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THE FORTIS FEATURE IN JJU (KAJE): AN INITIAL STUDY[1]

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The fortis feature in JJu (more widely known as Kaje) divides the consonants of the language (except the simultaneous labio-velar plosives kp and gb) into a set of fortis ones and a set of their lenis counterparts. Minimal pairs and other words contrasting in the presence or absence of the fortis feature were studied with the aid of spectrograms, oscillo-grams, and a tape repeater-segmenter system for isolating time portions and measuring their durations. A variety of acoustic cues to the fortis feature was observed. The time span of a consonant is partitioned here into complete occlu-sion, partial occlusion and final transition. The principal experimental result reported here is that the partial occlu-sion portion of the fortis plosives and affricates was found to be consistently longer than that of the lenis ones.

1. Introduction

Jju[2] has a contrast occurring in the prevocalic consonants of noun roots and verb stems that I have chosen to call a fortis-lenis contrast. This choice is based on the auditory impression that fortis consonants are more prominent in various ways, not just longer, which accords with experimental results out-lined below. No claim is made here that this contrast in Jju can "be correlat-

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[1]Jju /ju/ , more widely known as Kaje, is spoken by a people known as the Bajju /bəju/ . According to Greenberg [1966] Kaje is a Benue-Congo Plateau 2a language. The home area of the Bajju is in Kaduna State, Nigeria, extend-ing roughly from Kafanchan at the southeast edge of the area to Kachia at the northwest tip. The 1963 Nigeria census counted 148,459 adult Kaje people in Kaduna State; many live elsewhere.

[2]A full-length paper on this study was presented at the 12th Congress of the West African Linguistic Society, 14-20th March, 1976, University of Ifé, Ile-Ifé, Nigeria. The manuscript of that paper and the data tape for speaker KTM were lost in a subsequent move from Nigeria. The present summary is writ-ten from a record of the measurements made on spectrograms and oscillograms and from memory.

ed with greater, as opposed to less, force being exerted by the respiratory system..., which would seem to be the proper domain of the fortis/lenis labels" according to Ladefoged [1964]. Williamson [1977], in discussing a multivalued feature of length for consonants, summarized reports on the nature and function of fortis-lenis contrasts in three Upper Cross languages and some Ẹdo languages of Nigeria. Debrock [1980] described experiments in which he confirmed that shortened rise time of the intensity of the postconsonantal vowel is a correlate of increased force of consonant articulation in Korean, French and Dutch.

Gerhardt [1980] discussed the role of the fortis-lenis contrast in the development of Plateau languages. In concluding his discussion of "the Central group of the Plateau 2-languages" he says: "In this group the fortis consonants are the marked members of the lenis-fortis congeners. They are marked by length and other articulatory characteristics, e.g. affriction [sic] in case of plosives."

A feature specification of Jju consonants is given in Table 1. Modification of consonants by the features [+ palatalized], [+ labialized] and [+ fortis] is illustrated by the following words. (The feature [+ fortis] is symbolized by a dot under the consonant letter.)

kam	'to scold'	nḳaŋ	'stories'
kʸaŋ	'thing'	ḳʸay	'to mix'
kʷak	'to drag (pl.)'	ḳʷat	'to drag (sg.)'

Labialized consonants are phonetically labio-velarized. Unvoiced plosives are phonetically either aspirated or else followed by a fricative that is not necessarily homorganic. There are many fortis voiced consonants and many lenis unvoiced consonants; the fortis and voicing features are independent, except for some relatively minor restrictions on formation rules.

Voiced plosives modified by the feature [+ palatalized] usually are followed phonetically by a voiced alveolar fricative [z] . The voiced labial consonant /b/ modified by the feature [+ labialized] usually is followed phonetically by the voiced labial fricative [v] . These fricatives account for the non-zero duration of the partial occlusion of tokens of /b/ in Figure 3.

