Deconstructing Tongue Root Harmony Systems*

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1. Introduction

In this article, I will discuss various manifestations of tongue root (TR) harmony in African languages and I will propose an account within the model proposed in van der Hulst (to appear a).[1] In this article, I will not be dealing with the phonetic correlates of TR harmony. This means that the designation 'tongue root harmony' is not meant to be a commitment to a specific phonetic correlate. Rather, my goal is to deconstruct the general label 'tongue root harmony' into a number of subtypes, based on the formal treatment of these harmonies within my model, not all of which necessarily involve activity of the tongue root.[2] In models that use a single binary feature [±ATR] for tongue root harmony, there is disagreement concerning the dominance or [+ATR] or [-ATR]. If both options seem to be necessary this suggests the need for a *binary* feature, which implies a problem for unary feature approaches. My goal in this article is to show that a unary model, as developed in Radical CV Phonology (RcvP; see van der Hulst (1995), (2015a), (2015b), (in prep.)), offers a straightforward solution which adopts, in part, the idea that TR harmony can involve headedness alignment, developed in Harris (1994a).[3] My account differs from Harris' proposal because while head alignment accounts for a certain type of TR harmony, I also adopt licensing of a unary ATR element to account for a second type of TR harmony. The difference between these two formal mechanisms correlates with a typological finding reported in Casali (2003, 2008, 2014) which bears directly on this issue. Based on an extensive typological study, Casali (2003, 2008, 2014) establishes a strong correlation between the structure of vowel systems in African languages and the choice of which 'value' is dominant. In his groundbreaking 2003 study, Casali has shown that dominance of [+ATR] (understood by him in a broader sense than just including dominant-recessive systems) correlates with having an ATR-distinction among high vowels. If such as distinction is present we speak of a 2H system. If such a distinction is missing, we deal with a 1H system and in this case Casali observes [-ATR] dominance. I will discuss this correlation and then show that the RcvP model provides a formal basis, and thus explanation for it that does not appeal to a binary feature [±ATR]. The crucial point is that in the RcvP model, languages that have a contrast among two series of high vowels *necessarily* have a different formal representation (namely one that activates the ATR element) than languages that lack this contrast (which do not require this element to be active). This implies that the contrast between [ɛ~e] or [ɔ~o] (in 'standard' seven- and nine-vowel systems) is phonologically represented in different ways, with the consequence that in the latter (with two series of high vowels), the unary element [ATR], notated as |∀|, is active (and needs licensing to account for harmony), whereas in the former harmony can only be expressed in terms of 'head alignment' for the element |A|. This account

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[1] TR harmony also occurs outside Africa. Van der Hulst (to appear a) discusses Asian TR systems in chapters 9 and 10. Of particular interest is also the South American language Karajá (Ribeiro 2000), discussed in van der Hulst (to appear a, chapter 10).

[2] Edmondson & Esling (2006) also point to the relevance of [−ATR] involving constriction of the aryepiglottic folds and the epiglottis.

[3] A general review of unary feature, or elements, can be found in van der Hulst (2016a). Also see Harris & Lindsey (1995).

suggests that both types of 'tongue root' harmony are fundamentally different in formal terms, which may correlate with a difference in the phonetic mechanisms.

This article is organized as follows. In section 2, I outline the RcvP model of segmental structure as well as the licensing approach to vowel harmony that is developed in van der Hulst (2012), (2014), (to appear a), (to appear b)). Section 3 summarizes Casali's typological findings. In section 4, I show how the RcvP model provides a formal basis for the correlation between the types of vowel system that a language has and the type of tongue root harmony. In section 5, I point to some further issues and present the conclusion from this study.

2. The framework[4]

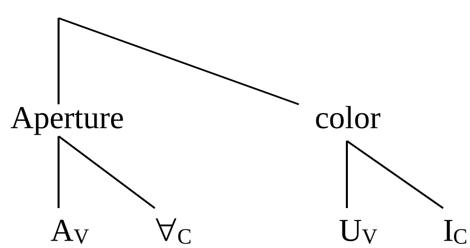
The account developed in van der Hulst (to appear a) adopts the following principles:

(1) Fundamental principles of my proposal

a. Phonological primes are unary (they are called *elements*), organized into classes[5]
b. Element specification is *minimal*
c. Vowel harmony involves the *licensing* of *variable* elements in nuclei, with licensers typically being vowels in adjacent nuclei that contain a licensed instance of the relevant element
d. A variable element is phonetically interpreted only if it is licensed
e. Licensing is strictly *local*

(1a) is characteristic of a model called *Radical CV Phonology* (RcvP for short, van der Hulst (1995), (2015a), (2015b), (in prep.)), which is a version of *Dependency Phonology* (DP; Anderson & Ewen (1987)). In RcvP, there are four non-laryngeal elements, divided over two classes, 'aperture' and 'color':[6]

(2)



Within a class, elements can occur alone or in two kinds of combinations (differing in which element is the head). Additionally, elements can occur in a primary (head) and secondary

[4] See van der Hulst (to appear a, chapter 2) for details concerning the model summary in this section.
[5] The idea to acknowledge element classes occurs in the earliest version of Dependency Phonology (e.g., see Anderson & Jones (1974)). The same idea later led to versions of what was called 'feature geometry' (see Clements (1985)).
[6] Strictly speaking, in RcvP these elements are all encoded in terms of two primitive elements, |C| and |V|. For the sake of clarity, I here use the unique labels for the elements, but in (2) their C or V-status is indicated by way of a subscript. Henceforth, I will omit these subscripts.

(dependent) subclass[7], where only the former allows combinations.[8] While the primary subclass indicates aperture differences in the oral cavity, the secondary subclass allows activation of the other the nasal and pharyngeal cavity:

(3) Aperture

Primary (Head)		Secondary (Dependent)
∀	HIGH	*N*: NASAL
<u>∀</u>A	HIGH-MID	
<u>A</u>∀	LOW-MID	
A	LOW	*A/∀*: RTR/ATR

In this article, I opt for a version of RcvP in which *both* ATR and RTR are possible interpretations of the secondary version of primary |A|.[9] The general interpretation of this secondary element is ‘activation of pharyngeal cavity’. I will assume that ‘activation’ can lead to two different phonetic realities. In one the contrast is expressed in terms of the secondary element being part of retracted vowels, whereas in the other the dominance is expressed by this same secondary element being part of the advanced vowels. In a sense, these two different phonetic realization of the pharyngeal cavity element display a C/V split in the phonetic domain, with the C-choice being ATR, while the V-choice is RTR.[10]

In (4) I represent the full RcvP geometry, even though in this article I will only be concerned with the aperture distinctions:

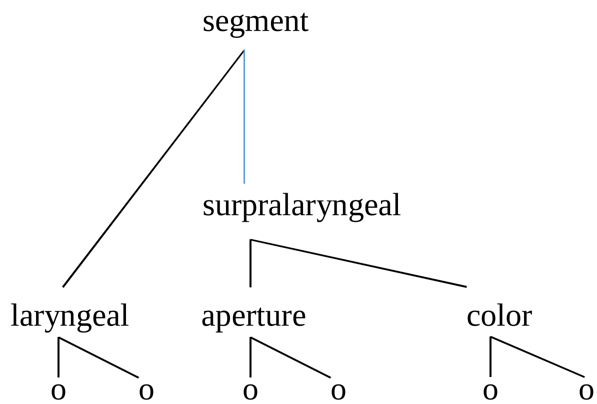
[7] This distinction is also adopted in Anderson (2011, volume 3); see also Morén (2006).

