Lowering harmony in Bantu

An RcvP account*

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In this article I propose an analysis of lowering harmony in the Bantu languages Kikuyu and Kimatumbi. This analysis is carried out within a model called Radical cv Phonology (RcvP). Following Dependency Phonology, RcvP uses unary elements as primitives and dependency relations between elements when they occur combined in one phoneme. Following proposals in Government Phonology, my account for harmony postulates that harmony involves a licensing relation. A novel aspect of my approach is that harmonic alternations are represented in terms of elements that are variably present. A variable element is phonetically interpreted only if it is licensed by a non-variable element in an adjacent syllable.

1. Introduction

In this article, I will analyze a number of vowel harmony systems which have been described or analyzed as having lowering processes. I will use a variety of "Element Theory" that is developed in "Radical cv Phonology" (van der Hulst 2005, in prep. a) and an approach to harmony in terms of "licensing" (van der Hulst 2012abc, in prep. b). This takes us into areas where the literature on vowel harmony discusses cases involving the following binary features:

(1)	a.	[±high]	(raising harmony)	$\vert\forall\vert$
	b.	[±low]	(lowering harmony)	$\vert A\vert$

In the third column I added the RcvP elements that, at first sight, we would expect to be involved in such cases. Both elements are grouped under one "class node" in the present model (see Section 2). The same two elements are also used for harmonies which have been analyzed in terms of the binary features in (2), although not all phonologists would recognize both (2a) *and* (2b):

(2)	a.	[±ATR]	(ATR-harmony)	|∀|
	b.	[±RTR]	(RTR-harmony)	|A|

It has of course been pointed out by several researchers that the tongue height dimension (1a and b) is closely related to the tongue root dimension (2a and b). Advancing the tongue root almost inevitably leads to raising (and fronting) the tongue body, and tongue root retraction would then have the opposite effect; see Archangeli and Pulleyblank (1994) for a detailed discussion of this correlation. Before the feature [ATR] was proposed in Stewart (1967), harmony systems that are now analyzed using this feature were often referred to as (cross-)height harmony systems. In fact, another feature that has been used to describe such systems is [±Tense] (see Stewart 1967). Focusing on often attested phonetic distinctions between two series of "mid" vowels, one can easily find different sources where this distinction is analyzed in three different ways:

(3)	/e, o/	[+high]	[+ATR]	[+Tense]
	/ɛ, ɔ/	[−high]	[−ATR]	[−Tense]

In RcvP there is only one way to make the distinction between "lower-mid" and "higher-mid" vowels. Both are represented in terms of a combination of the two elements |∀| and |A|, with either one or the other being the head.[1]

It would seem clear that traditional feature systems predict an abundance of harmony types. The features in (1) and (2), which belong to the common stock of many such theories, predict two harmony types for each feature, which, multiplied by 4 features, predict 8 different systems. When [±Tense] is also recognized that number goes up to 16. A feature system with these three features predicts that all these systems could exist within a single language. More crucially, there is no formal reason for such binary feature systems having any less or even more features. In other words, there is no theory of what features can be or of a feature "organization". In RcvP, on the other hand, there can be only two harmony types, those involving |∀| and those involving |A|. Elsewhere I have discussed [ATR]/[RTR] harmony systems, which involve the element |∀| or |A| (see van der Hulst 2012b; in prep. b). In this article, I will discuss harmony systems that appear to involve, in binary terms, either [±low] or [±high]. I will show that the systems involve the element |A| and/or the element |∀|. The focus is on Bantu languages; all examples are taken from Clements (1991). For reasons of space I can only analyze two of the lowering systems. For raising cases, see van der Hulst (in prep. b). I will offer a brief summary of RcvP and the licensing approach to harmony in Section 2 and 3.

2. A synopsis of Radical cv Phonology

Radical cv Phonology (RcvP; van der Hulst 2005, in prep a) is an approach based on both "Dependency Phonology" (DP; Anderson and Ewen 1987), as well as "Government Phonology" (GP; Kaye, Lowenstamm and Vergnaud 1985, 1990; Harris 1994a; Harris and Lindsey 1995). Roughly, RcvP shares its basic architecture with DP which adheres to the following foundational principles:

(4) a. Phonological primes are unary ("monovalent") elements
b. Elements, when combined, enter into head–dependency relations
c. Elements are grouped into units ("gestures" or "class nodes")
d. All elements are used for both consonants and vowels

DP and GP differ in a number of respects. Firstly, they employ different sets of elements (and different versions of each approach may have different elements as well). Secondly, DP and GP make somewhat difference usage of property (4b); see (5) below. Finally, and most essentially, property (4c) is not a recognized property of GP. Property (4d) restores a tradition in phonology, started in Jakobson, Fant and Halle (1952), but abandoned in Chomsky and Halle (1968). The idea of having a unified set of primes has also been restored in work within the model of "feature geometry" (see, for example, Clements 1993). DP and GP differ from Jakobson, Fant and Halle's proposal in exclusively capitalizing on the acoustic nature of elements.

