in the words (45a) and (45c), as these appear in a tape-recorded wordlist that was produced at a fairly fast rate of speech.

The rounding of the vowel of the root */ta/* 'pot' in (45b) is due to an independent anticipatory rounding process that occurs optionally and variably in fast speech.

coalescence and the dominant value in spreading as the underlyingly specified one. Although I am not aware of actual attempts to treat [ATR] dominance under coalescence entirely in terms of optimality theory constraint ranking, it would seem that the most natural approach to formulating such an account would be to rely on the same kinds of markedness constraints that have been employed to account for asymmetric assimilatory processes. The model proposed by Bakovic (2000), for example (which is almost certainly the most detailed account of [ATR] dominance proposed within optimality theory to date), would appear to predict that [+ATR] would be the dominant value in coalescence in any language in which it is dominant in assimilation, and for exactly the same reasons. Of course, the fact that formal phonological theories have generally attributed [ATR] dominance under both assimilation and coalescence to a common set of factors does not firmly establish that the two phenomena are in fact intimately related (theoretical proposals may after all be wrong), but it does at least establish a measure of precedent for assuming a connection.

A second relevant observation, for which empirical justification based on a large sample of languages is given in Casali (in preparation), is that in languages in which [ATR] is implicated in both coalescence and assimilatory processes, it is generally *the same* [ATR] value that emerges as dominant in both cases, at least to the extent that evidence is available. That is, it is not common to find languages in which one [ATR] value is dominant in coalescence and the other is dominant in assimilatory processes. It is not clear how this fact is to be explained if the mechanisms (whether they rely on underspecification, constraint ranking, or some other device) responsible for [ATR] dominance under coalescence are entirely independent of those which give rise to [ATR] dominance in assimilatory processes.

In view of these considerations, and in the absence of evidence to the contrary, I will continue to assume that the [ATR] dominance patterns observable in coalescence and assimilation in Nawuri are in fact related, i.e. the fact that the same feature value emerges as dominant in both processes is not coincidental. Rather, the regular dominance of [+ATR] over [-ATR] in both phenomena reflects a deep-seated and systematic property of the language.

5.2 NAWURI [+ATR] DOMINANCE IN TYPOLOGICAL PERSPECTIVE

A widely assumed typological distinction in work on ATR harmony (cf. Hall and Yokwe 1981) is the familiar one between root-controlled and dominant [+ATR] harmony. The former is generally assumed to be typical of West African languages and the latter of East African languages. It can be questioned however whether the difference is as clear-cut as is perhaps sometimes assumed. Kutsch Lojenga (1986) argues for example that the essential difference can be reduced to the question of whether or not a language happens to have [+ATR] suffixes, and that, moreover, there are East African languages, e.g. Alur, which are intermediate in this respect in the sense that they appear to be in the process of losing their [+ATR] suffixes. Moreover, Bakovic (2000) argues that the phenomenon of root-control (or, in his framework, stem-control) does exercise a role in at least some East African languages with dominant [+ATR] harmony. Thus, there appear to be points at which at least some East African ATR harmony systems may be more similar to root-controlled harmony systems than might seem to be implied by the standard typological division into root-controlled

West African harmony systems on the one hand, versus dominant East African harmony systems on the other.

What I would like to suggest, based on the behavior of Nawuri and a number of other West African languages, is that the reverse is also true: there are clearly identifiable respects in which many West African languages with five-height vowel systems exhibit elements of [+ATR] dominant harmony. This shows up most strikingly perhaps in the presence of at least a few reported cases of dominant [+ATR] suffixes in West African languages. It was suggested above that Nawuri might be analyzed as having one such suffix, a diminutive suffix */-bi/*. While the synchronic status of this morpheme as a suffix rather than a noun root can be questioned, it is interesting to note that several other West African languages have been reported to have (generally very limited) instances of dominant [+ATR] suffixes that cause underlying [-ATR] root vowels to become phonetically [+ATR]. The cases known to me at present are Dagara (Gur: Pénou-Achille 1982), Diola-Fogny (Atlantic: Hall et al. 1974, citing Sapir 1965), Foodo (Kwa, Tano, Guang: Plunkett 1991), Izi (Igboid: Meier et al. 1975), Kpokolo (Kru: Kaye et al. 1985), and Nkonya (Kwa, Tano, Guang: Peacock and Lear 1997).²⁰

