Assimilation, markedness and inventory structure in tongue root harmony systems[*]

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This paper is concerned with the related topics of assimilatory dominance and markedness relations in tongue root harmony systems. While a range of views has existed on these topics, much work in recent years adopts the view that either [+ATR] or [-ATR] can function as the dominant value in a language, and that markedness relations are determined in conjunction with tongue body height. That is, neither [+ATR] nor [-ATR] values are marked in absolute terms; instead, low [+ATR] vowels (or, in some work, all non-high [+ATR]) vowels and high [-ATR] vowels are assumed to be marked. These assumptions are reasonable ones that are supported not only by familiar functional considerations (gestural antagonism in the production of high retraced and non-high advanced) vowels but by the typological observations that languages (e.g., Yoruba) in which [-ATR] is dominant are strongly attested (as, of course, are those in which [+ATR] is dominant) and that it is the high [-ATR], low [+ATR] and mid [+ATR] vowels that are sometimes missing in languages with an [ATR] contrast.

I present typological evidence in this paper, however, that while such a view has elements of correctness as a kind of average picture of what occurs, it is incomplete in important respects. I argue for a fuller typological picture in which both dominance and markedness relations are strongly correlated with the contrastive vowel inventory of a language, behaving differently in systems with a tongue root contrast in high vowels ("/2IU/ systems") and systems ("/1IU/ systems") with an [ATR] contrast only in mid vowels. Not only do the two systems characteristically show different dominant [ATR] values ([+ATR] and [-ATR] respectively), as claimed in earlier studies (e.g., Casali 2003), but different (and essentially opposite) markedness relations in non-low vowels as well. /2IU/ systems characteristically treat both mid and (more surprisingly) high [-ATR] vowels as unmarked (e.g., in positional neutralization patterns) relative to their [+ATR] counterparts. /1IU/ systems display the opposite relations, treating [-ATR] as marked in both (as expected) high vowels and (more surprisingly) non-high vowels. (Low vowels exhibit some unexpected differences as well, though the problem of making full sense of these is complex.) Thus, in both systems, the marked value in non-low vowels is also the one that is characteristically dominant. It is also noteworthy that there is no single inventory type in which both mid [+ATR] and high [-ATR] vowels characteristically pattern as marked. The vowels [e], [o] behave as marked sounds in /2IU/ systems but unmarked in

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/1IU/ systems, while the vowels [ɪ], [ʊ] behave as unmarked in the former and marked in the latter.

I argue that the reversals of both markedness and dominance relations that exist in /1IU/ and /2IU/ systems defy easy explanation in functional terms, but that a formal explanation, based on representational underspecification, is more promising: the differences in patterning make reasonable initial sense under the assumption, proposed in various previous studies, that the two systems employ different specified [ATR] values, [-ATR] and [+ATR] respectively. A partial explanation is also speculatively proposed for why the two systems employ different values.

1. Introduction

A great deal of theoretical and descriptive work has been done on tongue root harmony systems. Among the various topics that have been frequently addressed are issues relating to markedness and dominance of tongue root feature values. Different answers have been suggested in particular to the following two questions:

(1) a. Which tongue root feature value(s) and/or classes of vowels characteristically pattern as *marked* in the sense of being subject to various forms of avoidance or distributional restrictions?

b. Which tongue root feature value(s), [+ATR] or [-ATR], is *dominant* in assimilatory processes?

Answers to Question (1a) have included the view (e.g., Bole-Richard 1981, Dawson 1975, Kutsch Lojenga 1986, 1994a, Parker 1985, Stewart 1967, Tchagbalé 1976) that all [+ATR] vowels are marked as a class, either in particular languages or perhaps universally, the view that [-ATR] vowels are marked (e.g., Zsiga 1997: 266, Note 21), the view that low [+ATR] and non-low [-ATR] vowels are marked (Bakovic 2000, Kaye et. al. 1985), and the view that non-high [+ATR] and high [-ATR] vowels are marked (e.g., Archangeli & Pulleyblank 1994, Calabrese 1995).

With respect to Question (1b), the existence of languages (e.g., Diola-Fogny, Maasai) in which [+ATR] is dominant has been universally recognized for a long time. There has been some disagreement, however, over whether there are languages in which [-ATR] functions as the dominant value. Though much work (e.g., Archangeli & Pulleyblank 1989, 1994, Leitch 1996, Pulleyblank et. al. 1995, Thomas 1992) has assumed that this is the case, some phonologists (e.g., Bakovic 2000, Polgárdi 1998) have maintained that only [+ATR] ever functions as the active or dominant value, and that apparent cases of [-ATR] spreading are better analyzed in other terms. In addition, it has been proposed (e.g., Casali 2003) that either [ATR] value may be dominant, but that the dominant value in a language is strongly correlated with the structure of language's vowel inventory.

Notwithstanding the wide variety of views that have existed on the topic, however, certain important typological generalizations that bear on the issues seem quite clear.

These include the fact that tongue root harmony systems, sometimes referred to as *dominant-recessive harmony* systems, in which [+ATR] vowels are dominant (i.e., in which [-ATR] vowels assimilate to [+ATR] vowels) are quite well attested, and some important generalizations about the structure of vowels inventories. Specifically, it is now well established (see for example Archangeli & Pulleyblank 1994, Casali 2003, 2008) that, of the ten vowels found in the system in (2a) below, which represents the maximal vowel inventory attested with any real frequency in tongue root harmony systems, the vowel that are sometimes missing in well-attested smaller inventories are the high [-ATR] vowels [ɪ], [ʊ], which are missing in the seven-vowel inventory in (2c), the mid [+ATR] vowels [e], [o], which are missing in the different seven-vowel inventory in (2d), and the low [+ATR] vowel (symbolized throughout this paper as [ạ]), which is absent, at least as a phoneme, from all the smaller inventories. (A low [+ATR] vowel [ạ] very often does occur as an allophone of /a/ in the inventories in (2b) and (2c). It rarely if ever occurs allophonically in the inventory in (2c), a fact which turns out to be potentially significant, as discussed further below.)

(2) Well-attested tongue root harmony systems

a. 10V inventory (e.g., Degema)

/i/	/u/	[+ATR]
/ɪ/	/ʊ/	[-ATR]
/e/	/o/	[+ATR]
/ɛ/	/ɔ/	[-ATR]
/ạ/		[+ATR]
/a/		[-ATR]

b. 9V inventory (e.g., Akan)

/i/	/u/	[+ATR]
/ɪ/	/ʊ/	[-ATR]
/e/	/o/	[+ATR]
/ɛ/	/ɔ/	[-ATR]
/a/		[-ATR]

c. 7V inventory (e.g., Yoruba)

/i/	/u/	[+ATR]
/e/	/o/	[+ATR]
/ɛ/	/ɔ/	[-ATR]
/a/		[-ATR]

d. 7V inventory (e.g., Kinande)[1]

/i/	/u/	[+ATR]
/ɪ/	/ʊ/	[-ATR]
/ɛ/	/ɔ/	[-ATR]
/a/		[-ATR]

Moreover, while the point has not always been conceded in the past, it now seems well established (see Section 2.2 below for more discussion) that tongue root harmony languages in which [-ATR] vowels are dominant are well attested as well. (See Allen et. al. 2013, Casali 2003, 2008, Clements 2000, Leitch 1996 for relevant discussion.)

These particular findings are clear enough, in fact, that it might be tempting to view some of the disagreement that has existed as of historical interest only, due to insufficiently clear knowledge of actual typological patterning, and to regard the matter as largely settled. In particular, the following position, which seems in fact to be quite widely

[1] Though missing as phonemes in the seven-vowel system in (2c), the mid [+ATR] vowels [e], [o] often occur as allophones in languages with this system.

assumed (e.g., Archangeli & Pulleyblank 1994, 2002, Calabrese 1995, Pulleyblank 1996), might appear to be warranted:

(3) a. Either [+ATR] or [-ATR] can be dominant, on a language-specific basis.

b. Neither [+ATR] nor [-ATR] vowels are marked as an entire set. Rather, markedness is determined in conjunction with height features. [+ATR] is marked in non-high vowels, while [-ATR] is marked in high vowels.

In essence, this can be seen as a kind of reasonable baseline position that is the minimal one which is clearly compatible with what is widely known and relatively uncontroversial. It now seems clear enough that either [ATR] value can serve as the dominant one in a language, and it is also clear that high [-ATR] vowels and non-high [+ATR] vowels are marked in at least some vowel systems. If for no other reason, this latter assumption is warranted by the complete absence of such vowels in some languages. (In contrast, high [+ATR] vowels [i], [u] and non-high [-ATR] vowels [ɛ], [ɔ], [a] are found in all the inventories in (2)). And, under fairly standard assumptions of optimality theory (OT), vowels that are systematically absent from some class of languages must be targeted by some markedness constraint that is responsible for their absence. In that important sense, they can be regarded as universally marked (though overt evidence of that marked status may be absent in a given language if the relevant markedness constraint is ranked low enough.) Moreover, high [+ATR] and mid [-ATR] vowels are often assumed to be more ideal than high [-ATR] or mid [+ATR] vowels on functional grounds. (See Section 3 below for more detailed discussion of this point.) Thus, the view summarized in (3) is an inherently plausible one and, in the absence of further surprises, it would be reasonable enough to suppose that it might turn out to represent the whole story as far as tongue root markedness and dominance relations are concerned.

It will be helpful to introduce some terminology at this point. We shall see below that there is evidence of some important respects in which the inventory in (2c) patterns differently in its typical behavior from the other inventories in (2). What distinguishes this inventory is that it has a tongue root contrast only in the non-high vowels, i.e., it has just a single set of phonemic high vowels, /i/, /u/. A few such systems (e.g., Ijesa dialect of Yoruba) do have high [-ATR] vowels [ɪ], [ʊ] phonetically, as allophones of /i/, /u/ in [-ATR] contexts. What is relevant for our purposes, however, is that [ATR] is not contrastive in high vowels in such a system, which we will refer to (following Casali 2008) as a */1IU/* system.

In all actual /1IU/ languages for which evidence is available, the contrastive high vowels are phonetically [i], [u] and not [ɪ], [ʊ]. Based on the terminological usage proposed here, however, this is not true purely by definition. A /ɪ e ɛ a ɔ o ʊ/ system, were it to occur, would qualify as a /1IU/ system, since it has only one set of phonemic high vowels, [ɪ], [ʊ]. The finding that /1IU/ systems of this latter type do not appear to exist is an empirical one (though one that is not very surprising under most current views about tongue root markedness).

We will define a */2IU/* system (also following Casali 2008) as one with two sets of vowels that contrast for [ATR], i.e., a contrast between /i/, /u/ and /ɪ/, /ʊ/. With the exception of (2c), all of the other three systems in (2) are /2IU/ systems by this definition.[2]

A major theme of this paper is that /1IU/ and /2IU/ inventories display some very significant differences in phonological patterning.

2. Two wrinkles

While the view summarized in (3) is a simple and attractive one, there are a couple initial concerns that might be raised about it, in the form of generalizations that do not necessarily square well with this view, at least if it is taken to represent the whole story on markedness and dominance relations in tongue root harmony systems. One of these involves a kind of conceptual puzzle involving a mismatch between the picture in (3) and widely held assumptions about the relationship between markedness and dominance, and the other involves some empirical findings which could suggest that the view in (3) is at least incomplete. We will consider these issues in turn.

2.1 Assimilation to the marked?

Under a fairly traditional conception of markedness, assimilation is normally expected to be to the marked value of a feature. That is, the marked value of a feature is generally the one that is expected to be spread. (See Causley 1999, de Lacy 2006, Rice 2007 for some discussion). Such a classical view of markedness has featured in work on tongue root harmony as well. For example, Stewart's (1967) classic paper on Akan vowel harmony adopts the view that Akan harmony involves assimilation of unmarked [-ATR] to marked [+ATR] vowels:

> "the phonological relationship between unraisedness [i.e., [-ATR]—RC] and raisedness [i.e., [+ATR]—RC] shows a particular kind of asymmetry which is characteristic of unmarked/marked contrasts: unraised vowels are assimilated to neighbouring raised vowels on a large scale, while there appears to be no assimilation at all of raised vowels to neighbouring unraised vowels…Whenever, in fact, a prefix is in a harmony span not controlled by the stem, any vowel in that prefix is unraised, and this points to the unraised forms of the prefixes as the

[2] I assume, as in Casali (2008), that the classification of a language's inventory type (/1IU/ or /2IU/) is based on the *contrastive* vowel inventory of a language and not its surface phonetic inventory. This means that to qualify as a /2IU/ system, a language must have two sets of *phonemic* high vowels. Thus, a language like Ijesa Yoruba (Oyelaran 1973, Orie 2003), which has a phonemic seven-vowel inventory of the type in (4) but a surface nine-vowel /i ɪ e ɛ a ɔ o ʊ u/ inventory, due to existence of surface high [-ATR] vowels [ɪ], [ʊ] that occur as conditioned allophonic variants of /i/, /u/ preceding [-ATR] vowels /ɛ/, /a/, ɔ/, is considered to be a /1IU/ rather than a /2IU/ system. It must also be emphasized that the terms /1IU/ and /2IU/ are meant to apply only to inventories in which [ATR] is contrastive to begin with. There are, of course, a great many African languages with five-vowel systems in which a feature [ATR] is not employed contrastively at all. Such languages do not qualify as either /1IU/ or /2IU/ systems under the terminological system employed here and will not be a significant focus of this paper.

> natural base forms, and to the treatment of the raising in terms of assimilation." – Stewart 1967: 192

Other descriptive and/or typological work on tongue root harmony systems that takes [+ATR] to be both the dominant value and the marked, distributionally restricted one, includes Bole-Richard (1981), Dawson (1975), Kutsch Lojenga (1986, 1994a), Parker (1985) and Tchagbalé (1976). The same connection between assimilatory dominance and markedness is also implicit or explicit in much work in underspecificaiton theories (e.g., Kiparsky 1985) that equate the marked value of a feature with the lexically specified one. Since assimilation rules can refer to the specified, marked feature value, this value is also the one that is potentially available to spreading.[3]

The picture of markedness summarized in (3) is incompatible with the traditional view of markedness under which marked values of a feature are expected to be dominant. The reasons for this are not difficult to see. Whereas the dominant [ATR] value can vary across languages, in accordance with (3a), the marked or unmarked status of particular vowel classes is invariant. Moreover, the vowels which are universally marked are a mixture of both [+ATR] (i.e., [e], [o], [ạ]) and [-ATR] ([ɪ], [ʊ]) vowels. Regardless of whether [+ATR] or [-ATR] is dominant, it cannot be the case that all dominant vowels are also marked and conversely. If [+ATR] is dominant, then the [-ATR] vowels [ɪ], [ʊ] are expected to be marked but recessive, while the same is true of the [+ATR] vowels [e], [o], [ạ] in languages in which [-ATR] is dominant. In neither case do we find the traditionally expected positive correlation between markedness and dominance. Rather, markedness and dominance are effectively decoupled.

What is less immediately obvious is how much cause for concern this should be. Conceivably, the view that marked feature values should be dominant, might turn out to be simply wrong, at least in the case of tongue root features. However, a positive correlation between markedness and dominance is evident in the case of various other features, and the finding that tongue root features should pattern differently in this regard is at least a potentially puzzling one.

A major claim of this paper, to be developed in greater detail below, is that robustly attested markedness and dominance patterns in tongue root harmony systems turn out, after all, to conform quite well to the traditional expectation that the marked [ATR] value should also be the dominant one. Note, however, that since the dominant [ATR] value in a language is known to vary, the only way in which a correlation between marked and dominant values could hold consistently across tongue root harmony languages is if the set of vowels showing marked patterning also varies across languages. Such a finding may well seem quite unexpected, since it is contrary both to the statement in (3b) and to the natural and widely held assumption that the markedness of vowels in tongue root harmony systems should be a consistent function of phonetic substance. Nevertheless, we shall see that it finds considerable empirical support. Surprisingly, markedness relations

[3] As discussed in Causley (1999), the generalization that marked feature values are dominant is not necessarily straightforward to capture in OT frameworks that eschew crucial use of underspecified features.

in tongue root harmony systems are not invariant in the way that much theoretical work would lead one to expect.

2.2 Assimilatory dominance and inventory structure

A further reason for questioning the correctness, or at least completeness, of the view in (3), is that there is now good evidence of significant differences in the dominance patterns that are characteristic of /1IU/ and /2IU/ systems. A claim to this effect has been made in various studies beginning in the early 1990s. Work such as Casali (1993, 1996/1998, 1998), Causley (1999), Goad (1993) and Steriade (1995) has suggested that while [+ATR] vowels are dominant in assimilation processes in /2IU/ systems, [-ATR] vowels are dominant in /1IU/ systems. More recently, such a claim finds strong empirical support in a survey of dominance patterns in a sample of 110 Niger-Congo and Nilo-Saharan languages described in Casali (2003). The survey results reveal that [+ATR] dominance, but not [-ATR] dominance, is highly typical of /2IU/ system, whereas the reverse is true of /1IU/ systems. While a few potential exceptions to a completely complementary distribution of [+ATR] and [-ATR] dominance based on inventory type exist, there is little room for doubt that /1IU/ and /2IU/ systems show strongly different dominance tendencies.

Several forms of [+ATR] dominance are quite well attested in /2IU/ languages, including spreading of [+ATR] across word boundaries (found in Akan, Anum, Bongo, Chumburung, Deg, Dilo, Ebira, Igbo, Nawuri, Kinande and Vata), [+ATR] spreading in compound words (found in Akan, Bete, Bongo, Frafra, Daza, Deg, Izi, Konni, Nankani, Mayogo, Nawuri, Ngiti and Nzema), spreading from dominant [+ATR] suffixes (found in (Acholi, Alur, Baka, Bari, Bila, Bongo, Budu, Burun, Dagara, Didinga, Diola-Fogny, Foodo, Izi, Kalenjin, Kanembu, Kinande, Kirangi, Koony, Kpokolo, Lango, Lika, Lotuku, Maasai, Mayogo, Nandi, Nawuri, Nkonya, Otuho, Päkot, Puguli, Talinga-Bwisi, Toposa, Turkana and Zande) and systematic preservation of [+ATR] in cases where adjacent underlying vowels of opposite [ATR] values undergo featural coalescence (found in Chumburung, Ebira, Foodo, Gichode, Kabiye, Krachi, Nawuri Talinga-Bwisi and Tem).[4] Many /2IU/ languages also display a kind of pattern, termed *allophonic [+ATR] dominance* in Casali (2003), in which a [-ATR] vowel that lacks a direct phonemic [+ATR] counterpart has an allophonic [+ATR] variant that occurs only in the context of neighboring [+ATR] vowels (where its [+ATR] surface value is potentially attributable to assimilatory spreading of [+ATR]). In a good number of nine-vowel /i ɪ e ɛ a ɔ o ʊ u/ or seven-vowel /i ɪ ɛ a ɔ ʊ u/ languages (e.g., Ahanta, Akan, Anum, Chumburung, Dagara, Didinga, Efutu, Gichode, Gonja, Kinande, Krachi, Lama, Lugbara, Nawuri, Nkonya, Talinga-Bwisi and Waja), for example, the low vowel /a/ has a [+ATR] allophone derived via assimilation to neighboring [+ATR] vowels.[5] Finally, many /2IU/

[4] Unless otherwise noted, languages cited in this paragraph as exemplifying various patterns are taken from Casali (2003), which may be consulted for the original descriptive source(s) on each language.

