

Enriching our understanding of language change with vowel formant trajectories

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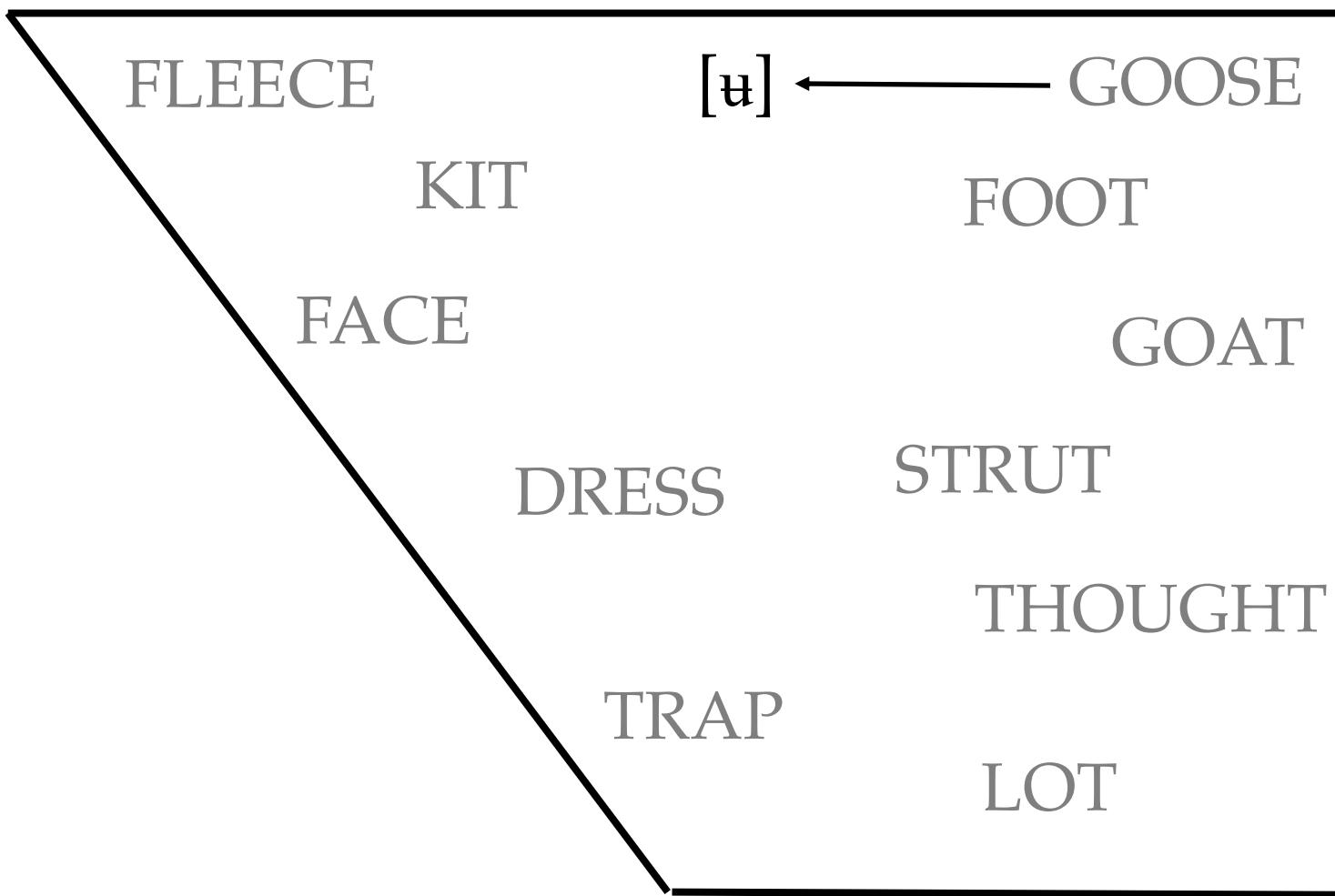
Colloquium Series

August 31, 2023

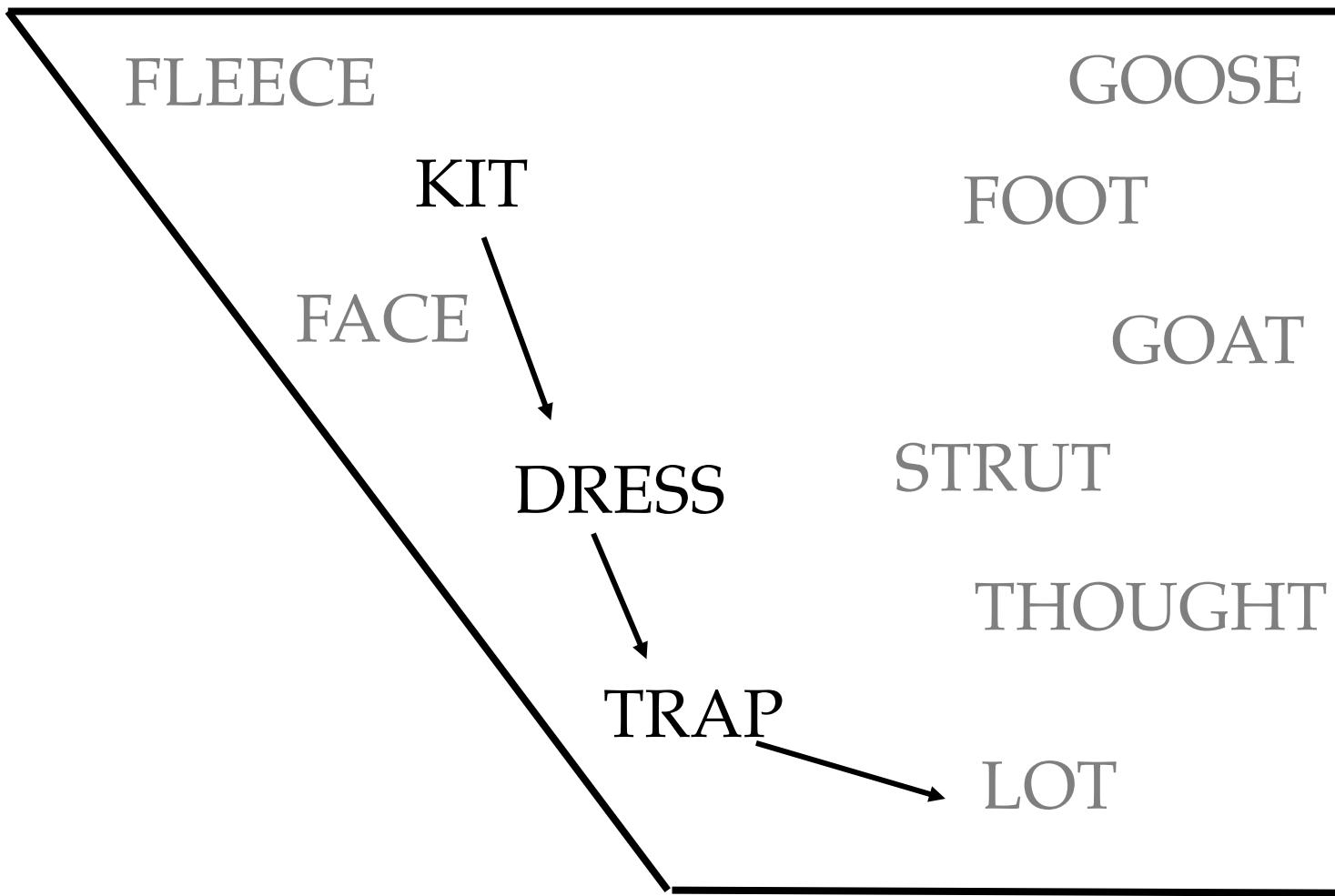
Vowels, Vowels, Vowels

- American English vowels are variable in pronunciation.
 - *ban* vs. *bat*, *too* vs. *boo*
 - *feel* vs. *fill*, [bæt] vs. [bæ_{t̪}t̪]
- We can categorize these differences:
 - Shifts
 - I pronounce /u/ fronter than my grandparents do.
 - My students pronounce /æ/ as lower and more centralized than I do
 - Mergers
 - For me, *cot* and *caught* are distinct; for 95% of my students, they're homophones
 - In Utah, *feel* and *fill* are often pronounced the same
- Language change happens as some variants spread to more and more people.