Quite apart from the apparent existence of dominant suffixes in a few languages, the common picture of West African languages as exhibiting root-controlled harmony, though not without some validity, may need to be qualified in other respects as well. Whereas in the prototypical picture of a root-controlled harmony system the two values of [ATR] behave symmetrically, such that neither value shows evidence of being dominant over the other, a large number of actual West African languages depart from this prototypical pattern in that [+ATR] is clearly active or dominant in a way that [-ATR] is not. Evidence of such activity typically comes from phenomena similar to those at work in Nawuri. Spreading of [+ATR] across word boundaries and/or between root morphemes in compounds occurs in Akan (Kwa, Tano: Clements 1981, Stewart 1967), Anum (Kwa, Tano, Guang: Obeng 1995), Bete (Kru: Werle and Gbalehi 1976), Chumburung (Kwa, Tano, Guang: Hansford 1988, Snider 1985, 1989c), Deg (Gur: Crouch and Herbert 1997), Dilo (Gur: Jones 1987), Ebira (Nupoid: Scholz 1976), Igbo (Igboid: Stewart 1967), Izi (Igboid: Meier et al. 1975), Kɔnni (Gur: Cahill 1996, 1999), Nzema (Kwa, Tano: Alabi Achini, personal communication), and Vata (Kru: Kaye 1982). Several languages with the same underlying nine-vowel system as Nawuri, including Ahanta (Kwa, Tano: Ntummy 1997a,b), Akan (Kwa, Tano: Clements 1981, Stewart 1967), Dagara (Gur: Pénou-Achille 1982), Lama (Gur: Ourso 1989a,b), and Waja (Adamawa: Kleinwillinghöfer 1990, 1996) have (like Nawuri) a process in which /a/ is realized as a [+ATR] allophone in (some) [+ATR] contexts, via assimilation to neighboring [+ATR] vowels. Languages which, like Nawuri, systematically preserve [+ATR] in preference to [-ATR] in cases involving fusion of vowels with opposite [ATR] values include Chumburung (Kwa, Tano, Guang: Hansford 1988; Snider 1985; 1989c), Ebira (Nupoid: Scholz 1976), Foodo (Kwa, Tano, Guang: Plunkett 1991), Gichode (Kwa, Tano, Guang: Keith Snider, field

²⁰ In addition to these cases of dominant [+ATR] suffixes, Puguli (Kevin Warfel, personal communication) and Ninkare (as described in the "Guide d'orthographe ninkare"), both Gur languages of Burkina Faso, have (limited) cases of dominant [-ATR] suffixes.

notes), Kabiye (Kézié Lébiakaza, personal communication, Lébiakaza 1998), Krachi (Keith Snider, field notes), and Tem (Gur: Tchagbale 1976, De Craene 1986).

Whereas assimilatory processes in which [+ATR] is clearly dominant are widely attested, clear cases in which [-ATR] functions as the active or spreading value in assimilation are more difficult to come by.²¹ This might suggest the view that [+ATR] is *universally* the dominant value, a position which has in fact been proposed by a number of scholars (cf. Hall et al. 1974:258, Hall and Yokwe 1981, Kutsch Lojenga 1986, Polgárdi 1998). Formally, this claim has been expressed in some phonological theories by means of an assumption that (plus) [ATR] is a privative or single-valued feature, [-ATR] being in reality (and universally) simply the absence of an [ATR] specification.

