Kejom (Babanki)

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Kejom [kə̀d͡ʒə́m], the preferred autonym for the language more commonly known as Babanki, is a Central Ring Grassfields Bantu language (ISO 693-3: [bbk]) spoken in the Northwest Region of Cameroon (Hyman, 1980; Simons and Fennig, 2017; Hammarström et al., 2017). The language is spoken mainly in two settlements, Kejom Ketinguh [kə̀d͡ʒə́mꜜ kə́tíŋgùʔ] and Kejom Keku [kə̀d͡ʒə́mꜜ kə́kù], also known as Babanki Tungoh and Big Babanki, respectively (Figure 1), but also to some extent in diaspora communities outside of Cameroon. Simons and Fennig (2017) state that the number of speakers is increasing; however, the figure of 39,000 speakers they provide likely overestimates the number of fluent speakers in diaspora communities. The two main settlements' dialects exhibit slight phonetic, phonological, and lexical differences but are mutually intelligible. The variety of Kejom described here is the Kejom Ketinguh variant spoken by the second author.

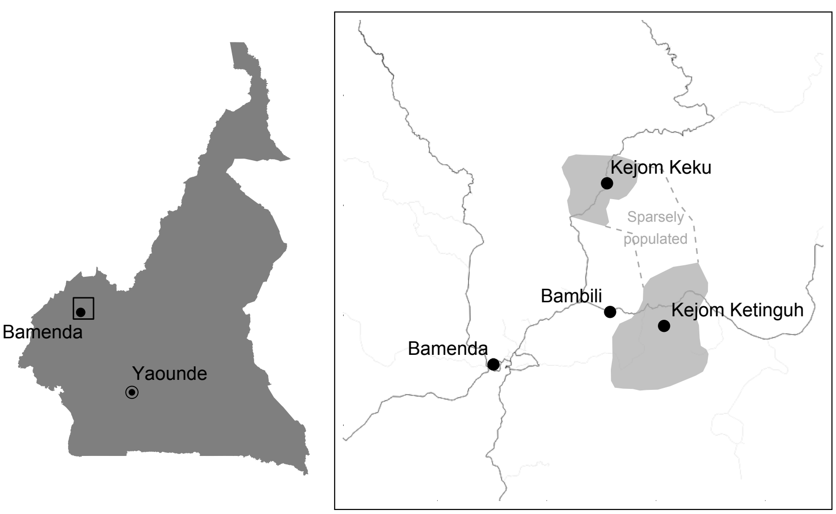


Figure 1: Kejom-speaking areas (right, shaded) within Cameroon (left). Map generated using ggmap in R (Kahle and Wickham, 2013).

Most speakers of Kejom also speak Cameroonian Pidgin English, which is increasingly used in all domains, even in the home (Akumbu and Wuchu, 2015). Some speakers in Kejom Keku are also proficient in Kom, a neighboring Central Ring language, depending on their level of engagement with Kom speakers nearby; speakers located in Francophone areas of Cameroon may also speak French. An orthography guide for Kejom has been developed (Akumbu, 2008b) and is currently used in literacy classes in the two settlements, as well as in an ongoing Bible translation effort.

Kejom has been the subject of some previous linguistic analysis. Beyond general grammatical description (Akumbu and Chibaka, 2012) and a lexicon (Akumbu, 2008a), previous works mainly concern analysis of lexical tone, grammatical tone, and other prosodic characteristics (Hyman, 1979b; Akumbu, 2011, 2015, 2017; Chie, 2002), with some coverage of the segmental phonology (Mutaka and Chie, 2006; Akumbu, 2016). However, relatively little attention has been paid to details of segmental and supersegmental phonetics, particularly the interesting allophones of the high vowels; this paper is an effort to fill this gap.

Consonants

The 25 consonant phonemes of Kejom are given in Table 1; examples of onset consonants are provided in Table 2. Fricatives, affricates, and plosives at all places of articulation are contrastively voiced, with the exception of /b/, which lacks a voiceless counterpart. Voiced obstruents are fully voiced in all positions, and voiceless obstruents generally have a voice onset time close to zero; for instance, the contrast between /t/ and /d/ is generally produced as short-lag [t] versus prevoiced [d]. The relatively numerous affricates occur at three places of articulation: labiodental, alveolar (sibilant strident), and postalveolar (non-sibilant strident). Onset /j/ and /v/ are rarer than the other consonants, occurring only in agreement morphology and a handful of common noun and verb stems (e.g. [jɛ́n] 'see', [vì] 'come').

In the syllable onset, there is relatively little allophony of consonants. The velar stops /k ɡ/ are palatalized before the front vowels /i/ and /e/, e.g. [kʲé] 'allow', [ɡʲìtə̀] 'add'. Analogously, the labiovelar approximant /w/ is realized as rounded palatal [ɥ] when it occurs before the high front vowels /i/ and /e/, as in [ɥìʔ] 'person', [ɥé] 'plant (v.)'. This process could be described as palatalization applying to a natural class of velars, excepting only /ŋ/ and /ɰ/, which do not occur before front vowels. The sequence /bʉ/ is sometimes produced as [bʙ̩]; this could well be transcribed simply as a syllabic bilabial trill[ʙ̩], given that bilabial trills are typically prestopped (Ladefoged and Maddieson, 1996). The trill is debatably an allophone of the vowel rather than the consonant, a point we discuss in more detail below in connection with the several allophones of the vowel /ʉ/.

The syllable coda is associated with more (and more salient) allophony. Six consonants /f, s, k, m, n, ŋ/ may occur in the syllable coda, as exemplified in Table 3. In this position, /k/ is realized as a glottal stop [ʔ]. Coda /n/ conditions diphthongization of all non-high vowels that precede it, namely the set /a, e, o/, resulting in syllable rhymes [aɪn, ɛɪn, ɔɪn]; other vowels followed by /n/ do not undergo diphthongization. Occasionally, the coda nasal stop is produced without closure, resulting in the free variants [aɪ̃, ɛɪ̃, ɔɪ̃]. This diphthongization pattern is shared in common with the neighboring language Kom and is attested mainly in the dialect of Kejom Ketinguh. All coda consonants except /m/ are frequently deleted intervocalically; this is discussed further below.

Velar approximant

The segment /ɰ/ is commonly transcribed as a voiced velar fricative [ɣ] in both Kejom (Hyman, 1979b; Akumbu and Chibaka, 2012) and other languages in the area (Hyman, 1979a; Schaub, 1985). A frictionless approximant version of the phone is sometimes reported instead (Hyman, 1981). The typical production of /ɰ/ in the second author's speech in Kejom shows little to no frication, motivating our description of it here as a frictionless approximant. Two representa-

	Labial	Labiodental	Alveolar	Postalveolar	Palatal	Velar
Plosive	b		t d			k ɡ
Affricate		p͡f b͡v	t͡s d͡z	t͡ʃ d͡ʒ		
Nasal	m		n		ɲ	ŋ
Fricative		f v	s z	ʃ ʒ		
Approximant	w				j	ɰ
Lateral approximant			l			

Table 1: The consonant phonemes of Kejom.

Context	-aŋ		-iʔ(i)	
/b/	bàŋ	‘be red’		
/f/	fáŋ	‘stay behind’		
/v/			víʔí	‘people’
/p͡f/			p͡fĭʔ	‘chew’
/b͡v/			b͡vìʔ	‘have chills’
/m/	ə̀màŋ	‘civet cat’		
/w/	wáŋ	‘throw over’	ɰ̟ìʔ /wìk/	‘person’
/t/	táŋ	‘count’		
/d/	dàŋ	‘extend’	dìʔ	‘be’
/t͡s/	t͡sàŋ	‘spread s.t. out’		
/d͡z/	d͡zàŋ	‘call’		
/s/	sàŋ	‘sun-dry’		
/z/	kə̀záŋ	‘raffia leaf’	zíʔí	‘teach’
/n/	náŋsə́	‘load (a gun)’		
/l/	làŋ	‘bar entry’		
/t͡ʃ/			t͡ʃíʔ	‘cover’
/d͡ʒ/	kə̀d͡ʒàŋ	‘in vain’	d͡ʒìʔ	‘show’
/ʃ/			ʃíʔí	‘descend’
/ʒ/			ə̀ʒíʔ	‘name’
/ɲ/	ɲàŋlə̀	‘tickle’		
/k/	káŋ	‘fry’	kíʔí	‘have, hold’
/ɡ/			ə̀ɡíʔ	‘chin’
/ŋ/	ŋàŋ	‘strength’		
/ɰ/	ə̀ɰáŋ	‘root’		

Table 2: Exemplification of consonants in stem onset position. Note that nouns are often preceded by noun class morphology (ə̀-, kə̀-, et cetera).

