Analyzing formant trajectories of Akuzipik vowels

College of Humanities and Social Sciences
LINGUISTICS PROGRAM
George Mason University

Giulia M. Soldati, Matthew C. Kelley, Sylvia L.R. Schreiner
George Mason University

Mason PhonLab

1. Introduction

Akuzipik is an Indigenous Yupik language spoken mainly on St. Lawrence Island, Alaska

- Endangered: 500-1000 speakers, most of whom are English-Akuzipik bilinguals [1, 2]
- Proposed vowel space: 4-7 vowels [a aː ə i iː u uː] with a length distinction of peripheral vowels and changes in vowel quality in some contexts [3]

Research goals

- Further investigate the acoustic properties of Akuzipik vowels
- Expand previous findings by looking at formant trajectories & vowel inherent spectral change [4, 5]

2. Materials and methods

Participants

- Four native speakers (2M/2F, ages 30s-40s), previously recorded for vowel analysis [3]

Materials

- 56 words beginning as VC
  V: one of the seven target vowels [a aː ə i iː u uː]
  C: labial, coronal, velar, or uvular obstruent
- ≈ 4-5 repetitions of each word per speaker
- Carrier sentence: *aghnat* X *atiimaat*
  [aʁnat X atiːmaːt] 'the women said X'

Methods

- Vowels manually annotated in Praat; formant values and durations extracted via script
- Two GAMMs (F1 and F2) fitted in R
  Fixed effects: sex, vowel, place, repetition number
  Interaction: four-way time/sex/vowel/place
  Smooths: duration, time
  Random effects: speaker, word

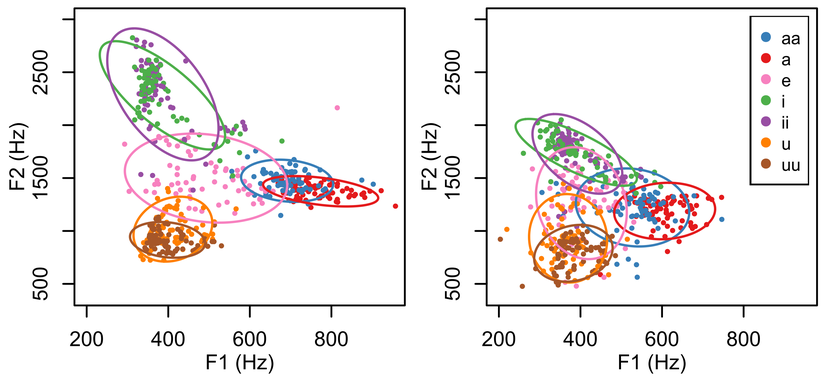

Fig. 1. Scatterplot of vowel space sampled at 50% duration. Left is female; right is male. 2-SD ellipses are drawn around each category to capture approx. 95% of the distribution.

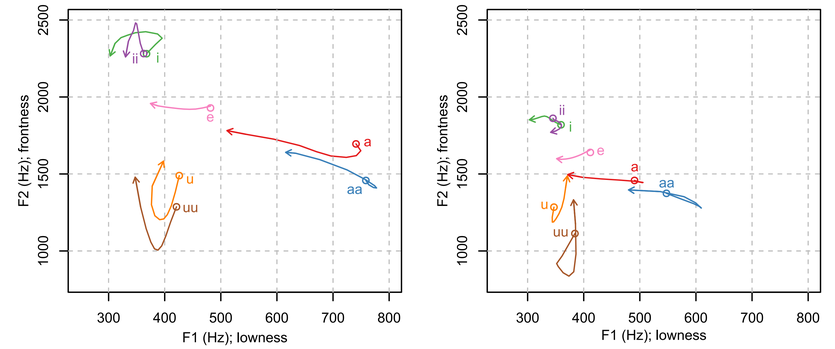

Fig. 2. Formant trajectories for each vowel quality from 10% to 90% duration. Left is female; right is male. Open circle is starting point of trajectory; arrow is end-point.