[8] In van der Hulst (in prep.) I motivate this, referring to the fact that in a dependency approach it is ‘natural’ for dependent to display fewer structural options than heads; see Harris (1990) and Dresher & van der Hulst (1998).

[9] In van der Hulst (to appear a) I also consider several variants of the RcvP model. In one, ATR is derived from secondary |*I*| (reviving a proposal in van der Hulst 1988b), which would do justice to the fact that frontness (represented by primary |I|) and ATR draw on the same articulatory mechanism of tongue root advancement involving activation of the genioglossus (see van der Hulst 2015c). In another variant ATR is the exponent of the secondary version of primary |∀|, i.e. |*∀*|.

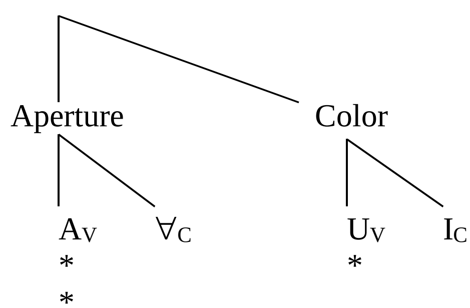
[10] The choice of |*∀*| for ATR derives from a version of the RcvP theory in which ATR is the secondary version of the primary element |∀|; see previous note. Here, I use the latter symbol to represent one of the two possible phonetic interpretations of the secondary version of primary |A|.

(4) The ‘geometry’ of elements in Radical cv Phonology[11]



Minimal specification, (1b), is achieved by following an algorithm proposed in Dresher (2009), the *Successive Division Algorithm* (SDA). This algorithm uses a specific ranking of the elements which I derive from (2), by assigning a grid mark each head position:[12]

(5) a.



b. Ranking: A > U > I/∀ > { *∀/A*, *N*}

(5b) also assumes that primary elements come before secondary elements. The equal ranking of |∀| and |I| allows for ‘free’ variation. However, I will assume that |I|, which has a more salient phonetic interpretation, takes precedence over |∀| because, unless this element is non-distinctive (as in Finnish where [i] and [e] are so-called neutral vowels). In section 3 I will explain how the SDA in conjunction with the element ranking in (5b) accounts for *a minimal, redundancy-free representation* of vowel systems.

(1c) presents a crucial innovation of the RcvP account of vowel harmony. The motivation for using the variable notation is that it allows a distinction between invariant ‘negative’ vowels (i.e. vowels that lack the harmonic element) in *disharmonic roots* and *non-alternating affix vowels*

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[11] This geometry deviates somewhat from the one adopted in Anderson & Ewen (1987) and bears a close resemblance to the original geometry that was proposed in Clements (1985). In van der Hulst (in prep.) I compare the RcvP model to other models with which it shares certain properties, such as the model proposed in Morén (2003).

[12] While elements within class nodes can enter in dependency relations with either one being a possible head, both the |A| element and the |U| elements are ‘natural heads’ in nuclear position. This is because the nuclear position is a V-position which thus favors V-type elements; see foot note 32 and van der Hulst (in prep.) for details.

on the one hand, and alternating vowels on the other. Thus, the model allows the following three-way distinction (where 'ε' stands for 'any element'):

(6)	a.	ε	b.	(ε)	c.	–
		X		X		X

a = invariant ε (*positive vowel*)
b = alternating vowel, element must be licensed to get interpreted
c = invariant non-ε (*negative vowel*)

This distinction parallels the distinction between [+F], [0F] and [-F] in a binary system.[13] While (6) allows a three-way distinction in how vowels in the lexicon are represented with respect to a given element, this proposal does not undermine the unary nature of the elements. Contrast *in the vowel system* is only expressed through presence or absence of an element. The variable notation encodes that certain vowels *as part of specific morphemes* have a dual character, most typically in displaying an alternation between presence and absence of the element. The notation '(ε)' simply means that for the relevant vowel it is undecided *in the lexicon* whether it will surface with or without the element in question.[14]

One potential difference between the present proposal and comparable three-way distinction in a binary system is that the notation in (6) suggests that the two 'marked values' of element |ε| are effectively (6a) ('|ε| is definitely present') and (6b) ('|ε| is potentially present, contingent on licensing'), while (6c) ('|ε| is definitely absent') is unmarked.[15]

(1d) is derived from approaches to vowel harmony in *Government Phonology* (GP; Kaye, Lowenstamm & Vergnaud (1985); Harris & Lindsey (1995); Ritter (1995); Charette & Göksel (1998), among others). In the present model (1d) implies that variable elements that are not licensed remain 'silent'. The notion of licensing has been widely referenced as playing a role in phonological generalizations (see e.g. Walker (2010)). In my account of vowel harmony, the key type of licensing will be *lateral licensing*[16] along phonological 'tiers'. I will assume that the default setting for licensing directionality is 'bidirectional'. This is necessary for both root-control systems that have both harmonic prefixes and suffixes and for dominant-recessive systems.[17]

(1e), locality, is a central theme in the discussion of vowel harmony (if not of all linguistic relations). The notion of locality has been used in different ways even within the study of vowel harmony. While virtually all accounts of vowel harmony appeal to some notion of locality, frameworks differ in important details of defining the relationship or in dealing with apparent violations of locality. I will adopt a *strict* interpretation of locality, which avoids mechanisms such 'discontinuous association' or 'feature/element insertion' to account for apparent violations. I emphasize that, for me, locality does *not* mean establishing a relation between two entities that are 'as close as possible' (as proposed in Nevins (2010)), but rather between elements that are adjacent with reference to the nuclear tier (*nuclear locality*). To account for some cases of expected 'transparency' I will also invoke *bridge locality*, in which case the locality requirement for

[13] Inkelas (1995) exploits this three-way difference in a binary system for much the same purpose that I exploit the three-way distinction in (6).
[14] This notation does not mean 'floating', as in autosegmental models, which is used for different purposes.
[15] This point was made explicit by a reviewer.
[16] In van der Hulst (to appear a) I also make use of another kind of licensing called *positional licensing*.
[17] In van der Hulst (to appear a, chapter 4) I propose that licensers must be head elements. This refers to the head status of elements within a class.

licensing is satisfied on an element tier that differs from the harmonic tier (such cases fall under the rubric of 'parasitic harmony', as first described in Steriade (1981), but form a special subclass of this rubric).

