

## Sibilant Harmony in Kinyarwanda and Coronal Opacity

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### 1. Introduction

#### (1) Opacity in coronal harmony

- Opacity in coronal harmony is rare. Sanskrit's Nati is the only previously reported case of which we are aware.
- Our study documents opacity in the coronal harmony of Kinyarwanda, a Bantu language spoken in Rwanda.
- Our research finds that Kinyarwanda's harmony involves retroflexion, rather than an alveo-palatal articulation as described in previous studies.
- Our investigation also reveals that Kinyarwanda's coronal harmony is sensitive to morphological conditions.

#### (2) Kinyarwanda coronal harmony

- Harmony has the potential to operate across intervening Cs and Vs (2a).
- However, certain sounds, such as coronal stops, are opaque to harmony (2b).

- |        |   |
|--------|---|
| a.     | /sákuz- + i-e/ → [sákuzɛ] ~ [sákuzɛ] "to shout+ perf."                    |
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| b.     | /zituz- + i-e/ → [zituzɛ], *[zɪtuzɛ] "to cause someone to detach + perf." |

Note: The perfective suffix /+i-e/ causes a stem-final alveolar fricative to become retroflex (see also below, the agentive suffix /-i/).

#### (3) Chief points

- Basic properties of Kinyarwanda retroflex harmony and its analysis.
- Comparison with Sanskrit's retroflex harmony (Nati).
- Patterns of coronal harmony with the long causative suffix *-iis-(i)-* in Kinyarwanda, with comparison to Kirundi.
- Theoretical implications of coronal opacity for the understanding of consonant harmony in general.

#### (4) Organization

- Kinyarwanda data description.
- Analysis.
- Widening the perspective on coronal harmony systems with blocking; examining Sanskrit.
- Treatment of causative *-iis-(i)-*.

### 2. Kinyarwanda data – basic facts

#### (5) Coronal and palatal consonants in Kinyarwanda

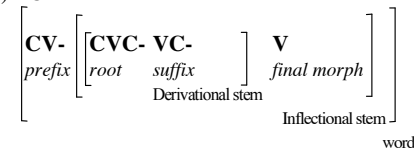
	Alveolar	Pre-Palatal	Palatal
Stops	t d		
Affricates	ts	tʃ	
Fricatives	s z	ʃ ʒ	
Nasals	n		ɲ
Liquids	ɾ		
Glides			j

- Prenasalized singleton segments also occur.
- Non-coronal consonants: [β (b) m f v pf k g w h (p)]

#### (6) Vowel inventory:

5 phonemes [i e a o u], with length and high / low tone opposition. The high tone is marked with an acute accent; the low tone is not marked.

#### (7) Canonical structure of inflected words in Bantu



(for detailed analysis, see Downing 1999a and Hyman 2002)

(8) **Kinyarwanda coronal harmony:**

- Triggers are /z/.
- Operates regressively.
- (Audible) targets are /s/.
- Interacting fricatives may disagree in voicing.
- Intervening vowels and consonants are perceived as unaffected.

- |    |                            |  |                                 |
|----|----------------------------|--|---------------------------------|
| a. | -sáaz- + i-e               | → [šáazɛ], *[sáazɛ]                            | "become old + perfective"       |
| b. | -úuz- + i-e                | → [úuzɛ], *[úuzɛ]                              | "fill + perfective"             |
| c. | -sas- + i-e                | → [šaše], *[saše]                              | "make the bed" + perfective"    |
| d. | -soo <sup>n</sup> z- + i-e | → [šo <sup>n</sup> zɛ], *[soo <sup>n</sup> zɛ] | "be hungry + perfective"        |
| e. | -baaz- + i-iš-             | → [baaziša], *[baaziša]                        | "plane (woodwork) + perfective" |

(9) **Retroflex harmony, rather than palatal harmony**

- Our preliminary investigation shows that triggers of coronal harmony in Kinyarwanda are phonetically characterized by retroflexion (cf. Kimenyi 1979).
- Articulatory observation conducted in two adult native speakers, and preliminary acoustic analysis.
- The spectrograms of the pre-palatal fricatives in (11), based on speech of a male native speaker, display the characteristics of retroflex sounds.

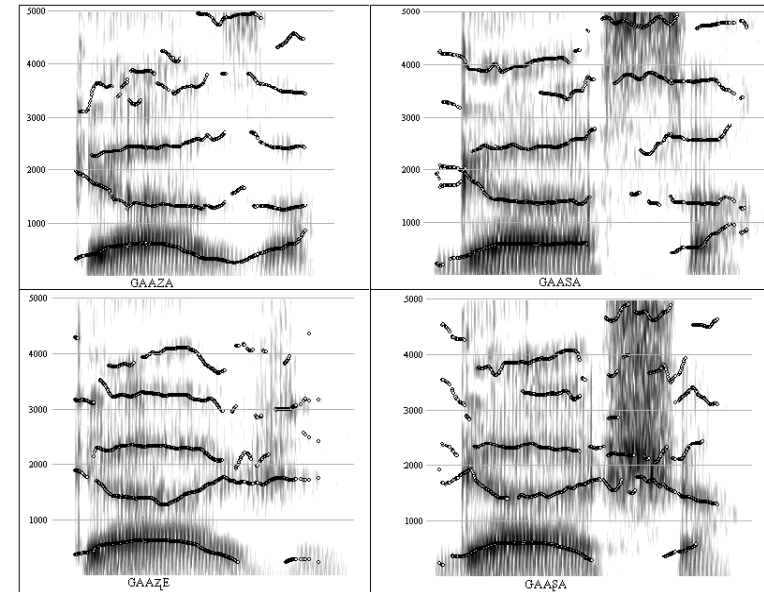
(10) **Observations**

- |    |   |
|----|---|
| a. | In spectrograms in (11), the second and third formants (F2, F3) for the long V [aa] in [gaaɛ] and [gaaša] show convergence. |
|----|---|

- According to Hamann (2003), transitions from vowels into consonants for retroflexes show some distinct lowering of F3, and mid to high F2 depending on vowel context.
- The lowered trajectory of F3 appears as the most distinctive acoustic feature of retroflex articulation (Hamilton 1996 on Australian Aboriginal languages; Ohala & Ohala 2001 on Hindi retroflex stops; see Hamann 2003 for an overview).