/m/	kám	'squeeze'
/n/	kàjn	'monkey'
/ŋ/	káŋ	'fry'
/f/	kàf	'carry excess'
/s/	kàs	'till (v.)'
/k/ → [ʔ]	kàʔ	'four'

Table 3: Exemplification of consonants in stem coda position.

tive examples of stem-initial, intervocalic [ɰ] are given in Figure 2[1]; no aperiodic energy in the low-frequency region can be seen, as would be expected for a velar fricative, although a general reduction in intensity and a weakening of formant structure can be seen, indicating the presence of an approximant constriction.

Prenasalized onsets

All oral onset consonants except /v/ may occur with prenasalization. The absence of /ⁿv/ onsets is most likely an accidental gap due to the low frequency of onset /v/ in general. Postnasal neutralization of obstruent voicing to [+voi] does not occur at either the phonological or phonetic levels, as is common in other Bantu languages (Hyman, 2003, 50), see, for instance, /ⁿpfʉ̀/ 'rope' versus /ⁿbvʉ́/ 'chicken'; /kə̀ⁿsäs/ '(act of) scattering' versus /kə̀ⁿzäs/ 'key'. We are agnostic as to whether prenasalized consonants as presented here are best phonologically represented as single complex segments or sequences of a placeless nasal /N/ and the simple consonants presented above. Both analytical routes equally well represent the phonetic events observed in the language, and there is a dearth of evidence that definitively supports one analysis over the other. Nonetheless, we opt to transcribe prenasalization with the secondary articulation diacritic as a necessary abstraction: prenasalization has several realizations that are dependent on the manner of articulation of the modified segment (continuant or non-continuant) and its position within the stem (stem-initial or preceded by a vowel), and which cannot be reduced to such a relatively invariant target as a placeless nasal stop.

If the prenasalized segment is a non-continuant (a stop or an affricate), prenasalization is generally realized as a homorganic nasal stop preceding the oral segment's closure, as seen in [kə̀ɲtʃíʔ] 'lid' or [áꜜŋgám] 'next week' (Figure 3, left). On the other hand, if the prenasalized segment is a continuant (an approximant, lateral approximant, or fricative), prenasalization is typically realized without a full closure in the oral cavity. Representative examples of /ⁿʃ/ and /ⁿɰ/ are given in Figure 3 (right). Vowels preceding prenasalized fricatives tend to be nasalized, with the nasalization of the consonant shifting completely onto the vowel, as in [fə̃̀ʃìʔ] 'grass beetle' (Figure 3, upper right). If the prenasalized segment is not a fricative, the entire segment *and* the preceding vowel are typically nasalized, as in [kə̃̀ɰ̃ɔ̃̀m] '(act of) beating' (Figure 3, lower right). No abrupt reduction of formant intensity or rapid shift in formant frequencies, either of which might suggest an oral closure with continuing nasal airflow and resonance, is visible in the spectrograms for either /ⁿʃ/ or /ⁿɰ/. This can be contrasted with the clear division beween a vowel [ɘ] or [a] and the following nasal stop in the other two examples. We speculate that the lack of a closure

[1]This and all subsequent spectrographic displays were produced using Praat (Boersma and Weenink, 2001).

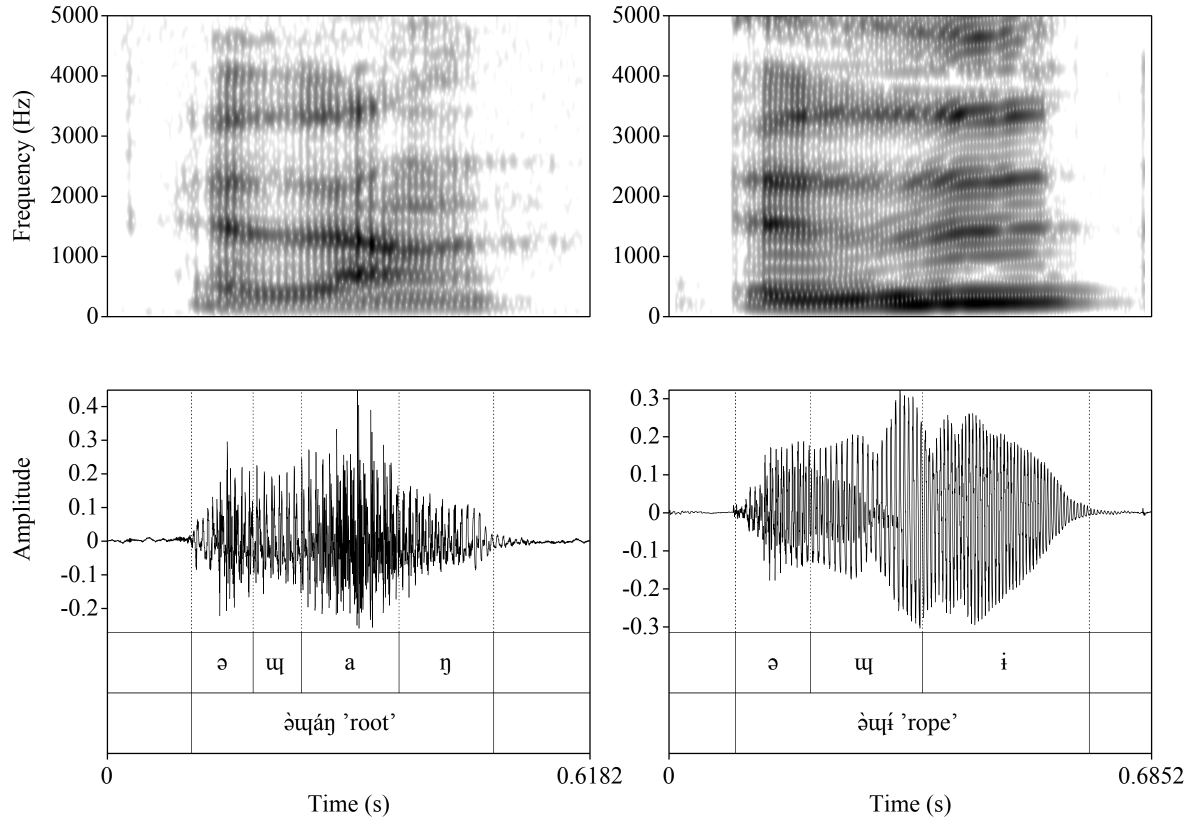


Figure 2: Two tokens of the velar approximant /ɰ/ in two different vowel contexts.

in the oral cavity for prenasalized continuant segments could be a learned aspect of articulatory timing in Kejom that has the effect of avoiding excrescent oral stops in nasal-continuant sequences (Browman and Goldstein, 1990; Ohala, 1993). Such a scenario would be particularly damaging to the fricative-affricate contrasts of Kejom, which have a relatively high functional load and could easily be lost if gestural timing promoted excrescent oral stops in this context.

The examples of prenasalized consonants used above all have at least a vowel preceding the prenasalized consonant in the stem. When prenasalized consonants occur at the left edge of a stem, with no other prefixal material present, the nasal portion of the segment gives the percept of having syllabic prominence and being produced with low tone, similar to most prefixal material in Kejom. Previous transcriptional schemes based on auditory impression, used by the second author and others (Hyman, 1980; Akumbu, 2008a), generally reflect this intuition, marking the nasal portion of prenasalized segments in this position as bearing a low tone, akin to most other prefixal material in Kejom. Prenasalized non-continuants in particular show this tendency, e.g. /^{n}dɔ̏ŋ/ 'potato' typically being transcribed as [ǹdɔ̏ŋ].

