

THE PHONETIC STRUCTURES OF DEFAKA

Aaron Shryock, Peter Ladefoged, and Kay Williamson

University of California at Los Angeles and University of Port Harcourt

An investigation of the phonetic structures of Defaka, an Ijoid language, shows that it has seven oral vowels—*i e ε a ɔ o u*—which can be short or long, and five long nasalized vowels. Acoustic analysis shows that there is only a very small difference between *e* and *ε*. There is some slight evidence for a difference in voice quality for the back vowels. There are voiced and voiceless unaspirated stops at three places of articulation; the labial velar stops differ in the degree of voicing. The affricate *dʒ* is realized as *z* for several speakers. The two tones in Defaka give rise to five distinct tonal patterns: H, L, HL, LH, and H↓H. The L, HL, and H↓H tonal contrasts are similar in that they are realized phonetically as a falling fundamental frequency.

Une étude des structures phonétiques du défaka, une langue ijoïde, montre qu'elle a sept voyelles orales—*i e ε a ɔ o u*—qui peuvent être courtes ou longues, et cinq voyelles nasales longues. L'analyse acoustique montre qu'il n'y a qu'une petite différence entre *e* et *ε*. Il semblerait y avoir une différence de la qualité de voix pour les voyelles postérieures. Il y a des occlusives non-aspirées voisées et non-voisées à trois lieux d'articulation; les occlusives labio-vélaires diffèrent l'une de l'autre par le degré de voisement. L'affriquée *dʒ* est réalisée comme *z* pour plusieurs locuteurs. Les deux tons du défaka créent cinq groupes tonaux distincts: H, B, HB, BH, et H↓H. Les oppositions tonales B, HB, et H↓H se ressemblent en ce qu'elles sont réalisées phonétiquement par une fréquence fondamentale descendante.

0. INTRODUCTION¹

Defaka (**défakà**) is an Ijoid language, belonging to the Atlantic-Congo family of Niger-Congo. It is spoken by a small community in Nkọrọ town in the Bonny Local Government Area, Rivers State, Nigeria. Defaka is the only known language which shows a considerable similarity to Ijo without actually being Ijo (Williamson 1989). The language was first described by Jenewari (1983, 1989) who was primarily concerned with its linguistic affiliation. The present article incorporates much of the only other linguistic work on Defaka, a long essay for the B. A. (Hons) degree by Bob-Manuel (1990). As so much of her work has been incorporated here, she deserves to have been listed as a co-author, but we have departed somewhat from her analysis, and she should not be considered responsible for the present form of the article.

Most of the Defaka live in a single ward of Nkọrọ town and consider themselves the same people as the Nkọrọ, who live in the other wards of the town and speak a different language, a dialect of Ijo. Both our principal informants came from mixed marriages, in one case with an Nkọrọ mother and a Defaka father and the other a Defaka mother and an Nkọrọ father. Nearly all the Defaka are bilingual in Defaka and Nkọrọ (often speaking other languages as well), and most of the Defaka under thirty do not speak the language. In these circumstances we must acknowledge that the phonetics and phonology of the language we are describing are heavily influenced by the Nkọrọ dialect of Ijo, and the two languages may be indistinguishable at this level. They are, however, quite distinct languages lexically and not mutually intelligible. There are probably no more than a few hundred speakers of Defaka. The 1963 census reported that the Defaka and the Nkọrọ together totaled 5,468 people (Jenewari 1983:6).

This study is based on data collected in August 1994 at the University of Port Harcourt and in the Defaka ward of the village of Nkọrọ. The data consists of recordings of twelve male speakers of Defaka. The first four speakers were recorded under reasonably good conditions at the University of Port Harcourt. The other eight speakers were recorded in one crowded session in a small house in Nkọrọ. Two or three tokens of each word were recorded for each of the four speakers at Port Harcourt;

¹ This article is dedicated to the Defaka people. We appreciate their patience and generous assistance which made this study possible.

only one token was recorded for the remaining eight speakers. The tokens were not recorded in a sentence frame. In order to examine the principal phonetic properties of the segmental and suprasegmental contrasts of Defaka, the collected data was digitized at a sampling rate of 20 kHz using the Kay Elemetrics Computer Speech Laboratory package.

1. VOWELS

1.1 VOWEL INVENTORY

Proto-Ijò has been reconstructed as having nine vowels in two harmony sets **i e a o** and **ɪ ɛ ɔ ʊ** with **a** being common to both sets (Williamson forthcoming). Defaka and the Nkọrọ dialect of Ijò are the easternmost of the Ijoid languages and are entirely surrounded by languages with considerably smaller vowel systems. Williamson (1973) has shown that Nkọrọ has been strongly influenced by its neighbors: **ɪ** has fallen together with either **i** or **e**, and **ʊ** with **u** or **o**. In addition **ɛ** has at least partially merged with **e** and **ɔ** with **o**. Williamson notes that the contrast between **e** and **ɛ** is rather tenuous in Nkọrọ and that there are comparatively few sequences of vowels in words involving **ɔ**. Nkọrọ is thus best regarded as a six or seven vowel language, which, if the language survives, may shortly be reduced to five vowels. The same may be true of Defaka.

Defaka has at most the seven oral vowels **i e ɛ a ɔ o u** and five nasalized vowels **ĩ ẽ ã õ ũ**. The oral vowels may be long or short, but the nasalized vowels are invariably long. All the oral vowels are allophonically nasalized when adjacent to a nasal consonant. The complete set of Defaka vowels is illustrated by the words in (1).

(1)	i	ìbì	sleep	ĩ	sĩ	sink
	e	èbè	pig	ẽ	dée	chief
	ɛ	èwèrè	children			
	a	ìbà	it is done	ã	sàà	urine
	ɔ	ìtò	stomach			
	o	ìdò	farm	õ	oóó	four hundred
	u	ó↓bú	door	ũ	sũũ	stretch

1.2 FORMANT FREQUENCY AND AMPLITUDE OF ORAL VOWELS

To examine the formant frequencies and amplitudes of the vowels of Defaka, we selected words which illustrate the seven contrasting short and long oral vowels as shown in (2). For the short vowels, words were selected in which the vowel occurred word-initially preceding a labial consonant. It was necessary, however, to measure vowels occurring in other environments in order to have data for the vowels **ɛ ɔ u**. For the long vowels, there were so few words in the data set illustrating these vowels that it was not possible to control the environment in which the vowels occurred.

(2) Words used in formant frequency and amplitude measures for the vowels

i	ìbì	sleep	ii	ìimà	heavy
e	èbè	pig	ee	tèè	play
ɛ	èdèlè	vulture	ɛɛ	jèè	bird
a	ápá	wing	aa	fàà	say
ɔ	úsóró	navel	ɔɔ	òò	roast
o	òbò	back	oo	óó	salt
u	ób↓ú	door	uu	túún	five

The frequency of the first three vowel formants (F1, F2, and F3, respectively) were measured during a steady-state portion of the vowel. The measurements were taken from a wideband spectrogram supplemented by reference to FFT spectra, averaged over an 80 ms window positioned where the formant measurements were taken. In the case that the steady-state portion of the vowel was less than 80 ms in length, a 52 ms window was used. In the case of the *ii* of *ìimà* 'heavy', the vowel formants were measured with a 52 ms window position near the onset of the vowel to minimize the effect of allophonic nasalization resulting from the adjacent nasal. Finally, in addition to the frequency measurements, the amplitudes of the formants in the FFT analysis were measured by taking the greatest amplitude of the harmonics comprising each formant.

The formant frequency and amplitude values for the mid short vowels *e* *ε* *o* *ɔ* in (3) represent only the vowels of the four speakers recorded in Port Harcourt. In the case of the eight speakers recorded in Nkọrọ, the word *èdèlè* 'vulture' was not collected. In addition, the speakers in Nkọrọ preferred to pronounce *ísórí* 'navel' as *ísórí*. As a result, we excluded the formant frequency and amplitude values for the corresponding mid vowel *e* and *o* of these eight speakers because including these measurements without the measures for *ε* and *ɔ* for the same speakers would produce an unbalanced data set for these vowels which could misrepresent the nature of the acoustic differences between them.

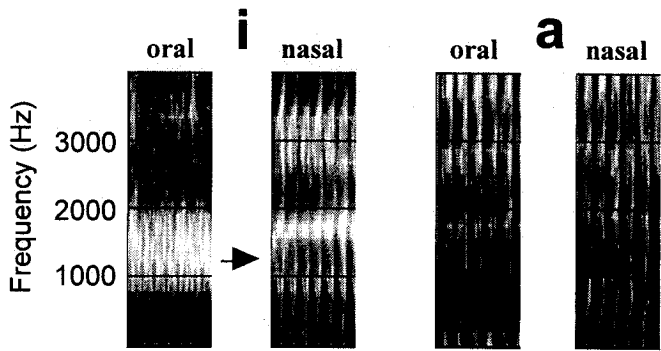
The mean formant frequencies and amplitudes for the short and long vowels are presented in (3). The means of the short and long vowels are not presented separately because a two-factor analysis of variance including the factors vowel quality and vowel length indicated that vowel length does not have a significant effect on vowel quality: For F1, $F[1,159]=0.39$, $p<.5334$; F2, $F[1,159]=0.469$, $p<.4944$; and F3, $F[1,159]=3.445$, $p<.0653$.