- |    |   |
|----|---|
| b. | F3 and F4 for the long V in [gaaɛ] and [gaaša] appear to be relatively lower than those for [aa] in [gaasa] and [gaaza], which show a rising orientation. |
|----|---|

Additional studies concerning the general lowering of high formants in retroflex consonants and/or their clustering include Fant 1968, Stevens & Blumstein 1975, Ladefoged 1993, Flemming 1995b, Steriade 1995, Ladefoged & Maddieson 1996, McDonough & Johnson 1997, Narayanan et al. 1999, Boersma & Hamann 2005.

(11) **Spectrograms of sibilants /z/ɛ, /s/ɛ**(12) **Proximity effects – basic pattern**

- Harmony is *obligatory* in adjacent syllables (see 12a–c).
- Harmony is *optional* in non-adjacent syllables (see 12d–g).

- |    |                          |  |                     |
|----|--------------------------|--|---------------------|
| a. | -soo <sup>n</sup> z- + i | → [šo <sup>n</sup> zɛ], *[soo <sup>n</sup> zɛ] | "victim of famine"  |
| b. | -sas- + i                | → [šaši], *[saši]                              | "bed maker"         |
| c. | -siiz- + i-e             | → [šiizɛ], *[siizɛ]                            | "level off + perf." |

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- |    |                 |                           |   |
|----|-----------------|---------------------------|---|
| d. | -zímagiz- + i-e | → [zímagizɛ] ~ [zímagizɛ] | "mislead + perf"                        |
| e. | -ášamuz- + i-e  | → [ášamuzɛ] ~ [ášamuzɛ]   | "make open largely one's mouth + perf." |
| f. | -sákuz- + i-e   | → [sákuzɛ] ~ [sákuzɛ]     | "shout + perf."                         |
| g. | -sakaaz + i-e   | → [sakaazɛ] ~ [šakaazɛ]   | "cover (the roof) with + perfective"    |

- (The special patterning of causative [-i-iš-(i)-] will be addressed in §5).

(13) **Palatals and coronal stops are opaque to coronal harmony**

- A property overlooked by previous descriptions of Kinyarwanda.
- Confirmed by direct investigation with native speakers.
- Also supported by data from the reference dictionary of Kinyarwanda (Jacob 1983-1986).

- a. -sítaaz- +i-e → [sítaazɛ], \*[ʃítaazɛ] "make stub + perf."  
 b. -zújaaz- +i-e → [zújaazɛ], \*[ʒújaazɛ] "bec. warm (liq.) + perf."  
 c. -sáa<sup>n</sup>daaz- +i-e → [sáa<sup>n</sup>daazɛ], \*[ʃáa<sup>n</sup>daazɛ] "make explode + perf."  
 d. -zíg-an-i- + iɛ → [zíganiɛ], \*[ʒíganiɛ] (n+i → [ɲ]) "economize + perf."  
 e. -súnuuk-i- + iɛ → [súnuukiɛ], \*[ʃúnuukiɛ] "show furtively + perf."  
 f. -sódoók-i- + iɛ → [sódookeɛ], \*[ʃódookeɛ] "make move slowly + perf."  
 (cf. k+i → [ts] in other contexts)

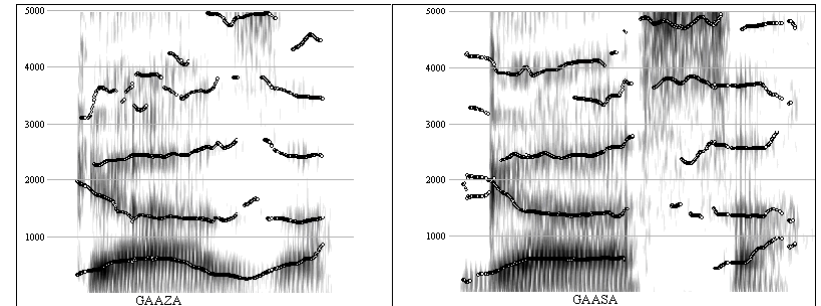
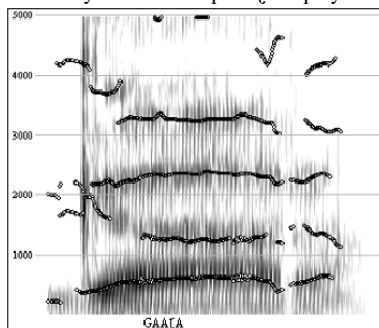
Note: In some contexts with an underlying suffix /-i-/, the perfective aspect is rendered by the allomorph [-iɛ].

(14) **The liquid /ɾ/ is neutral (neither triggers nor blocks)**

- a. -togoseɾez- + i-e → [togoseɾezɛ] ~ [togoʃezɛ] "make boil for / at + perf."  
 b. -seɾuz- i-e → [seɾuzɛ] ~ [ʃezɛ] "provoke, irritate + perf"  
 c. -ziɾ-a → [ziɾa], \*[ʒiɾa] "be forbidden (taboo)"  
 d. -soɾ-a → [soɾa], \*[ʃoɾa] "pay tax"

(15) **Spectrogram of [ɾ]**

- Kinyarwanda's liquid /ɾ/ displays characteristics of retroflexion:

(16) **Observations**

- F3 and F4 in [aa] appear to be overall lower in [gaara] (in (15)) than in [gaasa] and [gaaza]. Also, they do not show a rising orientation observed with F3 and F4 in [gaasa] and [gaaza].
- The acoustics of [aa] before [ɾ] is suggestive of retroflexion in the latter (see general observations in (10)).

