Variation in the Acoustic Structure of Defaka Vowels

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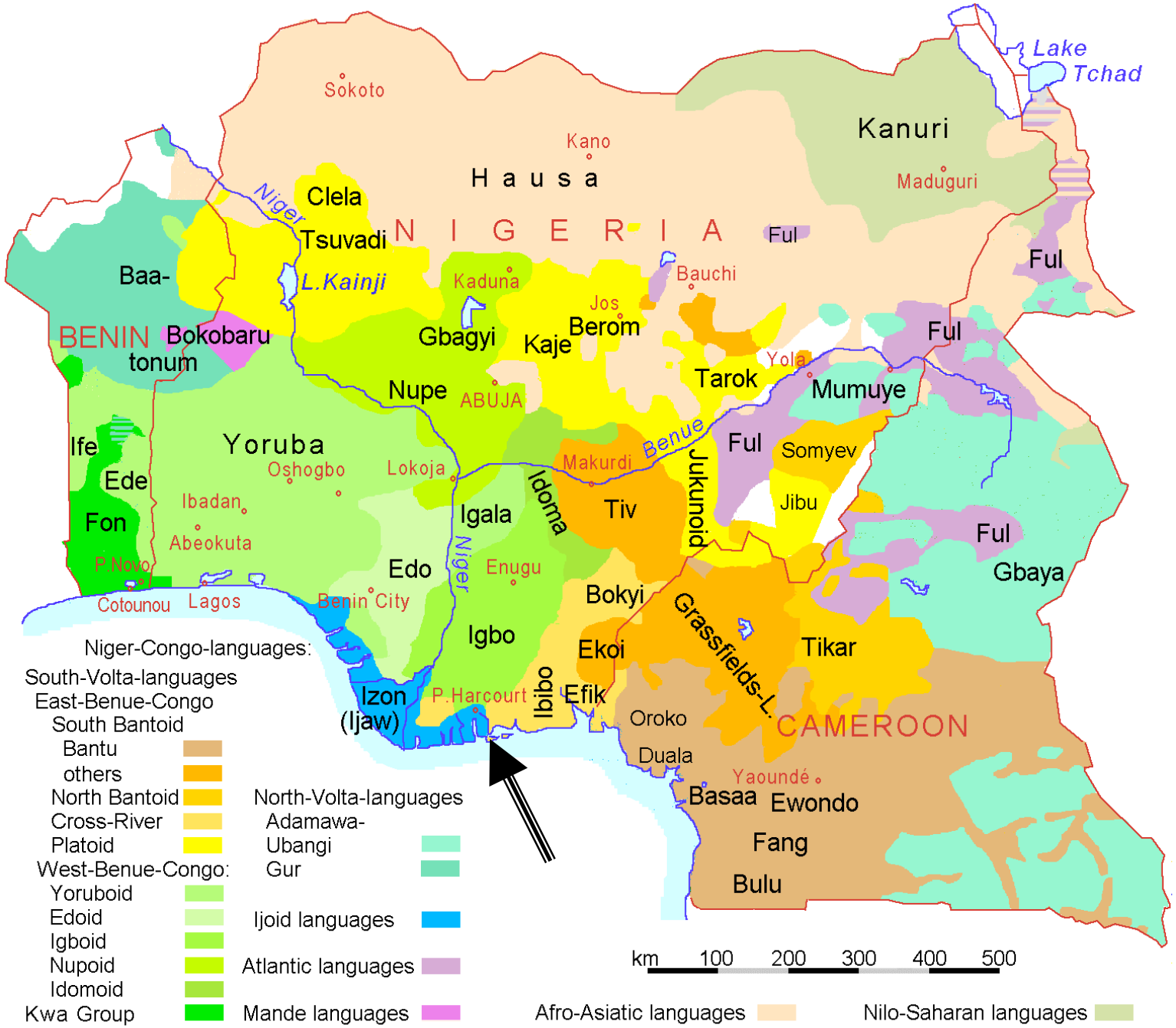
Overview

- Defaka background
- research on Defaka phonetics and phonology
- competing views on the role of [ATR] in Defaka
- acoustic measures of [ATR]
- acoustic structure of Defaka vowels
- the role of [ATR] in Defaka?
  - methodology; results; discussion
- summary, acoustic structure of Defaka vowels
- some general observations
  - loss of [ATR]
  - variation and language contraction

Defaka background

- Defaka spoken in one ward of Nkoroo town in SE Nigeria
- spoken fluently by fewer than 50 people; intergenerational transmission is largely broken
- Nkoroo is the language of daily use for all Defaka
- long-standing relationship between Defaka and Nkoroo; Nkoroo do not learn Defaka
- Nkoroo is itself endangered; both languages targets of documentation work
- both are Ijoid languages, with Defaka a branch on its own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Research on Defaka

- existing research on Defaka is minimal, at any level
- Jenewari (1983)
- Bob-Manuel (1990)
- Shryock, Ladefoged & Williamson (1996/7)
- Williamson (1998)
- Akinlabi et al (2009)
- Connell et al (2009)
- Connell et al (2010)