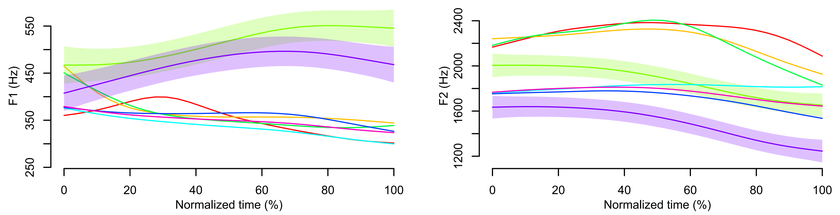

Fig. 3. Formant trajectories for [i] for different classes of place of articulation, separated by sex. Left is F1; right is F2.

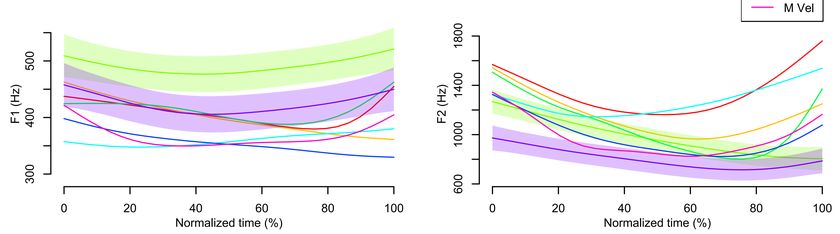

Fig. 4. Formant trajectories for [u] for different classes of place of articulation, separated by sex. Left is F1; right is F2.

3. Results

- Long vowels ≈ 1.7 times longer than short vowels

V	Mean short dur (ms)	Mean long dur (ms)	df	t	p-value
a	117.16	210.79	272.25	-25.38	< 0.001
i	122.25	198.20	249.29	-16.35	< 0.001
u	114.63	194.28	270.71	-21.74	< 0.001
ə	60.32	—	—	—	—

- M/F exhibit distinct vowel spaces (Fig. 1)
- Formant trajectories show movement and little overlap between each short/long pair (Fig. 2)
- For high vowels, F1 values were higher and F2 values were lower when preceding uvular obstruents than in all other contexts (Figs. 3-4)

4. Discussion & conclusion

- Significant length distinction in peripheral vowels
- Dynamic vowel qualities were observed in formant trajectories over time
- Short/long counterparts also seem to have a quality distinction, at least in pre-coronal environments
- High vowels are lower and backer in pre-uvular environments, which is typical and an expected coarticulatory effect
- Future directions: vowel overlap measures (Pillai scores), examine consonant acoustics

Acknowledgements: Many thanks to Benjamin Hunt (et al.) for sharing the Akuzipik recordings with us. Thanks to all the members of the Mason Phonetics and Phonology Lab for your feedback and continuous support. Igamsiqayugvikamsi, Sivuqaghhmiit - thank you to the people of Sivuqaq/St. Lawrence Island. Portions of this work were funded by NSF Documenting Endangered Languages Grant #BCS 1760977 and a George Mason University Presidential Scholarship.

References:
[1] Schwartz, L., Schreiner, S.L.R., & Chen, E. (2019). Community-focused language documentation in support of language education and revitalization for St. Lawrence Island Yupik. *Études/Inuit/Studies*, *43*(1/2), 291-312.
[2] Koonooka, C.P., Schreiner, S.L.R., Soldati, G.M., Schwartz, L., Hunt, B., Haas, P., Chen, E., & Park, H.H. (2021). Akuzipik/ Yupik – Language Snapshot. *Language documentation and description*, *20*, 135-144.
[3] Hunt, B., Kwon, H., & Schreiner, S.L.R. (2020). An acoustic analysis of St. Lawrence Island Yupik vowels. *The Journal of the Acoustical Society of America*, *148*, 2471-2471.
[4] Nearey, T.M., & Assmann, P.F. (1986). Modeling the role of inherent spectral change in vowel identification. *The Journal of the Acoustical Society of America*, *80*(5), 1297-1308.
[5] Hillenbrand, J., Getty, L. A., Clark, M. J., & Wheeler, K. (1995). Acoustic characteristics of American English vowels. *The Journal of the Acoustical Society of America*, *97*(5), 3099-3111.

Contact: gmasella@gmu.edu

4pSC9, 188th Meeting of the Acoustical Society of America (New Orleans, LA, USA)