(17) **Affricates do not participate in coronal harmony**

- [ts] does not undergo harmony, i.e. it acts like a stop (17a–b).
- [ʃ] is absent in triggering contexts (it is rare in post-initial position).

- a. -tsii<sup>m</sup>baɾaz- + i-e → [tsii<sup>m</sup>baɾazɛ], \*[ʃsii<sup>m</sup>baɾazɛ] "cause to be obstinate + perf."  
 b. -tsitsimuz- + i-e → [tsitsimuɛ], \*[ʃtsitsimuɛ], "make drink slowly + perf."  
 \*[tsiʃsimuɛ]

(18) **Coronal harmony does not affect prefixes**

- Kinyarwanda sibilant harmony applies only within the stem (see word structure in (7)).

- a. zi- + sáaz- + i-e → [ziʃaaɛ], \*[ʒiʃaaɛ], prefix cl.10 + "bec. old + perf."  
 \*[zisaaɛ]  
 b. zi- + :z- + i-e → [ziiɛ], \*[ʒiiɛ] prefix cl.10 + "come + perf."

(19) **Summary**

- a. Kinyarwanda's coronal harmony operates regressively among sibilants in the stem.
- b. It involves retroflexion, rather than (alveo-)palatalization.
- c. Intervening vowels and non-sibilant consonants are not perceptibly affected.
- d. Coronal stops and palatals are opaque. The alveolar affricate does not undergo harmony.
- e. The retroflex liquid is neutral in the harmony system.
- f. Harmony in adjacent syllables is obligatory.
- g. Harmony extending to non-adjacent syllables is optional.

**3. Analysis – basic pattern****3.1 Diagnosing the assimilation structure**(20) **The [retroflex] feature**

- *Assumption:* The assimilation involves the privative feature **[retroflex]** (after Ní Chiosáin & Padgett 1997; note also Gafos 1998).
- [Retroflex] is phonetically realized as a tongue-tip/blade orientation.
- We assume phonological feature representations here, but do not rule out a gestural alternative (e.g. Flemming 1995a, Gafos 1998).

For previous work on retroflexion feature(s) in the context of coronal harmony, see, e.g., Sagey 1986, Schein & Steriade 1986, Steriade 1986, Gafos 1998, Clements 2001, Hamann 2003.

**Two approaches to coronal harmony systems**

- Feature spreading
- Feature agreement

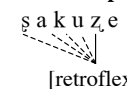
(21) **Feature Spreading**

- Coronal harmony results from feature spreading (or gestural extension) that carries through articulatorily adjacent segments (see (22) below).

- Spreading feature carries through all segments intervening between trigger and target, but it is not perceived by speakers on segments characterized as “transparent”.

(Flemming 1995a, Ní Chiosáin & Padgett 1997, <sup>1</sup> Gafos 1998; also Hansson 2001 and Rose & Walker 2004 on Sanskrit coronal harmony. See also Wiltshire and Goldstein 1998, and Hamann 2003 and cited work therein positing that retroflexion posture is held across intervening segments.)

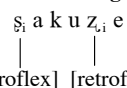
(22) **Feature Spreading Approach**

ʃ a k u z<sub>i</sub> e      Perceived: [ʃakuʒe]  
  
 [retroflex]

(23) **Feature Agreement**

- Coronal harmony results from feature matching in segments that stand in a correspondence relation which is established between *similar* segments (see (24) below).
- Intervening segments do not participate in the process—they are unaffected in both perceptual and articulatory terms.
- Other consonant harmonies are also posited to arise via feature agreement (e.g. for laryngeal features, [nasal], dorsal harmony, etc.).  
 (Hansson 2001, Rose & Walker 2004, note also Clements 2001.)

(24) **Feature Agreement Approach**

ʃ<sub>i</sub> a k u z<sub>i</sub> e  
  
 [retroflex] [retroflex]

(25) **Blocking:** A point of departure between the two approaches

- a. Feature Spreading
  - Potential for opacity effects. Harmony is blocked by segments that cannot undergo spreading. Factors: articulatory compatibility, contrast.

<sup>1</sup> Ní Chiosáin & Padgett (1997) allow the possibility that although phonological spreading is strictly local, the spreading feature might not be phonetically implemented on transparent segments.

## b. Feature Agreement

- Intervening segments will not show blocking effects, because they do not participate in harmony.

(26) *Kinyarwanda's coronal harmony shows blocking*

- Recall that coronal stops and palatals block harmony.  
[-zituze] 'to cause someone to detach (perf.)'  
[-zújaaʒe] 'become warm (liquid) (perf.)'

➤ Kinyarwanda's opacity effects therefore diagnose it as a *Feature Spreading* harmony.

## 3.2 A Spreading-based Account of Kinyarwanda's Retroflex Harmony

## The spreading constraint

- Operates within specified domains.
- Adapted with some changes from Ní Chiosáin & Padgett (1997) on Sanskrit.

(27) **SPREAD-L-DOMAIN-(retroflex)**

Any [retroflex] feature associated to a [–sonorant, +continuant] segment  $S_j$  is also associated to any [–sonorant, +continuant] segment  $S_i$  that precedes  $S_j$  in a given domain.<sup>2</sup>

(28) **Trigger asymmetry:**

Retroflex fricatives /ʒ z/ trigger harmony but not retroflex /t/.