Languages that display vowel harmony for some element 'ε' are subject to a constraint of the general format in (7):

(7) All units X in domain D must be positive or negative for element |ε|

In the usual case X=nucleus, but X can also be another element (when we are dealing with bridge locality). The constraint in (7) is satisfied by specifying alternating vowels with the variable element, which automatically triggers the licensing relation. Vowel harmony is thus *not* the result of a (repair) rule that fills in or changes segmental structure.

A key aspect of my approach to vowel harmony is that vowels that refuse to alternate, and as such either block harmony or are (seemingly) 'ignored' by it, should not simply be designated as 'opaque' or 'transparent' on a language-specific basis. In fact, following a proposal made by van der Hulst & Smith (1986), the behavior of non-alternating vowels is largely predictable from their element structure (which depends on the structure of the vowel system). So-called 'transparent' behavior is possible when a vowel is *compatible* with the harmonic element. Thus, a vowel [i] can behave as 'transparent' in a palatal system because it is compatible with the presence of the palatal element |I|. As such, this vowel could carry the harmonic element.[18] On the other hand, vowels that are *incompatible* with the harmonic element, such as a non-advanced [a] in advanced tongue root (ATR) systems are predicted to be opaque, because the licensing relation cannot ignore or 'skip' an intervening vowel, as per strict locality.[19]

As an illustration of the licensing approach to VH, consider the RcvP representation of ATR-harmony in Akan, illustrated by the following examples:[20]

(8)	ɔ- kasa -ɪ	[ɔkasaɪ]	'he spoke'
	o- fiti -i	[ofitii]	'he pierced it'
	o- bisa -ɪ	[obisaɪ]	'he asked'
	ɔ- kari -i	[ɔkərii]	'he weighted it'

The third example shows the form [bisa], in which the final [a] blocks the 'spreading' of ATR of the first vowel to the suffix, showing that [a] is opaque.

[18] However, such vowels can also act opaquely. In fact, we will see that there are four different ways in which a vowel such as [i] can behave in palatal harmony systems, following an important typological study of harmony on Balto-Finnic languages by Kiparsky & Pajusalu (2003). Importantly, none of the four types violate strict locality. See van der Hulst (to appear a, chapter 4). For a general account of transparency and opacity in vowel harmony see van der Hulst & van de Weijer (1995) and van der Hulst (2016b; to appear).

[19] Apparent counterexamples to the expected opacity of incompatible vowels can be explained in terms of allowing locality to be defined with reference to another element tier (i.e. in terms of bridge locality). See van der Hulst (to appear a, chapter 3).

[20] See Stewart (1967, 1983) and Clements (1981).

(9)	a.	ɔ- kasa -ɪ (Ɐ) (Ɐ)	[ɔkasaɪ]	‘he spoke’
	b.	o- fi ti -i (Ɐ) « Ɐ Ɐ » (Ɐ)	[ofitii]	‘he pierced it’
	c.	o- « bisa - ɪ (Ɐ) Ɐ (Ɐ)	[obisaɪ]	‘he asked’
	d.	ɔ - ka ri - i (Ɐ) Ɐ » (Ɐ)	[ɔkərii][21]	‘he weighted it’

As per Casali’s typological generalization, which I will discuss in section 3, Akan has a 2H system, which we expect to be ATR-dominant. The opacity of [a] in (9c and d) is expected since [a] is incompatible with the harmonic element |Ɐ| and given that licensing is local at the ‘nuclear’ projection. The ATR element of the root vowel [i] cannot license the variable element in the suffix and prefix, respectively, which thus is realized as non-advanced.

2.4. ATR as headedness

The analysis presented in this article uses a unary element system, a variant of the system that was developed in Anderson and Ewen (1987), Kaye, Lowenstamm & Vergnaud (1985) and Harris & Lindsey (1995). Harris (1994) and Harris & Moto (1994) developed the idea to treat ATR harmony in terms of headedness alignment. The RcvP model shares important characteristics with the system that Harris puts to use in his studies, but there are also some differences. While, as will be shown, I accept that certain types of tongue root harmony involve headedness alignment (or rather ‘licensing of headedness’), my system employs an actual ATR element, notated as |Ɐ|, as shown in the previous section. Specifically, I will argue that 2H system uses the ATR element, while 1H system use head alignment, the choice thus being dependent on the structure of the vowel system.

3. Asymmetries in African TR systems

Tongue root vowel harmony has been reported for many Niger-Congo and Nilo-Saharan languages and for some Afro-Asiatic languages (see Casali (2008: 505 ff.) for a more detailed survey). Hall et al. (1974) discuss ATR harmony in African languages, making reference to a well-known division of harmony systems into two types, which broadly correlate with geographical and genetic differences:

(10) a. Root-controlled harmony (~West Africa, ~Niger-Congo)
b. Dominant-recessive harmony (~East Africa, ~Nilo-Saharan)

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[21] The fact that the [a] in the fourth example shows up as [ə], an advanced version of [a], is attributed to a local ‘phonetic’ rule (i.e. an implementation process).

The typological difference is usually characterized with respect to the possibility of affixes being able to 'spread' their ATR value to roots and, indeed, across the entire word. Such affixes invariantly have advanced vowels and this is why this value is considered to be *dominant*. Any morpheme, root or affix, that contains this value will influence all other morphemes in the word. These systems are called 'dominant-recessive' (DR) systems. Systems that do not contain affixes with vowels that spread their ATR-value are called 'root controlled' (RC), because in such systems, affix vowels will always harmonize with the root vowels, whether the root's value is [+ATR] or [−ATR]. I will now discuss a very important contribution to the understanding of TR-systems in Casali (2003, 2008, 2014).

In his groundbreaking 2003 study, based on a database consisting of 110 languages, Casali replaces the typology in (10) by a different typology, namely one that correlates [+ATR] or [-ATR] dominance with the structure of the vowel system. The crucial and very important contribution of Casali (2003) is that dominance of [+ATR] is overwhelmingly attested in 2H systems only, whereas dominance of [−ATR] is highly typical of 1H-systems.[22] He mentions only one 1H system (Legbo) that would appear to have [+ATR] dominance (p. 526), adding a second case (Ikoma) in Casali (2014). Otherwise all his 1H systems have a harmony that requires [−ATR] to be active. On the other hand, there is one 2H language, Kimatuumbi, that apparently displays only dominance of [−ATR], but Casali (2008: 538, fn. 17) notes that this dominance is "quite restricted". However, Kimatuumbi can be analyzed as a case of *total aperture* harmony (see van der Hulst (to appear a, chapter 6) and the appendix in Casali (2014)), which removes this case as being problematic.