RcvP, while being rooted in these two approaches, differs from both in a number of ways.[2] I will first mention some differences between RcvP and DP. Firstly, RcvP uses a smaller set of elements than DP, grouped in a slightly different set of gestures. In fact, my initial incentive to work on DP was to arrive at a smaller and principled set of elements (van der Hulst 1995). Secondly, I apply the head-dependency relation rigidly, which means that I do not recognize structures in which elements stand in a relationship of "mutual dependency". I thus only allow (5a) and (5b):

(5) a. A is the head of B
b. B is the head of A
c. A and B are "mutually dependent"

Thirdly, RcvP employs a different gestural structure for phonological segments. The idea of gestures, proposed in Anderson and Jones (1974) is similar to that of "class nodes" that was later introduced in "Feature Geometry" (see Clements 1985, Sagey 1986). My gestural structure, as we will see below, is more in line with the one proposed in Clements (1985).

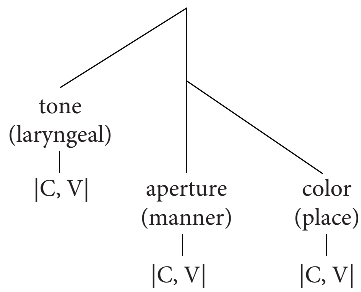

Figure 1. The "element geometry" of Radical cv Phonology.

In RcvP, each segment has a tripartite structure consisting of the Laryngeal, Manner and Place gesture, as in Figure 1.[4] Within each gesture, we find precisely two elements: a consonant- or onset-oriented element |C| and a vowel- or rhyme-oriented element |V|.[3] (Hence the name *Radical* cv Phonology).

In RcvP the dependency relations *between* the gestures are universally fixed, with Manner being the head. In this respect, RcvP departs from standard DP and arguably offers a more restrictive approach to segment-internal structure. For arguments in favor of the general dependency relation between gestures in Figure 1, see van der Hulst (2005, in prep. a).

In each class node, |C| and |V| receive a different set of interpretations. In (6), I indicate these interpretations mostly in very rough articulatory terms (although I subscribe to the view that elements must have both articulatory and acoustic interpretations):

(6)	|V|-elements	|C|-elements
	|Place: V| = labiality	|Place: C| = palatality
	|Manner: V| = openness	|Place: C| = closure
	|Laryngeal: V| = L, voicing	|Laryngeal C| = H, -voice

The choice of symbols is motivated by the fact that within each class node, one element is favored in the syllabic C-position (which corresponds to the onset head position), while the other is favored in the syllabic V-position (rhymal head position). However, both |C| and |V| can, despite their respective onset and rhyme head bias, occur in *all* onset and rhyme positions; see van der Hulst (2005, in prep. a) for a detailed presentation of the theory. In each gesture, the two elements form an "antagonistic pair". The members of such a pair represent opposite extremes within a certain phonetic "space", but this does not mean that they are like the plus and minus value of a binary feature. The two opponents in each opposition must have

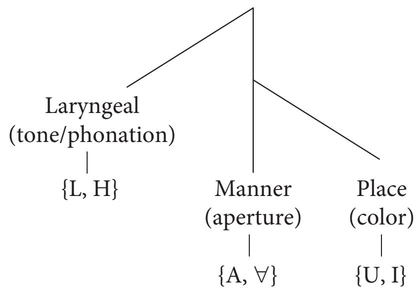

Figure 2. The "element geometry" of Radical cv Phonology.

independent status because, unlike the values of binary features, they can be combined. In van der Hulst (in press) I dub the principle that enforces the categorization of phonetic spaces into two opponent elements "The Opponent Principle".

However, for practical purposes, I will use the element names |A, U, L,∀, I, H| to avoid cumbersome (although more accurate) expressions such as '|Place: V|' (= '|U|') (where the term "place" is a shorthand for a structural position in the segmental structure).[5]

It is interesting to observe that Kaye (2000) and Backley (2011), working within the model of Government Phonology, also proposes six elements, which, as Backley states form "antagonistic pairs", much as in RcvP, although his model, lacking class nodes, provides no formal basis for any such grouping. In RcvP, on the other hand, antagonistic (or opponent) grouping forms a pivotal and formal part of the theory which expresses directly the idea that phonology is based on "binary contrast". Given the anatomy of the human speech apparatus there are three phonetic spaces within which contrast can be expressed (laryngeal, place and manner). The Opponent Principle enforces an equipollent contrast between two elements in each of these spaces. The exact phonetic interpretation of the elements is dependent on (1) which class node they occur in, (2) which syllabic position they occur in and (3) their status as head or dependent. Since in RcvP elements enter into combinations *within* their class node, each element combination is maximally binary. A specification of each gesture contains either zero, one or two elements. A segment can of course be characterized with more than two elements, provided that the specification involves elements from more than one class node (see Figure 2). In contrast to GP, RcvP uses headedness *obligatorily* to acknowledge the asymmetry which arises from merging (maximally two) elements per class node; mono-elemental structures are headed by default. In other words, RcvP does not employ "contrastive use of headedness" as GP does. For example, in RcvP |A| cannot be distinct from $|\underline{A}|$, nor is |AI| distinct from either $|\underline{A}I|$ or $|A\underline{I}|$. Note that GP's use of non-headedness is comparable to DP's use of mutual dependency that was discussed and rejected earlier (see 5). Another significant difference between RcvP and GP lies in RcvP's adoption of the element |∀| (although Kaye, Lowenstamm and Vergnaud 1985 originally proposed an element very much like it, i.e. |Ɨ| which was abandoned in favor of contrastive use of headedness which was just mentioned). In GP there is no theoretical reason for pairing up the element |A| with an antagonistic partner, as there is in RcvP, in which the Opponent Principle predicts the element |∀| as the antagonistic counterpart to |A|. The crucial availability of the element |∀| will be clear from its role in the analyses provided in this article (and in van der Hulst in prep. ab).[6]