Present research on Defaka

- investigation of the Defaka vowel system
- concerned with the phonetic nature of Defaka vowels
- how the system has and is undergoing change as the life of language comes to a close
- manifested in change in its phonetics as well as its phonology; i.e. the number of contrasts and how they are realized, the role of vowel harmony
- prompted by the current state of the Defaka vowel system in light of the Proto Ịjọ 5 + 5 [ATR] system proposed by Williamson (unpublished ms)

Competing views on the role of [ATR] in Defaka (1)

- Jenewari (1983)

symmetrical nine vowel system like most other Ijoid languages, with [±ATR] contrast in high and mid vowels:

i	ɪ	ʊ	u
e	ɛ	ɔ	o
	ɑ		

Competing views on the role of [ATR] (2)

- Jenewari (1983), proposed examples of [ATR] contrast in high vowels:

i / ɪ	kìà	‘market’	pìrà	‘oil’
			tìà	‘put on clothes”
u / ʊ	mbùà	‘bone’	tʊ̀à	‘cook’
	sùà	‘enter’		

Competing views on the role of [ATR] (3)

- Shryock, Ladefoged & Williamson (1996/97)
  - informed largely by Bob-Manuel (1990)
- seven oral vowels: / i, e, ɛ, ɑ, ɔ, o, u /
- contrary to Jenewari, SLW argue against an [ATR] contrast, except possibly for /o/ – /ɔ/
- /e/ – /ɛ/ contrast realized only in F1, and as such is considered to be one of height rather than [ATR]
- SLW make no mention of /ɪ/ or /ʊ/; presumably found no evidence of these vowels, or at least that they are contrastive

Competing views on the role of [ATR] (4)

- so, two divergent and conflicting views of the Defaka vowel system:
  - – Jenewari's, which recognizes an ATR distinction in high and mid vowels;
  - – SLW's, which does not have the contrast and does not recognize mention /ɪ/ and /ʊ/
- contradiction may be symptomatic of a system in flux;
- it is possible different Defaka speakers have different numbers of vowels in their inventories

Competing views on the role of [ATR] (5)

- the phonetic evidence that we present here shows there are at least 8, possibly 9, phonetic oral vowels in Defaka, i.e. closer to the picture presented by Jenewari…
- but only 6, possibly 7 (for at least one speaker) phonemic vowels – more in line with SLW's view
- but, it is not obvious any vowel contrasts in Defaka rely on [±ATR]

Phonetic vowels in Defaka

- we have documented 9 phonetic vowels in Defaka
  - [i, ɪ, e, ɛ, a, ɔ, o, ʊ, u]
  - not all used by all speakers
- phonetically, [ɪ] occurs in very few items, and not for all of our Defaka speakers;
- when is does, variation is evident and it is hardly distinguishable, impressionistically, from [e].
- [e, ɛ] may be merging in some speakers
- the back counterparts [o, ɔ] remain distinct.

Phonetic variation in Defaka vowels

- kùtà ‘saliva’; àkúmg̰ ‘spit’ contain clear cases of [ʊ]
- with kúɔ̀ ŋmǵgbɔ́lʊ́ ‘heart’, the story is different; in kúɔ̀, it is difficult to distinguish [ʊ] from [u] (and [w] is probably the more appropriate transcription in any case)
- instances of [ɪ] variation include:
  - párà ìkɔ̀kì ~ párà ìkɔ̀kì ‘ankle’ (the speaker showed variation between [ɪ], [i]);
  - lɔ̀ ìmà (or lɔ̀ èmà) ‘revive’;
  - ɔ̀pʊ̀pɔ̀lɪ (ɔ̀pʊ̀pɔ̀lè) ‘boil’

Acoustic correlates of [±ATR] (1)

- several proposed: formant frequency, formant bandwidth, fundamental frequency, vowel duration, spectral slope

- F1: a lower F1 is expected for [+ATR] vowels relative to corresponding [–ATR] vowels (Halle & Stevens 1969; Starwalt 2008)

- F2: more peripheral for [–ATR]; or, lower for [+ATR] (Lindblom & Sundberg 1971)

Acoustic correlates of [± ATR] (2)

- B1 (bandwidth of F1): narrower in [+ ATR] than in corresponding [–ATR] vowels (e.g. Hess 1992)
- spectral slope: relative energy of F1 vs F2 (or of H1 vs H2)
- both suggest to be a reflection of breathy phonation associated with [+ ATR]

- on this measure, SLW suggest the Defaka /o – ɔ/ contrast may be [ATR]-based; F2 of [o] has relatively lower amplitude than F2 of [ɔ].