Patterns of absence in our lexical data indicate some formation rules. For example, in the surface structure a fortis labial consonant is always modi-

	Plosives								Nasals			Sibilants						Glides				
	Labial		Alveo.		Velar		Labio-velar					Alveolar			Palatal							
	p	b	t	d	k	g	kp	gb	m	n	ɲ	s	ts	dz	ʃ	tʃ	dʒ	r	w	ɯ	ɥ	y
Anterior	+	+	+	+	-	-	+	+	+	+	-	+	+	+	-	-	-	+	-	-	-	-
Coronal	-	-	+	+	-	-	-	-	-	+	-	+	+	+	+	+	+	+	-	-	-	-
High	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-
Back	-	-	-	-	+	+	+	+	-	-	+	-	-	-	-	-	-	-	+	+	-	-
Round	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-
Continuant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+
Nasal	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-	-	-	-
Strident	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	-	-	-	-	-
Delayed Release	-	-	-	-	-	-	-	-	-	-	-	-	+	+	-	+	+	-	-	-	-	-
Voiced	-	+	-	+	-	+	-	+	+	+	+	-	-	+	-	-	+	+	+	-	+	-
Vocalic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Consonantal	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-
Orthog. Symbol	p	b	t	d	k	g	kp	gb	m	n	ng	s	ts	z	sh	c	j	r	w	hw	yw	hyw	y
Co-occurrences																							
Fortis Unglided					x	x				x		x	x	x				x					
Labialized	x	x	x		x	x	x		x		x	x	x	x	x	x	x	xx	+	+	+	+	ɥ
Fortis + Lab.	x	x			x	x						x	x	x	x	x	x		+	+	+	+	ɥ
Palatalized	x	x	x	x	x	x	x	x	x	x								xx			+	+	+
Fortis + Pal.	x	x	x		x				x	x					x	x	x				+	+	+

x = occurrence of the form
+ = intrinsically of the form

Table 1. Jju consonants. Some transcriptions in this paper use the orthographic symbols z , c and j in place of dz , tʃ and dʒ , respectively. The feature [+ fortis] is transcribed with a dot under the consonant letter(s) (e.g. t̤s , z̤). The features [+ labialized] and [+ palatalized] are transcribed with superscripts (e.g. tʷ , tʸ).

fied by a secondary articulation. This could be the result either of a formation rule or else of an obligatory rule that rewrites unmodified fortis labial consonants as [+ labialized].

ban	'to climb (contin.)'	*b̥a(C)	
bʷan	'to turn (contin.)'	b̥ʷa	'to dip (aor.)'

This study began with the fairly safe hypothesis, based on casual listening, that in most cases fortis consonants are longer than their lenis counterparts. Questions which the study tried to resolve are: What specific aspects of the consonant articulation are lengthened? And what are the other cues to the fortis feature in the speech wave?

2. Definitions

The time span of a consonant is partitioned here into complete occlusion, partial occlusion, and final transition, defined as follows: *Complete occlusion* refers to complete closure of both the oral and nasal passages to air flow through them. *Partial occlusion* refers to a period starting at the end of the complete occlusion, or at the beginning of the consonant if there is no complete occlusion. It continues as long as there is significant aspiration, frication, or impedance to air flow through the oral passageway. *Final transition* refers to a period of continued formant transition to the following vowel. It begins at the end of the partial occlusion.

The partial occlusion of a fully developed plosive or affricate is composed of the transient, fricative, and aspirative segments of Fant's analysis [1973]. For any other consonants the partial occlusion starts at the beginning of the consonant itself. Thus for a nasal most of the duration belongs to the partial occlusion.

Partial occlusion, as defined above, is a relatively simple construct that can be applied to a wide range of consonant articulations. For the unvoiced consonants it is not the same as voice onset time (VOT), and for some of the fortis consonants the quantitative difference between the two is large. The definition of partial occlusion was based on the author's intuition of the phonetic correlates of the systemic feature [+ fortis]. The duration of partial occlusion was found in this study to be consistently longer for fortis Jju consonants than for lenis ones.