Let us now focus on element expressions for vowels. Cross-classifying aperture and color, and allowing for both colorless and mannerless vowels, yields 25 different vowels, given in (8) in terms of IPA-symbols:

(8)

	I	$\underline{\text{I}}$U		$\underline{\text{U}}$I	U
∀	i	y	ɨ~ɯ	ʉ	u
	ɪ	ʏ	ə	-	ʊ
$\underline{\forall}$A	e	ø	ɘ~ɤ~ɐ	ɵ	o
$\underline{\text{A}}$∀	ɛ	œ	ɜ~ʌ	ɞ	ɔ
A	æ	Œ	a~ɑ	-	ɒ

Both Anderson and Ewen (1987) and Kaye, Lowenstamm and Vergnaud (1985) stipulate that there is no difference between |$\underline{\text{U}}$I| and |U$\underline{\text{I}}$|, which both yield a rounded front vowel.[7] However, I assume that these combinations denote two distinct vowels, which are sometimes referred to as "outrounded" /y/, i.e. a rounded front vowel, and "inrounded" /ʉ/, a fronted back-round vowel. These vowels are sometimes contrastive, for example in Swedish.

Needless to say that the proper placement of vowels in specific languages in cells cannot depend on what kind of IPA symbols linguists use for them, but rather on the way in which these vowels function in the phonological system. The goal of a phonological theory should not be to characterize each and every IPA symbol in terms of a unique element structure. What matters foremost is which sound types can occur contrastively in languages. Thus, by lumping different phonetic symbols in one cell, I make the claim that these phonetic units cannot occur contrastively in any language. Another possible mismatch between the phonological expressions for phonemes and the IPA is that certain IPA-symbols might correspond to different phonological objects in different languages or even in the same language (when different phonological objects receive the same phonetic interpretation).

3. Licensing

In RcvP, lexical vowel harmony is encoded in lexical representations (van der Hulst 2012abc, in prep. b). Specifically, when a vowel is involved in a vowel harmony alternation, it includes a variable element "(ε)", the harmonic element. To be phonetically interpreted a variable element must be *locally* licensed by a non-variable (i.e. licensed) element. Licensing of a variable element by a neighboring licensed element is an instance of "syntagmatic licensing" (S-licensing).

Variable elements represent the "neutralization" of the contrast between presence and absence of an element. In a binary feature system, absence of contrast would be expressed by saying that the harmonic feature is underspecified, but in the current model it is expressed in terms of a variable element "(ε)" which means "ε or nothing". It must be borne in mind that the so-called zero that is used in underspecification theory also refers to a disjunction namely "+ or –".[8]

As an illustration of this approach to VH consider the RcvP representation for the plural in Turkish, which alternates between [lʲer] and [lar] (see 9). Given that the suffix never alternates for height, the element |A| is present invariably (this element is thus lexically licensed, as are all other elements that are not involved in an harmonic alternation); in contrast, this morpheme's vowel alternates between a front and back variant, and, as such, the element |I| is represented as a variable "(|I|)" (or simply "(I)"). As shown in (9a), this variable element in the Turkish plural suffix can be syntagmatically licensed (indicated by "»"), resulting in a palatal realization [lʲer], or it remains unlicensed (cf. 9b), resulting in a non-palatal realization [lar], both being harmonic with their root: [9]

(9)	a.	ip	-	lʲer	b.	kız	-	lar
		∀		A		∀		A
		I_L	»	$(I)_S$				(I)

As mentioned, licensing relations are strictly local at "some level". In almost all cases this level is the sequence of "rhymal heads". Informally this means that licensing cannot skip a vowel. This leads to a principled account of opacity as will be shown in Section 4. Once a variable element is licensed, it can itself function as a proper licenser for another variable element which adds an ingredient of "iterativity" to the licensing relation:

(10)	a.	ip	-	lʲer-	in	b.	kız	-	lar-	ın
		∀		A	∀		∀		A	∀
		I_L »		$(I)_S$ »	$(I)_S$				(I)	(I)

Having explained how syntagmatic licensing accounts for inter-morphemic harmony, we must ask whether or how this approach deals with intra-morphemic harmony. I will now discuss this issue.

There has to be a parameter setting that distinguishes a language with harmony for some element |ε| from a language without harmony for that element. I suggest that the relevant parameter is as follows; its setting involves substituting "ε" by some actual element and choosing the left or right option for headedness:

(11) Specifications on the |ε| tier *must* enter into a left/right-headed licensing relation[10]

This parameter entails that all specifications, save the head specification (the leftmost/rightmost specification), must *be* licensed by a preceding/following specification on the same tier. It also entails that a head must have a licensee (provided that there is more than one V-position). The parameter setting in (11) is comparable to often proposed constraints like "Agree" or "Harmonize", or, in pre-OT models, a constraint than demands the same value for the harmonic feature in adjacent vowels. However, since in RcvP the relation between the two positions that need to agree is seen as a head-dependency relation (specifically a licensing relation) there is a necessary "asymmetry" between the two positions which adds an ingredient of "directionality" to the constraint.

