The phonetics and phonology of non-moraic schwas: New evidence from Piuma Paiwan

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Introduction: This paper presents new acoustic evidence that there are non-moraic schwas. Moreover, it shows that non-moraic, monomoraic, and bimoraic schwas can coexist in the same phonological system. These results eliminate the need for constraints that refer to both feet and segmental sonority, contra de Lacy (2006) and others. I examine an Austronesian language that has been reported to have sonority-sensitive stress: Piuma Paiwan (Chen 2009a, b, Yeh 2011; hereafter 'P'). I will show that although there is objective evidence that stress avoids landing on a schwa, such avoidance is actually a side-effect of schwa's prosodic status: schwa is usually non-moraic in P. However, schwa is required to be monomoraic when it is in the non-head position of a foot, and bimoraic when it is in the head syllable of a foot. The result is that P has *three* types of schwa: bimoraic [əː], monomoraic [ə], and nonmoraic [ᵊ]. The different kinds of schwa have significantly distinct acoustic effects, particularly in duration and vowel quality variability.

Background: All descriptions of P agree that the default position for stress is the penult (Chen 2009a, b, Yeh 2011), as in (1a). They also agree that stress avoids the lowest sonority vowel – schwa – when there is a more sonorous one in the final syllable, as in (1b). Surprisingly, stress still moves away from a penultimate schwa when the final syllable also contains schwa, as in (1c).

(1) Stress assignment in Piuma Paiwan

a.	[káka]	'sibling'	b.	[kərí]	'small'	c.	[ɭəʎə́t]	'lip'
	[vúvu]	'grandparents'		[cəvús]	'sugarcane'		[tsəmə́ɭ]	'grass'
	[ɭígim]	'needle'		[kəmán]	'to eat'			

Methodology: All the data were collected by the author during a field trip in southern Taiwan. Disyllabic words with the shape [CuCu], [CuCuC], [CəCu], [CəCuC], [CəCəC], and [CuCəC] were the focus of this experiment. Words with the shape [CuCu] and [CuCuC] were used to establish baselines for the acoustic realization of stressed and unstressed vowels. Crucially, other word types [CəCu], [CəCuC], and [CəCəC] were used to verify the claim that stress avoids schwa in P since those words have schwa in penultimate position. On consulting with native speakers, it was found that the total number of words with [u] in their lexicons was greater than that of words with [i] and [a]. So, words with the vowel [u] were the main focus in this study. Acoustic correlates of stressed/unstressed vowels were measured, including intensity, duration, F0, F1 and F2. Two female native speakers participated in the experiment (ages 48-59). Participants read 54 stimuli and 5 fillers in each session, yielding a total of 324 tokens per speaker (54 stimuli × 2 frame sentences × 3 repetitions). In order to assess the statistical significance of the acoustic differences, several linear mixed-effects model analyses were run in R (R Development Core Team 2017), using the *lmer()* function of *lme4* package (Bates *et al*. 2012).

Results: F0 provides clear evidence for stress placement in P. It was found that for words with the forms [Cu.Cu], [Cu.CuC], and [Cu.CəC], the vowel in the penult has a significantly higher pitch than the vowel in the ultima ($p<0.01$), as shown in Figure 1.

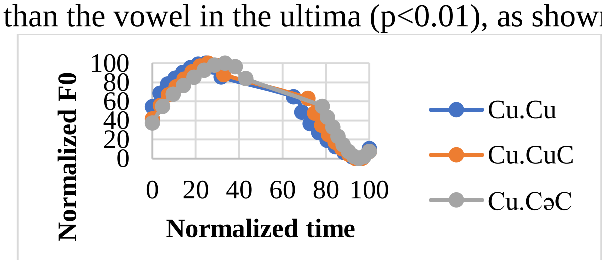

Figure 1. F0 on words with penultimate stress.

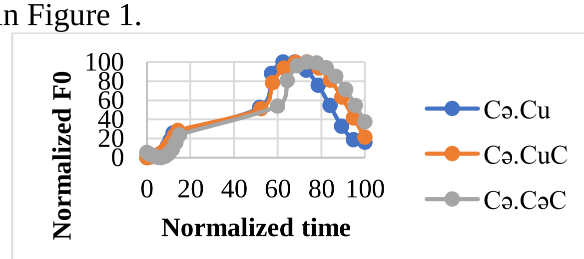

Figure 2. F0 on words with final stress.