➤ Fricatives alone trigger harmony because retroflexion is contrastive in only these segments: /s ʒ/ /z z/.

Related findings:

- Round harmony systems serve to make distinctive feature specifications more easily perceptible (Kaun 1995).
- Certain Romance raising harmonies uniquely promote contrastive [+high] specifications (Dyck 1995, Walker in press).

<sup>2</sup> Alternative formulations using ALIGN (Kirchner 1993), NO-INTERVENING (Zoll 1998), AGREE (Bakovic 2000) or \*A-SPAN (McCarthy 2004) are conceivable. There might well be reason to choose among them, but this is beyond the scope of our present focus.

**Obligatory harmony in adjacent syllables**

- Ex. [ʃaʃi], \*[saʃi] 'bed maker.'
- Two constraints at play.

(29) **SPREAD-L-ADJσ-(retroflex)**

Any [retroflex] feature associated to a [–son, +cont] segment  $S_j$  is also associated to any [–son, +cont] segment  $S_i$  in an adjacent syllable that precedes  $S_j$  in the stem.

➤ Version of SPREAD-L requiring that [retroflex] spread to an adjacent syllable.

Processes limited to adjacent syllables or consonants separated by no more than a vowel in other work:

- Syllable-adjacent nasal agreement in Lamba, Ndonga, and certain other Bantu languages (Odden 1994, Piggott 1996, Hansson 2001, Rose & Walker 2004).
- OCP effects characterized as restricted to segments separated by only a mora ("syllable adjacency") (e.g. Yimas, Dahl's Law in Bantu, Meeussen's rule in Bantu; Odden 1994, Suzuki 1998) or only a vowel ("consonant adjacency") (Tigre, Tigrinya; Rose 2000).

Whether adjacent syllables constitute a "domain" requires further investigation. Nevertheless, a window of adjacent syllables is evidenced in proximity effects in various languages.

(30) **IDENT-OI(retroflex)**

Let  $\alpha$  be a segment in the input and  $\beta$  be any correspondent segment of  $\alpha$  in the output. If  $\beta$  is [retroflex], then  $\alpha$  is [retroflex].

➤ Prohibits segments that gain a [retroflex] feature. (IDENT-OI(F) after Pater 1999.)

**Constraint ranking**(31) **SPREAD-L-ADJσ-(retroflex) >> IDENT-OI(retroflex)**

- Accomplishes *obligatory* harmony in adjacent syllables.

(32) **Obligatory harmony in adjacent syllables:**

/sáaz+i-e/	SPREAD-L-ADJσ-(retro)	IDENT-OI(retro)
a. šáazɛ		***
b. sáazɛ	*!	

**Optional harmony extending to non-adjacent syllables**

- Ex. [zĩmagiz̥e] ~ [zĩmagiz̥e] ‘mislead + perf.’
- (33) **SPREAD-L-STEM-(retroflex)**  
Any [retroflex] feature associated to a [-son, +cont] segment  $S_j$  is also associated to any [-son, +cont] segment  $S_i$  that precedes  $S_j$  in the stem.
- (34) SPREAD-L-STEM-(retro) and IDENT-OI(retro) are variably ranked
- Accomplishes *optional* harmony that extends across multiple syllables.
- (35) **Variable ranking**
- Captured by constraints that are probabilistically ranked according to assigned ranking values (Boersma 1998, Hayes & MacEachern 1998, Zuraw 2000, Boersma & Hayes 2001).
  - A constraint with a much higher ranking value than another will effectively always dominate, e.g. in obligatory harmony in adjacent syllables.
  - Two constraints with close ranking values will vary in their ranking. This is the case for SPREAD-L-STEM-(retro) and IDENT-OI(retro).

- (36) Harmony extending to non-adjacent syllables:  
SPREAD-L-STEM-(retro) >> IDENT-OI(retro)

/sákuz+i-e/	SPREAD-L-STEM-(retro)	IDENT-OI(retro)
a. sákuz̥e		*****
b. sákuz̥e	*!	

- (37) Absence of harmony extending to non-adjacent syllables:  
IDENT-OI(retro) >> SPREAD-L-STEM-(retro)

/sákuz+i-e/	IDENT-OI(retro)	SPREAD-L-STEM-(retro)
a. sákuz̥e	*!*****	
b. sákuz̥e		*

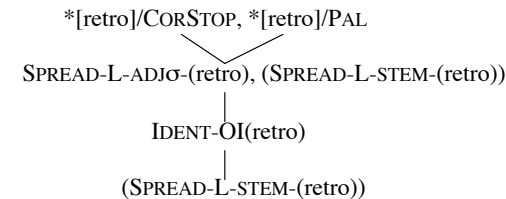
**Opacity effects**

- Ex. [sĩtaaze], \*[sĩtaaze] ‘make stub + perf.’
- (38) **Markedness constraints**
- \*[retro]/CORSTOP: No retroflex coronal stops.
  - \*[retro]/PAL: No retroflex palatals.  
(On the incompatibility of retroflex and palatal articulations, see Gafos 1998, Clements 2001, Hamann 2003, Boersma and Hamann 2005; note also Flemming 2003.)

**Constraint ranking**

- Coronal stops and palatals never undergo harmony; hence the constraints in (38) dominate [retroflex] spreading constraints, as in (39).
- The markedness constraints in (38) will also function in the grammar to enforce the lack of contrastive retroflex coronal stops and palatals.