In van der Hulst (in prep. b) I consider various reasons for postulating a head position for morpheme-internal harmony, and thus directionality, and I side with those who postulate that there is always a head position, as has in fact been standard in the GP literature on vowel harmony where the privileged position is called the "head" (Kaye, Lowenstamm and Vergnaud 1985; Harris 1994; Charette and Göksel 1994, 1996; Cobb 1997, among others). The relationship between the specification in the head position and the specifications in other positions is represented as a licensing relation. Assuming, for purposes of demonstration, the case in which the element in the first vowel occupies the head position, we can represent root-internal harmony as follows (with the head element specification in bold):

(12) Fully harmonic roots

a. ATR-root					b. Non-ATR root		
V		V		V	V	V	V
∀	»	∀	»	∀			

Let us now ask how the language learner decides on the specification for any given vowel. On a first encounter with a morpheme the learner may simply assume that an element is either absent or present. If this same morpheme then occurs with the element present or absent, respectively, the learner can postulate a variable element:

(13) Learning path for elements

ε? → a. V if the element is absent → (ε)
V

ε
→ b. V if the element is present → (ε)

The parameter in (11) enforces a licensing relation between a licensed element and a following variable element which then, as was suggested above, makes this variable element invariable (and thus audible). Since variable elements are licensed by a preceding licenser, one might ask why I have not chosen to represent roots with the harmonic elements as in (14a):

(14) Fully harmonic roots

a. ATR-root

V V V
∀ » (∀) » (∀)

b. Non-ATR root

V V V

We must note, however, that the variable elements in (14a) would not follow from the learning path in (13) because the vowels in question do not alternate. The argument for representations like (14a) is that it is undesirable to make a separate statement about root (or morpheme) internal harmony and intermorphemic harmony. However, it seems to me that the full specification in (12a) does not entail that we must make separate treatments for root (or rather morpheme-internal) harmony and intermorphemic harmony. The parameter in (11) generalizes over both. The fact that (11) enforces the realization of variable elements does not require a separate statement in addition to (11). The fact that variable elements can only be pronounced if licensed is a general principle of grammar and is thus independent from the harmony parameter.

In a harmonic language we may encounter disharmonicity. In a head-first harmony, disharmonicity arises when the following configuration is found in the input (in a left-headed harmony system):

(15) Disharmonicity

.... V V ....
∀

Such strings violate the constraint in (11). When the learner encounters such sequences he decides that the vowel that fails to harmonize with the preceding vowel lacks the harmonic element, which is why is acts like a blocker or so-called opaque vowel.

It has often been observed that intermorphemic harmony is more stable than morpheme internal (specifically root-internal) harmony. For example, in the account of Clements and Sezer (1982), Turkish maintains the licensing relationship in (16a) to account for suffix harmony, while roots allow massive disharmony.[11] It is perhaps possible to explain this fact by asking how the grammar responds to the possible sequences of variable and invariable elements. Given the difference between invariantly and variantly specified elements, we have four possible syntagmatic sequences of element specifications:

(16) Possible licensing relations

a.	∀	»	(∀)	('SW')
b.	∀	»	∀	('SS')
c.	(∀)	»	(∀)	('WW')
d.	(∀)	»	∀	('WS')

Interestingly, we can relate these four possibilities, and their likelihood of occurrence (i.e. their stability), to a general pattern that has been observed for all head-dependency relations. Following the spirit of Harris (1990)'s Complexity Condition and Dresher and van der Hulst (1998)'s Head-Dependent Asymmetry, it seems to be the case that a general condition on head-dependency relations is that the head cannot be less "strong" than the dependent, where "strength" can be manifested in structural complexity, sonority or, as I suggest in this case, "(in)variability". Invariable elements are, I suggest, "stronger" than variable elements. This being so, we expect the relationship in (16a), which regulates intermorphemic harmony, to be the most likely and most stable licensing relationship between element specifications that occur in a harmonic language because in this case the head is "strong" and the dependent is weak. In the preceding sections, we have seen that this relation removes the variability of the variable element, so that it can be phonetically interpreted. The "stronger" invariable element empowers the weaker variable element so that it gains equal strength as its licensor, which accounts for the fact of harmony.

The cases in (16b and c) represent a relationship between specifications of equal "strength" (both specifications being either invariant or variable). (16c) would occur in polysyllabic alternating morphemes. These relationships represent "static" intramorphemic harmony, indicating that non-initial elements specifications are dependent on the preceding element specification. The relationship between elements of equal strength has no effect on the status of the elements as either variable or invariable. We observe that harmonic languages are more likely to give up on the mandatory status of this licensing relationship which then leads to roots allowing disharmony.

Finally, (16d) represents a "mismatch" in that a weaker occurrence of an element licenses a stronger occurrence. This relationship violates the essence of dependency and is thus universally ruled out, just like, in weight-sensitive stress language, no foot type can have the heavy syllable and the light syllable in the weak and strong position, respectively. The situation is analogous to sensitivity in footing where, if sensitivity applies, one out of four cases is excluded as a left-headed foot:

(17) (L L) (H H) (H L) *(L H)

Another way of stating this constraint is in term of a "No Mismatch Condition": a dependent in a licensing relation cannot be "stronger".