(3) Mean formant frequencies (Hz) and amplitudes (dB) for the short and long vowels

Vowel	F1	F2	F3	A1	A2	A3
i	363	2113	2912	63	41	40
e	418	1917	2634	61	40	38
ε	446	1866	2675	58	42	35
a	751	1446	2451	57	51	40
ɔ	542	1144	2417	58	53	35
o	423	1064	2137	65	51	33
u	344	1022	2338	62	45	30

The formant frequencies are plotted in (4) with F1 plotted against F2'-F1. F2' is a weighted average of F1, F2 and F3 calculated as suggested by Fant (1973:52). Because speakers have different vocal tract sizes and different personal idiosyncrasies, each vowel is represented by a scatter of points. As an aid in assessing the distinctiveness of each group of vowels, ellipses are drawn with radii of two standard deviations along the principle components of variation within each vowel. To a first approximation, pairs of vowels with non-overlapping ellipses are very significantly different, even without allowing for different speaker characteristics. Pairs of vowels with overlapping ellipses may be significantly different when appropriate statistical analyses are carried out, as noted in (4).

(5) Spectrograms of oral and nasal vowels



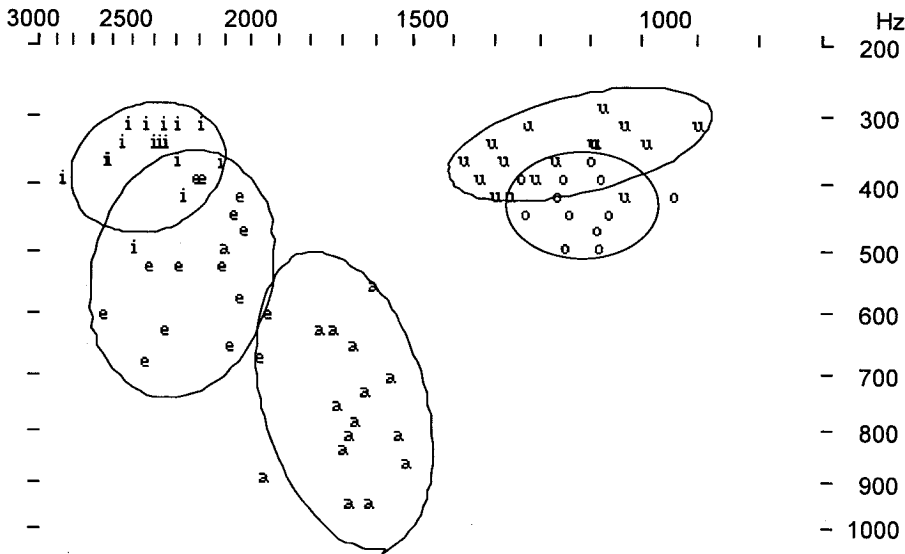
The words used in the examination of formant frequencies and amplitude measures are presented in (6), and the mean formant frequencies and amplitudes of the nasalized vowels in (7).

(6)	ĩ	sĩĩ	sink	õ	óóóó	four hundred
	ẽ	děế	chief	ũ	sũũ	stretch
	ã	sãã	urine			

(7)	Vowels	F1	F2	F3	N	A1	A2	A3	AN
	ĩ	356	2163	2882	1256	60	34	34	32
	ẽ	541	1923	2793	1231	56	46	40	40
	ã	753	1483	2533	—	53	51	35	—
	õ	432	930	2446	1510	58	44	30	28
	ũ	358	958	2345	1509	56	41	31	33

In (8) the mean formant frequencies of the nasalized vowels are plotted with F1 against F2'– F1. As noted above, F2' is a weighted average of F1, F2 and F3 (Fant 1973:52).

(8) The formant frequencies of the nasal vowels



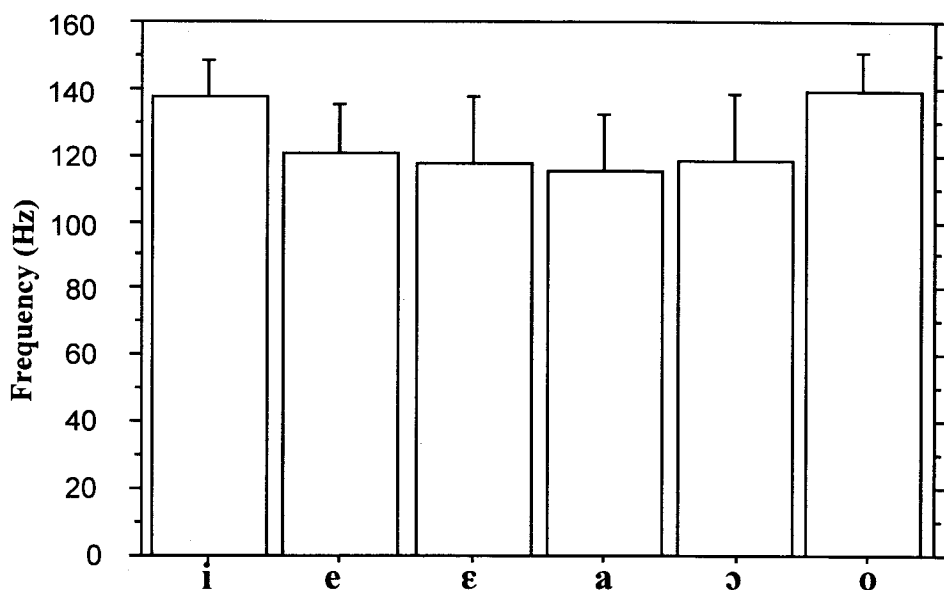
1.4 INTRINSIC PITCH

The intrinsic pitch of the vowels was also investigated. The fundamental frequency (F0) of the low-toned vowels **i e ε a ɔ o** was measured from a narrow band spectrogram display. A low-toned **u** does not occur in the collected data. F0 was calculated from the frequency of the 10th harmonic or the highest distinguishable harmonic in the steady-state portion of the vowel. For the words of the shape VCV, the F0 of the first and second vowels was measured and averaged. The words used in the investigation of inherent pitch are presented in (9) and the mean frequencies in (10).

(9)	i	ìbì	sleep	a	fàà	say
	e	tèè	play	ɔ	òò	roast
	ε	jèè	bird	o	òbò	back

It has been reported that there is a correlation between vowel height and intrinsic pitch such that high vowels have an intrinsic pitch which is higher than low vowels. The intrinsic pitch of the low-toned vowels of Defaka show a tendency to conform to this correlation between vowel height and intrinsic pitch. However, the differences in pitch between these vowels are not significantly except in the case of **o** and **a**. Moreover, the pitch of **o** is higher than that of **i**, an unexpected result.

(10) Means and standard deviations (Hz) of the low-toned vowels



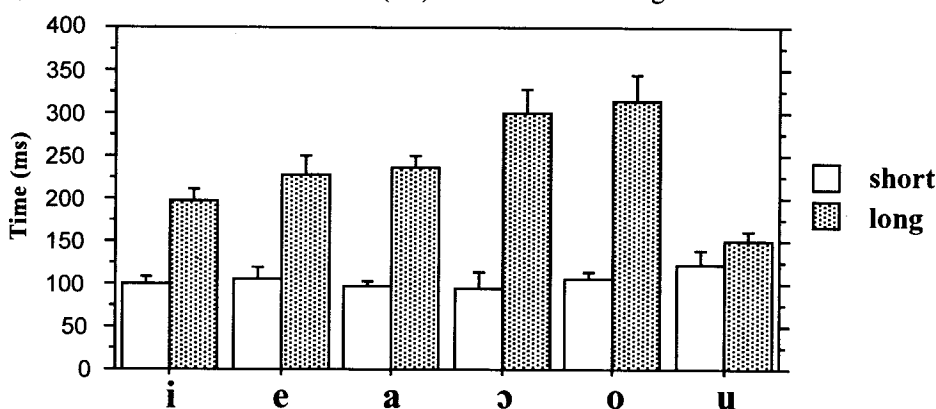
1.5 DURATION

Finally, vowel length is contrastive in Defaka. The duration of the short and long oral vowels was measured. In the case of words of the shape VCV, the duration of the first vowel was measured. In the case of **u**, however, the vowel only occurs in the word **óbú** 'door'. The vowels **ε** and **εε** were not measured because of the difficulty in determining the duration of **εε** in the word **jèè** 'bird', the only word in the corpus with this vowel. The words used in the investigation of vowel duration appear in (11). The mean duration of the short and long vowels is presented in (12).