3. Methods and Results

Data illustrating several phenomena were recorded from two adult male speakers. Sets of words illustrating the fortis-lenis contrast, some of which were used in this study, are listed in Table 2.

bo	'again'
b̥ò	'refuse, chase away'
b̥ó	'to know, understand'
kaat	'to disregard'
kat	'to go about'
k̥at	'to cut (grass)'
yl	'you (subj. pron., pl.)'
y̥l	'to steal'
nʸak	'cow'
n̥ʸak	'to hide (something), pl.'
nʸat	'to hide (something), sg.'
rak	'to refuse'
r̥ak	'to lick'
rʸa	'heart, liver'
r̥ʸa	'to have contempt'
fʷl	'to become furious'
b̥ʷl	'to rest'
jl	a noun class marker
j̥l	'to repair, correct'
tʸak	'to finish'
t̥ʸak	'to cut'
zuk	'millet'
z̥u	'to hit (sg.)'
zam	'young men'
z̥ak	'to dream'
cet	'strength'
c̥et	'a trip'
ku	3 sg. obj. pronoun
k̥u	'root, tuber'
ga	'may' (particle in VP)
g̥a	'to try hard'
ya	'to eat'
y̥a	'to do, make'
ʃek	'to move oneself, sg.'
ʃ̥ek	'to move oneself, pl.'
cot	'to carry on the head, sg.'
c̥ok	'to carry on the head, pl.'
run	'to carry on the back, sg.'
r̥uŋ	'to carry on the back, pl.'
ʍa	'to think'
m̥a	'lump (as in food)'
cam	'to watch (guard)'
c̥aŋ	'to look at'
bʸi	'bedbug'
b̥ʸi	'to have, own, possess'
bʸey	'to greet, pl.'
b̥ʸek	'to greet, sg.'

Table 2. Examples of the fortis-lenis contrast in Jju.

Data were recorded from one speaker (KMC) in a single session in 1971 and from the second speaker (KTM) in a single session in 1976. The test words were embedded in the frame / ə y̥a ___ brak/ 'He said ___ again', except for six tokens from KMC. A total of 50 utterances by KMC and 72 by KTM were studied to investigate the phonetic nature of the fortis-lenis contrast.

Phonetic correlates of the specification [+ fortis] in Jju were studied with the aid of spectrograms, oscillograms, and a tape repeater-segmenter system for listening to and measuring the duration of precisely selected time-spans of the speech wave. The results are summarized in Table 3.

Vocalic Environment:		e,i,y		o,u,w		a	
		Partial Occlusion	Final Transition	Partial Occlusion	Final Transition	Partial Occlusion	Final Transition
Sibilants							
Plain alveolar	s	L	L	L	L	-------	
Affric. alv.	ts,dz(z)	L	L	L	L	L	L
Plain palatal	ʃ	L	L	L	L	L	L
Affric. pal.	tʃ(c),dʒ(j)	L	L	L	L	L	L
Plosives							
Labial	p,b	L,!	L	L,!	L	-------	
Alveolar	t	h → s/L,!	L	-------		-------	
Velar	k,	h → x	L	h → x	L	h → x	
	g			L	L	L	
r	r	r → r̃/ɹ	L	r → r̃/ɹ	L	r → r̃/ɹ	
Semivowels							
Unvoiced	ʍ,ɥ	L,!	L	L,!	L	L,!	L
Voiced	w,ɥ,y	!	L	!	L	!	L
Nasals	m,n,ŋ	L	L	L	L	L	

Key: L Phonetic feature of fortis sound is longer than that of lenis counterpart.
! Closer articulation and/or intensified or lengthened post-release frication.

Table 3. Acoustic phonetic cues to the feature specification "fortis" in Jju.

The phonetic correlates of the fortis feature were found to be in some ways fairly diverse, as may be seen in the illustrations below. Several of the correlates in Jju are similar to those described for Cajonos Zapotec by Nellis and Hollenbach [1980].