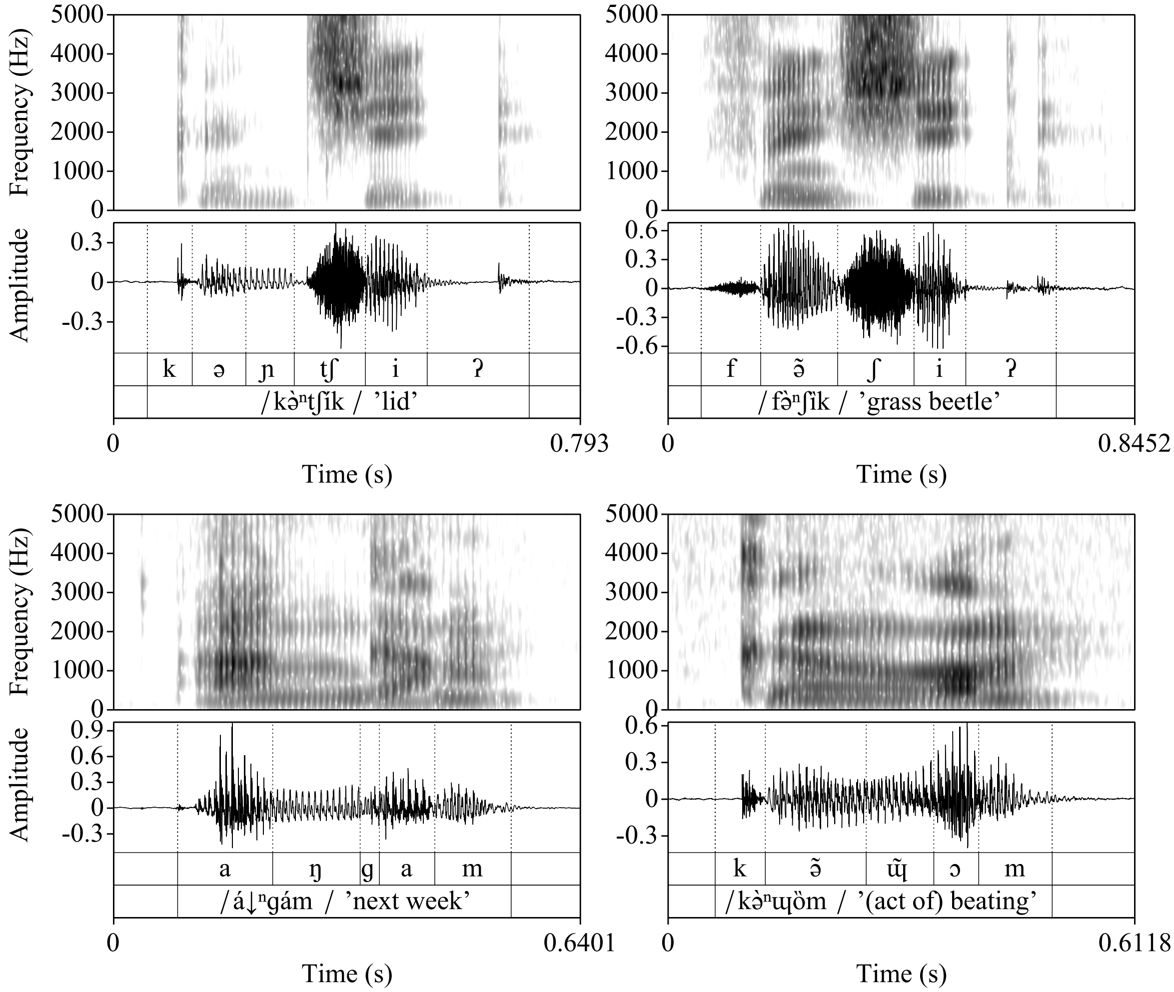


Figure 3: A homorganic nasal stop can be observed during prenasalized stops (left column) but not during prenasalized continuants (right column). Prenasalized approximants are typically themselves nasalized (bottom right).

Labialized and palatalized onsets

Syllable onsets in Kejom may also be accompanied by palatalization or labialization, as shown in Table 4. Complex onsets that have both prenasalization and either palatalization or labialization (i.e. $^{n}C^{j}$, $^{n}C^{w}$) are attested fairly frequently and are referenced throughout this section; this results in strikingly complex onset consonants (or lengthy clusters, depending on one's analysis). As with prenasalization above, there is some ambiguity as to whether labialized and palatalized consonants are single complex segments with secondary articulations or sequences of the plain segments and approximants /j, w/. Also as before, there is little evidence at present that supports one analysis to the exclusion of the other. In this sketch, we opt to treat palatalization and labialization as attributes of complex segments, primarily because it allows for a simpler description of velar palatalization. This analytical decision greatly increases the number of distinct consonants, since the secondary articulations are relatively freely combined with onsets.

	Labial	Labiodental	Alveolar	Postalveolar	Velar
Plosive	bʲ bʷ		tʲ dʲ (∼ tʃ dʒ)		(kʲ ɡʲ) kʷ ɡʷ
Affricate		p͡fʲ p͡fʷ		tʃʷ dʒʷ	
Nasal	mʲ mʷ				ŋʷ
Fricative		fʲ fʷ vʷ		ʃʷ	
Approximant					(wʲ)
Lateral approximant			lʲ lʷ		

Table 4: Palatalized and labialized consonant phonemes of Kejom. Palatalization of parenthesized velars is allophonic.

Palatalization can primarily be observed on bilabial and labiodental segments, and it is particularly frequent before the front and central non-low vowels /i, e, ɨ, ʉ, ɘ/. Minimal or near-minimal pairs hinging on the contrast between palatalized and non-palatalized versions of the same segment are relatively easy to find for the bilabials and labiodentals, e.g. [ɘ̀bí] 'kola nut' versus [bʲí] 'goat'; [fɨ́f] 'white' versus [fʲɨ̀f] 'blind', et cetera. The palatalized labiodental /p͡fʲ/, however, is attested only with prenasalization and only in one word, [kɘ̀^{n}p͡fʲɨ̀ŋ] 'owl'. Palatalized alveolar plosives [tʲ] and [dʲ] do occur, but are in free variation (or perhaps near-merger) with postalveolar affricates /tʃ/ and /dʒ/, respectively, as in [dʲa̋ŋ] 'cross (v.)', which freely varies with [dʒa̋ŋ]. As discussed above, palatalized velar plosives [kʲ, ɡʲ] occur, but are conditioned by a following front vowel /i/ or /e/ and occur nowhere else; no minimal pair contrast between palatalized and non-palatalized velars occurs in any Kejom lexeme. The [ɥ] allophone of /w/ before /i/ and /e/ could be thought of as a non-contrastively palatalized /w/, in a sense [wʲ].

Unlike palatalization, labialization is never an allophonic feature of the consonant, and co-occurs with a somewhat broader range of consonants compared to palatalization. Except for the alveolar plosives /t, d/, all consonants that can be palatalized can be labialized, and several that cannot be palatalized (the postalveolars /tʃ, dʒ, ʃ/) or contrastively palatalized (the velars /k, ɡ, ŋ/) may be contrastively labialized. Labialization is typically produced with a labiovelar constriction, as in [ɘ́ʃʷàɪn] 'INF-shuck corn', [ɘ́ŋʷɘ̀ ʔ] 'INF-be bright, clean'. Akin to the allophony described for /w/ above, labialized consonants are realized with a rounded palatal secondary articulation when followed by the high front vowel /i/, e.g. [kᶣì] 'up', [kᶣé] 'meet up with', [ʒᶣìsɘ̀] 'breathe', [lᶣı̏] 'bitter'. Bilabial and labiodental consonants with this secondary articulation, however, are still produced with a labiovelar secondary articulation, e.g. [bʷí] 'give birth', [fʷí] 'get burnt'.

Vowels

Kejom has at least eight vowel phonemes contrasting in height, backness, and rounding (Figure 4). Lengthened vowels frequently occur in running speech owing to a process of vowel coalescence, but length is only marginally phonemic (see the following section). The low-mid vowels are also only marginally contrastive but frequently observed due to vowel coalescence. Kejom has several typologically unusual vowel contrasts, including a set of high vowels containing both a central rounded vowel /ʉ/ and a central unrounded vowel /ɨ/; there is also a contrast between mid and high central unrounded vowels /ɨ/ and /ɘ/. Of additional interest are the various allophones of

	Example	Gloss
/i/	ə̀bí	‘kola nut’
/ɨ/	gɨ́ꜜsə́	‘voices’
/ʉ/	gʉ́ꜜsə́	‘skins’
/u/	bú	‘more, extra’
/e/	àbé	‘liver’
/ə/	gə́ꜜsə́	‘bundles’
/o/	bó	‘weave’
/a/	bá	‘dad’
[ɛː]	^{n}bɛ̀ː	‘address term for fon’
[ɔː]	^{n}bɔ̀ː	‘hey’

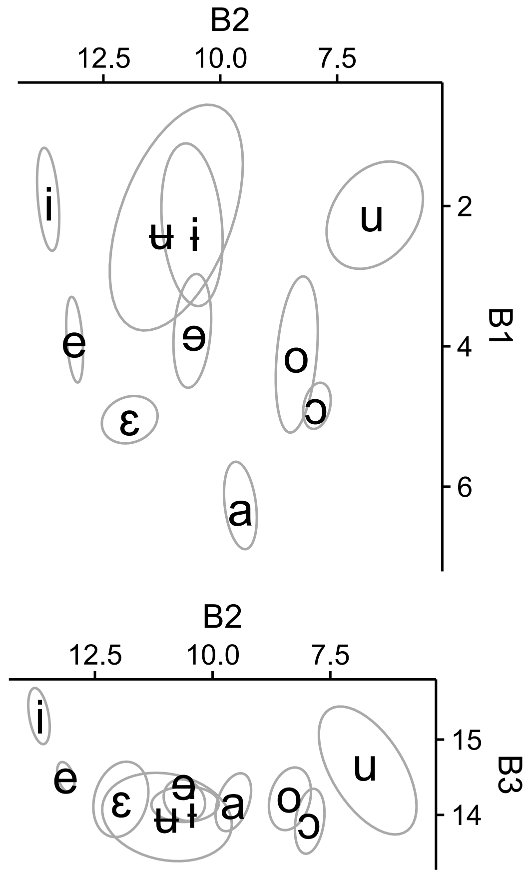


Figure 4: (Left) Contrastive vowel phonemes of Kejom, with marginally contrastive [ɛ] and [ɔ]. (Right) Mean formant frequencies for Kejom vowels in Bark with 95% confidence ellipses drawn about category centers, F1 with F2 (top) and F2 with F3 (bottom). Stimuli are the relevant words in the table at left.