(11)	i	ìbì	sleep	ii	ììmà	heavy
	e	èbè	pig	ee	tèè	play
	a	ápá	wing	aa	fàà	say
	ɔ	ósó	navel	ɔɔ	òò	roast
	o	òbò	back	oo	óó	salt
	u	óbú	door	uu	túún	five

The long vowels are at least twice the length of the corresponding short vowels except in the case of **u** and **uu**. As noted above, the vowel **u** occurs in final position as opposed to initial position as with the other short vowels. In order to determine the effect of final position on the duration of **u**, its duration was compared to the duration of the initial and final vowels of **òbò** 'back'. The initial **o** has a mean duration of 106 ms, the final **o** 130 ms. Assuming a comparable relation between the duration of **u** in initial and final position, an initial **u** would have a mean duration of approximately 100 ms given the mean duration of 123 ms for the final **u**. Even with the inferred duration of 100 ms for **u**, the difference in duration between **u** and **uu** is not as great as seen with the other vowel pairs. The relatively shorter duration of **uu** may result, in part, from its position in a penultimate syllable with a consonant in the onset position of the syllable.

(12) Means and standard deviations (ms) of the short and long vowels



2. CONSONANTS

2.1 CONSONANT INVENTORY

The consonants of Defaka are shown in (13). Notable allophones of these consonants are shown in parentheses.

(13) Defaka consonants

	Bilabial	Labio-dental	Alveolar	Palatal	Velar	Labial velar
Plosive	p b		t d		k g	kp gb
Affricate				dʒ		
Implosive	ɓ					
Nasal	m		(n)		(ŋ)	
Tap			r			
Fricative		f v	s (z)			
Lateral			l			
Approximant	w		(ɹ)	j		

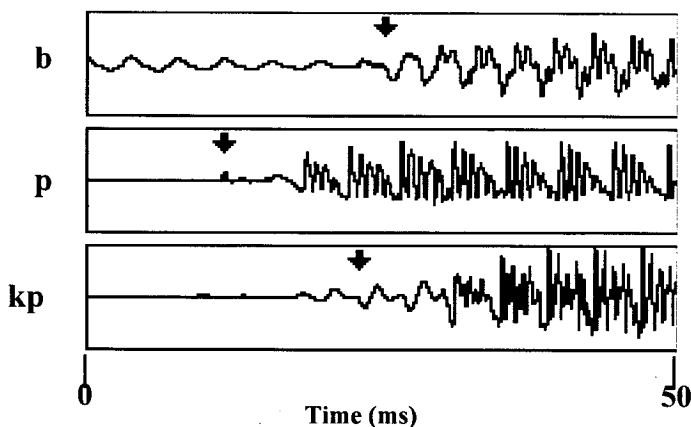
2.2 PLOSIVES

Defaka contrasts voiced and voiceless unaspirated stops at three places of articulation: bilabial, alveolar, and velar. In addition, there are two labial velar stops that might be considered to be voiced as opposed to voiceless, but which do not contrast in the same way as the other voiced and voiceless stops. There is also an implosive produced at the bilabial place of articulation. The plosives and implosive of Defaka are illustrated by the words in (14).

(14)	p	pàrà	leg	ápá	wing
	b	bìà	river	èbè	pig
	t	tèè	play	ìtá	stomach
	d	déé	chief	ìdò	farm
	k	káà	hand	ḡéké	fall
	g	gògó	namesake	àgàrà	lizard
	kp	kpáǎ	wind around	kpìkpìkì	owl
	gb			àgbà	bite
	ḡ	ḡéké	fall	òḡóó	four hundred

The voiced plosives **b d g** are fully voiced throughout the stop closure, contrasting with the voiceless plosives **p t k** which have no voicing during the closure and are followed by a short voice onset time (VOT) before the following vowel. The so-called voiceless labial velar **kp** is phonetically distinct from both these sets of stops in that it is characterized by the onset of voicing during the closure, prior to the release, a property of voiceless labial velars previously observed (Ladefoged 1964, Garnes 1975, Connell 1994; Pettorino and Giannini 1995). Waveform displays illustrating the differences in the timing of the onset of voicing for **b p kp** are shown in (15). The release of the stop closure is indicated by an arrow. It is difficult to be precise about this moment, but it is taken to be when the first cycle indicating vocalic quality occurs. In the case of **b** there are voicing vibrations throughout the period prior to the release. For **p**, there is a short interval after the release before voicing begins; and for **kp** the voicing commences slightly earlier than the release. This small difference between **p** and **kp** is consistent across all our speakers. The degree of voicing in the so-called voiceless labial velar **kp** is similar to that in the so-called voiced stop **b** in English.

(15) Waveform displays of the release of **b p kp**

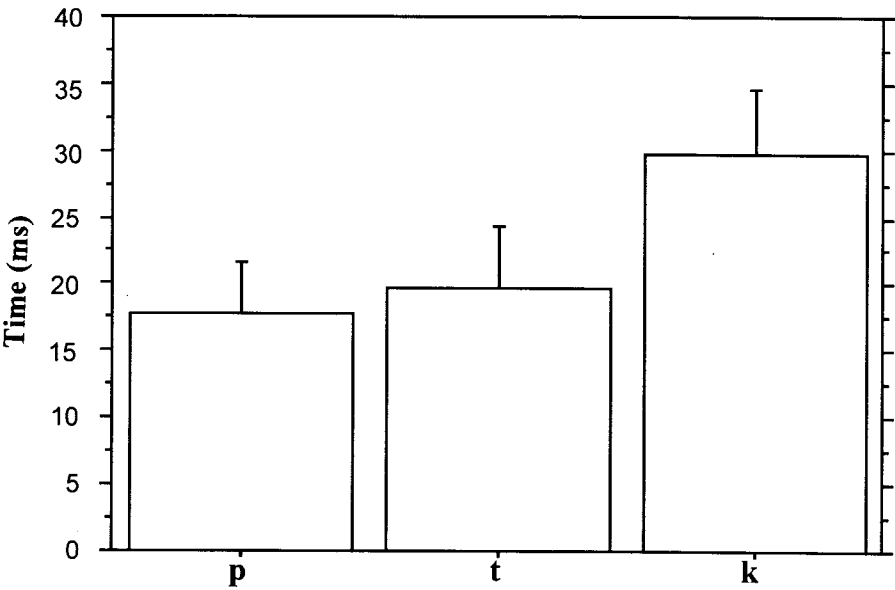


We measured the VOT for the three voiceless unaspirated stops **p t k**. The words used appear in (16) and the mean VOT durations are presented in (17). As has been

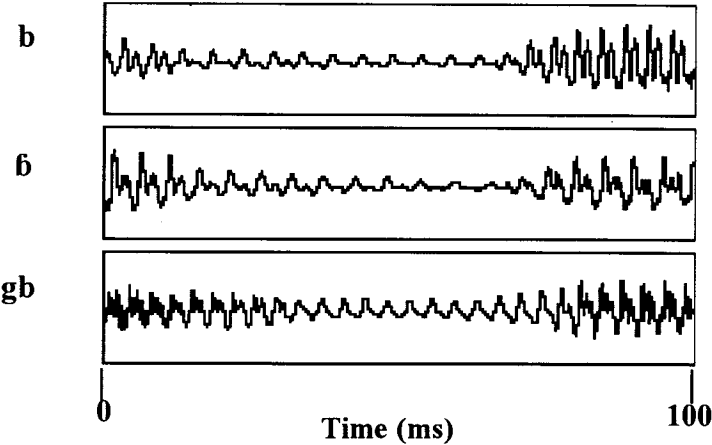
found for many other languages, the VOT for the velar stop is significantly longer than that for the alveolar and bilabial stops, which in Defaka are not significantly different from one another.

- (16)
- | | | |
|---|-------|-------|
| p | pàrà | leg |
| t | taátú | three |
| k | kàrì | curse |

(17) Means and standard deviations for the voiceless unaspirated stops



(18) Waveform displays illustrating the voiced closures of **b** **ɓ** **gb**



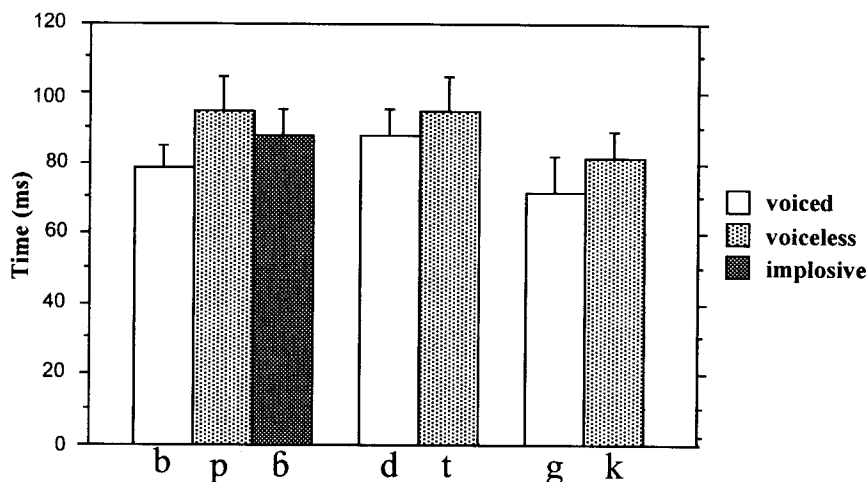
The closure intervals of the voiced plosives and implosive are primarily fully voiced. There is, however, a difference in the way that the voicing is manifested. As exemplified in (18), the voiced plosives **b d g** are voiced throughout the entire closure, with the intensity of the voicing (the amplitude of the waveform) sometimes diminishing slightly during the latter part before the release. In the case of the implosive **ɓ**, other

investigators describing other languages (Ladefoged and Maddieson 1996) have suggested that there is usually a tendency for the amplitude of voicing to gradually increase. This was not evident in most of our samples; the implosive in (18) has a definite decrease in the amplitude of voicing. As illustrated in (18), the labial velar **gb** is characterized by greater amplitude of voicing during the closure. Moreover, the amplitude of the voicing generally increases toward the release of the closure.