The frequency of the first formant was found to be lower at the onset of fortis /y̰/ than it was for lenis /y/ , as in

[ya] 'to eat' [y̰·a] 'to do'

Similarly, the second formant frequency at the onset of /y̰/ was higher. And the time duration of fortis semi-vowels, measured from the onset of the semi-vowel to the point of formant transition to the next vowel, was greater than that of lenis ones. These physical observations correlate with the auditory impression from listening casually and with the repeater-segmenter that the articulation of fortis semi-vowels is closer and longer than that of corresponding lenis ones.

Affrication or a heterorganic fricative may be added, intensified or lengthened, or it may be substituted for aspiration, as in

[kʰʷak] 'to drag (pl.)' [kxʷat] 'to drag (sg.)'
[bʏ̰ey] 'to greet (pl.)' [bzʏ̰·ək] 'to greet (sg.)'

Either a trilled articulation or else a retroflexed articulation may be substituted for a flap articulation, as in

[ɾak] 'to refuse' [ɾak] or [ɹak] 'to lick'

And a nasal becomes lengthened, as in

[nʏ̰ak] 'cow' [nʏ̰·ak] 'to hide'

Although there is a variety of phonetic correlates of the fortis feature, that portion of the articulation which we have defined here as the partial occlusion was found in these data to be consistently longer for the fortis consonants than for the lenis ones. The durations measured for the complete occlusion and partial occlusion portions of the plosives and affricates in these data are plotted in graphs in Figures 1, 2 and 3. Data for a few cases where the boundaries of the complete occlusion and/or partial occlusion portions of the consonant were especially indistinct and the measurements therefore of more doubtful accuracy are plotted with symbols in parentheses.

For most of these consonants the period of complete occlusion was taken to be the whole of the silent interval from the [a] in / y̰a / in the sentence frame to the beginning of the partial occlusion. The exception to this was for those tokens in which there was obviously a long pause between frame and substitution item, in which the speaker hesitated due to uncertainty about the