/i/ and /ʉ/, which exhibit carryover coarticulation of the supralaryngeal constrictions of certain immediately preceding onset consonants.

The mid vowels /e/ and /o/ exhibit higher or lower allophones depending on syllable shape and palatalization or labialization of the onset. In open syllables, mid-high allophones are consistently observed (i.e. [e] and [o]), as in [àbé] ‘liver’, [ə̀kó] ‘money’. Both mid vowels are realized as lower (i.e. [ɛ] and [ɔ]) in closed syllables, as in [bɛ̀ʔ] ‘snatch’, [kɔ́ʔ] ‘chop’. The lower mid allophones [ɛ] and [ɔ] also both occur in some open syllables: [ɛ] and [ɔ] appear due to vowel coalescence, and may be marginally contrastive with [e] and [o] in a handful of words where this process cannot be said to operate (see next section).

The acoustic vowel space of one male speaker of Kejom (the second author) is shown at right in Figure 4: the vowel tokens used to populate this space are drawn from 17 to 20 tokens of the words shown in at left in Figure 4. The low-mid vowel qualities [ɛ] and [ɔ] are included here because they are frequently observed, if not phonemic. The supralaryngeally constricted allophones of /i/ and /ʉ/ are not included in Figure 4 since acoustic overlap in the front-high region would render the figure less easily interpretable; see Figure 8. Of note is that the two high central vowels [ɨ] and [ʉ] overlap in F1 and F2; there is also no additional separation in F3 that would allow for easy discrimination between [ɨ] and [ʉ]. The acoustic data from the single speaker examined here do not clarify whether speakers produce a robust contrast between [ɨ] and [ʉ], and future research will likely be needed to determine whether this contrast is actually robust.

Vowel coalescence

	C is /f, s, k, n/		C is /ŋ/
ɨCɘ → ɨː	ɥìʔ ɘ́ ꜜbʲɨ́ː ‘bad person’ wìk ɘ́ bʲɨ́f ɘ́ person(C1) SM bad PROG	ɨCɘ → ɨː	ɘ̀kɨ̄ː ɰɔ́mɘ́ ‘my pipe’ ɘ̀-kɨ́ŋ ɘ́ ɰómɘ́ C3-pipe AM 1SG.POSS
ɘCɘ → ɘː	ɥìʔ ɘ́ dʲɘ̆ː ‘tall person’ wìk ɘ́ dʲɘ̀f ɘ́ person(C1) SM long PROG	ɘCɘ → ɘː	fɘ̆ː ɥìʔ ‘confusing someone’ fɘ̀ŋ-ɘ́ wìk mix-PROG person(C1)
eCɘ → ɛː	kɘ̀bɛ̄ː kɔ́m ‘my dance’ kɘ̀-bén ɘ́ kóm C7-dance AM 1SG.POSS	ɘCɘ → eː	kɘ̀bēː kɔ́m ‘my compound’ kɘ̀-bɘ́ŋ ɘ́ kóm C7-compound AM 1SG.POSS
oCɘ → ɔː	kɘ̀zɔ̀ː kɔ́m ‘my speargrass’ kɘ̀-zòn ɘ́ kóm C7-speargrass AM 1SG.POSS	oCɘ → uː	ɘ̀sūː ɰɔ́mɘ́ ‘my tooth’ ɘ̀-sóŋ ɘ́ ɰómɘ́ C7-tooth AM 1SG.POSS
aCɘ → aː	kɘ̀bāː kɔ́m ‘my fufu’ kɘ̀-bán ɘ́ kóm C7-fufu AM 1SG.POSS	aCɘ → oː	ɘ̀sōː ɰɔ́mɘ́ ‘my corn’ ɘ̀-sáŋ ɘ́ ɰómɘ́ C7-corn AM 1SG.POSS

Figure 5: Some attested mappings between stem VC and coalesced vowels resulting from the addition of a following /ɘ/.

Phonetic long vowels are quite common in Kejom, but these can generally be analyzed as a reduction of /VCV/ sequences. All coda consonants except /m/ may be deleted when followed by a /ɘ/ whether or not this additional vowel is in the same morpheme or word as the coda. The resulting /VV/ sequence coalesces to a single phonetically long vowel [Vː], which often does not match the quality of either the first or second vowel. Examples of this process are given in Figure 5. /VCV/ sequences that lead to coalescence generally arise when a morpheme of the form /ɘ/ (of which there are several in Kejom) follows a stem ending in a /VC/ sequence, either through suffixation (as in the imperative or progressive) or placement of a separate morpheme (as in the associative marker). In addition, any sequence of a vowel immediately followed by /ɘ/ with no intervening consonant coalesces to a lengthened version of the first vowel, e.g. /tó/ + -/ɘ́/ > [tóː] ‘be strong-PROG’. When the deleted stem-final consonant is /ŋ/, coalescence results in a different, generally higher set of long vowels compared to deletion of /f, s, k, n/.

The sketch of the coalescence process given here skims over a number of complications treated in more depth in Akumbu (2016), in particular morphophonological factors. Deletion and coalescence do affect /ŋ/ and /n/ and their flanking vowels in a wide variety of morphological contexts, but affect the set /f, s, k/ only when they occur in certain high-frequency lexemes, e.g. [jɛ̀s] '1PL.EXCL', [b^{j}ɨ́f] 'bad', [d^{j}ə̀f] 'long', [ɰɔ́ʔ] 'big' (Akumbu, 2016). Furthermore, a given combination of stem vowel and coda does not neatly correspond to a single coalesced vowel: for instance, a stem-final sequence of [ɘŋ] may coalesce to [ɘː] or [eː], depending on the word that plays host to it, as shown in the right of Figure 5.

Most long vowels are obviously derived, but there are a handful of exceptional [ɛː] and [ɔː]. The two low-mid vowel qualities [ɛ] and [ɔ], outside of closed syllables, where they occur as allophones of /e/ and /o/, only occur as lengthened [ɛː] and [ɔː] and can primarily be attributed to coalescence of /eCɘ/ and /oCɘ/ sequences, respectively. However, [ɛː] and [ɔː] also appear in a handful of lexemes that do not obviously include a derived environment—e.g. [ə̀kɔ̀ː] 'which', [^{n}bɔː] 'hey (attention-getting)', [^{n}bɛː] 'term of address for fon'—so we regard these vowel qualities as marginally contrastive.

Vowels with postalveolar and labial constrictions

The phonetic realization of the phonemes /i/ and /ʉ/ is highly dependent on the preceding consonant, particularly for /ʉ/. This allophony can be broadly described as a process of assimilation to the syllable initial's place of articulation. This is most obviously the case for two allophones of /ʉ/, which exhibit labial constrictions other than the outrounding observed elsewhere in Kejom. After labiodental fricatives and affricates, /ʉ/ is produced with a labiodental constriction continuous with that of the onset that persists through the vowel, which is denoted here as [ʉ^{v}]. Slight labiodental frication is produced through most of the duration of the vowel as a consequence of the labiodental constriction (Figure 6, left). A central vowel with significant lip compression, denoted as [ʉ^{β}] here, is an allophone of /ʉ/ after non-labialized, non-palatalized /b/; bilabial trilling frequently occurs after the release of the [b] and may persist for the duration of the vowel (Figure 6, right).

Both /i/ and /ʉ/ acquire a postalveolar, [ʒ]-like constriction following postalveolar fricatives and affricates. The vowel /i/ has a postalveolar-constricted allophone transcribed here as [i̻] that occurs after postalveolars;[2] the vowel /ʉ/ has a similarly constricted allophone [ʉ̻] occurring in the same environment. Both allophones are transcribed using the laminal diacritic to indicate the change in active articulator. Phonetic [i] occurs as an allophone of /i/ following bilabial, labiodental, alveolar, and velar consonants; phonetic [ʉ], the only vowel quality associated with /ʉ/ that cannot be attributed to assimilation to a preceding consonant, occurs only after velar consonants and /ɲ/.