- (39) **Retroflex harmony ranking**



- (40) Blocking by a coronal stop

/sĩtaaz+i-e/	*[retro]/CORSTOP	SPREAD-L-STEM-(retro)	IDENT-OI(retro)
a. sĩaaze		*	
b. sĩaaze	*!		*****

- (41) **Summary – Analysis**

- Harmony is accomplished via feature spreading.
- The spreading [retroflex] feature carries through intervening vowels and consonants but is not perceived on segments described as “transparent”.
- Retroflex fricatives trigger harmony but not the retroflex liquid, because retroflexion is contrastive only in fricatives.
- A regressive spreading constraint requiring harmony in adjacent syllables drives obligatory harmony in this context.
- A spreading constraint operating in the stem domain is variably ranked with IDENT-OI(retro) to produce optional harmony over longer distances.
- Blocking results from markedness constraints that prohibit retroflex coronal stops and palatals.

**Further issues**

Kinyarwanda’s coronal harmony and its analysis clearly provoke a number of issues for further research. See §6 for discussion.

#### 4. Sanskrit: A Second Coronal Harmony System with Blocking

- Sanskrit's retroflex harmony (Nati) is the only other coronal harmony of which we know that shows blocking

##### (42) Coronal and palatal consonants in Sanskrit (after Gafos 1998)

Dental: /t t<sup>h</sup> d d<sup>h</sup> s n l/  
 Retroflex: /ʈ ʈ<sup>h</sup> ɖ ɖ<sup>h</sup> ʂ ʂ<sup>h</sup> r ɻ/  
 Palatals: /c c<sup>h</sup> ɟ ɟ<sup>h</sup> ɟ̞ ɟ̞<sup>h</sup> j̞ j̞<sup>h</sup>/

##### (43) Basic facts – Sanskrit nasal retroflexion harmony

Retroflexion illustrated in nominal and adjectival suffix *–ana*, (cf. data in (43b)) (Whitney 1889).

- Triggers are [ʂ r ɻ].
- (Perceptible) target is /n/.
- Intervening vowels and consonants are not (perceptibly) affected.

- a. rakṣaṇa 'protection'  
 kṛpaṇa 'miserable'  
 ākramaṇa 'striding'  
 kṣajaṇa 'habitable'

- Opaque segments are all coronal and palatal consonants (except /j/).

- b. vard<sup>h</sup>ana 'increase'  
 rocana 'shining'  
 vr̥jana 'enclosure'  
 ceṣṭana 'stirring'

- Operates progressively only.

- c. -niṣṭ<sup>h</sup>a- 'eminent'  
 -nrmṇa- 'manhood'

Previous work on Sanskrit's Nati harmony includes Allen 1951, Selkirk 1980, Schein & Steriade 1986, Steriade 1986, 1995, Shaw 1991, Clements & Hume 1995, Flemming 1995a, Ní Chiosáin & Padgett 1997, Gafos 1998, Hansson 2001, Hamann 2003, Rose & Walker 2004. See this work for discussion of further complexities in the system.

##### (44) Analytical highlights

- Sanskrit retroflex harmony involves *feature spreading*, not feature agreement by correspondence (Flemming 1995a, Gafos 1998, Ní Chiosáin & Padgett 1997, Hansson 2001, Rose & Walker 2004).
- The spreading feature continues through intervening segments, but its production is not perceived on transparent consonants and vowels.
- Intervening dentals are opaque because spreading [retroflex] to them would neutralize a contrast. Palatals (except /j/) block because they are incompatible with [retroflex]. (E.g. Ní Chiosáin & Padgett 1997, Gafos 1998.)

##### (45) Trigger and targets

- Continuants alone trigger retroflex harmony, because retroflexion is more acoustically salient in them vs. stops (Ní Chiosáin & Padgett 1997, Gafos 1998).
- Nasals alone are targeted, because they are more susceptible to place / retroflexion assimilation (Ní Chiosáin & Padgett 1997, Gafos 1998).

##### (46) Why Sanskrit retroflex harmony involves spreading, not agreement (Evidence discussed by Hansson 2001; cf. also Rose & Walker)

- Shows opacity.** This is not seen in any other pattern of consonant assimilation across an unaffected vowel (or across vowels and consonants).
- Does not show a similarity effect.** Patterns of consonant assimilation across an unaffected vowel (at minimum) always target sounds most similar to the triggers. Inclusion of additional targets implies inclusion of any sounds that are more similar to the trigger.
- Shows progressive directionality.** Patterns of consonant assimilation across an unaffected vowel (at minimum) show (a strong tendency for) regressive directionality (excluding root-controlled assimilations).
- Potentially applies at the phrasal level, across word boundaries.** Patterns of consonant assimilation across an unaffected vowel (at minimum) apply within the word or a smaller morphological domain.

### Points of comparison: Sanskrit and Kinyarwanda retroflex harmony

#### (47) Similarities

- Assimilating feature.* Both involve retroflexion assimilation.
- Triggers.* Retroflex fricatives trigger harmony (but in Sanskrit, /r/ does too).
- Opacity.* Dental/alveolar consonants and (most) palatals block harmony.

#### (48) Differences

- Triggers.* Triggers in Sanskrit are the continuants [ʃ r], but in Kinyarwanda the triggers are only the fricatives [ʃ z] (/r/ is neutral).
- Targets.* Target of Sanskrit's harmony is /n/, which is relatively dissimilar from the triggers. Targets in Kinyarwanda's harmony are fricatives, which are highly similar to the triggers.
- Opaque segments.*
  - Opaque dentals in Sanskrit contrast with a retroflex series. In Kinyarwanda, most blocking alveolars do not contrast with retroflex sounds.
  - The palatal glide /j/ is opaque in Kinyarwanda and transparent in Sanskrit.
- Direction.* Sanskrit's harmony is progressive, Kinyarwanda's is regressive.
- Domain.* Sanskrit harmony can operate across words, in Kinyarwanda it is limited to the stem.