[5] A second, and somewhat less common, type of allophonic [+ATR] dominance discussed in Casali (2003) is found in a number of seven-vowel /i ɪ ɛ a ɔ ʊ u/ languages, e.g., Kinande (Archangeli & Pulleyblank 2002, Mutaka 1995) and Zande (R. Boyd 1997), in which mid [+ATR] vowels [e], [o], though not contrastive, occur as allophonic variants of /ɛ/, /ɔ/ preceding and/or following (depending on the language [+ATR] vowels /i/, /u/.

languages (e.g., Abouré, Akposso, Anyi, Anywak, Burun, Ega, Emalhe, Kirangi, Kusuntu, Lama, Nkonya, Talinga-Bwisi, Tem, Tepo and Turkana) display a type of pattern, termed *weak assimilatory [+ATR] dominance* in Casali (2003), in which one or more affixes that harmonize for [ATR] in some contexts also fail to harmonize in certain other contexts, in which they surface invariably in a [-ATR] form. In at least some theoretical approaches, the [-ATR] form with such an affix surfaces apart from the influence of harmony could be treated as its inherent or underlying form. If so, then the [+ATR] form the same affix acquires in cases where it assimilates to a [+ATR] root might naturally be seen as an instance of [+ATR] spreading.[6] In all, 69 /2IU/ languages which manifest some form (and often multiple forms) of [+ATR] dominance are reported in Casali (2003).

While assimilatory dominance of [+ATR] vowels is highly characteristic of /2IU/ systems, dominance of [-ATR] vowels is not. Limited instances of superficial [-ATR] dominance are found in some /2IU/ languages. As discussed at length in Casali (2003), however, such patterns generally have a marginal character, occurring only in highly restricted circumstances, and are usually accompanied in the same language by more productive and regular [+ATR] dominance in other contexts. Moreover, at least some such cases have plausible alternative analyses (Casali 2002b, 2003:344-349) which do not require the assumption that [-ATR] is systematically dominant in the language, but are potentially analyzable as instances of *dominance reversal* (Bakovic 2000, Casali 2003, Hyman 2002, Sasa 2007), i.e., cases in which the non-optimality of a [+ATR]-dominant outcome that might otherwise be expected in a language is plausibly attributable to well motivated independent factors. /2IU/ languages in which [-ATR] plainly functions as the regularly dominant value are not very clearly attested at all. (See below for slightly more discussion of this point as well.)

Since [+ATR] dominance is so highly typical of /2IU/ systems, it would be entirely natural to anticipate that the same should be true of /1IU/ systems (which are also extremely common and widely distributed in Sub-Saharan Africa) as well. Virtually all of the manifestations of [+ATR] dominance that are well attested in /2IU/ systems are logically possible (and, seemingly, entirely natural) in /1IU/ systems as well, and there is no obvious reason, within most theoretical frameworks, why the absence of a tongue root contrast in high vowels (the sole essential respect in which /1IU/ systems differ from /2IU/ systems) should lead to a different propensity for assimilatory spreading of

[6] From an OT perspective, there is another way of looking at the "weak assimilatory [+ATR] dominance" cases. In many actual patterns of this type, the [-ATR] form taken by harmonizing affixes in contexts where harmony is, for one reason or another, inapplicable, affects an entire class(es) of morphemes and is plausibly indicative of a systematic prohibition against [+ATR] vowels in the relevant non-harmonizing context. We shall see (Section 3 below), for example, that many /2IU/ languages have pronominal morphemes that harmonize for [+ATR] when affixed to a verb but are consistently [-ATR] elsewhere (for example, in their independent or citation forms). The generalization that [+ATR] vowels are disallowed in a particular context(s) in such languages must of course somehow be captured. In a standard OT model assuming Richness of the Base, this cannot be done by some constraint on underlying forms, and must be handled instead by some constraint ranking which guarantees that if underlying [+ATR] vowels did occur in the relevant context, they would not be permitted to surface as [+ATR] vowels. Cases of this type can be seen as instances of positional neutralization, and will be discussed in such terms below.

[+ATR]. Very surprisingly, however, the natural expectation that [+ATR] dominance should be highly typical of /1IU/ systems as well is not borne out in actuality. In fact, it proves rather difficult to find clear cases of [+ATR] dominance in /1IU/ systems at all. Of 38 /1IU/ languages examined in the survey, only a single /1IU/ language Legbo (based on unpublished data from Larry Hyman) showed any form of [+ATR] dominance. Legbo has both instances of [+ATR]-preserving coalescence and "weak assimilatory [+ATR] dominance," involving a subject pronoun that harmonizes for [ATR] in certain contexts but is [-ATR] elsewhere.[7] (See Casali 2003: 335 for examples and discussion.) More recently, another potential case of a /1IU/ language with [+ATR] dominance has come to light. The harmony system of Ikoma (Higgins 2011), a seven-vowel /i e ɛ a ɔ o u/ Bantu language of Tanzania, has some apparent instances of [+ATR] dominant suffixes.[8]

If the Legbo and Ikoma cases are taken at face value, then we must conclude that the absence of [+ATR] dominance in /1IU/ systems is not an absolute universal. Nevertheless, it is quite clear that /1IU/ and /2IU/ systems behave very differently in their propensities for [+ATR] dominance. [+ATR] dominance is ubiquitous in /2IU/ languages, but scarcely reported at all in /1IU/ languages (despite the fact that the latter are extremely common in overall terms). This difference, which is not clearly anticipated by most current theories, is a very surprising one that ultimately calls for some explanation.

Whereas clear evidence of [+ATR] dominance is not very well-attested in /1IU/ systems, certain indicators of [-ATR] dominance are much more strongly attested. Indeed, to the extent that evidence of asymmetric dominance of one or the other tongue root feature value is found at all in /1IU/ systems, evidence far more commonly implicates [-ATR] as the spreading value. This is not to say that the patterns that are observed in /1IU/ systems are the exact mirror image of those found in /2IU/ systems. We do not find numerous cases of dominant [-ATR] suffixes or of spreading of [-ATR] across word boundaries or in compounds.[9] We do, however, find that [-ATR], and not [+ATR], is commonly preserved in patterns involving coalescence of adjacent [+ATR] and [-ATR] vowels. Thus, coalescent realizations such as /a+e/ > [ɛ], /ɛ+o/ > [ɔ], or /a+i/ > [ɛ] are found in various /1IU/ languages. In all, 20 cases of [-ATR]-preserving coalescence in /1IU/

[7] The survey included only languages that manifest some form(s) of superficial [+ATR] and/or [-ATR] to begin with. Since none of the 38 languages except Legbo displays [+ATR] dominance, this means that the remaining 37 languages actually display dominance of [-ATR] vowels in some context(s). Manifestations of [-ATR] dominance in /1IU/ systems are discussed directly below.

[8] Higgins (2011) suggests, however, that the relevant patterns might also be amenable to an analysis in terms of dominance reversal (with [-ATR] being the systematically dominant value), as other considerations argue that [-ATR] vowels are distributionally marked in Ikoma, and also appear superficially dominant in at least one context. The full range of facts is both interesting and complex.

[9] Casali (2003) reports one case of a /1IU/ language with [-ATR] spreading across word boundaries (Mbosi Oléé; Fontaney 1989, Leitch 1996) and one case of a /1IU/ language with [-ATR] spreading in compounds (Standard Yoruba; Archangeli & Pulleyblank 1989). Tuwuli, a /1IU/ language spoken in Ghana, has an apparent case (which may, however, be of marginal productivity) of a dominant [-ATR] suffix (Harley 2005:61).

languages are reported in Casali (2003),[10] as against only one /1IU/ language (Legbo, as noted above) with [+ATR]-preserving coalescence.

In addition, a number of /1IU/ languages (12 cases are noted in Casali 2003) manifest a type of pattern, referred to as *weak assimilatory [-ATR] dominance* in Casali (2003), that is essentially the mirror image of weak assimilatory [+ATR] dominance discussed above. That is, certain affixes that harmonize for [ATR] in some contexts are consistently [+ATR] in non-harmonizing contexts. Such patterns are analyzable in some frameworks as manifestations of [-ATR] spreading (see Casali 2003: 313-316 for discussion), and it is striking that whereas weak assimilatory [+ATR] dominance is highly characteristic of /2IU/ systems, weak assimilatory [-ATR] dominance is highly typical of /1IU/ systems.

An additional form of evidence, not discussed in Casali (2003), that [+ATR] is not characteristically dominant in /1IU/ systems, as it is in /2IU/ systems, comes from co-occurrence patterns involving mid [-ATR] and high [+ATR] vowels. Many, and possibly most, /1IU/ languages permit at least some (and sometimes all) logically possible combinations of mid [-ATR] vowels [ɛ], [ɔ] with high [+ATR] vowels [i], [u] in root-internal VC_0V sequences. This is the case quite generally in Bantu C languages (Leitch 1996), all of which permit some sequences in which mid retracted vowels precede high advanced vowels, and many of which permit sequences involving the opposite order as well. Other /1IU/ languages which permit mid [-ATR] and high [+ATR] to occur fairly liberally include Anufo (Adjekum et. al. 1993), DuRop (Kastelein 1994), Jowulu (Djilla et. al. 2004), Komo (Thomas 1992), Mbodomo (G. Boyd 1997), Ngbaka (Archangeli & Pulleyblank 1994), Ogori (Chumbow 1982), Selee (Tate & Harflett 1999), Jenaama (Lauschitzky, in preparation), Turka (Suggett 2005), Yoruba (Archangeli & Pulleyblank 1989) and Wolof (Pulleyblank 1996). Although no systematic survey of this possibility in /1IU/ (or other) languages has yet been carried out as far as I am aware, it seems quite likely that such co-occurrence patterns are highly typical of /1IU/ languages. At least, it is quite easy to find /1IU/ languages in which such co-occurrence is permitted, and much harder to find /1IU/ languages where [ɛ], [ɔ] cannot co-occur with [i], [u]. (I am currently aware of only one such language, Ikoma, describe in Higgins 2011.) In the vast majority of /2IU/ harmony languages, on the other hand, root-internal co-occurrence of mid [-ATR] and high [+ATR] values in adjacent syllables is generally disallowed.[11]

[10] For detailed discussion and examples of robust cases of [-ATR]-preserving coalescence in two particular /1IU/ languages, Anufo (Adjekum et. al. 1993) and Owon Afa (Awobuluyi 1972) see Casali (1996/1998) and Causley (1999).

[11] In seven-vowel /i ɪ ɛ a ɔ ʊ u/ /2IU/ systems, in which mid [+ATR] vowels /e/, /o/ do not occur as phonemes, the mid [-ATR] vowels [ɛ], [ɔ] sometimes do co-occur with [i], [u] in one or both orders. Such an ability to co-occur with both harmony sets is, of course, not unexpected in the case of harmonically unpaired vowels. Even in /i ɪ ɛ a ɔ ʊ u/ systems, however, co-occurrence of [ɛ], [ɔ] with [i], [u] is not always permitted. A good number of /2IU/ languages which have seven-vowel /i ɪ ɛ a ɔ ʊ u/ languages (or the same basic system plus an additional central vowel), including Burun (Andersen 1999), Daza (Kevin Walters, p.c., Connie Kutsch Lojenga, p.c.), Kinande (Archangeli & Pulleyblank 2002, Mutaka 1995), Kirangi (Stegen 2000), Lese-Mvuba (Connie Kutsch Lojenga, p.c.), Lugbara (Andersen 1986), Lugungu (Kutsch Lojenga 1999), Mayogo (McCord 1989) and Talinga-Bwisi (Paluku 1998, Tabb 2001), disallow mid [-ATR] vowels phonetically either preceding or following high [+ATR] vowels, due to a process that realizes /ɛ/, /ɔ/ as [+ATR] allophones [e], [o] in the relevant context.

There is a very natural analysis of root-internal patterns in which co-occurrence of [i], [u] with [ɛ], [ɔ] is permitted in /1IU/ systems. What must be explained, of course, is why disharmonic inputs involving mid and high vowels are not resolved by assimilation, given that sequences involving only mid vowels generally must be harmonic in /1IU/ systems (i.e., [+ATR] [e], [o] do not co-occur root-internally with [-ATR] [ɛ], [ɔ]). It is quite natural to attribute the permissibility of disharmonic sequences combining high [+ATR] and mid [-ATR] vowels to the general absence in /1IU/ systems of high [-ATR] vowels [ɪ], [ʊ]. If the vowels /i/, /u/ were to undergo assimilation to neighboring mid [-ATR] vowels [ɛ], [ɔ], this would result in high [-ATR] vowels [ɪ], [ʊ], which are disallowed quite generally in such languages. Thus, by blocking spread of [-ATR] to /i/, /u/, a general and independently required constraint against the combination [high,-ATR], is responsible for the fact that the vowels /i/, /u/ are neutral and are permitted to occur disharmonically with [-ATR] vowels. With some variation, essentially this analysis attributing the co-occurrence of mid [-ATR] and high [+ATR] vowels in a /1IU/ system(s) to a blocking effect of a markedness constraint against [ɪ], [ʊ] is found in a number of OT studies, including Leitch (1996), Orie (2003) and Pulleyblank (1996).

As natural as this explanation is, however, it is not actually complete in the form presented above. While the impermissibility of high [-ATR] vowels [ɪ], [ʊ] suffices to explain why /i/, /u/ do not assimilate to the [-ATR] value of /ɛ/, /ɔ/, it has nothing to say about a second possibility by which a disharmonic input such as /ɛCu/, /iCɔ/, etc. might be rendered harmonic: spreading of *[+ATR]* from /i/ or /u/ to /ɛ/ or /ɔ/, resulting in a fully harmonic output with only [+ATR] vowels (e.g, eCu, iCo, etc.). The failure of such spreading to occur cannot be easily attributed to the markedness of the output sequences that would result, since such sequences combining high and mid [+ATR] vowels are entirely permissible and quite well-attested in nearly all /1IU/ systems. (Moreover, we shall see evidence below that the mid [+ATR] [e], [o] vowels characteristically pattern as *unmarked* sounds in /1IU/ systems.) As long as [+ATR] spreading is possible in general, it is not obvious why disharmonic inputs combining /i/, /u/ with /ɛ/, /ɔ/ should not be rectified by such spreading. If, however, [+ATR] spreading is not in fact freely possible in /1IU/ systems, in keeping with the fact that [-ATR] is the dominant value, then the pattern is entirely explicable. [-ATR] does not spread due to a well-motivated prohibition against high [-ATR] vowels, while [+ATR], as the recessive value, simply does not spread at all. In /2IU/ systems, on the other hand, [+ATR] spreading very clearly *is* widely permitted, and thus the fact that the same root-internal co-occurrence of [i], [u] with [ɛ], [ɔ] is generally not possible in such systems is unsurprising. That is, [+ATR] spreading would suffice to eliminate disharmonic sequences involving high [+ATR] and mid [-ATR] vowels in such systems.

Arguments that take co-occurrence of high [+ATR] and mid [-ATR] vowels to be an indicator that [-ATR], not [+ATR], is the spreading value can be found in various studies of /1IU/ tongue root harmony languages (e.g., Archangeli & Pulleyblank's 1989 analysis of Yoruba). As far as I am aware, however, the claim presented here that the possibility of such co-occurrence represents a systematic difference in the patterning of /1IU/ and /2IU/ inventories has not been made previously in the literature.

In all, there is quite strong evidence that the characteristic dominance patterns in /1IU/ and /2IU/ systems are not the same. Whereas the latter show an overwhelming tendency for [+ATR] to function as the dominant value, [-ATR] is far more typically dominant in the former.

Clear counterexamples to this generalization are few and far between. We have noted the existence of just two counterexamples to the generalization that [-ATR] is the dominant value in /1IU/ systems, in the form of the languages Legbo (Casali 2003, based on unpublished data from Larry Hyman) and Ikoma (Higgins 2011), which show indicators of [+ATR] dominance (and no entirely unambiguous evidence of [-ATR] dominance). In the case of /2IU/ systems, it is not clear that there are *any* clear cases of /2IU/ languages in which [-ATR] is regularly and productively the dominant value. While a single such case is reported in Casali (2003), in the form of the Bantu language Kimatuumbi (Odden 1996), questions can be raised (see the Appendix for some discussion) about whether the seven contrastive vowels of Kimatuumbi are /i ɪ ɛ a ɔ ʊ u/ (in which case it is a /2IU/ system, as assumed in Odden 1996 and Casali 2003) or /i e ɛ a ɔ o u/ (in which case it is a /1IU/ system). I am not aware of any other /2IU/ language in which there is clear and compelling evidence that [-ATR] is regularly dominant.[12]

Given what remains unknown about tongue root harmony languages, it is not possible to safely conclude that /2IU/ systems in which [-ATR] is systematically dominant are currently unattested, let alone impossible. And, as we have noted, apparent counterexamples already exist to the corresponding generalization that [-ATR], rather than [+ATR], is dominant in /1IU/ systems. What seems clear enough, however, is that the two system types differ quite strikingly in their characteristic dominance patterns. There is a strong skewing that must ultimately be explained.

For our immediate purposes, the finding that /1IU/ and /2IU/ systems show different dominance asymmetries, with [-ATR] characteristically dominant in the former and [+ATR] in the latter, is of potential significance for two reasons. First, the existence of such a difference at least suggests that the formulation in (3) is incomplete. While it is true enough that either [+ATR] or [-ATR] can be dominant in a language, the simple formulation in (3a) fails to reveal a more complex picture, in which the choice of dominant value is heavily skewed based on inventory structure. Second, the difference is itself a very surprising one, which is not clearly expected by most theoretical treatments of markedness and/or dominance and has never been adequately explained. (See Casali 2008 for discussion.) This at least raises the possibility that additional surprises might

[12] A possible case of a /2IU/ language(s) with regular dominance of [-ATR] that is sometimes cited (e.g., Allen et. al. 2013: 198, Pulleyblank 1997) involves the Tungusic language family, whose harmony systems have been analyzed by Li (1996) as involving spreading of [-ATR] / [RTR]. However, much of the motivation for this choice is based on phonetic observations leading to a conclusion that tongue root retraction is the active gesture that forms the basis of the contrast between the two harmony sets in Tungusic. That is, [-ATR] vowels are realized with significant tongue root retraction, while [+ATR] vowels involve a relatively neutral vocal tract configuration. While Li's line of reasoning is both suggestive and impressively detailed in its treatment of relevant phonetic observations, however, there does not appear to be any unequivocal evidence to show that [-ATR], rather than [+ATR] is phonologically dominant in Tungusic.

exist as well, and suggests that seemingly straightforward and reasonable extrapolation from clear observations about well attested patterns in one inventory to assumptions about what is possible in other inventories may not always turn out to be as safe as might have been initially supposed. Rather, even seemingly fairly safe conclusions about tongue root markedness need to be carefully verified through detailed investigation of actual typological patterns. We shall see, in fact, that certain further surprising conclusions turn out to be warranted. These are discussed below.