The claim that [+ATR] is universally the dominant [ATR] value has not won unanimous acceptance however. Other phonologists have maintained the position that either [+ATR] or [-ATR] may function as the dominant value, the choice among these alternatives being language-specific. Languages in which [-ATR] has been taken to be the dominant value by at least some phonologists include Anufo (Kwa, Tano: Adjekum et al. 1993), Komo (Bantu: Thomas 1992, Kutsch Lojenga 1994a), Yoruba (Defoid: Archangeli and Pulleyblank 1989, 1994), and a number of Bantu C languages (Leitch 1996).

A third, less common, view (cf. Goad 1993, Casali 1993, 1996, 1998, in preparation) holds that while both [-ATR] and [+ATR] dominance are possible,²² the dominant value in a given language is fundamentally dependent on the size and structure of the language's underlying inventory: [+ATR] is regularly the dominant value in languages which have an [ATR] contrast among high vowels (including both five-height /iɛɛɔɔu/ languages and languages with the four-height system /iɛɛɔu/), while [-ATR] is the dominant value in languages which have an [ATR] contrast only among non-high vowels (in particular those languages with the four-height system /iɛɛɔu/ found in Yoruba and many other West African languages).

Detailed arguments for this third view, based on a sample of approximately 100 Niger-Congo and Nilo-Saharan languages, are presented in Casali (in preparation). For our present purposes, it should simply be noted that, as far as I am aware, reports of *five-height* languages in which [-ATR] regularly functions as the dominant value are (contrary to what might be expected under the second view described above) entirely absent from the literature on ATR harmony systems. In contrast, five-height languages with regular and robust [+ATR] dominance are both widespread and common. This being the case, the fact that it is [+ATR] which functions as the dominant value in Nawuri can hardly be viewed as an accidental property of the language. Rather, this fact must presumably follow from some phonological principles, whatever these may ultimately turn out to be.

²¹ Languages in which [-ATR] functions as the dominant value in coalescence, on the other hand, are quite common (Casali 1996, 1998, in preparation). This phenomenon has received relatively little attention however in theoretical discussions concerning the feature [ATR].

²² The qualification "superficially" should be understood here, because Goad (1993) and Casali (1993) actually analyze apparent cases of [-ATR] as involving in reality the feature specification [+low].

6. MARKEDNESS AND THE HIGH [-ATR] VOWELS /ɪ/ AND /ʊ/

The high [-ATR] vowels /ɪ/ and /ʊ/ have often been characterized as highly marked sounds (cf. Stewart 1970, Archangeli and Pulleyblank 1994, Calabrese 1995), their markedness being allegedly due to a gestural antagonism between tongue body raising (= [+high]) and tongue root retraction (= [-ATR]). The putative markedness of these sounds has been invoked as an explanation for the tendency for /ɪ/ and /ʊ/ to be the first vowels lost historically in the reduction of nine-vowel systems (Elugbe 1983, Ford 1973, Painter 1972, Stewart 1970, Williamson 1983).

A variety of criteria has been used by phonologists to diagnose particular sounds as *marked* or *unmarked*. Among the criteria which have been employed are those listed below (cf. Rice 1999):

- (49) a. Unmarked segments are found in more languages, marked segments in fewer languages.
- b. Unmarked segments occur more commonly (within a language), less marked segments less commonly.
- c. Unmarked sounds are sometimes used as epenthetic segments; marked sounds are not (cf. also Riggle 2000, Harrison 2001, Burquest 1998, Hooper 1976).
- d. Unmarked segments are frequently targets of neutralization, i.e. in positions where contrast between two elements is neutralized, it is generally the unmarked sound which occurs phonetically. Marked sounds are frequently absent in positions of neutralization and are sometimes changed to unmarked sounds in such positions, in cases where assimilation is not involved (as in the frequently observed tendency of voiced segments to devoice word-finally).
- e. The presence of a marked sound in a language generally implies the presence of the corresponding unmarked sound (cf. Stewart 2000). For example, the presence of phonemic nasal vowels in a language generally implies the presence of the corresponding oral vowels, but not conversely.