We can summarize Casali's finding as follows:[23]

(11) Casali's Correlation
2H $\rightarrow$ [+ATR] dominance
1H $\rightarrow$ [−ATR] dominance

The typology that is implied in (11) replaces the old one in (10), which turns out to be misguided since the presence of affixes that can spread [+ATR] throughout the word is only one of the possible signs of [+ATR] dominance.[24] In previous accounts (such as Aoki (1968) and Hall et al. (1974)), this is the property that was said to be defining of the so-called dominant-recessive pattern. These accounts also suggest that whereas vowel harmony in root control (RC) systems is 'morphologically-driven' (roots dominating over affixes), dominant-recessive (DR) systems would be 'phonologically driven' (one value of the feature dominating over the other). Casali convincingly argues that this is also not the correct dividing line. In so-called DR systems, there are morphological factors as well, such as the limitation of the dominant value to roots and suffixes,

[22] This idea, as mentioned above, is already present in Casali (1996), which studies the effects of mid vowel coalescence in 1H and 2H systems. In the former, the result is a low mid vowel, showing [-ATR] dominance, while in the latter the result is a high mid vowel, which shows ATR dominance.

[23] If this correlation is fundamentally in effect, it implies that several languages that have a 1H system and that have been analyzed in terms of [+ATR] must be reconsidered. Casali (2003: 310) mentions Korop (Polgárdi (1998: Ch. 5); Archangeli & Pulleyblank (1994)), Ogori (van der Hulst & van de Weijer (1995)); analyzed with [−ATR] in Salting (1998)), Wolof (Ka (1988), analyzed with [−ATR] in Archangeli & Pulleyblank (1994)). Another celebrated case is Standard Yoruba, which is analyzed using [+ATR] in Bakovic (2000), but with [−ATR] in Orie (2001) and Archangeli & Pulleyblank (1994).

[24] Casali (2003: 320 ff.) identifies a number of properties that are diagnostic of [+ATR] dominance.

thus excluding prefixes.[25] The often observed asymmetry between prefixes and suffixes is also manifested in so-called RC systems that exclude prefixes from undergoing harmony; see Leitch (1996) on Bantu-C languages. Clearly, then, both types of systems, DR or RC, display similar morphological sensitivity. It is also important to note that, while it is true that affixes may contain the dominant value in certain systems, affixes with this value can be merely marginally present, or not at all, which means that we then should also expect systems in which [+ATR] is dominant, even in the absence of dominant affixes.

Some authors (Hall et al. (1974); Ringen (1975, 1979); Anderson (1980); Hall & Yokwe (1981); Kutsch Lojenga (2008)) have previously suggested to lump all TR-systems into one set in which [+ATR] is always the dominant value, proposing that the difference between so-called RC and so-called DR systems merely lies in the fact that the former lack suffixes with the dominant value. This idea cannot be the whole story, however, because it leaves two facts unaccounted for. Firstly, Turkic languages have suffixes with invariant frontness which do not harmonize back into the stem.[26] This means that the occurrence of affixes with invariant vowels is not sufficient to cause a so-called DR system. Secondly, while it minimizes the difference between RC and DR systems, it fails to explain why the distinction only occurs in systems with [+ATR] as the active element. We also need to take into account those tongue root systems in which [+ATR] is not dominant at all, namely systems that fall into the 1H group. As we will see, such systems do not display a distinction between DR and RC types; all appear to fall into the RC type, even though they may sometimes contain invariant affix vowels (see Leitch (1996)).

Summarizing, Casali argues that the crucial property that typologically classifies African VH systems is [+ATR] dominance versus dominance of [−ATR]. Whether or not affixes can have the [+ATR] value in systems with [+ATR] dominance is a secondary issue and merely a sign of [+ATR] dominance, which causes 'strong assimilatory effects'. There can be some or many dominant affixes, or indeed no affixes with dominant [+ATR] at all. In the latter case, the system has the appearance of an RC system, but this does not mean that such a system is not [+ATR] dominant in Casali's terms.

Seeking for an explanation for why these two types of tongue harmony seem to exist, Casali (2008: 527) states:

> "It is not obvious where a satisfactory explanation for system-dependent [ATR]-dominance might be found. There have thus far been comparatively few attempts to explicitly account for system-dependent [ATR] harmony, something that is likely due in part to the fact that the correlation itself may not be that widely known."

One proposal that he discusses involves the use of the feature [+low], instead of [−ATR], for 1H systems. In element theories, this would take the form of using the element |A|. Indeed, van der Hulst (1988a) made precisely such a proposal for Yoruba which has a 1H system. One could then appeal to the fact in 2H systems [low] (or |A|) cannot be used to distinguish two series of high vowels,[27] which might imply that 2H systems *must* use the feature [ATR]. Casali concludes (Casali 2008: 527):

[25] However, there are, in fact, also some systems that have dominant prefixes (such as Tunen, see Mous (1986), Kibudu (Kutsch Lojenga 1994) and Kinande (Hyman 2002).

[26] See van der Hulst (to appear, chapter 5).

[27] Schane (1984) actually does propose that the high [−ATR] series contains the 'particle' |a|.

> "Perhaps the fairest assessment at present is that a fully satisfactory solution to the problem of explaining system-dependent [ATR] dominance has yet to be found."

Seeking an account, Casali (2014) observes that of all the possible combinations of [ATR] values occurring (a) as dominant, (b) as specified (marked) in high vowels and (c) as specified in low vowels, only two are systematically attested – namely the two in which for all these three cases the value is either [−ATR] (in 1H) or [+ATR] (in 2H). Casali says that this pattern follows if we assume that a language can have either [+ATR] or [−ATR] as literally marked, but not both. This, in itself, does not explain that the value is [+ATR] in 2H and [−ATR] in 1H. Casali then explores whether we can predict which value is dominant by looking at gaps in the vowel system. If there is a gap among high vowels, and retracted vowels are missing – as in a 1H system – this implies that [−ATR] is dominant. The idea here is that one could only have a constraint involving features that are active; hence *[+high, -ATR]. For gaps in the low vowel region, this means that if there is only a low [−ATR] vowel, the active value is [+ATR], which allows the constraint *[+low, +ATR]. As he realizes, this proposal does not result in a solution for ten-vowel systems (where there are no gaps) even though we would like to derive that such a system has [+ATR] as the active value. It would seem then that looking at gaps does not provide the answer.

To explain why the feature [ATR] is not used in 1H systems, we would have to derive somehow that the feature [ATR] will only be 'activated' for systems that have two series of high vowels. This suggests a 'hierarchy' of features or elements of the kind that was discussed in section 2. I will argue in section 4 that RcvP might be the kind of theory that explains the correlations with respect to system-dependency reported in Casali (2003).

4. Toward an explanatory account

I would now like to suggest that the RcvP provides a principled basis for explaining why [+ATR] dominance comes into play only when there are two series of high vowels. I will also try to provide an account, in terms of this model, of some of the differences between [+ATR] and [−ATR] dominance effects.