Acoustic correlates of [±ATR] (3)

- F0: generally said to be unreliable in distinguishing [±ATR], but cf Snider (2001)
- duration also found unreliable, but cf Appiah-Padi (1994)

Acoustic correlates of [±ATR] (4)

Problems with ATR analysis

- F1 correlates with vowel height, cannot alone reflect [±ATR]
- bandwidth differences only reliable when formant values of [±ATR] pairs are relatively close
- of all acoustic parameters tested, no single parameter has been found reliable across speakers/languages
- most studies have involved just one or two speakers

Acoustic structure of Defaka vowels (1)

Methodology

- recordings by seven native Defaka speakers, 4M, 3F
- speech materials included words with each of the vowels in different positions (3)
- test items embedded in sentence frame
- 3 tokens of each item; different Ns for each vowel, each speaker

Acoustic structure of Defaka vowels (2)

- measurements of formant frequencies, bandwidths, F0 and durations done with Praat
- F1, F2 and B1 values reported here; F0 showed no correlation with [±ATR]; duration did, but is considered unreliable
- results for five speakers are presented grouped for sex and individually

Fig 1: F1 x F2 (Female speakers)

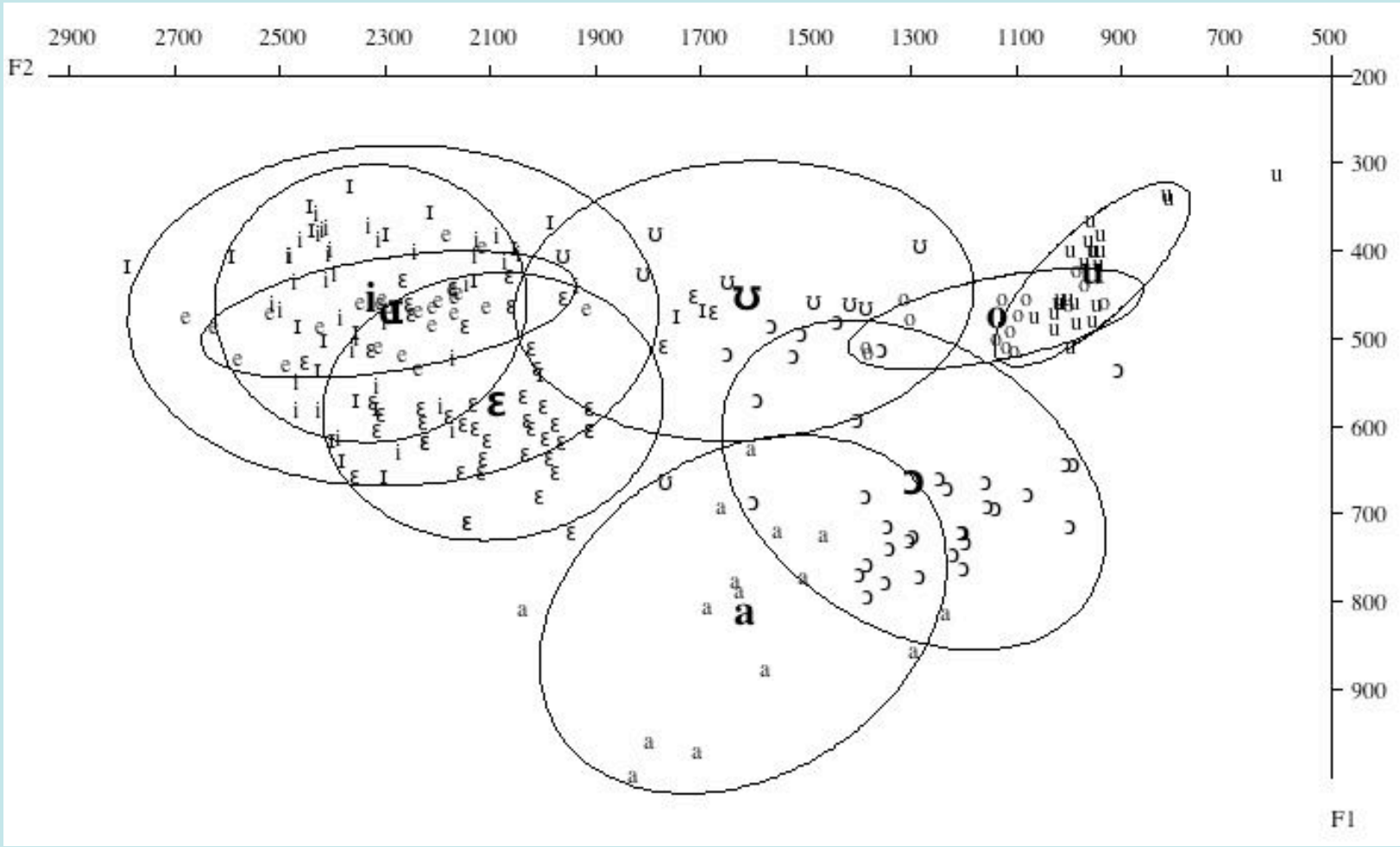


Fig 2: F1 x F2 (Male speakers)