3. Markedness reversals

As we have noted, there is ample evidence both that high [-ATR] vowels and mid and low [+ATR] vowels are treated as highly marked sounds in some languages. This is clearly reflected in the frequent use of markedness constraints against such vowels in formal OT (and earlier rule-based) analyses of individual tongue root harmony languages (e.g., Akinlabi 1997, Archangeli & Pulleyblank 2002, Bakovic & Wilson 2000, Cahill 2007, Calabrese 1995, Casali 2003, Leitch 1996, Orie 2003, Pulleyblank 1996, Pulleyblank & Turkel 1996, Wayment 2009). While the degree to which any of these three classes might actually behave as marked in a given language is, under standard assumptions, a consequence of how highly the relevant markedness constraint is ranked, most existing frameworks in which tongue root markedness relations are expressed by means of constraints *[+high,-ATR], *[+low,+ATR] and *[-high, -low,+ATR] or their equivalents provide no straightforward mechanisms under which the expected markedness relations in high, mid or low vowels might be reversed.

These considerations have implications for the kinds of positional neutralization (Alderete 2003, Beckman 1997, 1998/1999, Steriade 1993) patterns we expect to find. Given the assumptions about marked vowel classes sketched above, we expect, for example, to find patterns in which high [-ATR] vowels [ɪ], [ʊ] have a restricted distribution relative to [+ATR] [i], [u]. In one possible approach (Beckman 1997, 1998/1999), which relies on positional faithfulness constraints, ranking a markedness constraint against some marked combination of height and tongue root features above general faithfulness constraints protecting those features but below a positional faithfulness constraint(s) protecting the relevant features in some more specific (and, under widespread assumptions, prominent) context, derives a pattern in which the marked combination is permitted only in the latter. As a concrete specific example, a ranking IDENT-ROOT(ATR) >> *[+high,-ATR] >> IDENT(ATR) potentially derives a pattern in which the vowels [ɪ], [ʊ] are permitted in roots but not affixes, as shown below. (In a more complete analysis, constraints protecting the feature [high] must also be highly-ranked, though this has not been shown in (4).)

(4) a. Underlying high [-ATR] vowel preserved in root

	/ɪ/ (in root)	IDENT-ROOT(ATR)	*[+high,-ATR]	IDENT(ATR)
☞	ɪ		*	
	i	*!		*

b. Underlying high [-ATR] vowel lost in affix

	/ɪ/ (in affix)	IDENT-ROOT(ATR)	*[+high,-ATR]	IDENT(ATR)
	ɪ		*!	
☞	i			*

While alternative technical approaches (e.g., an approach based on positional markedness, as in Walker 2001) to the problem of positional neutralization exist, the same general expectations arise in other OT frameworks that assume the view in (3) as well. What we do not expect to find, in straightforward implementations of this view, is positional neutralization to any of the putatively marked classes [ɪ] & [ʊ] (high, [-ATR]), [e] & [o] (mid, [+ATR]) or [ạ] (low, [+ATR]). The general reason is clear: there is, under the view in (3), no basis for positing markedness constraints that favor any of these classes over its [-αATR] counterpart, and hence no ranking that could give rise to such a pattern.

A major empirical claim of this paper is that, perhaps surprisingly, we do in fact encounter such neutralization patterns, at least in the case of high and mid vowels. In fact, a very well-attested positional neutralization pattern, found in many /2IU/ languages, especially in West Africa, is one in which only [-ATR] vowels are found in certain classes of function words or affixal contexts. This is potentially significant inasmuch as function words and affixes are both non-prominent contexts which are prone to support fewer phonological contrasts (Alderete 2003, Beckman 1997, 1998/1999, Casali 1997, Steriade 1993). And in cases where neutralization of contrast occurs in such a context, the general expectation, once again, is that the classes of sounds permitted in such positions will be sounds which are unmarked relative to their excluded counterparts.

A function word class in which positional neutralization to [-ATR] vowels is particularly well attested in /2IU/ ATR harmony languages is pronouns. Typically, pronouns in such languages come in two forms: bound subject and object forms, which are affixed to verbs stems, with which they usually harmonize for tongue root features, and free forms that occur in other contexts (in which harmony is generally inapplicable), for example as a one-word answer to a question. In quite a few such languages independent forms of pronouns contain only [-ATR] vowels. This is the case in Abouré (Burmeister 1982), Abron (Ravenhill 1982), Ahanta (Burmeister 1988), Akan (Casali 2012, Dolphyne 1988), Anyi (Burmeister 1988), Avatime (Schuh 1995), Bete (Werle & Gbalehi 1976), Chumburung (Hansford 1988, Snider 1990), Dagara (Somé 1982), Diola-Fogny (Sapir 1965), Ebira (Adive 1989), Efutu (Obeng 2008), Ega (Bole-Richard 1981: 47-48, 1982:392-393), Gichode (Snider 1989a), Kabiye (Delord 1976), Konni (Cahill 2007), Nawuri (author's own data), Ngiti (Kutsch Lojenga 1994b: 200, 209), Tépo (Dawson 1975), and Vata (Kaye 1981, 1982).

It must also be noted that in all of these cases except one, the set of [-ATR] vowels found in pronouns includes the high [-ATR] vowels [ɪ], [ʊ]. (Avatime, whose pronouns contain

only the non-high vowels [ɛ], [a], [ɔ], is the lone exception.) This fact is relevant in view of the expectation of many current theories (and of the view in (3)) that high, but not non-high, [-ATR] vowels should pattern as marked sounds. In fact, some /2IU/ languages permit only the high vowels [ɪ], [ʊ] and the low vowel [a] in independent pronouns and/or other contexts. This is the case in Chumburung (Hansford 1988, Snider 1990), for example, whose independent pronouns are shown below.

(5) Chumburung independent pronouns

Person & number	Independent pronoun
1st singular	[mɔ́]
2nd singular	[fɔ́]
3rd singular	[mɔ̀]
1st plural	[àní]
2nd plural	[mɔ̀ní]
3rd plural	[bámɔ́]

The Chumburung pattern is readily intelligible as a combination of two independent markedness avoidance effects: avoidance of [+ATR] vowels (which excludes [i], [u], [e], [o] and [ạ]) and avoidance of mid vowels (which excludes [ɛ], [ɔ], as well as the already-excluded [e], [o]). That mid vowels can be systematically avoided in certain contexts is well known from other work on positional neutralization, most notably Beckman (1997). Other nine-vowel languages which permit only the three vowels [a], [ɪ], [ʊ] occur in some class of function words include Konni (Cahill 2007: 13-14), Nawuri (author's own data, Snider 1989a) and Ngiti (Kutsch Lojenga 1994b).[13]

Although pronouns are a particularly common class of grammatical word in which tongue root contrasts are frequently neutralized to [-ATR] in /2IU/ languages, some languages show such neutralization in other function word classes as well. Such cases include Diola-Fogny (Sapir 1965), in which pronouns (1965: 70), prepositions (1965: 88) and sentence connectives (1965: 108-109) have only [-ATR] vowels, Ega (Bole-Richard 1981: 47-48), in which independent pronouns and conjunctions ("morphèmes relateurs") are invariably [-ATR], Kabiye (Delord 1976), in which personal pronouns, noun class markers in their non-harmonizing, pronominal, (1976: 337) uses, postpositions (1976: 370), nominalized possessive adjectives (1976: 348-349), and demonstrative forms constructed from noun class markers (1976: 355) all have only [-ATR] vowels, Nawuri (author's own data), which permits only [-ATR] vowels in independent pronouns and also demonstratives and determiners, Ngiti (Kutsch Lojenga 1994b), in which several classes of pronouns (1994b: 89, 200, 209) and demonstratives (1994b: 372, 375) as well as "postpositions functioning in the alienable possessive construction" (1994b: 154-157) have only [-ATR] vowels, and Talinga (Paluku 1998: 202-204), in which several types of demonstrative pronouns have only [-ATR] vowels. Finally, Bete (Werle & Gbalehi 1976) and Ebira (Adive 1989) permit only [-ATR] vowels in all function words.

[13] The Nawuri case is similar to the one in Chumburung (to which it is closely related) exemplified in (5): independent pronouns contain only high and low [-ATR] vowels.

Other /2IU/ languages systematically neutralize tongue root contrasts to [-ATR] in some affixal contexts. In Akposso (Anderson 1999) and Emalhe (Laniran 1985), for example, leftward spreading of [+ATR] from a verb root affects only the prefix closest to the verb; prefixes further to the left (including those with high vowels) are consistently [-ATR]. In Kalabari Ijo (Akinlabi 1997), prefixal clitics harmonize with verb roots, while suffixal clitics (including those with high vowels) are consistently [-ATR].[14]

It is also noteworthy that [-ATR] vowels occur with far greater frequency than [+ATR] vowels in many of the same languages (e.g., Chumburung, Diola-Fogny, Konni), in both lexical entries and running text, sometimes outnumbering them by a factor of three or four to one (Casali 2002a and references therein).[15] While the consistent reliability of frequency as a diagnostic of markedness is sometimes questioned (de Lacy 2006, Hume 2011 and references therein), it is certainly true, at least as a general tendency, that marked sounds occur much less commonly than unmarked ones, even if exceptions exist.[16]

In all, there is substantial evidence that some tongue root harmony languages treat the entire [+ATR] set [i], [u], [e], [o], [ạ] as marked relative to the [-ATR] set [ɪ], [ʊ], [ɛ], [ɔ], [a]. While the finding that [e], [o], [ạ] should be marked relative to [ɛ], [ɔ], [a] is consistent with the view in (3), the finding that high vowels should also be positionally neutralized to [-ATR] in some languages is not.

There is also good evidence that a similar reversal of the markedness expectations in (3) is possible in mid vowels, i.e., there are languages in which mid [-ATR] vowels [ɛ], [ɔ] have a systematically restricted distribution relative to their [+ATR] counterparts. However, such patterns turn out to be characteristic of /1IU/, rather than /2IU/, systems. Perhaps the most striking cases of such a pattern are found in the seven-vowel /i e ɛ a ɔ o u/ languages of Bantu Zone C described in Leitch (1996). Positional neutralization of the tongue root contrast in mid vowels to [e], [o] (instead of [ɛ], [ɔ], which would have been expected under the view in (3)) in certain contexts is a pervasive phenomena in Bantu C harmony systems. All known Bantu C languages have some

[14] It might seem surprising that (non-assimilatory) positional neutralization in affixes is not more common than it is, given that the root-affix distinction is one that is, in general, very commonly associated with positional neutralization. That such cases are relatively infrequent can be attributed at least in part to the fact that the tongue root value of affixes is so consistently determined by vowel harmony in most /2IU/ languages. That is, harmony considerations typically override whatever purely positional effects might otherwise occur. (See Casali 2003 for some discussion.)

[15] It is also interesting to note that [ɪ], [ʊ] often occur with particularly high frequency (Casali 2002a) in such languages.

[16] It is also noteworthy that the high [-ATR] vowel [ɪ] is employed as an epenthetic vowel to break up impermissible consonant sequences in a number of /2IU/ systems (Casali 2002a: 33 and references therein). In fairness, in most languages which show such epenthesis, tongue root harmony also plays a role, so that [i] is used in words with [+ATR] vowels, and [ɪ] in words with [-ATR] vowels. (In some such languages, rounding harmony also plays a role, so that epenthetic [ʊ] and [u] are possible as well.) However, there are at least two /2IU/ languages, Sesotho (Rose & Demuth 2006) and Rangi (Oliver Stegen, personal communication) where epenthetic [ɪ] is employed to the exclusion of [i] even in words with [+ATR] vowels. I am not aware of any /2IU/ language that regularly uses [i] as the epenthetic vowel to the exclusion of [ɪ].

degree of tongue root harmony in mid vowels, with the extent of harmony varying in interesting and complex ways across the languages of the zone. In many Bantu C languages, however, there are certain contexts involving prefixes and/or suffixes in which mid vowel tongue root harmony fails to apply. Quite consistently in these languages, affixal mid vowels in non-harmonizing contexts show up as [e], [o] and not [ɛ], [ɔ] (Leitch 1996). This generalization might reasonably be taken to indicate that [+ATR] is functioning as the unmarked value in mid vowels in Bantu C languages.

In Bolia (Leitch 1996:41; the original source is Mamet 1960), for example, both nominal and verbal prefixes consistently fail to undergo [ATR] alternations. Mid vowels in prefixes are invariably [e] or [o]. Some examples are shown in (6) (nouns) and (7) (verbs) below. (Acute accent indicates high tone, the wedge represents a rising tone, low tone is unmarked. Roots are italicized.)

(6)	a. bo-*nsɛ́lɛ́*	'lezard gris commun'
	b. bo-*nsélé*	'nudité'
	c. bo-*tómbo*	'chasse-palanquin du chef en form de pirogue'
	d. bo-*tɔ́ndɔ*	'toit'
(7)	a. kŏ-*kel*-a	'fais donc' (imperative exhortative)
	b. kŏ-*kɛnd*-ɛ	'marche donc' (imperative exhortative)
	c. lo-yo-*kɔh*-e	'venez prendre' (imperative motional)
	d. bá-pó-*bɔng*-é	'ils ne conviennent pas' (indicative present negative)

Avoidance of mid retracted vowels in affixes occurs in Ikoma (Higgins 2011) as well. In Mono (Olson 2005), a Ubangi language with a /ieaəiɔou/ system (treatable as a /1IU/ system due to the three-way contrast in back vowels, despite the absence of /ɛ/), a fairly extensive set of pronouns (Olson 2005: 85) contains only the three vowels [a], [e] and [ə]. Finally, there are /1IU/ Bantu languages outside Zone C, including Mokpwe (Henson n.d.), and Komo (Thomas 1992), in which mid affix vowels are [e], [o] except when they are attached to roots containing mid retracted vowels [ɛ], [ɔ], in which case they undergo [-ATR] spreading, surfacing as [ɛ], [ɔ]. Crucially, such affixes surface (as in Bantu C) in their [e], [o] allomorphs in cases where the root vowel /a/. Such a pattern is potentially analyzable as positional neutralization to [+ATR] quality in mid affix vowels that is overridden by mid vowel harmony requirements in cases where a root contains [ɛ] or [ɔ].

The existence of markedness reversals involving high and mid vowels is very surprising, based on any kind of well understood and generally accepted phonological principles. Very clearly, high [-ATR] vowels are strongly avoided, to the point of total absence in some tongue root harmony languages (i.e., most /1IU/ systems), which makes it very natural to assume that they should be consistently marked relative to their [+ATR] counterparts. The finding that the opposite relation should ever hold in a language is quite unexpected under widespread assumptions. Similarly, the finding that [e], [o] are clearly marked relative to [ɛ], [ɔ] in many tongue root harmony languages (include those languages that positionally neutralize all tongue root contrasts to [-ATR], as well as seven-vowel systems of the type in (2d) above, in which [e], [o] are non-contrastive)

should very reasonably lead us to expect to find that such a relation holds consistently across tongue root harmony languages.

The expectation that high [-ATR] and mid and low [+ATR] vowels should consistently pattern as marked sound in tongue root harmony languages is also a very natural one in light of certain functional factors. It is very widely assumed that the markedness of particular combinations of tongue root and height features is grounded in their phonetic substance—something suboptimal about their articulatory and/or perceptual properties. Such a view is perhaps most clearly expressed in Archangeli & Pulleyblank (1994), but has been adopted in much other work as well (e.g., Archangeli & Pulleyblank 2002, Backley 1997, Calabrese 1995, 2005, Leitch 1996, Vaux 1996, Wayment 2009:45-46). More specifically, it is assumed that tongue root retraction is disfavored in high vowels, due to natural tendency for raising the tongue body in making a high vowel to pull the tongue root forward, while tongue root advancement is disfavored in mid and (especially) low vowels, due to a corresponding natural articulatory tendency for a lowered tongue body position to favor tongue root retraction. (Archangeli & Pulleyblank 1994:172-179, Jacobson 1980, Ladefoged et. al. 1972, Perkell 1971, Stewart 1970) Some work (e.g., Archangeli & Pulleyblank 1994) also suggests a perceptual basis for the same relations. [+ATR] is favored in high vowels because tongue root advancement and tongue body raising have mutually enhancing acoustic effects, i.e., a lowering of first formant frequency, while [-ATR] is favored in non-high vowels due to a similar, but opposite, acoustic effect (raising of F_1).

4. Limits to variation: connecting markedness, dominance and inventory structure

Taken in isolation, the finding that some languages reverse the markedness relations (i.e., those in (3b)) that are generally assumed to hold in tongue root harmony systems in high or mid vowels might almost tempt one to conclude that there simply are no interesting cross-linguistic restrictions on tongue root markedness relations in non-low vowels. For high vowels, we find languages (e.g., Yoruba, Ewe) in which high [-ATR] vowels [ɪ], [ʊ] are clearly marked relative to their [+ATR] counterparts [i], [u], and we find languages (e.g., Akan, Chumburung) in which the opposite relation holds. For mid vowels, we find languages (e.g., Kinande, Zande) in which mid [+ATR] vowels [e], [o] are clearly marked relative to their [-ATR] counterparts [ɛ], [ɔ] and we find languages (e.g., Bolia, Komo) in which the reverse relation holds. In the case of dominance relations as well, we find that both logically possible alternatives (dominance of [+ATR], dominance of [-ATR]) are amply attested. Taken by themselves, and ignoring the possibility of any non-trivial correlations involving dominance with markedness or of either of these with inventory structure, the variation we find with respect with respect to these atomistic choices could easily suggest that virtually anything goes.

When we take a closer look, however, the number of distinct language types we find turns out to be surprisingly limited, at least when it comes to patterns that are robustly attested. The limited variation can be attributed to some strong non-trivial correlations that hold among different factors. That is, we find some strongly recurrent clustering of properties that is not clearly anticipated by the view in (3).

