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Is There a Right-to-Left Bias in Vowel Harmony?[1]

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1. Basic issues

Despite decades of scholarship, and a steady stream of important theoretical and descriptive studies, our understanding of the phenomenon of vowel harmony remains only partial. Among the questions which still confront phonologists are the following:

(i) Questions of synchrony:

What is vowel harmony (VH)? How do we know it when we see it? Is VH the same as or different from processes identified as "umlaut", "metaphony" or "vowel assimilation"?

What is possible vs. not possible? What vowel features can vs. cannot harmonize? Can VH be both bounded and unbounded? What are the constraints on triggers and targets of VH? Is the directionality of VH predictable? What are the possible domains of VH: stem, word, phrase? What can be a "neutral" vowel in VH systems?

How do we implement VH? Among the proposals: feature copying, spreading, government, licensing, metrical trees/grids, dependencies, alignment, agreement, no disagreement etc.

(ii) Questions of diachrony:

Where does VH come from? Does VH result from the "phonologization" of VCV coarticulation (coperception) effects? How does VH generalize from bounded to unbounded? Does VH develop to mark stem or word boundaries?

What other phenomena enhance or impede the development of VH? What is the relation of vowel reduction to VH? Is the development of VH dependent on the preexisting system of vowel contrasts?

Can VH have other than a phonetic source, e.g. restructuring, transphonologization, analogy?

(iii) Questions of typology:

(i) How is VH the same as or different from other harmonies (nasal harmony, consonant harmony etc.)?

(ii) How is VH the same as or different from other assimilatory processes not identified as harmony (tonal assimilations, C to V and V to C assimilations etc.)?

(iii) How is VH the same as or different from (vowel, consonant, tone) disharmony?

Of course, most of the above questions are interrelated. The answer to the question of "what is vowel harmony?", i.e. what should be included within the class of VH systems, may determine how VH is formally implemented, how we explain its diachronic origin, and how we typologize VH with respect to other phonological phenomena.

In this paper I address some of the above questions. Focus will be primarily on one question: Is the directionality of VH predictable, and if so, to what does it owe its predictability? My concern will be determine how the two vowels of a VCV sequence should be expected to assimilate "if left to their own devices". I will suggest that the phonetic expectation is that assimilation will be anticipatory—i.e. contrary to the best-known VH systems (Finnish, Hungarian, Turkish, most Bantu etc.). As will become clear, vowels are rarely left to their own devices, as other factors intervene and complicate this natural phonetic tendancy. One conclusion, therefore, is that one cannot explain the robustly attested properties of VH systems on the basis of VCV coarticulation alone (Ohala 1994). The paper is organized as follows. In §2 I do a first characterization of VH by comparing it with tonal assimilations. The distinction between descriptive vs. analytical generalizations concerning VH is presented in §3. §4 describes a case of unpredictable directional VH from Punu. §5 attempts to sort out what is predictable in VH directionality. In §6 I outline the anticipatory and perservative ATR harmony found in Kinande. §7 discusses the marked situations of prefix triggers and stem targets in VH. A brief conclusion is presented in §8.

2. VH vs. Tone

Since the beginning of phonology there have been many attempts to define VH and characterize different types of VH systems. Important overviews within the generative literature include Clements (1977),

Anderson (1980) and van der Hulst & van de Weijer (1995). Such studies have tried to find a formal coherence to what might be identified as VH (vs. non-VH). However, the discussion has generally been limited to vowel assimilations involving segmental (supralaryngeal) features: front/back, rounding, vowel height, tongue root.[2] I suggest that one might get a clearer view of what is typical of VH by contrasting it with with non-segmental assimilations such as those concerning tone. Tonal assimilations are not usually referred to as "tone harmony." However, since tone is typically manifested on vowels, the comparision with VH is a natural one to make. In this section I discuss the following five differences between tone and VH:

(i) Partial tone assimilation is asymmetrically sensitive to featural content in a way that VH appears not to be

(ii) Full tone assimilation (tone spreading) is asymmetrically perseverative, whereas full (or partial) vowel assimilation may be anticipatory or perseverative

(iii) Tone triggers occur freely, whereas VH is frequently root- or stress-controlled

(iv) Tone assimilations can be bounded or unbounded; VH is almost always unbounded

(v) Tone assimilations can be lexical or postlexical; VH is almost always lexical

First, tone is asymmetrically sensitive to feature content in a way that VH appears not to be. The tables in (1) compare tone height assimilations with vowel height harmony:

(1) Tone height assimilation vs. vowel height harmony

a.

Input:	Anticipatory	Perseverative
L-H	M-H	L-M
H-L	? M-L	? H-M

b.

Input:	Anticipatory	Perseverative
aCi	əCi	aCe
iCa	eCa	iCə

In (1a) it is seen that a /L-H/ input may undergo height assimilation in one of two ways: either the L may rise to M, or the H may lower to M. That is, a /L-H/ input may undergo either an anticipatory or perservative tone-height adjustment. What is striking is that a /H-L/

input is not subject to height assimilation at all.[3] In (1) and in the following tables, I use the symbol "?" to indicate outputs which are either unattested or sparsely attested (perhaps only under special circumstances). As seen, /H-L/ is not expected to assimilate to either M-L or H-M.[4] In (1b) I attempt to schematize parallel vowel height assimilations (which may or may not involve ATR/RTR). The claim is that these are completely symmetric: an input /aCi/ may be modified by raising the /a/ or by lowering the /i/. Similarly, /iCa/ undergo height assimilation by lowering the /i/ or by raising the /a/.

A second difference between tone and VH is seen when we compare tone spreading with total vowel assimilation.[5] As seen in (2a), anticipatory tone spreading is only sparsely attested, often under special circumstances, whereas perseverative tone spreading is massively found in tone systems throughout the world:[6]

(2) Tone spreading vs. total vowel assimilation

a.

Input:	Anticipatory	Perseverative
L-H	? H-H	L-L
H-L	? L-L	H-H

b.

Input:	Anticipatory	Perseverative
aCi	iCi	aCa
iCa	aCa	iCi

As seen in (2b), and nicely summed up by Javkin (1979:75), "...vowel harmony, unlike tone spreading, is not predominantly perseverative." Hyman & Schuh (1974:90) suppose that we are dealing with a major difference between tonal vs. segmental assimilations: "...tonal assimilations differ from segmental ones. The former are usually perseverative, while the latter are usually anticipatory. Thus, a rule palatalizing /k/ to [č] before [i] is more frequent than a rule palatalizing /k/ to [č] after [i]...".[7]

The third difference between tone and VH is displayed in the tables in (3).

(3) Restriction to prominent trigger/non-prominent target

a.

Trigger:	Root V	Stressed V
VH	✓	✓
Tone	?	?

b.

Target:	Affix V	Unstressed V
VH	✓	✓
Tone	?	?