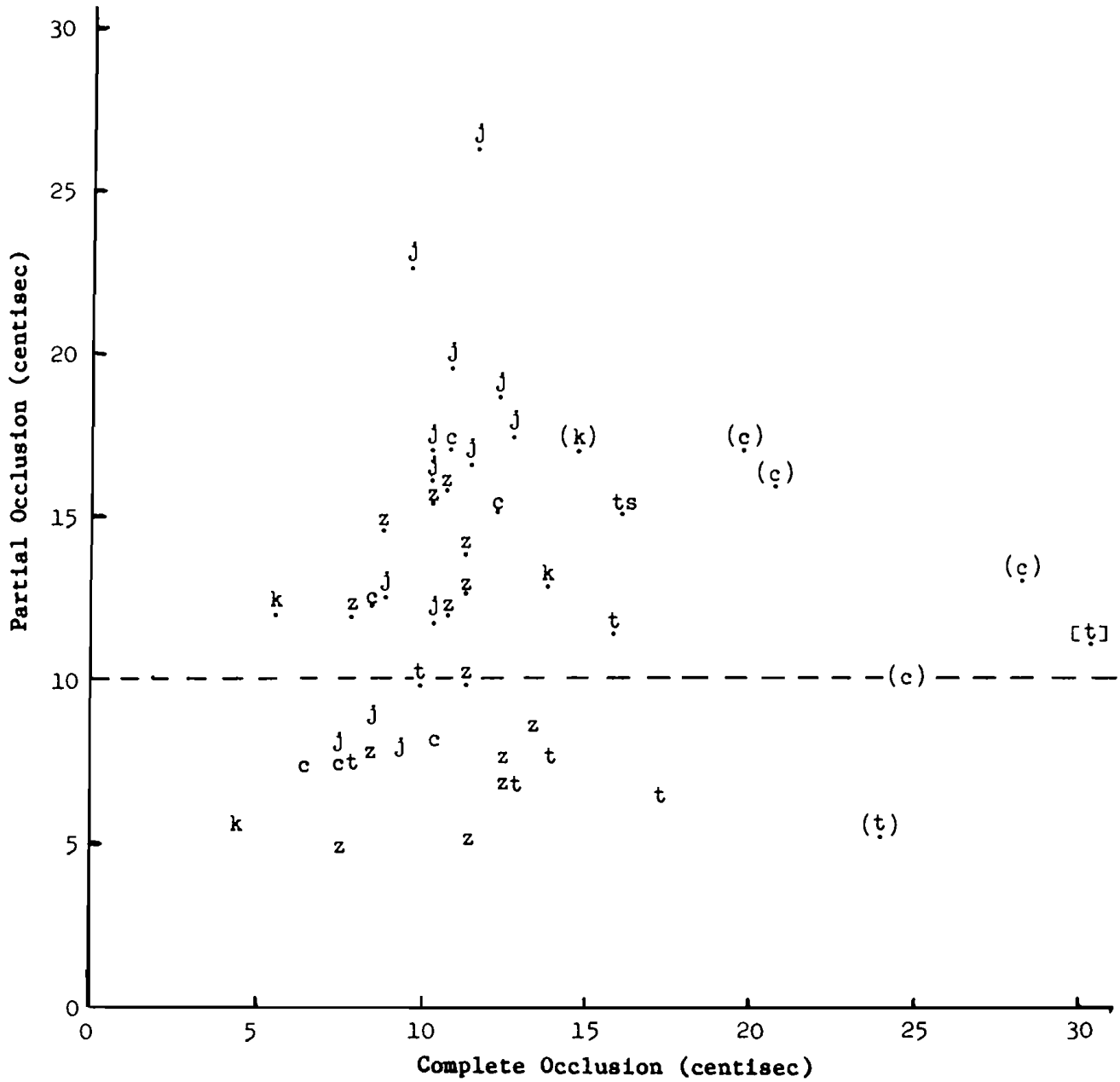

Figure 1. Durations of partial and complete occlusion for lenis and fortis obstruents in Jju: Speaker KMC.

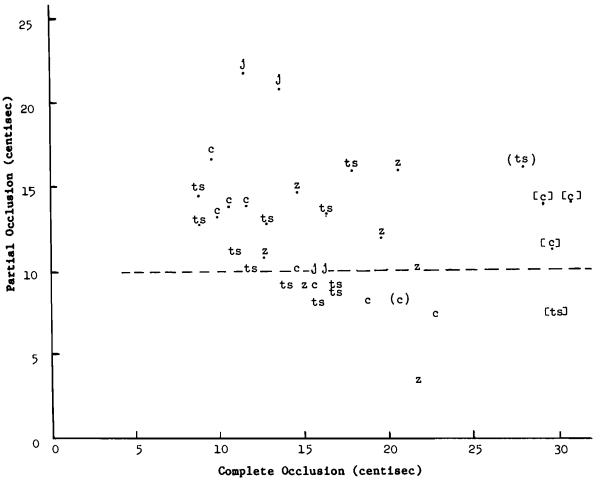

Figure 2. Durations of partial and complete occlusion for lenis and fortis affricates in Jju: Speaker KTM.

