Acoustic Correlates of Stress in Tongan
and Their Use in Diagnosing Syllable Fusion

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Background
- Common acoustic correlates of stress include higher pitch and intensity, longer duration, and vowel quality differences (e.g., Gordon & Applebaum 2010)
- Greater positive spectral tilt (i.e., difference in voice quality) has also been found (Stuijler & van Hauven 1996)
- Correlates of secondary stress may differ from those of primary stress (Adisasmito-Smith & Cohn 1996)
- Almost no work looking at acoustic correlates of stress in Polynesian languages.

Research Questions
1) Which acoustic measures correlate with stress in Tongan?
2) How do the acoustic stress of Tongan compare with those reported in other languages?
3) Can we use these cues to tell us about the status of a phonological process of syllable fusion?

Tongan Basics
- Spoken in Kingdom of Tonga by about 96,000 speakers (Lewis, 2009)
- Malayo-Polynesian (Austronesian)
- Five vowels: /i, e, a, o, u/
- Primary stress: Penultimate mora
- Secondary stress: Depends on morphology, but in our words will always be on leftmost mora

Procedure
- 4 female speakers recorded
- Primary stress: CV CVCV - V1 compared to V2
- Sec. stress: CVCV CV-CV
- 10 words/vowel, 3 tokens/word for each speaker, uttered in a carrier sentence
- Stat. analysis: Linear mixed-effects models

Fundamental Frequency (F0)

<table>
<thead>
<tr>
<th>Vocal Quality (F1 and F2)</th>
</tr>
</thead>
</table>
| Sig. higher F1 (lower vowel) for primary stress (all vowels), secondary stress only for /a/.
| No difference in F2 for primary or secondary stress.

RMS Energy

<table>
<thead>
<tr>
<th>Vowel Quality (F1<em>H2</em> and CPP)</th>
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| Sig. higher energy for primary stress (all vowels) and secondary stress (a, o, u) only.
| 

Duration

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<th>Vowel Quality (F1<em>H2</em> and CPP)</th>
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| Sig. longer duration for primary stress (all vowels), but not for secondary stress.
| 

Vowel Quality (F1 and F2)

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| 

Conclusions

- Vowels higher overall when unstressed.
- Distance between vowels maintained when stressed and unstressed.
- Not consistent with commonly discussed patterns of stress-based vowel reduction (e.g., see Crosswhite 2001).
- Not tongue undershoot (should cause centralization).
- Not contrast enhancement through (near-)ymerger.
- Not peripheralization.
- Possible explanations: jaw undershoot or enhancement of stress contrast via sonority.

Syllable Fusion

- Lower-to-higher vowel sequences (ai, au, ae, ao, ei, ou, etc.) often said to fuse into single-syllable diphthongs, but their higher-to-lower counterparts do not (Chung and Poser 1985, Schütz 2001, but see Taumoepeau 2002).
- Are there any acoustic differences between them?
- 2nd vowel of Fusing 'VV sequences more like a stressed vowel in terms of F1
- F0 contours show a later peak for /ai, au/ than for /ia, uai/.

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References