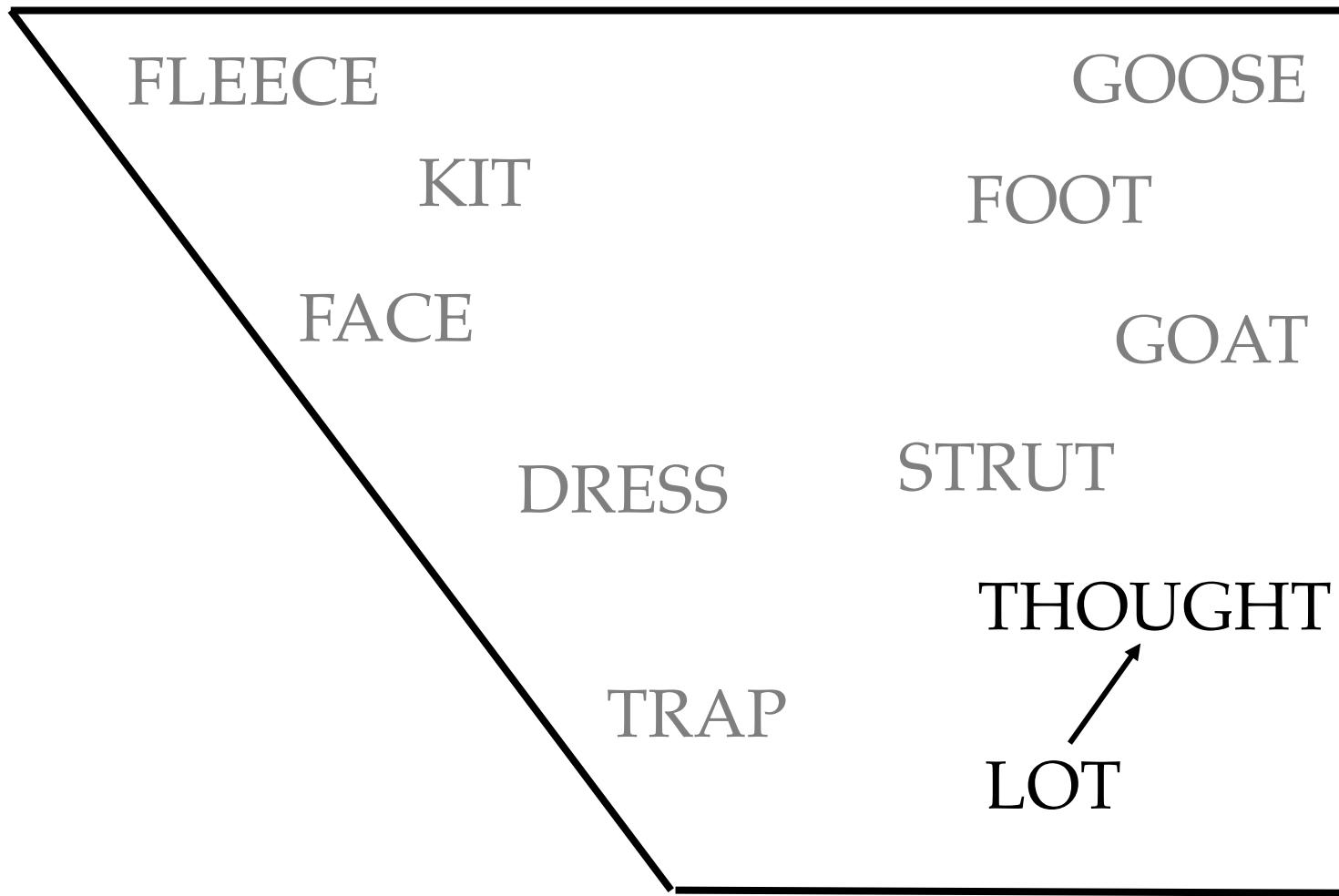
Vowel Shifts

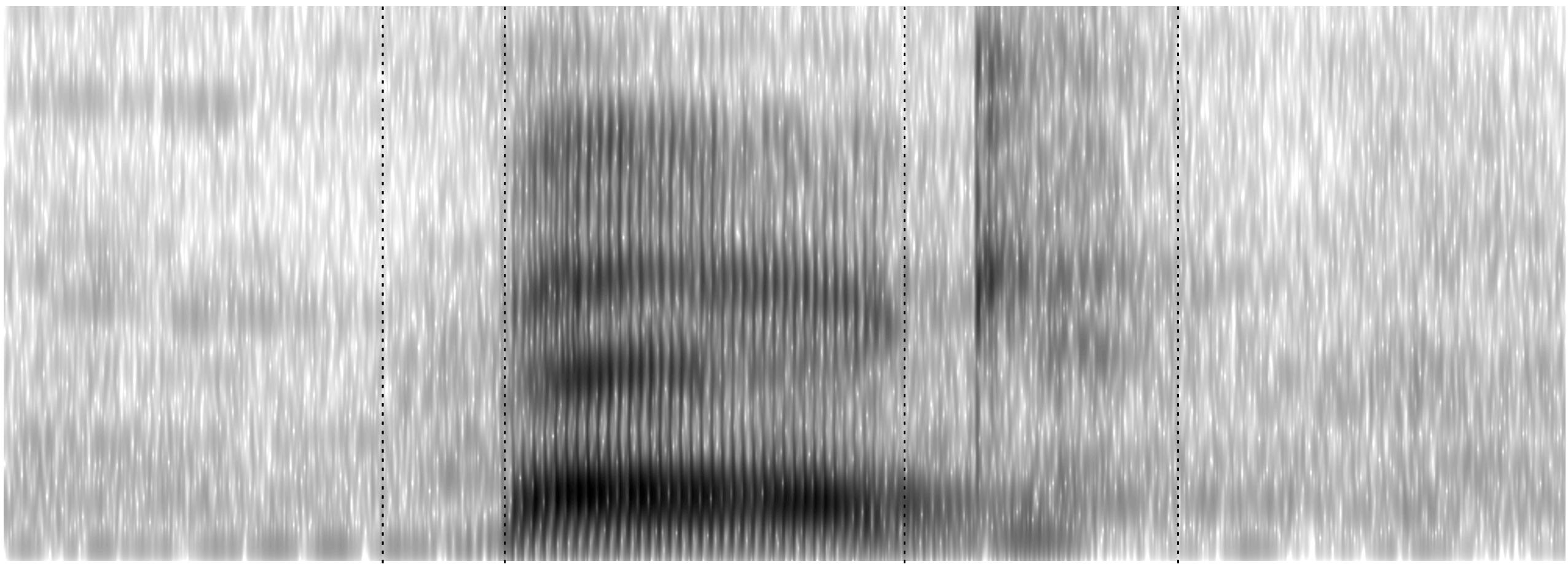


Chain Shifts



Mergers



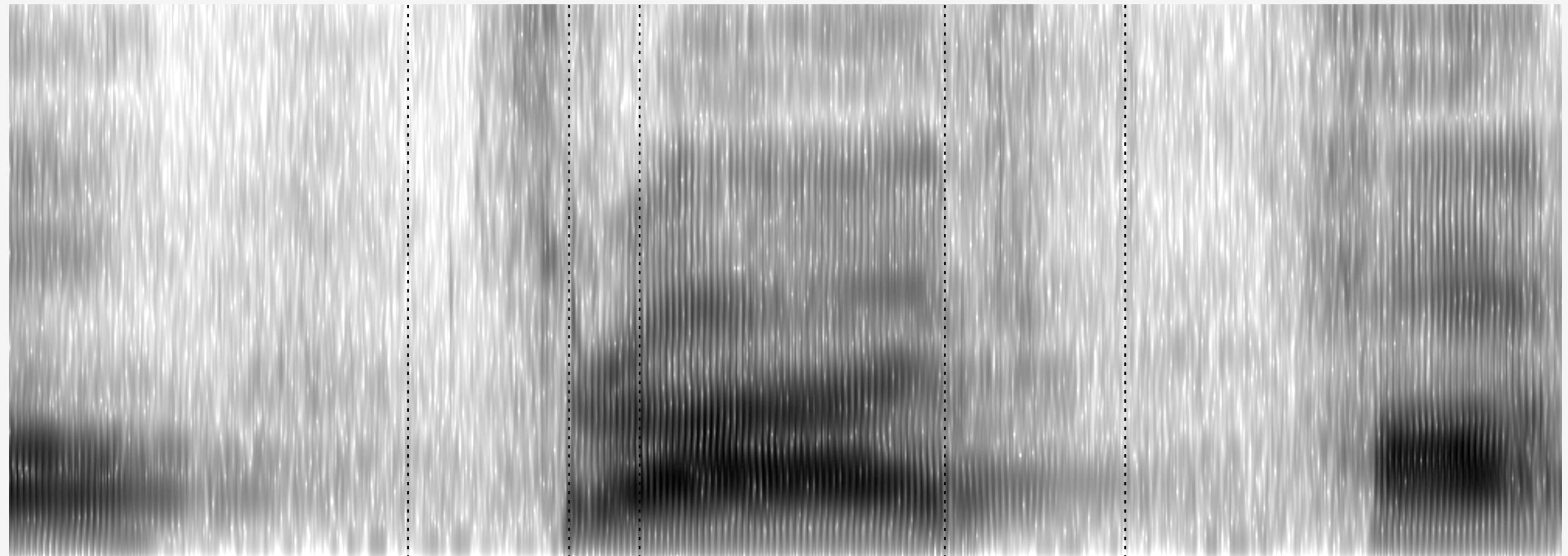


b

ε

g

beg



θ

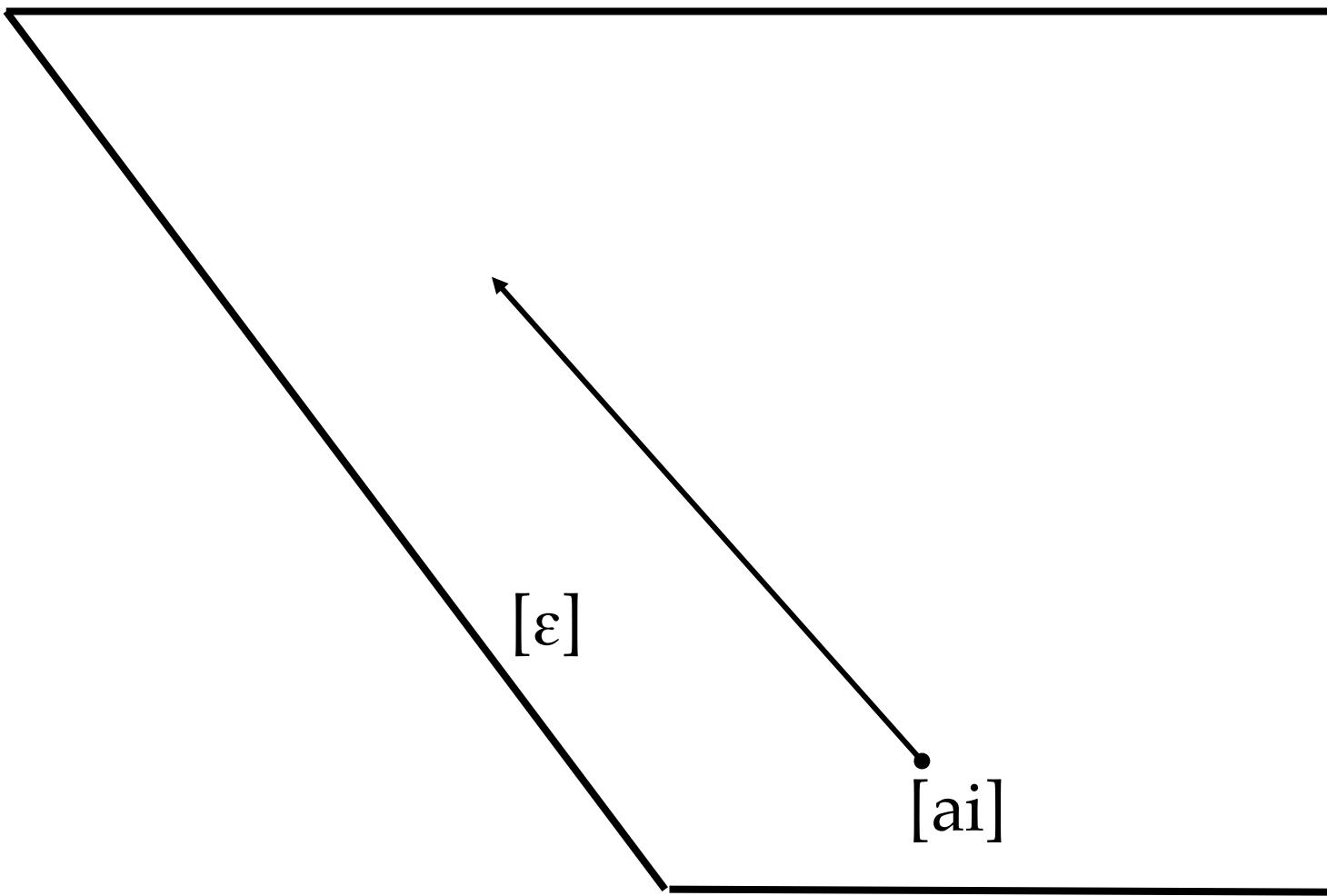
r

ai

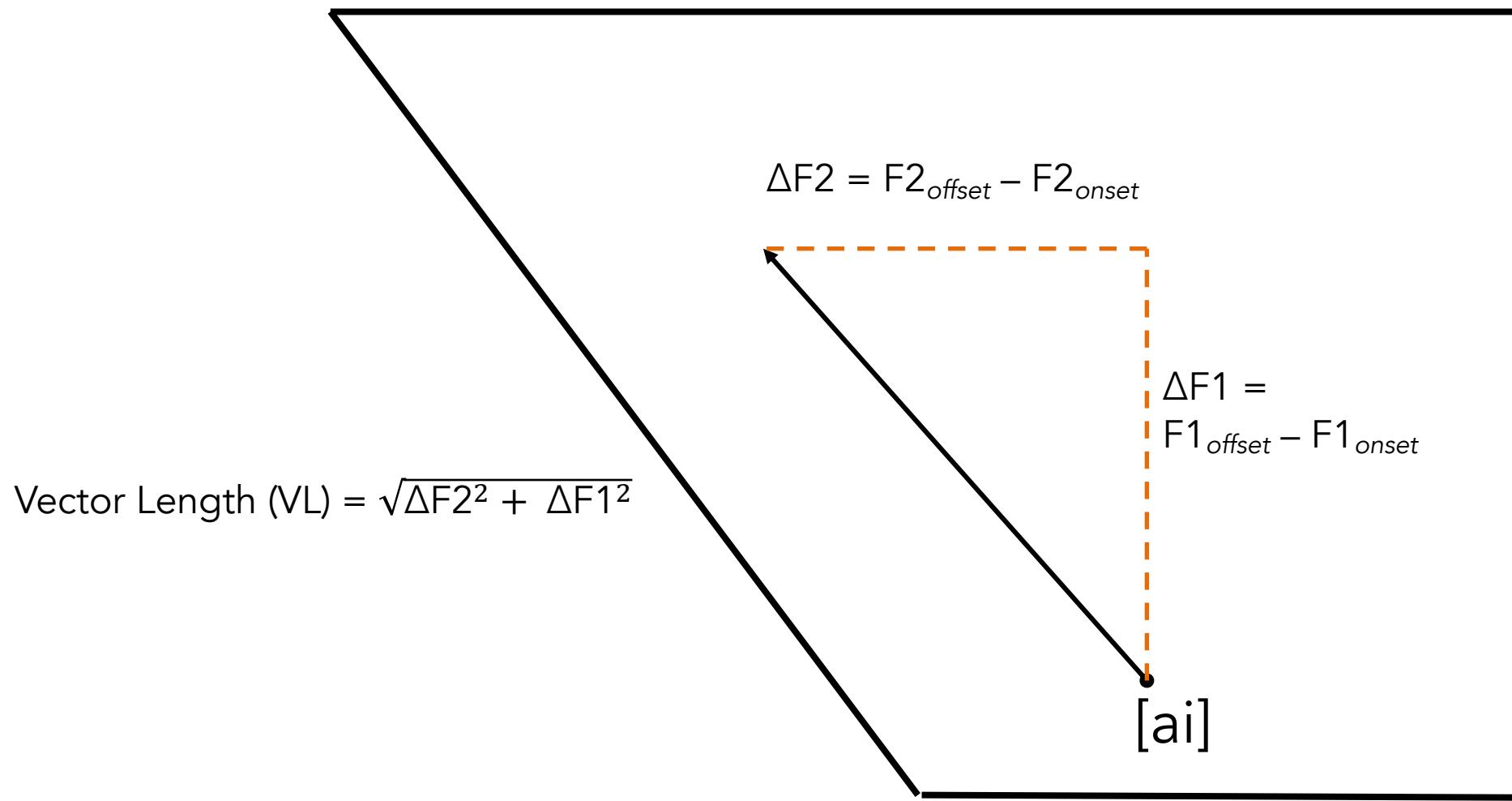
v

thrive

Monophthongs vs. Diphthongs



Studying Diphthongs

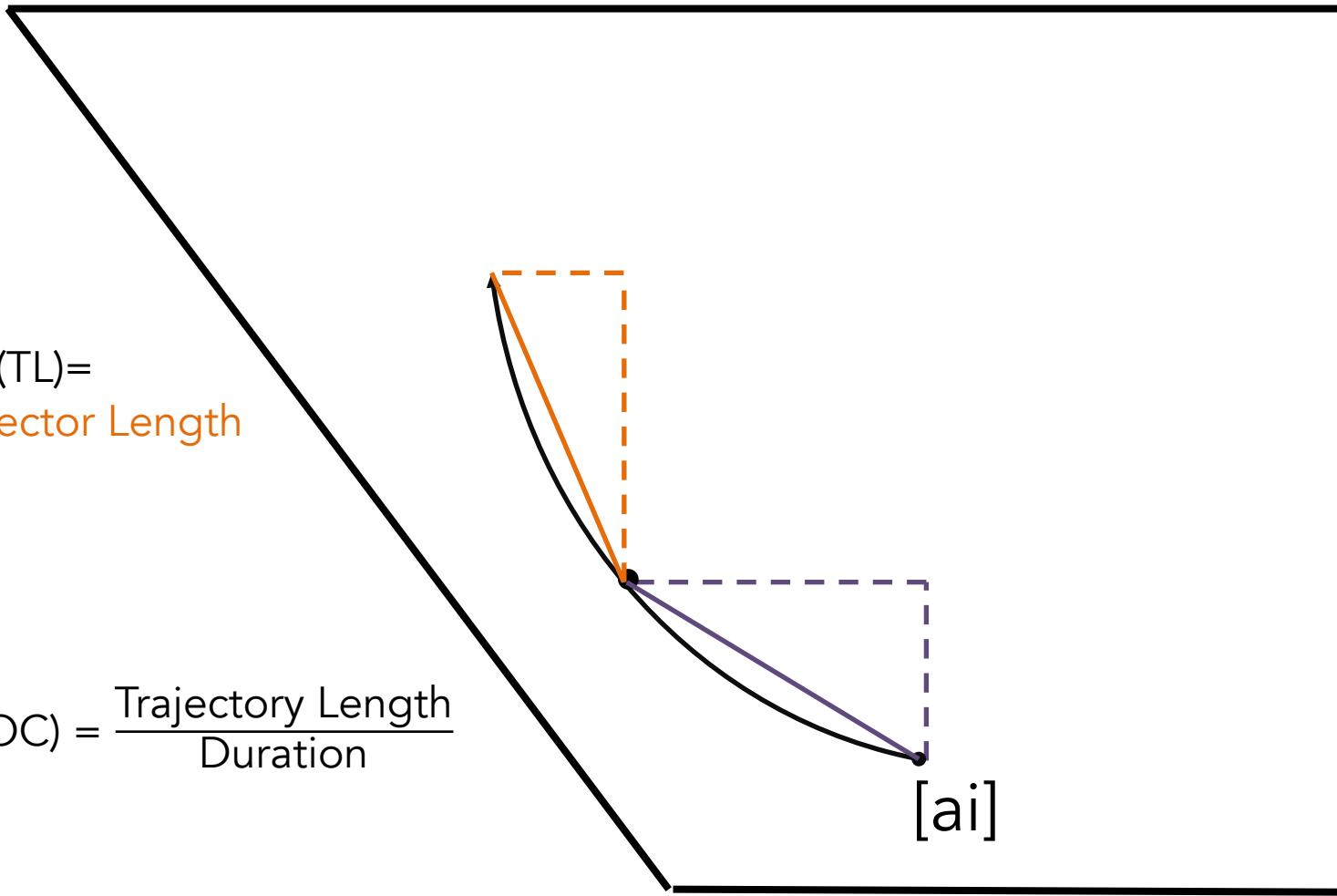


Farrington et al. (2018),
Fox & Jacewicz (2009)

