Cue weighting after a tone-split in Tamang (Tibeto-Burman, Nepal) A perception study of stop initial words
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**Introduction**

- Tamang: close to Tibetan. = 2000K speakers.
- A transphonologization: Tone split (general pattern) [+voiced] > H (+ modal) vs. L (+ breathy)

<table>
<thead>
<tr>
<th>Initial C</th>
<th>Old &gt; modern</th>
<th>Height</th>
<th>Tone split</th>
</tr>
</thead>
<tbody>
<tr>
<td>p, pʰ</td>
<td>s</td>
<td>*m &gt; m, *n &gt; l</td>
<td>high</td>
</tr>
<tr>
<td>*p &gt; p [p–b–b]</td>
<td>*s &gt; s</td>
<td>m, l</td>
<td>low</td>
</tr>
</tbody>
</table>

NB: Voicing contrast totally disappeared on continuants in Tamang: [l, n, r, j] always voiced [s] always voiceless

(FIGURED SLOPES AT TIME OF SPLIT ARE SYMBOLIC: PHONETIC VALUE UNKNOWN)
- Cessychrony consequence in Risiangku Tamang (a conservative Tamang dialect): multiple cues used in production of tones
- Production data using electrolaryngograph (Mazaudon & Michaud 2008): (higher open quotient (OQ) => breathier voice)
  - 20% token plosives Ci prevoicing on low tones (0% on high tones)
  - lower F0 and breathier voice on low tones
  - some inter-speaker tradeoff relation between low F0 and breathiness

<table>
<thead>
<tr>
<th>Fig1. F0 curves</th>
<th>Fig2. OQ curves</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average across the 5 speakers</td>
<td>Average across the 5 speakers</td>
</tr>
</tbody>
</table>

**This study**

**Research question**

- What is the contribution of the older cues in tone perception?
  - CI prevoicing: marginal in production of plosive CI
  - Breathiness: secondary/enhancing cue of low F0 (see Kuang & Liberman 2015)

**Method**

- Who: 28 participants (14M + 14F, mean age: 49, from 33 to 79)
- Where: Kathmandu and Risiangku village of Nepal
- What: synthesized stimuli
  - Carrier sentence /tsu X-psi/ ‘This is X’ (A) or ‘Someone X’s this’ (V)
  - Forced choice among 4 pictures
    - ‘pa-pa ‘thin’; ‘pa-pa ‘harsh’; ‘pa-pa ‘bring’; ‘pa-pa ‘pile up’
  - NB: Perfect quadruplet with a plain stop => target words have a vowel length difference (ambiguous vowel duration was used in all stimuli)
- Variables: 4 * 2 * 3 * 2 * 2 = 96 stimuli (already too long for some older villagers)
- Synthesized parameters
  - F0 onset
  - Prevoiced
  - Voice quality of V1
  - V1 slope
  - V2 slope
  - 115 Hz
  - 130 Hz
  - 145 Hz
  - 160 Hz
  - Yes/prevoiced +modal
    - H (H1-H2 = 2.5dB)
  - No/standing
    - H (H1-H2 = 7dB)
  - Rising (+10Hz)
  - Falling (−20Hz)
  - Rising (+5Hz)
  - Falling (−15Hz)

Based on glottal opening degree settings in VocalTractLab (Birkholz)

**Results**

- Ci prevoicing, although rare in production, carries the decision for Low tone in perception (>50%) whatever the associated feature (H/L pitch or Voice quality)
- RT > if high F0 contradicts Ci prevoicing
- Fastest RT for lowest F0+breathy, whatever Ci prevoicing
- Modal voice has become associated with high tone (congruent H + Modal => fastest RT); clashing L + Modal => 60% H responses
- Breathy voice does not prevent high tone identification in %, but slows down the RT, esp. if the pitch if not Highest

**Discussion**

- Old features/cues continue to be used in production
- H/L emphasized in this study, because of historical perspective, but each of the 4 tones has its profile: e.g., T3 is breathier and has higher pitch than T4. (Hence, perception results are also influenced by properties other than the 4 tones has its profile: e.g., T3 is breathier and has higher pitch than T4. (Hence, perception results are also influenced by properties other than H/L pitch or Voice quality)
- CI prevoicing: very important in perception, although de-phonologized, and currently marginal in production
- Voice quality: important, esp. when the other two cues are conflicting

**Ci prevoicing: most important in perception, main component of the tone**

**F0: most important in perception, main component of the tone**

<table>
<thead>
<tr>
<th>F0 onsets</th>
<th>CI prevoiced</th>
<th>Voice Quality of V1</th>
<th>CI prevoiced</th>
<th>Voice Quality of V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;=130 Hz</td>
<td>yes</td>
<td>rising</td>
<td>yes</td>
<td>rising</td>
</tr>
<tr>
<td>&gt;130 Hz</td>
<td>no</td>
<td>falling</td>
<td>no</td>
<td>falling</td>
</tr>
</tbody>
</table>

Based on glottal opening degree settings in VocalTractLab (Birkholz)

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**Figure 1. F0 curves**

**Figure 2. OQ curves**