

Examining acoustic evidence for word-level prosodic prominence in Waima'a

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This paper examines acoustic evidence for stress at the word level in Waima'a, an Austronesian language spoken in Timor-Leste, located in the south east of the Indonesian archipelago. Waima'a has been described as having no word-level stress, but only phrase-level prosody, characterised by pitch movements at the right edge of the intonation unit (Himmelman 2010). The location of Waima'a can be seen in Figure 1.

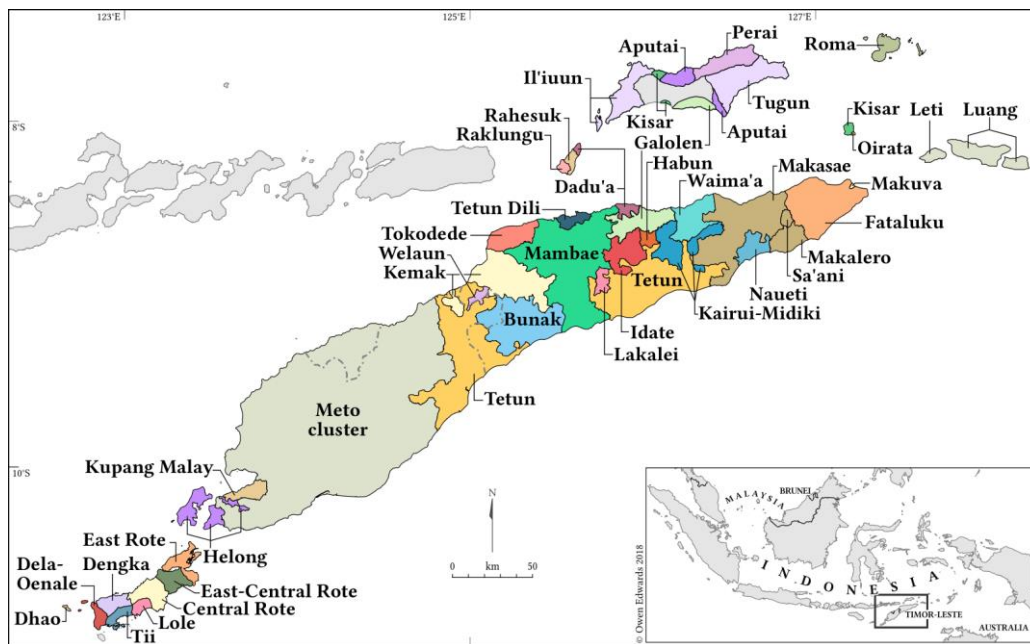


Figure 1: Languages of Greater Timor

Following the methodology of Kaland (2019), this study considers six potential acoustic correlates of word stress, namely F0 movement, rise/fall ratios, duration per segment, duration deviation¹, two measures of spectral tilt (H1-A2 and H1-A3) and vowel displacement from the centre of the vowel space (i.e. vowel reduction). These measurements are mostly derived from raw measures such as raw F0 and raw duration, and are intended to reduce the possible interference of phrase-level prosodic phenomena (Kaland 2019: 59). More broadly, derived measures have been found to be more reliable correlates of stress than raw measures (Gordon and Roettger 2017).

The data used in this study was taken from spontaneous narratives collected by the author during a field trip in 2019. Penultimate and ultimate syllables of disyllabic words were compared. This is because word stress — if there is evidence for it — tends to fall on the penultimate syllable in languages of Eastern Indonesia (Kaufman and Himmelman 2021).

A statistical analysis was carried out using Linear mixed models fit by maximum likelihood. A given measure was the response and syllable (penultimate and ultimate) was the predictor. Speakers and items (words) were included as random intercepts. For each measure, likelihood

¹ Duration deviation refers to duration of a given syllable minus the mean duration of all syllables with the same structure (e.g. CV, CVC). Positive duration deviation is indicative of longer syllables, while negative indicates shorter syllables.

ratio tests (χ^2) were carried out, comparing the model to an intercept-only model (i.e. without the effect of syllable) in order to determine the significance of syllable (penultimate vs ultimate). Table 1 reports the results of the statistical analysis for all measures, except for vowel displacement which is reported in Table 2.

Table 1

	Penultimate syllable		Ultimate syllable		χ^2	p
	mean	SD	mean	SD		
F0 movement (ST)	3.04	3.38	2.87	3.22	0.45	=0.503
Rise/fall ratio	0.77		0.62		0.82	=0.366
Duration per segment (ms)	82.8	35.39	68.14	22.88	1.34	=0.247
Duration deviation (ms)	2.28	42.19	-2.28	46.08	1.48	=0.224
H1-A2 (dB)	14.46	11.54	13.45	12.22	0.61	=0.433
H1-A3 (dB)	24.09	10.98	21.73	14.05	5.20	=0.23

Although differences can be observed between penultimate and ultimate syllables for several measures, no significant effects of syllable were found for any of the acoustic measures listed in Table 1.