There is strong frication present during some productions of the postalveolar allophones, particularly when they are preceded by a voiced postalveolar /dʒ/ or /ʒ/ (Figure 7). In this context it can be difficult to segment the onset from the vowel, given the continuous voiced frication over the entire onset-vowel sequence. This issue is encountered in Figure 7 (left), where the speaker is essentially producing a syllabic fricative for the sequence /ʒi/ in [ə̀ʒ̩̈] 'INF-be slow'. An analogous rounded segment, not shown in this figure, is also attested for the sequence /ʒʉ/, e.g. [ə̀ʒ̩̈^{w}] 'INF-be

[2]Note that this does not extend to labialized postalveolars, as in [ʒ^{ɥ}ìsə̀] 'breathe'.

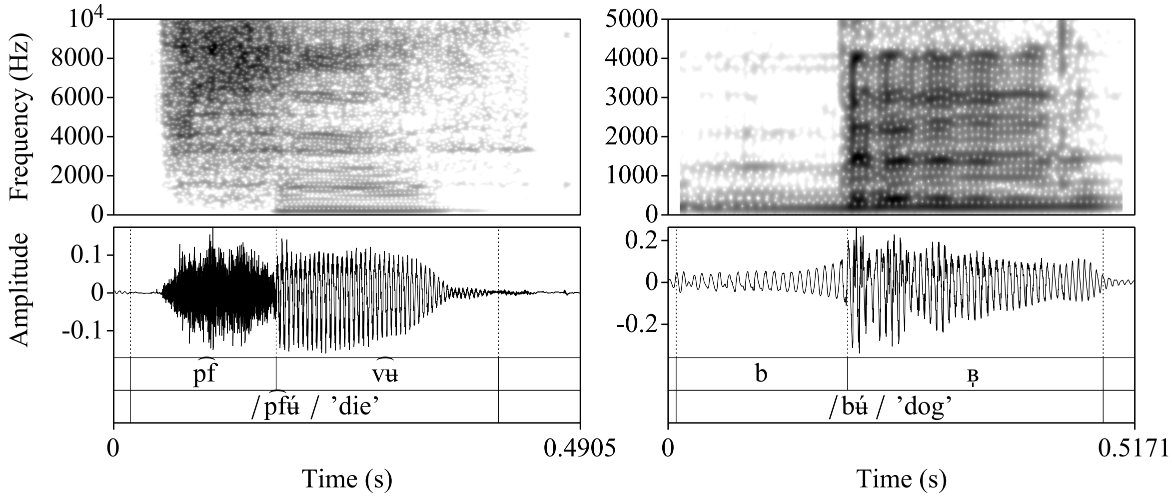


Figure 6: Left: labiodental frication in [p͡fʉ́^{v}] 'die', visible in spectrogram above 7 kHz. Right: Bilabial trilling in a token of /bʉ́/ 'dog' realized as [bʙ̩́], visible as vertical striations in the spectrogram.

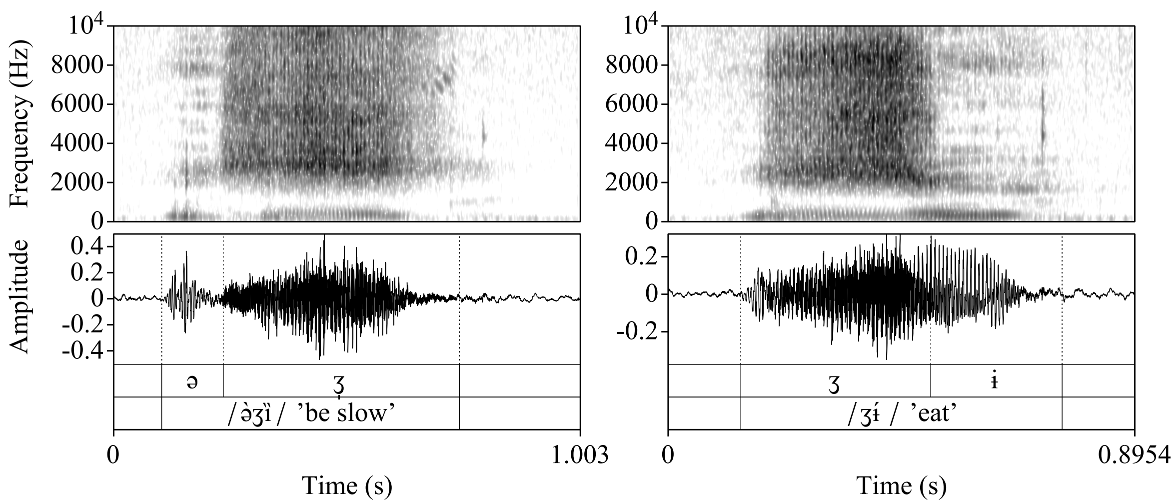


Figure 7: Left: postalveolar frication across entire second syllable of [ə̀ʒ̩̏] 'INF-be slow'. Right: for comparison, a fricative-vowel sequence in [ʒɨ́] 'eat'.

	Allophone		Example
/i/	postalv.	[i̻]	[kə̀^{n}dʒí̻] ‘fool’
/ʉ/	postalv.	[ʉ̻]	[tʃʉ̻́] ‘spit’
/ʉ/	labiodent.	[ʉ^{v}]	[p͡fʉ́^{v}] ‘die’
/ʉ/	bilabial	[ʉ$^{\beta}$]	[bʉ́$^{\beta}$] ∼ [ʙ̩́] ‘dog’

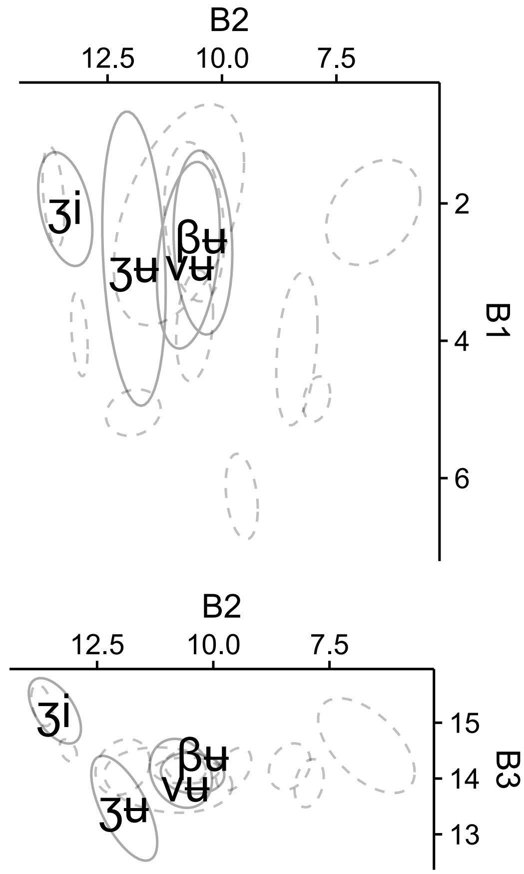


Figure 8: (Left) Supralaryngeally constricted allophones of /i/ and /ʉ/, by the preceding consonant’s place of articulation. (Right) Mean formant frequencies for these vowels in Bark with 95% confidence ellipses drawn about category centers, F1 with F2 (top) and F2 with F3 (bottom). Stimuli are the relevant words in the table at left; the labels ʒi, ʒʉ, βʉ, and vʉ stand for [i̻], [ʉ̻], [ʉ$^{\beta}$], and [ʉ^{v}], respectively.

cold’. Nonetheless, the postalveolar allophones of /i/ and /ʉ/ cannot simply be described as syllabic fricatives, given that the intensity of frication varies substantially depending on aerodynamic conditions.

F1-F2-F3 values for the supralaryngeally constricted allophones of /i/ and /ʉ/ are given in Figure 8. Postalveolar [ʉ̻] has a lower F3 than the other vowels, but otherwise there is little separation in F1-F2-F3 space to allow for easy discrimination between [i] and its allophone [i̻] on the one hand and [ɨ], [ʉ], and the latter’s allophone [ʉ^{v}] on the other hand. However, given that the [i]–[i̻] and [ʉ]–[ʉ̻] contrasts are predictable from the preceding consonant, it is not unexpected that acoustic differences among allophones would be slight, since the functional load that this acoustic difference would assume is low to nonexistent.

Articulation of vowels with postalveolar and labial constrictions

In this section, we use ultrasound and video records to characterize the vowels with postalveolar and labial constrictions in greater detail, and in particular to demonstrate the existence of the extra supralaryngeal constrictions described above. This data confirms the initial impression that /i/ and /ʉ/ assimilate in place of articulation to preceding postalveolar consonants. We provide evidence that the fricativized allophones of /i/ and /ʉ/ exhibit lingual or labial constrictions not normally expected in vowel sounds, which canonically have unobstructed central channels and laminal airflow.