To see this, consider what we might expect to find if inventory structure, markedness patterns in both high and mid vowels, and the dominant [ATR] value in a language all varied independently. Combining two attested inventory types (/1IU/ and /2IU/), two attested dominance possibilities ([+ATR] dominance and [-ATR] dominance), two attested possibilities for neutralization of high vowel contrasts (to [+ATR], as in Yoruba, and to [-ATR], as in Chumburung), and two attested possibilities for neutralization of mid vowel contrasts (to [+ATR], as in Bolia, and to [-ATR], as in Kinande) leads to a total of sixteen expected possibilities, summarized in (8). (Numbers in the leftmost column have no absolute significance and are simply for the purpose of referring to patterns in the text. The significance of the shading is discussed further below.)

(8)	System	Dominant value	Marked [ATR] value in high vowels	Marked [ATR] value in mid vowels
1	/2IU/	[+ATR]	[+ATR]	[+ATR]
2	/2IU/	[+ATR]	[+ATR]	[-ATR]
3	/2IU/	[+ATR]	[-ATR]	[+ATR]
4	/2IU/	[+ATR]	[-ATR]	[-ATR]
5	/2IU/	[-ATR]	[+ATR]	[+ATR]
6	/2IU/	[-ATR]	[+ATR]	[-ATR]
7	/2IU	[-ATR]	[-ATR]	[+ATR]
8	/2IU/	[-ATR]	[-ATR]	[-ATR]
9	/1IU/	[+ATR]	[+ATR]	[+ATR]
10	/1IU/	[+ATR]	[+ATR]	[-ATR]
11	/1IU/	[+ATR]	[-ATR]	[+ATR]
12	/1IU/	[+ATR]	[-ATR]	[-ATR]
13	/1IU/	[-ATR]	[+ATR]	[+ATR]
14	/1IU/	[-ATR]	[+ATR]	[-ATR]
15	/1IU/	[-ATR]	[-ATR]	[+ATR]
16	/1IU/	[-ATR]	[-ATR]	[-ATR]

The variation that we actually find is much more limited, and is interesting for two other reasons as well. First, it turns out that the most strongly attested types are not those that would be expected under the view in (3). Second, we find evidence of a strong inventory effect. The /1IU/ and /2IU/ types that are most clearly attested show quite different, and indeed virtually opposite, markedness and dominance relations. Because the two system types pattern very differently, we will discuss their behavior separately.

As far as can be determined from available evidence at present, /2IU/ systems are remarkably consistent with respect to all three of the markedness and dominance alternatives in the three rightmost columns in (8). As noted in Section 2.2 above, [+ATR] dominance is highly typical of /2IU/ systems; [-ATR] dominance is not. What is less well known is that marked distributional patterning of [+ATR] vowels is also highly typical of /2IU/ systems. All of the cases of positional neutralization to [-ATR] vowels described in Section 3 above occur in /2IU/ systems. Moreover, while positional neutralization of tongue root contrasts to [-ATR] vowels is very robustly attested in /2IU/ languages,

positional neutralization to [+ATR], at any tongue height, is not. Compelling cases (which are highly expected under the view in (3)) of positional neutralization to the set [i], [u], [ɛ], [ɔ], [a] are not very strongly in evidence. Even finding clear cases of neutralization of tongue root contrasts to [+ATR] in high vowels alone in /2IU/ systems is not easy. I am aware of only a small number of potential cases and few, if any, are fully compelling.

Because this is an important issue, it is appropriate to discuss possible cases of positional neutralization of high vowel contrasts to [i], [u] in /2IU/ systems in reasonable detail. However, because this will require significant space and might distract from the big picture if presented here, I defer such discussion to the Appendix to this paper. While there is certainly some room for debate over at least some of the cases discussed there, the major tendency seems clear enough, in my opinion. While positional neutralization of high (as well as non-high) tongue root contrasts to [-ATR] is highly characteristic of /2IU/ systems, the much more expected outcome (under the view in (3)) of positional neutralization of such contrasts to [+ATR] is not. There is good evidence that both high and non-high [-ATR] vowels characteristically pattern as unmarked sounds in /2IU/ systems.

What all of this means, if these empirical generalizations are correct, is that only one of the eight possible /2IU/ system types in (8) is robustly attested. With very few if any compelling exceptions, /2IU/ systems consistently conform in their markedness and dominance patterning to the first type, Type 1, which is shaded in (8).

To avoid any misunderstanding, it is important to emphasize here that in making this claim I am not suggesting that all /2IU/ languages show clear overt evidence of both [+ATR] dominance and marked patterning of [+ATR] vowels. There are many /2IU/ languages that do show evidence of both phenomena, including Ahanta (Burmeister 1988, Ntumy 1997a,b), Akan (Casali 2012 and references therein), Bete (Werle & Gbalehi 1976), Chumburung (Hansford 1988, Snider 1990), Dagara (Somé 1982), Diola-Fogny (Sapir 1965), Ebira (Adive 1989, Scholz 1976), Efutu (Obeng 2008), Gichode (Casali 1996/1998, Snider 1989a), Kabiye (Delord 1976, Lébikaza 1998, Pere 2001), Konni (Cahill 2007), Nawuri (Casali 2002a, author's own data), Ngiti (Kutsch Lojenga 1994b: 200, 209), Talinga-Bwisi (Paluku 1998, Tabb 2001) and Vata (Kaye 1981, 1982). But there are also /2IU/ languages that lack clear evidence of one or both patterns, at least as far as can be determined from available descriptive sources.[17] What is significant, however, is that while both marked and dominant patterning of [+ATR] vowels are quite well attested in /2IU/ languages, neither /2IU/ languages in which [-ATR] is regularly dominant nor /2IU/ languages that show clear evidence of marked patterning of (any) [-ATR] vowels are well attested. This means that, with extremely few, if any, clear exceptions, /2IU/ tongue root harmony languages fall into one of two groups: those that clearly instantiate Type 1 by showing overt evidence of both [+ATR] dominance and [+ATR] markedness, and those that are compatible with Type 1 but are also potentially

[17] One such case is Degema (Archangeli & Pulleyblank 2007). It is worth noting, however, that finding /2IU/ languages that show no evidence of either [+ATR] dominance or [+ATR] markedness are not very common.

ambiguous, in that they are consistent with more than one of the /2IU/ types 1-8, because they lack clear evidence to determine the marked [ATR] value in mid and/or high vowels, dominant value, or both. There is thus little or no unambiguous evidence for the existence of any of the /2IU/ types 2-7. While it is impossible to be sure that no clear departures from Type 1 in /2IU/ systems will yet come to light, the generalization that [+ATR] dominance and markedness of (both high and non-high) [+ATR] vowels are highly characteristic of /2IU/ systems, while various other logically expected possibilities are not, is a very robust one.

When we look at the behavior of /1IU/ systems, we find that quite different generalizations apply. As discussed above, dominance of [+ATR] vowels, which is so highly typical of /2IU/ systems, is not very strongly attested in /1IU/ languages, which far more frequently treat [-ATR] as the dominant value. While a very few apparent exceptions (Legbo and Ikoma) exist, the dominance relations that characterize /1IU/ and /2IU/ systems are, to a very strong first approximation, exactly opposite.

The same, quite clearly, is true of markedness relations in high vowels. While [+ATR] [i], [u] are frequently avoided relative to (i.e., have more restricted distributions than) their [-ATR] counterparts [ɪ], [ʊ] in /2IU/ systems, this is manifestly not the case in /1IU/ languages, the vast majority of which contain *only [+ATR]* high vowels, [i], [u]. That is, tongue root contrasts in high vowels are neutralized (not positionally, but absolutely) in such languages to [+ATR].

It might be worth reemphasizing here that (absolute) neutralization of high vowel tongue root contrasts to [+ATR] in /1IU/ systems is not a matter of sheer definition, since a system of the form /ɪ e ɛ a ɔ o ʊ/ (in which the high vowels are [-ATR] [ɪ], [ʊ] rather than [+ATR] [i], [u]), were it to occur, would also be a /1IU/ system. While standard assumptions (in particular, those in (3)) about markedness give us no reason to expect that such systems should occur, the fact that (positional) neutralization of high vowel contrasts to [-ATR] [ɪ], [ʊ] in /2IU/ systems, which is equally unexpected under the same assumptions, *does* turn out to be attested means, perhaps, that the absence of /ɪ e ɛ a ɔ o ʊ/ systems is a less trivial finding than might have been supposed. At any rate, there is no very obvious reason why markedness relations in high vowels should be essentially opposite in /1IU/ and /2IU/ systems, nor do most existing theories predict that this should be the case. Thus, we have a further non-trivial difference that ultimately requires explanation.

Finally, we find reasonably good indications of a difference in markedness relations involving mid vowels as well. We have seen evidence above that positional neutralization of mid vowel tongue root contrasts to [+ATR] is at least clearly attested in /1IU/ languages. The Bantu C pattern and similar cases of such neutralization discussed above are all found in /1IU/ systems. In contrast, positional neutralization of mid vowel contrasts to [-ATR] does not appear to be very robustly attested in /1IU/ systems. (I am not aware of any clear cases at present.) To date, no systematic study of positional neutralization of vowel contrasts in /1IU/ languages exists at present, and it remains perhaps to be seen how typical neutralization patterns of the Bantu C type are.

Nevertheless, we have at least reasonably suggestive evidence of a systematic difference in the markedness patterning of mid vowels in /2IU/ and /1IU/ systems, with [e], [o] functioning as marked in the former and unmarked in the latter. In what follows, I will provisionally assume that unmarked patterning of [e], [o] is indeed characteristic of /1IU/ systems, though it should be kept in mind that this further research on this point is needed.[18]

If these conclusions are accepted, it means that [-ATR] dominance and marked patterning of both high and mid [-ATR] vowels are robustly attested in /1IU/ systems, and that neither [+ATR] dominance nor marked patterning of either high or mid [+ATR] vowels is very strongly attested in the same systems. In effect, we have strong evidence for only one of the eight logically possible /1IU/ types in (8), the shaded Type 16 in which [-ATR] is both dominant and marked in non-low vowels.

It might fairly be conceded here that the case that /1IU/ languages consistently conform to Type 16 is not quite as strong as the case that /2IU/ languages conform to Type 1, for a couple reasons. First, we have already noted the existence of a couple apparent counterexamples, Legbo and Ikoma, to the generalization that [-ATR] is the dominant value in /1IU/ systems.[19] Second, positive evidence of marked patterning of mid [-ATR] vowels is in /1IU/ systems is, at this point, not as abundant as evidence for marked patterning of mid (and indeed all) [+ATR] vowels in /2IU/ systems. Nevertheless, it seems clear enough that [-ATR] dominance and marked patterning of non-low [-ATR] vowels are both strongly attested in /1IU/ systems, while there is little clear corresponding evidence for marked and/or dominant patterning of non-low [+ATR] vowels in the same systems. If so, then it is appropriate to regard Type 16 as the only robustly attested /1IU/ type. It is thus quite clear that, at least as a strong tendency, /1IU/ and /2IU/ systems pattern diverge sharply in their markedness and dominance patterning.

As is the case with other strong typological tendencies, it is entirely appropriate to raise questions about the universality of the generalizations suggested by the picture in (8). Even apart from the existence of a few known exceptions to the general trend, it is impossible to be sure, given the large number of unstudied (or incompletely described) tongue root harmony languages, that no further counterexamples to the generalizations (including, perhaps, cases of /2IU/ systems that clearly instantiate a type other than Type 1) will come to light. However, while such questions are of interest, the more interesting and important problem, in my view, is to understand why we should find anything remotely resembling the picture in (8) to begin with. It is not at all obvious, based on any

[18] An interesting case of a /1IU/ language, Gengbe, in which the vowel [e] is very widely distributed and functions in certain respects as a kind of default vowel is discussed in Abaglo & Archangeli (1989). The arguments presented are to some extent theory-dependent and must probably be seen, from the perspective of more recent theories, as suggestive at best. Nevertheless, the very wide distribution and seemingly default-like behavior of [e] in Gengbe is at least arguably indicative of rather unmarked status, and I am not aware of any /2IU/ language in which a mid advanced vowel [e] (or [o]) exhibits similar behavior.

[19] Legbo has limited evidence of [+ATR] dominance (but none of [-ATR] dominance), and Ikoma has (perhaps somewhat stronger) evidence of [+ATR] dominance, combined with some evidence of marked patterning of [-ATR] mid vowels. If these patterns are taken at face value, Legbo might be an instance of Type 11 or 12, and Ikoma of Type 12.

kind of presently well understood principles, why such differences in the characteristic patterning of /1IU/ and /2IU/ systems should exist at all. Why shouldn't the vowels [ɪ], [ʊ], which are so strongly and clearly avoided in /1IU/ systems, also typically pattern as marked relative to their [+ATR] counterparts in /2IU/ systems? And given that various forms of [+ATR] dominance (e.g., spreading from dominant [+ATR] suffixes, or allophonic [+ATR] variants of /a/) that are very common in /2IU/ systems are also logical (and seemingly natural) possibilities in /1IU/ systems, why should such patterns prove to be in any way uncommon (let alone extremely rare) in /1IU/ languages? Conversely, given that /1IU/ languages in which [-ATR] functions as the regularly dominant value are quite well attested, why shouldn't the same be true of /2IU/ systems? And given that there is no clear evidence that the vowels [ɛ], [ɔ] are ever marked relative to (e.g., have a systematically more restricted distribution than) [e], [o] in /2IU/ systems why should we find that such a state of affairs is well enough attested in /1IU/ systems?

Moreover, the rarity or absence of most of the patterns in (8) takes on greater significance in the light of the wide range of variation that does exist with respect to more narrow alternatives. The sixteen possibilities presented in (8) derive from the logical combination of either a /2IU/ or a /1IU/ system with either [+ATR] or [-ATR] dominance, marked patterning of either [i], [u] or [ɪ], [ʊ] in high vowels, and marked patterning of either [e], [o] or [ɛ], [ɔ] in mid vowels. For each of these four binary alternatives, both of the two individual possibilities are very robustly attested, as noted previously. This fact is quite surprising by itself, as many phonological theories would exclude at least some of these attested possibilities.[20] However, once we accept, as we are forced to, that such variation does exist on the level of each of the atomistic alternatives, it becomes very challenging to understand why do not find that most or all of the logical combinations of these choices in (8) are amply attested. That is, it is not very obvious, at least based on any clear consensus theoretical understanding, why the different individual alternatives should not vary independently, so that various (or even all possible) combinations of inventory type, dominant [ATR] value, and markedness relations in high and mid vowels should all be clearly instantiated.

Finally, the significance of the typological picture in (8), regardless of whether it is exceptionless or just reflective of very strong tendencies, becomes evident when we consider just how sharply it diverges from what many, if not most, existing theoretical approaches to tongue root harmony might lead us to expect. It is not simply that existing theories predict the robust existence of various types (e.g., those in which the high [-ATR] and mid [+ATR] vowels are simultaneously marked, or those which combine regular dominance of [-ATR] with a /2IU/ system) that are not very clearly attested, few existing theories clearly predict the two types, 1 and 16, that are most strongly attested. (If nothing else, few existing theories predict the possibility of neutralization, which is characteristic of Type 1, of high-vowel tongue root contrasts to [-ATR].) And this is understandable; most contemporary work is based on very different assumptions about the actual typology of tongue root harmony systems, i.e., a picture that corresponds quite

[20] The fact that none of the atomistic possibilities is excluded may have much to do with the extreme diversity of views (Section 1 above) that exists concerning tongue root markedness and dominance relations.

closely to the one in (3). Moreover, as noted in Section 1 above, the assumptions in (3) are inherently reasonable ones, involving as they do some simple and natural extrapolations from facts that are quite clearly established. Thus, the finding that the markedness and dominance typology of tongue roots harmony systems conforms much more closely to the picture in (8) (with only Types 1 and 16 strongly attested) than the one in (3) is a very surprising and significant one that ultimately requires explanation.

5. Functional vs. formal bases for tongue root markedness asymmetries

While no full explanation for the typological skewing evident in (8) can be proposed in this paper, it is worth briefly considering, in general terms, some possible lines of explanation that might be pursued. At least three very different approaches exist at present to explaining markedness and dominance asymmetries in phonological systems.

An approach that was widely used in earlier decades, though somewhat less so in recent years, is a formal representational one that equates marked and dominant patterning with active specification of a feature value and models unmarked and recessive pattern via absence of a specified feature. Such an approach was widely pursued in much work in rule-based underspecification or privative feature theories of the 1970's, 1980's and early 1990's, including various analyses of tongue root harmony systems (e.g., Archangeli & Pulleyblank 1989, Cahill 1996, Kiparsky 1985, Ringen 1975, Snider 1989b, Thomas 1992). Crucial use of underspecification has also featured in various OT treatments of harmony systems (e.g., Akinlabi 1997, Cahill 2007, Casali 2003, Causley 1999, Leitch 1996)

The major alternative to such a representational approach to explaining tongue root (or other) markedness asymmetries is a functional one. Segments which are subject to avoidance in languages (i.e., pattern as marked) exhibit such behavior because they are articulatorily and/or perceptually non-optimal. As discussed above, the view of markedness in (3b) has often been supported based on this type of reasoning from assumptions about phonetic difficulty to conclusions about marked patterning.

Functional approaches can be further subdivided into two different types, both of which are widely pursued today. One is a constraint-based approach (e.g., Bakovic 2000, Pulleyblank 1996, Pulleyblank & Turkel 1996, Orie 2003) that models markedness asymmetries using functionally grounded UG markedness constraints and their possible rankings, with no crucial appeal to non-trivial representational assumptions (in particular, crucial use of underspecification). The other major functional approach (e.g., Blevins 2004, 2006, Hale & Reiss 2008) is one that rejects any UG encoding of functional factors and attempts to explain markedness asymmetries by direct appeal to the external functional factors themselves. Markedness and dominance patterns arise in response to phonetic (articulatory and/ perceptual) pressures and pathways by which languages are prone to change diachronically. Robustly attested patterns should be patterns that are favored by such external factors, while rare or unattested patterns should be those that are not. It is significant, however, that such approaches do not assume that external factors are completely deterministic, i.e., suffice to define rigid boundaries between possible and

impossible patterns. Diachronic developments are never fully predictable, and so it is expected that various synchronic patterns which are not the most favored ones on functional grounds alone might come about through unusual (or perhaps even not so unusual) historical circumstances.

With this background in mind, let us consider the problem of making sense of the picture in (8). Perhaps the most striking and obvious challenge this picture presents is the problem of understanding why /1IU/ and /2IU/ systems behave differently. This is not the only challenging aspect of the problem, however, and it is not the one we will focus on initially here. Quite apart from the inventory correlation, the sheer existence of two types of languages that display very different and largely opposite markedness and dominance patterns presents an interesting problem in and of itself. That is, even setting aside the issue of inventory structure, it is quite significant that the two robustly attested cases are precisely the two in which the same [ATR] value appears in the three rightmost columns, i.e., in which the same value serves as the dominant value, the value that is marked in high vowels and the value that is marked in mid vowels. And this value can be either [+ATR] or [-ATR]. This means that either the non-low class [i], [u], [e], [o] or the class [ɪ], [ʊ], [ɛ], [ɔ] can be both marked and dominant. Though the formal symmetry here is obvious, the finding that such agreement should exist among these three "parameters" is anything but trivial.

