

Acoustic correlates of stress in contrastive short and long vowels in ‘ōlelo Hawai‘i

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‘Ōlelo Hawai‘i (Eastern Polynesian) is reported to have phonemically contrastive vowel duration. For words containing only short vowels, Schütz [9,10] argues that stress assignment is fully predictable for words up to four syllables long (but not longer, cf. [8]), exhibiting a trochaic pattern with rightmost primary stress and secondary stress on preceding feet: /ho.(‘pe.na)/ ‘result’, /(,ma.ka)(‘hi.ki)/ ‘year’. Syllables containing long vowels or diphthongs are considered heavy syllables that are always stressed, with a word-final heavy syllable bearing primary stress and all other heavy syllables bearing secondary stress: /(,ka:)(‘pi:)/ ‘to sprinkle’, /(,la:)(,la:)(‘wai)/ ‘prosperous’. We investigate acoustic correlates of stress in ‘ōlelo Hawai‘i to address three questions: (a) do phonetic correlates support the assumption of three levels of stress, (b) do speakers distinguish long/short vowels with duration, and (c) are the correlates of stress in long/short vowels the same? Discriminating three levels of stress seems to be rare [6], though found in languages like Chickasaw [5] and Tongan [4]. Chickasaw is also a potential model for the realization of stress in ‘ōlelo Hawai‘i; it exhibits prominence on long vowels in all positions relative to short unstressed syllables and a duration distinction between long and short vowels. We examine two- to four-syllable words only containing short vowels flanked by consonants (e.g., /‘pu.ke/ ‘book’, /ho.‘pe.na/, /,‘ma.ka.‘hi.ki/), and two-syllable words containing only long vowels flanked by consonants (/‘ka:.‘pi:/). No pre-pausal vowels were used.

The data come from spontaneous speech from eight native speakers interviewed on the *Ka Leo Hawai‘i* radio program in the early 1970s [7]. These interviews were force aligned, then vowel duration and median intensity (RMS amplitude) were extracted using Fast Track [2]; mean fundamental frequency (F0) was extracted with REAPER. For each measurement, LMERS were constructed with one fixed effect of syllable position, plus speaker, vowel, and individual word utterance as random intercepts. To reduce variability in the measurements, tokens were only included when all vowels in an individual word utterance could be measured for a given correlate. For short vowels, F0 and intensity are significantly higher for both types of stressed syllable than for unstressed syllables, with no distinction between primary and secondary stressed syllables. Duration does not correspond to differences in stress; instead, vowels in the final foot in four-syllable words are lengthened. In comparing two-syllable words with long and short vowels (e.g. /(,ka:)(‘pi:)/-/(‘pu.ke)/, both long vowels are nearly twice the duration of short vowels. There are no differences in F0 between the long vowels, nor between the long vowels and the stressed short vowel, and no difference in intensity between the two long vowels; however, both long vowels are higher in intensity than the unstressed short vowel. In a comparison of two-syllable words with long vowels and four-syllable words with short vowels, no significant F0 or intensity differences are observed between long and short secondary stressed syllables. Figures 1-2 illustrate four-syllable short vowel words, and two-syllable long and short vowel words; results are similar for two- and three-syllable short vowel words.

In ‘ōlelo Hawai‘i, two levels of stress are distinguished by intensity and F0: primary/secondary vs. unstressed. Long vowels contrast with short vowels in duration, which has not been previously confirmed. The long vowels do not differ from one another in F0 or intensity, but their prominence is cued by intensity. In contrast, duration is not a correlate of stress, but is more likely indicative of lengthening of the entire final foot or prosodic word, similar to findings reported for other languages (see [3]). The lack of acoustic correlates distinguishing primary from secondary stress may have implications for phonological accounts of stress system of ‘ōlelo Hawai‘i (e.g., [1]).

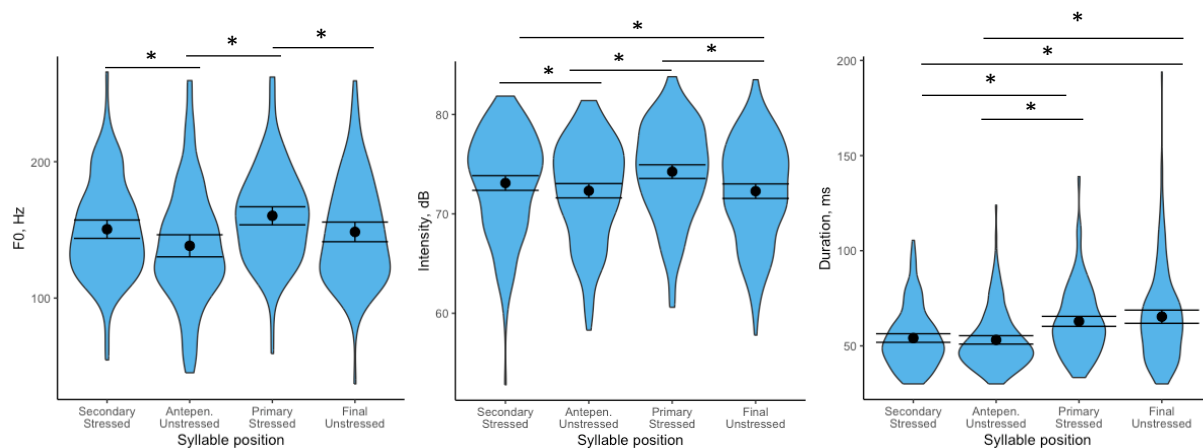


Figure 1: 4-syllable words with short vowels only (e.g. /ma.ka.'hi.ki/). F0 (left), Intensity (middle), Duration (right). Asterisks indicate significant result ($p < 0.05$)