The duration of the stop closure was measured for the voiced and voiceless unaspirated stops and the labial implosive. The closure duration of the labial velar stops was not measured because the collected data did not contain words with these consonants in the appropriate environment. The words used in the investigation of closure duration appear in (19), and the mean closure durations are presented in (20). As is generally found, the intervocalic voiceless stops are slightly longer than their voiced counterparts, although in this language the difference is statistically significant only in the case of the bilabial stops.

(19)	p	ápá	wing
	b	èbè	pig
	ɓ	èɓè	carve
	t	ítò	stomach
	d	ìdò	farm
	k	àkàdà	pepper
	g	àgàrà	lizard

(20) Mean closure duration (ms) of the intervocalic stops

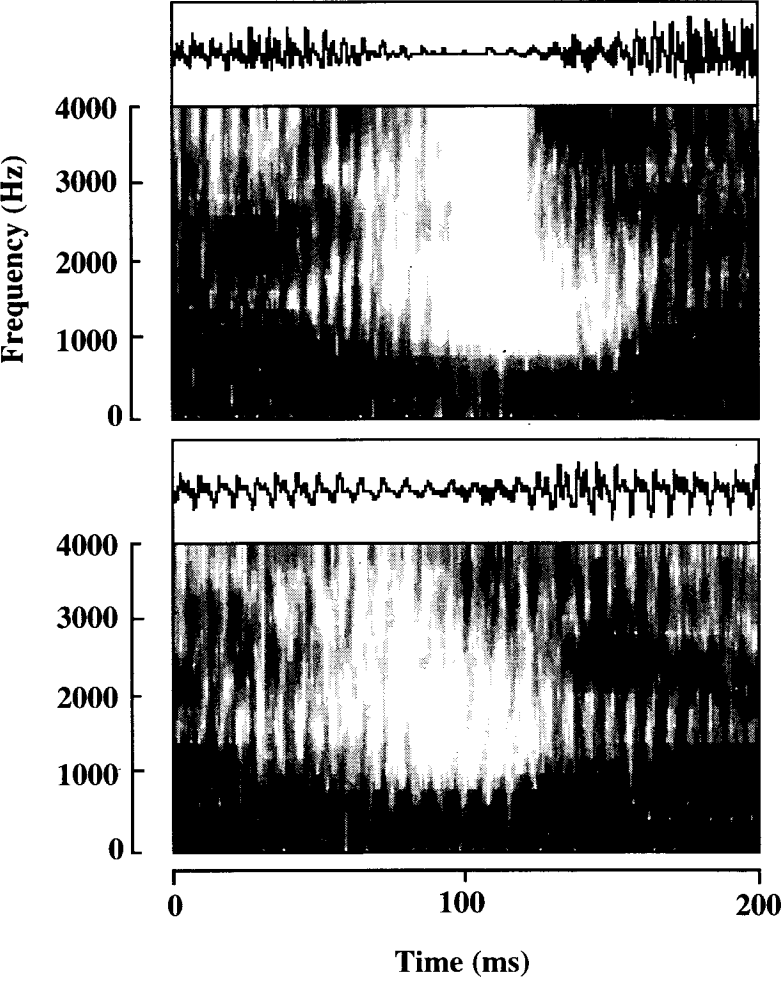


2.3 AFFRICATE

There is a single voiced affricate **dʒ** in Defaka. It occurs intervocalically in our data, but it is reported to occur word-initially as well by Bob-Manuel (1990). As noted above, **z** occurs as an allophone of **dʒ** for some speakers. Two speakers consistently produced **z** in the place of **dʒ**. Six speakers produced **dʒ** for each of the four words in the corpus with **dʒ**. The remaining speakers produced instances of **dʒ** as well as **z**.

(21)	dʒ	ídʒá	cooking pot
		ìdʒè	death
		ádʒaré	rust
		ìdʒùlè	father

(22) Spectrograms of **d₃** with complete closure (upper figure) as opposed to incomplete closure (lower figure) in the first two syllables of **ád₃áré** ‘rust’



There is voicing through the entire closure interval of **d₃**. Moreover, there is a tendency for the closure to be only partially formed resulting in frication and a greater amplitude of voicing. These differing degrees of constriction are illustrated by the spectrograms of **d₃** in the word **ád₃áré** ‘rust’ in (22).

2.4 NASALS

There is a single nasal phoneme in Defaka: the bilabial **m**. The alveolar **n** occurs as an allophone of **l** in the presence of contrastive nasalization on a following vowel. The velar **ŋ** occurs in homorganic consonant closures with velar and labial velar stops. The fact that Defaka has a single nasal phoneme and that this nasal is bilabial is not unusual in West African languages, but is cross-linguistically rare. The nasals of Defaka are illustrated in (23).

(23)	m			ìmà	heavy
	n	nóm	person	ónúmá	bush
	ŋ	ŋgbè	pick	ìŋgì	ax

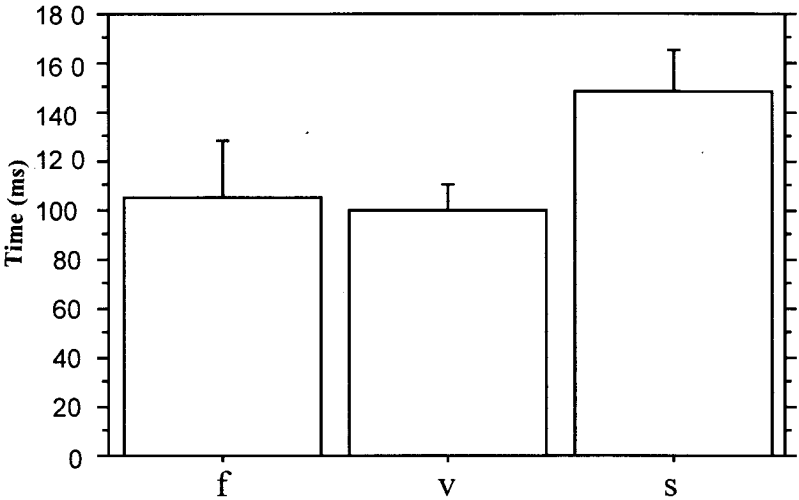
2.5 FRICATIVES

There are three fricatives in Defaka: the voiceless and voiced labio-dental fricatives **f** **v** and the voiceless alveolar fricative **s** illustrated in (24).

(24)	f	fàà	say	òfòrò	blow with mouth
	v	válà	sail	ìvè	throw
	s	sùù	stretch	śśóró	navel

The duration of the fricatives in initial position was measured. The three words in (24) were used for this purpose with the results in (25).

(25) Means and standard deviations (ms) of fricatives in word-initial position



The sibilant is longer than the labial fricatives by 46 ms. The difference is significant as determined by an analysis of variant (ANOVA) with the factor place (labial versus alveolar), ($F[1,45]=23.404, p<.0001$). The greater duration of sibilant fricatives has been previously observed in English (Behrens and Blumstein 1988, You 1979).

2.6 TAP, LATERAL, AND APPROXIMANTS

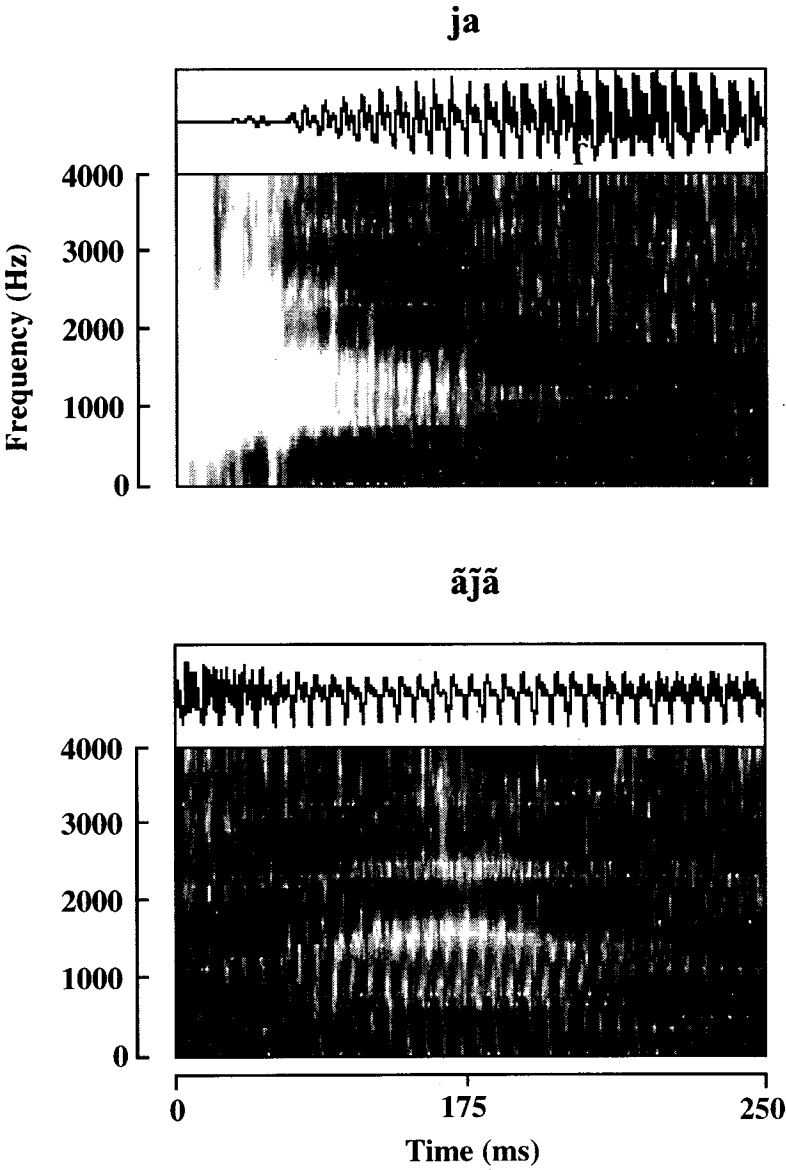
Defaka has a single rhotic, an alveolar tap **r**. There is an alveolar lateral **l** as well. The approximants include the labial-velar **w** and the palatal **j**. These consonants appear in (26).