Studying Diphthongs

Trajectory Length (TL)=
Vector Length + Vector Length

Rate of Change (ROC) = $\frac{\text{Trajectory Length}}{\text{Duration}}$

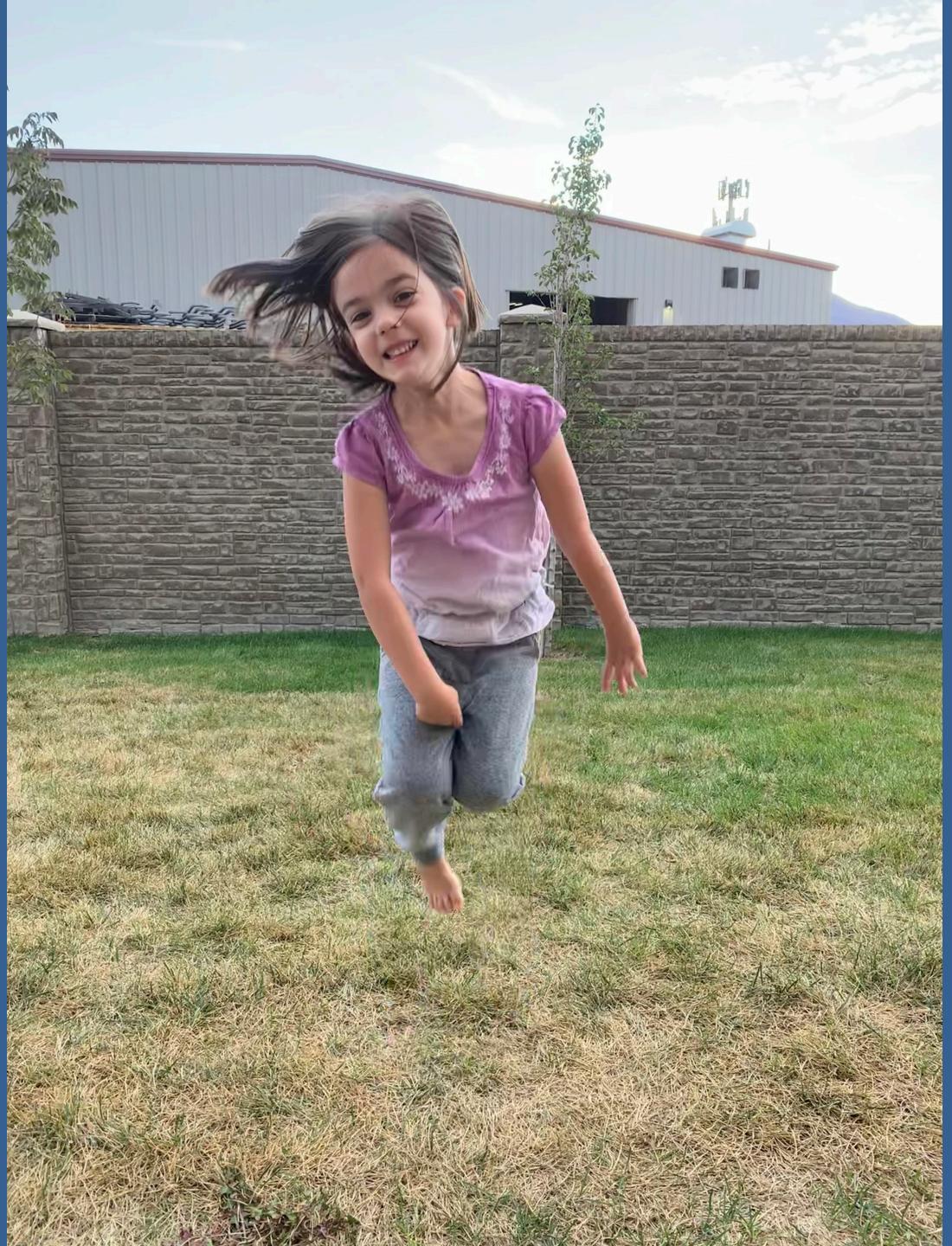


Farrington et al. (2018),
Fox & Jacewicz (2009)

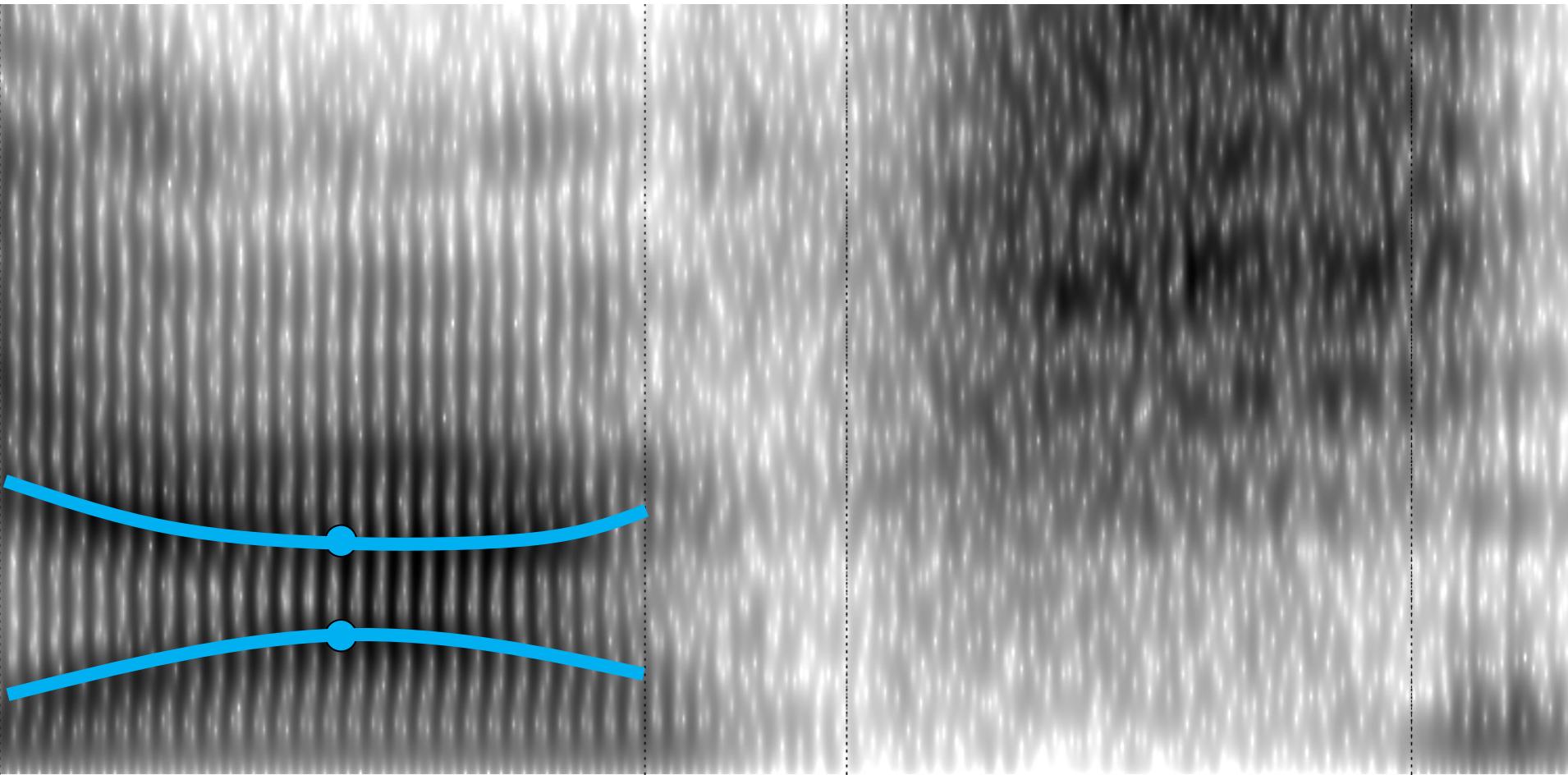
Issues

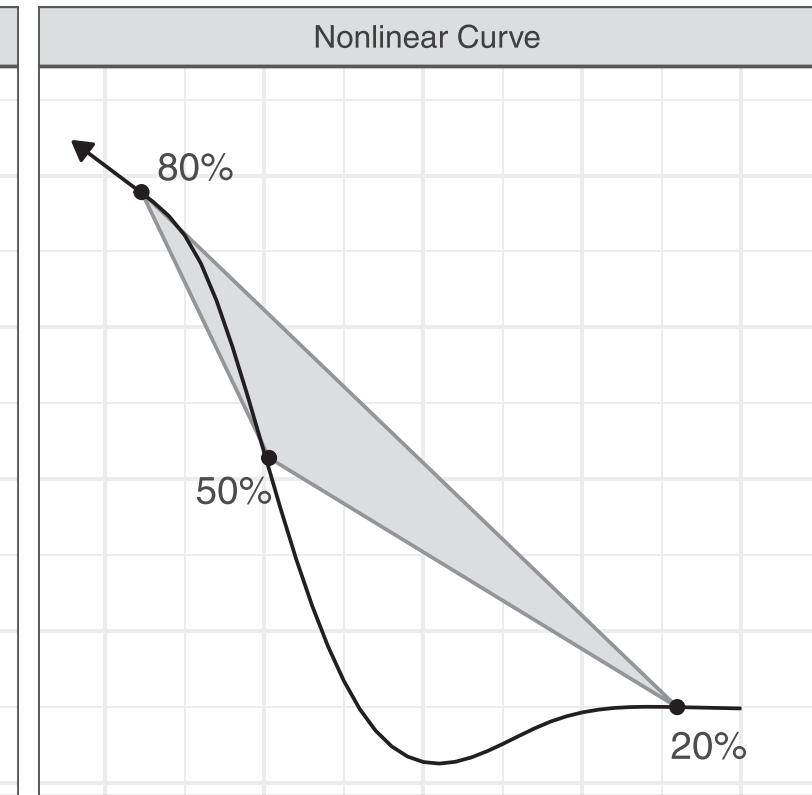
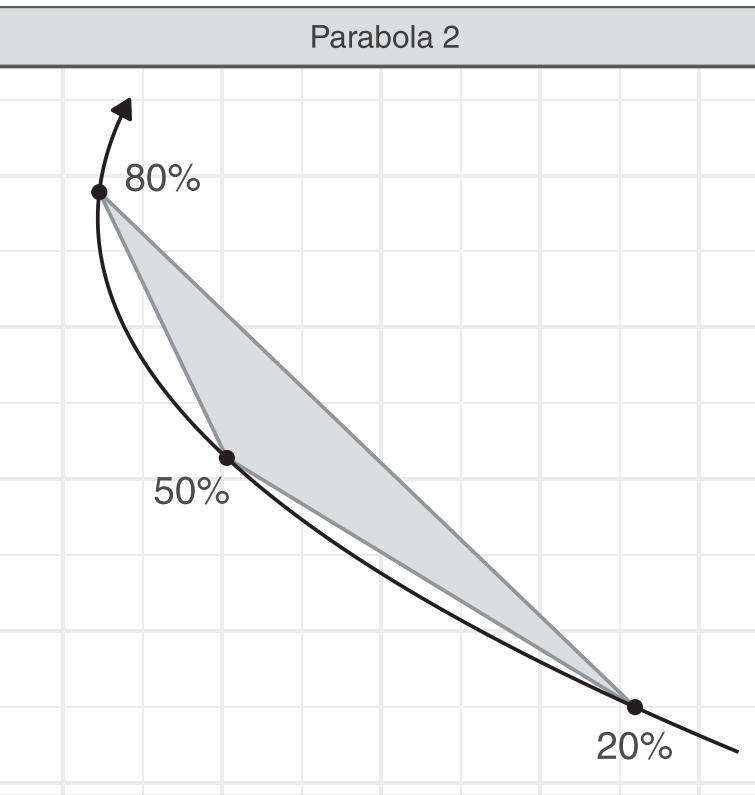
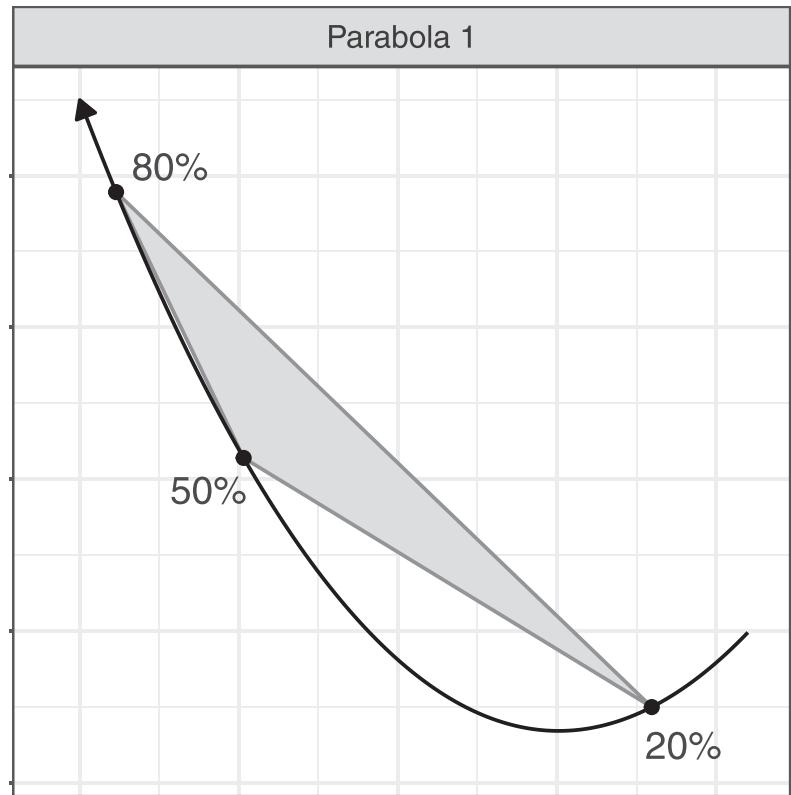
- A false dichotomy between monophthongs and diphthongs
 - Diphthongal methods only applied to canonical diphthongs
 - Are trajectories in monophthongs not important?
- Missing gradience in studying trajectory
 - VL, TL, ROC, etc. are only *properties* of trajectories
 - Are we missing nuance in the trajectory itself?