Such a finding is all the more surprising in view of the fact that neither of these two formally consistent and essentially opposite types is very ideal in terms of well-understood functional factors. Based on standard assumptions about articulatory difficulty, we should have expected the non-low set [i], [u], [ɛ], [ɔ] to be unmarked and the complementary set [ɪ], [ʊ], [e], [o] to be marked, since [+ATR] quality is articulatorily favored in high vowels and [-ATR] quality in non-high vowels. Moreover, this mixed set, which combines high [+ATR] and mid [-ATR] vowels, should also be highly preferred on perceptual grounds to either of the [ATR]-consistent sets [ɪ], [ʊ], [ɛ], [ɔ] and [i], [u], [e], [o], since the four vowels [i], [u] and [ɛ], [ɔ] are acoustically better dispersed (and perceptually more distinct from each other) than is the case with either of the latter. From both an articulatory and a perceptual perspective, positional neutralization to the mixed-[ATR] set [i], [u], [ɛ], [ɔ] ought to be a highly favored pattern.

In other words, the most optimal pattern in terms of well-understood functional factors should be one that is a kind of formal middle ground in which both [+ATR] and [-ATR] markedness play a role, i.e., in which [-ATR] is treated as marked in high vowels and [+ATR] as marked in mid vowels. Types which satisfy these conditions in (8) are 3, 7, 11 and 15. The finding that these functionally preferred but formally heterogeneous types are not very well attested and that languages gravitate instead to either of two formally consistent but functionally suboptimal extremes is not anticipated by approaches that treat markedness asymmetries as fairly direct reflections of substantive phonetic factors, whether these are encoded as UG constraints (as in much current OT work) or assumed to be entirely external to the language faculty (as in work such as Blevins 2004).

For diachronic approaches, there are at least two important challenges. First, we must understand why a particular markedness pattern, positional neutralization to the mixed set [i], [u], [ɛ], [ɔ], that seems so highly preferred on functional grounds is so rarely attested in comparison to two other patterns (positional neutralization to the uniformly [+ATR] set [i], [u], [e], [o] or uniformly [-ATR] set [ɪ], [ʊ], [ɛ], [ɔ]) that seem far less ideal. Second, there is no doubt that each of the three classes of vowels [ɪ] & [ʊ], [e] & [o] and [ạ] (and especially the classes [ɪ] & [ʊ] and [ạ]) that is putatively marked under the view in (3), and which is functionally suboptimal under standard assumptions, is indeed avoided to some extent cross-linguistically and prone to diachronic loss (Casali 1995a, Elugbe 1983, Ford 1973, Painter 1972, Stewart 1970, Williamson 1983). A major assumption of diachronic approaches to markedness is that synchronic patterns largely mirror diachronic ones. That is, the same kinds of patterns that are avoided in existing present-day languages are those that are prone to loss historically. Under the most straightforward application of this generalization to tongue root harmony systems, we should presumably expect to find many present-day tongue root harmony languages in which the diachronically challenged classes consisting of high [-ATR], mid [+ATR] and low [+ATR] vowels are subject to systematic avoidance synchronically as well. That is, we should expect to find many languages in which the diachronically favored vowels [i], [u], [ɛ], [ɔ], [a] occur in some contexts to the exclusion of any of the vowels [ɪ], [ʊ], [e], [o], [ạ] (i.e., languages of types 3, 7, 11 or 15). In other words, we have evidence of a non-trivial mismatch between preferred synchronic patterns and diachronic tendencies.

The same findings present analogous challenges for standard OT approaches that attempt to model markedness asymmetries exclusively in terms of the possible rankings of substantively motivated markedness constraints (i.e., without relying crucially on underspecification or other non-trivial representational assumptions). Within such a framework, markedness constraints against high [-ATR] and mid and low [+ATR] vowels are well motivated both on functional grounds and by the observation that it is precisely these classes of vowels that are sometimes absent in tongue root harmony systems. In fact, it is not easy to see how this latter finding could be accounted for at all without assuming such constraints. If they are adopted, however, a relatively standard OT framework of this type can scarcely avoid predicting positional neutralization patterns that exclude the vowels targeted by these constraints, permitting only the vowels [i], [u], [ɛ], [ɔ], [a] in some context(s). Moreover, in the absence of further assumptions, free combination of the same three substantively motivated and typologically justifiable constraints is not able to generate the much more clearly attested positional neutralization of tongue-root contrasts in non-low vowels to the uniformly [-ATR] set [ɪ], [ʊ], [ɛ], [ɔ] (in /2IU/ systems) or the uniformly [+ATR] set [i], [u], [e], [o] (in /1IU/ systems). Various modifications might be considered in order to expand the range of predicted possibilities, but it is difficult to see how this might be done without freely generating various unattested typological possibilities and/or abandoning fundamental assumptions adopted within such approaches (in particular, the assumption that markedness constraints are grounded in substantive factors.) While it might be premature to conclude that no way around the difficulties is possible, the challenges facing such an approach seem quite severe.

A further aspect of the picture in (8) that is difficult to explain in terms of presently well-understood functional factors is the correlation that exists between assimilatory dominance and markedness, i.e., the generalization that the marked [ATR] value in non-low vowels is also the dominant one in both of the two well-attested types. Given that dominance of both [+ATR] and [-ATR] and marked patterning of both [+ATR] and [-ATR] non-low vowels are all well attested, why do we not find the two varying independently? It is not immediately obvious, in purely functional terms, what might exclude a language in which [-ATR] is dominant while [+ATR] vowels are distributionally restricted, or in which the reverse is true. As argued persuasively by Causley (1999), standard OT approaches that reject any representational basis for markedness do not easily predict a consistent positive correlation between the marked and dominant harmony feature in a language. Nor is it very obvious how such a correlation might be adequately accounted for in theories that attribute markedness generalizations to external functional pressures and diachronic developments.

In making these arguments, I am in no way denying that external functional and diachronic factors have considerable value in general as explanations for many typological generalizations. Indeed, it is quite possible that various recurrent characteristics of tongue root harmony systems may be at least partly explicable in such terms. Nor am I rejecting an explanatory role for either constraint ranking or of markedness constraints, including constraints against the particular combinations [high,-ATR], [mid,+ATR] and [low,+ATR]. It is not easy to see how the synchronic patterns found in tongue root harmony languages could be accounted for without assuming such constraints. A constraint against the combination [high,-ATR] must be assumed for /1IU/ languages like Yoruba, for example, while there is evidence for constraints against non-high [+ATR] vowels in the harmony patterns of many /2IU/ systems, in particular seven-vowel /i ɪ ɛ a ɔ ʊ u/ languages like Kinande (Archangeli & Pulleyblank 2002). My claim is simply that we are dealing, in the present case, with a particular set of typological generalizations that resist explanation in terms of either external functional factors or the rankings of functionally motivated constraints alone.

Setting aside the further challenge of a correlation with inventory type, the essence of the challenge we are facing can be summed up as follows. We are looking at exactly two robustly attested language types which, as far as non-low vowels are concerned, are essentially polar opposites with respect to both markedness and dominance. We also find that a third logically expected markedness possibility that combines individually attested aspects of both patterns (i.e., a pattern that combines unmarked patterning of [+ATR] in high vowels with unmarked patterning of [+ATR] in mid vowels) and is seemingly functionally more optimal than either, is not robustly attested. In addition, we find, within both robustly attested types, a non-trivial correlation between markedness and dominance (such that the same set of non-low vowels is both marked and dominant) which must be explained as well.

Although this state of affairs is difficult to understand in functional terms, it is possible to make reasonable initial sense of such a bimodal picture in terms of familiar representational assumptions. Suppose that [ATR] is a binary feature, and that either

value, but not both, can be employed in a language. (Or, more or less equivalently for our present purposes, suppose that tongue root contrasts are for some reason constrained to be specified in terms of complementary privative features [ATR] and [RTR].) Further imagine a constraint-based framework in which only specified [ATR] values are visible, on the one hand, to markedness constraints that might restrict their distribution and, on the other hand, to faithfulness constraints that would favor their preservation (at the expense of unspecified tongue root quality) in assimilatory contexts. Invisibility to markedness constraints entails, all else equal, that unspecified tongue root quality should be distributionally unrestricted in non-assimilatory contexts, so that vowels which lack the specified [ATR] value should show unmarked patterning. And invisibility to faithfulness constraints on feature preservation (e.g., MAX(+ATR), MAX(-ATR)) should entail that unspecified tongue root quality is not the one preserved where assimilation must occur (e.g., because of undominated harmony constraints). Hence, unmarked tongue root quality is expected to be recessive.

What we naturally expect to find, under these assumptions, conforms very closely with what we actually do find, at least to a good first approximation. The possibility that only [+ATR] might be specified in a language leads us to expect the existence of languages like Chumburung in which non-low [+ATR] vowels are both dominant and marked, while the possibility that only [-ATR] would be specified leads us to expect the existence of languages like Bolia, in which [-ATR] is both marked and dominant in non-low vowels. At least in the absence of further assumptions beyond those sketched above, these two cases exhaust the predicted possibilities for markedness patterning in non-low vowels.

If the typological generalizations argued for above are correct, there is clearly a further correlation to be accounted for as well, involving inventory structure. The case where [+ATR] is marked and dominant is generally found in /2IU/ systems and the case in which [-ATR] is marked and dominant in non-low vowels in /1IU/ systems. If we are to pursue the representational approach sketched above, this naturally calls for the hypothesis that [+ATR] is the specified value employed in the former, while [-ATR] is the value employed in the latter. I will assume this hypothesis in what follows. Of course, the account is not complete unless an explanation can eventually be given for *why* the two systems employ different active values. While no full explanation can be proposed in this paper, we will look briefly at a partial line of explanation in Section 7 below.

6. Low vowel markedness

There is of course a further issue here which must ultimately be faced, which is that the considerations just outlined should seemingly lead us to expect the same markedness relations that hold in high and mid vowels to hold in low vowels as well. In the case of the [+ATR]-dominant /2IU/ systems, i.e., systems that conform to Type 1 in (8), this prediction is unproblematic (and indeed desirable), since low as well as non-low vowels are clearly marked relative to their [-ATR] counterparts. However, in the case of /1IU/ systems, in which [-ATR] is marked and dominant in non-low vowels (i.e., Type 16 in (8)), we might presumably expect, based on these considerations alone, to find [-ATR]

patterning as the marked value and [+ATR] as the unmarked value in low vowels as well. In other words, we should seemingly expect to find that markedness relations involving low (and non-low) vowels in /1IU/ systems are essentially reversed relative to what we observe in /2IU/ systems. Based on familiar expectations (see Section 3 above) about functional factors involving tongue root position in low vowels, this would seem to be a very implausible prediction.

Perhaps surprisingly, however, there is reasonably good evidence that the characteristic patterning of low vowels in /1IU/ systems does not conform exactly to what we observe in /2IU/ systems. Rather, there are indications of some significant differences that are at least potentially suggestive of a systematic difference in markedness relations. Specifically, whereas we clearly find/2IU/ systems in which a low, or at least non-high, central [+ATR] vowel is both plainly attested and behaves like a marked segment with respect to its frequency and distribution, unequivocal cases of /1IU/ systems in which a low or mid central [+ATR] vowel patterns as a marked vowel are surprisingly difficult to find. A major factor of importance here is that, for reasons that are not necessarily well understood, it turns out to be quite difficult to find clear cases of /1IU/ systems with a genuinely low [+ATR] vowel to begin with.

In /2IU/ systems, low [+ATR] vowels arise from two main sources: as allophones of /a/ in [+ATR] contexts (See 2 above), and as underlying contrastive segments in ten-vowel /i ɪ e ɛ a ą ɔ o ʊ u/ systems in languages like Akposso (Anderson 1999) and Degema (Archangeli & Pulleyblank 2007, Fulop et. al. 1998, Kari 2007). Clearly, both of these cases are logically possible in /1IU/ systems as well, and there is no immediately obvious reason why we should not expect to find that they are amply attested in /1IU/ languages.

In actuality, however, such cases are not very clearly in evidence. As noted previously, *allophonic* low [+ATR] vowels are not very clearly attested in /1IU/ systems at all. (No cases of this type are reported in Casali 2003, nor are any such cases known to me at present.) Such a finding is arguably reflective of the broader generalization that spreading of [+ATR] is not characteristic of /1IU/ systems at all. (See Section 2.2 above.) Perhaps more surprisingly, however, fully unambiguous cases of /1IU/ languages with a genuinely low [+ATR] *phonemic* vowel are not very clearly attested either.[21] Because

[21] One possible explanation that might be proposed for the relative rarity of genuinely low and tongue root advanced vowels in /1IU/ systems is a historical one. If it is reasonable to suppose that articulation of the vowel [ą] involves the most problematic combination of gestures of all the vowels found in tongue root harmony systems (Archangeli & Pulleyblank 1994, Calabrese 1995), then it might not be surprising on functional grounds if this vowel should typically lost earlier than the high [-ATR] vowels [ɪ], [ʊ] in the course of diachronic reduction of original ten-vowel /i ɪ e ɛ a ą ɔ o ʊ u/ systems from which present-day seven- and nine-vowel systems are often assumed to originate (see for example Elugbe 1983, Casali 1995a, Stewart 1970). It would thus be unlikely that a /i e ɛ a ą ɔ o u/ would develop diachronically from an original ten-vowel system, since this would reverse the usual scenario under which [ą] is lost before [ɪ], [ʊ].

While this explanation has some plausibility, it is harder to assess whether it is entirely sufficient, given that other plausible diachronic sources for /1IU/ systems with a low advanced vowel can be imagined as well, for example a pathway in which an allophonic [+ATR] variant of /a/ arises through phonologization of coarticulatory tendencies (i.e., we might expect such tendencies to lead to realization of /a/ with a more advanced tongue root position preceding a [+ATR] vowel in the next syllable) in an original seven-vowel

this is a strong claim, and one that may well strike the reader as implausible, it will be worth looking at it in some detail.

Certainly, there are /1IU/ languages which have been analyzed as having a contrastive low [+ATR] vowel. In all likelihood, the best known such case is Wolof. Wolof has a non-high central vowel, symbolized [ə] in most accounts, that functions harmonically as the [+ATR] counterpart of /a/. At least two detailed analyses of the Wolof harmony patterns, Archangeli & Pulleyblank (1994) and Pulleyblank (1996), treat the vowel [ə] as a [+low], [+ATR] vowel. However, while the harmonic patterning of /ə/ makes this analysis an attractive one (since alternations involving [ə] and [a] involve, under this analysis, just a single featural change, to a vowel's [ATR] value), it is not very clear that the eighth vowel [ə] in Wolof is in fact phonetically low rather than mid. The original source on Wolof on which most subsequent analyses have been based, Ka (1987), is more suggestive of a /i e ɛ a ə ɔ o u/ system, where /ə/ is a mid central [+ATR] vowel.

Various other /1IU/ languages also have a non-high central vowel, generally transcribed [ə], that contrasts with [a]. Such systems include Akoose (Hedinger & Hedinger 1977), the Anglo and Tongu dialects of Ewe (Mensah 1977), Attie (Kutsch Lojenga & Hood 1982), Bini (Wescott 1962), Ewondo (Hartell 1993), Kwanja (Blench 1993), Mabaan (Andersen 1999), Mono (Olson 2005), Nizaa (Blench 1993), Omotik (Rottland 1980) and Seme (Marchese 1983). However, in none of these cases is it entirely clear that the relevant vowel is low and not mid, and in many of them there are fairly clear indications that it is *not* phonetically low.

A more promising example is the Kwa language Likpe (Sekpele), spoken in Eastern Ghana. Likpe is generally described (Ameka 2009, Heine 1968, Lomotey 2009, Ring 2003) as having a system of eight contrastive oral vowels /i e ɛ a ə ɔ o u/.[22,23] Formant

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/i e ɛ a ɔ o u/ system, and later achieves contrastive stratus through loss of the original conditioning [+ATR] vowel in some context(s). Questions might also be raised, about how safe it is to assume that the steps involved in the reduction of vowel stems via loss of particular vowels must follow a predictable sequence.

[22] Likpe has phonemic nasal vowels as well. According to Ameka (2009), each of the eight oral vowels has a phonemic nasal counterpart as well.

[23] Although most researchers (Ameka 2009, Ring 2003, Heine 1968, Lomotey 2009) have described Likpe as having eight phonemic oral vowels /i e ɛ a ə ɔ o u/, an article that appears in the same volume as Lomotey's paper, Delalorm (2009), notes some contrastive instances of /ɪ/, /ʊ/ in Likpe as well, and concludes on this basis that the language is actually a ten vowel /i ɪ e ɛ a ə ɔ o ʊ u/ system. Since Delalorm does not specify which Likpe dialect or location his study is based on, it is difficult to know whether the difference in the number of vowel described might be a matter of dialect variation. Given, however, that other work has consistently described Likpe as an eight vowel system without phonemic /ɪ/, /ʊ/, it is appropriate to require fairly strong evidence for the existence of a tongue root contrast in high vowels before concluding that Likpe is a /2IU/ language.

For several reasons, the evidence Delalorm provides to show the phonemic status of /ɪ/, /ʊ/ in Likpe is not sufficiently compelling, in my view, to warrant the conclusion that Likpe dialects, at least in general, have ten vowels. While twenty examples (ten each for [ɪ] and [ʊ]) are given (2009: 202) of words with high [-ATR] vowels, most have these vowels occurring in contexts which are nor very ideal for demonstrating contrast, either because (in ten examples) the high [-ATR] vowel is followed by a non-high [-ATR] vowel [ɛ], [ɔ] or [a] which might conceivably condition a more retracted quality in a preceding high vowel and/or because (in ten examples) the relevant vowel is directly preceded and/or followed by a nasal consonant, a

measurements obtained from 16 adult speakers of Likpe, published in an acoustic study by Lomotey (2009) strongly suggest that the non-high central vowel /ə/ is a low, rather than a mid, vowel. For both of the two Likpe dialects investigated, its average F_1 value was found to be lower than that of both of the mid [-ATR] vowels /ɛ/, /ɔ/, though it was higher than that of the low [-ATR] vowel /a/. This is entirely consistent with the assumption that /ə/ is a low tongue-root-advanced vowel. If, on the other hand, /ə/ were a mid [+ATR] vowel, we might expect, all else equal, that its F_1 value would be comparable to that of the mid [+ATR] vowels [e], [o] (i.e., significantly lower than the values typical of [ɛ], [ɔ]). In fact, the average F_1 value shown for /ə/ in vowel space plots for both dialects is around 600 Hz, which is about 200 Hz more than those of /e/, /o/ (which lie close to 400 Hz).