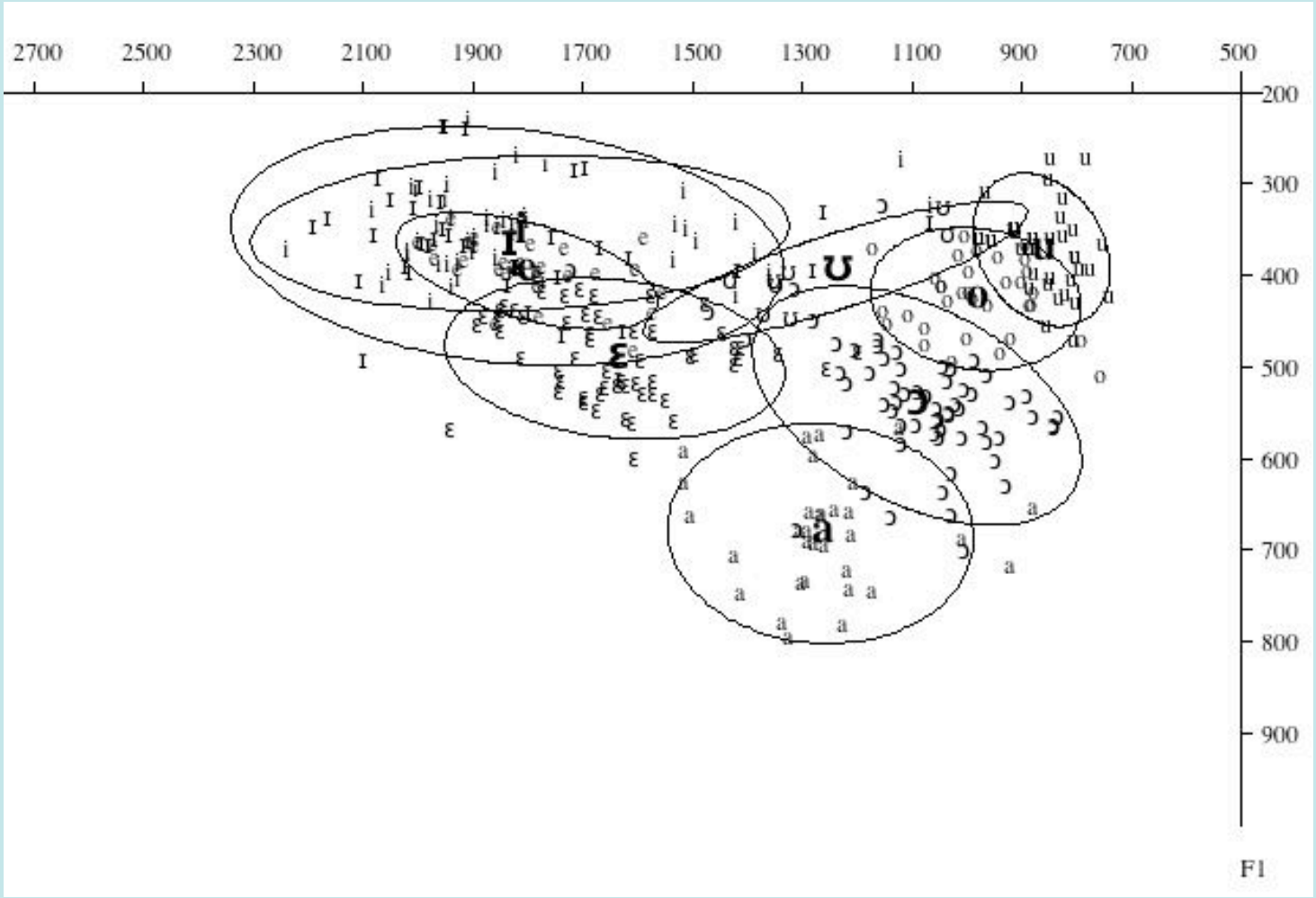


Fig. 3: F1 x F2, speaker GI (F)