As seen in (3a), the trigger of VH may be restricted to being a root vowel, something which Clements (1981) terms "root-controlled" (✓ = robustly attested). Alternatively, the trigger may be restricted to being a stressed vowel. Turning to (3b), the typical targets are vowels which are either in affixes or are stressless. In such VH systems, the trigger is restricted to a prominent position (root/stressed) while targets are non-prominent (affixes/unstressed). Tonal assimilations, however, are rarely, if ever, restricted in this way. First, there is no bias for affix vowels to assimilate in tone to root vowels. Thus, I am unaware of any language which, for instances, contrasts /H/, /M/ and /L/ on roots, and where affixes assimilate to the root tone. In this case morphologically complex words would be all H, all M, or all L.[8] Similarly, I am unaware of any language where all unstressed vowels take the same tone as a neighboring stressed vowel. There are, of course, tone languages where either affixes or unstressed vowels do not have a tonal contrast. They may assimilate by general rules of tone spreading, take a default tone or, if the root is carrying a contour, allow part of that contour to map onto the root-adjacent affix. What they seem not to do is assimilate (i.e. copy) the same tone as is realized on the root.[9] This, however, appears to be the norm for VH.

The fourth difference between VH and tone is summarized in (4).

(4) VH must be unbounded; tone may be either bounded or unbounded

	Bounded	Unbounded
VH	?	✓
Tone	✓	✓

As indicated, VH is typically unbounded, targeting any number of successive appropriate targets falling within the relevant domain. It is harder to find cases which look like VH, except that only one vowel is targeted.[10] For some linguists, in fact, this is definitional: If only one vowel assimilates, this is "vowel assimilation", not VH. In any case, tone has both properties: tone spreading may apply once or "iteratively". In fact, there are also systems where tone spreads exactly twice.[11] The unbounded character of VH is something which requires both a synchronic and diachronic explanation.

The fifth difference between VH and tone concerns the domain in which each applies. As seen in (5), both can be restricted to the (prosodic) stem or word, but only tonal assimilations can apply at the phrase (potentially, utterance) level:

(5) VH is lexical; tone assimilations may be lexical or postlexical

Domain:	Stem	Word	Phrase
VH	✓	✓	?
Tone	✓	✓	✓

In §5 we discuss some of the few cases reported where VH crosses a word boundary, but there be no doubt about the generalization: VH is almost always lexical, whereas tone-spreading can be either lexical and/or postlexical. Again, VH and tone go their separate ways.

3. Description vs. analysis of VH

In the preceding section I presented some of the major differences between VH and tone, especially tone spreading. We could add others, e.g. the fact that tone has little corresponding to the transparent vowels found in a number of VH systems.[12] The comparison helps us establish the following properties of VH on which phonologists (mostly) agree: (i) VH tends to unbounded; (ii) VH tends to be lexical (restricted to the stem or word domain); (iii) VH tends to be root-controlled. In addition, phonologists are generally agreed on which features can or tend to assimilate in VH. As seen in (6), these include both "color" and aperture features (cf. van der Hulst & van de Weijer 1995):[13]

(6) The features which are active in VH systems

a.	color (palatal, labial):	Front (✓)	Back (?)
		Round (✓)	Unround (*?)
b.	aperture (height, tongue root)	Close (✓)	ATR (✓)
		Open (✓)	RTR (✓)

As indicated in (6a), it is not clear if both Front (palatal, coronal, [-back]) and Back (dorsal, [+back]) need to be active in VH systems.

While cases of labial (rounding) harmony abound, it is frequently questioned whether non-labial harmony exists: "No examples of

[-round] harmony systems have been put forward" (van der Hulst & van de Weijer 1995:505). Steriade (1995:148) accounts for this gap by assuming that Round is a privative (unary, monovalent) feature. The non-existence of [-round] would also account for certain transparency effects: "A possible answer [to why Round harmony goes through an /i/ in Mongolian] is that [-round] does not exist: the feature is universally and permanently privative. The chief predictions of this approach are that [-round] will never give rise to assimilation or dissimilation. We can refer to the absence of an autosegment—and unrounded vowels will form a natural class on the basis of the absence of [round]—but absence cannot spread and repeated absence does not violate the OCP and cannot lead to dissimilation. These predictions are largely correct." Let us now consider that statement as preparation for what we shall have to say about whether there is (unpredictable) directionality in VH.

The best case for [-round] harmony that I know comes from Ineseño (Applegate 1971).[14] As seen in (7), there are six underlying root vowels vs. three underlying prefix vowels:

(6) Ineseño Vowel System (Applegate 1971)

a. underlying root vowels

i	ɨ	u
e	a	o

b. underlying prefix vowels

i	u
a	

As shown in (7), the prefixes /a-/ and /u-/ undergo VH (Applegate 1971:7):

(7) Prefixal VH

a. /a-/ → e / __ C_o e

/qal-wala-tepet/ → [qel-wele-tepet] 'to roll up and tie bundle'
of tying-with body/bulky obj.- roll

b. /a-/ → o / __ C_o o

/aqpala-woyoc/ → [oqpolo-woyoc] 'to wear down crookedly'
of grinding-twist/be crooked

c. /u-/ → ɨ / __ C_o ɨ

/su-yul-c'ɨ/ → [sɨ-yɨ-c'ɨ] 'to heat'
caus-of heat-be sharp

The examples in (7a) and (7b) illustrate that prefixal /a-/ assimilates to a following root /e/ and /o/, respectively. We can refer to these as Front and Round harmony. The interesting process is (7c), which shows that prefixal /u-/ becomes unrounded when the root begins with /ɨ/. As seen, all three harmonies are unbounded in their application.

The question is how to account for what looks to be a case of Unround harmony in (7c). To show the robustness of the process, in (8a) I present Applegate's (1971:3) table of vowel sequences in bisyllabic stems:

(8) Vowel sequences found in bisyllabic stems

a. Surface (Applegate 1971:3)

	i	**ɨ**	**u**	**e**	**a**	**o**
i	i-i	i-ɨ	i-u	i-e	i-a	i-o
ɨ		ɨ-ɨ				
u	u-i		u-u	u-e	u-a	u-o
e	e-i		e-u	e-e		
a	a-i	a-ɨ	a-u		a-a	
o	o-i		o-u			o-o

b. Interpretation

	i	**ɨ**	**u**	**e**	**a**	**o**
i	i-i	i-ɨ	i-u	i-e	i-a	i-o
u	u-i	**ɨ - ɨ**	u-u	u-e	u-a	u-o
e	e-i		e-u			
a	a-i	a-ɨ	a-u	**e - e**	a-a	**o - o**
o	o-i		o-u			

In (8b) I propose to analyze surface [ɨ-ɨ], [e-e] and [o-o] as /u-ɨ/, /a-e/ and /a-o/, respectively. This allows the statement of the generalizations in (9).

(9) Generalizations

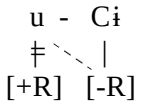
a. /ɨ/ can only occur stem-finally
b. /ɨ/ can only be preceded by /i, u, a/
c. /i/ and /u/ can follow any of the five vowels /i, u, e, a, o/ (but not /ɨ/, which must be final)

As seen, /ɨ/ may not be preceded by /e/ or /o/, and because of the harmony in (7c), /ɨ/ will only be preceded by a [-round] vowel (and not [e]).

The question is how to express u-Cɨ → ɨ-Cɨ? Let us consider the two implementations of this process in (10).