A possibility that is harder to immediately exclude is that /ə/ is a *mid [-ATR]* vowel. This would be consistent with the fact that it has typical F_1 values lower than those of /a/ but higher than those of /e/ and /o/. Such an analysis would not account for the finding that the F_1 values of /ə/ are even lower (by about 50 – 75 Hz) than those of /ɛ/, /ɔ/ in Lomotey's vowel space plots. However, if we allow (as we must) for some degree of variability in the correspondence of height feature specifications to formant values, it is not clear that this discrepancy must be seen as fatal to the view that /ə/ is, like /ɛ/, /ɔ/, a mid [-ATR] vowel.

Available phonological evidence is also not very conclusive. Due to the existence of alternations involving vowel height as well as [ATR] in Likpe (Delalorm 2009), roots with the vowel /ə/ consistently condition high vowel allomorphs of prefixes. The fact that root /ə/ takes [i], [u] in prefixes cannot necessarily be attributed to [ATR] agreement, however; since high vowels are invariably [+ATR] in Likpe's /1IU/ system. That is, once prefixes are constrained to have high vowels before a root vowel [ə], we could hardly expect them to surface with [-ATR] vowels ([ɪ], [ʊ] being entirely excluded in Likpe), regardless of whether [ə] is itself [-ATR].

There is at least a minor additional argument in favor of the conclusion that Likpe [ə] is a [+ATR] vowel. In recordings I made of the SIL Comparative African Wordlist (Snider & Roberts 2004) as pronounced by an adult male Likpe speaker in Ghana in July 2005,

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context which, in the typical case where the vowel acquires a measure of coarticulatory nasalization itself, can render vowel quality identification more problematic. In addition, nasalization on a vowel also tends to raise its first formant frequency, potentially rendering a high vowel [i] or [u] both acoustically and impressionistically less clearly distinct from the corresponding retracted vowel. Delalorm does provide four examples in which neither of these potential complications applies, all involving instance of [ɪ]: [ɔ̀sî] 'witch', [lɛ̀jî] 'tooth', [dísì] 'head', and [ɔ́kpì] 'grasscutter'. All four words also occur in sound recordings I made at Santrokofi in the Volta Region of Ghana in July 2005 of the SIL Comparative African Word List (Snider & Roberts 2004) as pronounced by an adult male speaker (from the town of Agbozome, whose speech may or may not be the same as the variety described by Delalorm) of Likpe. As they occur in these recordings, I would transcribe these words respectively as [ɔ̀sí] (with a final high-toned [i] vowel with heavy nasalization that has not been transcribed here for reasons of typographic clarity), [lɛ̀jî] (with heavy nasalization, also not transcribed, throughout the word) [dísì] 'head', and [ɔ́kpì]. In what follows, I will continue to assume the view, found in most previous work, that Likpe is an eight vowel system, though without excluding the possible existence of ten-vowel dialects and with the proviso that the matter may need further study.

[+ATR] and [-ATR] vowels are typically produced, to my ears, with an overall difference in voice quality of a sort that has been described in impressionistic reports in various other West African languages (see Casali 2002a, 2008 and references therein). Specifically, [+ATR] vowels [i], [u], [e], [o] have a deeper, more hollow quality,[24] suggestive of pharyngeal expansion, that is missing in the vowels [ɛ], [ɔ], [a]. I hear this same deeper quality found in the non-central [+ATR] vowels in the vowel [ə], suggesting the likelihood that this vowel is also produced with tongue root advancement and pharyngeal cavity expansion. Although it is appropriate to take such arguments based on subtle auditory impressions with a grain of salt, the most reasonable tentative conclusion, in my view, is that the eight vowel [ə] in Likpe is indeed a [+ATR] vowel, and I will provisionally assume that this is correct in what follows.

There is yet a further complication to the picture, however. Although Lomotey's study reveals [ə] to be a low vowel for the Likpe speakers whose speech she investigated, the speaker whose speech I recorded in 2005 produces the corresponding vowel as a higher vowel, with F_1 values considerably higher than those Lomotey measured. These values typically fall in a range between 350 and 400 Hz) that is more characteristic of mid vowels in the language.[25]

In light of this, we must concede that while Likpe is a promising case of a /1IU/ language with (in at least some dialects) a genuinely low and phonetically advanced vowel it is not, pending further study, a fully conclusive one. Although there is good evidence that the "eighth" vowel [ə] is indeed a low vowel in some Likpe speech varieties, and also some weak but suggestive evidence that it is an advanced-tongue-root vowel in the speech of at least some speakers, it remains to be conclusively determined whether [ə] is both low and advanced in the speech of any single speaker(s). While such a possibility might seem likely on a priori grounds, its correctness cannot necessarily be taken for granted, especially in the absence at present of clear evidence from other /1IU/ languages that low tongue body position and tongue root advancement ever co-occur.

Further research is needed both on Likpe and on the general question of the existence of low tongue-root-advanced vowels in /1IU/ systems. For now, however, it seems fair to say that clear instances of such cases are quite rare at best.

Similar empirical challenges potentially arise, of course, in connection with the interpretation of non-high central [+ATR] vowels in /2IU/ languages; it is not always easy to tell from a descriptive source(s) on a language whether such vowel is a low or a mid vowel phonetically. Descriptions are not always very clear and detailed on this point, and even if a "/ə/" vowel is shown as mid or low in a vowel chart, one might be tempted to wonder, in the absence of detailed discussion of the issue, how clearly the matter has been resolved and on what basis. Nevertheless, we find at least a reasonable number of /2IU/ languages in which it is possible to be fairly confident that such a [+ATR]

[24] This voice quality difference may, however, be somewhat noticeable in the vowel [o] than the other three non-low [+ATR] vowels.

[25] It should be noted here, however, that this statement is based on a very limited number of F1 measurements on an exploratory basis. I have not yet carried out a more systematic acoustic study.

counterpart of /a/ is in fact a low vowel, either because formant measurements clearly warrant such a conclusion (this is the case in Akposso; Starwalt 2008, Degema; Fulop et. al. 1998, Igede; Armstrong 1985:104, Lango; Noonan 1992 and Kasem; Adongo 1976) or because such a conclusion is at least strongly supported by very clear impressionistic phonetic reports, as in Crouch & Herbert's (2003) description of Deg or Local & Lodge's (1996) description of Kalenjin.

Interestingly, and perhaps importantly, it does not seem to matter very much in /2IU/ systems whether a non-high vowel functioning as the [+ATR] counterpart of [a] in a /2IU/ system is low or mid, at least as far as markedness is concerned. In either case, such vowels typically pattern as marked relative to the [-ATR] vowel [a], e.g., in having a restricted distribution and/or low frequency of occurrence. I am not aware of any /2IU/ languages in which it might be tempting to regard a non-high (whether low or mid) central [+ATR] as an unmarked sound. And, of course, we have seen that non-central mid [+ATR] vowels [e], [o] also pattern as characteristically marked in /2IU/ systems. Thus, the overall descriptive generalization appears to be a very simple one: non-high [+ATR] vowels in /2IU/ systems are marked.

The finding that low and mid vowels pattern alike with respect to markedness raises the natural possibility that the same might be the case in /1IU/ systems as well. If so, then perhaps it should not matter much in a /1IU/ language, as it seems not to in /2IU/ languages (as far as markedness status is concerned), whether a non-high central vowel functioning as a [+ATR] counterpart of /a/ is low or mid. Plausibly, we might expect non-high central [+ATR] vowels, whether or low or mid, to pattern alike with respect to markedness in /1IU/ systems. In this case, the quantity of relevant evidence to consider increases significantly. For while /1IU/ languages with a clearly low [+ATR] central vowel are quite rare, /1IU/ languages with a *non-high* [+ATR] central vowel (whether clearly mid or ambiguously low / mid) are well enough attested, as noted above. It thus becomes worth asking whether such vowels characteristically pattern as marked sounds (as they clearly do in /2IU/ systems) or as unmarked ones.

Though the question clearly warrants more extensive investigation, there is, perhaps quite surprisingly, very little clear evidence at present that non-high central [+ATR] vowels, whether their height is mid or (at least potentially) low, characteristically behave as marked segments in /1IU/ systems.[26] In fact, there is at least some weakly suggestive evidence to the contrary, in that low/mid central vowels in /1IU/ systems sometimes occur with high frequency and/or have wide distributions.

[26] Archangeli & Pulleyblank (1994:225-239) note that the non-high vowel [ə] which functions as the [+ATR] counterpart of [a] in Wolof cannot occur as a long vowel: [a] can occur both with and without contrastive length whereas [ə] is always short. While this might perhaps be taken as a form of markedness avoidance, the pattern does not necessarily lend itself straightforwardly to analysis as classical positional neutralization effect. A lengthened syllable nucleus is not generally considered to be a weak prosodic position, in which marked sounds might be expected to be avoided, but rather a strong one. This suggests that the absence of [ə] is not simple markedness avoidance and that the explanation for the gap may lay elsewhere. I am not aware of any other evidence that would diagnose [ə] as a marked sound in Wolof.

According to Mensah (1977), the vowel /ə/ (which Clements' 1974 analysis of Ewe vowel harmony treats as a low advanced vowel functioning as the harmonic counterpart of /a/) is the most frequently occurring vowel in the Anlo and Tongu dialects of Ewe. In Mono, a Ubangi language with a /ieaəɨɔou/ system, the vowel /ə/ is treated by Olson (2005) as having the same height features as /e/, /o/. Although Mono does not have a productive tongue root harmony system and lacks a front retracted vowel /ɛ/, it nevertheless qualifies as a /1IU/ system (in view of the /o/ - /ɔ/ contrast in back vowels) in our terms. The vowel /ə/ is the most frequently occurring vowel (/a/ is second) in text material and is particularly common in function words. For Likpe, Ring (2003: 19) notes that /ə/, /a/ and /o/ are the three most common vowels in roots. /ə/ is also the most frequent vowel found in pronouns, occurring in three out of six paradigmatic forms. Ameka's (2009) description of Likpe verb extensions also suggests the conclusion that /ə/ is a common and widely distributed vowel in the language. In particular, it is found in a number of verbal affixes (a causative suffix [sə], a contactive suffix [fə], a stative suffix [ə]) and function morphemes (e.g., a very common determiner morpheme [mə], a locative particle [lə]) and (as claimed by Ring) several pronouns. (In none of these morphemes is the quality of the vowel determined by assimilation to the root; the vowel is consistently [ə] in all cases.) Likpe is a particularly interesting case, moreover, in light of the fact that it is arguably the most promising case at present of a /1IU/ system with a genuinely low [+ATR] vowel, as discussed above.

Again, there is clearly a need for more systematic and thorough investigation of the patterning of non-high [+ATR] vowels in /1IU/ systems. At present, however, there is little if any clear evidence that non-high [+ATR] phonemic vowels, whether central or non-central, low or non-low, pattern as marked sounds in /1IU/ systems, and a certain amount of evidence which points to the opposite conclusion. This contrasts with what we find in /2IU/ systems, for which there is quite good evidence of marked patterning of non-high [+ATR] vowels. While the number of /1IU/ languages that can be cited at present in which a low or mid [+ATR] vowel /ə/ shows evidence of unmarked patterning is small, it is interesting that such cases, which have no clear precedent in /2IU/ languages, occur at all. Moreover, the admittedly limited evidence that exists for unmarked patterning of non-high central [+ATR] vowels in /1IU/ systems is convergent with the reasonably clear evidence that exists (see Section 3 above) for unmarked patterning of front and back round mid [+ATR] vowels /e/, /o/ in the same systems. While the proposal that all phonemic non-high (as well as high) [+ATR] vowels should (in contrast to what clearly holds in /2IU/ systems) function as unmarked sounds in /1IU/ systems might seem a very implausible one in light of widely held assumptions about tongue root markedness, it would be, if nothing else, quite premature to dismiss the possibility at this point. Far from being easily refuted, as might have been expected, such a proposal is actually supported by some limited but suggestive evidence. It seems quite clear, moreover, that /1IU/ and /2IU/ systems show other unexpected differences in their phonological patterning, e.g., in connection with assimilatory dominance. This suggests that it is appropriate to remain open, at this point, to the possibility of other surprising differences in inventory-related patterning as well.

If it should indeed turn out that unmarked patterning of non-high central (and non-central) [+ATR] vowels is indeed characteristic of /1IU/ but not /2IU/ systems, as the best available (albeit limited) evidence might suggest, this would be a very surprising finding based on familiar assumptions (Section 3 above) about the functional bases of tongue root markedness. Such a finding is potentially much more intelligible, on the other hand, in a framework that equates markedness with feature specification and in which [+ATR] quality is representationally unspecified in /2IU/ systems. If a non-high (whether low or mid) tongue-root-advanced vowel is represented with no tongue root feature in languages like Ewe and Likpe, its unmarked patterning (which is without clear precedent in /2IU/ languages) in such languages is expected, due to the invisibility of such vowels to constraints against tongue root features (and their co-occurrence with other features).

One might naturally object here that the sheer fact that low [+ATR] vowels are so rare in /1IU/ systems to begin with, while the corresponding retracted vowel /a/ is found in all /1IU/ systems is, by itself, a clear proof that [-ATR] is unmarked and [+ATR] marked in low vowels in such systems, just as in /2IU/ systems. While this point needs to be taken seriously, however, it is not necessarily as telling as might be supposed. It is not clear that a simple assumption that [ạ] is marked adequately accounts for the level of attestation of /ạ/ in /1IU/ inventories. (And, of course, it does not account for the absence of [ạ] as an allophone of /a/ derived via [+ATR] spreading.) If markedness of [ạ] were the whole story, we would expect /ạ/ to be relatively rare, but clearly attested in /1IU/ languages, just as it is in /2IU/ languages. In fact, it is not fully clear that /1IU/ languages with a genuinely low and tongue-root-advanced vowel exist at all. If not, this gap is not plausibly explained by the assumption that [ạ] is marked, since there is no reason to expect that a marked sound must be entirely absent from *all* languages with a particular inventory in which it is logically expected. Rather, there is seemingly something more to the story; other factors beside markedness relations must be at work.

In fact, it is possible to speculate on a possible representational explanation for the absence of genuinely low and tongue-root-advanced vowels in /1IU/ systems, should this gap prove real, under the assumption that /1IU/ systems employ [-ATR] as the specified value. Since a low and tongue-root-advanced vowel [ạ] could not be represented in a [-ATR]-specified system as a low [+ATR] vowel ([+ATR] being unavailable in such systems), the only conceivable representation for such a vowel would be as a low [ATR]-unspecified vowel. Suppose, however, that some principle(s) of phonetic interpretation requires that [ATR]-unspecified vowels, lacking any clearly specified articulatory instruction for tongue root position, must be realized with a tongue root position which is reasonably natural for the vowel's tongue height. Let us further suppose, as is both plausible and widely assumed (see Section 3 above), that tongue root advancement in a low vowel is an extremely unnatural gestural configuration, to the point that it is outside the range of gestural configurations that the phonetic implementation system might assign to a low [ATR]-unspecified vowel, but is possible only in the presence of an explicit articulatory instruction in the form of a [+ATR] specification. If so, then a vowel [ạ] is possible only in a [+ATR]-specified system and not a [-ATR]-specified system. If, as hypothesized, /1IU/ systems are [-ATR]-specified, then we expect not to find tongue

root contrasts in genuinely low vowels (or instances of [ą] arising from other sources) in such systems.

One might conceivably object to this proposal on the ground that the same considerations should also eliminate [ATR]-unspecified high retracted vowels [ɪ], [ʊ] in [+ATR]-specified systems, since, like tongue root advancement in low vowels, tongue root retraction in high vowels is also widely assumed to be an unnatural, and perhaps highly unnatural, gestural configuration. While this objection is reasonable enough, however, a good case can be made that the two cases are not exactly analogous. Plausibly, there is a difference in the *degree* of unnaturalness in the two cases, and it might be that the difference matters. It is sometimes assumed (e.g., Archangeli & Pulleyblank 1994, Calabrese 1995) that tongue root advancement in low vowels entails greater articulatory difficulty than tongue root retraction in high vowels. While we may concede that tongue root advancement is to some extent preferred in high vowels on both articulatory and perceptual grounds, as often claimed, it is not clear that less advanced or even tongue-root-retracted high vowels are necessarily all that unnatural.

Potential evidence bearing on the natural realization of vowels at various tongue heights comes from the attested range of phonetic realizations found in five-vowel ("i e a o u") systems, in which, plausibly, [ATR] specifications are generally absent. If we look at the range of variation in high vowels in such systems, we find that while [i]- and [u]-like realizations predominate, it is also possible to find five-vowel languages in which the highest vowels are described in terms much more suggestive of [ɪ], [ʊ]. (See Casali 1996/1998:196-200 for some discussion.) Mid vowels in five-vowel systems also show variation from more advanced to more retracted qualities. What we never find, however, as far as I am aware, is a five-vowel system in which the single low vowel is realized with an advanced tongue root. Based on these considerations, a reasonable case might be made that the phonetic interpretation of [ATR]-unspecified vowels is variable enough to encompass both advanced and retracted realizations of both high and mid vowels but not advanced realizations of low vowels, which are unnatural enough to be possible only where the advancement gesture is licensed by an overt [+ATR] specification.

Whether an explanation along these lines is ultimately viable remains perhaps to be seen, and, as we have noted, there are empirical questions surrounding the existence of low [+ATR] vowels in /1IU/ languages that require further investigation as well. At the same time, there is reason for cautious optimism that various surprising aspects of low, as well as non-low, vowel patterning might prove at least partially intelligible in terms of underspecified representations. At least, such an approach seems capable of suggesting answers to important puzzles that lack obvious solutions in non-representational terms.

There is a further reply that can be made to the objection raised above, that unmarkedness of low [-ATR] and markedness of low [+ATR] vowels is entirely demonstrated by the fact that the former, but not the latter are found in all /1IU/ languages. While it is true that all /1IU/ languages have a low and phonetically retracted vowel /a/ and that most (if not all) lack a low phonetically advanced vowel /ą/, the picture is complicated by a further fact, which is that the vowel /a/ does not consistently pattern (as it does in /2IU/

languages) as a [-ATR] vowel in /1IU/ languages. Rather, there are /1IU/ languages in which, a single low vowel /a/ shows greater phonological affinity with [+ATR] non-low vowels /i/, /u/, /e/, /o/ than with [-ATR] non-low vowels /ɛ/, /ɔ/. Such patterns, which are described below, present an interesting and seemingly quite difficult challenge for phonological theories in general. What is relevant for our immediate purposes, however, is that such cases call into question the correctness (or at least completeness) of the claim that only [+ATR], ant not [-ATR], low vowels are ever absent in /1IU/ systems. It is true enough, on the one hand, that phonetically retracted low vowels are, as far as is known at present, always present in /1IU/ languages. At the same time, there is ample room for questioning the claim that all /1IU/ languages have a low vowel that is *phonologically* [-ATR]; the existence of /1IU/ languages in which the only low vowel patterns with [+ATR] non-low vowels presents a problem for such a claim. Moreover, there is no evidence at present that such behavior is ever found in /2IU/ languages, and this suggests a further systematic difference in the patterning of low vowels in the two systems that is not clearly expected on well understood functional grounds and which must ultimately be explained.