(26)	r		pára	leg
	l	lèlè	àálà	the woman
	j	jèè	śjò	eye
	w	wá	èwèrè	children

As noted above, in the presence of contrastive nasalization of the following vowel, **l** is realized as **n**. In contrast to **l**, the approximants **w** and **j** are not realized as nasals in the presence of a contrastively nasalized vowel. However, these approximants are also nasalized in this environment. The spectrograms in (27) contrast oral and nasal counterparts of **j**. In comparing the formants in (27), note the additional nasal formant in **j̃** at approximately 1200 Hz. As for the following vowels **a** and **ã**, the first and second

formants have comparable values although the formants in the nasalized vowel are slightly higher.

(27) Spectrogram of **ja** in **jáà** ‘thing’ (upper) and **ājā** in **àtájā** ‘good things’ (lower)



3. TONE

There are two contrastive tones in Defaka: high and low. There are also two contour tones HL LH which arise from the combination of the two contrastive tones on a monosyllabic word containing a long vowel or diphthong. Finally, Bob-Manuel (1990) reports a downstepped high tone ↓H resulting from a HLH sequence of tones. The tones of Defaka are illustrated in (28).

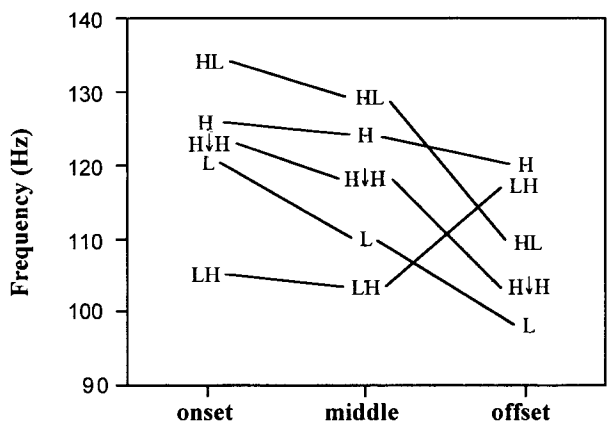
(28)	H	wá	we	óó	salt	ápá	wing
	L	ì	I	tèè	play	èbè	pig
	HL			jáà	thing	ḡátà	feces
	LH			dàá	father	gògó	namesake
	H↓H			kpá↓á	wind around	ób↓ú	door

In order to investigate the phonetic characteristics of these tones, the fundamental frequency (F0) of these distinct tones and tonal contours was measured. The words used, all of which contain the vowel **a**, are presented in (29). The measurements were taken from a narrow band spectrogram display of the vowel. The F0 was calculated from the frequency of the 10th harmonic or the highest distinguishable harmonic at the onset, middle, and offset of the vowel. We limited our measurements to the data collected from the four speakers at the University of Port Harcourt because these recordings were of higher quality, and three of the five words investigated were not collected from the speakers recorded in Nkọrọọ. A word with a high tone and the long vowel **aa** does not occur in the data set for the four speakers in question. Therefore, we measure the F0 of the first vowel in **ápá** ‘wing’.

(29)	H	ápá	wing
	L	bàà	day
	HL	káà	hand
	LH	dàá	father
	H↓H	kpá↓á	wind around

The mean F0 of these tones and contours appear in (30). Note that there are essentially three F0 contours: level as in the case of H, rising as in the case of LH, and falling for HL, H↓H, and L. The falling F0 patterns of HL, H↓H, and L are not significantly distinct at the onset, middle, or offset of the vowel as determined by a series of single factor ANOVAS: in the case of HL and H↓H, $F[1,14]=0.65$, $p=.4337$ at the onset, $F[1,14]=0.461$, $p=.5082$ at the middle, and $F[1,14]=0.496$, $p=.4927$ at the offset. For H↓H and L, $F[1,14]=0.062$, $p=.8071$ at the onset, $F[1,14]=0.52$, $p=.4826$ at the middle, and $F[1,14]=0.417$, $p=.5289$ at the offset. For HL and L, $F[1,14]=1.451$, $p=.2483$ at the onset, $F[1,14]=2.646$, $p=.1261$ at the middle, and $F[1,14]=2.165$, $p=.1633$ at the offset. These findings may draw into question the phonological status of the proposed contrasts between, for instance, HL and H↓H. More likely, though, these findings indicate that more controlled data is required to determine the phonetic differences between these tonal contrasts.

(30) Mean F0 (Hz) at onset, middle, and offset of vowel



4. CONCLUSION

This article has investigated the principal phonetic properties of the segmental and suprasegmental contrasts of Defaka. The results reported here represent the first phonetic study of the language. Moreover, this is one of the first acoustic studies of an Ijoid language. In several respects, Defaka exhibits the phonological and phonetic structures common to other languages of West Africa. The vowel inventory consists of seven vowels: i e ε a ɔ o u. There are also five nasal vowels. The mid vowel sets e ε and ɔ ɔ̃ are distinguished by the value of F1, indicating a height difference. They may also differ in the position of the tongue root. The consonant inventory of Defaka includes voiced and voiceless unaspirated stops, labial velars, and an implosive. There is a single affricate dʒ which is realized as z for several speakers. The nasal inventory consists of a single phoneme m. n and ŋ are allophones of m. The fricatives include f v s. The language has an alveolar tap r which has an approximant allophone ɹ. The remaining sonorants include l w j. l has the allophone n in the presence of contrastive nasalization on a following vowel. The approximants j and w are nasalized in this environment. Finally, there are two tones in Defaka which give rise to five distinct tonal patterns: H, L, HL, LH, and H↓H. The L, HL, and H↓H tonal contrasts are similar in that they are realized phonetically as a falling F0 contour.

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APPENDIX A: DEFAKA WORD LIST

ask	bìè	lizard	àgàrà
ax	ìngì	madness	álàgà
back	òbò	masquerade	ègbèlègbè
bat	pèkù	namesake	gògò
beat (drum)	ònùmá	navel	śśśś
big	ìbò	old person	ślòtí
bird	jèè	owl	kpìkpi
bite	àgbà	palm fruit	lòm
blow with mouth	òfòrò	pepper	àkàdà
bush	ónúmá	person	nóm
carve (vb)	èbè	pick	ngbé
catarrh	bájá	pig	èbè
catch	àrì	plate	àlilá
chief	déé	play	tèè
child of someone	bòm	possessions	ètéjà
children	èwèrè	river	bìò
climb	àngí	roast	òò
compound	ókúná	robe	óngbía
cooking pot	ídzá	rust	ádžaré
curse	kàrì	sail	válà
cut	kée	salt	óó
day	bàà	say	fàà
death	ìdžè	sell	lèlè
dog	èbèrè	she said	áfàrà
door	óbíú	sing a song	túó tòò
eat	èè	sink	sìì
eye	ójò	sleep	ìbì
feces	bátà	song	tùò
fall	béké	spirit	éwèrè
farm	ìdò	steal	éwé
father	ìdžùlè	stomach	ìtò
father	dàá	stretch	sùù
five	túúnò	take	ìtá
flowing tide	búú	the woman	àálà
four hundred	òbóó	thing	jáá
fowl	òkúnà	thread	lìrì
get out	ònúmá	three	táátó
good thing	àtájà	throw	èvè
hand	káá	trick	èpèlè
hawk	ákpánákpá	urine	sáá
heavy	ìimà	vulture	èdèlè
horse	ìjìjà	we	wá
hot	òrò	wife	tàà
it is done (food)	ìbà	wind around	kpá,á
kill	báá	wing	ápá
leg	pàrà	yesterday	ìbà
light	féréféré	young person	àwò

APPENDIX B: ACOUSTIC DATA

The following tables contain the numerical data reported in the article for the segmental and suprasegmental contrasts of Defaka. In each of the following tables, the token is indicated in the rightmost column. The token is followed by a letter designating the speaker; E, J, M, and P are the four speakers from Port Harcourt and Q through X the eight speakers recorded in the Defaka ward of the village of Nkoro. The number following the letter designating the speaker indicates the repetition. Finally, if measurements are presented for both vowels of a word, onset and coda are included in the token column to indicate which vowel the reported measurements represent.