4. Lowering harmony in Bantu

As Clements (1991) points out, Bantu languages differ in having a 7- or 5 vowel system. A 7-vowel system is reconstructed for Proto-Bantu. 5-vowel systems have undergone a merger of two highest series:

(18)

a.			b.		
i		u	i		u
ɪ		ʊ			
e		o	ɛ		ɔ
	a			a	

RcvP represents the 7 vowel systems as follows:[12]

(19)

/i/	/u/	/ɪ/	/ʊ/	/e/	/o/	/a/
∀	∀			∀	∀	
				A	A	A
I	U	I	U	I	U	

For the sake of simplicity, headedness is only specified where contrastive, i.e. where two elements belonging to one class node co-occur in two contrastive combinations. However, in both a 7 and a 5 vowel system, the phonetic value of the mid vowels is worth discussing since these vowels can be either transcribed as "low" mid or as "high" mid:

(20)

a.			b.		
i		u	i		u
e		o			
			ɛ		ɔ
	a			a	

Given the representations in (19), we could see the difference between these two vowel qualities as a result of a late "spell out" of the dependency relation for the aperture elements, but we could also assume that when two elements co-occur, there is always a dependency relation which, then, could lead to either (20a) or (20b).

Another issue is whether it is always necessarily the case that a vowel in a 7 vowel system that is transcribed as "ɪ" and "ʊ" could not be analyzed as high mid, i.e. /e/ and /o/ which would lead to the system in (21):

(21)	/i/	/u/	/e/	/o/	/ɛ/	/ɔ/	/a/
	∀	∀	$\underline{\forall}$	$\underline{\forall}$	∀	∀	
			A	A	$\underline{A}$	$\underline{A}$	A
	I	U	I	U	I	U	

Whether (19) or (21) is correct ultimately must depend on the phonological behavior of phonemes and thus not on their transcriptions in descriptive sources. Acoustically /ɪ/ and /ʊ/ are very similar to /e/ and /o/.

I now turn to a common pattern of height "assimilation" in which the first vowel of the stem determines what the height of subsequent vowels will be in the stem and the suffixes.

4.1 Kikuyu

In Kikuyu (7 vowels), the applied suffix shows the following alternation:[13]

(22)	a.	tiɣ-ɪr-a	'stop for'
	b.	rut-ɪr-a	'work for'
	c.	rɪh-ɪr-a	'pay for someone else'
	d.	kʊm-ɪr-a	'rebuke for'
	e.	ɣamb-ɪr-a	'bark at'
	f.	kɛr-ɛr-a	'chop for'
	g.	rɔr-ɛr-a	'look at'
	h.	tɛm-ɛr-ɛk-a	'cut into specific shapes'
	i.	βɔy-ɛr-ɛk-a	'calm down, slow down'

The examples in (22h and i), taken from Long Peng (2000, 372, examples 5b) show that the lowering can extend to more than one suffix vowel.

Since the higher variant occurs after /a/, we must analyze this process as a case of lowering. While in some languages (e.g. Kongo) lowering applies generally, in Kikuyu, suffixes may only show an /ʊ/-/ɔ/ alternation after stems with /ɔ/.[14] (23) displays the configurations that select high vowels because the variable "($\underline{A}$)" is not licensed:

(23)	a.	I	I	b.	U	I
		∀				∀
			(A)			(A)
		/i/	/ɪ/		/u/	/ɪ/

c.	I	U	d.	U	U
		(A)			(A)
	/ɪ/	/ʊ/		/ʊ/	/ʊ/

In (24) we see the configurations that produce low vowel alternants. Given that the element |∀| is not shared by the alternating vowels, it cannot be included in the lexical specification of the suffix vowels. This means that if |A| is licensed (as in 24a,b,c) the element |∀| must be added.[15]

(24)	a.	I		I	b.	U		I
		∀		$\boxed{\forall}$		∀		$\boxed{\forall}$
		$\underline{A}$	»	($\underline{A}$)		$\underline{A}$	»	($\underline{A}$)
		/ɛ/		/ɛ/		/ɔ/		/ɛ/
	c.	I		U	d.	U		U
		∀		$\boxed{\forall}$		∀		$\boxed{\forall}$
		$\underline{A}$	»|	($\underline{A}$)		$\underline{A}$	»	($\underline{A}$)
		/ɛ/		/ɔ/		/ɔ/		/ɔ/

Neither /i/ and /u/ nor /a/ participate in this harmony and it will be shown below that these vowels act opaquely when intervening between potential triggers and targets.

How can we formalize the limitation which prevents /ɛ/ from lowering a rounded vowel (case 24c)? I will now show that this can be expressed by saying that the combination of A and U must be licensed by a shared U. Focusing on the interaction between A-licensing and color elements, we note that of the four configurations, one is excluded, namely the case in which the trigger is I-colored and the target is U-colored:

(25)	I		I	U		U	U		I	I		U
	A	»	(A)	A	»	(A)	A	»	(A)	A	»	(A)

The case in which harmony is excluded is precisely the case one would expect if we realize that U (V-type) is "stronger than" I (C-type). In other words we can say the following:[16]

(26) A-Licensing is "color sensitive"

The fact that out of four possible situations, only one is excluded is another illustration of the mismatch condition that I discussed earlier (see 16 and 17). As shown in van der Hulst and Moskal (2013), a parallel situation occurs in several Turkic languages in which rounding harmony shows sensitivity to aperture elements:

(27)	∀		∀	A		A	A		∀	*∀		A
	U	»	(U)	U	»	(U)	U	»	(U)	U	»	(U)

Since the element |∀| is a C-type element and |A| a V-type element, the case which is most likely prohibited in labial systems is of the same mismatch kind.