In /2IU/ systems, the low vowel /a/ quite consistently patterns with the non-low vowels [ɪ], [ʊ], [ɛ], [ɔ] in its harmonic behavior in /2IU/ languages. In particular, root morphemes whose vowel is /a/ consistently take [-ATR], rather than [+ATR], allomorphs of harmonizing affixes. The pattern illustrated in the Nawuri (a nine-vowel /i ɪ e ɛ a ɔ o ʊ u/ language of Ghana) examples below (from Casali 1995b, with minor changes to phonetic symbols to conform to IPA usage, from Casali 1995b) is typical. Shown in (9) are some nouns which take a singular noun class whose vowel is either [ɔ] or [o], in agreement with the [ATR] category of the following root vowel. Examples (9a-c) illustrate the behavior of the prefix with [+ATR] root vowels,[27] while the examples in (9d-g) illustrate its behavior with non-low [-ATR] root vowels. In the examples in (9h-j) which are most relevant for our purposes, the same prefix shows up in its [-ATR] allomorph [ɔ] before roots whose vowel is /a/. This is true of all other harmonizing affixes in the language as well.

(9) [+ATR] root vowels

a. o-bi	child/person
b. o-bu	room
c. o-geːʔ	valley

Non-low [-ATR] root vowels

d. ɔ-bɔ	hole

[27] The absence of examples in (9) with the root vowel /o/ is due to a general absence in my data of noun roots with /o/ as their vowel among nouns that the very common [ɔ] ~ [o] singular noun class prefix shown in (9). This absence is in, all likelihood, a simple reflection of the fact that mid [+ATR] vowels are, in comparison with other vowels, rather uncommon in root morphemes to begin with. Relative rarity of mid [+ATR] vowels in a nine-vowel /i ɪ e ɛ a ɔ o ʊ u/ system of the type found in Nawuri is consistent with the assumption, advocated here, that such vowels are marked in a /2IU/ system.

e. ɔ-bʊŋ body of water
f. ɔ-fɛ broom
g. ɔ-tʃɪːʔ woman

Low [-ATR] root vowel /a/

h. ɔ-kpa path
i. ɔ-kaːʔ end
j. ɔ-paːʔ guinea worm

Such behavior is extremely regular in /2IU/ systems. As far as I am aware, there are no reported cases of /2IU/ languages in which the root vowel /a/ conditions [+ATR], rather than [-ATR], allomorphs, of harmonizing affixes.

Quite interestingly, however, while the vowel /a/ consistently patterns phonologically as a member of the [-ATR] harmony set in /2IU/ systems, this is not always the case in /1IU/ systems. In a number of /1IU/ languages, including Mokpwe (Henson n.d.), and Komo (Thomas 1992) and nearly all Bantu C languages, the low vowel /a/, in its occurrence as a root vowel, fails to condition [-ATR] allomorphs of harmonizing affixes, but takes [+ATR] allomorphs instead, as illustrated in the Ntomba examples below, drawn from Leitch (1996: 51; original source: Mamet 1955). Examples (10a-d) illustrate the normal harmonizing behavior of two mid vowel affixes with roots containing non-low vowels: a word-initial noun class prefix [e] ~ [ɛ] and an applicative suffix [el] ~ [ɛl] ~ [en]. Example (9e) shows that the same mid vowel affixes surface disharmonically with a [+ATR] form [e] or [o] when the root vowel is [a]. (Note that the word-final [o] is a nominalizing suffix that is not subject to harmony.)

(10) a. ɛ-*lɔk*-ɛl-o ‘ensorcellement’
b. e-*bót*-el-o ‘gestation
c. ɛ-*kɛ́nd*-ɛl-o ‘marche’
d. e-*kih*-el-o ‘siege’

e. e-*kan*-en-o ‘pensee’

Moreover, in many of the Bantu C languages that display this pattern (Leitch 1996: 174), the vowel /a/ is, very surprisingly, able to freely co-occur root-internally with both high and mid [+ATR] vowels *but not with* [-ATR] vowels [ɛ], [ɔ]. In essence, the single low vowel /a/, though phonetically retracted in such languages, shows greater harmonic affinity with the [+ATR] than the [-ATR] non-low vowels, and could virtually be treated, as far as its phonological patterning (though not its phonetic quality) is concerned as a [+ATR] vowel.

As argued extensively by Leitch (1996), patterns of the type found in Bantu C languages (and elsewhere), in which a low retracted vowel [a] patterns harmonically with non-low [+ATR] vowels [i], [u], [e], [o] in a /1IU/ system can be readily accounted for under the assumptions that such systems are [-ATR]-based (or, in a privative feature approach of

the sort opted for by Leitch, [RTR]-based) and that the low vowel [a] is unspecified for [-ATR] (or [RTR]). While detailed discussion of Leitch's constraint-based analysis is not possible here, the analytical framework he proposes succeeds in accounting for an impressive variety of harmony patterns using a small number of simple assumptions. Although crucial assumptions about underspecified representations of the sort employed by Leitch have sometimes been rejected or downplayed in theoretical work on harmony systems (e.g., Artstein 1998, Bakovic 2000, Pulleyblank & Turkel 1996, Smolensky 1993), it is not very obvious how the same Bantu C patterns might be analyzed in terms that do not appeal to such assumptions, and no alternative analysis of the relevant harmony patterns in non-underspecification terms has yet been given, as far as I am aware.

If Leitch's proposal that [-ATR] / [RTR] is specified only on mid vowels [ɛ], [ɔ] (with the remaining non-low vowels [i], [u], [e], [o] and the low vowel [a] unspecified for tongue root features) is justified for Bantu C languages, it must be concluded that [-ATR] is systematically avoided on low vowels in such languages and that such languages have, in effect, five unmarked non-[-ATR] vowels [i], [u], [e], [o], [a] and two marked [-ATR] vowels, [ɛ], [ɔ]. For such a system, it is hardly justifiable to speak of [-ATR] as the unmarked value in low vowels, since the only low vowel is not [-ATR]. Indeed, in a general constraint-based framework of the type employed by Leitch, absence of [-ATR] specifications on low vowels must be enforced by some markedness constraint against the combination [+low,-ATR]. As Leitch discusses in some detail , the motivation for such a constraint is not entirely clear; presumably it cannot be an articulatorily grounded constraint, since tongue root retraction is in no way disfavored (on the contrary, it is highly favored) in low vowels. While the ultimate basis of such a constraint remains perhaps unclear (see Leitch 1996 for some discussion), however, it is well motivated as an analytical hypothesis. At least, Leitch succeeds in demonstrating how a variably ranked constraint against [-ATR] specifications on low vowels accounts for intricate and interesting typological variation in Bantu C harmony patterns. If absence of [-ATR] on low vowels is consistently enforced by some such formal mechanism, then there is clearly a sense in which [-ATR] can appropriately (if surprisingly) be regarded as the marked value in low as well as non-low vowels in such systems.[28]

Moreover, if Leitch's fundamental assumption that harmonic affiliation of [a] with non-low [+ATR] vowels in Bantu C-type /1IU/ systems is due to its underspecification for tongue root features, and if, as hypothesized here, /1IU/ systems differ from /2IU/ systems in being specified for [-ATR], rather than [+ATR], we can understand not only why such a seemingly counter-intuitive harmony system should exist at all, but why it occurs, as far as is indicated by the best evidence available at present, only in /1IU/ and not in /2IU/ systems. In Leitch's account, the Bantu C pattern arises because 1) /a/ is

[28] Of course, a full treatment of the Bantu C patterns would also need to account for the phonetic interpretation of the [ATR]-unspecified low vowel as a tongue-root-retracted vowel [a]. A possible basis for such an account is the one suggested above: if tongue-root-unspecified vowels can only have a tongue root position that falls within a range of reasonably natural gestures consistent with the vowel's tongue body position, and if an advanced tongue root position falls outside such a range for a low vowel, then a tongue-root-advanced low vowel [ạ] is not a possible interpretation of a low tongue-root-unspecified vowels.

unspecified for the active [ATR] value, 2) underspecification for the active [ATR] value naturally groups [a] phonologically with other unspecified vowels, and 3) the active value is [-ATR], so that the unspecified non-low vowels consist of the advanced set [i], [u], [e], [o]. There is every reason to expect that underspecification of a single low vowel for the active [ATR] value should also be possible in /2IU/ systems, and that this would similarly serve to group [a] phonologically with other [ATR]-unspecified vowels. However, under our current hypothesis that [+ATR], and not [-ATR], is the specified value in /2IU/ systems, such underspecification can only group [a] phonologically with the retracted (and [ATR]-unspecified) non-low vowels [ɪ], [ʊ], [ɛ], [ɔ] and never with the advanced set (which must be actively specified as [+ATR]) [i], [u], [e], [o]. The only way in which a low vowel could pattern phonologically with the latter in a [+ATR]-specified /2IU/ system is if it were itself specified as [+ATR]. In this case, however, we should expect it to surface, under any reasonable assumptions about phonetic interpretation, as an advanced vowel [a̟] and not a retracted vowel [a]. Since there is no natural avenue for deriving phonological patterning of [a] as a [+ATR] vowel in /2IU/ systems we can straightforwardly account for the confinement (which is very surprising on other grounds) of such patterning to /1IU/ systems. Crucial to the account, of course, is the assumption that the two system types employ different specified [ATR] values. Thus, not only does such an assumption account for important differences in the patterning of non-low vowels, as argued in Section 5 above, it potentially serves to account for certain differences in low vowel behavior as well.

These brief remarks in no way constitute a complete understanding of markedness patterning of low vowels in tongue root harmony systems. One important problem that has not been addressed is the existence of /1IU/ systems in which, in contrast to what holds in Bantu C and some other /1IU/ languages, the low vowel /a/ does pattern with the [-ATR] mid vowels /ɛ/, /ɔ/, in the harmony system. The best-known case of this type is Yoruba (Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1996, Pulleyblank & Turkel 1996, Orie 2003), in which [-ATR] spreads leftward from a low vowel /a/ to a preceding mid vowel, so that only [-ATR] [ɛ], [ɔ] and not [+ATR] [e], [o] are able to occur before a low vowel [a] in the following syllable. This appears to require the assumption that [-ATR] is redundantly specified on all low vowels. The challenge of accounting for such cases cannot be tackled here, and various other important issues must await future research as well.

Notwithstanding the incompleteness of the account offered here, however, we have seen some fairly good evidence that the markedness-related patterning of low vowels in /1IU/ systems does not conform to the simple picture we find in /2IU/ systems, in which low tongue-root-advanced vowels are clearly attested and consistently pattern, along with all non-high vowels, as marked sounds, and in which a low and phonetically retracted vowel [a] patterns consistently in its harmonic behavior with retracted non-low vowels [ɪ], [ʊ], [ɛ], [ɔ]. In /1IU/ systems, such a picture breaks down at two points. First, there is surprisingly little clear evidence at present that non-high central (or non-central) tongue-root-advanced vowels actually pattern as marked sounds /1IU/ languages in which they occur. Second, while many /1IU/ languages have just a single low, and phonetically retracted, vowel /a/, this vowel does not always pattern phonologically, as it does in /2IU/

systems, as a [-ATR] vowel would be expect to pattern. We have further seen how an assumption that [-ATR], and not [+ATR], is the specified value in /1IU/ systems might shed at least partial light on aspects of the behavioral differences we observe. Thus, in place of a conclusion, which might perhaps have been anticipated, that low vowel typology presents insurmountable obstacles to a model that treats [-ATR] as the specified (and hence marked) value in /1IU/ systems, a fairer conclusion at present is that 1) there are aspects of low vowel patterning in /1IU/ systems which present challenges for virtually any existing theoretical framework, and 2) while the ultimate viability of an underspecification account of low vowel behavior remains to be demonstrated, such an approach shows reasonable promise and at least merits serious further exploration.

7. The inventory-correlation problem: a proposed partial solution

I have argued that we can make good initial sense of many of the differences in characteristic behavior of /2IU/ and /1IU/ under the assumption that the two systems employ different specified tongue root feature values, [+ATR] in the former and [-ATR] in the latter. What we have not addressed to this point is the important question of why this should be the case.

The conclusion that tongue root contrasts in /2IU/ and /1IU/ systems are based on different specified feature values has been suggested before, in work going back to the early 1990s (e.g., Casali 1993, Causley 1999, Goad 1993, Steriade 1995), and a number of different explanations have been proposed to account for the difference. As discussed elsewhere (see Casali 2008 and references therein), none of these existing explanations is entirely without problems. It would not be unreasonable, in my view, to regard the problem as an essentially unsolved one whose adequate treatment must await future research. Nevertheless, it seems worthwhile to briefly speculate on a possible basis for a solution. I emphasize from the outset, however, that the proposals to be offered here in no way constitute a full and definitive solution to the problem. Rather, it must suffice for our present purposes to identify some factors that seem potentially relevant to a solution and to suggest a partial line of explanation that seems worth developing further.

We can begin with some simple observations about well-attested vowel inventories in (2). For convenience, I repeat this as (10) below, with the slight modification that only one [ATR] value, the one proposed as the specified value, is shown with each inventory.[29]

[29] As discussed above (see below for additional discussion as well), there is evidence that the low vowel /a/ is not specified for [-ATR] in some /1IU/ systems of the type in (10c), hence this specification is shown in parentheses.

(10) Well-attested tongue root harmony systems

a. 10V inventory (e.g., Degema)

/i/		/u/	[+ATR]
/ɪ/		/ʊ/	
/e/		/o/	[+ATR]
/ɛ/		/ɔ/	
	/ạ/		[+ATR]
	/a/		

b. 9V inventory (e.g., Akan)

/i/		/u/	[+ATR]
/ɪ/		/ʊ/	
/e/		/o/	[+ATR]
/ɛ/		/ɔ/	
	/a/		

c. 7V inventory (e.g., Yoruba)

/i/		/u/	
/e/		/o/	
/ɛ/		/ɔ/	[-ATR]
	/a/		([-ATR])

d. 7V inventory (e.g., Kinande)

/i/		/u/	[+ATR]
/ɪ/		/ʊ/	
/ɛ/		/ɔ/	
	/a/		

Of these four inventories, three (those in (10a,b,d)) are /2IU/ systems and are assumed to be [+ATR]-specified, while the single inventory in (10c) is a /1IU/ system and assumed to be [-ATR]-specified.

If we look at the three inventories ((10b,c,d)) that contain fewer than ten vowels, i.e., in which one or more sub-classes of vowels are missing, we can observe evidence of an interesting correlation between the specified [ATR] value and the class(es) of vowels which are missing. Consistent with what is becoming something of a theme, we shall see that low vowels in the /1IU/ seven-vowel inventory in (10c) pose an exception to the general rule we observe elsewhere. Setting that problem aside for the time being, however, what we observe in general is that, in cases where certain vowels are phonemically unpaired (i.e., lack a phonemic counterpart with the opposite [ATR] value to which they are otherwise featurally identical), the phonemically unpaired vowel always lack the [ATR] value that is specified in the system. Or, to look at it from the opposite angle, the active [ATR] value is the one that characterizes the missing vowels.

It is particularly interesting and, I think, instructive, in this connection to compare the two systems, (10c) and (10d), which are missing non-low vowels. With respect to non-low vowels, these two inventories are essentially mirror images of each other. The seven-vowel system in (10d) is missing two mid [+ATR] vowels, [e], [o], and it is [+ATR] that is the specified value. The seven-vowel system in (10c) is missing two high [-ATR] vowels, [ɪ], [ʊ] and it is [-ATR] that is the specified value. Thus, for these cases, the specified [ATR] value in the system is the one found on missing non-low vowels.

Nor must this observation be dismissed as just an interesting curiosity or the result of factors that are not yet well understood. In a general underspecification framework, it is, very plausibly, exactly what we should have expected, without further stipulation, given certain entirely natural assumptions. Underspecification frameworks have quite typically

associated feature value specification with markedness and underspecification with unmarkedness. Given, in particular, a pair of segments that contrast only for a single feature, it is natural to assume that the segment which is specified for the relevant feature is the marked member of the pair and the unspecified segment the unmarked one. Formally, this can be accounted for in a constraint-based framework if constraints are formulated in such a way that they are violated only by specified feature values and not by unspecified ones. As argued in Section 5 above, such an assumption is also warranted to account for positional neutralization patterns in tongue root harmony languages. If we further suppose, in keeping with fairly standard assumptions, that vowels may be systematically absent in a language only if they are effectively targeted by some highly-ranked markedness constraint, we predict, all else equal, that [+ATR] vowels can be absent only in languages in which [+ATR] is the specified value, while [-ATR] vowels can be absent only in languages in which [-ATR] is the specified value.

By themselves, these principles do not, of course, dictate *which* [+ATR] vowels might be absent in a [+ATR]-specified system or which [-ATR] vowels might be absent in a [-ATR]-specified system. In a general OT framework that assumes some universal constraint set, the classes of vowels that are potentially absent will depend on specific assumptions about the constraints referring to [ATR] values that exist. Let us provisionally assume, in keeping with much previous work, the existence of a constraint *[+high,-ATR] targeting high [-ATR]-specified vowels, and constraints *[+low,+ATR] and *[-high,+ATR] targeting, respectively, low and non-high [+ATR] vowels.[30] Given such constraints, we predict, for [+ATR]-specified systems, exactly the three attested inventories in (10a,b,d). A [+ATR]-specified system must have a full set of five [ATR]-unspecified vowels (there being no effective constraint, in the current framework, against such vowels in a [+ATR]-specified system), which we may reasonably assume are phonetically realized as retracted vowels [ɪ], [ʊ], [ɛ], [ɔ], [a]. It must also have the two [+ATR] vowels [i], [u], since the combination [+high,+ATR] is not specifically targeted by any markedness constraint. This means that if [+ATR] is employed in a system at all, it will be employed on high vowels. An interesting and important consequence of these assumptions is that a [+ATR]-specified system must contain two sets of high vowels /i/, /u/ and /ɪ/, /ʊ/ in phonemic contrast, and must, by definition, be a /2IU/ system. Thus, we exclude, in principled fashion, the possibility of a [+ATR]-specified /1IU/ system. That is, the absence of /ɪ/, /ʊ/ in a /1IU/ system entails that such a system must be [-ATR]-specified, for otherwise the constraint *[+high,-ATR] against such vowels would be inactive.

[30] In order to account for the very common case in /2IU/ systems in which *all* [+ATR] vowels are excluded in certain contexts, it is also appropriate, in such a framework, to assume a general constraint *[+ATR] (and/or positional variants of the same) against all [+ATR] specifications. (For parallel reasons, an analogous markedness constraint(s) targeting [-ATR] values might be adopted as well.) Of course, if [+ATR] specifications are to be employed at all in a language, such a constraint cannot be entirely undominated.