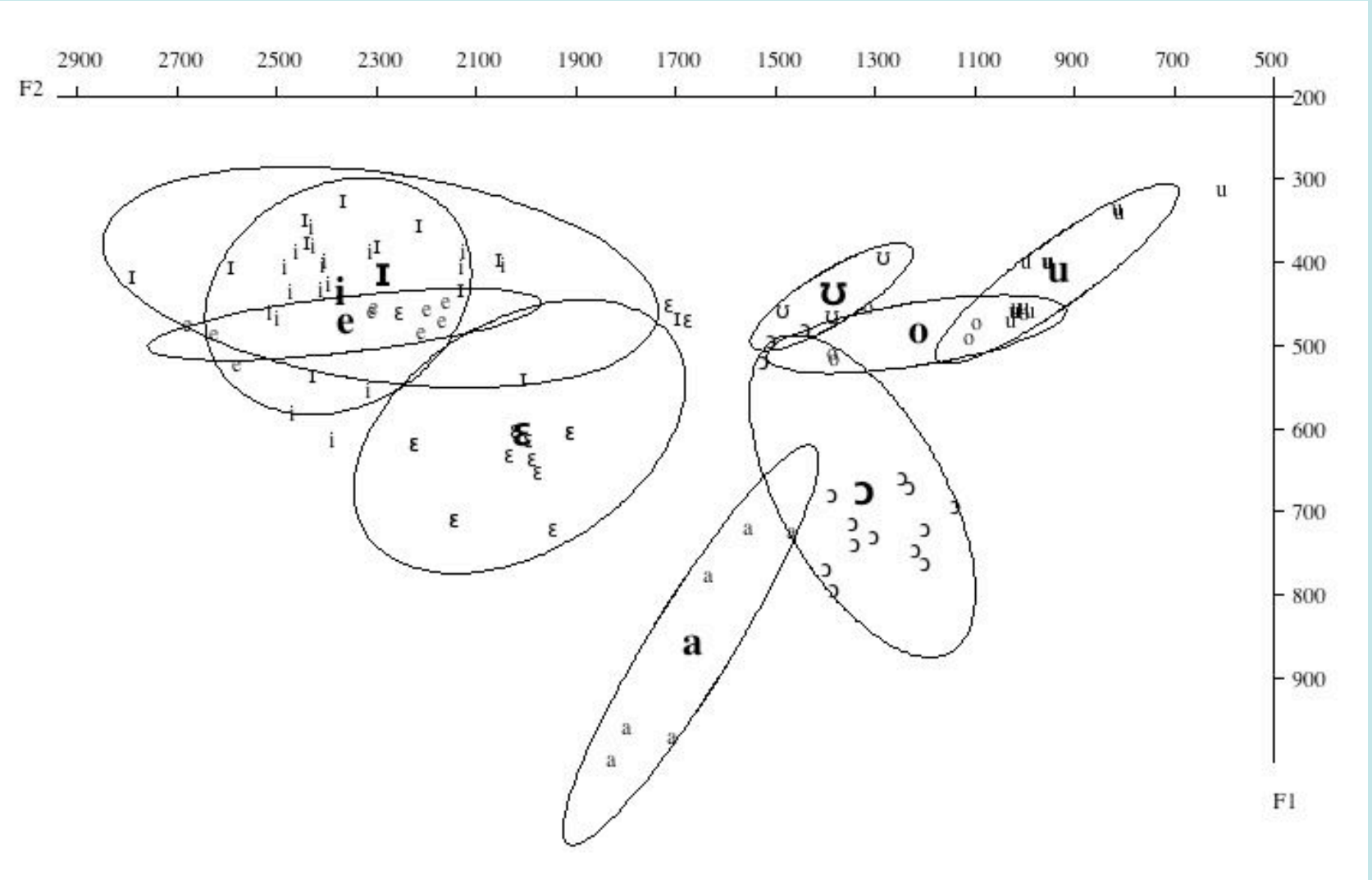


Fig. 4: F1 x F2, speaker EM (F)