Method

All articulatory data in this section was collected in the UC Berkeley PhonLab in April and May of 2016. All records are of the second author. Video of the speaker's face was collected using a Canon XF100 HD camcorder. The lingual ultrasound records shown in this section are still frames from videos taken from the approximate acoustic midpoint of the segments examined. Ultrasound video was recorded at a frame rate of 107 Hz using an Ultrasonix SonixTablet and a C9-5/10 microconvex transducer. The transducer was held in place under the chin and approximately perpendicular to the speaker's occlusal plane by an Articulate Instruments stabilization headset (Scobbie et al., 2008). A palate trace in the same frame of reference as the recordings, which is superimposed on the ultrasound frames shown below as a landmark, was collected by asking the subject to drink water while scanning the swallowing action with the ultrasound.

Labial vowels

Using video stills, substantial differences in labial activity can be confirmed between out-rounded [u], labiodental [ʉ^{v}], and compressed or in-rounded [ʉ] and [ʉ^{β}]. Constriction of the lower lip against the teeth is evident in the video frame for [ʉ^{v}] provided in Figure 9 (left), and muscular effort to retract the upper lip is also visible. At the other extreme, out-rounding is clearly visible in [u], to the exclusion of the other vowels with labial activity (Figure 9, right). Productions of [ʉ^{β}] and [ʉ] both exhibit labial compression rather than out-rounding, but they differ substantially in the degree of compression exhibited. Somewhat counterintuitively, compression appears to be looser for [ʉ^{β}] than for [ʉ], as visible in Figure 9 (center). However, the lip opening for [ʉ^{β}] is smaller; combined with the loose approximation of the lips, this likely encourages the bilabial trilling that is sometimes observed.

Some differences in lingual activity are also evident in the ultrasound data for [u], [ʉ^{v}], [ʉ] and [ʉ^{β}]. The tongue position of both the [ʉ^{v}] and [ʉ^{β}] allophones, in spite of the transcriptions used here, is actually substantially lower than for [ʉ]: as Figure 10 illustrates, the tongue body is as low as a typical Kejom [a] during production of both the [ʉ^{β}] and [ʉ^{v}] allophones of /ʉ/. However, for both [ʉ^{β}] and [ʉ^{v}], the tongue blade is slightly raised relative to its position in [a]. This is unexpected given recent evidence of a secondary tongue blade lowering gesture in labiodental fricative consonants (Shadle et al., 2017). It is possible that this tongue blade adjustment serves some aerodynamic or acoustic function, but further research on more speakers is needed to determine the

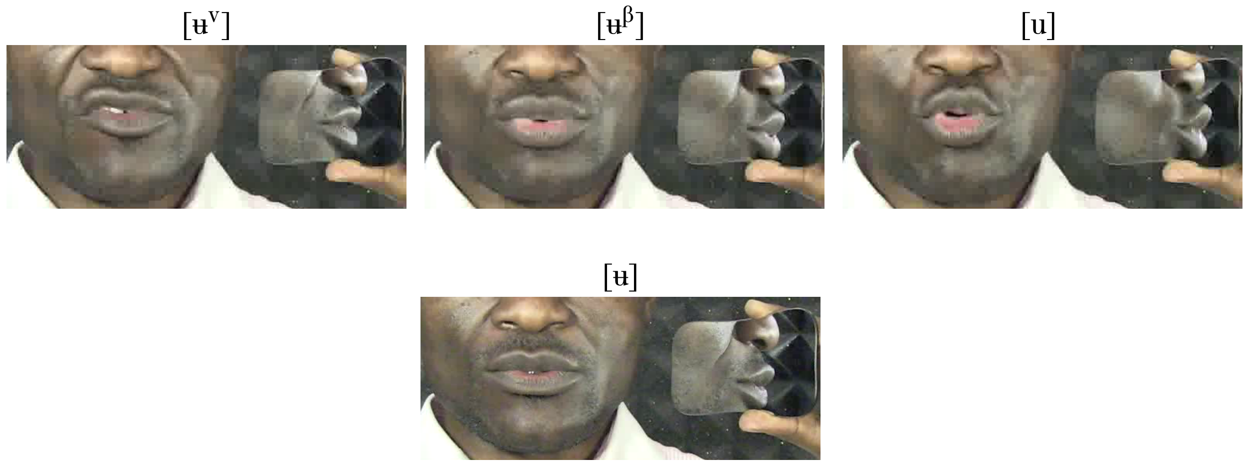


Figure 9: Lip activity during production of [ʉ^{v}], [ʉ$^{\beta}$], [ʉ], and [u]. Frames were sampled from the acoustic midpoints of the vowels in [^{n}bʉ́^{v}] ‘chicken’, [bʉ́$^{\beta}$] ‘dog’, [ɡʉ̀] ‘skin’, and [bú] ‘more, extra’, respectively. The mirror to the right of the speaker is held at a 45-degree angle to the coronal plane and gives a view of the lips in profile.

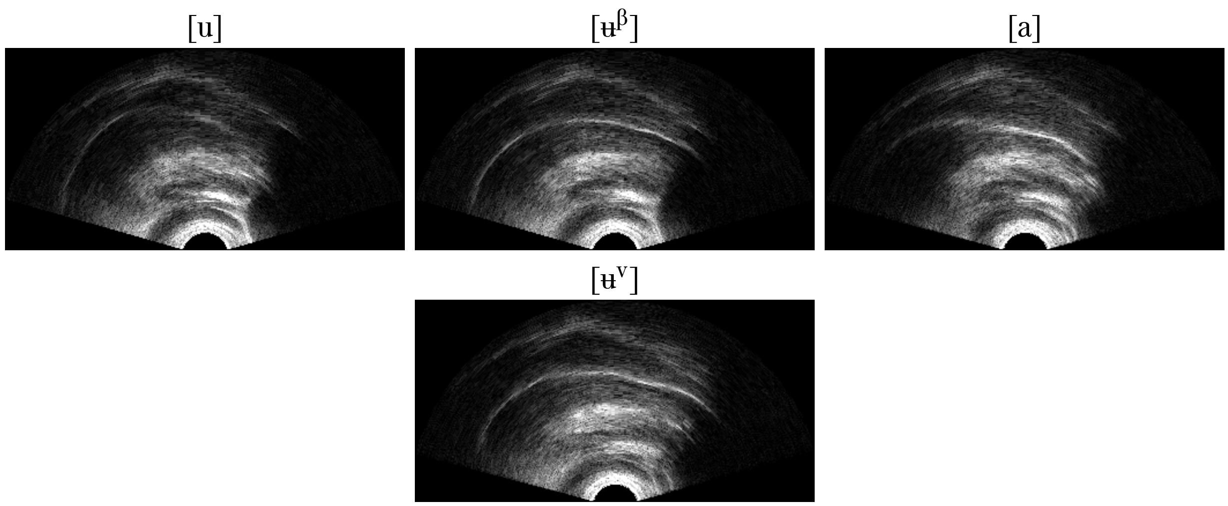


Figure 10: Lingual positions, with superimposed palate trace, exhibited during production of (from left to right) [u], [ʉ$^{\beta}$], [ʉ^{v}] and [a]. Ultrasound frames from the approximate acoustic midpoints of the vowels in [bú] ‘more, extra’, [bʉ́$^{\beta}$] ‘dog’, [^{n}bʉ́^{v}] ‘chicken’, and [ə̀báʔ] ‘verandas’, respectively. Right is anterior.

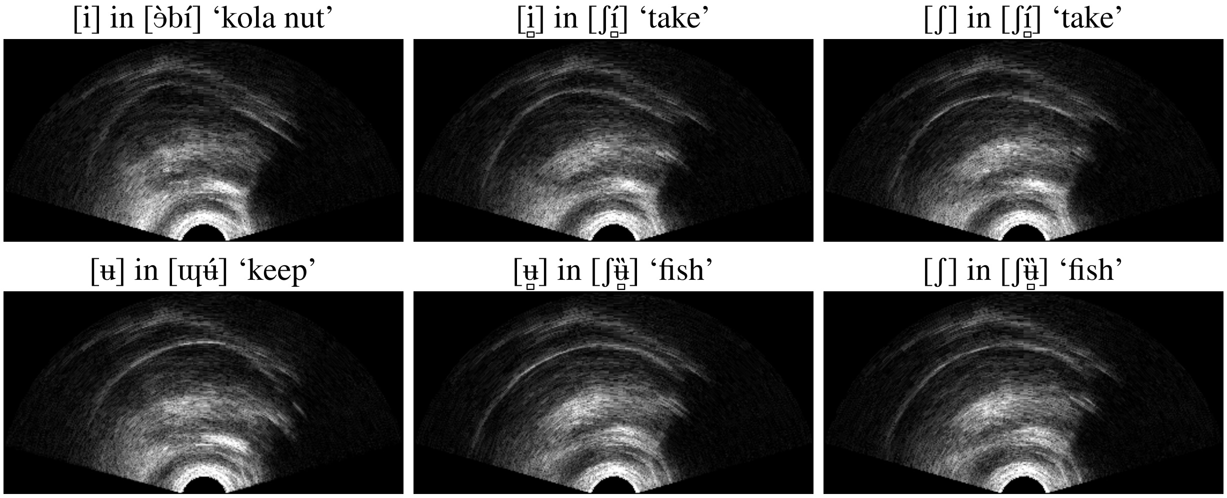


Figure 11: Lingual positions, with superimposed palate trace, exhibited during production of the indicated segments. Ultrasound frames selected from the acoustic midpoint of the target vowel or fricative. Right is anterior.

specifics.

