Vowel laxing in Indonesian as a test case for interaction of morphological and syllabic structure

Daniel McCloy

Linguistic Phonetics Laboratory ◇ Department of Linguistics ◇ University of Washington

5pSC21

Background

- Vowels in closed syllables tend to be shorter than vowels in open syllables (MADDIESON 1985).
- Closed-syllable vowel *quality* changes (A.K.A. reduction or laxing) are widely attested, e.g., French (DELL 1995), Portuguese (REDENBARGER 2005), Thai (APILUCK 1996), and Klamath (BLEVINS 1993).
- Morpheme boundaries shown to influence closed-syllable reduction; in Ngayu Dajak (ISO 639-3: nij, AUSTRONESIAN, BORNEO), /toso + n/ "breast of ___" shows some vowel reduction, but less than tautomorphemic /toson/ "red squirrel" (BRUNELLE & RIEHL 2002).

Research Question

Is vowel reduction in Indonesian (ISO 639-3: ind, AUSTRONESIAN, INDONESIA) mitigated by morphemic structure?

Hypothesis

Morpheme boundary will interfere with resyllabification in condition E2 (see below) which will thus have a reduced vowel. Conditions E1 and E3 should pattern with the canonical unreduced condition (R1).

Methods

Four Indonesian males (age 20-21), Standard Indonesian L1.

Fully randomized word list: 75 distractors + 225 tokens per speaker (5 vowels × 5 conditions × 3 words per condition × 3 repetitions).

Two reference conditions and three experimental conditions:

R1	CV]$_{word}$	(canonical unreduced)
R2	CVC]$_{word}$	(canonical reduced)
E1	CV+kan]$_{word}$	(circumfixes ber-kan, me(N)-kan, memper-kan)
E2	CVC+an]$_{word}$	(circumfixes pe-an, ke-an)
E3	CVCaN]$_{word}$	(monomorphemic)

Theory predicts a single intervocalic C should syllabify into the onset of the following syllable; if so, all three experimental conditions should syllabify as CV.CaN, and V should manifest unreduced.

Stress is penultimate unless penult vowel is /ə/, so all experimental conditions have equivalent stress.

Segmentation in Praat (BOERSMA & WEENINK 2011)

- Measurements extracted from midpoint of modally voiced portion of vowel.
- Modal voicing := low cycle-to-cycle changes, minimal aperiodic noise, glottal pulses visible in high frequencies; this ensures reliable F1 measurements.
- Word-final vowels (condition R1), measurement was done at 50ms after the onset of modal voicing (if modally voiced portion exceeded 100ms) to minimize effect of diphthongization due to word-final lengthening.
- Modal-voiced portions shorter than the 25ms analysis window, and any measurements >2 s.d. from the vowel mean were re-measured by hand.

Pairwise t-tests (Bonferroni corrected) performed using R (R DEVELOPMENT CORE TEAM 2011).

Results

Tables 1-4: Bonferroni-corrected pairwise t-tests for /i/, /u/, /e/, and /o/. (All results for /a/ were non-significant and are not reported.)

- significant difference in either F1 or F2
- significant difference in both F1 and F2

Table 1: Pairwise t-tests for /i/

	F1	F2	F1	F2	F1	F2	F1	F2
i+kan	0.0247	0.0029						
iCaN	>0.05	>0.05	>0.05	>0.05				
iC+an	0.0000	0.0000	0.0014	0.2553	0.0001	0.0012		
iC#	0.0000	0.0000	0.0001	0.0028	0.0000	0.0000	>0.05	>0.05
	i#		i+kan		iCaN		iC+an	

Table 2: Pairwise t-tests for /u/

	F1	F2	F1	F2	F1	F2	F1	F2
u+kan	0.0073	>0.05						
uCaN	0.0161	0.0064	>0.05	>0.05				
uC+an	0.0000	>0.05	>0.05	>0.05	>0.05	>0.05		
uC#	0.0000	0.0224	0.0007	>0.05	0.0000	>0.05	0.0173	>0.05
	u#		u+kan		uCaN		uC+an	

Table 3: Pairwise t-tests for /e/

	F1	F2	F1	F2	F1	F2	F1	F2
e+kan	>0.05	>0.05						
eCaN	0.0005	0.0087	>0.05	>0.05				
eC+an	0.0430	>0.05	>0.05	>0.05	>0.05	>0.05		
eC#	0.0000	0.0000	0.0287	0.0188	>0.05	>0.05	>0.05	>0.05
	e#		e+kan		eCaN		eC+an	

Table 4: Pairwise t-tests for /o/

	F1	F2	F1	F2	F1	F2	F1	F2
o+kan	0.0008	>0.05						
oCaN	0.0000	0.0002	0.0000	>0.05				
oC+an	0.0000	0.0059	0.0000	>0.05	>0.05	>0.05		
oC#	0.0000	0.0000	>0.05	0.0000	0.0000	>0.05	0.0000	0.0089
	o#		o+kan		oCaN		oC+an	

Figure 1: Formant values, means, and ±σ̂ confidence regions

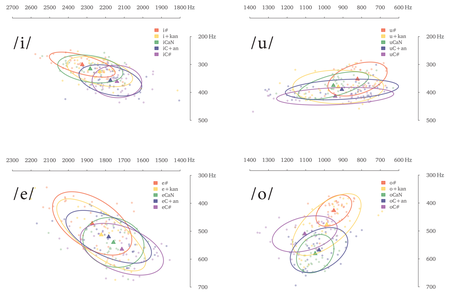


Figure 2: Illustration of "reduction score" technique

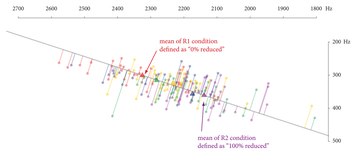
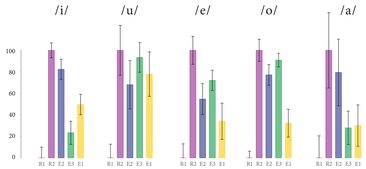


Figure 3: Reduction scores (±σ̂) grouped by vowel



/i/ iCaN patterns with i# (unreduced). i+kan falls in the middle, significantly different from the endpoints but not distinct from iCaN. iC+an patterns with iC# (reduced).

/u/ u+kan, uCaN and uC+an pattern together, partway between (and significantly different from) the endpoints u# (unreduced) and uC# (reduced).

/e/ e+kan patterns with e# (unreduced). eCaN and eC+an pattern with eC# (reduced).

/o/ all conditions distinct except oCaN and oC+an.

/a/ no significant differences found among any of the reference or experimental conditions.

Discussion

- Some results support hypothesis, others unexpected; no unified pattern across vowels.
- Trends suggest that within-category phonetic variation may index morphological information.
- Perceptual salience of differences unknown.
- Gradient vowel reduction → gradient syllabification?
- Future directions: duration; individual differences in production; perception study.

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