

# Spectral coarticulation in Hawaiian /aV/ and /aCV/ sequences

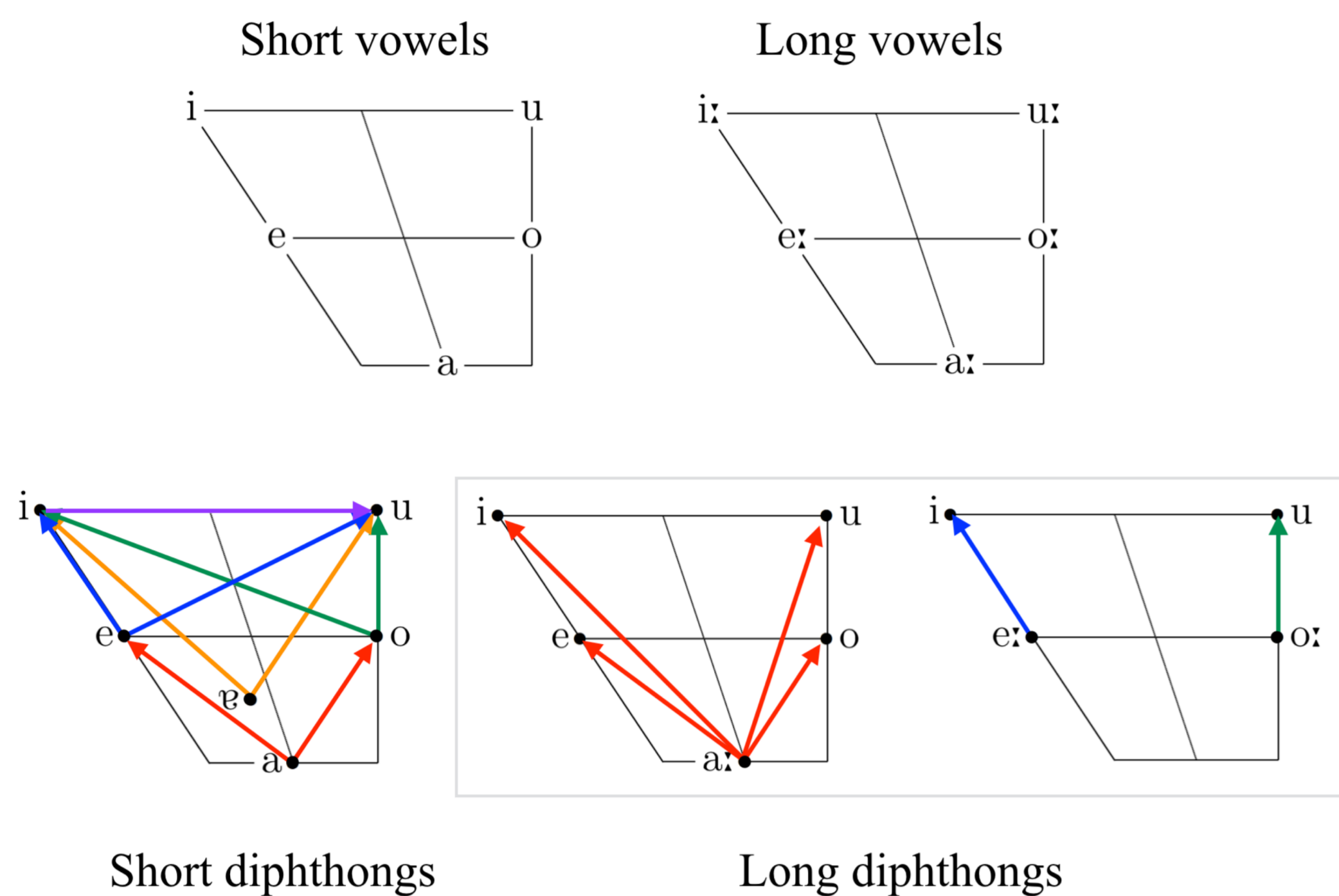


Thomas Kettig

Department of Linguistics, University of Hawai'i at Mānoa ([tkettig@hawaii.edu](mailto:tkettig@hawaii.edu))

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## Background: Hawaiian vowel system



(Parker Jones 2017: 7; reprinted with permission)

- However, "diphthongs in Hawaiian are not 'unit phonemes'" (Parker Jones 2017: 8)
- VV sequences seem to be underlyingly two separate units, despite /aV/ exhibiting a distinctive raising pattern (Schütz 1981, Rehg 2007)
- Few previous instrumental acoustic analyses
  - Parker Jones (2017): 1 speaker, ~2 min. read speech
  - Piccolo (2005): 2 speakers, 11 words each, read speech