Table 2 reports mean F1 and F2 (Bark) per vowel for penultimate and ultimate syllables. It also reports on the affect of syllable on formant displacement relative to centre of the vowel space. This was calculated by performing post-hoc pairwise comparisons using Tukey HSD test (Bonferroni corrected) on the interactions between the fixed factors syllable (two levels: penultimate, ultimate) and vowel (five levels: /i/, /e/, /a/, /o/ and /u/) with speakers and items (words) as random factors. This was to test the possible effects of syllable on formant displacement for each vowel separately.

Table 2

	F1		F2		p
	Penult. syllable	Ult. syllable	Penult. syllable	Ult. syllable	
/i/	3.95	3.85	13.25	12.75	=0.99458
/e/	5.04	4.81	12.21	12.4	=1
/a/	6.64	6.33	11.1	10.9	=0.9539
/o/	5.45	5.24	9.98	10.26	=0.99997
/u/	4.04	4.45	10.25	9.91	=0.59567
centre	5.35		11.21		

The approximate vowel space of Waima'a can be seen in Figure 2.

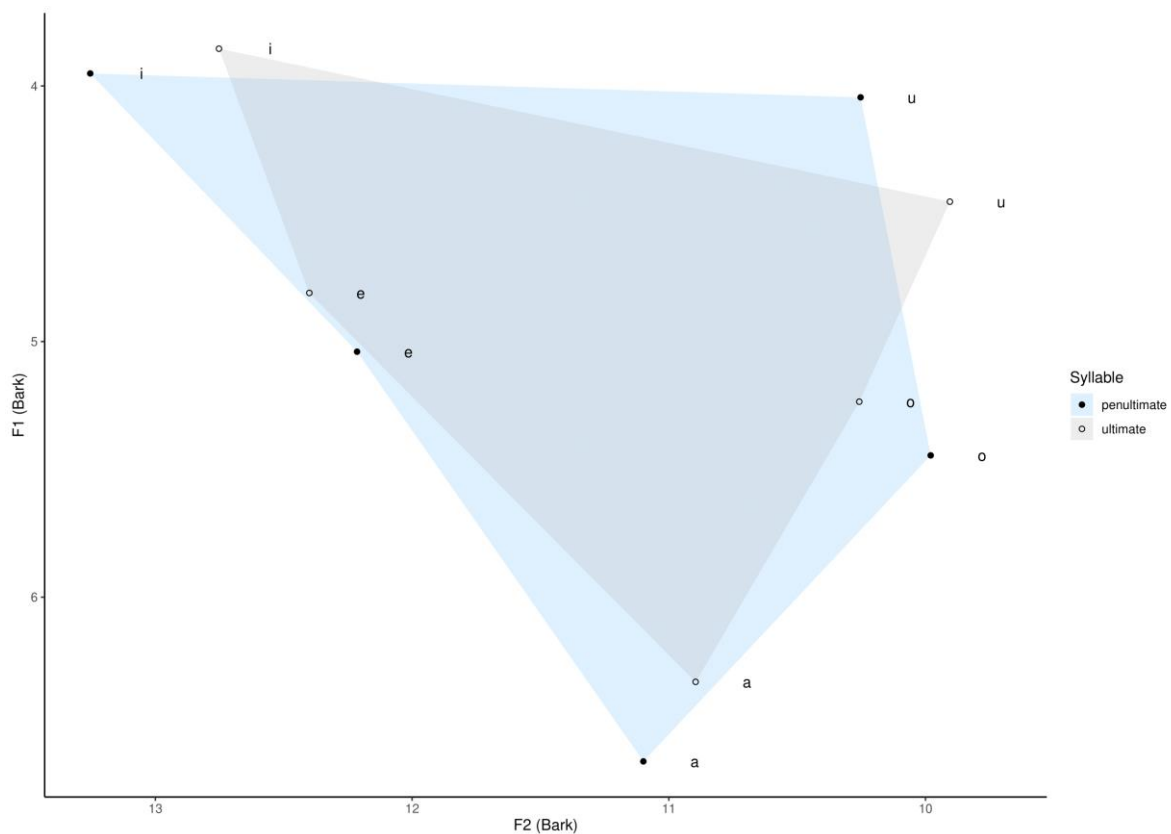


Figure 2: Waima'a vowel space

Some differences can be observed in the between the position of penultimate and ultimate syllables in the vowel space in Figure 2. However, the syllable was not found to have any significant affect on formant displacement for any of the vowels, as can be seen in Table 3.

This paper finds no evidence for acoustic marking of word stress in Waima'a, supporting an analysis of Waima'a as a language without word stress as described by Himmelmann (2010). This study also contributes to our understanding of word prosodic systems in languages of Eastern Indonesia more broadly, which have generally not been well-studied quantitatively.

References

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