In some cases, these criteria converge to yield a fairly clear characterization of a particular sound as relatively marked or unmarked. By virtually all of the criteria listed above, the vowel /ɑ/ must be considered a highly unmarked sound for example. At the other extreme, a low (or at least non-high) [+ATR] central vowel (variously symbolized as /ə/, /ɜ/, or /ʌ—the first of these will henceforth be used for our purposes) that functions as a [+ATR] harmonic counterpart of /ɑ/ in some ten-vowel (/iɛeəəɔoʊ/) African languages (e.g. Akposso: Anderson 1999; Pări: Andersen 1989; Anywak: Reh 1996; Deg: Crouch and Herbert 1997; Kasem: Bonvini 1974) must qualify under virtually all these same criteria as a marked sound. To begin with, phonemic non-high central [+ATR] vowels are found in comparatively few languages. Second, although I have access to direct frequency statistics on the occurrence of /ə/ for only a few ten-vowel languages, this data appears reasonably consistent with the expectation that /ə/, as a marked sound, should be relatively uncommon. Thus, /ə/ is the least common of the ten vowel phonemes of Akposso (a Kwa language of Togo described in Anderson 1999), and of Koromfe (a Gur language of Burkina Faso described in Rennison 1984). It is somewhat more common in Kasem (Gur, Burkina

Faso); Bonvini (1974) lists /ə/ as fifth of the ten vowels in overall frequency in the lexicon and seventh in texts. As far as I am aware, non-high [+ATR] central vowels are not used as the epenthetic vowel in any ATR harmony language. There also appear to be ten-vowel languages in which /ə/ has a restricted distribution in that it is not permitted in positions in which other, less marked vowels, can occur. In Akposso (Anderson 1999), /ə/ occurs only in roots, being systematically avoided in affixes, even in contexts where it might, according to the most regular harmony pattern, be expected to occur as the harmonic counterpart of /a/. A similar state of affairs appears to hold in Lòkóə (Runsewe 1988). Finally, it would seem to be true that the presence of a non-high [+ATR] central vowel in a language usually implies the presence of other, less marked vowels.²³

Discussions in the literature (cf. Stewart 1970, Calabrese 1995, Archangeli and Pulleyblank 1994) have tended to treat the case of /ɪ/ and /ʊ/ as very much like that of /ə/, the difference being if anything one of degree only. I believe however that there are a number of important respects in which /ɪ/ and /ʊ/ behave quite differently from /ə/ and other indisputably marked segments. These differences can be observed both in Nawuri and in a number of other African languages. I strongly suspect that these observed behaviors are fairly typical of vowel systems which have /ɪ/ and /ʊ/ as underlying segments.

To begin with, both vowels are on the whole quite common in Nawuri. In both root morphemes and text material, /ɪ/ is the second most frequent vowel (after /a/) in my data. Though it ranks only seventh in overall frequency in the lexical count given in (20) above, the back vowel /ʊ/ ranks third in frequency in the count based on text material in (21). Both vowels occur quite commonly in function words and affixes. By contrast, the allegedly less marked vowels /e/ and /o/ are absent almost entirely in function words and are the least common vowels in the language in both lexical and text material.

The common occurrence of /ɪ/ and /ʊ/ in function words and affixes may be especially significant in view of the oft-made observation that these are frequently positions which support fewer contrasts than lexical roots. The very strong cross-linguistic tendency (cf. Beckman 1998) is for the sounds that occur phonetically in such positions of neutralization to be relatively unmarked sounds; highly marked sounds are frequently excluded from such positions. In the case of consonants, for example, Cahill (2000) has documented a strong tendency for labiovelar consonants, generally considered to be marked sounds, to be avoided in affixes and function morphemes.