Let us now turn to the question as to *why* /a/ cannot act as a licensor. The following example shows that /a/ does not cause lowering (Long Peng 2000, 372, example in 5a; see also example 22e above):

(28) βaθ-ɪr-ɪk-a 'become rich'
U
A »| (A)
/a/ /ʊ/

I suggest that this is related to the sensitivity of A-harmony to color. Let us say that lowering harmony is not just sensitive to color, but that is it "parasitic" on color. This means that it only applies among vowels that have color. There is, as van der Hulst and Moskal (2013) put it, a "bridge condition" on A-harmony.

(29) A-Licensing is parasitic on color

The condition in (29) implies that only vowels with a color element (|I| or |U|) can license a variable A-element (provided of course that they also contain a licensed A-element):

(30) U
A » | (A)
/a/ /ʊ/

In addition to failing to trigger lowering /a/ also displays opacity. A preceding mid vowel cannot license the variable A-element of the suffix (Long Peng 2000, 373, examples 7i and j):

(31) a. tɛt-an-ɪr-a 'speak for'
b. cɛh-an-ʊr-a † 'undo the act of cutting'
c. kɔman-ɪr-i-a 'unite/make ends meet'
d. ɔy-an-ʊk-a 'bring down'
I U
A A »| (A)
/ɛ/ /a/ - /ʊ/

† In this case there would be no lowering anyway because /ʊ/ only lowers after a round low vowel.

How can we explain the opacity of /a/?

Let me first show how parasitic harmony can cause "apparent non-local licensing" if an intervening nucleus lacks the harmonic element. This situation obtains in Mongolian rounding harmony in which the vowel /i/ is transparent, while the vowel /u/ is opaque. This is precisely the opposite of what we would expect, given the account of transparency and opacity (van der Hulst 2012a). The solution to this paradox lies in the fact that Mongolian rounding harmony is parasitic on |A| (see van der Hulst in prep. b); see (32).

The crucial idea here is that whereas locality is normally defined with reference to the tier on which syllabic heads are represented, when harmony is parasitic it is implied that locality is defined with respect to the "host" tier, i.e. the tier on which the bridge condition is specified. This means that in Mongolian locality of U-licensing is defined with reference to the A-tier:

(32) Mongolian

Transparency of /i/				Opacity of /u/			
a.	A		A	b.	A		A
	U	»	(U)		U	U	»|(U)
	/o/	/i/ -	/o/		/o/	/u/	-/a/
						»|	

Thus in (32a) the U-element of /u/ can license a variable U-element of a suffix vowel *across* the vowel /i/ because the /i/ has no presence on the A-tier. However in (32b) the variable element cannot be licensed by the preceding U-element of the vowel /u/ because this element does not fulfill the parasitic condition; it does not correspond to an A-element. Nor can it be licensed by the |U|-element of /o/ because that would violate locality.

I will now show, with reference to (33a), how this theory of "relativized" locality explains why the vowel /a/ is opaque. Next, I will turn to the representation in (33b) which accounts for the fact that /i/ and /u/ are also opaque.

(33) Kikuyu

Opacity of /a/					Opacity of /i/ and /u/			
a.	I			U	b.	I	I	U
	∀			∀		∀		∀
	A̲	A	»|	(A̲)		A̲	»|	(A̲)
	/ɛ/	/a/		/ʊ/		/ɛ/	/i/	/ʊ/
			»|					

In (33a) the variable element cannot be licensed by the preceding A-element because this element does not fulfill the parasitic condition; it does not correspond to a color element. Nor can it be licensed by the |A|-element of /ɛ/ because that would violate locality. Hence /a/ is opaque for the same reason that /u/ is opaque to rounding harmony in Mongolian.

Turning to (33b) we can see that /i/ must also be opaque. The relation between the vowel /ɛ/, a potential licensor, and the suffix vowel (which can be either /ɔ/ or /ʊ/) is not local because at the color tier that provides the necessary bridge condition, these vowels are not adjacent. Hence /i/ must be opaque (and this also holds for /u/ for the same reason). The examples in (34) illustrate the opacity of /i/ and /u/ (Long Peng 2000, 373, examples 7e):

(34)	a.	tɛm-iθ-ɪr-a	'become cut-able'
	b.	cɛβi-ʊr-a	'undo the act of slipping away'
	c.	ɛŋgut-ɪr-a	'move away for'
	d.	ɛŋgut-ʊk-a	'undo the act of moving away'

The overall generalization here is as follows: in case of parasitic harmony there can be no intervener either at the harmonic (as in 32b and 33a) tier or at the bridge tier (as in 33b).