Postalveolar vowels

Since labial activity does not determine the major characteristics of [i̻] and [ʉ̻], we turn to lingual ultrasound data for articulatory details. Figure 11 shows that [i] and [ʉ] have a slightly higher tongue dorsum compared to their respective allophones [i̻] and [ʉ̻] after postalveolars. However, [ʉ] also exhibits a constriction closer and more anterior than that for [i], looking rather like a bunched rhotic approximant. Tongue blade elevation is not typically a feature of front rounded vowels, but is sometimes encountered as an idiosyncratic feature of individual speakers’ implementation of the contrast between front unrounded and front rounded vowels (Wood, 1986). We reserve further comment, given that data from one speaker could reflect idiosyncrasy rather than a community norm.

Regardless of differences between [i] and [ʉ], in the postalveolar allophones, the tongue tip and blade are more angled toward the post-alveolar region, which is obscured by the ultrasound shadow of the mandible. This suggests that the tip or blade is making a close constriction slightly out of view. That these segments’ constriction is in the postalveolar region, resembling the constriction of the fricatives and affricates that precede them, is reinforced by comparing the vowels to the fricatives immediately preceding them (Figure 11, right). It can thus be said that /i/ and /ʉ/ both exhibit a [ʒ]-like tongue posture when they follow postalveolar fricatives; acoustic consequences described above are likely subsequent to this change in constriction location relative to the [i] and [ʉ] allophones. This similarity to the preceding fricative segment is reminiscent of the so-called APICAL VOWELS found in Standard Chinese, which also adapt the lingual posture of their fricative or affricate onset and maintain it through production of the entire syllable (Lee-Kim, 2014).

H	sé	‘profit’
ꜜH	ə́ꜜsé	‘INF-profit’
L (level)	d͡zè	‘soap fruit’
L (falling)	ə̀sȅ	‘grave’
HM	múˉ	‘water’
HL	bʲə̂	‘avocado’
LH	ⁿgǔ	‘rake’

Table 5: Tone melodies on monosyllabic stems. Note that downstepped high (ꜜH) is phonetically indistinguishable from the derived mid (M) tone described in more detail below.

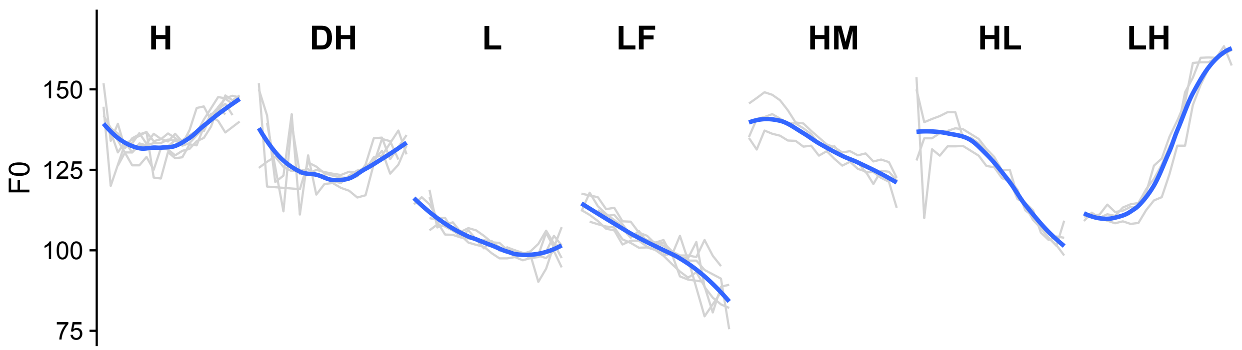
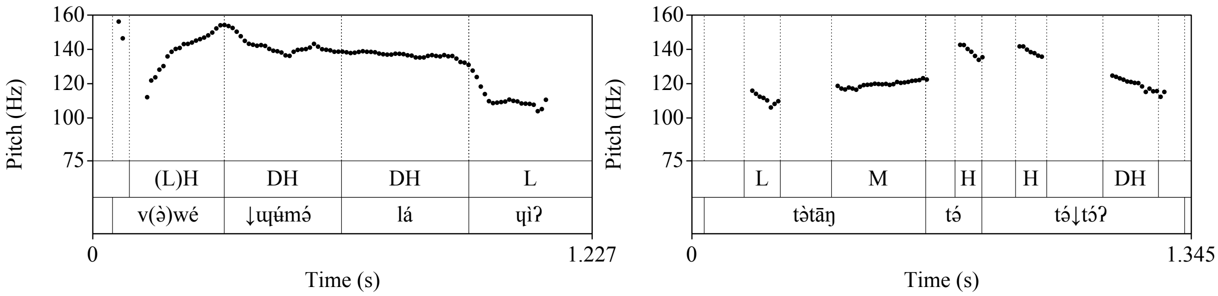


Figure 12: f0 tracks for the stem vowels of the words in Table 5 (loess regression, 3–6 tokens per word). f0 estimates taken at 20 sampling points evenly distributed over the vowel’s duration using an inverse filter control method (Ueda et al., 2007). Clear octave errors were manually removed. DH is downstepped high tone (ꜜH); LF is low-falling tone.

Prosody

The most salient prosodic feature of Kejom is its extensive use of tone for lexical and grammatical purposes. At the phonological level, Kejom’s tonal system has been described as a simple opposition between /H/ and /L/ tonemes in various combinations and associations with stem segments (Hyman, 1979b). However, a relatively large number of surface tonal sequences are attested; lexical tone of stems is highly ‘mobile’ and spreads progressively to inflectional material; and tone is used for verb inflection, e.g. the imperative and hortative moods, both a suffixed high tone with no associated segmental material (Akumbu and Chibaka, 2012, 167–170). A full discussion of Kejom’s tonal phonology and morphology would necessarily be very complex and is not included here for the sake of space.

Tonal contrasts are not evenly distributed in Kejom, with stems exhibiting several contrastive melodies while prefixal material (i.e. noun class inflectional prefixes) is generally only low-toned. Most suffixal material is toneless and receives tone from stems via spreading. There are exceptions to these generalizations, namely the infinitive verbal prefix ə́`- and the inflectional suffix -sə́ for noun class 10, which both carry a high tone. We limit further discussion here to the phonetic realization of the contrastive tonal contours observed on short (i.e., non-coalesced) noun and verb



[v(ə̀)wě ꜜɰʉ́mə́ lá ɥìʔ] 'they agreed that the person . . . '

[tə̀tāŋ tə́ tə́ꜜtɔ́ʔ] 'hills of bushes'

Figure 13: Effects of M and ꜜH tones on subsequent H tones in two sentences. Downstep imposes an f0 ceiling of about 140 Hz (left); the occurrence of a mid tone does not (right).

stem vowels, in addition to the phonetic and phonological properties of two frequently occurring derived tones, the downstepped high tone and the mid tone.

Stem tone melodies

The tonal contours attested on single stem vowels are shown in Figure 5. Kejom contrasts simple high (H) and low (L) tone melodies on monosyllables. In addition, a downstepped high tone (ꜜH) occurs when an unassociated L tone is stranded between two H tones (as with the infinitive prefix /ə́ˋ/- in Figure 5). The L tone contrasts with a low falling tone (LF), which we transcribe here as super-low.[3]. The latter starts at a pitch level typical of the low tone, but falls more rapidly to a lower level than the low tone and ends near the bottom of the speaker's pitch range. The L tone, by contrast, is relatively level and does not reach the extremely low pitch of the LF tone. The contrast between this pair of tones only occurs before pause; in all other positions, the distinction is neutralized to the level low tone.

Tonal melodies involving multiple clear pitch levels are rare on monosyllabic stems, but do occur. High-low falling (HL) and low-high rising (LH) contours are attested, mainly in loanwords, as in [bʲə̂] 'avocado', from Cameroonian Pidgin English [pia] '(avocado) pear'. Phonetic contours occur in rapid speech with reasonable frequency, mainly due to dislocation of a following H or L tone onto a preceding syllable due to reduction or deletion of its host vowel, as occurs in the attached North Wind text in the phrase /mú ɰə̀ mòk/ → [mû ɰ mɔ̀ʔ] 'while he was wearing'. The contour tones that do consistently occur on monosyllabic stems regardless of speech rate (HM, HL, LH) are all rare outside of derived environments. In particular, a high-mid (HM) falling contour is only attested on the word [mú¯] 'water'.

