**Introduction – Sibilant Harmony**

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

- [-ṣaši] 'bed maker' Not [-ṣaši] cf. [ṣiše] 'penetrated'
- [-ṣa:ze] 'become old (perf.)' Not [-sa:ze]
- [-užuze] 'fill (perf.)' Not [-uzuže]

**Introduction – Transparency & Blocking**

- Harmony is optional in non-adjacent syllables:
  - [-ašamuže] or [-asamuže]
    'make open wide one's mouth (perf.)'
  - [-šaka:ze] or [-saka: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.)

- Intervening coronal stops block sibilant harmony:
  - [-si:ta:že] 'make stub (perf.)' Not [-si:ta:že]

**Introduction – Coronal Consonants**

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

<table>
<thead>
<tr>
<th>Alveolar</th>
<th>Retroflex</th>
<th>Palatal</th>
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<tbody>
<tr>
<td>t d</td>
<td>ć j</td>
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<td>s z</td>
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**Research Question 1**

**Goal:** To characterize tip-blade orientation involved in sibilant harmony.

**General description:** What is the tip-blade angle in [ʂ ʐ] vs. [s z]? (Measured in a syllable preceding [t].)
**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 [游戏操作]) vs. **non-harmony** ([ゲーム])

**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)**

- Time and position for tip and blade receivers at landmarks in above figure identified using Matlab-based MAVIS (Tiede et al., 1999).
- Receiver positions for [m] and [k] based on acoustically-identified timepoints using Matlab-based MView.

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**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** ([警察]) vs. **non-harmony** ([警察])

**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** ([ゲーム]) vs. **failed harmony** ([ゲーム], [ゲーム])
  (the option where harmony does not occur in non-adjacent syllables) VS. **non-harmony** ([ゲーム], [ゲーム])

**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 z].
- [s z] 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 z] 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 z]. Tongue tip in [s z] 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.
Summary

1. [s z], 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.

Question 4: Transparency – Further Results & Discussion

• To follow up, mean angle for [m] in harmony context was compared with mean angle for [s z] in non-harmony context ([bašata], [baša:ta]).

• Mean angle variable: No significant difference for [m] vs. [s z] was found (F(1,21) = 3, p=.1).

• To examine, because its constriction is independent of the tongue.

Question 4: Transparency – Further Discussion

• Mean angle during “transparent” [m] in harmony context was comparable to that of [s z] in contexts independent of harmony.

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

Implications

• The Gesture Extension Model predicts that a retroflex tip-blade gesture will occur during non-corporal 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.

References


Summary (Cont’d)

References


