Lexical stress: Phonetic variation under phonological stability in 23 Australian languages

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Indigenous Australian languages are known for having an unusually high degree of phonological similarity to one another with respect to many parameters [1,3]. However, recent work has shown that phonological similarity often abstracts over systematic phonetic variation within individual languages; Kakadelis (2018) showed three distinct patterns of phonetic variation in stop voicing across three languages without a phonological voicing distinction [2]. The present study considers phonetic variation in lexical stress, which in most Australian languages has the same phonological profile – fixed and word-initial [3]. Little to no work has been done investigating cross-linguistic phonetic variation in the realization of lexical stress, especially among a group of related languages, nor the forces by which the phonetic realization of stress influences, or is influenced by, a language's segmental phonology. Gordon & Roettger (2017) surveyed results from acoustic studies of stress in many languages, though the authors note that differences in analytic methods and types of measurements used could be roadblocks to a true comparison. The present study applies the same method to all data in the survey, making between-language comparisons more straightforward with respect to this issue.

Data & Methods: The present study considers acoustic correlates of fixed initial stress in 23 languages of Australia (10 Pama Nyungan, 13 non-Pama Nyungan). Narrative and other natural-language audio materials with utterance-level transcriptions were obtained for each language from three archives [4,5,6]. These data were force-aligned using the Montreal Forced Aligner (MFA) [7]. After manual correction of these automatic segmentations, acoustic information was extracted using Praat [8] for analysis in R [9]. The factors considered as potential correlates of stress were: vowel (V) duration, intensity, and f0, most often associated with stress cross-linguistically [10]; onset consonant (C) duration, post-vocalic C duration, and V peripheralization, which are cited in the Australianist literature as stress correlates in some languages [11]. Status as a stress correlate was determined using linear regression in R, with independent variables controlling for segment identity, position in word, phonemic V length (where applicable), and syllable profile, as well as random effects of word and speaker.

Results: Preliminary results (reporting on 9 of the 23 languages) show much phonetic variation across all acoustic factors considered in this analysis, both in terms of overall distribution and in which of these factors correlate with lexical stress. While f0 is often cited as the canonical stress correlate in Australian languages [11], two languages in this preliminary set did not have a significant correlation of stress and f0. Both duration and intensity showed strong effects in some languages, and both onset and post-vocalic C duration factors and V peripheralization showed some small but significant effects in a subset of languages as well. Notably, languages with a phonemic V length distinction showed correlation of V duration with stress, while those without such a distinction did not show correlation. This result suggests a relationship between these two uses of duration that contradict claims that have been made in the literature on the matter [12].

Data were analyzed both within-language and across languages. Within-language effects were minimal (Fig. 2); aside from expected speaker gender effects on factors such as f0 and vowel space, each acoustic factor investigated showed language-internal consistency. Across languages, however, significant differences of each of the factors considered, such as V duration (Fig. 1) and f0 peak location (Fig. 3) were common.

In sum, these results suggest that the acoustic correlates of stress are systematic within a language, but vary across languages, even when those languages are historically related, and have the same phonological stress profile. This study also provides a methodology for making use of natural language archival materials in quantitative analysis.

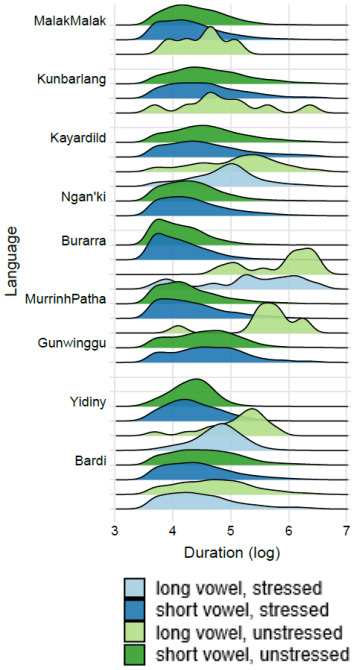

Figure 1. (left) V duration distributions across languages, separated by vowel length and presence or absence of stress. Most pairwise language differences are significant ($p<0.05$).

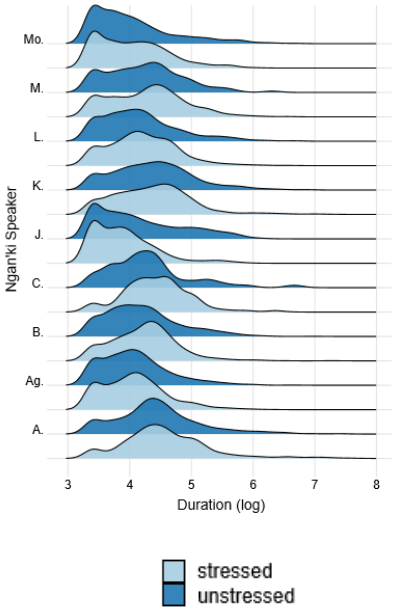

Figure 2. (right) V duration distributions in one language, Ngan'ki, across speakers, separated by presence or absence of stress. Between-speaker differences not significant ($p>0.05$).

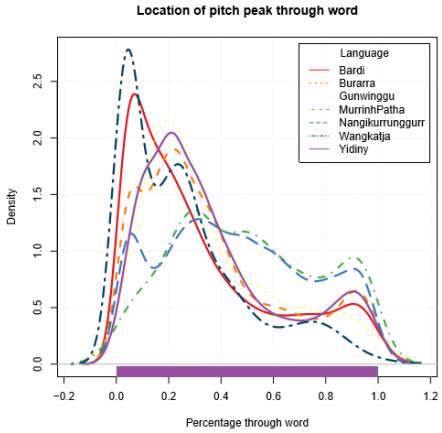

Figure 3. Density plot showing location of f0 peaks across all words in each language. High leftward density peaks indicate f0 as initial stress correlate.

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