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

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Background: Hawaiian vowel system

- Short vowels
- Long vowels
- Short diphthongs
- Long diphthongs

(Figures not shown)

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’] > [pəli]
  - [kai ‘sea’] > [kəi]
  - [pa ‘done’] > [pəu]
  - [pa ‘group’] > [pəe]
  - [ao ‘light’] > [əo]

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 Kan’īlana
- 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
  - /a/ n=186
  - /aCu/ n=62
  - /a/ + /aCu/ n=202
  - /aCo/ n=104
  - /a/ + /aCo/ n=101
  - /a/ + /aCu/ + /aCo/ 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)

- Robust coarticulation of /a/ based on following vowel in both F1 and F2
  - /a/ means at F1 max, others at F2 max

Results: [a] in /aCV/

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

- /aCl/ 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

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

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