(10) How to express u-Cɨ → ɨ-Cɨ ?

a. Unround harmony: spreading of [-round]



b. Delinking of privative Round

The first option in (10a) accepts that [-round] exists and simply spreads right-too-left, parallel to the Front and Round harmonies which affect /a-/. The second option in (10b) keeps Round as privative and delinks it when followed by /ɨ/.[15] The first proposal is incompatible with the privative interpretation of Round, while the second is incompatible with the idea that there is no "assimilatory delinking": "*no harmony process will ever involve subtraction* (i.e. the dissociation of an element)" (Rennison 1990:202, his emphasis). Other approaches might be to drive the delinking by Steriade's (1995:161) "indirect licensing": "Nonperipheral vowels must be licensed, in at least one associated segment, by membership in the root morpheme." However, this presumably requires some feature to be present on root /ɨ/, e.g. [-round]? Since prefixal [u-] is "sanctioned" by any of the root vowels /i, e, o, u, a/, i.e. whether round or not, we seem unable to extend Harris & Lindsey's (1995:43) proposal for Aperture-delinking to Round: "A nucleus which determines the harmonic category of a span can be said to license the other nuclei within that domain.... [A] is sustainable in a licensed nucleus only if it is sanctioned by an [A] in the licensing nucleus. Any [A] that fails to receive such a sanction is delinked." One might try to drive derounding from some notion of phonetic similarity, but how can this be expressed without reference to [-round]?[16]

What the above is the potential ambiguity of a statement like "Unround harmony does not exist." First, this can be taken as a *descriptive* statement: No language has a process by which rounded vowels become unrounded in the context of unrounded vowels.

Alternatively, it can be taken as an *analytical* statement: Privative Feature Theory X or VH Theory Y disallows (cannot express) Unround harmony.

The same ambiguity is true of the statement "Directional VH does not exist." As a descriptive statement it might mean that no language has a VH process which applies in only one direction (L → R or R → L). As an analytical statement the intended meaning is that phonological theory disallows stipulation of directionality in VH. Instead, directionality follows from general principles, e.g. the direction of VH will be from root to affix. The issue hinges then on whether all directionality can be predicted in VH.

4. Unpredictable directionality in VH: the case of Punu

Two hypotheses can be distinguished: The first is that directionality is VH is unpredictable and, thus, language-specific. The second is that directionality is fully (or mostly) predictable, based on one or more factors concerning the potential triggers and/or targets. We have seen that some directionality will follow from root-control. Early typologies of VH systems such as Aoki (1968) and Halle & Vergnaud (1981) assumed that at least some directionality was predictable from dominance, metrical structure, contrastiveness or underspecification: "unspecified segments...harmonize with fully specified segments" (Poser 1982:125). A useful typology which seems to represent somewhat of a consensus distinguishes root- (or stem-) controlled VH from dominant systems (van der Hulst & van de Weijer 1995, Bakovic 2002, 2002 etc.). In root-controlled systems, where the trigger = root and the target = affixes, there is potential bidirectionality when both prefixes and suffixes assimilate to the root. In dominant systems such as Nez Perce (Aoki 1966), where both the trigger and the target = roots and affixes, bidirectionality is generally assumed. But neither follows automatically: In root-controlled VH, if only suffixes harmonize, VH will be left-to-right; if only prefixes harmonize, VH will be right-to-left. Is such directionality predictable, or is a stipulation required? In dominant systems where harmony may be triggered by a root, prefix or suffix, any directionality effects would have to be stipulated. The question, then, is whether such stipulation is ever needed. The Bantu language Punu, spoken in Gabon, provides just such a case.

In Punu, five vowels contrast in the first or radical syllable of stems: /i, ɛ, u, ɔ, a/ (Kwenzi Mikala 1980; Fontaney 1980). Both pre- and postradical positions are limited to the three vowels /i, u, a/: prefixes, suffixes, and non-initial syllables of long roots. In addition, CV stems, where the root vowel is final, are also limited to /i, u, a/. The vowels /ɛ, ɔ/ have the following realizations (Kwenzi Mikala 1980):

(11) Realization of root /ɛ, ɔ/, which occur only in radical stem syllable

a.	/ɛ, ɔ/	→	[e, o]	/ ___	i
b.	/ɛ, ɔ/	→	[e, o] ~ [ɛ, ɔ]	/ ___	u
c.	/ɛ, ɔ/	→	[ɛ, ɔ]	/ ___	a

As seen, /ɛ, ɔ/ are obligatorily realized [e, o] before /i/, and optionally before /u/. I will assume from this that the feature ATR is active in this language. In (12) I present a privative feature analysis of the five underlying and three derived vowels of Punu (including "[ə]", which will be discussed shortly):

(12) System-driven privative feature analysis

a. underlying vowels

		i	**u**	ɛ	ɔ	**a**
ATR	**A**	x	x			
Front	**F**	x		x		
Round	**R**		x		x	
Open	**O**			x	x	x

b. derived vowels

e	**o**	ə
x	x	
x		
	x	
x	x	

This analysis is system-driven in the sense that only feature specifications are indicated which are active in Punu. As seen, the features A and O account for all of the height/F1 distinctions. F and R are needed to account for the coalescences of /a+i/ and /a+u/ as [e] and [o], respectively, illustrated in (13a).

(13) Vowel coalescence

a. /a-i-lab-i/ → [é-lá̋b-ì] 'il voit'
/a-u-lab-a/ → [ó-lă̋b-ə̀] 'il verra'

b. /a + i / → [e] c. / a + u / → [o]
O AF OAF O AR OAR

As seen in (13b), when O combines with F or R, the result is a mid vowel. We obtain [e, o] rather than *[ɛ, ɔ] thereby confirming the decision to treat ATR as activated on /i, u/.

Recall that vowels in positions other than the radical syllable are restricted to /i, u, a/. This would suggest that two post-radical syllables should produce nine combinations. While prefixes are not affected, post-radical vowels undergo the modifications in (14).

(14) Postradical VH and reduction

a. a, i → u / __ C_0 u
b. a → i / __ C_0 i
c. a → ə (= [ɨ]?)

As seen, both postradical /a/ and /i/ assimilate to a following /u/. Postradical /a/ also assimilates to a following /i/. Finally, any postradical /a/ that does not assimilate is realized as a non-low vowel. As seen in (15), the processes in (14) reduce nine input VCV postradical sequences to six outputs:

(15) Combinations of post-radical vowels and their realizations

	i	**u**	**a**
i	i-i	u̲-u	i-ə
u	u-i	u-u	u-ə
a	i̲-i	u̲-u	ə-ə

I assume that the assimilation of postradical /a/ to a following [i] or [u] is through an intermediate [ə] stage. While the Punu references transcribe a schwa, my interpretation is that postradical /a/ loses its O specification, and hence is identical to [ɨ]).[17] Examples are seen in (16).