#### (49) Kinyarwanda's basic coronal harmony: typological / theoretical issues

- Data.** Revised description: retroflexion, optionality at a distance, blocking by coronal stops and palatals.
- Triggers.** Triggers for retroflex harmony may be restricted to those for which the feature is contrastive.
- Targets.** A coronal harmony resulting from feature spreading that shows an apparent "similarity effect".
- Opacity.**
  - A second case of coronal harmony that shows opacity.
  - Coronal opacity may result from markedness (incompatibility) alone, independent of contrast.
- Diagnostics.** Apart from opacity, Kinyarwanda's harmony is suggestive that the diagnostics for feature spreading vs. agreement in *coronal harmony* are not always clear cut.

### 5. Patterns involving the long causative formative [-iɪʃ-(i)-]

#### 5.1 Data: Coronal harmony in Kinyarwanda causative forms

- The retroflex fricative in the causative suffix [-iɪʃ-(i)-] triggers harmony only in sibilants that occur in a preceding *adjacent* syllable (see (50) vs. (51))<sup>3</sup>.

(50) Harmony from [ʃ] in the causative affecting an adjacent syllable.

- |    |                              |  |
|----|------------------------------|--|
| a. | -mes+iɪʃ-(i)-                | → [meʃeeʃa], *[meseʃa] “wash (cloth)” + caus.                            |
| b. | -sáaz+iɪʃ-(i)-               | → [śáazɪiʃa], *[śáazɪiʃa], *[śáazɪiʃa] “make bec. old” + caus.           |
| c. | -sas+iɪʃ-(i)-                | → [śaʃiʃa], *[sasiʃa], *[saʃiʃa] “make the bed” + caus.                  |
| d. | -soo <sup>n</sup> z+iɪʃ-(i)- | → [ʃoo <sup>n</sup> ʒeeʃa], *[soo <sup>n</sup> ʒeeʃa] “be hungry + caus. |

Note: In (50b-d), fricatives affected by sibilant harmony in the syllable preceding [ʃ] in the causative themselves trigger harmony in preceding fricatives.

(51) No harmony from [ʃ] in the causative affecting a non-adjacent syllable.

- |    |                              |   |
|----|------------------------------|---|
| a. | -som+iɪʃ-(i)-                | → [someeʃa], *[ʃomeeʃa] “drink + caus.”   |
| b. | -soɾ+iɪʃ-(i)-                | → [soɾeeʃa], *[ʃoɾeeʃa] “pay tax” + caus.   |
| c. | -ásam+iɪʃ-(i)-               | → [ásamiʃa], *[áʃamiʃa] “open one's mouth” + caus.                                  |
| d. | -a <sup>n</sup> zik+iɪʃ-(i)- | → [a <sup>n</sup> zikiʃa], *[a <sup>n</sup> ʒikiʃa] “make s.o. to begin (grinding)” |

In Kinyarwanda, suffix front vowels /i/ are realized as [e] after a root mid vowel /e,o/.

- The long causative [-iɪʃ-(i)-] blocks harmony from a following trigger.

#### (52) Blocking by causative [-iɪʃ-(i)-].

- |    |                                    |  |
|----|------------------------------------|--|
| a. | -som+iɪʃ-(i)- + iʒe                | → [someeʃeʒe], *[ʃomeeʃeʒe] “drink” + caus. + perf.  |
| b. | -soɾ+iɪʃ-(i)- + iʒe                | → [soɾeeʃeʒe], *[ʃoɾeeʃeʒe] “pay tax” + caus. + perf.                                      |
| c. | -ásam+iɪʃ-(i)- + iʒe               | → [ásamiʃiʒe], *[áʃamiʃiʒe] “open one's mouth” + caus. + perf.                             |
| d. | -a <sup>n</sup> zik+iɪʃ-(i)- + iʒe | → [a <sup>n</sup> zikiʃiʒe], *[a <sup>n</sup> ʒikiʃiʒe] “begin (grinding)” + caus. + perf. |

<sup>3</sup> Coronal harmony triggered by -iɪʃ-(i)- is *optional* when the target sibilant occurs in the stem-initial syllable (cf. -se+iɪʃ-(i)- → [seeʃa] ~ [seeʃa], “mould” + caus).



**(53) Summary – Coronal harmony and the causative suffix**

- a. The retroflex fricative in the causative suffix triggers harmony only in *adjacent* syllables, i.e. it is a weaker trigger than retroflex fricatives elsewhere in the stem.
- b. The causative [-iɪʂ-(i)-] blocks harmony from a following trigger.

**5.2 Analysis****(54) Morphology of causative formation**

- a. *Two formatives*: short *-i-* and long *-iɪʂ-(i)-*; same meaning.
- b. *Allomorph choice*:
  - Morphophonology: e.g. no *-i-* with stem-final sibilant or monosyllabic stem.
  - Semantics: e.g. instrumental vs. active: -som+iɪʂ-(i)- [-someeʂa] ‘drink with (utensil)’; -som+i- [som<sup>h</sup>ja] ‘make s.o. drink’ (see Mpiranya 1998).
- c. *The long causative is morphologically complex*.
  - *-iɪʂ-(i)-* is composed of two morphological segments, i.e. as a discontinuous morpheme, because they can be separated in morphological processes. (On similar representations in other Bantu languages, see Hyman 1999, 2003, Bastin 1986, Munya Rugero & Mukala 1987).
  - The long causative is reconstructed in Proto-Bantu as \*-itʃ-i- (Guthrie 1967-1971, Hyman 1999, 2003).
- d. *Evidence for the long causative’s final -(i)-*.
  - Perfective form [-ize] follows *-iɪʂ-(i)-* (see (52)). Perfective allomorph [-ize] (vs. perf. allomorph *-i-e*) is realized only after stems ending in underlying /i/ (compare forms with short causative *-i-* in (13)).
  - Short *-i-* and long *-iɪʂ-(i)-* both trigger spirantization from postposed *-i-* in reduplicative forms, e.g. -óg-i- + -iɾ- → -óg-iɾ-iɾ-i- [ógeɾeza] ‘cleanse for / at’; -óg+iɪʂ-(i)- + -iɾ- → -óg-eɛʂ-iɾ-iɾ-i- [ógeɛʂeɾeza] ‘wash with, for / at.’