Many languages also show a tendency to neutralize contrasts in non-initial syllables; as in the case of affixes and function words, the normal expectation is that the sounds which are permitted to occur non-initially under such cases of neutralization will be relatively less marked sounds. This tendency can also be illustrated for consonants using labiovelars as an example; Cahill's survey reveals that these sounds are restricted, in many languages, to occurring in root- (or even word-) initial position.

In Nawuri, positional neutralization occurs in non-initial syllables of verbs, in which only a limited set of segments is commonly found (Casali 1995c). The consonants

²³ Exceptions do exist; Zande (Boyd 1997) for example has an eight vowel system /iɛaəɔu/ that has a non-high [+ATR] central vowel /ə/, though it lacks the "less marked" vowels /e/ and /o/. Such cases appear however to be relatively uncommon.

that occur with any frequency in non-initial syllables of verbs are /l/, /r/, /t/, /s/, /g/, and /ŋ/. With the possible exception of /ŋ/, these are all sounds which would normally be regarded as relatively unmarked. The vowels that commonly occur non-initially in verbs are /a/, /ɪ/, and /i/. The inclusion of /ɪ/ in this set might seem somewhat surprising under the common assumption that /ɪ/ and /u/ are the most marked vowels in a nine-vowel system.

The vowels [ɪ] and [u] exhibit a further behavior typical of unmarked, rather than marked vowels: they frequently occur as epenthetic vowels employed to resolve impermissible consonant sequences in loanwords. The epenthetic vowel in such cases is always a high vowel whose roundness and [ATR] value are determined by harmony (and/or, in the case of roundness, consonantal effects). In cases where the epenthetic vowel occurs in a word with /a/ (e.g. *start* > [sɪtaati]), the epenthetic vowel is [ɪ] rather than [i], even though (given the neutrality of /a/ to ATR harmony) either vowel could in principle be employed in such cases without violating the attested harmony patterns of the language.²⁴

Moreover, such evidence as is available to me at present does not suggest that Nawuri is in any way unusual in this regard. It seems to be fairly common in nine- and ten-vowel languages for /ɪ/ and/or /u/ to be among the most frequently occurring vowels. This is the case for example in Akposso (Kwa: Anderson 1999), Chumburung (Kwa, Tano, Guang: Cahill 1991), Dagaari (Gur: Cahill 1991), Kaansa (Gur: Stuart Showalter, personal communication), Bete (Kru: Werle and Gbalehi 1976), Wali (Gur: Cahill 1991), Nafara (Aglo 1989–1990), Kabiye (Delord 1976),²⁵ Kasem (Bonvini 1974), and Konni (Gur: Cahill 1991). /ɪ/ and/or /u/ are also used epenthetically in some other nine-vowel languages as well, including Kabiye (Delord 1976), Chumburung (Hansford and Hansford 1989), Kaansa (Gur: Stuart Showalter, personal communication), Konni (Gur: Cahill 1996), and Kalabari Ijo (Ijoid: Jenewari 1973). Exactly how common this latter phenomenon is remains to be seen.

Perhaps the strongest argument in favor of the widely-held position that /ɪ/ and /u/ are highly marked sounds comes from the cross-linguistic observation that the presence of these vowels in a language implies the presence of other, presumably less marked, vowels, in particular the high [+ATR] vowels /i/ and /u/, though not vice versa (Stewart 2000). This diagnostic, to which considerable importance has been attached in the literature (cf. Archangeli and Pulleyblank 1994, Calabrese 1995), appears to be at variance with the language-internal evidences of unmarked behavior of /ɪ/ and /u/ cited above. At least, this is the state of affairs that confronts us in the case of

²⁴ The vowels /ɪ/ and /u/ can also be argued to participate to some extent in a type of reduplication (described in Casali 1995c), known as fixed segmentism (Alderete et al. 1997), in which some segment(s) of the reduplicant are copied from the base form, while one or more other segmental slots in the reduplicant are not copies but are filled by some predictable consonant(s) or vowel(s). The relevance of this to claims about markedness is that the fixed segments (including, in Nawuri, the sounds /ɪ/ and /u/) which surface under this type of reduplication are normally assumed to be very unmarked sounds. This line of reasoning cannot be pressed very strongly, however, since the reduplication process in question is of very limited productivity synchronically.