(16) Examples of anticipatory post-radical harmony and reduction

a. general "default" /-a/

-bíng-asan-a	→	-bíng-əsən-ə	'roll (sth.)'
-bund-igil-a	→	−bund-igil-ə	'slander'

b. present, subjunctive /-i/

-bíng-asan-i	→	−bíng-isin-i	'roll (sth.)'
-bund-igil-i	→	-bund-igil-i	'slander'

c. passive /-u/

-bíng-asan-u	→	−bíng-usun-u	'be rolled'
-bund-igil-u	→	−bund-ugul-u	'be slandered'

The assimilations in (16) contrast with the better-known perseverative, root-controlled VH found in familiar Bantu languages (see Hyman 1999 for an overview). In languages such as Chichewa, Shona, Swahili, Luganda etc. a derivational front-vowel suffix is realized [e] after /e/ and /o/ and [i] after /i, u, a/. The directionality of VH in these languages is predictable from the principle of root-control: VH proceeds from the direction of the radical vowel rightwards. It is not clear how one might "predict" the right-to-left suffixal harmony in Punu. One could always propose an ad hoc "representational fix," e.g. giving more grid marks to the final vowel than to the root:

(17) Ad hoc "representational fix"

a.
```
        x
    x   x
    x x x
CuC - a C -i
  |   `.` |
  R       F
```

b.
```
        x
    x   x
    x x x
CiC - a C -u
  |   `.` |
  F       R
```

In (17) the principle determining directionality is that the internal stems vowels assimilate to the features found in the most prominent position—the final vowel. However, there is no Punu evidence to support the three grid marks on the final vowel. In fact, as we have said, like other post-radical vowels, the final vowel is limited to /i, u, a/ vs. the radical vowel, where /ɛ, ɔ/ are also possible. It is thus unlikely that final position is "stronger" than stem-initial position. In addition, it is not only the final vowel that conditions VH. The historical derivational

suffix sequences -am-in- and -am-un- are realized -imin- and -umun- (Fontanay 1980).[18] Note finally from the inputs in (17), where internal /a/ is surrounded by /u...i/ and /i...u/ that we cannot predict directionality from the nature of the input vowels. We must conclude, therefore, that directionality is not predictable in at least some VH systems.

5. Quasi-Predictable Directionality in VH

In the preceding section we saw that directionality is not predictable in Punu. Of course, one might object to this conclusion by insisting that the vowel assimilations in Punu do not constitute "real" VH. After all, this is not a case of root-control VH. In (18) I list three prototypical properties which might be proposed to define "canonical VH":

(18) Three prototypical properties defining "canonical VH"

a. a canonical trigger V occurs in a prominent syllable (e.g. root, stressed) with a contrastively specified feature

b. a canonical target V occurs in a non-prominent syllable (e.g. affix, unstressed) with a non-contrasting unspecified feature

c. canonical VH is structure-preserving

Punu clearly does not satisfy the properties in (18a,b) and only partially satisfies the property in (18c): the assimilation of /a/ to [i] and [u] is structure-preserving, but the reduction of /a/ to schwa is not. One might try to argue for predictable directionality in VH by eliminating cases of non-root control. This would then reduce to the question of whether one can predict if VH will hit prefixes vs. suffixes—or both.

Following Vergnaud (1980), we might take a word-tree approach to VH. Perhaps bidirectional dominant VH occurs in languages such as Nez Perce, because prefixes, roots and suffixes (P, R, S) form an undifferentiated flat word-tree, as in (19a).

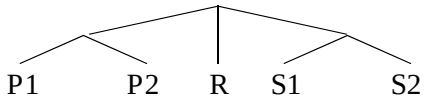
(19) Identifying triggers and/or directionality: word-tree approach

a. flat tree (Nez Perce?) b. common hierarchical tree (Bantu)

On the other hand, languages which show asymmetries in directional root-controlled harmony would have a hierarchically branching word-tree, for example, as in (19b). In this widely attested structure (e.g. in Bantu), suffixes form a stem with the root, while prefixes form a word with the stem. Whether this approach is explanatory depends on whether the different structures in (19a,b) can be established independently of VH. We can note in this connection the difficulty of determining the root vs. affix status of morphemes in Nez Perce vs. in most of Bantu, where VH is mostly restricted to the stem constituent (R+S). Still, this is at best an oversimplification of the problem.

A full discussion of directional possibilities would have to consider cases of multiple prefixation and suffixation, as represented in (20).

(20) Multiple affixation word-tree



The target/trigger + directional possibilities of forms having up to two prefixes or suffixes are evaluated in (21).

(21) Target/trigger + direction possibilities of P1-P2-R-S1-S2

	left to right		**right to left**	
a.	local VH			
	P1 → P2	?	P2 → P1	✓
	P2 → R	?	R → P2	✓
	R → S1	✓	S1 → R	✓
	S1 → S2	✓	S2 → S1	✓
b.	non-local VH (affix transparency)			
	P1 → R	?	R → P1	✓
	R → S2	✓	S2 → R	✓
c.	non-local VH (root transparency)			
	P2 → S1	?	S1 → P2	?
d.	non-local VH (affix+root transparency)			
	P1 → S1	?	S1 → P1	?
	P1 → S2	?	S2 → P1	?
	P2 → S2	?	S2 → P2	?

e. root-root compound VH

R1 → R2 ✓ R2 → R1 ✓

f. root-internal VH (also within P & S)

$[V \rightarrow V]_R$ $[V \leftarrow V]_R$

While I have given my own impressionistic judgments as to what occurs and what does not, it is obviously necessary to do a thorough study of the world's VH systems to see how many of the possibilities in (21) are robustly attested.

Whether and how VH applies may depend on a number of parameters (cf. Archangeli & Pulleyblank 1994). First, what is the active trigger feature? Second, which elements carry this feature (root, suffix, prefix)? Next, what are the directionality restrictions, if any? What is the domain of VH (stem, word), etc.? In approaching each case, it is necessary to execute what Clements (2001) calls "an active feature specification analysis." As Archangeli and Pulleyblank make clear, an analysis for one language may not carry over to another.

Given that VH is such a widespread phenomenon, and so varied, an exhaustive study is still some ways off. Still, there is considerable evidence that right-to-left VH is more robust than left-to-right, other things being equal. As noted in §2, segmental assimilations tend to favor right-to-left application (cf. Javkin 1979). In addition, VCV coarticulation effects appear to be more robustly anticipatory, even in languages with left-to-right VH, e.g. Turkish (Beddor et al 1995, Inkelas et al 2000), Shona & Swahili (Manuel & Krakow 1984). Might it be that the right-to-left directionality required in Punu (§4), rather than having to be stipulated, is in fact the "unmarked" option, once root-control is not involved?[19]

Another context in which root-control is deactivated concerns cases where VH applies across word boundaries. Somali is frequently cited in this context, and it may be no accident that the ATR harmony is regressive (Hall & Hall 1980). The common case occurs in languages which have a robust lexical VH, but more restricted postlexical VH. Nez Perce is the textbook case of a language with bidirectional "dominant" VH within words. The five vowels in this language divide up into two sets, with /i/ belonging to both: /i, o, a/ (set 1) vs. /i, u, æ/ (set 2). Hall & Hall (1980) propose that the active feature of the dominant set 1 vowels is retracted tongue root (RTR). Be that as it may, Aoki (1966:761) indicates the following concerning phrase-level VH: "In

rapid speech, there is consistent anticipatory assimilation across the harmonic sequence boundary by one syllable....” He provides the examples in (22).