**(55) Proposal: A strong affix**

- The long causative formative in Kinyarwanda involves a category that is stronger than other suffixes. For present purposes we call it a “strong-suffix.”
- It has a more robust morphological boundary that inhibits spreading into or out of its domain.

**(56) Phonological evidence for strength of long causative [-iɪʂ-(i)-]**

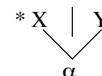
- a. Phonological size:
  - No other suffix in Kinyarwanda has an underlying long vowel. (Other suffixes with a long vowel are variants of -VC- forms and generally have emphatic connotation.)
- b. Weak/absent participation in phonological processes in the stem
  - *Sibilant harmony*. (i) *-iɪʂ-(i)-* triggers harmony only in adjacent syllables, and (ii) it blocks harmony from following suffixes. (See discussion above.)
  - *Voicing dissimilation*. Dahl’s Law in Kinyarwanda causes dissimilation involving obstruents: ku-ʂiim- → [gu-ʂiim-a] ‘congratulate’; -sót-uuk- → [sódooka] ‘move slowly.’ But *-iɪʂ-(i)-* does not participate: -haat-iɪʂ-(i) → [haatiɪʂa] ‘shuck with’).

**(57) Further research: Category of long causative**

- In containing a long vowel, *-iɪʂ-* has a prosodic size resembling a root rather than an affix. Moreover, its phonological weight is suggestive that it holds the status of a head. (For related work, see Drescher & van der Hulst 1998, McCarthy & Prince 1995, 1999, Urbanczyk 1996, 1999, Downing 2004, a.o.).
- It is conceivable that *-iɪʂ-(i)-* belongs to a category-type that stands between a suffix and a root. (For a review of work supporting word-formations intermediate between derivation and compounding, see Booij 2000. Note also Matthews 1974 on the notion of complex roots or stems.)
- Also to explore is whether *-iɪʂ-(i)-* is a root or stem, and it attaches to form a type of compound. The lack of sibilant harmony in other compounds requires scrutiny in this regard: -guz- ‘to loan’; -guzaaguz+i-e → [guzaaguze], \*[guzaaguze] ‘to loan many times’ (perf.). The presence/absence of stem “final vowels” also needs to be considered here. (Related work includes Downing 1999ab, 2000, 2003, 2004, Inkelas & Zoll 1999, Hyman et al. to appear.).

**(58) The effect of boundary strength**

- CRISP-EDGE[Cat] prohibits multiple linking of phonological structure across the boundary of a given type of linguistic category. (For formal definitions of CRISP-EDGE, see Itô & Mester 1999, Walker 2001, Kawahara to appear.)

**(59) CRISP-EDGE[strong-suffix]**

where “|” represents the boundary of a strong-suffix morpheme

(60) **Ranking**

SPREAD-L-ADJσ-(retro) &gt;&gt; CRISP-EDGE[strong-sfx] &gt;&gt; SPREAD-L-STEM-(retro)

- Accomplishes harmony from that occurs in adjacent syllables only.

**Exemplification**

(61) Obligatory harmony from retroflex in long causative to adjacent syllable:

SPREAD-L-ADJσ-(retro) &gt;&gt; CRISP-EDGE[strong-suffix]

/mes+iiš-(i)-a/	SPREAD-L-ADJσ-(retro)	CRISP-EDGE[strong-sfx]
ᵐᵃᵐ a. meš-eeš-a		*
b. mes-eeš-a	*!	

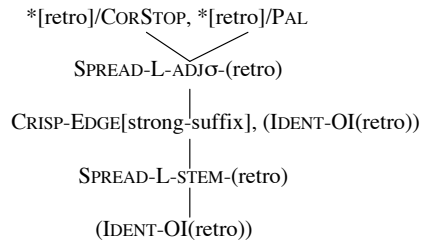
(62) No harmony from retroflex in long causative form to non-adjacent syllable:

CRISP-EDGE[strong-suffix] &gt;&gt; SPREAD-L-STEM-(retro)

/ášam+iiš-(i)-a /	CRISP-EDGE[strong-sfx]	SPREAD-L-STEM-(retro)
ᵐᵃᵐ a. ášam-iiš-a		*
b. ášam-iiš-a	*!	

(63) Long causative form blocks harmony from a retroflex which follows it:

/ášam+iiš-(i)-ize/	SPREAD-L-ADJσ-(retro)	CRISP-EDGE[strong-sfx]	SPREAD-L-STEM-(retro)	IDENT-OI(retro)
ᵐᵃᵐ a. ášam-iiš-ize			*(š) **(z)	
b. ášam-iiš-ize		*!		*****

(64) **Revised ranking****5.3 Cross-dialectal perspective – Coronal harmony in Kirundi**

- Standard Kirundi: sibilant harmony is triggered by /ž, š/ and targets /s, z/ in preceding *adjacent* stem syllables (Meeussen 1959; Rodegem 1967,1988; in Ntahokaja 1994).<sup>4</sup>
- In stem-initial position, sibilant harmony targets only /s/.<sup>5</sup>
- In post-initial positions, sibilant harmony in Kirundi targets both /s, z/.