²⁵ Delord notes however that /ɪ/ and /u/ do not occur in CV verbals in Kabiye, a fact which might, perhaps, be attributed to the relative markedness of these segments. On the other hand, CV verbals do not constitute a typical neutralizing context, and it is thus not clear whether this gap is related to markedness considerations at all.

Nawuri and a number of other five-height languages, and there does not seem to be any reason at present to believe that these languages are in any way atypical. If this is right then we must conclude, at a minimum, that the markedness behavior of /ɪ/ and /ʊ/ diverges in clear and interesting respects from that of /ə/, for which *all* indications, both language-internal and from cross-linguistic generalizations about inventories, converge on the same conclusion that this vowel is a highly marked sound.

If the synchronic behavior of /ɪ/ and /ʊ/ in Nawuri in fact proves to be typical, the problem facing phonologists becomes to explain why these vowels are on the one hand less favored than some other vowels (in particular /i/ and /u/) when it comes to selection in vowel inventories, but on the other hand do not behave as marked vowels in terms of their language-internal behavior. While space will not permit a detailed discussion of this problem here, the key to a resolution may lie in recognizing a distinction between the articulatory markedness of individual segments and factors affecting the auditory markedness of inventory contrasts, as proposed by Flemming (1996) (cf. also Rice 1999, Riggle 2000). I suggest that in terms of their articulatory properties, /ɪ/ and /ʊ/ are, contrary to what has been widely assumed, relatively *unmarked* segments; this accounts for the fact that they do not, so far as the evidence discussed above with respect to Nawuri and a number of other languages would indicate, tend to behave like typical marked segments in terms of their frequency of occurrence, contextual distributional properties, or other phonological behavior. On the other hand, the tendency for /ɪ/ and /ʊ/ to be somewhat less favored for inclusion in vowel inventories than some other vowels (most especially /i/, /u/, and /a/) can be explained in terms of the certain perceptual disadvantages incurred by inventories in which /ɪ/ and /ʊ/ are present (Casali 1995d). Inventories in which these vowels occur in contrast with /i/ and /u/ (and in some cases with /e/ and /o/) are in some measure dispreferred because of the fact, documented in a great many languages,²⁶ that /ɪ/ and /ʊ/ tend to be perceptually quite similar to (and hence potentially confused with) the [+ATR] vowels immediately above and/or below them. Moreover, an inventory in which /ɪ/ and /ʊ/ were to occur *instead of* the high [+ATR] vowels /i/ and /u/, as in the case of a five-vowel inventory /ɪəɑɔʊ/ or /ɪəɑou/, would be disfavored because the height 1 vowels /ɪ/ and /ʊ/, being acoustically less peripheral than /i/ and /u/, do not lead to as great a degree of overall acoustic (and auditory) dispersion as is found in the more familiar systems /iəɑɔʊ/ or /iəɑou/. That is, the vowels in a /ɪəɑou/ system are not as widely separated from each other acoustically as in a /iəɑou/ system. To the extent that wide acoustic spacing of vowels is perceptually desirable (cf. Lindblom and Liljencrants 1972, Lindblom 1986, Flemming 1995, 1996, Maddieson 1984), it makes sense that systems with /ɪ/ and /ʊ/ as height 1 vowels would be less favored than those in which the highest vowels are /i/ and /u/. Thus, the generalization that /ɪ/ and /ʊ/ do not occur unless /i/ and /u/ also occur does not require the assumption that