(22) Postlexical VH in Nez Perce

	normal speech	**rapid speech**
a.	míniku:ne pá:kciqa	míniku:na̲ pá:kciqa
	‘which one did they see?’	(e → a)
b.	ʔitam’ yá:t’ as ʔewsí:x	ʔitam’ yá:te̲s ʔewsí:x
	‘they are for sale’	(a → e)

My impression is that anticipatory postlexical VH of this sort occurs more frequently than its perseverative counterpart. Where both (rarely) occur, anticipatory phrasal VH is more robust. In Nawuri, a Kwa language of Ghana, anticipatory phrasal VH is unbounded, with no target condition: “The extent of leftward postlexical [+ATR] spreading is variable and dependent on rate/style of speech.... In casual speech, however, cases of [+ATR] spreading over several syllables... are not uncommon.... I assume that the process is unbounded, although its effect may tend to diminish with distance from the triggering [+ATR] morpheme, as has been claimed for Akan (Clements 1981).” (Casali 2002a:32). On the other hand, perseverative phrasal VH hits only one syllable whose target must be [+high]: “Limited rightward spreading of [+ATR] also occurs in Nawuri. It is optional and speech-rate dependent, often failing to apply except in very rapid or casual speech. In contrast to leftward [+ATR] spreading, rightward spreading affects only a single syllable to the right of the trigger, and the target vowel must be high” (Casali 2002a:32).

Besides postlexical VH, neutral vowels appear either to be undergoers or show greater permeability in anticipatory VH than in perseverative VH. Nawuri has both anticipatory and perservative ATR VH. However, Casali (2002a:20) states: “In situations involving the rightward spreading of [+ATR] onto a suffix, the vowel /ɑ/ clearly behaves opaquely in Nawuri.” On the other hand: “... /ɑ/ appears superficially to be transparent rather than opaque in cases where it intervenes between a [+ATR] root vowel to its right and a harmonizing prefix to its left” (p.21). Available data from Budu (Kutch Lojenga 1994a), Bila (Kutch Lojenga 1994b), and Lika (Kutsch Lojenga 1999) suggest the same asymmetry with respect to /a/ in these Bantu languages. As seen in the

Ntomba forms in (23a), /i/ and /u/ are transparent to anticipatory RTR VH which converts /e, o/ to [ɛ, ɔ], but opaque to the perservative harmony of /-a/ to [ɛ, ɔ] in (23b).

(23) RTR harmony in Ntomba (Leitch 1996:109, 111-2)

a. /i, u/ are transparent in right-to-left /e, o/ → [ɛ, ɔ]

ɛ-kiɔ	'Cayor worm under skin' (cf. Bolia bo-kihɔ)
mɛ-nyitɛ	'wrinkles on skin of chicken'
lɔ-pumbɛ	'all kinds of small fish' (cf. Bolia lo-pumbɛ)
mɔ-nkinyɛ́	'tick, jugger nit' (cf. Bolia bo-kinyɛ́)

b. /i, u/ are opaque in left-to-right /a/ → [ɛ, ɔ]

bɛl-i-a	'bring near'	*bɛl-i-ɛ
tɛl-i-a	'raise'	*tɛl-i-ɛ
tɛ́ng-um-a	' limp'	*tɛ́ng-um-ɛ
nyɔng-ut-an-a	'swarm'	*nynyɔng-ut-ɔn-ɔ

All of these observations are duplicated in Kinande ATR harmony, which I briefly outline in the next section.

6. Anticipatory and Perseverative ATR VH in Kinande

The ATR harmony system of Kinande has been the subject of numerous treatments, e.g. Schlindwein (1987), Hyman (1989b), Archangeli & Pulleyblank (1994, in press), Mutaka (1995). As seen in (24), right-to-left VH targets all seven underlying vowels:

(24) Right-to-left ATR harmony in Kinande

a.	/-lím-/	'exterminate'	/ɔ-mʊ-lím-i/ 'exterminator'	→	o-mú-lim-i /i/ → [i]
	/-húk-/	'cook'	/ɔ-mʊ-húk-i/ 'cook'	→	o-mú-huk-i /u/ → [u]
b.	/-lɪm-/	'cultivate'	/ɔ-mʊ-lɪm-i/ 'cultivator'	→	o-mu-lim-i /ɪ/ → [i]
	/-hʊm-/	'beat'	/ɔ-mʊ-hʊm-i/ 'beater'	→	o-mu-hum-i /ʊ/ → [u]
c.	/-hɛ́k-/	'carry'	/ɔ-mú-hɛk-i/	→	o-mú-hek-i

			‘carrier’		/ɛ/ → [e]
	/-bɔ́h-/	‘tie’	/ɔ-mʊ-bɔ́h-i/	→	o-mú-boh-i
			‘tier’		/ɔ/ → [o]
d.	/-kar-/	‘force’	/ɔ-mʊ-kar-i/	→	o-mu-kar-i
			‘forcer’		/a/ → [a] ~ [ɜ]

The indicated assimilations are triggered by the ATR agentive suffix /-i/. As indicated, /a/ is either an undergoer or transparent (see Archangeli & Pulleyblank, in press). On the other hand, as seen in (25), perseverative VH targets high vowels.

(25) Left-to-right ATR VH targets only high vowels in Kinande

a.	/-lím-/	‘exterminate’	→	-lį́m-ir-a	‘exterminate for/at’
	/-húk-/	‘cook’	→	-húk-ir-a	‘cook for/at’
b.	/-lɪm-/	‘cultivate’	→	-lɪm-ɪr-a	‘cultivate for/at’
	/-hʊm-/	‘beat’	→	-hʊm-ɪr-a	‘beat for/at’
	/-hɛk-/	‘carry’	→	-hɛk-ɛr-a	‘carry for/at’
	/-bɔh-/	‘tie’	→	-bɔh-ɛr-a	‘tie for/at’
	/-kar-/	‘force’	→	-kar-ɪr-a	‘force for/at’
c.	/mɔ́-tu-a-lim-ir-ɛ́/		→	mó-tw-á-lím-ir-ɛ̀	‘we exterminated’
	/ɛ-ri)-bɛ́rɛ/		→	e-rí-bɛ́rɛ̲	‘breast’
	/ɛ-ri)-bɔndɔ/		→	e-ri-bɔ̲ndɔ̲	‘wild palm’

As a result, the applicative suffix /-ɪr-/ becomes -ir- after /i, u/ in (25a). It remains non-ATR in (25b), although, as seen, it is subject to progressive height harmony. The perfective and class 5 forms in (25c) show that a mid vowel /ɛ/ or /ɔ/ will not become ATR after /i/ (or /u/). Since progressive VH only targets high vowels, it is not surprising that /a/ shows differential directional behavior. Further examples are seen in (26).

(26) Different behavior of /a/ with respect to directionality in Kinande

a. /a/ is transparent or an undergoer in anticipatory ATR VH

i.	/-hɛk-/	‘carry’	→	mó-tw-a-kí-hék-ir-è
				‘we carried it’
	/-bɔ́h-/	‘tie’	→	mó-tw-a-kí-bóh-ir-ɛ
				‘we tied it’

ii. /-kar-/ 'force' → mó-tw-a-mú-kár-ir-è
'we forced him/her'

b. /a/ is opaque in perseverative ATR harmony

i. /-hi̱mat-/ 'press, rub' → e̱-ri̱-hi̱mat-ır-a
'to press for/at'

ii. /-gʊmat-/ 'stuff in mouth' → e̱-ri̱-gʊmat-ır-a
'to stuff in mouth for/at'

The forms in (26a) have the ATR perfective suffix -ir-ɛ, while those in (26b) have the non-ATR applicative suffix -ır-, i.e. we do not derive *-himat-ir-, *-gumat-ir-. There can be no doubt that anticipatory lexical VH is more robust than perseverative in Kinande.