dʒ	æ	k	s	ə	n
jackson					





From Renwick & Stanley (2020:582)

Recent Developments

- Easier to extract trajectory data
 - FAVE is good, but only returns 5 points, English-only
 - Fast Track has more gradience, cleaner, any language.
- Easier to analyze trajectory data
 - Generalized additive mixed effects models
 - “Difference smooths” can tell us where along the trajectory we see statistical significance between two curves.
- We can analyze the trajectories *themselves*, rather than *properties* about them.
- Pause

Overview

1. Vowel shifts may involve changes in trajectory
 - Data: sociolinguistic interviews in Cowlitz County
 - Phenomenon: The Low-Back-Merger Shift
2. Vowel shift might not involve changes in trajectory
 - Data: Legacy linguistic atlas interviews in the South
 - Phenomenon: Southern Vowel Shift
3. Enrich our understanding of merger
 - Data: Wordlists in Heber City, Utah
 - Phenomenon: The *feel-fill* merger

Trajectories Change as Vowels Shift



Joseph A. Stanley. 2020. *Vowel Dynamics of the Elsewhere Shift: A Sociophonetic Analysis of English in Cowlitz County, Washington*. Ph.D. Dissertation. University of Georgia: Athens, Georgia.

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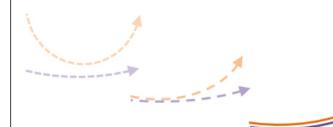
Vowel Shifts without Trajectory Changes



Joseph A. Stanley, Margaret E. L. Renwick, Katie Ireland Kuiper, & Rachel Miller Olsen (2021). "Back vowel dynamics and distinctions in Southern American English." *Journal of English Linguistics*. 49(4): 389–418.

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Trajectories' Role in Vowel Merger

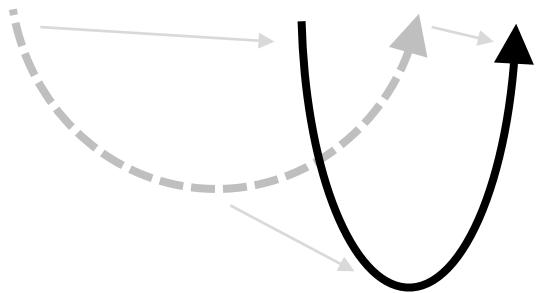


Joseph A. Stanley & Lisa Morgan Johnson. Vowels can merge because of changes in trajectory: Prelaterals in rural Utah English. The 96th Annual Meeting of the Linguistic Society of America. Washington, D.C. January 6–9, 2022

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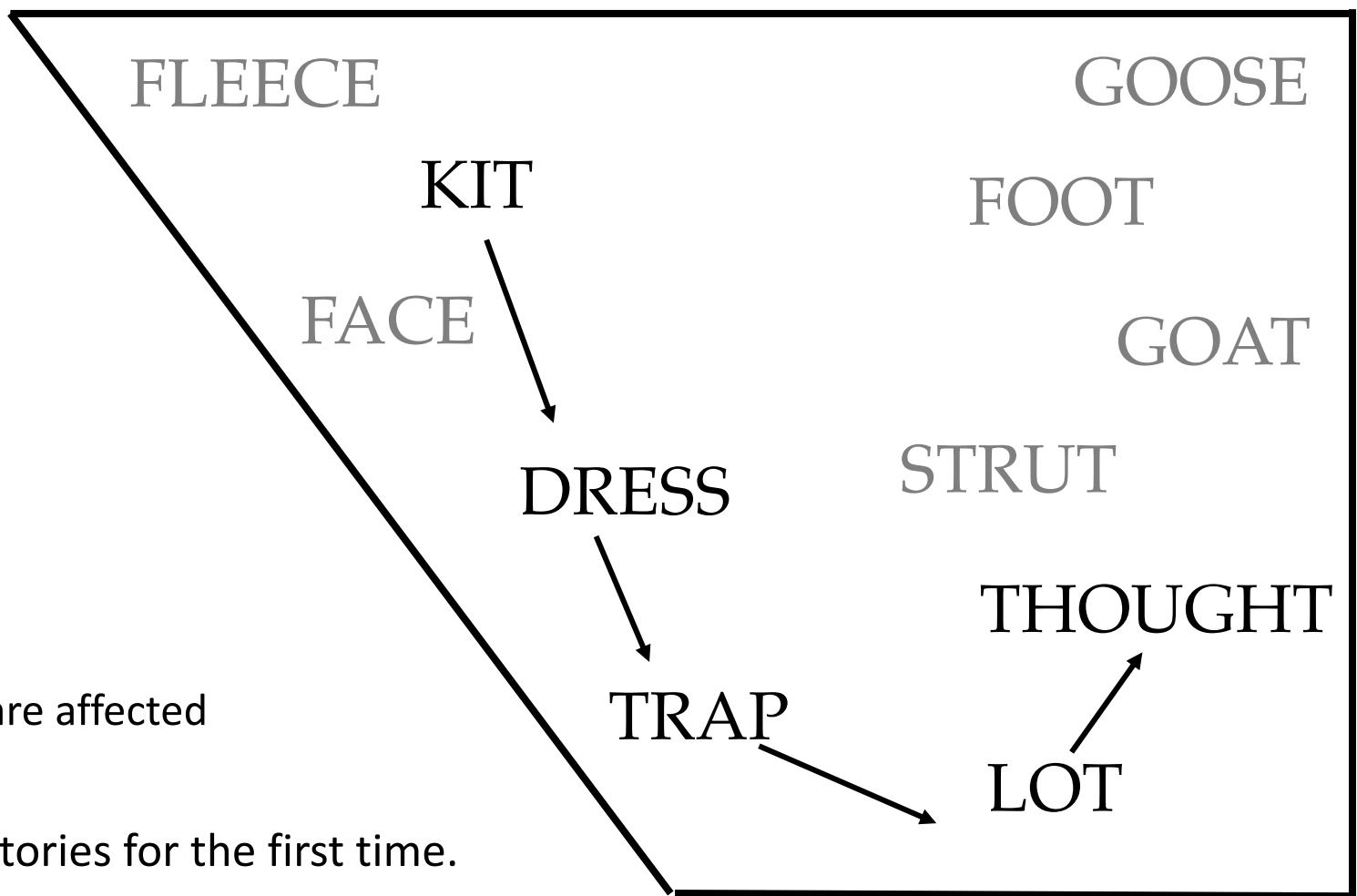
Trajectories Change as Vowels Shift



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The Low-Back-Merger Shift

- Geographically widespread.
 - California (Hinton et al. 1987)
 - Canada (Clarke et al. 1995)
 - Colorado (Holland & Brandenburg 2017)
 - Ohio (Durian 2012)
 - Massachusetts (Stanford et al. 2019)
 - Michigan (Mason 2018)
 - Georgia (Stanley & Renwick 2021)
- Applies to elsewhere allophones
 - Only preobstruent allophones are affected
- Stanley (2020) describes its trajectories for the first time.



Data Collection



- When** Summer 2016
- Field site** Cowlitz County in southwestern Washington
- Recruitment** face-to-face, business cards, snowball, family
- Method** Traditional sociolinguistic interviews (Labov 1984)
-
- Speakers** 54
- Audio** 45h 16m
- Corpus size** ~350,000 words
- Vowels analyzed** 128,370

Data Processing

Transcription Manual

Forced-Alignment Montreal Forced Aligner (McAuliffe et al. 2017)

Formant Extraction Praat (Boersma & Weenink 2018) at 11 points per vowel

Filtering Mahalanobis distance (Mahalanobis 1936)

Normalization ANAE method (Labov, Ash, Boberg 2006; cf. Nearey 1978)

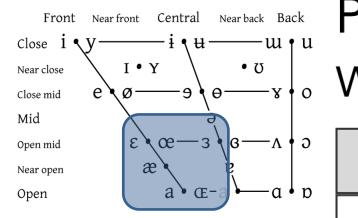
Transformation Barks (Zwicker 1961, Traunmüller 1990)

Statistical Modeling Generalized additive mixed-effects models (Wood 2017)

Software R (R Core Team 2018), tidyverse (Wickham 2018)

Visuals ggplot2 (Wickham 2015)

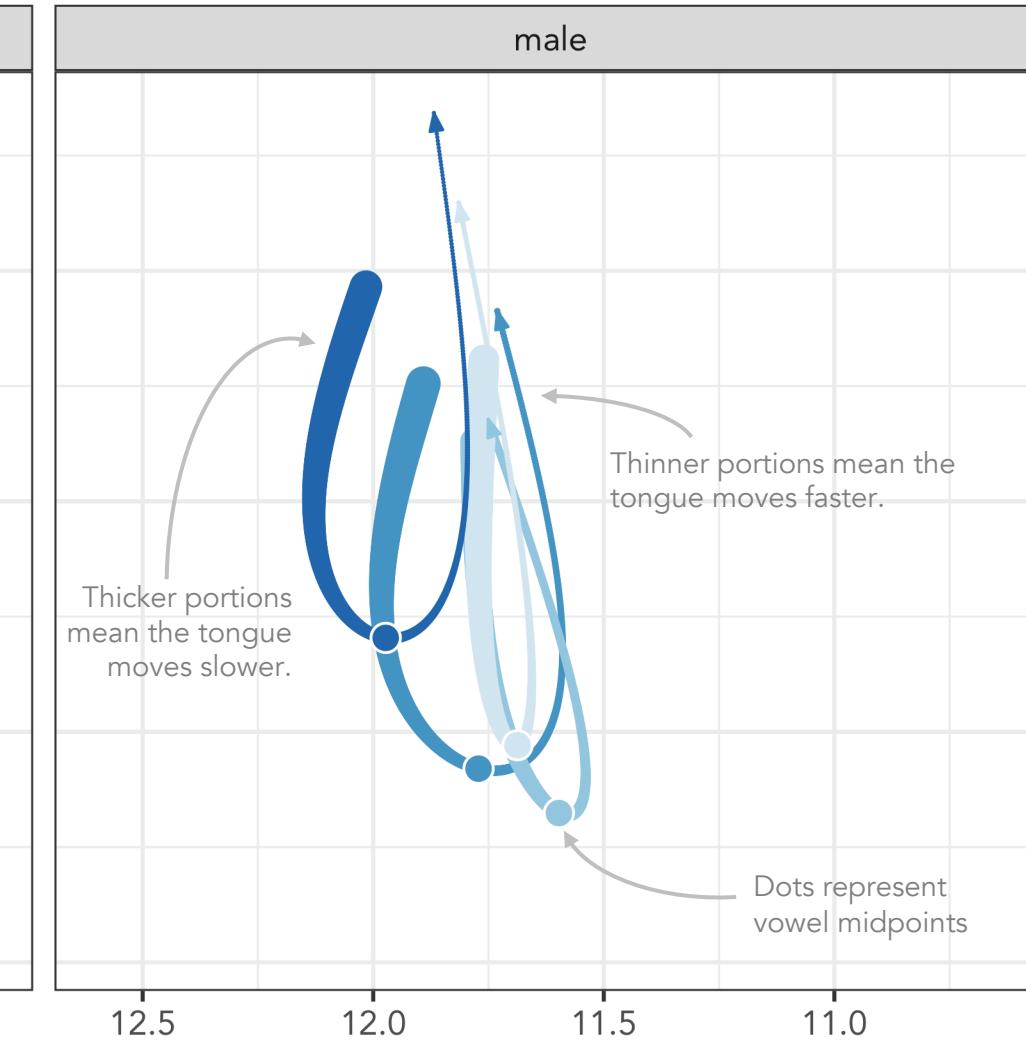
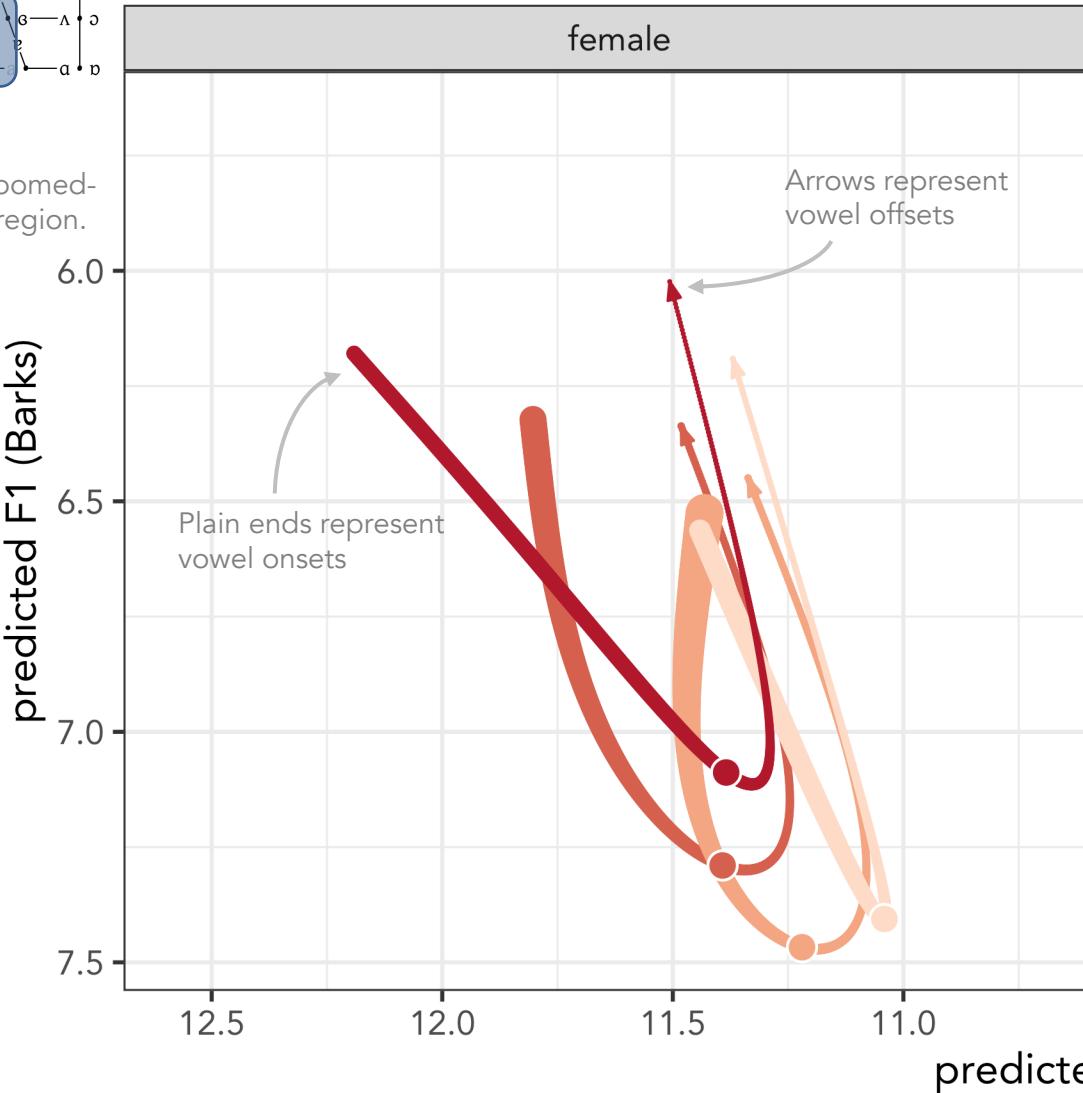
VOWELS