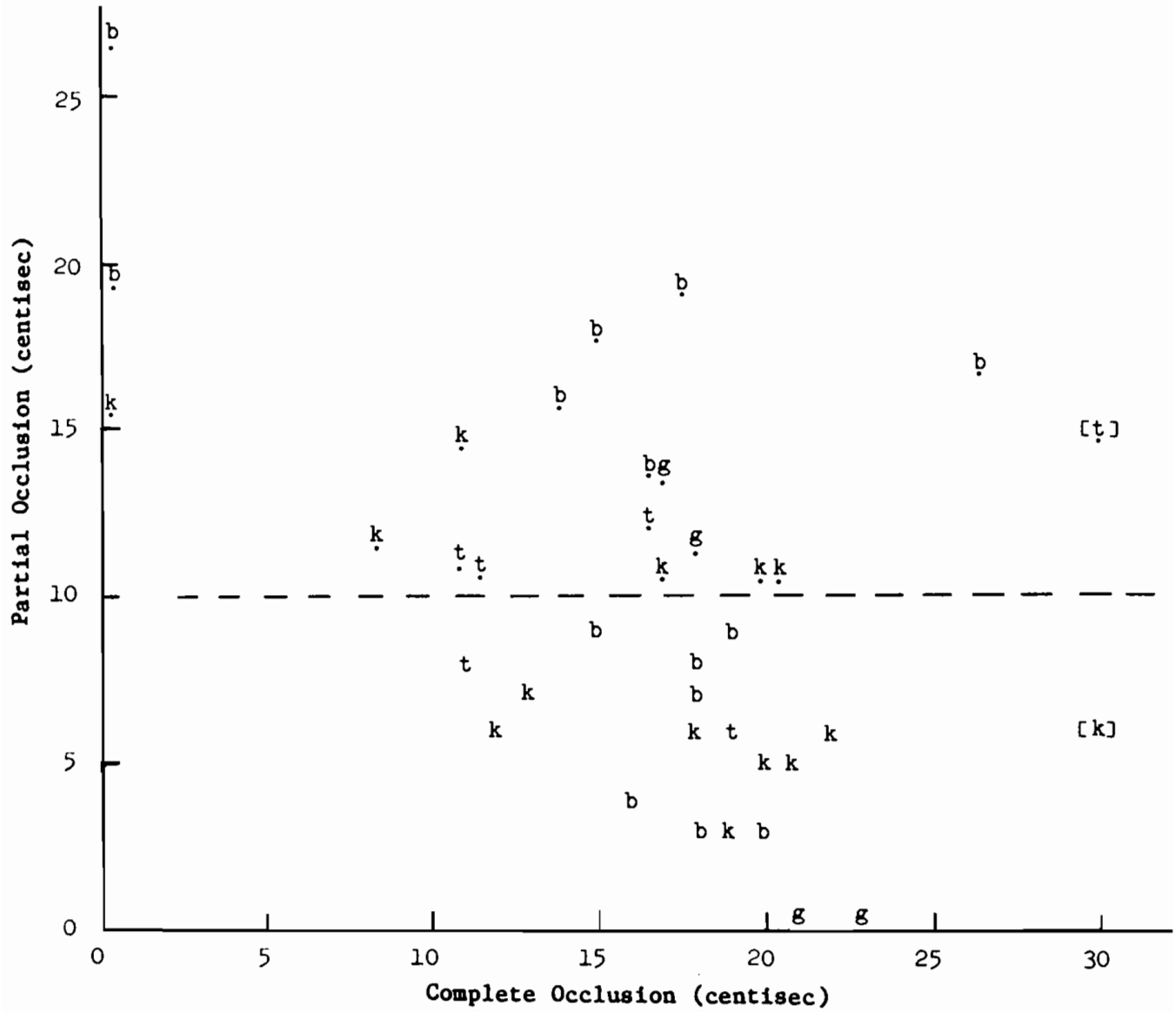

Figure 3. Durations of partial and complete occlusion for lenis and fortis plosives in Jju: Speaker KTM.

word he was to pronounce. The partial occlusion durations for these tokens are plotted at the right (30 cs abscissa) with symbols in square brackets.

Duration of the partial occlusion was plotted versus duration of the complete occlusion in these graphs. This was done in the expectation that although durations might vary with speaking rate, the variations would be correlated in such a way that the fortis consonants and lenis consonants would occupy regions of the graph roughly partitioned by a diagonal line. It was found that the separation of fortis consonants from lenis consonants in these data according to durations was simpler and more nearly complete than had been expected. For most of the data from both speakers, the duration of partial occlusion for fortis consonants is greater than or equal to 10 cs, and that for lenis ones is less than 10 cs.

4. Summary

The fortis feature in Jju is manifested by a variety of phonetic features, including in most cases a lengthened period of partial occlusion. For fortis obstruents this period was found to be consistently greater than or equal to 10 cs, and for lenis ones it was less than 10 cs. The fortis feature applies to all the consonants of Jju except kp and gb .

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