The same conclusion can be reached at the postlexical level, where we can compare the realization of noun + adjective sequences involving the following words:

(27)

		Nouns		**Adjectives**	
a.	non-ATR:	ɔ-mú-tahı	'branch'	mú-nɛnɛ	'big'
b.	ATR:	o-mú-kalì	'woman'	o-mú-kuhì	'short'

As seen in (28), ATR harmony across word boundaries is strictly right-to-left:

(28) Four combinations of ATR and non-ATR words

a. [-ATR] ## [-ATR] : ɔ-mú-tahí mú-nɛnɛ 'big branch'
b. [+ATR] ## [+ATR] : o-mú-kalí mú-kuhì 'short woman'
c. [+ATR] ## [-ATR] : o-mú-kalí mú-nɛnɛ 'big woman'
d. [-ATR] ## [+ATR] : ɔ-mú-tahí mú-kuhì 'short branch'

(28a,b) have identical harmonies on the noun and adjective, while (28b,c) have opposite harmonies. (The binary feature [±ATR] is used for convenience.) As seen, only the final /ı/ of the noun in (28d) undergoes ATR harmony—and in this case the preceding /a/ is opaque!

Mutaka (1995) provides the general properties of Kinande phrase-level ATR assimilation, which is remarkably similar to that reported for the Kru language Vata (Kaye 1982:430): Postlexical ATR harmony (i) applies across (some) word boundaries; is unidirectional (right-to-left); (iii) is subject to certain vowel height constraints (the last vowel of the first word must be [+high]); (iv) is optional; (v) is optionally unbounded, perhaps gradient (potentially targeting more than one [+high] vowel in

successive syllables). In addition, /a/ is opaque in (28d). However, it is transparent in examples such as in (29), where there is V ## V coalescence:

(29) Postlexical VH involving vowel coalescence (Mutaka 1995:52)

a.	ɛ́-ŋ-gɔkɔ̀	+	eyì	→	ɛ́-ŋ-gɔk͟w eyį	→	é-ŋ-gǫkw eyì
	chicken		this				‘this chicken’
b.	ɛ-m-básа	+	eyì	→	ɛ-m-bás_ eyì	→	e-m-bás eyì
	axe		this				‘this axe’

All of the above substantiates the claim that when root-control is not involved, anticipatory VH will have exclusive or greater effects than perseverative. The last place where this is observed in Kinande concerns prefix triggers. As seen in (30a), the class 4 & 10 numeral prefix /i-/ spreads its ATR feature onto a following high vowel (Bbemo 1982, Kahindo 1981):

(30) Prefix-controlled ATR VH in Kinande

a.	/i-βɪrɪ/	→	i-βįrį	‘two’	cf.	class 2	βa-vɪrɪ
	/i-nɪ/	→	i-ni	‘four’	cf.	class 2	ba-nɪ
b.	/i-tanʊ/	→	i-tanʊ	‘five’	cf.	class 2	βa-tanʊ

(30b) shows that no harmony will occur if the following vowel is non-high. This of course is reminiscent of the progressive VH in verb stems in (25).

The data in (31) show a more interesting harmony situation which is limited to the class 5 prefix /ɛ-ri-/ (and its variant /i-/):

(31) The realization of 5 /ɛ-ri-/ on (inherent) class 5 noun stems

a. /ɛ-ri-/ → e-ri- when the stem includes an ATR /i/ or /u/

/-riba/	→	e-ri-rį̀ba	‘spring’	pl.	a-ma-riba
/-kúndo/	→	e-rí-kúndɔ	‘knot’	pl.	a-má-kúndɔ
/-kánzi/	→	e-rí-kánzi	‘plantain’	pl.	a-má-kánzi
/-tsengú/	→	e-ri-tsengû	‘big head’	pl.	a-ma-tsengû

b. /ɛ-ri-/ → e-ri- when all stem vowels are non-ATR /ɛ, ɔ, a/

/-bére/	→	e-rí-bɛ́rɛ	‘breast’	pl.	a-má-bɛ́rɛ
/-bɔndɔ/	→	e-ri-bɔndɔ	‘wild palm’	pl.	a-ma-bɔndɔ
/-gana/	→	e-ri-gana	‘hundred’	pl.	a-ma-gana
/-bálɛ̀/	→	e-rí-balɛ̀	‘callus’	pl.	a-má-balɛ̀

	/-gɔmba/	→	e-ri-gɔmba	‘drum’	pl.	a-ma-gɔmba
c.	/ɛ-ri-/ → ɛ-rɪ- when the first stem vowel is non-ATR /ɪ/ or /ʊ/					
	/-hírì/	→	ɛ-rí-hɪrì	‘crab’	pl.	a-má-hɪrì
	/-túgù/	→	ɛ-rí-tʊgù	‘yam’	pl.	a-má-tʊgù
	/-túmbì/	→	ɛ-rí-tʊmbì	‘night’	pl.	a-má-tʊmbì

In (31a) this prefix is realized as ATR throughout when the noun stem has an ATR vowel. Since ATR would have spread in any case from the noun stem, we cannot tell from such forms whether there is also an ATR feature on the prefix. The forms in (31b) whose noun stems contain only non-high vowels reveal that the prefix is ATR. While Archangeli & Pulleyblank (1994) and Mutaka (1995) attribute this to a property of the stems, the fact that all non-high-vowel stems require an ATR class 5 prefix suggests that the latter is in fact underlying ATR, as I now claim.[20] The problem concerns nouns such as those in (31c) whose stem-initial vowel is high and non-ATR. As seen, the class 5 prefix is realized without its ATR feature. To account for this, I propose that the underlying form of the class 5 prefix sequence is /ɛ-ri-/, but that there is ATR-delinking in (31c) by what Bakovic (2000) terms “dominance reversal). This is triggered by the fact that /i, u/ cannot co-occur with /ɪ, ʊ/ within a word at the lexical level in Kinande.

Kinande ATR can be summarized as follows:

(i) Lexical right-to-left VH is obligatory and unbounded. The trigger can be a root, suffix, or prefix, the last exemplified by e.g. /ɛ-ri-/ → e-ri- in (31). The target can be high, mid, or low (assuming /a/ → [ɜ]).

(ii) Lexical left-to-right VH is obligatory and unbounded. The trigger can be a root (25a) or prefix (30a). There is no reason why it cannot also be a suffix, although there is no ATR suffix followed by a [+high] non-ATR suffix to test this. The trigger and target must both be high vowels. The ATR trigger of /ɛ-ri-/ is delinked if followed by /ɪ, ʊ/ in the following class 5 noun stem.

(iii) Postlexical right-to-left VH is optional. The target must be [+high] as in (28d), or VH must be fed by vowel coalesence, as in (29). In the former case, VH is bounded; in the latter is potentially unbounded.