Predicted vowel trajectories for /æ/ in Cowlitz County, WA, by gender and generation

What you should see: Trajectories change shape as the midpoints shift.

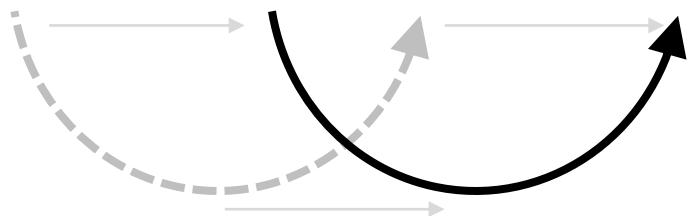
This plot is a zoomed-in view of this region.



generation and gender

- silent F ● genX F ● silent M ● genX M
- boomer F ● millennial F ● boomer M ● millennial M

Vowel Shifts without Trajectory Changes



Joey Stanley



Peggy Renwick



Rachel Olsen

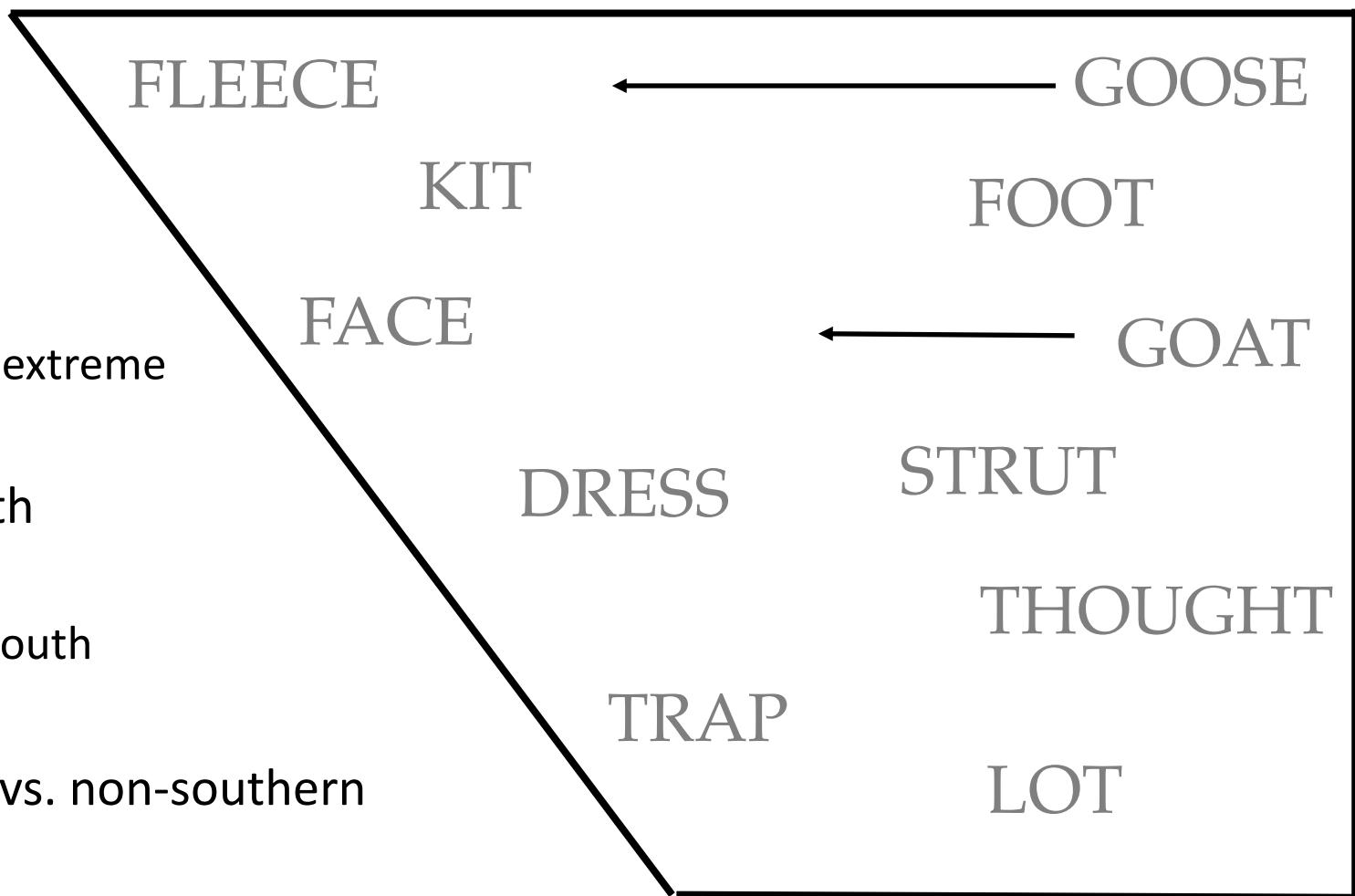


Katie Kuiper

Joseph A. Stanley, Margaret E. L. Renwick, Katie Ireland Kuiper, & Rachel Miller Olsen (2021). “Back vowel dynamics and distinctions in Southern American English.” *Journal of English Linguistics*. 49(4): 389–418.

Back Vowel Fronting

- Canonical back vowels are becoming phonetically central or even front
 - /u/-fronting is older and more extreme
 - /o/-fronting is newer and less extreme
- Found in most varieties of North American English
 - Today's focus: The American South
- Koops (2010) describes southern vs. non-southern trajectory shapes



Data “Collection”

Dataset Linguistic Atlas of the Gulf States (Pedersen et al. 1986)

Field site Texas, Arkansas, Louisiana, Tennessee, Mississippi, Alabama, Georgia, Florida

When 1968–1983

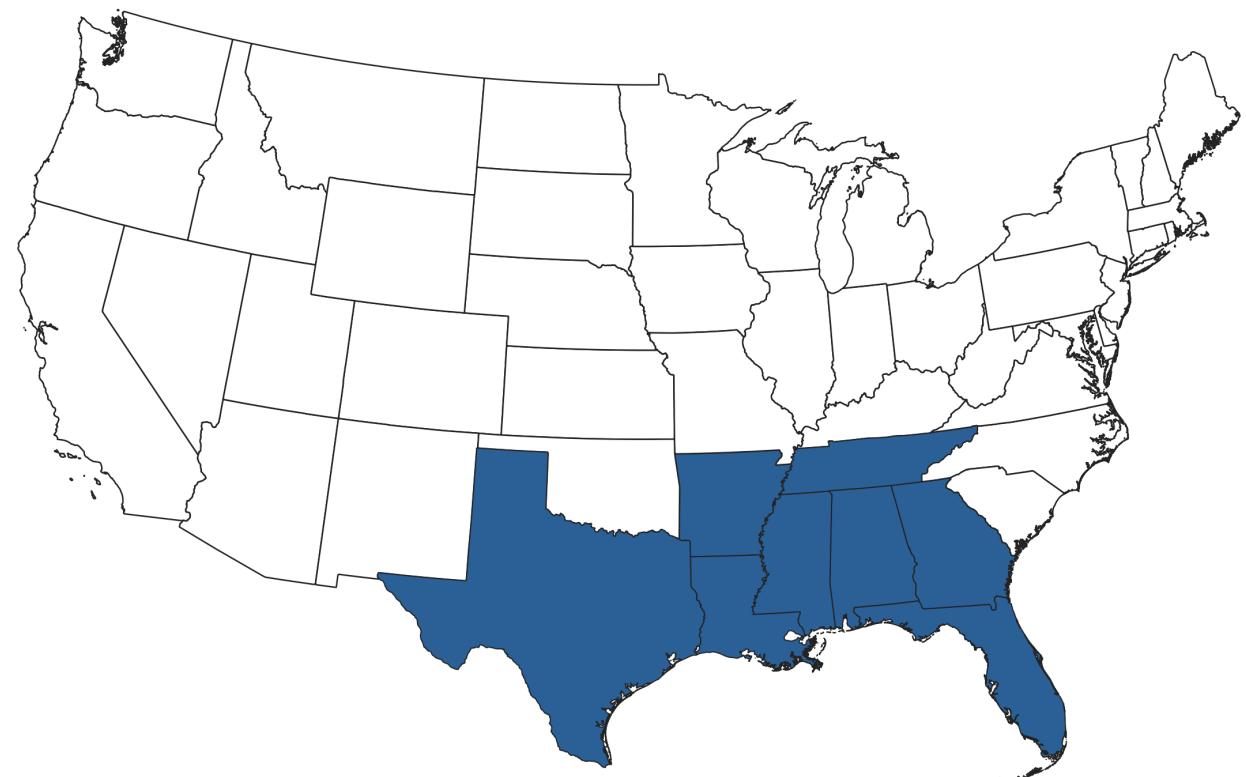
Method Linguistic Atlas interviews

Format Reel-to-reel; digitized

Speakers 48

Audio 290 hours

Vowel tokens 89,367



Data Analysis

Transcription manual (Olsen et al. 2017)

Forced-Alignment Montreal Forced-Aligner (McAuliffe et al. 2017)

Formant Extraction FAVE (Rosenfelder et al. 2014) at 20%, 35%, 50%, 65%, 80% into vowels' durations

Exclusions stopwords, pre-liquids, pre-nasals, non-primary lexical stress

Outlier detection Mahalanobis Distance (Mahalanobis 1936); furthest 5% removed

Transformation Barks (Zwicker 1961, Traunmüller 1990)

Statistics generalized additive mixed-effects models (Wood 2017; cf. Sóskuthy 2017, Gahl & Baayen 2019, Renwick & Stanley 2020)

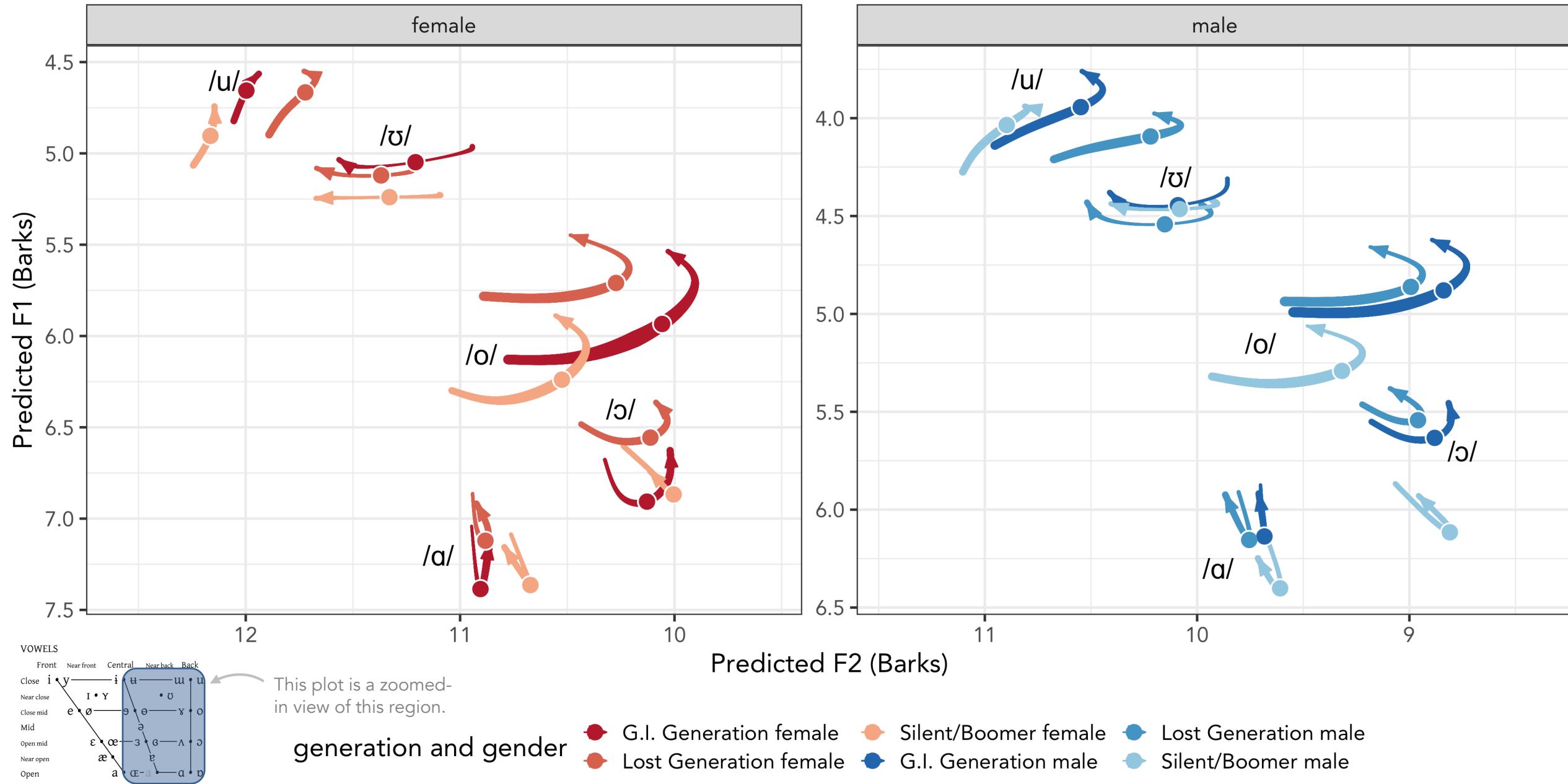
Modeling Five separate models: /aɪ/, /eɪ/, /ɛ/, /u/, /oʊ/