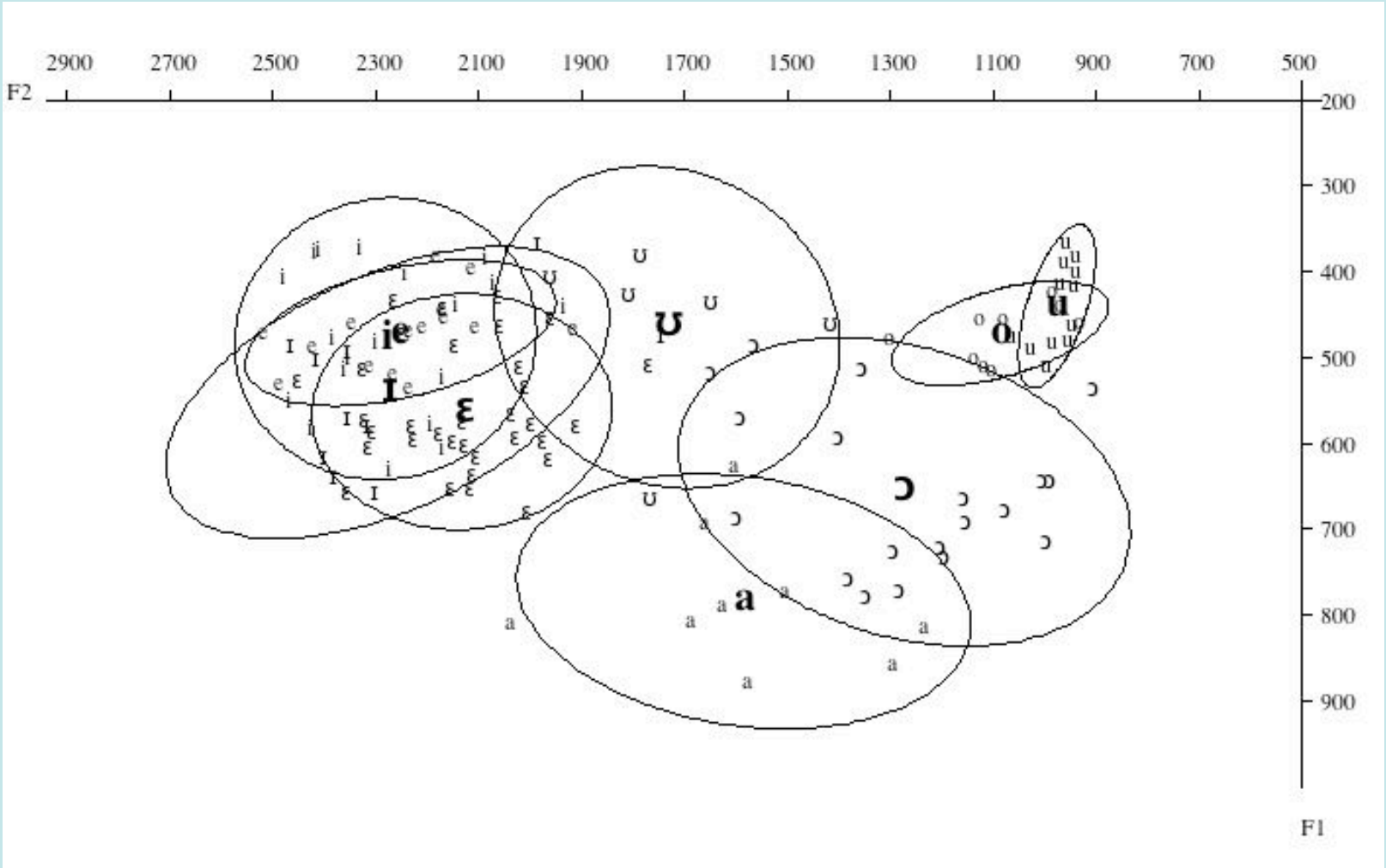


Fig. 5: F1 x F2 for BO (M)

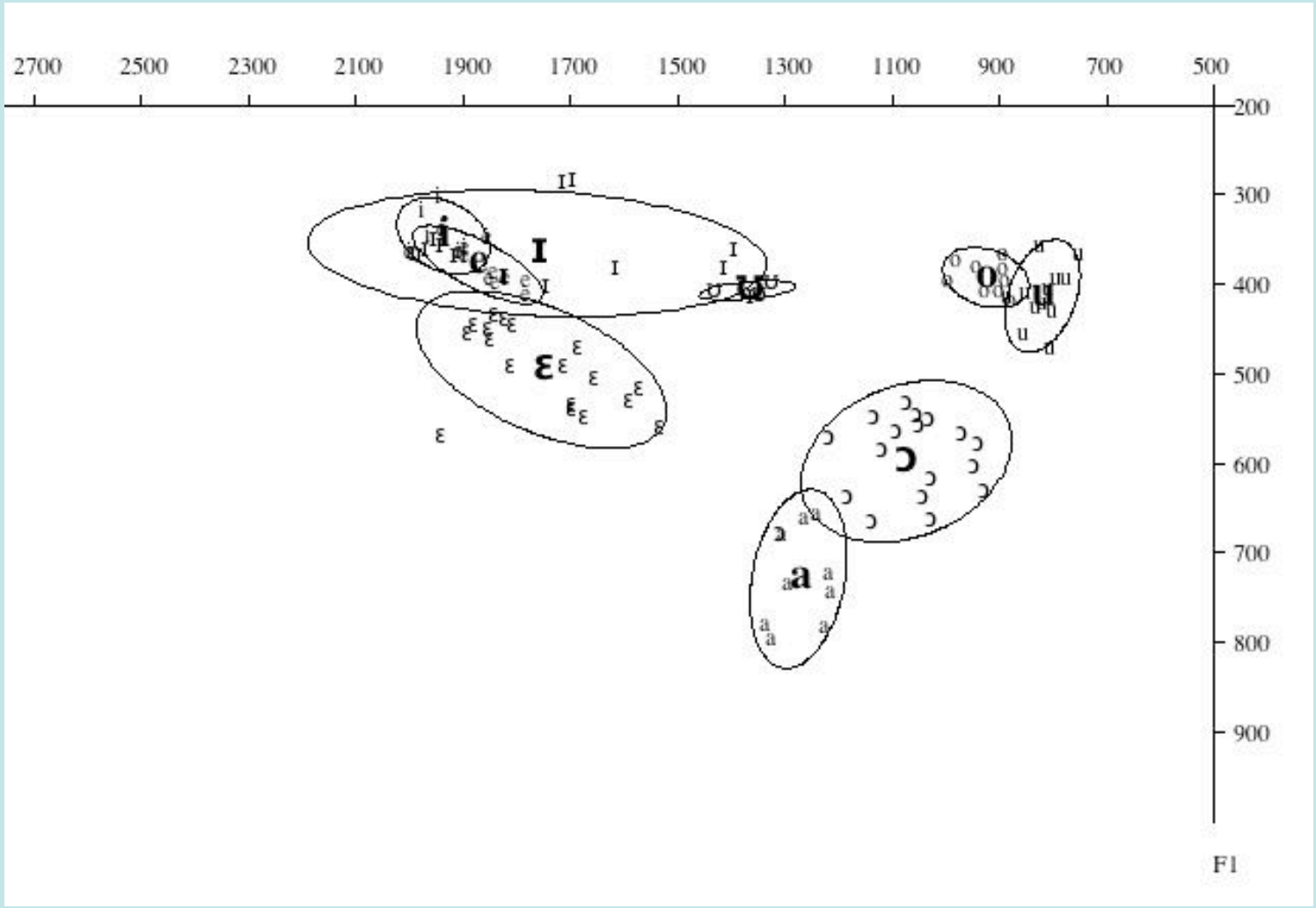


Fig. 6: F1 x F2, speaker HI (M)

