The articulation of consonants in Kinyarwanda’s sibilant harmony

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Introduction – Coronal Consonants

Coronal fricative and stop consonants in Kinyarwanda: (Affricates and prenasalized stops also occur)

<table>
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<th>Alveolar</th>
<th>Retroflex</th>
<th>Palatal</th>
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Introduction – Sibilant Harmony

Sibilant harmony in Kinyarwanda (Bantu, Rwanda) causes [s z] to become retroflex preceding [s z] in a stem (Walker & Mpiranya, to appear). (Tones not shown.)

- [-ṣaːzę] ‘become old (perf.)’ Not [-saːze]
- [-uzuże] ‘fill (perf.)’ Not [-uzuże]

Introduction – Transparency & Blocking

Harmony is optional in non-adjacent syllables:
- [-aṣamuže] or [-asamuže] ‘make open wide one’s mouth (perf.)’
- [-ṣakaː ze] or [-sakaː ze] ‘cover (the roof) with (perf.)’

Above, [m] and [k] are transparent: they do not block harmony and are not perceived as affected by it. (For related work in vowel harmony, see Gafos & Benus, 2003, 2006; Benus et al, 2004; Benus & Gafos, 2006; Gick et al., 2006.)

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**Research Question 2**

**Goal:** To assess if harmony operates in a categorical fashion, consistent with a phonological process.

**Fricative targets:** Is tip-blade angle equivalent for retroflex fricatives in the following contexts?
- **harmony target** (1st [га] in [башаґе]) vs.
- **non-harmony** ([башата])

**Research Question 3**

**Goal:** To determine whether alveolar consonants are unaffected by retroflexion when they block harmony.

**Blocking:** Is there a difference in tongue tip-blade angle during [t] in the following contexts?
- **blocking** ([басатаґэ]) vs.
- **non-harmony** ([басатаґе])

**Research Question 4**

**Goal:** To assess models.
- **Gesture Extension Model** predicts retroflexion will occur during [m, k] in harmony context.
- **Repeated Gesture Model** does not predict retroflexion during [m, k] in harmony context.

**Transparency:** Is there difference in tip-blade angle during [m] and [k] across the following contexts?
- **harmony** ([башама:зе], [башака:зе]) vs.
- **failed harmony** ([башама:зе], [башака:зе]) (the option where harmony does not occur in non-adjacent syllables) VS.
- **non-harmony** ([башама:зе], [башака:зе])

**Methods**

**Subject:** One native speaker of Kinyarwanda.

**Procedure:**
- Kinematic data collected using EMA magnetometer (Carstens Articulograph AG200) to track horizontal and vertical movements of receivers adhered to tongue tip and blade.
- Simultaneous audio recording was made.
- Each stimulus read aloud 7 times – once each across 7 blocks.
- Carrier phrase used: [soma] X [gusa] 'read X only.'

**Methods (Cont’d)**

**Articulatory dependent variable:**

**Mean angle:** Mean of angle (in degrees) between receivers adhered to tongue tip and blade (relative to occlusal plane) over constriction interval. (Cf. Wiltshire & Goldstein, 1998.)

**Statistical analysis:**
- Measurements submitted to ANOVA tests with context (harmony, non-harmony, etc.) and consonant as independent variables.
- Criterial p value set at p<.05.
**Question 1: General Description – Results**

- Mean angle variable clearly separates [s z] vs. [g ẓ].
- [s ẓ] are produced with a higher tongue tip relative to blade than [s z].

Number of viable recorded tokens varies due to some recording errors.

**Question 1: General Description – Discussion**

- **Position:** [s ẓ] are produced with a tongue tip position that is higher and more retracted at target timepoint than [s z].
- **Angle:** Tongue tip receiver was lower than tongue blade receiver in both [s z] and [g ẓ]. Tongue tip in [s ẓ] is only slightly curled up, like retroflex fricatives in Mandarin and Polish (Ladefoged & Maddieson, 1996; note also Hamann, 2003).

**Question 2: Fricative targets – Results & Discussion**

- Mean angle variable: **No significant difference** for a retroflex fricative in harmony vs. non-harmony context (F(1,12) = .001, p=.98).
- Suggests that harmony affects fricatives in a categorical fashion.

**Question 3: Blocking – Results & Discussion**

- Mean angle variable:
  - **No significant difference** for [t] in blocking vs. non-harmony context (F(1,11) = .27, p=.62).
  - Confirms that [t] is not affected by retroflex sibilant harmony.

**Question 4: Transparency – Results**

Harmony context factor showed a significant main effect (F(2,36) = 286.18, p < .0001).

- Fisher’s PLSD post hoc tests found significant differences for the following context contrasts only:
  - Harmony vs. failed harmony (p < .0001)
  - Harmony vs. non-harmony (p < .0001).

- [m] and [k] showed a mean tip-blade angle that is more retroflex in harmony contexts than in contexts where harmony does not occur.

- The lack of difference in failed harmony vs. non-harmony contexts suggests that the retroflexion in harmony contexts is not wholly due to coarticulation.
Question 4: Transparency – Further Results & Discussion

- To follow up, mean angle for [m] in harmony context was compared with mean angle for [ʂ ʐ] in non-harmony context ([βaʃata], [βaʃaːta]).

- Mean angle variable: No significant difference for [m] vs. [ʂ ʐ] was found ($F(1,21) = 3, p=.1$).

Implications

- The Gesture Extension Model predicts that a retroflex tip-blade gesture will occur during non-coronal consonants that are perceived as transparent (e.g. [m] and [k]). This prediction is borne out by our findings.

- The Repeated Gesture Model does not predict that transparent [m] and [k] would show a retroflex gesture. Our finding that they show retroflexion thereby does not support a Repeated Gesture representation.

Question 4: Transparency – Further Discussion

- Mean angle during “transparent” [m] in harmony context was comparable to that of [ʂ ʐ] in contexts independent of harmony.

- This suggests that the retroflex tip-blade angle is systematically sustained over the interval separating harmonizing fricatives.

Summary

1. [ʂ ʐ] are characterized by a higher tip relative to blade than [s z].
2. Sibilant harmony functions in a categorical manner, consistent with a phonological process.
3. Blocking [t] is unaffected by harmony.
4. Transparent [m] and [k] show a higher tip relative to blade in harmony contexts. Further, transparent [m] presents a mean tip-blade angle equivalent to that of retroflex fricatives.

References


References (Cont’d)