Software R (R Core Team 2018), tidyverse (Wickham 2018); mgcv (Wood 2011); itsadug (van Rij et al. 2020)

Visuals ggplot2 (Wickham 2015)

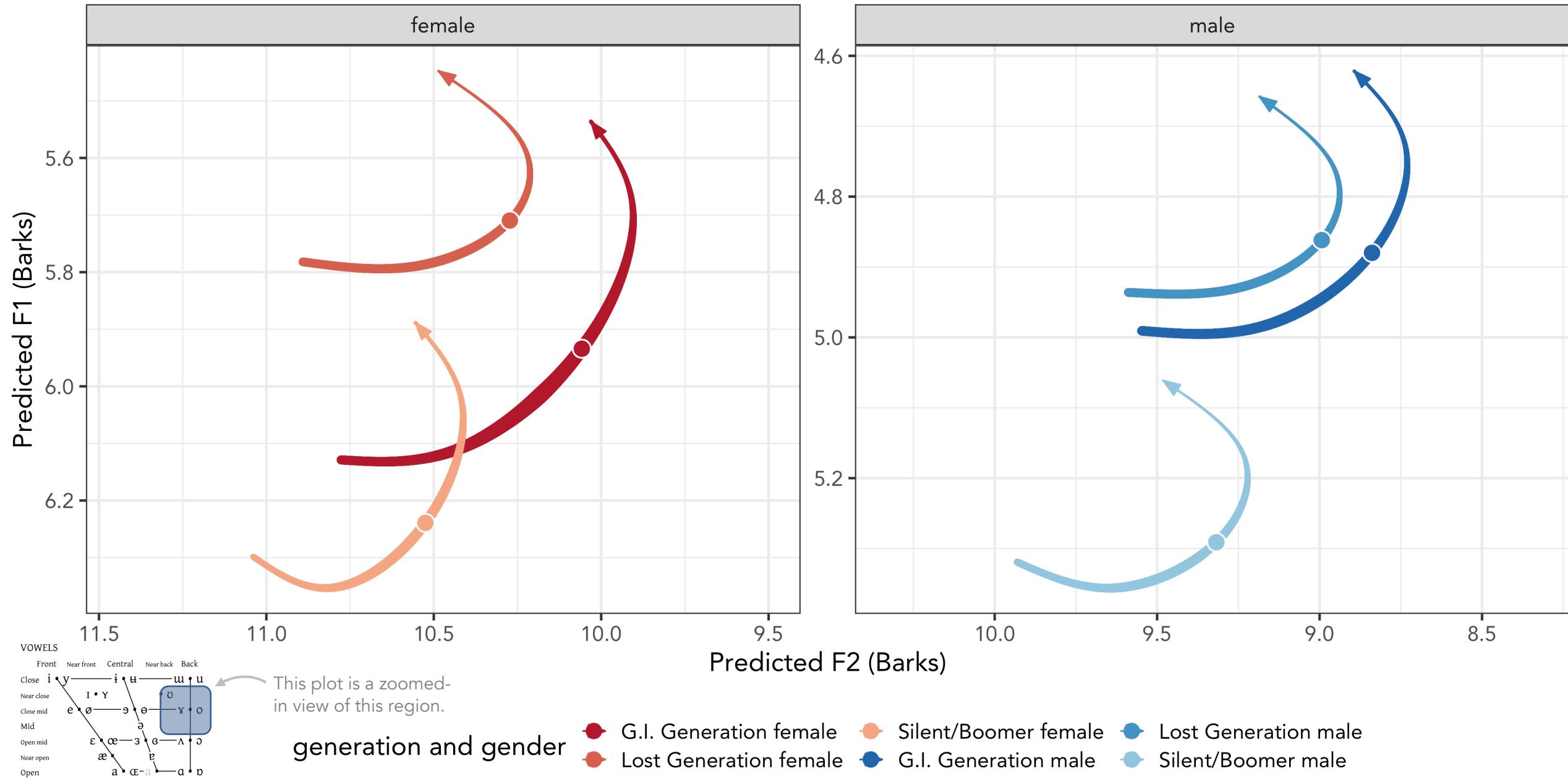
Predicted vowel trajectories for /o/ in the South, by gender and generation

What you should see: Trajectories don't change even though midpoints shift

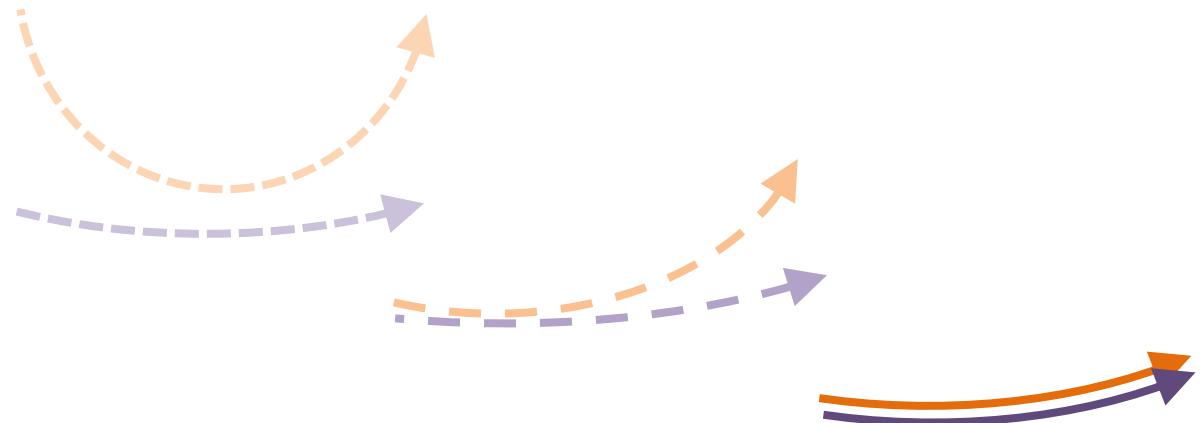


Predicted vowel trajectories for /o/ in the South, by gender and generation

What you should see: Trajectories don't change (much) even though midpoints shift