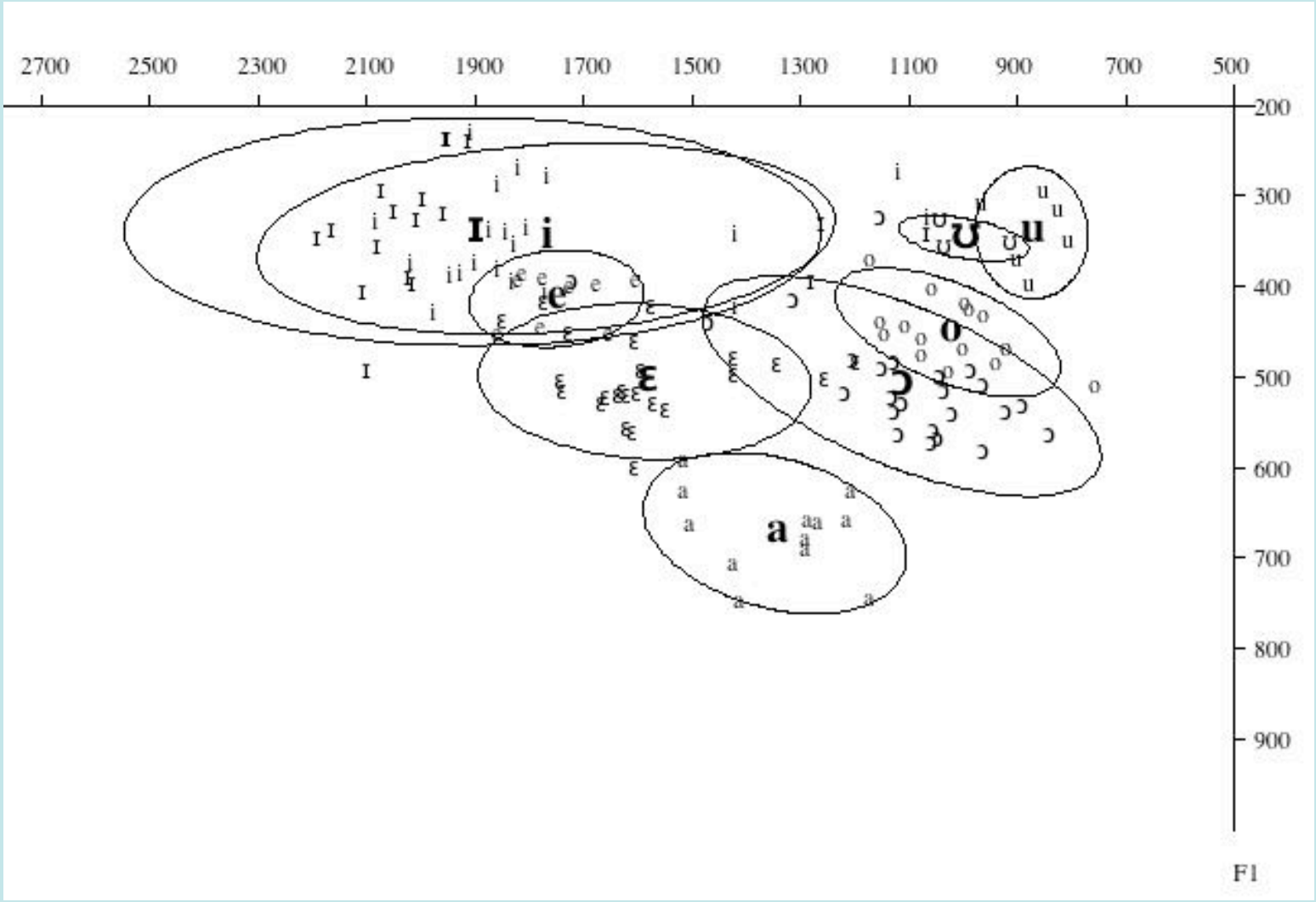
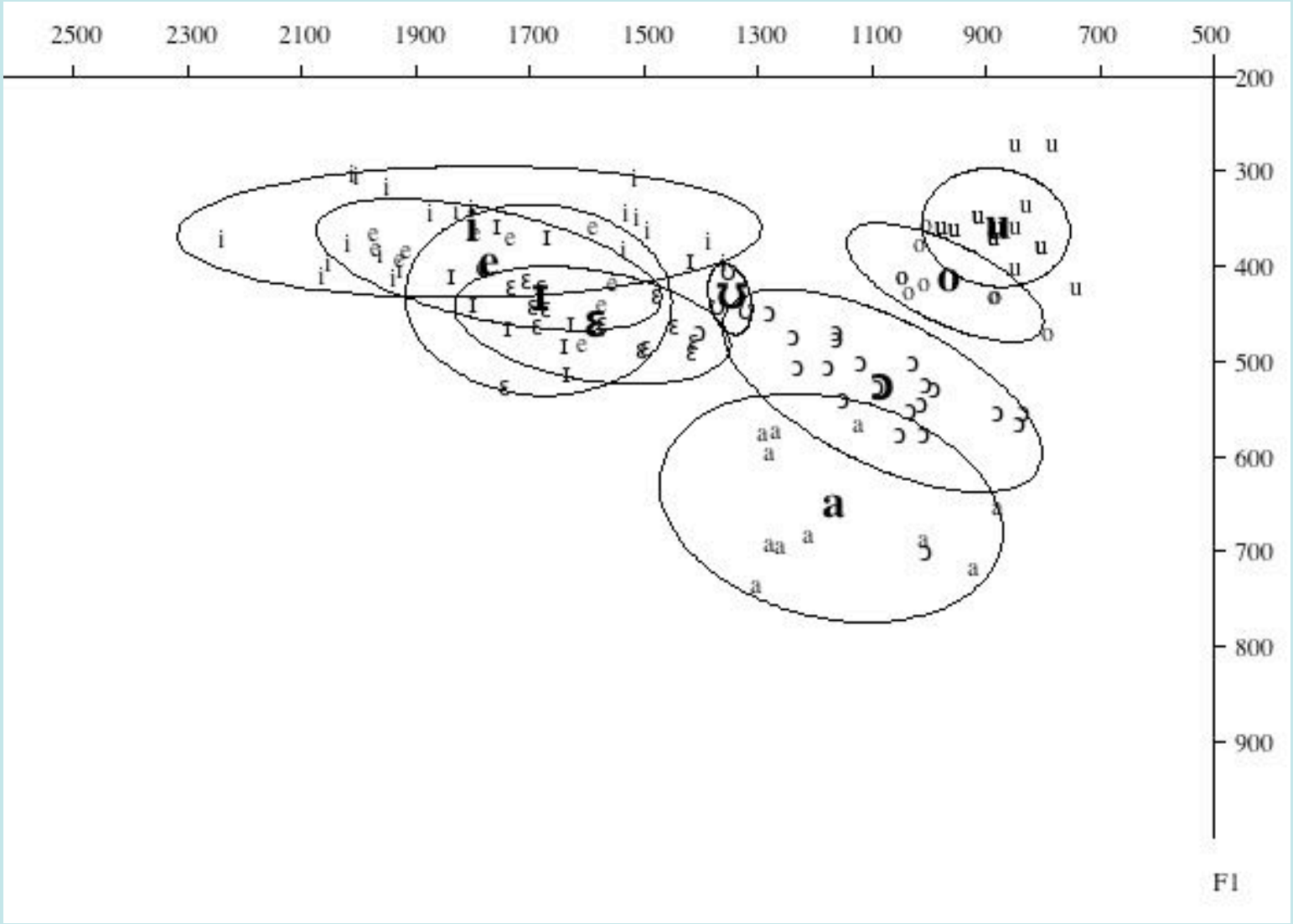


