The effects of prosody on pitch and voice quality of White Hmong tones

Voice quality in tonal systems

- Lexical tones are often distinguished by voice quality, in addition to f0/pitch.

- Assumption: if voice quality differences are found, these are probably used as cues to tonal identification.

- Possible exception: creaky tone in White Hmong?
White Hmong citation tones

- **High-rising**  
  /pɔ ˦˧/  
  ‘ball’

- **High-falling**  
  /pɔ ˦˨/  
  ‘female’

- **High-falling breathy**  
  /pɔ̤ ˦˧, pɔ̤ ˦˨/  
  ‘grandmother’

- **Mid**  
  /pɔ ˧/  
  ‘spleen’

- **Low-rising**  
  /pɔ ˨˦/  
  ‘throw’

- **Low**  
  /pɔ ˨/  
  ‘thorn’

- **Low-falling creaky**  
  /pɔ̰ ˨˩/  
  ‘see’

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Ratliff (1992, 2015); Esposito (2012); UCLA Voice Project

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White Hmong citation tones

Two high falling tones, one breathy

Two low tones, one falling and creaky

Esposito (2012)
Voice quality in WH citation tones

<table>
<thead>
<tr>
<th>H1*-H2* (lower = more contact)</th>
<th>Breathy tone</th>
<th>Modal tones</th>
<th>Creaky tone</th>
</tr>
</thead>
<tbody>
<tr>
<td>🟢</td>
<td>↑</td>
<td>—</td>
<td>↓</td>
</tr>
</tbody>
</table>

| Harmonics-to-noise ratio (lower = more aspiration, more irregular voicing) |
|-----------------------------|----------------------|
| 🟢                            | ↓                    | ↓           |

Garellek (2012), Esposito (2012)

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Voice quality in WH citation tones

- Consistent acoustic correlates of the **breathy** high-falling tone and **creaky** low-falling tone, relative to the other **modal** tones.

- Do listeners make use of voice quality to identify tones?
  - It depends on the particular contrast.

Garellek et al. (2013, 2014)
White Hmong tone identification

<table>
<thead>
<tr>
<th>Tone Type</th>
<th>Phoneme</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-rising</td>
<td>/pɔ ˥˧/</td>
<td>‘ball’</td>
</tr>
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<td>/pɔ ˥˨/</td>
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Garellek et al. (2013, 2014)

Listeners rely only on breathy voice

Listeners do not rely on creaky voice, only f0 and duration

Production vs. perception

• Why do speakers produce the high-falling breathy tone with a consistently falling pitch contour, but ignore f0 in perception?

• Why do speakers produce the low-falling creaky tone with consistent creaky voice, but ignore creaky voice in perception?
Production vs. perception

Two possibilities:
1. Voice quality might not always be perceived independently of pitch.
2. Production of citation tones differs from non-citation forms.

Hypotheses for non-citation tones

Hyp1: Maybe the high-falling *breathy* tone is consistently breathy…
  – But not consistently high-falling in f0

Hyp2: Maybe the low-falling *creaky* tone is consistently low-falling…
  – But not consistently creaky
Corpus

- 10 literate speakers of White Hmong from the Twin Cities, Minnesota.
- Speakers read 3 folk tales, with all possible ditones.
- All words were coded for position in utterance (initial, medial, final).
- Words adjacent to disfluencies, utterance-medial phrase boundaries were excluded.
- Vowels were segmented and analyzed for f0, voice quality measures.

High-falling breathy tone

- Utterance-finally, both high-falling tones are high-falling.
High-falling breathy tone

• Medially, the breathy high-falling tone is lower in f0 than the modal high-falling tone.
Results for high-falling tones

Hyp1: Maybe the high-falling breathy tone is consistently breathy…
   – But not consistently high-falling in f0.

• Result: it’s consistently high-falling
  – But in different phrasal positions, the breathy tone differs in scaling from the modal high-falling tone.

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High-falling breathy tone

<table>
<thead>
<tr>
<th>Tone</th>
<th>modal high→fall</th>
<th>breathy high→fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Cepstral peak prominence (normalized)
- H1* - H2 (normalized)
Recall: hypotheses

Hyp1: Maybe the high-falling breathy tone is consistently breathy…
   – But not consistently high-falling in f0

Hyp2: Maybe the low-falling creaky tone is consistently low-falling…
   – But not consistently creaky

Low-falling creaky tone
Low-falling creaky tone

Results for low tones

Hyp2: Maybe the low-falling creaky tone is consistently low-falling…
   – But not consistently creaky

• Result: it’s consistently creaky
   – Also consistently low-falling
Interpretation

• High-falling breathy tone is consistently high-falling, but scaling varies vs. modal.
  – Listeners could rely on f0, but it would be a more variable cue.

• Low-falling creaky tone is consistently low-falling, but also consistently creaky.
  – Listeners ignored creaky voice.

Interpretation

• Production target for low-falling creaky tone is a falling f0.

• Creaky voice is being used in White Hmong to guarantee an extra-low pitch
  – More like a pitch setting than like a phonation type
Implications

• Role of voice quality in tonal systems can be either:
  – Independent of pitch
  – Dependent on pitch

• Studies of non-citation forms of tones in different prosodic positions help elucidate listener behavior in tonal identification.

Thank you! Ua tsaug!
Appendix

White Hmong tone contours

<table>
<thead>
<tr>
<th></th>
<th>F0 (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td></td>
</tr>
<tr>
<td>Medial</td>
<td></td>
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<tr>
<td>Final</td>
<td></td>
</tr>
<tr>
<td>Tone</td>
<td></td>
</tr>
<tr>
<td>45 b</td>
<td></td>
</tr>
<tr>
<td>53 j</td>
<td></td>
</tr>
<tr>
<td>12 v</td>
<td></td>
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<td>33 x</td>
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<tr>
<td>22 s</td>
<td></td>
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<tr>
<td>43 g</td>
<td></td>
</tr>
<tr>
<td>21 m</td>
<td></td>
</tr>
</tbody>
</table>