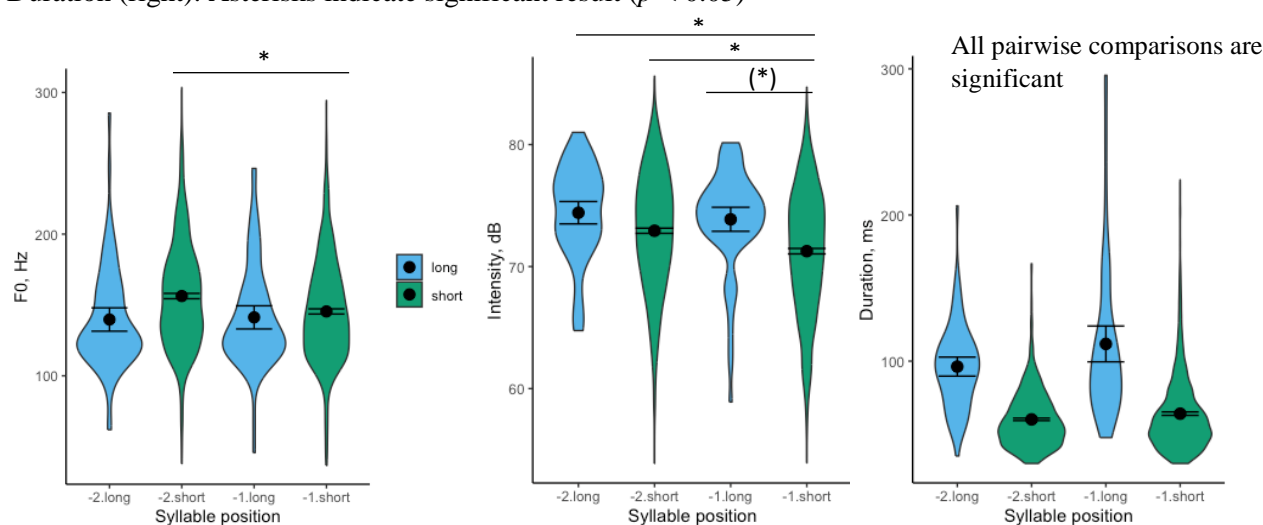


Figure 2: 2-syllable words comparing long and short vowels. “-1” and “-2” refer to the vowel position from the right edge, where -1 is the final syllable and -2 is the penultimate syllable (e.g. /ka:.2.'la:./ ‘money’, /'pa-2. pa-1/ ‘class’). F0 (left), intensity (middle), duration (right). Asterisks indicate significant result ($p < 0.05$), parentheses indicate $p = 0.051$.

References

- [1] Alderete, J., & MacMillan, K. (2015). Reduplication in Hawaiian: variations on a theme of minimal word. *NLLT*, 33, 1-45.
- [2] Barreda, S. (2021). Fast Track: Fast (nearly) automatic formant-tracking using Praat. *Linguistics Vanguard* 7(1).
- [3] Fletcher, J. (2010). The prosody of speech: Timing and rhythm. In W. Hardcastle, J. Laver & F. Gibbon (Eds.), *The Handbook of Phonetic Sciences* (pp. 521–602). Hoboken, NJ: Wiley-Blackwell.
- [4] Garellek, M., & White, J. (2015). Phonetics of Tongan stress. *JIPA*, 45, 13-34.
- [5] Gordon, M. (2004). A phonetic and phonological study of word-level stress in Chickasaw. *IJAL*, 70, 1–32.
- [6] Gordon, M., & Roettger, T. (2017). Acoustic correlates of word stress: A cross-linguistic survey. *Linguistics Vanguard*, 3, 20170007.
- [7] Kimura, L. L. K. (1972–1973). Kani‘āina, ulukau.org Digital Repository of Ka Haka ‘Ula O Ke‘elikōlani College of Hawaiian Language, University of Hawai‘i at Hilo, Ka Leo Hawai‘i. Retrieved from: ulukau.org/kaniaina.
- [8] Parker Jones, ‘Ö. (2010). *A computational phonology and morphology of Hawaiian*. Unpublished DPhil. thesis, University of Oxford.
- [9] Schütz, A. (1978). Accent in two Oceanic languages. *Anthropological Linguistics*, 20, 141–149.
- [10] Schütz, A. (1981). A reanalysis of the Hawaiian vowel system. *Oceanic Linguistics*, 20, 1-43.