Table 1. Numerical data for the frequency (Hz) of the first three formants (F1, F2, and F3) and amplitude (dB) of the first three formants (A1, A2, and A3) of the oral vowels.

F1	F2	F3	A1	A2	A3	Token
707	1415	2410	56	53	41	ápá E 1
707	1310	2096	59	51	37	ápá E 2
838	1493	2646	59	47	37	ápá J 1
838	1572	2542	52	49	39	ápá J 2
838	1441	2358	61	50	41	ápá M 1
733	1336	2175	65	55	44	ápá M 2
864	1677	2542	60	49	42	ápá P 1
812	1415	2410	59	51	39	ápá P 2
655	1362	2489	55	41	36	ápá Q
786	1572	2148	53	55	43	ápá R
681	1362	2410	56	48	36	ápá T
707	1598	2725	56	41	35	ápá U
628	1310	2830	36	41	35	ápá V
733	1651	2751	50	51	34	ápá W
812	1677	3170	55	46	42	ápá X
366	2044	2673	60	41	36	èbè E 1
419	1860	2463	62	41	40	èbè E 2
393	2070	2751	59	28	31	èbè J 1
497	2044	2646	58	36	32	èbè J 2
366	1965	2777	64	27	27	èbè M 1
445	1886	2673	55	51	50	èbè M 2
366	2279	3066	59	32	29	èbè P 2
445	1808	2646	60	45	35	èdèlè E 1
445	1729	2542	59	39	29	èdèlè E 2
445	2096	2777	52	41	43	èdèlè J 1
471	1965	2725	59	35	36	èdèlè J 2
471	1860	2673	61	54	44	èdèlè M 1
497	1886	2646	53	44	44	èdèlè M 2
524	1834	2830	63	43	38	èdèlè P 2
681	1310	2489	54	56	43	fàà E 1
707	1388	2122	58	53	45	fàà E 2
759	1441	2594	48	51	36	fàà J 1
733	1519	2410	54	55	44	fàà J 2
733	1336	2227	59	55	40	fàà M 1
707	1284	2017	61	58	42	fàà M 2
786	1388	2489	61	59	42	fàà P 1
812	1467	2148	53	45	42	fàà P 2
628	1310	2384	58	55	38	fàà Q

838	1572	2279	60	56	46	fàà	R
602	1205	2175	61	58	43	fàà	S
759	1415	2515	68	52	46	fàà	T
759	1441	2227	69	51	48	fàà	U
707	1231	2673	67	62	34	fàà	V
864	1624	2646	45	44	34	fàà	W
864	1703	2882	54	49	46	fàà	X
340	2017	2620	57	45	41	ìbì	E 1
366	2044	2725	59	42	41	ìbì	E 2
340	1991	2673	53	35	32	ìbì	E 3
366	2306	2856	67	44	37	ìbì	J 1
340	2279	2961	63	35	35	ìbì	J 2
288	1965	2804	62	49	44	ìbì	M 1
288	2017	2882	58	52	49	ìbì	M 2
340	2070	3223	68	39	39	ìbì	P 1
340	2384	3223	53	30	32	ìbì	P 2
366	1886	2620	62	46	47	ìbì	Q
393	1834	2646	70	41	43	ìbì	R
366	1913	2882	66	40	36	ìbì	S
340	1703	2882	65	39	42	ìbì	T
366	1991	2699	64	34	36	ìbì	U
393	1913	2961	67	51	41	ìbì	V
445	2358	3170	61	36	46	ìbì	W
419	2148	2751	64	40	42	ìbì	X
366	2070	2804	65	40	43	ùmà	E 1
366	2017	2777	58	47	33	ùmà	E 2
366	2306	2882	69	41	39	ùmà	J 1
393	2358	3039	70	41	41	ùmà	J 2
314	2122	2961	71	41	39	ùmà	M 1
314	2201	2961	66	49	52	ùmà	M 2
340	2463	3223	65	28	44	ùmà	P 1
366	2489	3302	47	28	22	ùmà	P 2
366	1939	2830	61	47	49	ùmà	Q
419	1939	2699	64	50	42	ùmà	R
419	1808	2882	56	41	40	ùmà	S
366	1808	2961	63	42	43	ùmà	T
366	2175	2908	66	42	39	ùmà	U
314	1939	2882	63	50	36	ùmà	V
393	2646	3328	56	33	35	ùmà	W
419	2646	3092	65	36	39	ùmà	X
419	1991	2673	53	40	24	jèè	E 1
419	1572	2542	58	42	36	jèè	E 2
445	1782	2673	65	40	28	jèè	J 1
419	1886	2620	52	40	31	jèè	M 1
445	1913	2620	58	48	44	jèè	M 2
393	1755	2987	58	31	37	jèè	P 1
419	2279	3092	54	35	31	jèè	P 1
497	1703	2489	54	36	35	jèè	Q
419	1782	2437	58	47	29	jèè	S
419	1729	2384	64	46	38	jèè	T
471	1913	2620	60	39	39	jèè	U
419	1965	2856	62	48	31	jèè	V
419	1048	2332	64	53	27	òbò	E 1

419	1074	2096	63	48	37	òbò	E 2
419	1179	2568	66	51	38	òbò	J 1
393	1100	2358	66	40	25	òbò	J 2
366	1022	2358	61	51	32	òbò	M 1
419	1074	2410	62	54	32	òbò	M 2
419	1048	2568	68	43	28	òbò	P 1
314	891	2096	55	51	32	ób↓ú	E 2
314	1048	2646	63	51	28	ób↓ú	J 1
340	995	2332	64	52	23	ób↓ú	J 2
288	943	2227	64	45	27	ób↓ú	M 1
288	943	2253	56	46	30	ób↓ú	M 2
340	812	2279	61	41	20	ób↓ú	Q
366	891	2201	58	44	22	ób↓ú	R
340	995	2437	59	33	28	ób↓ú	S
288	917	2279	51	34	25	ób↓ú	V
524	1126	2463	58	55	32	à	E 1
445	1100	2148	57	48	34	à	E 2
524	1100	2515	52	55	22	à	J 1
524	969	2122	61	58	46	à	J 2
471	969	2463	52	58	39	à	M 1
550	1048	2122	62	60	39	à	M 2
393	1048	1729	56	51	31	à	P 1
471	1048	2253	58	46	26	à	P 2
471	1126	2489	65	53	36	à	Q
550	1179	2306	65	53	41	à	R
419	969	2070	64	56	40	à	S
497	1048	2463	64	63	38	à	T
576	1153	2646	67	56	36	à	U
576	1074	2437	66	59	36	à	V
576	1284	2751	57	54	40	à	W
707	1415	3013	56	48	36	à	X
393	1022	2384	65	52	41	óó	E 1
445	1048	2227	65	58	43	óó	E 2
419	1153	2594	74	50	36	óó	J 1
393	1074	1782	72	52	43	óó	J 2
419	1022	2384	66	58	36	óó	M 1
471	1022	1703	67	59	35	óó	M 2
393	943	1624	70	53	34	óó	P 1
419	969	2463	47	37	20	óó	P 2
419	1048	2332	69	48	42	óó	Q
393	1126	2096	68	59	29	óó	R
419	1074	2148	65	43	31	óó	S
445	969	1782	69	60	40	óó	T
419	1022	1913	70	55	34	óó	U
471	1074	2096	62	50	38	óó	V
471	1022	—	60	48	—	óó	W
497	1336	2935	60	48	35	óó	X
655	1231	2594	56	53	36	ǎǎǎǎ	E 1
576	1231	2384	60	48	31	ǎǎǎǎ	E 2
786	1310	2594	49	40	23	ǎǎǎǎ	J 1
524	1179	2646	56	50	37	ǎǎǎǎ	J 2

471	1153	2332	58	52	36	śśśś	M 1
471	1231	2437	59	58	40	śśśś	M 2
602	1284	2489	54	56	35	śśśś	P 1
655	1179	2542	49	50	25	śśśś	P 2
393	1860	2515	64	56	42	tèè	E 1
393	1808	2489	66	50	44	tèè	E 2
419	1808	2673	60	38	32	tèè	J 1
393	1834	2568	65	45	42	tèè	M 1
419	2017	2699	64	54	52	tèè	M 2
419	2122	2777	61	42	38	tèè	P 1
445	1651	2332	63	30	42	tèè	P 2
419	1808	2568	59	42	41	tèè	Q
419	2201	3039	53	31	36	tèè	R
419	1703	2489	59	42	38	tèè	T
445	1965	2646	60	43	44	tèè	U
419	1886	2515	63	51	30	tèè	V
497	1519	2332	57	28	41	tèè	X
340	1074	2175	55	47	35	túúnǎ	E 1
340	943	2306	60	47	44	túúnǎ	E 2
366	1074	2489	71	44	23	túúnǎ	J 1
393	1074	2332	67	48	29	túúnǎ	J 2
340	1100	2332	59	47	43	túúnǎ	M 2
314	891	2515	63	41	34	túúnǎ	P 1
340	1048	2699	56	37	29	túúnǎ	P 2
340	1126	2306	68	48	34	túúnǎ	Q
366	1048	1808	70	56	34	túúnǎ	R
366	943	2358	65	40	35	túúnǎ	S
314	1022	2332	65	52	40	túúnǎ	T
366	1179	2358	63	46	33	túúnǎ	V
393	1126	2542	64	40	34	túúnǎ	W
445	1415	2463	60	34	17	túúnǎ	X

Table 2. Numerical data for the frequency (Hz) of the first three formants (F1, F2, and F3) and nasal formant (η) and the amplitude (dB) of the first three formants (A1, A2, and A3) and the nasal formant (AN) of the nasal vowels.