Perhaps the most puzzling thing about Kinande is why there is dominance reversal rather than progressive harmony in (31c). As will be discussed in the next section, prefixes are non-canonical triggers and stems are non-canonical targets.

7. Prefix triggers and stem targets

It is sometimes claimed in the literature that there are no dominant prefixes or prefix-control in VH: "Prefix controlled harmony is unattested so far, as is triggering by prefixes in dominant-recessive harmony" (Krämer 2002:3); "...dominant suffixes are the norm while dominant prefixes are the exception...." (Bakovic 2000:237). This claim is apparently due to Hall & Hall (1980) who reanalyze alleged prefixes that could be counterexamples in Nez Perce: "It is interesting to note that in Nez Perce, as in the African languages we report on below, there seem to be no true cases of Dominant grammatical prefixes which cause harmony to themselves. Apparent counterexamples... are clearly compounds..." (p.227n). That is, prefixes whose dominant RTR feature triggers harmony are to be analyzed as roots.

In §6 we saw a limited prefix-controlled ATR harmony in Kinande. It therefore seems unlikely that there would not be others. Still, there is no question that prefix-controlled VH is quite rare as compared to suffix-controlled VH. Possible functional interpretations of prefix-suffix asymmetry might be due to one or more of the following factors:

(i) Roots are bad right-targets. Perhaps this could be related to oft-cited stem-initial resistence/strengthening/faithfulness effects. In Kinande class 5, noun stems are strong enough to resist progressive VH in (31c), as opposed to numeral stems (a closed class) which undergo progressive VH in (30a).

(ii) Prefixes are bad (left-) triggers, i.e. on subsequent prefixes as well as on stems. While I have found cases where a prefix triggers VH on a preceding prefix, it is harder to find examples where it triggers VH on a following one.

(iii) VH is preferentially anticipatory (right-to-left), other things being equal.[21]

(iv) VH effects are stronger between roots + suffixes, which form (stratum 1) stems vs. prefixes + roots, which combine at the word (stratum 2) level. Recall the [P [R-S]] branching structure in (19b)).

Perhaps the prefix-stem asymmetry is due to a cumulative effect of two or more of the above factors.

At this point I would like to offer the following two hypotheses:

The first hypothesis is that root-triggered VH on suffixes derives from post-tonic reduction. Striking support of this comes from Punu, where postradical /a/ reduces to schwa, which then makes it vulnerable

to Front and Round harmony. Preradical (prefixal) /a/ does not reduce to schwa and is not subject to VH. Perhaps most "carry-over" effects of this sort can be related to the fact that post-tonic position is weaker and hence more prone to reduction than pre-tonic position (cf. Barnes 2002). Of course, there is nothing preventing pretonic reduction from feeding VH as well.

The second hypothesis is quite simple: All VH that does not owe its existence to reduction is anticipatory, i.e. articulatory, perceptual, and/or conceptual "pre-planning".

By adopting these two hypotheses we can account for the following observations:

(i) Roots are good VH triggers on affixes, because the latter are subject to reduction, which feeds VH.

(ii) Suffixes are reasonable VH triggers on roots, because the process is anticipatory (= unmarked for segmental assimilations). Suffix-controlled VH is less frequent than root-control, presumably because roots do not as readily undergo reduction as do affixes.

(iii) Prefixes are poor VH triggers on roots for two reasons: First, roots do not readily undergo reduction; and second, the VH process would not be anticipatory.[22]

(iv) An earlier word is a poor VH trigger on a following word, since neither reduction nor anticipatory directionality is involved.

Others predictions of these hypotheses require further study in order to be confirmed:

(i) A P2 prefix should be able to trigger VH on a preceding P1 more readily than on a following prefix P3.

(ii) An S2 suffix should be able to trigger VH on a preceding S1 as an anticipatory process, but also on a following S3 suffix which may be in a weaker position.

In terms of what should be the most commonly occurring, root-controlled VH on prefixes has a good trigger and the anticipatory direction in its favor, while root-controlled VH on suffixes has a good trigger and the best (weakest) target. My impression is that languages with both types of affixes more readily harmonize suffixes rather than prefixes, but there are counterexamples in the literature.[23]

8. Summary and Conclusion

In the preceding sections I have surveyed some of the basic issues involved in the study of VH systems. I done so with little regard to questions of "implementation": Whether we adopt spreading as the means of expressing VH or other means, question of what VH is and why it takes the forms it does can be fruitfully addressed at some distance from our preoccupation with formal analysis. There still are lots of VH systems which have not been incorporated into the theoretical public domain—and, of course, there are more VH systems waiting to be described. The present paper is a small contribution to a large problem, which, I have no doubt, will continue to intrigue phonologists of all persuasions.

I would like to conclude by comparing my interpretation of VH with recent results concerning the directionality of consonant harmony (CH), about which Hansson (2001:198-9) writes:

> ...consonant harmony in heteromorphemic contexts seems to display only two fundamental directionality patterns. One is stem control, whereby affixes harmonize with the base to which they attach. This can give rise either to right-to-left harmony (in prefixation contexts) or to left-to-right harmony (in suffixation contexts), or a combination of both (i.e. 'bidirectional' harmony) in those cases where prefixes and suffixes are both within the domain in which harmony holds. The other type is fixed directionality, which is insensitive to morphological structure. In this case, harmony applies in a right-to-left fashion, i.e. as anticipatory assimilation. There are no cases of fixed directionality involving progressive (left-to-right) assimilation. Put somewhat differently, a suffix may affect the stem it attaches to, or it may be affected by that stem; a prefix, on the other hand, may be affected by the stem it attaches to, but it may *not* affect that stem. In other words, progressive harmony never goes against what the morphological structure dictates, but anticipatory harmony frequently does.

If I'm correct in what I have proposed in the preceding sections, VH and CH show the same directionality properties, except: (i) Stem-control is more prevalent in VH than in CH; (ii) VH is more sensitive to reduction than CH; (iii) CH may apply to underlyingly contrastive consonants (e.g. /s/ vs. /š/), while (root-controlled) VH is typically non-neutralizing. Concerning directionality in VH, Hansson (2001:180) is well-aware of the complexities involved: "If anything, progressive vowel harmony appears to be more common cross-linguistically than

regressive vowel harmony, but this may well be due to the fact that suffixation is far more common than prefixations." In light of the above, it would be quite interesting to consider whether VH and CH are not more alike than we have heretofore believed.

Notes

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[1] This paper was originally conceived within the context of a joint seminar on vowel harmony with I taught with John Ohala at Berkeley in Fall 2002, whom I thank, as well as our students, as well as Nick Clements, Sharon Inkelas, Sharon Peperkamp, John Rennison, Robert Vago and Cheryl Zoll, for their valuable responses and challenges to the ideas presented herein.

[2] Vowels, of course, also participate in harmonies that target both vowels and consonants (nasal harmony, emphatic harmony etc.). Since my interest is specifically in VH systems, I will ignore these o tonal dissimilation by raising the H to a superhigh in anticipation of the follother harmonies in this study.

[3] In fact, a /H-L/ input can be expected to undergowing L. A particularly striking case of this occurs in Engenni (Thomas 1974, 1978).