## Research questions

- What are the spectral (F1/F2) characteristics of stressed short /a/?
- How are these characteristics affected by coarticulation to the following vowel? Does having an intervening consonant affect coarticulation?
- *Hypothesis:* An unstressed final vowel may have the same coarticulatory effect on a preceding stressed /a/ regardless of intervening consonant:

*pali* 'cliff' > [ˈpɻ.li]    *nalu* 'wave' > [ˈnɻ.lu]    *hale* 'building' > [ˈhɻ.le]    *kalo* 'taro' > [ˈkɻ.lo]  
*kai* 'sea' > [kɻi]    *pau* 'done' > [pɻu]    *pae* 'group' > [pɻe]    *ao* 'light' > [ao]

## Data and methodology

- Speaker: **Dr. Larry Kimura**, interviewer & producer, *Ka Leo Hawai'i*
- Data: **41 minutes** of spontaneous speech from six radio episodes, 1972–1973
- Episodes digitized, transcribed, and archived by [Kani'āina](#)
- Transcripts automatically force-aligned using [Montreal Forced Aligner](#)
- F1 & F2 automatically extracted by Praat script
- **n=1,550** /a(C)V/ tokens in primary lexical stress position

/aCi/ n=186    /ai/ n=306  
 /aCu/ n=62    /au/ n=202  
 /aCo/ n=104    /ao/ n=7  
 /aCe/ n=101    /ae/ n=7  
 /aCa/ n=575



- Separate linear mixed effects models run for F1 and F2 /a/ measurements in subsets:
  - /aV/ environments
  - /aCV/ environments
  - /aV/ + /aCV/ environments, minus /aCa/