Constraints of the form *[+ATR] and *[-ATR] (or, in a privative feature approach, *[ATR], *[RTR]) make sense in a general framework that equates markedness with phonological structure. See Causley (1999) for discussion.

For parallel reasons, we predict that the [+ATR] vowels [e], [o] may be absent only in a [+ATR]-specified system, since the constraint *[-high,+ATR] would be inactive in a [-ATR]-specified system. This excludes a seven-vowel system /i ɪ ɛ a ɔ ʊ u/ (corresponding to (10d)) in which [-ATR] is the specified value.

The general expectation that vowels of a particular [ATR] quality may be absent only in systems in which that quality corresponds to that of the specified [ATR] value holds correctly of the /2IU/ inventories (10b) and (10d), in which only [+ATR] vowels are missing and in which [+ATR] is the specified value. (It also holds, vacuously, of the ten-vowel inventory (10a) in which no unpaired vowels occur.) It is also borne out, as far as non-low vowels are concerned, by the seven-vowel /1IU/ system in (10c), since the high [-ATR] vowels /ɪ/, /ʊ/ are absent, while [-ATR] is the specified value. There is only one point at which the prediction does not straightforwardly hold. As already hinted, this concerns low vowels in the seven-vowel /1IU/ system (10c). Missing from this inventory is a low tongue-root-advanced vowel [ạ]; the inventory contains only a single low, and phonetically retracted, vowel [a]. The absence of [ạ] constitutes an apparent exception to the principle that [+ATR] vowels can be absent only in an inventory in which [+ATR] is the specified value.

Faced with this problem, one possible conclusion we might draw is that the line of explanation we have been pursuing, which relies on the assumption that [ATR]-unspecified vowels, being invisible to tongue root markedness constraints, cannot be absent form an inventory, is fundamentally wrong. This would be unfortunate in my view, as there are reasons to suspect that such an explanatory approach may well be on the right track. It is quite striking that the only inventory in which [-ATR] is specified, under the theory proposed here, is also the only one in which any [-ATR] vowels are missing. All three of the [+ATR]-specified inventories (10a,b,d) have a full complement of five [-ATR] vowels /ɪ/, /ʊ/, /ɛ/, /ɔ/, /a/, as the proposed principles would lead us to expect. In the absence at present of any clearly preferable alternative, we should be reluctant to quickly abandon an explanation that shows such a level of initial promise.

A different response to the problem, which seems preferable to me, is to suppose that the proposed explanation is correct as far as it goes, but that it is not the whole story. Following this strategy, we would look for some additional factors to which the absence of [ạ] in /1IU/ systems might be attributed.

In fact, we have already seen reason to believe that additional factors, unrelated to markedness alone, may play a role in the behavior of low vowels in /1IU/ systems. As discussed in Section 6 above, it is not clear that genuinely low and tongue-root-advanced vowels occur in /1IU/ systems at all. If they do not, then this cannot plausibly be explained in terms of markedness alone, since the assumption that a vowel [ạ] is marked does not, based on any kind of generally accepted or well-understood principles, entail that it should be entirely absent in /1IU/ systems. As argued above, an alternative explanation is to suppose that that a low [ATR]-unspecified vowel is not phonetically interpretable as a tongue-root-advanced vowel, due to the extreme departure which a

gesture of tongue root advancement entails from a position which is tolerably natural for a low vowel. If so, then the only viable representation for [ạ] is one in which an explicit [+ATR] specification is employed, and an [ATR]-unspecified low vowel is only interpretable as [a]. From this, it follows, independently of any assumptions about the constraint system, that a vowel [ạ] is not possible in a [-ATR]-specified system.

It is interesting to note, moreover, that the exception posed by low vowels in /1IU/ systems to the generalization that phonemically unpaired vowels are [ATR]-unspecified and that missing vowels are ones that would have the specified value is not necessarily as blatant as might perhaps be supposed. At first glance, such a generalization seems simply untenable in the case of low vowels in the [-ATR]-specified system (10c), since it entails that only [-ATR] low vowels may be missing from such a system and that an [ATR]-unspecified vowel must be present. While such a prediction would be grossly falsified (if not ludicrous) if we were to assume that an [ATR]-unspecified vowel must be realized as [ạ] in a [-ATR]-specified system (since we would then predict that [ạ] must be present in all such systems), the picture changes considerably if we assume, as just proposed, that an [ATR]-unspecified vowel should be realized as [a], rather than [ạ]. Given this assumption, a [-ATR]-specified /1IU/ system with a missing low [-ATR] vowel would have the form in (11b) below, rather than the form in (11a) which we might have naively expected under different phonetic interpretation principles.

(11) a.

	/i/		/u/
	/e/		/o/
[-ATR]	/ɛ/		/ɔ/
		/ạ/	

b.

	/i/		/u/
	/e/		/o/
[-ATR]	/ɛ/		/ɔ/
		/a/	

Not only is the system in (11b) much less inherently implausible, there is reason to suppose that it exists. As we have seen, /1IU/ systems of the Bantu C type, in which a single low and phonetically retracted vowel patterns phonologically with the non-low advanced set [i], [u], [e], [o], are very plausibly analyzable as being of this form. If this assumption is warranted, we can conclude that the general principle that phonemically unpaired vowels are [ATR]-unspecified holds not only of the unbalanced /2IU/ systems in (10b,c) and of non-low vowels in /1IU/ systems, it can be accurately applied to low vowels in at least some /1IU/ systems, (i.e., those of the Bantu C type) as well.

In summary, we have looked at some factors that might account in part, for the generalization that /2IU/ systems are [+ATR]-specified and /1IU/ systems [-ATR]-specified. These brief and somewhat speculative proposals do not constitute a complete solution to the problem. Various details remain to be fleshed out and several important and seemingly difficult challenges remain unaddressed. No explanation has been proposed for why [+ATR], rather than [-ATR], is specified in ten-vowel systems of the

type in (10a). Several challenges also remain to a fully adequate account of low vowel behavior in /1IU/ systems. While the hypothesis that a low [ATR]-unspecified vowel is not interpretable as [ạ] potentially accounts for the absence of a phonetic tongue root contrast in low vowels in [-ATR]-specified systems, no mechanism has been proposed which could ensure that low vowels in Bantu C type systems are consistently unspecified for [-ATR]. In addition, while the low vowel /a/ patterns phonologically as a non-[-ATR] vowel in /1IU/ systems of that type, there are other /1IU/ systems, of which Yoruba (Archangeli & Pulleyblank 1989, 1994, Pulleyblank 1996, Pulleyblank & Turkel 1996, Orie 2003) is the best known case, in which the same vowel serves as a trigger of assimilatory spreading of [-ATR] and must be assumed to bear a [-ATR] specification at some level. The challenge of accounting for typological variation in low vowels in tongue root harmony systems is not at all trivial, and it remains to be seen whether a fully adequate account based on proposals of along the general lines suggested above can be developed. I think it is noteworthy, however, that the only existing theory (as far as I am aware) that has so far attempted to account both for the Bantu C and Yoruba low vowel patterns in /1IU/ systems, Leitch (1996), relies crucially on underspecification of tongue root features (and, in particular, on the assumption that low vowels in Bantu C type systems are [ATR]-unspecified).

In keeping with the limited goals of this section, no further attention to these important issues can be given here, and they will be left instead for future research. What I have attempted to establish here is that aspects of the inventory correlation problem are intelligible in terms of principles that make sense within a general framework in which either of two values of a feature [ATR] (but not both) may be specified within a language. We can observe, I believe, evidence of a general pattern in which, in inventories with unequal harmony sets, phonemically unpaired vowels have the unspecified [ATR] value, while absent vowels take the specified value. This generalization, which is as we might expect if 1) unspecified [ATR] values are invisible to potentially relevant markedness constraints, so that [ATR]-unspecified vowels are necessarily unmarked and 2) vowels may be absent from an inventory only if effectively targeted by some markedness constraint, holds straightforwardly of both of the unbalanced /2IU/ vowel inventories, (10b,d), and it accurately characterizes the non-low vowels in the unbalanced /1IU/ inventory (10c). Perhaps surprisingly, it can also be extended to low vowels in at least some /1IU/ languages, i.e., those that display the Bantu C pattern in which /a/ behaves phonologically as a non-[-ATR] vowel. Thus, while much work remains to be done, the possibility of an explanation along these general lines is an interesting and promising one that in my view merits further exploration. This is especially so inasmuch as it relies on a principle, invisibility of unspecified vowels to relevant markedness constraints, which, in addition to being entirely natural in an underspecification framework, is independently warranted for its explanatory potential in accounting for synchronically attested positional neutralization patterns involving tongue root contrasts, as discussed in Section 5 above.

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Appendix: Possible cases of positional neutralization to [-ATR] in /2IU/ systems

A number of potential cases of positional neutralization of high vowel contrasts to [+ATR] have been reported, as described below.

One apparent case is discussed briefly in Calabrese (2005: 125). Citing a study by Omamor (1973), Calabrese describes Uvwie, an Edoid language of Nigeria, as having nine contrastive vowels /i ɪ e ɛ a ɔ o ʊ u/ in roots, but only the seven vowels /i e ɛ a ɔ o u/ in affixes. Since it is the two high [-ATR] vowels [ɪ], [ʊ] that are systematically excluded in the latter context, such a pattern would be a case of positional neutralization of high vowel tongue root contrasts to [+ATR] of the type that is expected under the view in (3). As it turns out, however, the generalization as described by Calabrese appears to be incorrect. While Omamor's original study does indeed state (1973: 129) that high [-ATR] vowels are absent in Uvwie prefixes, a later study, Omamor (1988), clearly describes Uvwie as having all nine vowels in both roots and affixes.[31] Thus, Uvwie does not appear to be a genuine case of a language in which high vowel tongue root contrasts are positionally neutralized to [+ATR].

A number of Cameroonian languages of Bantu Zone A treated in Boyd (in preparation) have /2IU/ systems in which high [-ATR] vowels occur somewhat less frequently than other vowels and fail to occur in certain positions in which other vowels can occur. However, it is not clear that the patterns should be attributed to straightforward markedness avoidance of [ɪ], [ʊ] or positional neutralization of high vowel tongue root contrasts to [+ATR]. Rather, the limited distributions of [ɪ], [ʊ] mainly involve neutralization of contrast between these vowels and mid retracted vowels [ɛ], [ɔ] through various lowering processes, differing in detail and degree of productivity from language to language, which replace the former by the latter in certain contexts, especially closed syllables. In some of the languages, this is accompanied by a parallel avoidance of [ɛ], [ɔ] in open syllables, leading to apparently complete complementary distribution between [ɛ] and [ɪ], with the former occurring in closed syllables and the latter in open ones. Comparative evidence and other indications (e.g., native speaker awareness of vowel distinctions involving [ɪ], [ʊ]) strongly suggest that the vowel systems are undergoing diachronic changes in which the vowel [ɪ], [ʊ] are likely being lost historically. However, it is less clear that the patterns must be understood, synchronically, as simple markedness avoidance of [ɪ], [ʊ]. At least, the associated tendency for [ɪ], [ʊ] to occur to the exclusion of [ɛ], [ɔ] in open syllables does not have a straightforward analysis in such terms. This, together with the fact that the vowel systems may be in a state of diachronic flux, at least muddies the picture somewhat. At any rate, the relevant patterns seemingly involve neutralization of a height contrast, rather than a tongue root contrast.

A further potential case of positional avoidance of [ɪ], [ʊ] in a /2IU/ language occurs in Bila, a nine-vowel /i ɪ e ɛ a ɔ o ʊ u/ language of Democratic Republic of Congo (Kutsch

[31] Even in the 1973 paper, the conclusion that high [-ATR] affixes are absent in prefixes is not entirely unequivocal. Omamor's discussion of formant measurements toward the end of the paper (pp. 133-135) seems to leave open the possibility that high [-ATR] and mid [+ATR] vowels might be distinct in prefixes as well, though in the process of merging historically.

Lojenga 1994a). While all nine vowel qualities contrast in verbs and in initial syllables of CVCV noun roots, the high retracted vowels [ɪ], [ʊ] do not occur in non-initial syllables of disyllabic noun roots. (All [+ATR] vowels are permitted in non-initial syllables, as are all non-high [-ATR] vowels.) Kutsch Lojenga does not discuss the distribution of vowels in verbs in great detail, but does note (1994a:8) that "the verbal system clearly presents a nine-vowel system with cross-height [ATR] harmony." If it turns out that most verb roots in Bila, as in most Bantu languages, are maximally CVC, then the question of whether high [-ATR] vowels are able to occur in non-initial syllables of verb roots may well be moot, in which case it might be possible to maintain the simple generalization that [ɪ], [ʊ] do not occur in non-initial syllables of roots at all. Since the initial syllable of a root is a position that has been characterized as a prominent one (Beckman 1997) that is prone to license marked sounds (which may be prohibited elsewhere) the absence of [ɪ], [ʊ] in non-initial syllables in Bila could be considered a case of positional avoidance of these vowels.

Kutsch Lojenga speculates, quite plausibly, that the Bila nine-vowel inventory is the result of a historical innovation from an earlier seven-vowel /i e ɛ a ɔ o u/ inventory. If so, the current distribution of [ɪ], [ʊ] likely derives in part from somewhat unusual historical developments. Whether or not the distributional limitations on these vowels must also be treated as a synchronic markedness effect in a synchronic grammar is perhaps a harder question to answer, at least on entirely theory-independent grounds. However, the fact that one of very few potentially clear cases in which [ɪ], [ʊ] are distributionally restricted in a /2IU/ system is likely the result of idiosyncratic and unusual historical developments cannot, in my view, be seen as very reassuring for the view (which might be taken to reflect the current mainstream) that [ɪ], [ʊ] are universally marked relative to [i], [u], especially given that patterns in which the latter have a more restricted distribution than the former are quite strongly attested.

The only other potential case I am aware of is found in Kimatuumbi, described in Odden (1996). Kimatuumbi is described by Odden as a seven-vowel /i ɪ ɛ a ɔ ʊ u/ language. In noun class prefixes, only the three vowels [i], [u], [a] are permitted.[32] The non-occurrence of mid vowels in such positions is a fairly common restriction in Bantu languages, and applies elsewhere in Niger-Congo as well. Of more direct relevance to our present concerns is fact that the high advanced vowels [i], [u] are permitted to the exclusion of [ɪ], [ʊ]. Like the Uvwie pattern as described by Calabrese, this appears to be a case of positional neutralization of high vowel tongue root contrasts to [+ATR].

While there is no apparent ground for questioning the conclusion Kimatuumbi pattern involves positional neutralization of the contrast between its two highest vowels to [i], [u], there is seemingly at least some room for questioning whether the vowel system of the language is in fact a /2IU/ system to begin with. If the Height 2 vowels were treated

[32] As is typical in Bantu languages, noun class prefixes in Kimatuumbi have several paradigmatically related agreement markers (Odden 1996: 33ff). For the most part, these also have only the vowels /i/, /u/, /a/. There is one exception, however: determiner forms have only the three vowels /ɪ/, /ʊ/, /a/. Odden derives the high [-ATR] vowels of the determiner forms from underlying /i/, /u/ by a morphologically conditioned rule.

as [e], [o] rather than [ɪ], [ʊ], Kimatuumbi would be a /1IU/ /i e ɛ a ɔ o u/ system with a simple prohibition, for which there is much precedent in the patterning of other languages, against mid vowels in various affixal contexts. It is worth noting that, as a /2IU/ system, Kimatuumbi is also somewhat exceptional in a second respect as well, which is that, as noted above [check], [-ATR] vowels appear to be dominant in assimilation processes. As we have noted, such behavior is not very typical of /2IU/ systems but is typical of /1IU/ systems.

As discussed by Hyman (1999), it is not always easy to determine whether a seven-vowel system is /i ɪ ɛ a ɔ ʊ u/ or /i e ɛ a ɔ o u/, and it has sometimes been questioned (Clements 1989, 1991, Parkinson 1996) whether the distinction is phonologically real. I argue elsewhere (Casali 2003: 326-330) that the distinction is real enough and that various criteria often suffice in practice to settle the question. This does not mean, however, that clear and relatively theory-independent grounds for settling the question will necessarily be readily available in all particular cases. Kimatuumbi is one of twelve /i ɪ ɛ a (ə) ɔ ʊ u/ languages included in the survey of [+/-ATR] dominance patterns reported in Casali (2003). Though treated, following Odden's description, as a /i ɪ ɛ a ɔ ʊ u/ system in that survey, it is perhaps the only language of the twelve for which this classification is potentially open to question. In contrast to /i ɪ ɛ a ɔ ʊ u/ languages like Kinande (Archangeli & Pulleyblank 2002, Mutaka 1995) or Zande (R. Boyd 1997), in which the surface occurrence of [e], [o] as allophones of /ɛ/, /ɔ/ in [+ATR] contexts leaves little room for doubt that the height 2 vowels are /ɪ/, /ʊ/ (see Casali 2003: 328-329) and not /e/, /o/, Kimatuumbi has only seven vowels on the surface, nor does there appear to be any other phonological evidence that might decisively favor the /i ɪ ɛ a ɔ ʊ u/ analysis over /i e ɛ a ɔ o u/. Neither does impressionistic phonetic evidence discussed by Odden (1996: 5) appear to be all that decisive.[33]

It would certainly be premature to conclude with any certainty that Kimatuumbi is actually a seven vowel /i e ɛ a ɔ o u/ language. On the other hand, it is not very clear that it must be treated as a /i ɪ ɛ a ɔ ʊ u/ system either. It is thus not a completely compelling example of a /2IU/ language which positionally neutralizes high vowel tongue root contrasts to [i], [u].

[33] Odden reports (1996: 5) that whereas he found the Height 1 ([i], [u]) and Height 2 ([ɪ], [ʊ]) vowels to be perceptually difficult to distinguish, Charles Kisseberth found it more difficult to distinguish the height 2 vowels from Height 3 ([ɛ], [ɔ]). In any case, the relative height of [ɪ], [ʊ] and [e], [o] is known to be quite variable (Casali 2008: 507-511) in languages in which the two sets contrast; in some such languages, [e], [o] are acoustically higher than [ɪ], [ʊ]. Also, the auditory distinction between [ɪ] and [e] and between [ʊ] and [o] is often quite subtle, to the point where the distinction has been missed in descriptions of a number of nine-vowel languages (Casali 1995a, 2008). (Impressionistic voice quality differences potentially help to resolve the issue in some cases (Casali 2003: 326-330, Starwalt 2008), but no such differences are described for Kimatuumbi.) Thus, a finding that Height 2 vowels are relatively high auditorily is not incompatible with the assumption that they are [e], [o] rather than [ɪ], [ʊ].