Trajectories' Role in Vowel Merger



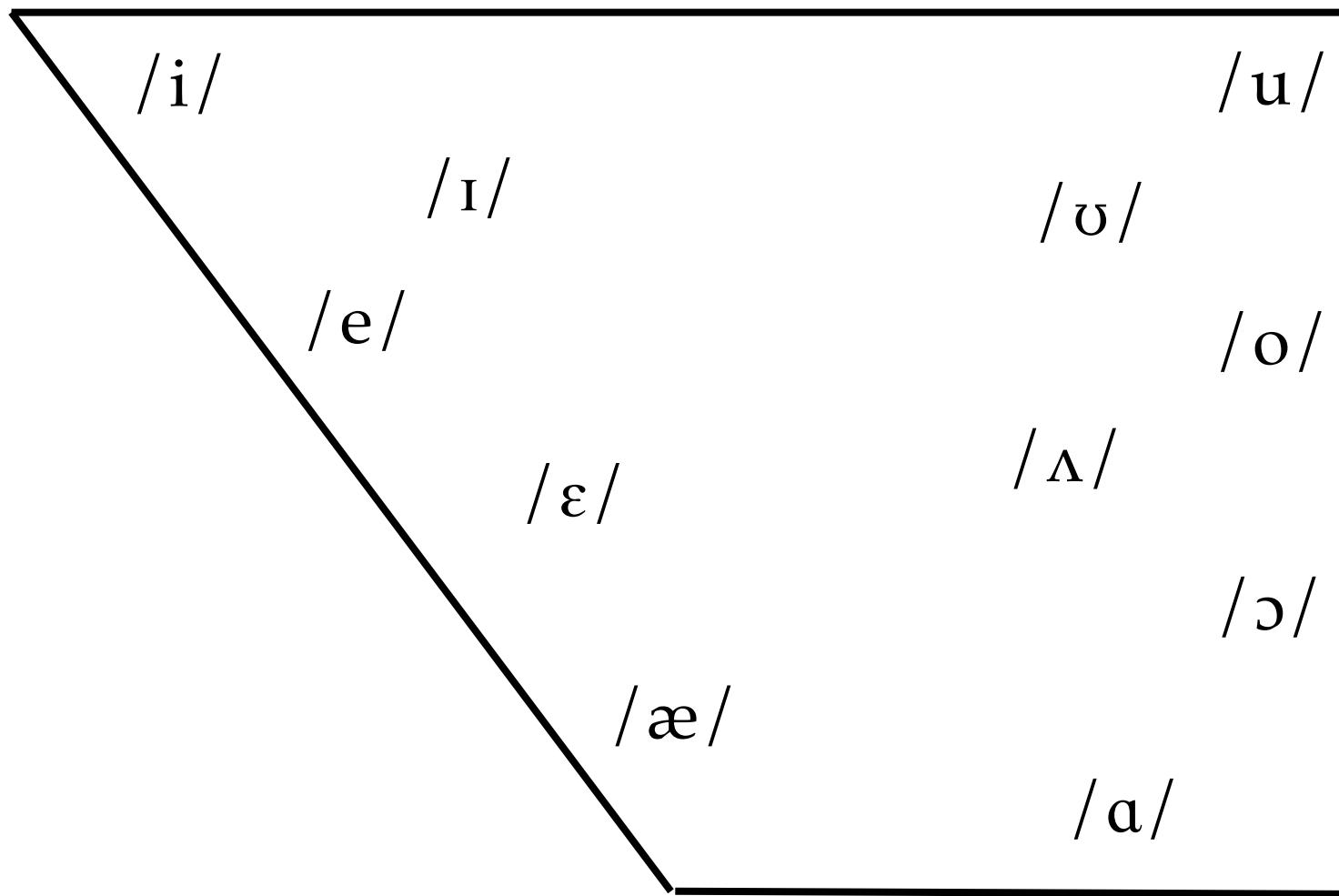
Joey Stanley



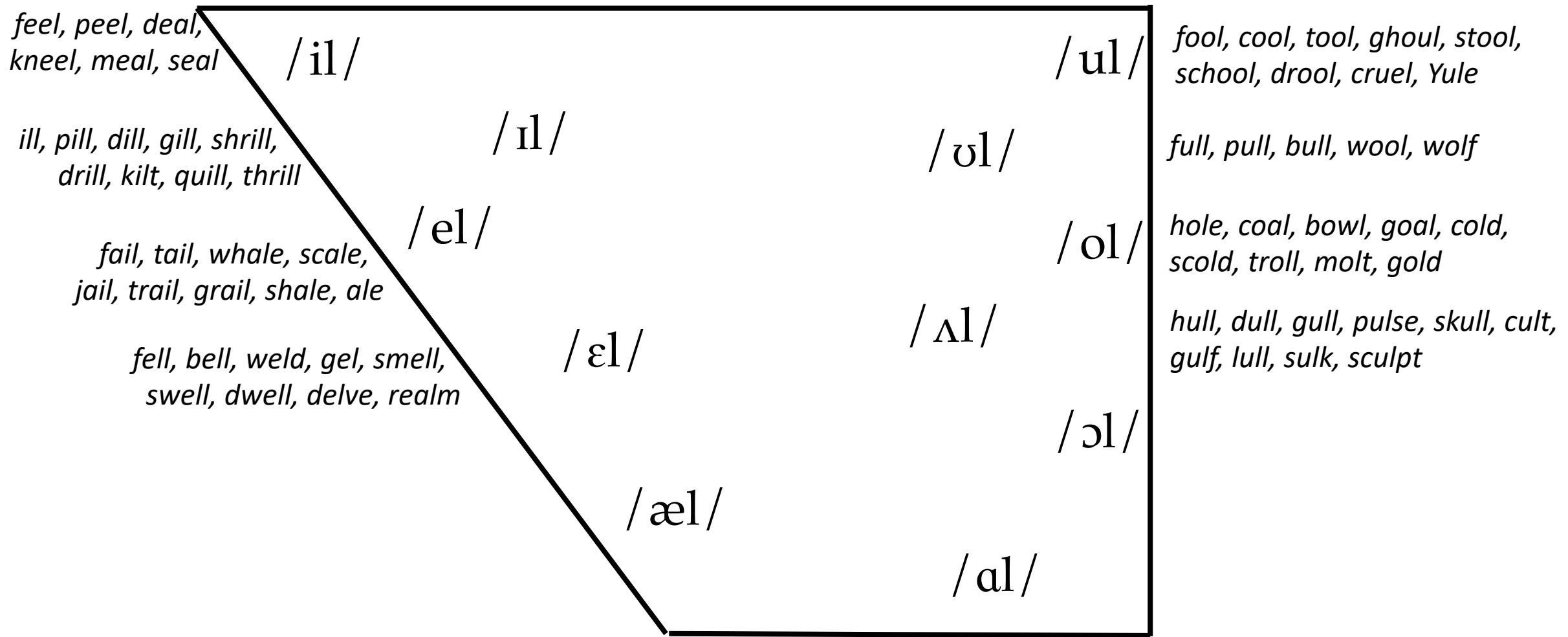
Lisa Johnson

Joseph A. Stanley & Lisa Morgan Johnson. Vowels can merge because of changes in trajectory:
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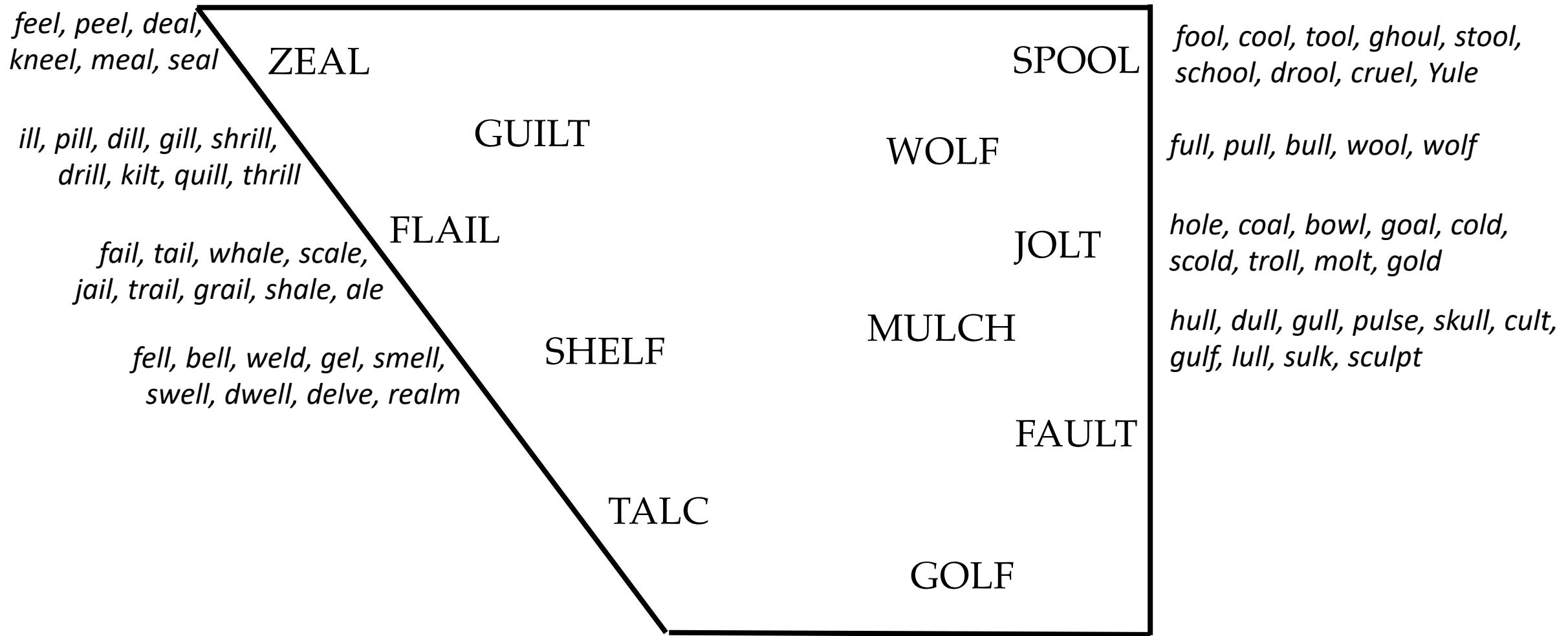
Prelateral Mergers



Prelateral Mergers

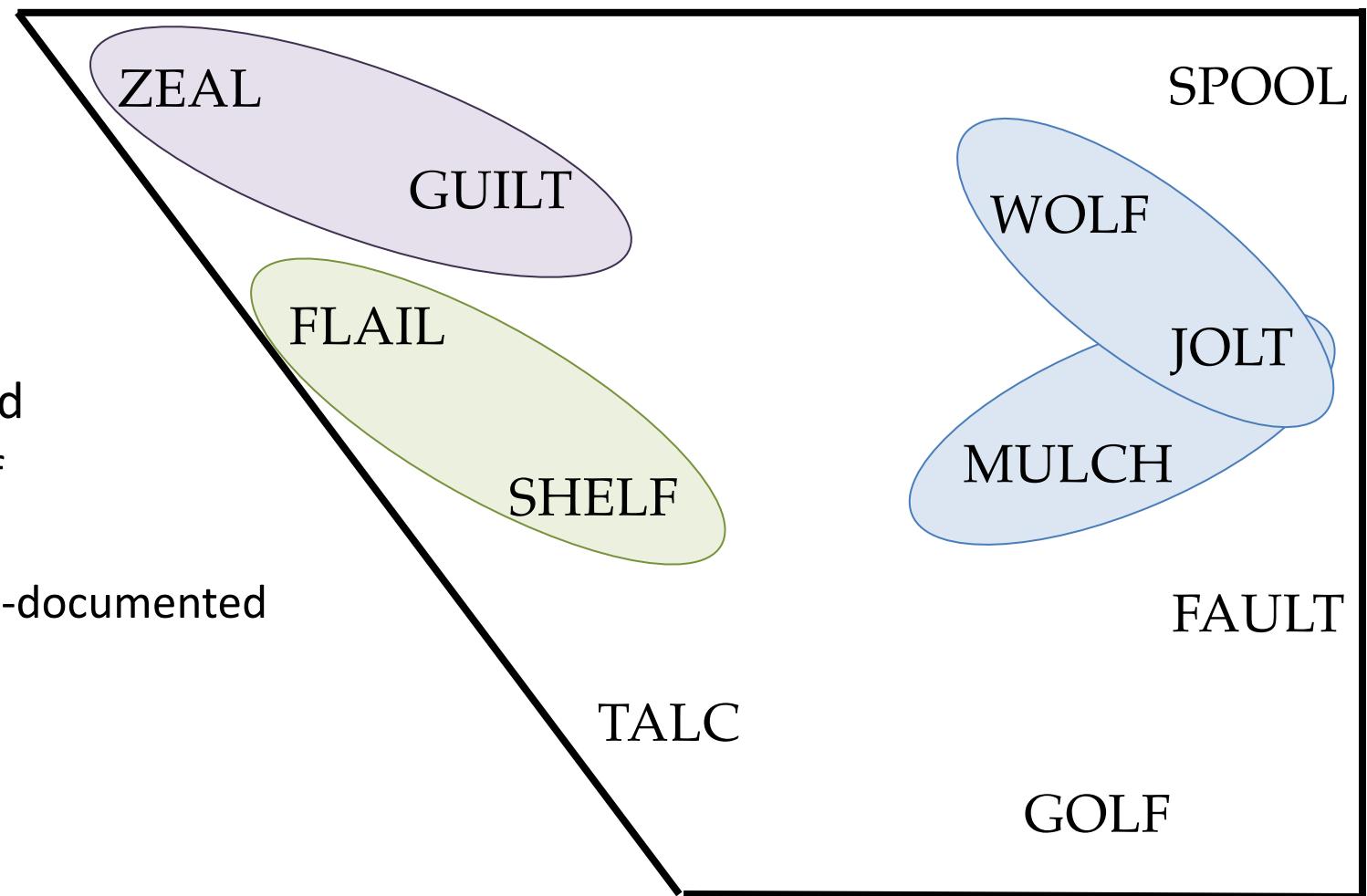


Prelateral Mergers



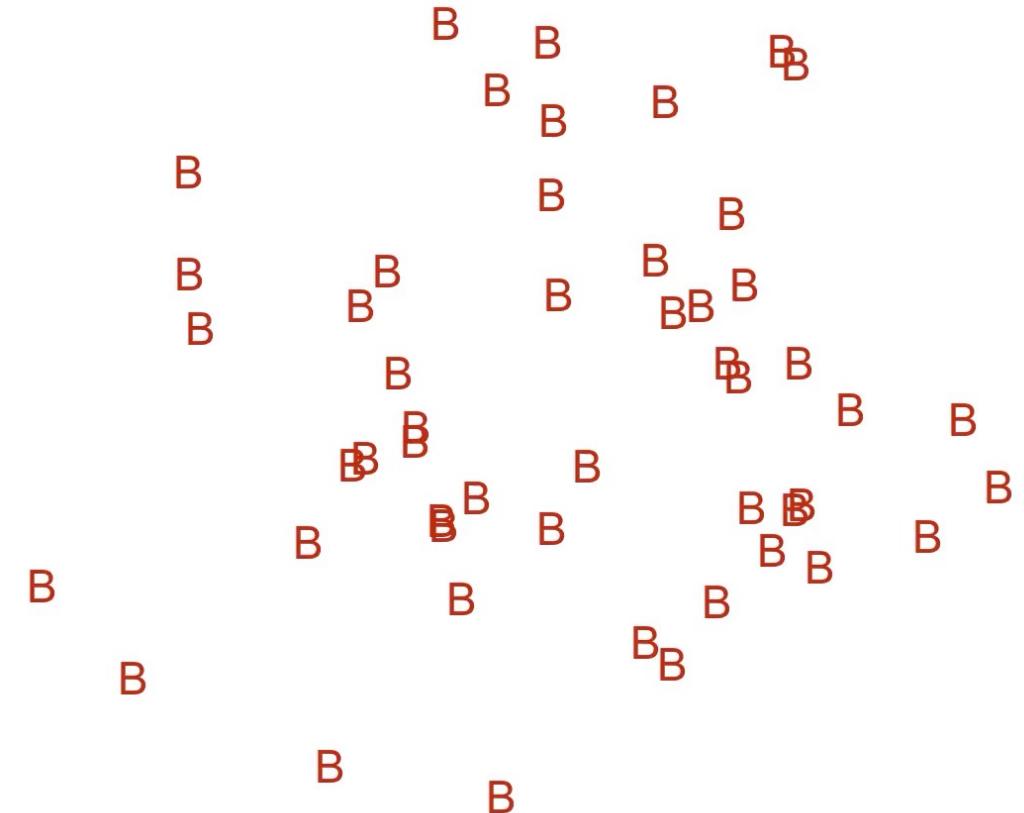
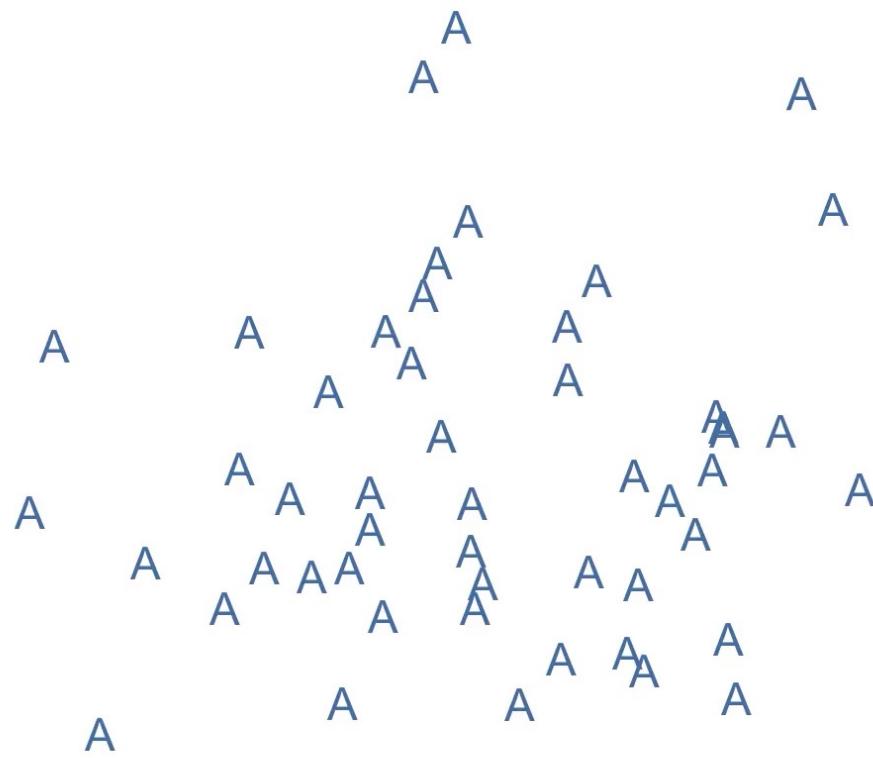
Prelateral Mergers

- In front vowels, tense-lax distinction is lost before /l/
 - Found in Utah, Texas, and scattered elsewhere
- In back vowels, it's complicated
 - Basically, any configuration of mergers has been attested.
 - Regional distribution not well-documented