## Results: /aV/ trajectories

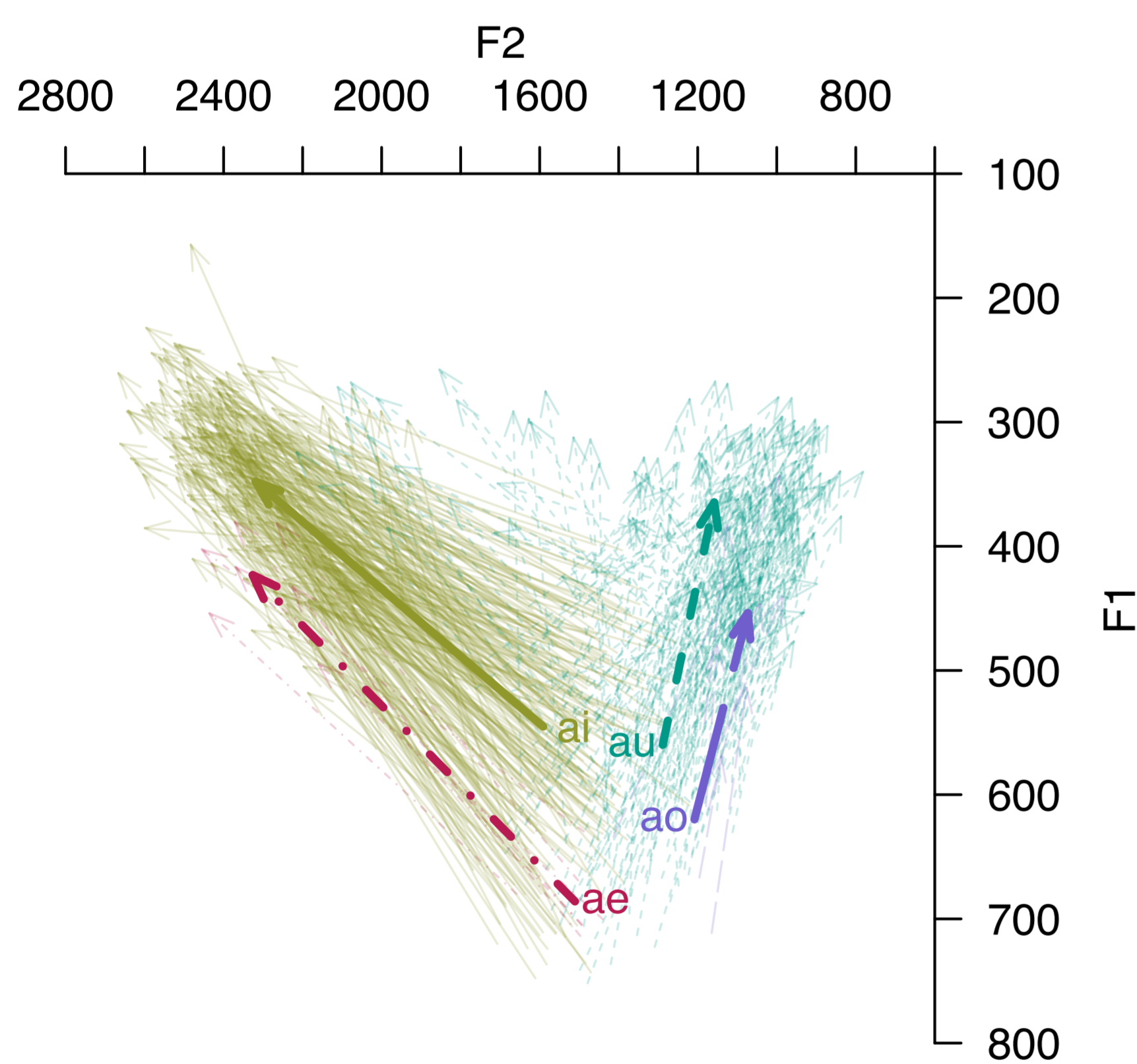


Fig. 1: Individual trajectories (light) and means (bold) [a] means at F1 max, others at F2 max