It is now crucial to explain *why* in RcvP the element that represents [+ATR] (i.e. | $\not\forall_v$ | is only active if there is a distinction in the high vowel series or among two low vowels. Recall that the present model adopts a version of the Successive Division Algorithm proposed in Dresher (2009), in conjunction with a specific ranking order of the elements:

(12) A > U > I/∀ > { $\not\forall$/*A*|, *N*}

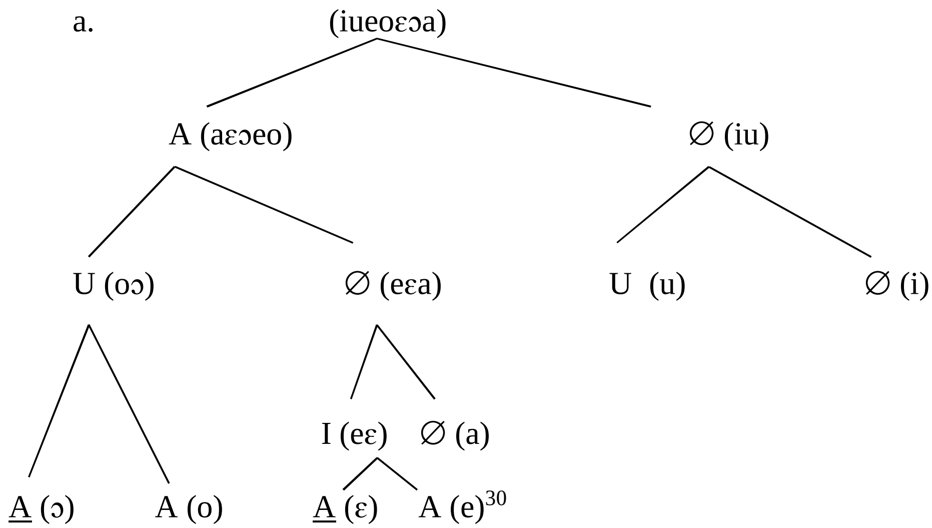
The languages that are central in Casali's typological work have either seven vowels (with two mid series and one high series, called 1H) or nine vowels (with two mid series and two high series, 2H).[28] In (13) and (14) I apply the SDA to the two types of systems, respectively. In a seven-vowel system, after activation of the ∀-element to differentiate mid front vowels from [a], the next step is to differentiate between the two rows of mid vowels. At this point, no new element needs to (or

[28] There are also seven-vowel systems with two high series and one mid series; those are included in the 2H class that calls for ATR-dominance.

can be) activated. Rather, the SAD algorithm must be assumed to apply such that it introduces a headedness distinction for the A-element that the mid vowels share:[29]

(13) Seven-vowel system (iueoɛɔa)

a.



b.

[ɔ]	[o]	[ɛ]	[e]	[a]	[u]	[i]
$\underline{A}$	A	$\underline{A}$	A	A		
U	U				U	
		I	I			

As shown, there is no need in this system to activate the ATR-element in this system.

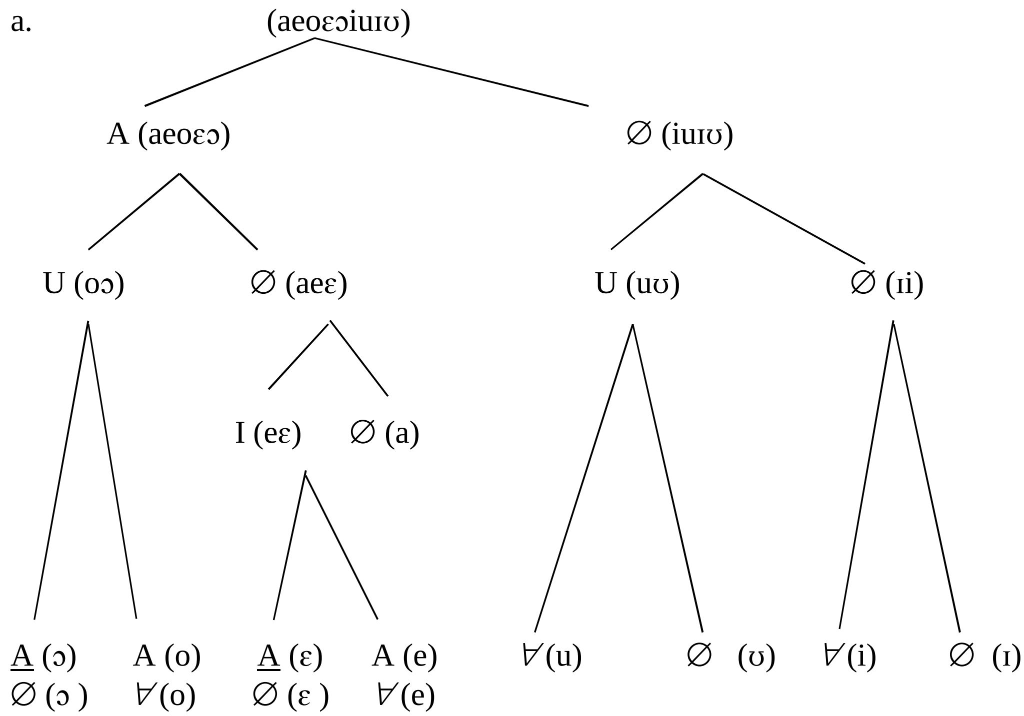
Let us now consider a nine-vowel system:

[29] In van der Hulst (to appear a) I argue that the head specification of the A-element is the only option. I suggest that the natural preponderance of |A| follows from the fact that this element is of the V-type. This feeds into the idea that such systems are ‘rtr-dominant, as expressed by the headedness of |A|. I adopt the idea that the ∀-element cannot be a head, neither in segmental structure, nor in licensing. This means that high mid vowels are represented as ‘headless’ combinations of the aperture elements. Despite this fact, the parsing algorithm distinguishes between the ∀-element as either a head or a dependent. This is necessary because this element is activated later than the |A| element. In the actual representation of the vowels, the asymmetry between the two aperture elements is minimally expressed by designating headedness on the A-element only. Perhaps, this natural prominence of |A| can in some cases be overruled. This will account for the apparent [+ATR] dominance in some 1H languages such as Legbo and Ikoma. This is the only situation in which RcvP would then allow a kind of ‘markedness reversal’.

[30] Making the contrast between mid-vowels in terms of headedness of the A-element does not mean that RcvP subscribes to ‘diacritic headedness’ as advocated in Government Phonology (see Backley 2011); see van der Hulst (to appear, in prep.).

(14) A nine-vowel system (aeoɛɔiuɪʊ)

a.



b.

[ɔ]	[o]	[ɛ]	[e]	[a]	[u]	[ʊ]	[i]	[ɪ]
A	A	A	A	A				
U	U				U	U		
		I	I					
∀		∀			∀		∀	

As shown, for 2H-9 systems the assignment of |∀| in the dependent unit is necessary for [i] and [u], so that these vowels are distinguished from [ɪ] and [ʊ].[31] For the mid vowels there are then two ways to encode the tongue root difference, headedness of |A| or in terms of the ATR-element. Given that the ATR-element must be activated, I will assume that the most minimal encoding of the 9-vowel system is in terms of the ATR element for both mid and high vowels.[32] It would seem that once activated to distinguish the two series of high vowels, |∀| asserts its presence 'aggressively'. As we will see shortly, the aggressiveness of |∀| also explains its syntagmatic dominance effects that have been noted by in Casali's work.

