

The phonetic details of word-level prosodic structure: evidence from Hawaiian

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Previous research has shown that the segmental and phonetic realization of consonants can be sensitive to word-internal prosodic and metrical boundaries [1-3]. At the same time, other work has shown that prosodic prominence, such as stressed or accented syllables, has a separate effect on phonetic implementation [4-6]. This talk focuses on the word-level factors affecting the phonetic implementation of glottal and oral stops in Hawaiian. We first investigate whether prosodic or metrical structure, or prosodic prominence such as stressed syllables account for the realization of glottal stop. We then extend the same analysis to the realization of voice onset time (VOT) in oral stops to determine whether both of these phonetic correlates have a similar or different relationship with the prosodic and/or metrical structure of Hawaiian.

Data come from 8 speakers (4M, 4F) from Ka Leo Hawai'i, a 1970s Hawaiian language radio show featuring interviews with bilingual Hawaiian/English speakers. The targets of the first analysis were phrase-medial phonemic glottal stops (N=758, e.g. ['ʔa.ka] 'to laugh', ['pu.ʔu] 'hill'). Three broad categories for classifying the realization of /ʔ/ were identified: no glottalization or only a dip in F0 (27%), a period of glottalization (66%), or a full glottal closure (7%). Using the computational prosodic grammar developed in Parker Jones [7], the words were automatically categorized as to the stress of the syllable (primary stress, secondary stress, unstressed), the position of the glottal stop in the word (initial vs. medial), and the position of the glottal stop relative to prosodic word boundaries (prosodic word initial vs. medial). A multinomial regression for phonemic glottal stops indicated that glottalization was less likely and full glottal closures were more likely in prosodic word-initial position (see Figure 1) (e.g. {(ki:)}{(ʔa.ha)} 'cup'). Neither stressed nor heavy syllables were significant factors. One interpretation of these results is that a full closure may help indicate prosodic word boundaries, which could resolve cases where stress assignment does not disambiguate possible parses, e.g., {(ho:)}{(ʔo.(a.ka))} or {(ho:.ʔo)}{(a.ka)}, 'to open'.

The second analysis examined the VOT duration of the oral stops /p/ and /k/ (N=5692, e.g., [papa] 'class', [kokoke] 'near'. Hawaiian only has /t/ in restricted contexts). Like for the glottal stops, the oral stops were also categorized for syllable stress, (lexical) word position, and prosodic word position. An additional aspect of the analysis was to determine whether stops in Hawaiian are aspirated or unaspirated, which had not previously been conclusively established [8, 9]. First, results indicate that oral stops in the Hawaiian speakers of this generation are unaspirated (avg /p/=24ms, /k/=39ms). The effects of the prosodic factors show that there are no main effects of stress or prosodic word on VOT duration, but there is an effect of lexical word position and an interaction between word position and stress (see Figure 2). Whereas VOT is longer in word-initial position for secondary and unstressed syllables, there is no difference for word position when a syllable has primary stress. If this difference is perceptible in secondary and unstressed syllables, perhaps it could serve as a cue that a less prominent syllable belongs to the beginning of a word, instead of being the final syllable of a preceding word.

Taken together, results show that word-internal metrical structures do condition phonetic realization, but prosodic prominence does not for either kind of stop. In contrast, in studies of languages like English, German or Polish, the insertion of glottalization and full stop realizations is more likely before stressed syllables or at higher prosodic boundaries [10, 11], and are taken to be the articulatory reflection of prosodic strengthening. Relatedly, languages with unaspirated stops like Dutch and Sahaptin Yakima demonstrate shortening of the stop release in prominent syllables, a fortition effect [12, 13], whereas a lengthening effect possibly

attributable to word initial position occurs in secondary and unstressed syllables in Hawaiian. These results for both types of stops may reflect the recruitment of phonetic correlates to disambiguate or protect weaker elements, which is complemented by recent findings on the use of non-phonemic glottalization in Hawaiian to demarcate single-vowel function words (e.g. [a] or [i]) where they might otherwise be imperceptible [14].

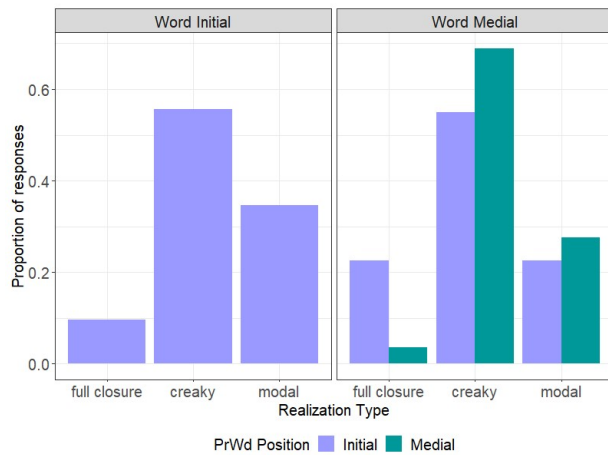


Figure 1. Proportions of full closure, creaky and modal implementations by prosodic and lexical word position.

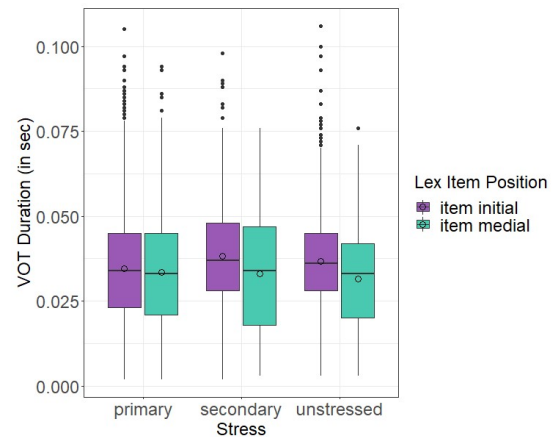


Figure 2. VOT durations by stress level and word position

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