F1	F2	F3	N	A1	A2	A3	AN	Token
681	2227	2804	1598	48	33	41	46	dée E 1
393	1965	2673	1467	52	42	39	31	dée E 2
471	1755	2673	1100	48	50	41	44	dée J 1
393	1886	2882	812	60	41	29	53	dée J 2
524	1860	2620	917	57	53	42	37	dée M 1
655	1808	2777	1205	52	49	38	38	dée M 2
524	2017	2856	1467	52	47	38	39	dée P 1
602	2384	3092	1100	50	35	40	31	dée P 2
602	1651	2908	1179	61	45	37	40	dée R
419	1808	2489	1205	59	52	41	47	dée S
681	1782	2358	1231	61	48	43	45	dée T
576	1755	2856	—	65	52	46	—	dée U
445	1782	2725	—	60	52	38	—	dée V

524	2148	2935	1284	60	41	40	27	dée	W
628	2017	3249	1441	59	43	51	40	dée	X
419	786	2725	1388	56	39	31	34	obóó	P 2
366	891	2673	1441	60	40	26	32	obóó	E 1
471	917	2227	1572	58	54	41	33	obóó	E 2
393	943	2620	1519	68	52	31	36	obóó	J 2
497	969	2358	1388	60	38	37	32	obóó	M 1
445	891	2306	1493	55	58	38	33	obóó	M 2
497	917	2332	1388	55	47	35	36	obóó	P 1
393	891	2279	1519	57	43	24	16	obóó	R
445	1022	2463	1572	60	33	26	22	obóó	S
419	969	2253	1624	51	34	26	18	obóó	V
445	943	2673	—	50	34	15	—	obóó	W
393	1022	2437	1703	67	52	30	20	obóó	Q
864	1336	2751	—	48	56	32	—	sàà	E 1
786	1467	2332	—	51	53	31	—	sàà	E 2
943	1441	2620	—	50	47	37	—	sàà	J 1
943	1493	2594	—	46	47	36	—	sàà	J 2
812	1362	2279	—	55	60	43	—	sàà	M 1
707	1362	2332	—	64	54	39	—	sàà	M 2
812	1467	2620	—	50	47	38	—	sàà	P 1
838	1493	2542	—	61	57	23	—	sàà	P 2
733	1415	2568	—	39	45	27	—	sàà	Q
759	1493	2594	—	57	52	37	—	sàà	R
628	1493	2935	—	54	51	35	—	sàà	S
655	1467	2227	—	52	45	33	—	sàà	T
628	1519	2253	—	59	47	35	—	sàà	U
550	1388	2410	—	55	53	37	—	sàà	V
497	1782	3013	—	53	54	42	—	sàà	W
891	1755	2463	—	51	47	29	—	sàà	X
314	2148	2961	1336	56	25	25	36	sìì	E 1
366	2279	3354	1441	55	33	39	34	sìì	E 2
340	2122	2699	1336	64	26	33	23	sìì	J 1
340	2227	2646	1467	58	38	36	24	sìì	J 2
314	2096	2830	1205	69	28	27	30	sìì	M 1
314	2044	2725	1022	60	36	31	29	sìì	M 2
314	2279	2908	1231	55	25	30	34	sìì	P 1
340	2279	3013	1231	54	32	20	37	sìì	P 2
366	1834	2646	—	63	39	42	—	sìì	Q
366	2384	2987	1467	55	32	41	25	sìì	R
419	2017	2751	1153	61	36	33	37	sìì	S
314	1913	2751	1415	67	35	35	31	sìì	T
340	2122	2804	1126	64	33	32	40	sìì	U
366	2044	2751	917	67	45	40	43	sìì	V
393	2620	3223	—	61	46	44	—	sìì	W
497	2201	3066	1231	54	36	38	25	sìì	X
340	812	2175	1441	56	41	30	36	sùù	E 1
419	864	2201	1493	54	42	38	37	sùù	E 2
366	969	2096	1546	53	43	23	29	sùù	J 1

393	995	2489	1598	52	36	23	26	sùù	J 2
340	891	2332	1284	52	36	29	29	sùù	M 1
314	838	2253	1572	48	40	34	32	sùù	M 2
288	864	2332	1467	50	35	27	33	sùù	P 1
314	733	2306	1362	52	36	20	38	sùù	P 2
314	995	2437	1677	62	41	32	24	sùù	Q
419	1074	2463	1441	50	44	27	28	sùù	R
393	1100	2437	1519	58	42	31	33	sùù	S
340	891	2279	1441	57	46	43	36	sùù	T
340	1074	2306	—	62	43	31	—	sùù	U
419	1048	2463	1598	66	51	42	37	sùù	V
366	1048	2437	1624	64	43	38	41	sùù	W
366	1126	2515	1572	54	36	25	32	sùù	X

Table 3. Numerical data for the fundamental frequency (F0) (Hz) of oral vowels.

F0	Token	181	ìbì	W coda	190	òbò	S onset
111	ìbì E 1 onset	181	ìbì	X onset	161	òbò	S coda
91	ìbì E 1 coda	149	ìbì	X coda	200	òbò	W onset
101	ìbì E 2 onset	88	jèè	E 1	172	òbò	W coda
86	ìbì E 2 coda	90	jèè	E 2	167	òbò	X onset
104	ìbì E 3 onset	148	jèè	J 1	138	òbò	X coda
88	ìbì E 3 coda	119	jèè	M 1	93	àà	E 1
156	ìbì J 1 onset	114	jèè	M 2	92	àà	E 2
140	ìbì J 1 coda	127	jèè	P 1	130	àà	J 1
153	ìbì J 2 onset	135	jèè	P 2	166	àà	J 2
148	ìbì J 2 coda	102	òbò	E 1 onset	110	àà	M 1
114	ìbì M 1 onset	91	òbò	E 1 coda	102	àà	M 2
100	ìbì M 1 coda	101	òbò	E 2 onset	126	àà	P 1
111	ìbì M 2 onset	95	òbò	E 2 coda	124	àà	P 2
96	ìbì M 2 coda	150	òbò	J 1 onset	91	fàà	E 1
148	ìbì P 1 onset	143	òbò	J 1 coda	86	fàà	E 2
132	ìbì P 1 coda	158	òbò	J 2 onset	130	fàà	J 1
143	ìbì P 2 onset	148	òbò	J 2 coda	141	fàà	J 2
117	ìbì P 2 coda	114	òbò	M 1 onset	108	fàà	M 1
144	ìbì Q onset	93	òbò	M 1 coda	105	fàà	M 2
136	ìbì Q coda	113	òbò	M 2 onset	131	fàà	P 1
180	ìbì R onset	99	òbò	M 2 coda	128	fàà	P 2
165	ìbì R coda	140	òbò	P 1 onset	101	tèè	E 1
192	ìbì S onset	122	òbò	P 1 coda	92	tèè	E 2
161	ìbì S coda	140	òbò	P 2 onset	143	tèè	J 1
153	ìbì T onset	119	òbò	P 2 coda	135	tèè	J 1
143	ìbì T coda	150	òbò	P 3 onset	135	tèè	J 2
140	ìbì U onset	124	òbò	P 3 coda	109	tèè	M 1
131	ìbì U coda	174	òbò	Q onset	100	tèè	M 2
136	ìbì V onset	153	òbò	Q coda	132	tèè	P 1
121	ìbì V coda	176	òbò	R onset	135	tèè	P 2
213	ìbì W onset	161	òbò	R coda			

Table 4. Numerical data for the duration (seconds) of short and long vowels.