In this section I have shown that lowering harmony in Kikuyu is parasitic on and sensitive to color. We have seen that the opaque behavior of /a/, /i/ and /u/ is a natural consequence of the parasitic nature of lowering harmony. The behavior of /a/ in lowering systems in Bantu languages has been addressed in other works such as Goldsmith (1985), Rennison (1987), Harris and Moto (1989) and most explicitly in Harris (1994). Goldsmith accounts for the inability of /a/ to initiate lowering by stipulating that vowels that initiate lowering harmony must not only possess the A-element but also another element. This certainly excludes /a/, but, as Harris (1994b, 528–529) states, only by "allowing the spreading of some prime to be arbitrarily conditional on the presence of some other prime". Harris and Moto (1989), taking a different approach, stipulate that the licensor must be a "dependent" A-element, which it would be in /ɛ/ and /ɔ/, but not in /a/. This also excludes /a/ by force, albeit less brutally, given the independent motivation for a head/dependent distinction and the reasonable expectation that this distinction can play a role in harmony. Rennison (1987) and Harris (1994b) offer an account that comes very close to the approach taken in the RcvP model. Rennison proposes the idea that the A-element is representationally dependent on the color elements, while Harris sees a representational dependency between the "tiers" that these elements reside on. In either account (which are very similar), the representational dependency of |A| on color elements is seen as a requirement for "spreading". In both accounts it is assumed that languages can differ in terms of the dependency relation between tiers or elements. In the account offered here, aperture elements and color elements enter into a universally fixed dependency relation (see Figure 1), in which the color node is dependent on the aperture node. Thus there can be no language-specific differences in terms of the dependency relations between elements or their tiers. If the universal relationship between aperture and color would be an indication of parasitic effects, we would not expect A-harmony to be dependent on color bridges.[17] Thus, the "dependency" of A-harmony on color is of a different nature and in the present model this dependency must be captured in terms of a requirement on licensing which is stated in the form of a bridge condition.

Finally we must note that the color sensitivity that we see in Kikuyu (which prevents non-round licensors to a variable element in a round suffix vowel; see 26) is not an automatic consequence of lowering being parasitic on color because other Bantu languages that have lowering do not necessarily display this extra condition (cf. Harris and Moto 1989).

4.2 The unique case of Kimatuumbi

Kimatuumbi also has a 7-vowel system (Clements 1991). The initial vowel in the stem can be any of the 7 vowels. In subsequent syllables we find neutralization so that we only get a simple |I|, |U|, |A| distinction, with vowels having |I| and |U| being subject to vowel harmony as in (36):

(35)

i		u
ɪ		ʊ
e		o
	a	

(36)

Initial vowel	following vowels
i u a	i u a
ɪ ʊ	ɪ ʊ a
e o	e o a

This harmony only applies *within the stem*. The following examples are from Clements (1991, 45) (where the mid vowels are transcribed as /e/ and /o/):

(37)

ɪ + I	ɪ + ɪ	yɪpɪlya	'thatch with for'
ɪ + U	ɪ + ʊ	lɪbʊlwa	'be ground'
ʊ + I	ʊ + ɪ	ʊtɪka	'be pullable'
ʊ + U	ʊ + ʊ	yʊpʊlwa	'be served'
i + I	i + i	twikilwa	'be lifted (of a load)'
i + U	i + u	tikulya	'break with'
u + I	u + i	ugilwa	'be bathed'
u + U	u + u	kumbulya	'beat with'
e + I	e + e	cheengeya	'make build'
e + U	e + ʊ	kwemʊlya	'comb'
o + I	o + e	boolelwa	'be de-barked'
o + U	o + o	bomolwa	'be destroyed'
a + I	a + ɪ	asɪmɪlwa	'be borrowed'
a + U	a + ʊ	tyamʊlya	'sneeze on'

Note that a vowel with only |U| does not assimilate to /e/ (kwemʊlya 'comb' instead of *kwembolya), but it does to /ɪ/ (lɪbʊlwa 'be ground') which suggests that A-licensing is color sensitive (and color parasitic since /a/ does not cause lowering).

Clements (1991) analyzes the harmony as involving spreading of the entire "aperture node" (which is similar to the "height node" spreading proposed in Odden 1991). It is easy to see why this works: the height of non-initial non-low vowels is identical to the height of the initial non-low vowel. In the RcvP account we could say that licensing applies among color nodes, instead of the individual elements.

I propose the following analysis of the vowel system:

(38)	/i/	/u/	/ɪ/	/ʊ/	/e/	/o/	/a/
	∀	∀			∀	∀	
					A	A	A
	I	U	I	U	I	U	

The vowel alternants suggest that both aperture elements are variable, with neither specified as the head:

(39)	Initial vowel		following vowels:	
			I(∀) (A)	U(∀) (A)
	i u	i u	I ∀(A)	U ∀(A)
	ɪ ʊ	ɪ ʊ	I (∀) (A)	U (∀) (A)
	e o	e o	I ∀ A	U ∀ A

The following examples illustrate the relevant cases:

(40)	$\underline{\forall}$	»	($\underline{\forall}$)		(∀) licensed
			(A)	A	
	U		I		
	u		ti	ka	'be pullable'

(41)			(∀)		no licensing
			(A)	A	
	I		U		
	tɪ		kʊl	ya	'break with'

(42)	∀	»	(∀)		
	$\underline{A}$	»	($\underline{A}$)	A	Both (A) and (∀) licensed
	U		I		
	boo		lel	wa	'to be de-barked'