(65) Regressive coronal harmony targeting stem-initial /s/ in an adjacent syllable

a.	-sas- + i-e → [šaše], *[saše] “extend (on flat surface)” + perfective
b.	-sees- + i-e → [šeeše], *[seeše] “overturn (e.g. liquid)” + perfective
c.	-sáaz- + i-e → [šáaže], *[sáaže] “become old” + perfective VERSUS
d.	-zooz- + i-e → [zoože], *[žoože] “incite + perfective
e.	-ziz- + -iže → [zižiže], *[žižiže] “persecute for”+perf. (cf. -zir-i- “avoid”+caus.)
f.	-sékuz- + i-e/ → [sékuže], *[šékuže] “make pound” + perfective

(66) Regressive coronal harmony targeting post-initial /s, z/

a.	-kíz- + -iže → [kížiže], *[kíziže] “restore to health” (perfective)
b.	-úuz- + -i-e → [úuže], *[úuže] “fill” (perfective)
c.	-báz- + -iže → [bážiže], *[báziže] “ask” (perfective)
d.	-tos- + -iže → [tošeže], *[toseže] “wet” (perfective) (cf. Ntuhirageza 1993)

(67) **Preservation of stem-initial /z/:** Might be related to free alternation of voiced fricatives with affricates, depending on individual or dialect (Meeussen 1959:11). The shift from voiced affricates to fricatives seems a relatively recent innovation in Kirundi, and, as in Kinyarwanda, affricates do not undergo coronal harmony.

- The causative suffix *-iiš-(i)-* in Kirundi does not trigger harmony (see Meeussen 1959; Ntuhirageza 1993; Ntahokaja 1994).

(68) No harmony triggered by the causative suffix [-iiš-(i)-]

a.	-ses-iiš-(i)- → [seseša], *[šeseša], *[sešeša] “check” + causative
b.	-sáaz-iiš-(i)- → [sáaziiša], *[sáaziiša], *[šáaziiša] “become old” + causative
c.	-rás-iiš-(i)- → [rášiiša], *[rášiiša] “shoot” + causative
d.	-sa-iiš-(i)- → [seeša], *[šeeša] “resemble” + causative

<sup>4</sup> According to Ntuhirageza (1993; personal communication), in some varieties of Kirundi, sibilant harmony applies also in non-adjacent syllables, varying by individual and occasion.

<sup>5</sup> According to Meeussen (1959), coronal harmony targeting a stem-initial fricative may apply optionally, depending on lexical items and individual speech (see also Rodegem 1967; 1988).

(69) **Implications for analysis – comparison with Kinyarwanda**

- a. *Harmony distance*
  - Operates only between adjacent syllables in standard Kirundi, optionally at greater distances in Kinyarwanda.
  - In Kirundi, SPREAD-L-STEM-(retro) has a comparatively lower ranking value such that it is regularly ranked below IDENT-OI(retro).
- b. *Long causative -iiš-(i)-*
  - Does not trigger harmony in Kirundi, triggers harmony in adjacent syllables in Kinyarwanda.
  - In Kirundi, SPREAD-L-ADJØ-(retro) has a comparatively lower ranking value such that it is regularly ranked below CRISP-EDGE[strong-suffix].

**6. Conclusion and further issues**(70) **Summary — Some key points**

- a. *Kinyarwanda sibilant harmony*
  - Optionally extends over multiple syllables.
  - Palatal and coronal consonants are opaque.
  - It is a feature spreading harmony.
- b. *Distance of harmony*
  - Evidence for harmony restricted to adjacent syllables.
  - Kinyarwanda's harmony optionally operates over longer distances.
- c. *Morphological effects*
  - Long causative form shows effects that impede harmony.
  - Phonological size of the long causative resembles that of a root.
  - Analyzed as a “strong-suffix” with morphological boundary strength that inhibits spreading across it. Further research on category-type needed.
- d. *Cross-linguistic comparison*
  - Only other coronal harmony reported to show opacity is found in Sanskrit.
  - Kinyarwanda is the first *living* language with coronal harmony in which opacity has been found.
  - Kirundi sibilant harmony is weaker than Kinyarwanda's. It operates in adjacent syllables only, and the long causative does not trigger harmony.

(71) **Further issues: Feature Spreading vs. Feature Agreement**

- Kinyarwanda's coronal harmony shows some properties consistent with both the feature spreading approach and feature agreement approach, which point to directions for further research.
  - Nevertheless, the existence of blocking in Kinyarwanda's harmony system remains diagnostic of feature spreading.
- a. *Articulation in transparent segments*
    - The feature spreading analysis provokes the question whether retroflexion is truly produced in intervening segments.
    - A study underway at USC is investigating this using magnetometry (EMMA) (in collaboration with D. Byrd & S. Lee). (cf. Gafos & Benus 2003 on Hungarian).
    - If it is found that retroflexion is *not* held through transparent segments, there will be implications for the theory of strict locality. In that event, a possible solution would be to allow that a harmonizing feature might not be phonetically implemented on transparent segments (Ní Chiosáin & Padgett 1997).
  - b. *An apparent similarity effect*
    - Kinyarwanda's coronal harmony shows an apparent “similarity effect” in the sense that it is (audibly) restricted to only fricatives.
    - At first blush, this suggests diagnostics of agreement-based coronal harmony vs. spreading-based are not as straightforward as previously conceived.
    - However, unlike feature agreement harmonies, Kinyarwanda's similarity effect might result from a confluence of factors in the language including its contrast system, markedness constraints, and its harmony system.
  - c. *Assimilation within adjacent syllables*
    - The adjacent syllable domain that restricts spreading is reminiscent of proximity effects in agreement-based consonant assimilation (Hansson 2001, Rose & Walker 2004).
    - The special status of neighboring syllables, its formal characterization, and why it cross-cuts spreading-based and agreement-based assimilations, as well as OCP effects, merits further investigation.

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