Dur	Token	.1067	ìbì	E 2	.1127	ób↓ú	S
.1061	ápá E 1	.0935	ìbì	E 3	.0946	ób↓ú	W
.1072	ápá E 2	.1733	ìbì	J 1	.3418	óó	E 1
.1098	ápá J 1	.1080	ìbì	J 2	.3074	óó	E 2
.1332	ápá J 2	.1221	ìbì	M 1	.3767	óó	J 1
.1051	ápá M 1	.1233	ìbì	M 2	.3318	óó	J 2
.0909	ápá M 2	.1157	ìbì	P 1	.3239	óó	M 1
.1131	ápá P 1	.0852	ìbì	P 2	.3159	óó	M 2
.0979	ápá P 2	.0901	ìbì	Q	.4198	óó	P 1
.0733	ápá Q	.1348	ìbì	R	.3936	óó	P 2
.0944	ápá R	.0997	ìbì	S	.2966	óó	Q
.0987	ápá T	.1059	ìbì	T	.2938	óó	R
.1028	ápá U	.0931	ìbì	U	.2700	óó	S
.0785	ápá V	.0897	ìbì	W	.3160	óó	T
.0864	ápá W	.0693	ìbì	X	.2636	óó	U
.1063	ápá X	.1875	ììmà	E 1	.2025	óó	V
.1002	èbè E 1	.2143	ììmà	E 2	.3235	óó	W
.1463	èbè E 2	.1582	ììmà	J 1	.2547	óó	X
.1484	èbè J 1	.1979	ììmà	J 2	.2743	tèè	E 1
.1107	èbè J 2	.1815	ììmà	M 1	.2443	tèè	E 2
.1050	èbè M 1	.1730	ììmà	M 2	.2679	tèè	J 1
.1022	èbè M 2	.2040	ììmà	P 1	.2145	tèè	J 2
.1160	èbè P 1	.2007	ììmà	P 2	.2789	tèè	M 1
.0931	èbè P 2	.1970	ììmà	Q	.2467	tèè	M 2
.0932	èbè Q	.1998	ììmà	R	.2773	tèè	P 1
.1056	èbè R	.2116	ììmà	S	.2646	tèè	P 2
.1095	èbè S	.2540	ììmà	T	.1863	tèè	Q
.1113	èbè T	.2077	ììmà	U	.1806	tèè	R
.1297	èbè U	.1818	ììmà	V	.2130	tèè	T
.0835	èbè V	.2315	ììmà	W	.2234	tèè	U
.0833	èbè W	.1581	ììmà	X	.1874	tèè	V
.0801	èbè X	.0696	òbò	E 1	.1972	tèè	W
.2521	fàà E 1	.0992	òbò	E 2	.1772	tèè	X
.2267	fàà E 2	.1007	òbò	J 1	.1740	túúnṣ	E 1
.2509	fàà J 1	.1142	òbò	J 2	.1613	túúnṣ	E 2
.2408	fàà J 2	.1200	òbò	M 1	.1298	túúnṣ	J 1
.2683	fàà M 1	.1212	òbò	M 2	.1542	túúnṣ	J 2
.2250	fàà M 2	.1213	òbò	P 1	.1320	túúnṣ	M 2
.2731	fàà P 1	.1164	òbò	P 2	.1673	túúnṣ	P 1
.2578	fàà P 2	.1351	ób↓ú	E 1	.1707	túúnṣ	P 2
.1876	fàà Q	.1526	ób↓ú	E 2	.1227	túúnṣ	Q
.2885	fàà R	.1237	ób↓ú	J 1	.1447	túúnṣ	R
.2129	fàà S	.1367	ób↓ú	J 2	.1177	túúnṣ	S
.2106	fàà T	.1250	ób↓ú	M 1	.1612	túúnṣ	T
.2095	fàà U	.1244	ób↓ú	M 2	.1235	túúnṣ	V
.2217	fàà V	.1595	ób↓ú	P 1	.1899	túúnṣ	W
.2167	fàà W	.0778	ób↓ú	Q	.1381	túúnṣ	X
.2032	fàà X	.1100	ób↓ú	R			
.1074	ìbì E 1						

Table 5. Numerical data for the duration (seconds) of voice onset time (VOT).

VOT	Token		.0206	pàrà X	.0403	kàrì P 2
.0136	pàrà	E 1	.0303	kàrì Q	.0142	taátú Q
.0131	pàrà	E 2	.0209	kàrì R	.0212	taátú R
.0168	pàrà	J 1	.0298	kàrì S	.0255	taátú S
.0162	pàrà	J 2	.0341	kàrì T	.0251	taátú T
.0111	pàrà	M 1	.0233	kàrì U	.0150	taátú V
.0102	pàrà	M 2	.0277	kàrì V	.0170	taátú V
.0067	pàrà	P 1	.0562	kàrì X	.0432	taátú W
.0188	pàrà	P 2	.0284	kàrì W	.0169	taátú X
.0215	pàrà	Q	.0140	kàrì E 1	.0171	taátú E 1
.0136	pàrà	R	.0265	kàrì E 2	.0213	taátú E 2
.0204	pàrà	S	.0308	kàrì J 1	.0140	taátú J 1
.0389	pàrà	T	.0282	kàrì J 2	.0089	taátú J 2
.0200	pàrà	U	.0310	kàrì M 1	.0150	taátó M 1
.0211	pàrà	V	.0238	kàrì M 2	.0223	taátó M 2
.0225	pàrà	W	.0307	kàrì P 1	.0100	taátó P 1
					.0301	taátó P 2

Table 6. Numerical data for the closure duration (seconds) of intervocalic consonants.

Dur	Token		.0737	ápá R	.0720	èbè V
.0911	àkàdà	E 1	.0681	ápá S	.1064	èbè W
.0799	àkàdà	E 2	.0858	ápá T	.1089	itò E 1
.0703	àkàdà	J 1	.1020	ápá U	.1044	itò E 2
.0625	àkàdà	J 2	.0881	ápá V	.0816	itò J 1
.1001	àkàdà	M 1	.0667	ápá W	.0925	itò J 2
.0814	àkàdà	M 2	.0813	ápá X	.1089	itò M 1
.1000	àkàdà	P 1	.1016	èbè E 1	.0959	itò M 2
.0789	àkàdà	P 2	.0909	èbè E 2	.1120	itò P 1
.0899	àgàrà	E 1	.0830	èbè J 1	.1075	itò P 2
.0685	àgàrà	E 2	.0953	èbè J 2	.0708	itò Q
.0547	àgàrà	J 1	.0742	èbè M 1	.0958	itò R
.0672	àgàrà	J 2	.0770	èbè M 2	.0762	itò S
.0945	àgàrà	M 1	.0597	èbè P 1	.0721	itò T
.0595	àgàrà	M 2	.0741	èbè P 2	.0947	itò U
.1135	àgàrà	P 1	.0840	èbè P 3	.0622	itò V
.0787	àgàrà	P 2	.0768	èbè Q	.1345	itò W
.0369	àgàrà	Q	.0859	èbè R	.1003	itò X
.0802	àgàrà	R	.0705	èbè S	.0903	idò E 1
.0543	àgàrà	S	.0734	èbè T	.0962	idò E 2
.0634	àgàrà	T	.0585	èbè U	.0855	idò J 1
.0672	àgàrà	U	.0665	èbè V	.0771	idò J 2
.0496	àgàrà	V	.0961	èbè W	.1141	idò M 1
.0942	àgàrà	W	.0721	èbè X	.1014	idò M 2
.0796	àgàrà	X	.1059	èùè E 1	.0928	idò P 1
.1252	ápá	E 1	.0888	èùè E 2	.0909	idò P 2
.1133	ápá	E 2	.0849	èbè J 1	.0703	idò Q
			.1068	èbè J 2		

.1079	ápá	E 2	.0969	èbè	M 1	.1135	ìdò	R
.0909	ápá	J 1	.1001	èbè	M 2	.0729	ìdò	S
.0762	ápá	J 2	.0785	èbè	P 1	.0790	ìdò	T
.1276	ápá	M 1	.0840	èbè	P 2	.0758	ìdò	U
.1076	ápá	M 2	.0768	èbè	Q	.0700	ìdò	V
.1002	ápá	P 1	.0984	èbè	R	.0844	ìdò	W
.1199	ápá	P 2	.0758	èbè	S	.0954	ìdò	X
.0769	ápá	Q	.0747	èbè	T			
			.0717	èbè	U			

Table 7. Numerical data for the fundamental frequency (Hz) at the onset (ON), middle (M), and offset (OF) of the vowel.

ON	M	OF	Token	149	133	114	bàà	J 1
104	101	97	ápá E 1	136	118	102	bàà	J 2
101	101	96	ápá E 2	114	99	87	bàà	M 1
145	147	138	ápá J 1	112	101	88	bàà	M 2
67	69	66	ápá J 2	132	124	115	bàà	P 1
118	114	114	ápá M 1	132	120	109	bàà	P 2
117	115	114	ápá M 2	113	102	91	káà	E 1
143	140	132	ápá P 1	104	101	90	káà	E 2
138	136	134	ápá P 2	165	157	117	káà	J 1
96	89	83	bàà E 1	172	169	128	káà	J 2
96	90	84	bàà E 2	124	114	101	káà	M 1
114	106	97	káà M 2	97	90	88	kpá↓á	E 1
147	134	130	káà P 1	95	87	82	kpá↓á	E 2
135	131	117	káà P 2	174	170	126	kpá↓á	J 1
97	96	96	dàá E 1	147	140	121	kpá↓á	J 2
88	90	93	dàá E 2	128	121	100	kpá↓á	M 1
87	88	101	dàá J 1	115	110	96	kpá↓á	M 2
108	109	130	dàá M 1	101	96	88	kpá↓á	P 1
97	99	112	dàá M 2	132	128	121	kpá↓á	P 2
128	123	149	dàá P 1					
127	124	139	dàá P 2					