Returning now to the case in which lowering is blocked (cf. 43), we must assume that, as in Kikuyu, lowering is parasitic on color and therefore subject to the mismatch condition:

(43)	∀ »|	(∀)		licensing *blocked*
	<u>A</u> »|	(A)	A	
	I	U		
	kwe	mʊl	ya	'comb'

(44)	(∀)			licensing *blocked*
	(A)	A		
	I	U		
	ɪ	bʊl	wa	'be ground'

In (44) there is a mismatch too, but here the absence of harmony is masked by the fact that the "default" for vowels is to surface as /ɪ/ or /ʊ/. This is confirmed by the occurrence of these vowels after /a/:

(45)			(∀)	
	A	»|	(A)	A
			U	
	tya		mʊl	ya

In conclusion, the Kimatuumbi case is only different from the Kikuyu case in that in addition to |A| being variable, in Kimatuumbi |∀| is variable as well.

5. Conclusion

In this article I have provided an RcvP account of lowering harmony (Kikuyu, Kimatumbi). The analyses make crucial use of four elements. It has been shown that harmony cases can be dealt with in terms of variable elements and licensing. The locality of licensing is defined at either the nuclear projection or another element tier that provides a bridge condition for licensing.

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Notes

* I use the term 'account' here, following a remark once made to me by Jean Lowenstamm when there was much talk about 'theories' and 'explanations'. Jean told me that one simply needs to come up with an *account* of the data. His own work shows that such accounts can appeal to unexpected and sometimes abstract theoretical notions which one must pursue with rigor.

1. There are two other models, besides RcvP, that try to unite all harmony cases in (1) and (2). Clements (1991) proposes an *aperture node* which allows multiple occurrences of the feature [±open]. Schane (1990) unites lowering, laxing and retraction harmony in terms of the element |A| which is precisely what I'm proposing here as well. See Goad (1993) and Parkinson (1996) for the representation of vowel height.

2. For more detailed comparisons of various versions of DP, GP and RcvP I refer to Den Dikken and van der Hulst (1988), Backley (2011, 2012), van der Hulst (in prep. a).

3. Radical cv Phonology is not the same theory as 'strict CV', a theory of syllable structure that has been developed by Jean Lowenstamm (see Lowenstamm 1996), but there is a similarity in the idea to reduce the building blocks of phonology to two antagonistic units. Lowenstamm pursues this idea at the level of *structure*, while RcvP pursues this idea with reference to phonological *content* (as well as structure, but differently from Lowenstamm's theory). The structure aspect of RcvP is not discussed here; see van der Hulst (in prep. a).

4. I will not discuss the laryngeal class node in this article.

5. See Odden (1991) and Goad (1993) for similar geometry involving height node and color node.

6. DP proposed additional elements such as a centrality element and an ATR element which together capture some of the properties of |∀|. I refer to den Dikken and van der Hulst (1988) for a detailed comparison of GP and DP.

7. Kaye, Lowenstamm and Vergnaud (1985) attempt to derive this using an elegant 'fusion calculus' but this idea was later abandoned (see Kaye 2000).

8. This means that the variable approach is an instance of the approach that accounts for non-automatic alternations in terms of disjunctive lexical representations, an approach originally proposed in Hudson (1974).

9. These subscripts are purely for clarity; they have no formal status and will not be used consistently. Notationally, we can think of licensing as the removal of the parentheses.

10. In van der Hulst (in prep. b) I show that we must add 'by element specifications of the same kid' since we must require that polysyllabic alternating morphemes contain a variable element on each vowel position.

11. The present discussion is geared toward so-called root-control systems, In van der Hulst (in prep. b) I include dominant-recessive systems and show that, in these case, disharmonic roots must contain variable elements which leads to the conclusion that S-licensing of variable element enables audibility of these element only if the licensing relation applies to a derived environment.

12. To express that |I| and |U| cannot combine in systems of this kind they are placed on the same 'line'. This is merely a notational convention in this model. See van der Hulst (in prep. b) for an explicit account of how to represent any given vowel system *minimally*, using a successive division algorithm as proposed in Dresher (2009), using a fixed order of elements, namely A>∀>U>I which can be derived from the model in Figure 1.

13. Clements mentions that the harmony is extended to prefixes in a few languages (Gusii, Llogoori).

14. Long Peng (2000) offers a detailed analysis of vowel harmony in Kikuyu. He transcribed the vowels here given as /ɪ/ and /ʊ/ as /e/ and /o/ which illustrates the issue raised by (14) and (16) in the text. Here I follow Clements in regarding the vowels in question as non-ATR high vowels. Long Peng analyzes the harmony in terms of active [−ATR] which is analogous to my use of |A|. Therefore, his analysis and mine, including his account of opacity of high and low vowels are entirely parallel.

15. This element can be predicted by a rule (A, color → ∀) which means that it could be omitted in many cases. However, here I do not explore the issue of making lexical representations redundancy-free.

16. Long Peng (2000, 379) accounts for the same gap by stating an 'Identity Condition' that his [−ATR] rule is dependent on agreement in frontness which fully parallels the account given here in terms of elements.

17. For a motivation for the universal dependency of color on aperture in RcvP, I must refer to van der Hulst (in prep. b).