²⁶ Such languages include, among numerous others, Koromfe (Gur: Rennison 1986), Akposso (Kwa: Anderson 1999), Avatime (Kwa: Schuh 1995), Dagara (Gur: Pénou-Achille 1982), Igbo (Igboid: Westermann and Ward 1933, as cited by Stewart 1967), Okpe (Omamor 1973, 1988), Uvwie (Edoid: Omamor 1988), Tem (Gur: Tchagbale 1976), Talinga-Bwisi (Bantu: Paluku 1998), LuGungu (Bantu: Kutsch Lojenga 1999), Zande (Ubangi: Boyd 1997), Kimatuumbi (Bantu: Odden 1996), Kirangi (Bantu: Oliver Stegen, personal communication), Kuche (Platoid: Wilson 1996), Omiti (Central Sudanic: Connie Kutsch Lojenga, personal communication).

the former are more marked in terms of their articulation than the latter, but can be explained instead in terms of acoustic and perceptual factors.

7. CONCLUSION

By way of conclusion, the chart below briefly summarizes the major characteristics of ATR harmony in Nawuri and how these compare with what has been reported in other languages.

<i>Characteristic</i>	<i>Typological status</i>
Nine-vowel system	Such systems are extremely common in both West and East Africa. Languages with nine-vowel systems are found in nearly all major branches of Niger-Congo (except Kordofanian?) and most branches of Nilo-Saharan.
Presence of ATR harmony	Although there is no logical requirement that a language with a nine-vowel system must have some form of ATR harmony, clear cases of nine-vowel Niger-Congo or Nilo-Saharan languages which lack ATR harmony altogether are very rare. ²⁷
Allophonic [+ATR] variant of /a/ in [+ATR] contexts	This is reported in Akan (Kwa, Tano: Clements 1981, Dolphyne 1988, Stewart 1967), Chumburung (Snider 1989a, c), Waja (Adamawa: Kleinewillinghöfer 1990, 1996), Ahanta (Kwa, Tano: Ntummy 1997a,b), Anum (Kwa, Tano, Guang: Obeng 1995), Dagara (Gur: Pénou-Achille 1982), Lama (Gur: Ourso 1989a,b). It may be relatively common, but is apparently not universal.
Voice quality difference between plus and minus [ATR] harmony sets	This has been commonly reported in Nilo-Saharan languages, not as commonly in Niger-Congo languages. It is likely however that such voice quality differences do occur in many West African languages.
Acoustic overlap of mid [+ATR] and high [-ATR] vowels	This appears to be fairly common but not universal in nine-vowel systems.
/a/ harmonically neutral	This is common but not universal in nine-vowel systems (see note 6).
Neutral /a/ is opaque (to rightward [+ATR] spreading).	Opacity of /a/ to [+ATR] spreading in nine-vowel languages is common and would appear to be the norm. There are however languages in which /a/ is reported to be transparent (cf. §4 above).
[-ATR] vowels occur more frequently than [+ATR] vowels.	This is common and probably the norm in five-height (e.g. nine-vowel) systems.

²⁷ While this is no doubt primarily for genetic reasons, there may be functional factors involved as well (Kaun 1995, Gorecka 1996).