Crucially, it was found that for words with the forms [Cə.Cu], [Cə.CuC], and [Cə.CəC], the vowel in the ultima has a significantly higher F0 than the vowel in the penult ($p<0.01$), as shown in Figure

2. The duration results show that there are three different types of [ə]: the 'overshort' schwas (Subscripts refer to schwas in particular word forms – see Figs 3. and 4; $ə_1$: 46ms, sd=16; $ə_2$: 44ms, sd=15; $ə_3$: 42ms, sd=14), the short schwa ($ə_5$: 80ms, sd=18), and the long schwa ($ə_4$: 137ms, sd=26), as illustrated in Figure 3. The differences between the three types of schwa are highly significant ($p<0.01$). It should be noted that duration is not an acoustic correlate of stress; a full model of vowel duration will be presented in the talk.

While the quality of schwa is highly influenced by surrounding consonants, when schwa has longer duration (i.e. ə4 and ə5), their F1 and F2 are much less influenced by the environment, as shown in Figure 4. The results concerning with [u] are not discussed in this abstract due to space limitations. In short, when schwa lacks a mora, it is phonetically realized as extremely short, and its height and backness are highly influenced by surrounding segments.

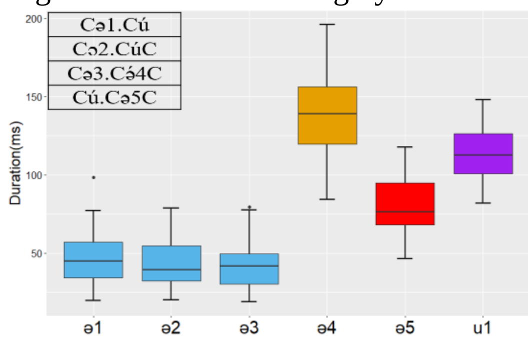

Figure 3. Durational differences between schwas.

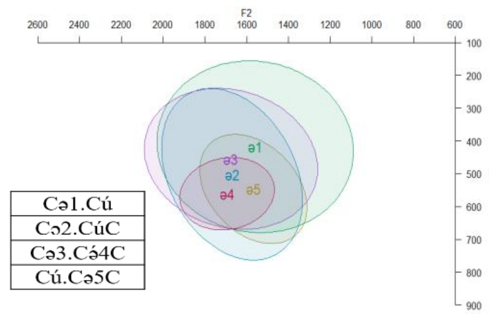

Figure 4. F1/F2 variations of different schwas.

Analysis: Based on the duration and F1/F2 results, I propose that every word in P ends in a right-aligned bimoraic trochaic foot: $[C^{ə1}(Cú^{μμ})]$, $[C^{ə2}(Cú^{μμ}C)]$, $[C^{ə3}(Cə́_4{}^{μμ}C)]$, and $[(Cú^{μ}.Cə_5{}^{μ}C)]$. The non-moraicity of schwa is motivated by constraints on syllabicity and headedness: *μ/ə (Incur a violation for every schwa that bears a mora; Zec 2007), and HDσ (Incur a violation for any σ that does not dominate a μ; Selkirk 1995). Crucially, moraic schwa is avoided because the constraint *μ/ə dominates HDσ. Candidate (2b) fatally violates *μ/ə because it contains a moraic schwa, while (2c) incurs two violations of HDσ since both vowels are moraless. However, schwa is forced to be moraic when it is a foot head (i.e. $ə_4$), and when foot form calls for it (i.e. $ə_5$). I use [CəCə] words for illustration. Since a foot in P is bimoraic, FTBINμ (Feet must contain two moras; Élias-Ulloa 2006) prevents both schwas from being non-moraic, and forces the rightmost one to be bimoraic. So, candidate (3c) is eliminated because it contains two non-moraic schwas. Although candidate (3b) satisfies the requirement, it incurs more violations of *μ/ə (cf. 3a).

(2) *Basic moraless schwa ranking*

/kəri/	*μ/ə	HDσ
☞ a. kᵊ(rí:)		*
b. (kə́.ri)	*!	
c. (kᵊ.rj)		**!

(3) *Bimoraic schwa ranking*

/ɭəʎət/	FTBINμ	*μ/ə	HDσ
☞ a. ɭᵊ(ʎə́:t)		*	*
b. (ɭə́.ʎət)		**!	
c. (ɭᵊ.ʎᵊt)	*!		**

Implications: Two major problems arise if we adopt the sonority approach (Kenstowicz 1997, de Lacy 2002, 2004). First, it falsely predicts that stress falls on the penult in [Cə.CəC] words as both vowels have the same sonority (see Yeh (2011)'s proposal). Second, the sonority approach provides no explanation for the differences in duration and quality between non-moraic and moraic schwas. I provide an extensive typology of sonority-driven stress systems, arguing that many cases of sonority-driven stress are better analyzed as stress avoiding moraless schwa, rather than avoiding low sonority segments.