[31] Given that the ATR-element would also be required for a distinction between two series of low vowels, the prediction is that this distinction would also require activation of the ATR-element. Usually, the distinction among low vowels is missing in systems that lack the distinction among high vowels. The case of Wolof presents an apparent example of a 1H language that has an ATR distinction for short vowels. However, my analysis in van der Hulst (to appear a, chapter 8) of Wolof effectively involves the postulation of two high series, to account for the transparent behavior of [i] and [u] (which will be represented with a variable ATR-element). As we have seen, Casali does not think that [+ATR] is dominant unless there is a 2H system. He considers advanced counterparts to [a] in 1H systems as unspecified mid vowels.

[32] This would follow from Martinet's (1955) idea, revived in Clements (2004), that phonological 'features' (which I here take to include marking of headedness), once active, are used maximally in a given system.

In any event, it is necessary that when there are two series of high vowels, we *must* activate the secondary pharyngeal element. But this could be either |*A*| or | ∀|, which are two different phonetic realization of the pharyngeal element. It would be good if we had an explanation for why 2H languages would pick| ∀| which leads to ATR dominance. As shown in van der Hulst (to appear a, chapter 10) in languages such as Nez Perce, Middle Korean and Chukchi (sometimes referred to as displaying 'diagonal harmony') harmony seems to involve licensing of the |*A*|- version of the pharyngeal element. The vowel systems of these languages do not contain two series of mid vowels, which means that the harmony could not be a matter of A-headedness. I suggest that the choice for |*A*| being the active element rather than | ∀| is perhaps dependent on the structure of the vowel system which, rather than falling in the class of 2H languages, can be analyzes as 'double triangular systems' (2X3 systems), i.e. a doubling of a three vowels system with two versions of 'i', 'u' and 'a', one retracted and the other plain. This would be another example of the system-dependency of vowel harmony.

The preceding discussion leads to the conclusion that the mechanism for VH in 2H systems *must* differ from the mechanism in 1H systems. In 2H systems, the active element is the ∀-element. I treat this in terms of a variable ATR-element. In 1H harmony systems, what is variable is not an element, but the headedness of the A-element. I will refer to the mechanism of harmony here as 'headedness agreement' (which is similar to the notion of head-alignment in Government Phonology; see Harris 1994). For easy of reference I will say that such systems are 'rtr-dominant', to distinguish them from diagonal systems that were just mentioned in which the secondary element |*A*| is dominant, which I refer to as RTR-dominant.

I repeat the two-fold representation of the [e] - [ɛ] contrast in (15):

(15)

	a. 1H		b. 2H	
	ɛ	e	ɛ	e
	$\underline{A}$	A	A	A
	I	I		I
				∀

In (16) I display the two types of licensing that account for tongue root harmony in both cases:

(16)

a. 1H: rtr-dominance

ɛ		e
$\underline{A}$	»	($\underline{A}$)[33]

b. 2H: ATR-dominance

ɛ		e
A		A
∀	»	(∀)

Let me now address how 1H harmony cases can be captured in RcvP, using examples from Bantu C languages discussed in Leitch (1996). All languages discussed there have a 1H seven-vowel system:

[33] Here the parenthesis are around the mark for headedness.

(17) Bantu C

[i]	[u]	[e]	[o]	[ɛ]	[ɔ]	[a]
		A	A	<u>A</u>	<u>A</u>	A
		I		I		
	U		U		U	

As we have seen, systems of this kind do not need the ATR-element, i.e. |∀|. There is a distinction between the two mid series in terms of headedness of the aperture element combination. The dominance of low mid vowels in this system can be captured by taking the low mid series to be A-headed and the high mid series (as represented in morphemes) to have variable headedness. Harmony then follows if the headedness of [e] and [o] is licensed by the headedness of a preceding low mid vowel (Leitch 1996: 205 ff.):

(18) Complete harmony (Nkengo): bɔ [hɛ - ɛl] - ɛ
<u>A</u> « <u>A</u> »(<u>A</u>) » (<u>A</u>)

Having established that 2H and 1H systems entail different kinds of representations, let us now ask whether we can also provide grounds for the fact that the dominance effects are, to some extent, different in nature. Casali reports that ATR dominance is 'aggressive' in comparison to rtr-dominance? For example, ATR dominance can involve spreading' across word boundaries, in compounds and from dominant affixes. ATR dominance can also produce allophonic effects. He did not find analogous dominance effects for rtr-dominance.

The dominance of ATR and dominance of rtr are expressed in different structural places in the RcvP model, namely in the secondary aperture and primary aperture units, respectively. This, then, could correlate with difference in these two kinds of harmony systems. So let us develop the idea that the structural difference indeed provides a rationale for seeing different behaviors. I suggest that aggressive 'spreading' of ATR is direct result of the secondary/dependent status of the ATR element. ATR may share this dominant behavior with nasal harmony, which is also a secondary aperture element (see 3). For a very similar reason, laryngeal properties, especially tonal properties, are also very likely to display across-the-board spreading behavior. The intuition here is that head classes are less mobile: they stay put. The RcvP theory of harmony embraces the following, condition, which essentially expresses the same point:

(19) Heads are reluctant to harmonize[34]

A corollary of (19) is:

(20) The 'looser' the dependent element, the less restricted is its 'spreading behavior'

With reference to the overall RcvP architecture, proposed in van der Hulst (to appear a), (19/20) predicts the following hierarchy for likelihood to be mobile (which is a wider concept than 'harmonize'):

---

[34] In van der Hulst (to appear a, chapter 4) I proposed that licensers must be head elements. This refers to the head status of elements within a class.

(21) Mobility hierarchy
secondary (lar >loc[35] > man) > primary (lar > loc > man)

Ignoring laryngeal elements, we can extend (21) to the elements themselves, taking into account that, within their classes, that V-elements are natural heads, which refines that part of the mobility hierarchy:

(22) *∀* / *A* > *N* > I > U > ∀ > A

Laryngeal properties of vowels are typically tonal properties and it is uncontroversial to say that tonal properties are the most mobile (and in fact most 'autosegmental' or 'suprasegmental') of vowel properties. For consonants, laryngeal elements encode phonation and it is perhaps justifiable to claim that phonation properties of consonants are more likely to be involved in long-distance relations than manner of location properties. This justifies ranking laryngeal overall as more mobile (if long distance behavior is an instance of 'greater mobility'). We have seen that location and manner elements can be involved in vowel harmony, in palatal and labial harmony systems and in height harmony systems, respectively. Typically, height related harmonies are more restricted than 'color' harmonies (see van der Hulst, to appear, chapter 6).[36]

Given the hierarchy in (22), we would expect |I| to be most prone to harmony, and |A| the least likely harmonic element. As evidence by its parasitic behavior in Altaic languages, the element |U| can overcome its reluctance to be harmonic within a domain that is front-harmonic; see van der Hulst (to appear a, chapter 5). This means that the more likely spreader |I| can set the stage for spreading of |U|, within the color class.[37]

Let us now ask in which sense the secondary TR-element |*∀*| is less restrictive in its spreading behavior than primary elements, including |I|, |U|, |∀| and |A|. The next question will be how we can derive less restrictive behavior from the element's secondary status, beyond appealing to the hierarchies in (21) and (22).