Mid and downstepped high tones

The downstepped high (ꜜH) and mid (M) tones occur only in derived environments (which are themselves in complementary distribution) and have very different effects on the tonological properties of the phonological phrases in which they occur. Within a phonological phrase, downstep lowers the pitch ceiling at which all subsequent H tones are produced. This can be seen in Figure 13 (left), where after a H of about 160 Hz is produced, downstep occurs and constrains subsequent ꜜH tones to an f0 ceiling of about 140 Hz. The occurrence of a mid tone within a phonological phrase, on the other hand, does not have any observable effect on subsequently produced H tones, as seen in Figure 13 (right): M, which is produced with a pitch similar to the ꜜH that occurs later in the utterance, is followed by two successive H tones with an f0 about 20 Hz higher.

In Kejom, the M and ꜜH tones appear to be phonetically indistinguishable. Akumbu (2017) argues from speaker intuition and some acoustic evidence that the M and ꜜH tones are phonetically indistinguishable in Kejom, but still exhibit the distinct phonological behaviors described above. We recapitulate the same argument here: both mid and downstepped high tones typically occupy an f0 range of 125–135 Hz (with the H tone occurring slightly higher at 130–150 Hz). This use of overlapping f0 ranges for two phonologically distinct tonal categories may be enabled by the fact that the two tones are derived in non-overlapping, complementary environments, and there is no possible need for speakers to distinguish the two tones from one another. A mid tone can only be derived in an environment immediately followed by a non-downstepped high tone (H), whereas downstepped high tones may occur with any other tone following (ꜜH, L, LF, etc.) and must be preceded by a non-downstepped high tone in order to be derived.

Illustrative passage: The North Wind and the Sun

We present a standard comparative text below at two levels of analysis. First, we provide a narrow phonetic transcription that illustrates some rapid-speech phenomena described above, particularly for tone. Second, for clarity, we provide a phonemic transcription with an interlinear gloss. Note that in this transcription, not all morphemes are assigned a phonemic tone. This is a deliberate representational choice, intended to reflect the analysis that much of Kejom's morphological material is underlyingly toneless and receives its phonetic tones from surrounding material via tone spread or reassignment.

Narrow phonetic transcription

ə̀fʷɔ́fꜜə́ gə̀ː kᶣì | wɛ̂ː ʧᶣìʧᶣì | ǹtáŋmə́ lá | à tóː ndə̀ ʧòː ndə̀ ló ‖ sə́ʦɛ̀jn wùʤèʔ | mû ɰ mɔ̀ʔ dàlə́ lɨ̀mtə́ vì̀ ‖ vwě ꜜɰʉ́mə́ lá ɥìʔ á ɰə́ ʧóː mbì̀ | ə̀ nè lá wùʤèʔ nájì ʦúʔ dàlə́ lɨ̀mtə́ː wɛ́jn | mwâ tóː wɛ́jn ʧòː wúꜜʦɛ́jn ‖ ə̀fʷɔ́fꜜə́ gə̀ː kᶣìː mə̀ zìtə̀ | sə̀ ʧǒ nôː nàntô ‖ ɰə̌ lì ʧǒː ɰɔ́ʔtə̀ | wùʤèʔ jí bɔ̀ŋsə̀ fʷɔ́mtə̀ dàlə́ lɨ̀mtə́ː wɛ́jn | á wɛ́ː wɛ̏jn ‖ kə̀ɲʉ̄ː kʲíkə́ ɰɔ́ʔ | ə̀fʷɔ́fꜜə́ gə̀ː kᶣì ɰə̀ kʲé ‖ ʧᶣìʧᶣì zìtə̀ bájn | ə̀ lɨ̀mə̀ vì̀ ‖ wùʤèʔ jí zàŋsə̀ ʦùʔ dàlə́ lɨ̀mtə́ː wɛ́jn ‖ kə́ ʧòː ə̀fʷɔ́fꜜə́ gə̀ː kᶣì | ɰə̀ bʲɨ́mə́ lá | ʧᶣìʧᶣĭː ꜜtóː ʧòː jì̀ ‖

[3] A convention common among researchers of Grassfields Bantu tone is to mark the non-falling low tone with a superscripted ring (°). Since this is not an IPA tone symbol, we refrain from using it here.

Phonemic transcription with interlinear gloss

ə̀-fʷóf ɘ gə̀ ə̀ kʷì wénə̀ ʧʷìʧʷì ǹ-táŋmə́ lá à tó-ɘ ndə̀
C3-wind AM.C3 part DIR above with sun(C1) PST-quarrel COMP FOC be.strong-PROG who
ʧò-ɘ ndə̀ ló,
pass-PROG who EMPH

The North Wind and the Sun were arguing about who was stronger than who

sə́tsèn wù-ʤèk mú ɰə̀ mòk dàlə́ lɨ̀mtə́ vì.
until C1.NMLZ-travel while 3SG.C1 wear gown(C1) hot come

until a traveler wearing a warm gown came.

və̀wé ɰʉ́mə́ lá wìk á ɰə́ ʧó-ɘ m̀bì ə̀ nè lá
3PL.C2 agree COMP person(C1) REL 3SG.C1 pass-PROG first CONJ cause COMP
wù-ʤèk náj̀ì tsúk dàlə́ lɨ̀mtə́ ə́ wén mú à tó-ɘ
CL1.NMLZ-travel DEM remove gown(C1) hot AM.C1 3SG.POSS.C1 so FOC be.strong-PROG
wén ʧò-ɘ wú-tsén.
3SG.C1 pass-PROG C1.NMLZ-certain

They agreed that the person who would first make the traveler take off his gown was stronger than the other.

ə̀-fʷóf ɘ gə̀ ə̀ kʷì ə́ mə̀ zìtə̀ sə̀ ʧò-ɘ nókə̀ nàntô.
C3-wind AM.C3 part DIR above SM.C3 then start PRS pass-PROG really much

The North Wind then began to blow with great force.

ɰə̀ ə́ lì ʧò-ɘ ɰóktə̀ wù-ʤèk jí bòŋsə̀ fʷómtə̀ dàlə́ lɨ̀mtə́
3SG.C3 SM.C3 so pass-PROG be.big CL1.NMLZ-travel DEM instead fold gown(C1) hot
ə́ wén á wén ə̀-wén.
AM.C1 3SG.POSS.C1 to 3SG.POSS.C3 C3-body

As he blew stronger, the traveler instead wrapped his warm gown around his body.

kə̀-ɲʉ́ ə̀ kí-kə́ ɰók ə̀-fʷóf ɘ gə̀ ə̀ kʷì ɰə̀ ké.
C7-thing AM.C7 THIS-C7 be.big C3-wind AM.C3 part DIR above 3SG.C3 allow

This thing was too much, and the North Wind gave up.

ʧʷìʧʷì zìtə̂ bán ə̀ lɨ̀m-ə̀ vì, wù-ʤèk jí zàŋsə̀ tsùk dàlə́
sun(C1) start shine CONJ hot-PROG come C1.NMLZ(C1)-travel DEM hurry remove gown(C1)
lɨ̀mtə́ ə́ wén.
hot AM.C1 3SG.POSS.C1

Then the Sun began to shine and make places hot, and the traveler quickly took off his gown.

kə́ ʧò ə̀-fʷóf ɘ gə̀ ə̀ kʷì ɯɽə̀ bʲɨ́mə́ lá ʧʷìʧʷì ə́ tó-ɘ
3SG.C7 pass C3-wind AM.C3 part DIR up 3SG.C3 accept COMP sun(C1) SM.C1 strong-PROG
ʧò-ɘ jì.
pass-PROG 3SG

This surpassed the North Wind; he accepted that the Sun was stronger than him.

Abbreviations

Interlinear morphemic glosses mainly adhere to the Leipzig Glossing Rules (Bickel et al., 2015) except for the morphemes below.

- Noun classes are glossed as C#, with the # indicating the class. Noun class is most frequently expressed with agreement morphology (mostly prefixal) distributed throughout the noun phrase, but is also inherent to some nouns (e.g. 'sun', 'person').
- The associative marker is glossed as AM. This set of morphemes agrees with the noun class of the head of its noun phrase and expresses a variety of semantic relations between the nouns it conjoins (Akumbu and Chibaka, 2012, 116–124).
- The subject marker is glossed as SM; this agrees with the noun class of the subject and immediately precedes the verb in some sentences (Akumbu and Chibaka, 2012, 67).
- A conjunction used specifically between serialized verbs is glossed as CONJ.

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