- **Robust coarticulation of /a/ based on following vowel in both F1 and F2**

## Results: [a] in /aCV/

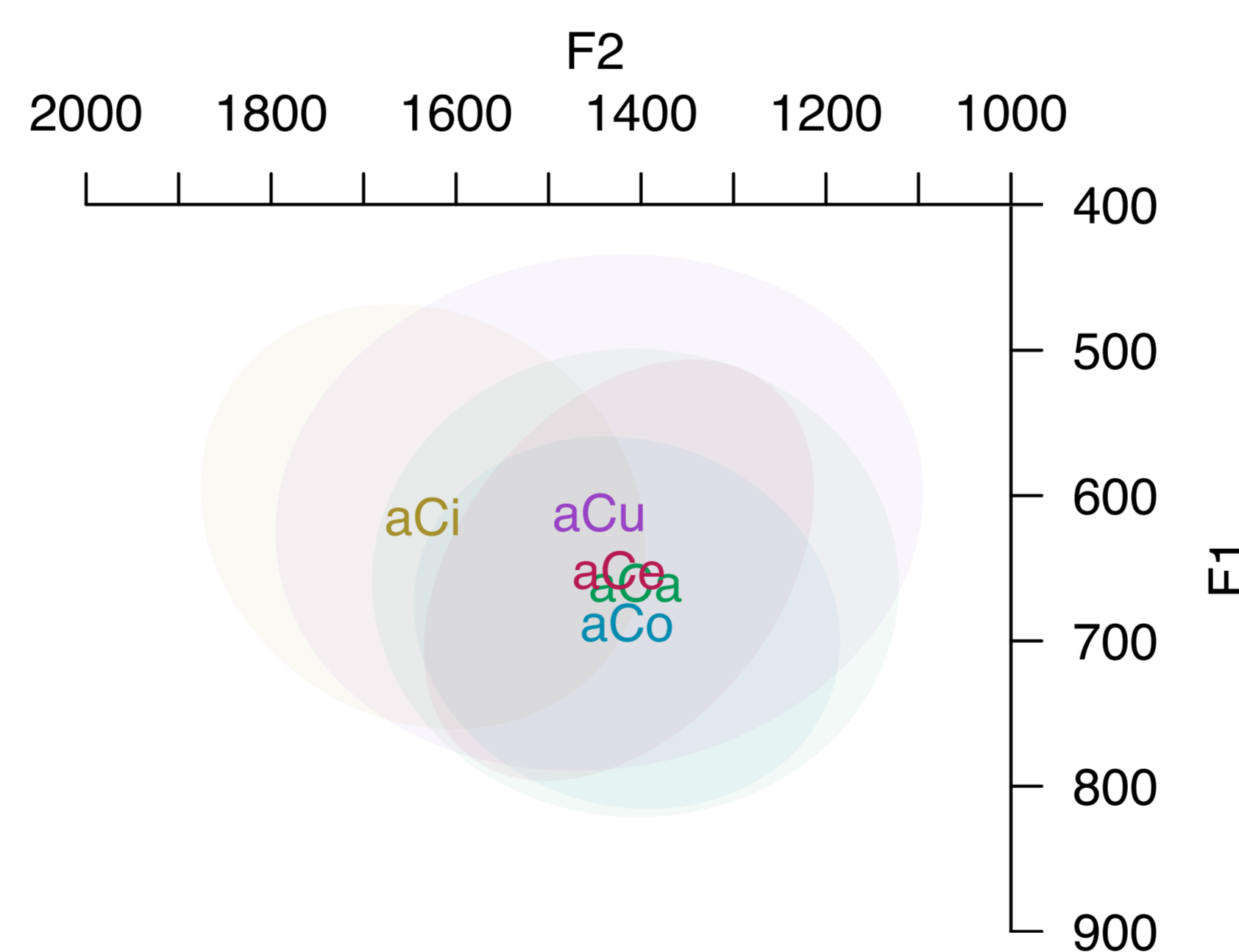


Fig. 2: [a] means at F1 max, ellipses ±1 sd over F1 & F2

- **/aCi/ higher and fronter than /aCa/**

## Results: [a] in /aV/ & /aCV/

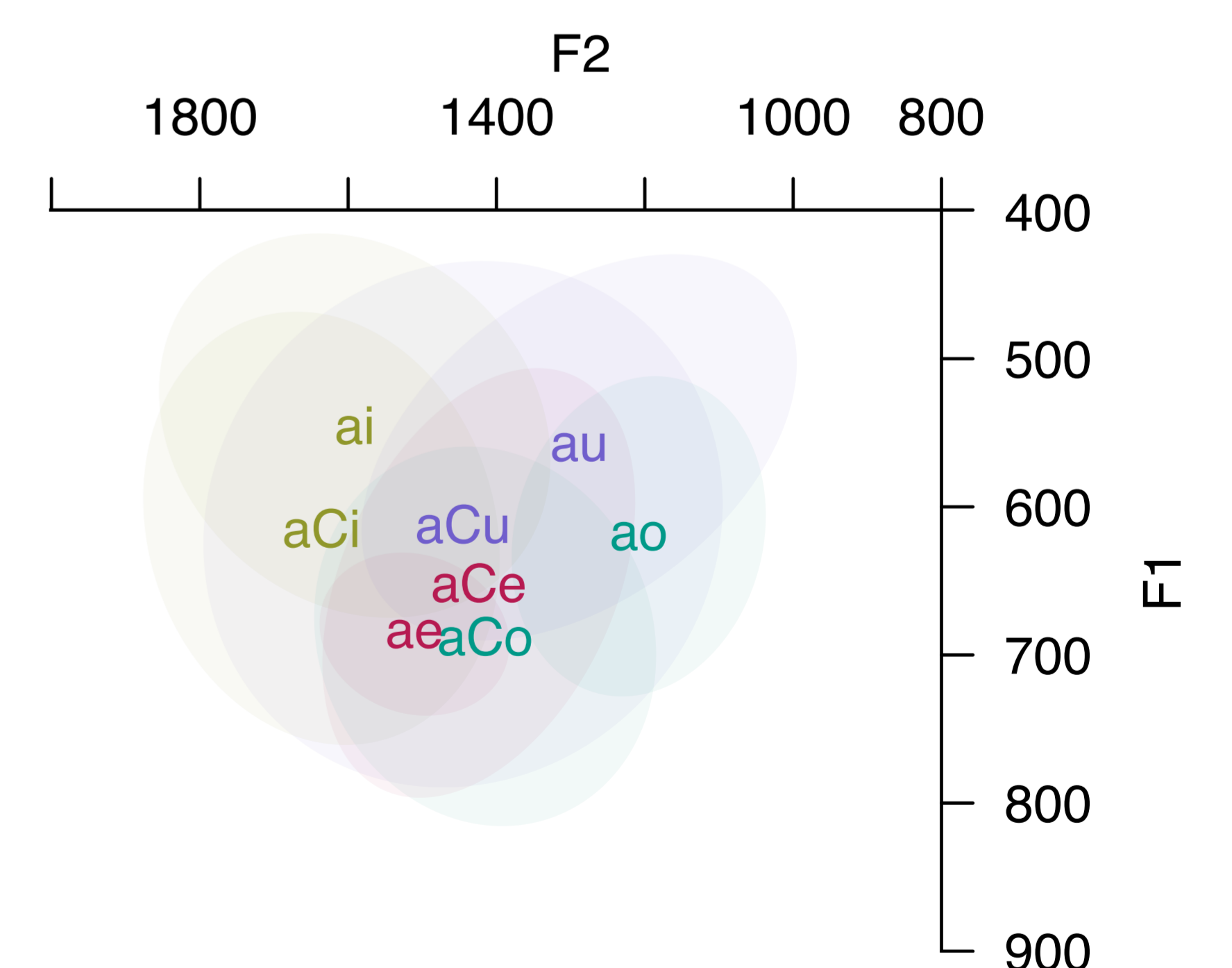


Fig. 3: [a] means at F1 max, ellipses ±1 sd over F1 & F2

- **F1 predicted by height of following vowel**
- **F2 predicted by height and backness of following vowel**
- **No significant effect of /aV/ vs. /aCV/, though trending towards more extreme coarticulation in /aV/ contexts**

## Future directions

- Hundreds of hours of recordings in radio archive yet to be transcribed; dozens of native speakers' voices for analysis
- How much inter- and intra-speaker consistency/variation in coarticulation?
- How much inter- and intra-lexeme consistency/variation in coarticulation?
- Raising has also been noted in some /aCa/ words – needs further investigation

## Takeaways

- /a/ before a high vowel = higher and fronter
- /a/ before a back vowel = backer
- Coarticulation occurs even when there is an intervening consonant
- Evidence against /aV/ clusters being unitary 'diphthong' phonemes