Casali has shown that ATR-harmony (however formalized) can apply across word boundaries (indicating a phrasal domain) and across compound boundaries, which suggests a form of harmony which is less likely to be classified as 'lexical' (in the sense of Kiparsky (1982)). In Kiparsky's sense, ATR-harmony that transcends 'words' would have to be *post*-lexical. Post lexical harmony is then expected also to cause allophonic and gradient effects.[38] It is thus tempting to regard all this as a manifestation of being less restrictive.

Turning now to rtr-harmony in 1H systems, Casali observes that this form of harmony is a more 'bounded' form of harmony in that it cannot transcend word boundaries, nor does it display allophonic effects. It also does not have dominant affixes that cause roots to harmonize with them. It is shown in Leitch (1996) that rtr-harmony is often even restricted to sub-word domains. 1H systems *can* have invariant rtr-suffixes. For example, Leitch (1996) shows that in Letela (Bantu

---

[35] Recall that location elements for vowels do not have secondary occurrences.

[36] While unexpected from (22), harmony in terms of |∀| is more restricted than harmony in terms of |A| which is due to the overall defective nature of the ∀-element; see footnote 26 and van der Hulst (to appear).

[37] We do not see a similar dependency of |A|-harmony on |∀|-harmony, but this follows from the fact that we did not find examples of |∀|-harmony at all. This was attributed to the 'defective' character of the |∀|-element.

[38] Allophonic raising of [ɛ] and [ɔ] to [e] and [o] may occur in 2H languages with one series of mid vowels. For discussion of such cases, I refer to van der Hulst (to appear a, chapter 7).

C), which has suffixes with invariant rtr-vowels, these vowels do not cause harmony in roots. This suggests that head licensing harmony does *not* allow inward harmony. These very characteristics make rtr-harmony more 'restrictive'.

The question is now how we can formally characterize these restrictions, or lack thereof. Here, I first turn to a suggestion in Bakovic (2000, 2001), who proposes that the distinction between root control (a characteristic of rtr-systems) and dominant/recessive harmony (a characteristic of many but not all ATR-systems) is due to the former being cyclic and the latter post-cyclic. I see two problems with this suggestion. Firstly, *post*-cyclic does not imply post-lexical and, indeed, Bakovic here had in mind that DR harmony falls within the post-cyclic lexical stratum (called the word-level in Booij & Rubach (1987)), rather than in the post-lexical stratum. Secondly, this proposal provides no basis for the fact that DR effects can only be observed for TR-harmony.

Given that in the present model ATR and rtr have a different structural status, the former being a secondary element, while the latter involves head-licensing in the primary aperture unit, we must try to connect this difference directly to the manner in which harmonies are restricted or not. I have already suggested that greater mobility correlates with being a secondary element, but, while this is a good start, it still does not lead to a formal account of the difference. We must make one additional step. For example, we could say that harmony which involves primary elements (whether the elements themselves or their headedness) is 'restricted' in the sense of being structure-sensitive, not only in the sense of being structure-preserving (which prevents allophonic effects), but also in the sense of being dependent on morpho-syntactic structure. This opens the door to postulating that harmony involving primary elements *must* be cyclic (and outward[39]), if being cyclic is an effect of being dependent on morpho-syntactic structure.

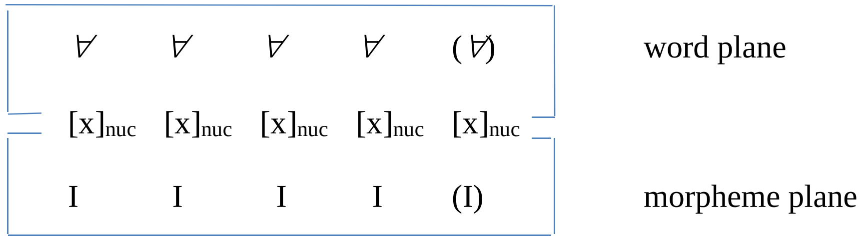
This account implies a distinction between a level of minimal specification that is accessed cyclically and a post-cyclic 'word level', the latter being input to phonetic implementation, thus assuming a model with three levels:

(23) Cyclic level
Word level
Phonetic implementation

But is the word level necessary? All things being equal, a simpler model would be one in which there are just two levels, the 'underlying level' and the level of phonetic implementation. If we were to attempt to reduce the number of levels to just two, the natural candidate for elimination would be the intermediate 'word-level'. Here I suggest, tentatively, that an approach which eliminates the need for an intermediate level, would be to see the difference between cyclic and non-cyclic licensing, *not* in terms of two derivational levels, but rather as involving two *planes* at the one and only 'phonological' level. In one plane, the morphological structure drives the application of rules and regularities. We could call this the 'cyclic plane', but I will adopt the term 'morpheme plane'. The other plane could be called the non-cyclic or word-level plan, but I will simply refer to it as the 'word plane'. We could then correlate this plane distinction with the distinction between primary and secondary elements by assuming that primary elements are active in the cyclic plane, whereas secondary elements are active in the word plane. A weaker position would be to say that only secondary elements can be active in the word plane:

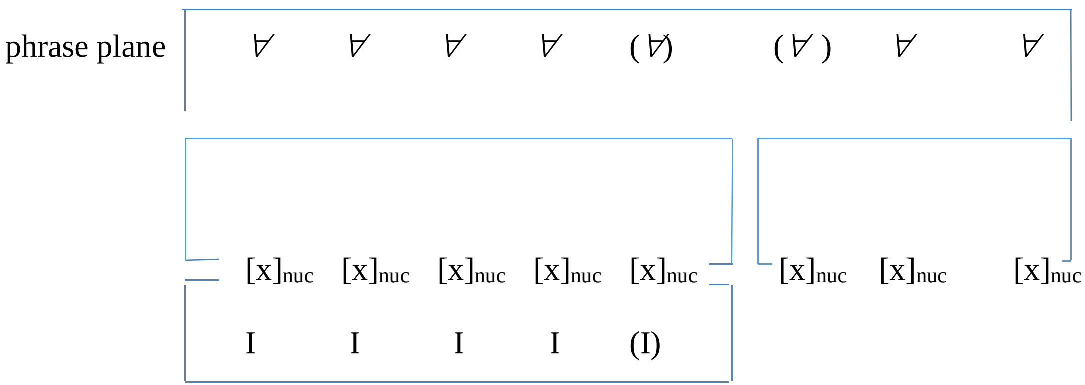
[39] In van der Hulst (to appear a) I explain why outward application follows from cyclicity if we assume that variable elements are deleted if not licensed within their own cycle.