<i>Characteristic</i>	<i>Typological status</i>
[+ATR] active and dominant	Although not all nine-vowel languages show evidence that one value of [ATR] is asymmetrically dominant, those which do may be more common than is generally supposed. To the extent that such evidence is available, [+ATR] rather than [-ATR] dominance appears to be nearly universal in nine-vowel languages and other systems with phonemic /ɪ/ and /ʊ/, though not, it appears, in systems which have an [ATR] contrast only among mid vowels (Casali in preparation).
[+ATR] spreading across word boundaries	This occurs in Akan (Kwa, Tano: Clements 1981), Anum (Kwa, Tano, Guang: Obeng 1995), Chumburung (Snider 1985, 1989c), Bongo (Central Sudanic: Kilpatrick 1985), Deg (Gur: Crouch and Herbert 1997), Dilo (Gur: Jones 1987), Ebira (Nupoid: Scholz 1976), Igbo (Igboid: Stewart 1967), Kinande (Bantu: Mutaka 1995), and Vata (Kru: Kaye 1982)
[+ATR] spreading in lexical compounds	Such spreading has been reported in Akan (Berry 1957), Bete (Kru: Werle and Gbalehi 1976), Bongo (Central Sudanic: Kilpatrick 1985), Izi (Igboid: Meier et al. 1975), Gur (Kɔnni: Cahill 1996), Ngiti (Central Sudanic: Kutsch Lojenga 1994c), Nzema (Kwa, Tano: Alabi Achini, personal communication).
Possible dominant [+ATR] suffix	Though generally assumed to be a trait that is more characteristic of East African languages, limited instances of dominant [+ATR] suffixes have been reported in a number of West African languages (cf. §5 above).
Leftward [+ATR] spreading more extensive than rightward	This would appear to be fairly common; there is a need however for systematic research in this area.
[+ATR] preserved under coalescence	In languages with height coalescence, [+ATR] appears to be regularly preserved in five-height languages. Examples include Igbara (Nupoid: Scholz 1976), Kabiye (Gur: Lévikaza 1998), Tem (Gur: Tchagbale 1976, De Craene 1986), and several other Guang languages (Keith Snider, field notes). [-ATR] is commonly preserved under height coalescence in four-height /iɛɛɔu/ languages (Casali in preparation).
/ɪ/ and/or /ʊ/ occur frequently.	Although more systematic research is needed, this appears to be common in nine-vowel systems.
/ɪ/ and/or /ʊ/ employed epenthetically	This is attested in at least several other nine-vowel languages (cf. §6 above).

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APPENDIX: WORDS USED FOR VOWEL FORMANT MEASUREMENTS

The words given in the table below are those which were recorded and used to make the formant measurements discussed in §3.2. In the case of polysyllabic words, the vowel used for the measurements was always the vowel of the final syllable.

<i>Phonemic form</i>	<i>Vowel measured</i>	<i>Phonetic form</i>	<i>Gloss</i>
a-fulee	ee	àfùlèè? ~ àfùl'è?	money
kubee	ee	kùbéé? ~ kùb'è?	coconut
o-gee	ee	ògèè? ~ òg'è?	valley
i-dee	ee	ìdéè? ~ ìd'è?	dream
lee	ee	lèé? ~ l'è?	to remove
tee	ee	tèè? ~ t'è?	to fall
gi-bee	ee	gìbéè? ~ g'ìb'è?	butterfly
kee	ee	kèè? ~ k'è?	to pay
taa	aa	tàà?	to take
laa	aa	làà?	to cross
gi-baa	aa	g'ìbáá?	hand
kaa	aa	kàá?	to lay (egg)
tii	ii	tìi?	to close
bii	ii	bìi?	to be black
kpii	ii	kpíi?	to rub
gi-kelii	ii	g'ìkèèlî?	kapok tree
tiu	ii	tìi?	to call
lii	ii	lìi?	to come from
bii	ii	bìi?	to sing
kii	ii	kìi?	to look
duu	uu	dùú?	to plant
buu	uu	bùù?	to follow

<i>Phonemic form</i>	<i>Vowel measured</i>	<i>Phonetic form</i>	<i>Gloss</i>
kuu	uu	kùú?	to dig
luu	uu	lùú?	to peel
tʊʊ	ʊʊ	tùù?	to shoot
bʊʊ	ʊʊ	bùù?	to be drunk
lʊʊ	ʊʊ	lùù?	to weave
ɔ-kʊʊ	ʊʊ	ɔkùù?	someone
loo	oo	lòó?	to enter
gi-botoo	oo	gìbòtòò?	leprosy
gi-tiriboo	oo	gìtìrìbòò?	well
pokoo	oo	pòkóò?	type of calabash
dɔɔ	ɔɔ	dòò?	to farm
lɔɔ	ɔɔ	lòò?	to scoop
bɔɔ	ɔɔ	bòò?	to fold
kɔɔ	ɔɔ	kòò?	to defecate