[4] A third possibility is that these exist only a result of restructuring. The one case I am familiar with where /H-L/ is realized H-M occurs in Ga, where it is restricted to utterance-final position and only certain parts of speech (see Paster 2000 and references cited therein). Since other Ghanaian languages instead have glottal stop insertion in this context (Snider 1986), I propose that such utterance-final changes of /H-L/ to [H-M] was due to the raising effect of a [ʔ] which has seen been lost.

[5] The idea is that tone-register adjustments such as in (1a) most directly correspond to the featural assimilations found in most VH systems, whereas tone spreading in (2a) corresponds to full vowel assimilations. Whether one accepts these latter as true cases of VH or not is not crucial, since both full and partial vowel assimilations can be anticipatory or perseverative; cf. (1b) and (2b).

[6] The more familiar way to show tone spreading is with /L-H/ and /H-L/ being realized L-LH and H-HL (i.e. with contouring of the second tone). I believe most phonologists would agree that tone is more prone to contouring than segmental vowel features. Where occurring, cases of /aCi/ becoming [aiCi] or [aCai] are frequently followed by loss of trigger vowel, ultimately deriving [aiC] or [Cai]. Cf. changes of /iCa/ to [iaCa] or [iCia] and then to [iaC] and [Cia], respectively.

[7] Javkin (1979:75-76) confirms this tendency: “I examined 365 segmental assimilatory rules culled from 60 languages... documented in the Stanford Phonology Archive. 195 of these rules involved assimilatory assimilation of a segment to a following segment. 89 of these involved the perseverative assimilation of a segment to a preceding segment.... The conclusion must be

that segmental assimilation is generally anticipatory, in sharp contrast to the situation in tonal assimilation."

[8] The closest example to this I know is Yabem (Bradshaw 1979; Ross 1993), where there is a tone/voicing correlation of some interest (cf. Poser 1981).

[9] The situation in Proto-Bantu reconstructed by Meeussen (1961), and exemplified still in many Bantu languages, is particularly interesting in this context. It is generally assumed that within verb stems (root + suffixes) a *H/*L (or *H/Ø) opposition was found only on the first root vowel and on the inflectional final vowel (FV). Derivational suffixes ("extensions") which occur between the root and FV take the same tone as the FV. Thus, the simplest tone patterns found on verb stems were L+L*, L+H*, H+L* and H+H*, where * indicates multiple realization of the tone of the FV. If described as an assimilation of non-final suffix tones to the tone of the FV, this becomes exactly parallel to the directional, anticipatory VH described in §4 in Punu. In both cases vowels assimilate in a weak position, the "prosodic trough" (Hyman 1998), but there is disregard for root-control.

[10] As indicated in note 23, there are languages in which VH is unbounded in one direction, but bounded in the other, and there are languages where VH is unbounded lexically, but bounded postlexically. What is harder to document is a language whose only VH is bounded, but at least one variant of Lango may be just that (Bavin Woock & Noonan 1979). There are, of course, ambiguous cases where word structure provides only one potential target vowel.

[11] Tone assimilation may be telescoped in such a way that tones come to be realized on the following (more rarely, preceding) tone-bearing unit (Hyman & Schuh 1974). An interesting, but extremely rare telescoping of vowel height harmony occurs in Esimbi, where the historical (and underlying) vowel height features of roots shift onto prefixes, leaving the roots as default high vowels (Stallcup 1980, Hyman 1988).

[12] The one quite specific case I know of a transparent tone comes from Tuki (Hyman & Biloa 1992), where H tone spreading skips over the L of a first person singular nasal prefix (which in turn conditions downstep on the targeted vowel).

[13] It is generally assumed that there is no vowel length harmony. See Hyman & Udoh (2003), however, for a possible, but inconclusive counter-example.

[14] The Ineseño facts are also cited by Steriade (1995:161) to illustrate "indirect licensing" (see below) rather than the existence of [-round].

[15] Cf. Unrounding triggered by -i suffixes in Kpokolo (Kaye et al 1985).

[16] In personal communications, John Rennison has proposed treating /ɨ/ as both front and round, i.e. as IPA [y], while Nick Clements has suggested Ineseño prefixal VH can be described as full vowel assimilation or as dominance reversal (Bakovic 2000), as discussed in §6 with respect to Kinande.

[17] This is consistent with the non-realization of /-a/ after a /CV/ root: /ji-a/ → ji 'eat', /nu-a/ → [nu] 'drink', /ba-a/ → [bə] 'be'.

[18] Suomi et al (1997) show experimentally that VH can be exploited to determine word boundaries in Finnish. However, as can be seen, no boundary is enhanced by VH in Punu. In addition, most Bantu languages with progressiveVH do not harmonize the final vowel of the verb stem. It thus seems unlikely that the processing explanation of VH proposed by Kaye (1989), will extend to these cases.

[19] The same might be expected where we can eliminate stressed/unstressed differentials. Thus, Farnetani (1990:122) states re VCV coarticulation: "…when the two flanking vowels have comparable articulatory strength [e.g. both are stressless—LMH], the anticipatory effects tend to increase in magnitude [in] respect to carryover effects...."

[20] There is, however, a curious gap in Kinande class 5 noun stems. Whereas /CaCɪ/ and /CaCʊ/ are both attested in other classes (Hyman 1999), e.g. ɔ-mʊ-sasi 'blood', ɔ-mú-lamʊ 'sister-in-law' (sister of wife), these stem shapes do not occur in class 5. Ngessimo Mutaka and I have looked so far in vain to determine what the historical fate of such class 5 noun stems might have been (for instance, did the final vowels merge with /ɛ, ɔ/ or with /ɪ, ʊ/?). The prediction here is that /CaCɪ/ and /CaCʊ/ noun stems, if existing in class 5, would take the prefix ɛ-ri-

[21] This may especially be true of ATR and umlaut-like processes which seem preferentially to be anticipatory.

[22] Interestingly, cases where a vowel prefix could have produced VH result instead in either local assimilation (umlaut), e.g. Chamorro foggon 'stove', ni-f̲eggon 'the stove' (Topping 1973:52) or diphthongization, e.g. Noni (*u-téŋ) > tw̲éŋ 'vine branch' (cf. pl. téŋ) (Hyman 1981:8).

[23] In a number of Bantu languages where stem-level suffixes harmonize, VH has been extended to prefixes. I know of three situations. The first, typified by the following statement of Hulstaert (1961:37) re Lomongo, is where only one prefix to the left of the root is affected: "Dans les éléments préradicaux du verbe conjugué l'influence harmonisante de la voyelle radicale se limite à l'élément qui la précède immédiatement; elle n'atteint jamais un élément situé au-delà, à moins que celui-ci ne précède immédiatement l'élément influencé sans en être séparé par une consonne." The second is illustrated by Llogooli, which obligatorily harmonizes the pre-radical prefix and optionally prefixes that precede: "An interesting observation to make is that vowel assimilation occurs not only between the root and the immediately preceding prefix, but also optionally among prefixes" (Leung 1986:81). Finally, some Bantu languages, particularly in the northwest harmonize prefixes, but sometimes not as robustly as suffixes. In Koyo, for example, there is RTR harmony of mid vowels in both

prefixes and suffixes, but Front and Round harmony of /a/ only in suffixes (Hyman 1999).

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