(24)



But *why* are secondary elements associated with the word plane, allowing them great mobility? What is the nature of the correlation between being a secondary element and being able to ignore morpho-syntactic bracketing? I suggest that we can understand this as an instance of a head/dependent asymmetry pattern (Dresher & van der Hulst 1998). One property of heads is their greater *sensitivity* to the structure in which they are embedded; dependent properties in comparison display a degree of insensitivity, resulting in greater 'freedom' to 'move around'. In this instance, the difference would be 'sensitivity or insensitivity to word-internal morphological structure' (and structure-preservation). Casali has also emphasized that ATR can cross word boundaries. This can be accounted for by assuming that elements that are active in the word plane can move to higher levels, such as a phrasal plane which dominates the word plane:

(25)



By eliminating the word level, we need to address the question how it is possible for rules in the morpheme plane to only operate on elements that are distinctive, whereas rules that operate in the word plane can refer to non-distinctive (redundant) elements. If both planes make reference to the same phonological level we must assume that non-distinctive elements are present after all, yet *invisible* to the subclass of rules that operate in the morpheme plane. This kind of 'visibility' approach has been proposed (for independent reasons) in Calabrese (2005). Alternatively, we could simply assume that the plane distinction regard the elements themselves, with distinctive elements being associated to the X-slots in the morpheme plane, while both distinctive and non-distinctive elements are associated to X-slots in the word plane (or higher planes).

Finally, we need to take into account a class of *allophonic* word-level rules that was identified in Harris (1989), which display sensitivity to morphological structure. A clear example involves the rule of Belfast dentalization (first discussed in Harris (1989)). This rules applies to a simplex word like *spider*, but not to a complex word like *wider*. The ich-laut/ach-laut rule in German has the same property. Both processes appear to be allophonic, which suggests reference to the implementation component. But perhaps we expect implementation rules to be insensitive to morpho-syntactic structure? The alternative is to place rules of this kind at the word plane, but this then implies word plane rules, while not driven by morpho-syntactic structure, can nonetheless be sensitive to it. The proper location of the rules that Harris (1989) identified, as well as the broader issue of replacing the derivational word-level by a planer distinction strikes me as an important domain for further research.

5. Conclusions and unresolved issues

The RcvP model, given its 'rich' structural geometry, allows us to *deconstruct* the notion tongue root harmony in several subtypes. All of them involve elements in the manner node:

(26) The deconstruction of 'tongue root' harmony

a. Licensing or secondary elements		
i. Licensing of (*∀/A*)	~	ATR/RTR-dominance
ii. Licensing of (*N*)	~	NASAL-dominance
b. Licensing of headedness of |A|		
Licensing of headedness of (<u>A</u>)	~	rtr-dominance
c. Licensing of primary element |A|		
Licensing of (A)	~	LOW-dominance

The designation on the right are those that occur in other feature systems and I have used these throughout this article simply to remind the reader how my element correlate with features in other models. Here I also included lowering harmony, which is not necessary included in the 'class' of 'tongue root' harmonies (although that depends on how the data are analyzed), which is due to licensing of the |A| element. I refer to Harris (1994b) who analyses systems that have lowering harmony in terms of licensing of the element |A|. As argued in van der Hulst (to appear a), while the | *∀*| plays a role in ATR-dominance harmony, there are no cases that involve the primary |∀|-element analogous to (26b) and (26c). This is due to a 'defectivity' of the |∀|-element for which I provide a phonetic explanation.

The proposal derives the difference between the two types of systems from the fact that there are two ways of representing the contrast between /eo/ versus /ɛɔ/. The contrast can be coded either through |A|-headedness or through the presence or absence of | *∀*| under the secondary Aperture node. A reviewer correctly points out that, given both mechanisms, we could then also represent a system with 4 series of mid vowels, distinguished both in terms of |A|-headedness and presence of | *∀*|*:*

(27)

category	vowels	primary	secondary
a. ATR high-mid	/e̘o̘/	∀A	*∀*
b. non-ATR high-mid	/e̙o̙/	∀A	
c. ATR low-mid	/ɛ̘ɔ̘/	<u>A</u>∀	*∀*
d. non-ATR low-mid	/ɛ̙ɔ̙/	<u>A</u>∀	

While a system like this is well-formed given the RcvP element syntax, its actual occurrence is unexpected. In van der Hulst (in prep.), I show that a general tendency of **complexity avoidance** disfavors both complex primary structures with a secondary structure and, also complex secondary structures in general. Indeed, a four-way distinction at in (27) is not present in the systems Casali surveys.[40]

Summarizing, I have made the following proposals:

- Following Casali's Correlation, systems with two series of high vowels are ATR-dominant
- ATR-dominance involves licensing of the ∀-element (in the secondary aperture)
- If this element is activated for high vowels, it will also be present in mid vowels
- Secondary element harmony applies in the word plane (or higher planes) and as such need not be dependent on morphosyntactic structure and as a consequence is not restricted to being outward bound
- Following Casali's correlation, systems with one series of high vowels are rtr-dominant
- rtr-harmony involves licensing of A-headedness (in the head aperture unit)
- rtr-harmony applies in the morpheme plane and as such is structure-dependent (i.e. cyclic), and, as such, must be outward-bound.

The consequence that ATR-harmony and rtr-harmony correlate with a different status of the harmonic element follows directly from the RcvP architecture, as well as the SDA in conjunction with a hierarchy of elements. Given this formal difference it is possible to correlate the primary vs. secondary status of the harmonic element with the notion of structure-dependence: only secondary elements can ignore morphological structure.

Two remaining issues must be addressed. Firstly, we need to explain the existence of languages such as Legbo and Ikoma, which have a 1H system, but display certain ATR-dominance effects. A second issue concerns the fact that Casali (2003: 345) reports that nine languages with 2H systems display some form of '[−ATR]' dominance. Such exceptional cases need special provisions, as they would in any other model. For discussion of these issues I refer to van der Hulst (to appear, chapter 7).

In conclusion, while the account given here for Casali's Correlation and some of his further observations is based on a specific theoretical model, this model was not designed to account for this correlation. It would seem, however, that the RcvP model gives us a way to account for the fact that (a) 2H systems *must* have an active ATR-element and also (b), given the structural position of the element that represents ATR, the 'aggressive', non-structure dependent nature of ATR-'spreading'. The model also explains why 1H systems cannot activate this ATR element, while allowing the expression of the difference between two series of mid vowels in terms of A-headedness, which allows us to represent harmony in such systems as head-licensing. While certain details of the SDA algorithm and the element ranking need further scrutinizing, the basis for the formal explanation that is proposed here rests crucially on the notion of minimal specification which refers to a specific theory of elements, as well as on the distinction between primary and secondary elements and their corresponding ranking.

[40] That said, systems of a complexity similar to that in (30) have been noted in the Kru language family; see Sapir (1931), Singler (2008) and Innes (1966).

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