Fig. 7: F1 x F2, speaker IM (M)



Formants summary

- [i] and [ɪ] are not distinct
  - [ɪ] has merged with [i] for most speakers
- [u] and [ʊ] appear to be distinguished in F2, not F1
  - few tokens of [ʊ] affect this result)
- [e] and [ɛ] distinguished in F1
- [o] and [ɔ] distinguished in F1
- [i] vs [e], [u] vs [o] need further examination
  - [i], [e], especially for the two female speakers

Table 1: F1Bandwidth

Vowel	BO	EM	GI
e	42.3 (16.9)	63.1 (20.1)	71.4 (19.3)
ɛ	50.1 (17.3)	67.8 (38.8)	93 (21.7)
o	152 (110.3)	72.1 (38.9)	77.7 (32.1)
ɔ	59.8 (16)	83.4 (30.1)	72.3 (33)

Bandwidth summary

- as a general trend, B1 follows predictions of Hess (1992)
  – in 4 of 6 comparisons, [+ATR] vowels have narrower bandwidths than their [–ATR] counterpart

- but… differences are slight
  – Hess suggested differences on the order of 33% for front vowels and 66% for back vowels
  – don't appear to be statistically significant

Summary: acoustic structure of Defaka vowels

- on the measures examined here it is not clear that here that [±ATR] plays a role in the phonetic structure of the Defaka vowel system, though one speaker (HI) appears to have a contrast with high [± ATR] vowels in a small number of words based on impressionistic transcription
- F1 x F2 appear sufficient to distinguish most vowels for most speakers, though some appear to be merging
- there is variation across speakers which needs to be explored further

Two general remarks

- loss of [ATR] harmony in Defaka appears to have followed – at least partially – the route reported for other reduced harmony systems (Williamson 1973)
- a final question of interest is whether the variation seen in Defaka vowels is symptomatic of language contraction (e.g. through 'lack of performance', Dressler 1988) or other factors
- reduction of the system itself may lead to variation;
- Defaka was never a large language demanding standardized norms…

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