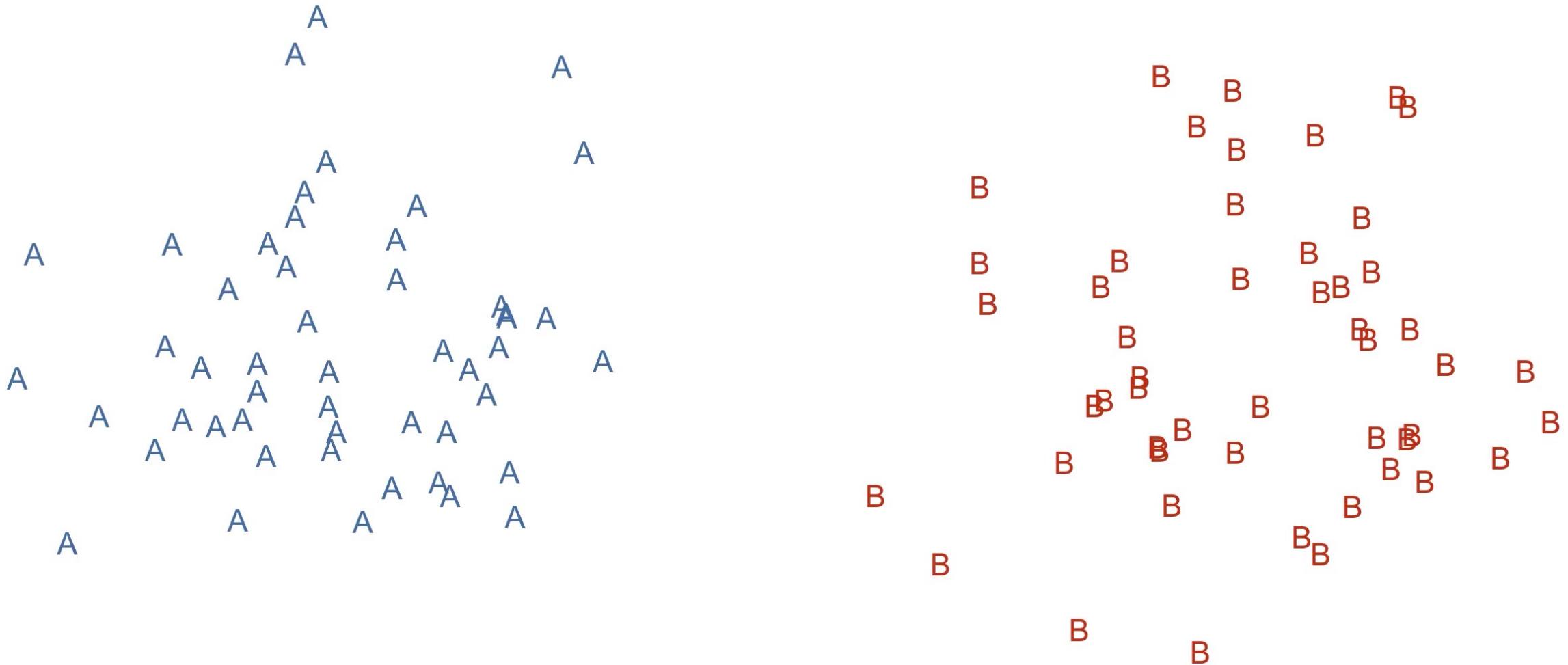
Merger by Approximation (Trudgill & Foxcroft 1978)

Based on 100 randomly generated data points



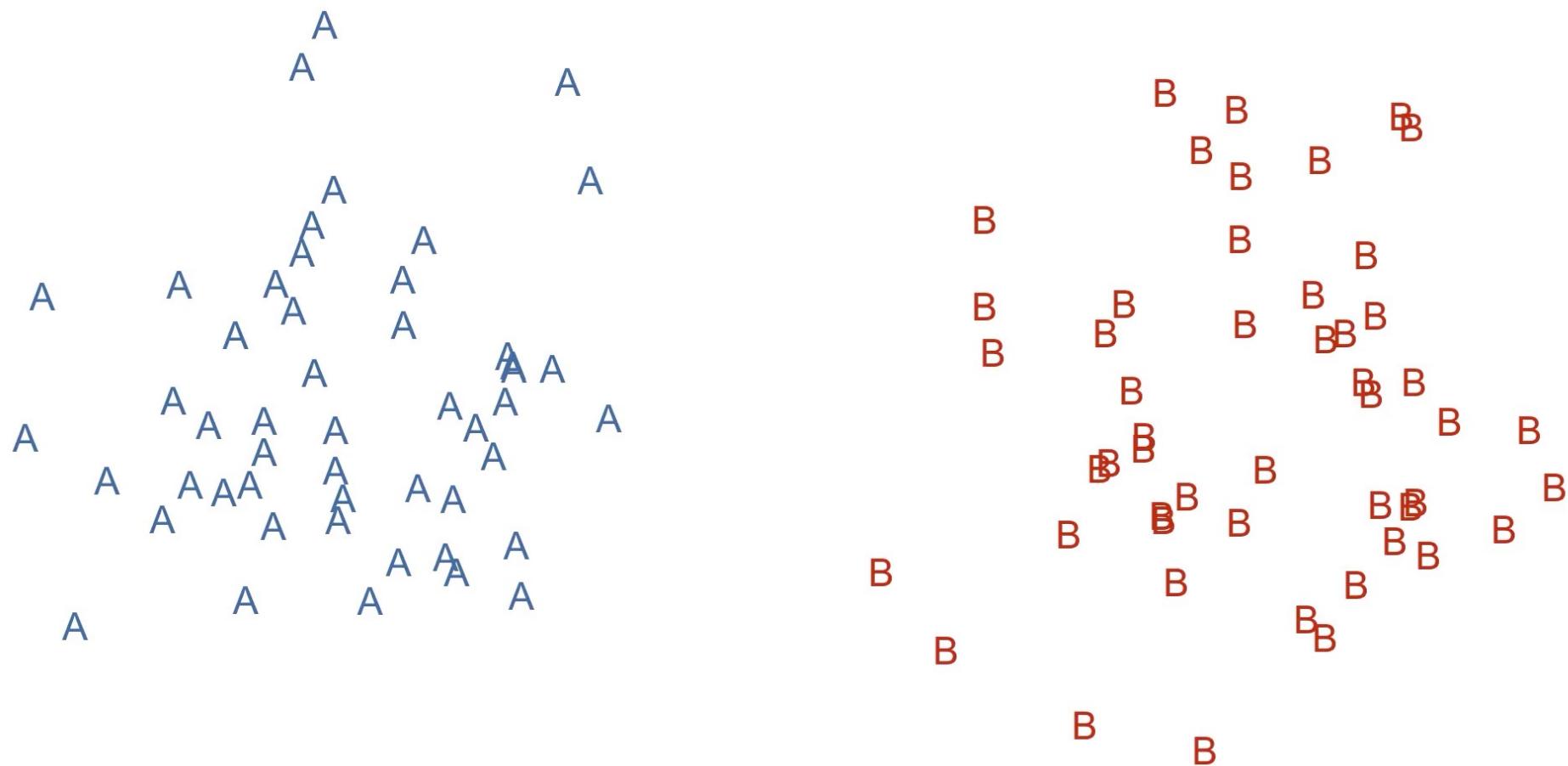
Merger by Transfer (Foxcroft & Trudgill 1978)

Based on 100 randomly generated data points



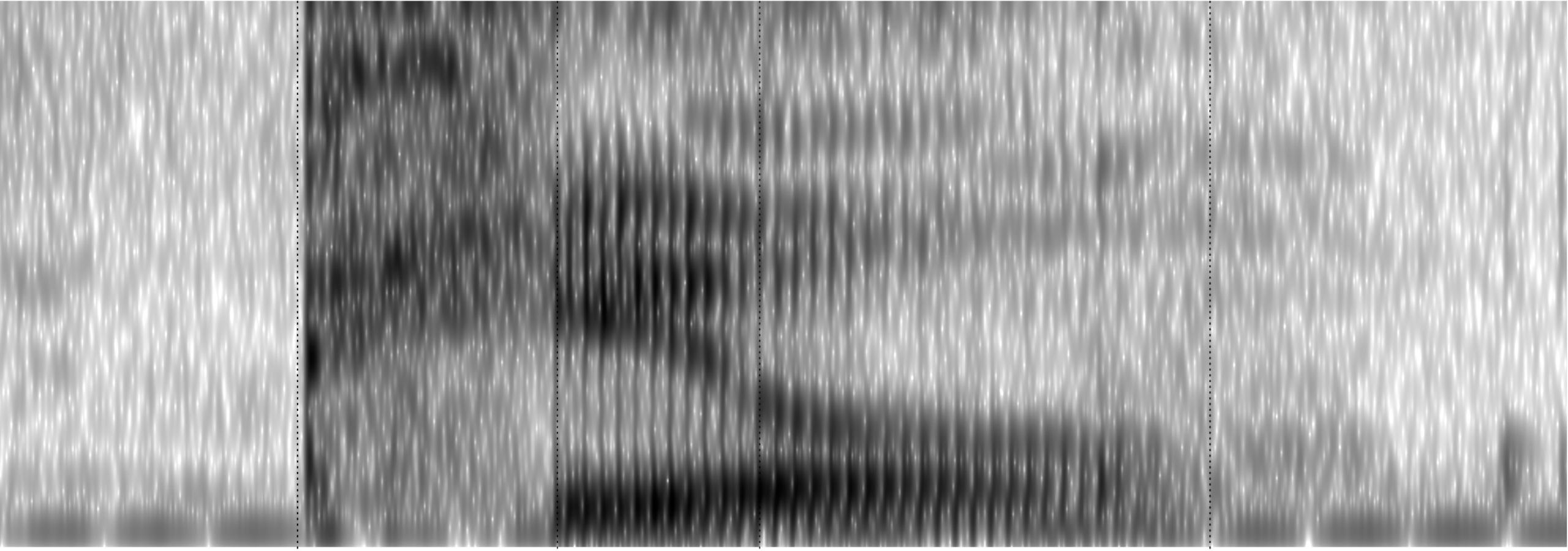
Merger by Expansion (Herold 1990)

Based on 100 randomly generated data points



Mechanisms of Merger

- Several have been proposed
 - Merger by approximation (Foxcroft & Trudgill 1978)
 - Merger by transfer (Foxcroft & Trudgill 1978)
 - Merger by expansion (Herold 1990)
 - Merger by phonological transfer (Dinkin 2016)
 - Merger by glide loss (Irons 2007)
- Trajectories and merger?
 - Other than merger by glide loss, trajectories have not been considered



p

i

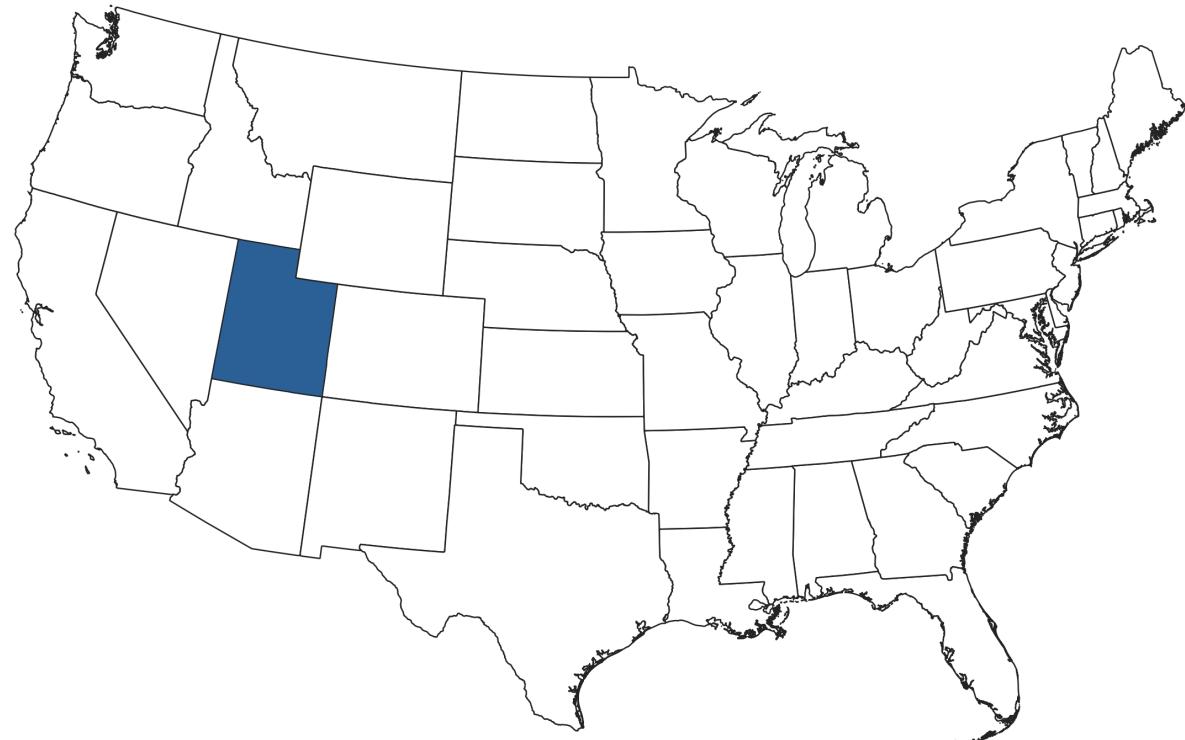
l

peel

Mechanisms of Merger

- Several have been proposed
 - Merger by approximation (Foxcroft & Trudgill 1978)
 - Merger by transfer (Foxcroft & Trudgill 1978)
 - Merger by expansion (Herold 1990)
 - Merger by phonological transfer (Dinkin 2016)
 - Merger by glide loss (Irons 2007)
- Trajectories and merger
 - Other than merger by glide loss, trajectories are not considered
 - What role do trajectories play in merger?

Data Collection



When January 2018

Field Site Wasatch County, Utah

Recruitment face-to-face, business cards, snowball, family

Method Wordlist

Speakers 28

Vowels analyzed 4,514 prelateral vowel tokens

Data Processing

Transcription Manual

Forced-Alignment Manual

Formant Extraction Fast Track (Barreda 2021), binned at 11 points per vowel

Filtering Mahalanobis distance (Mahalanobis 1936)

Normalization ΔF (Johnson 2020)

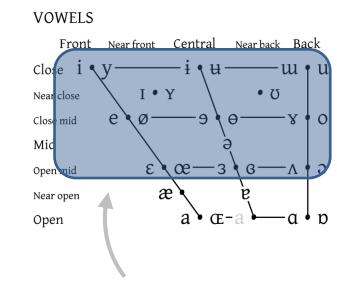
Statistical Modeling Generalized additive mixed-effects models (Wood 2017)

Software R (R Core Team 2018), tidyverse (Wickham 2018); mgcv (Wood 2011); itsadug (van Rij et al. 2020)

Visuals ggplot2 (Wickham 2015)

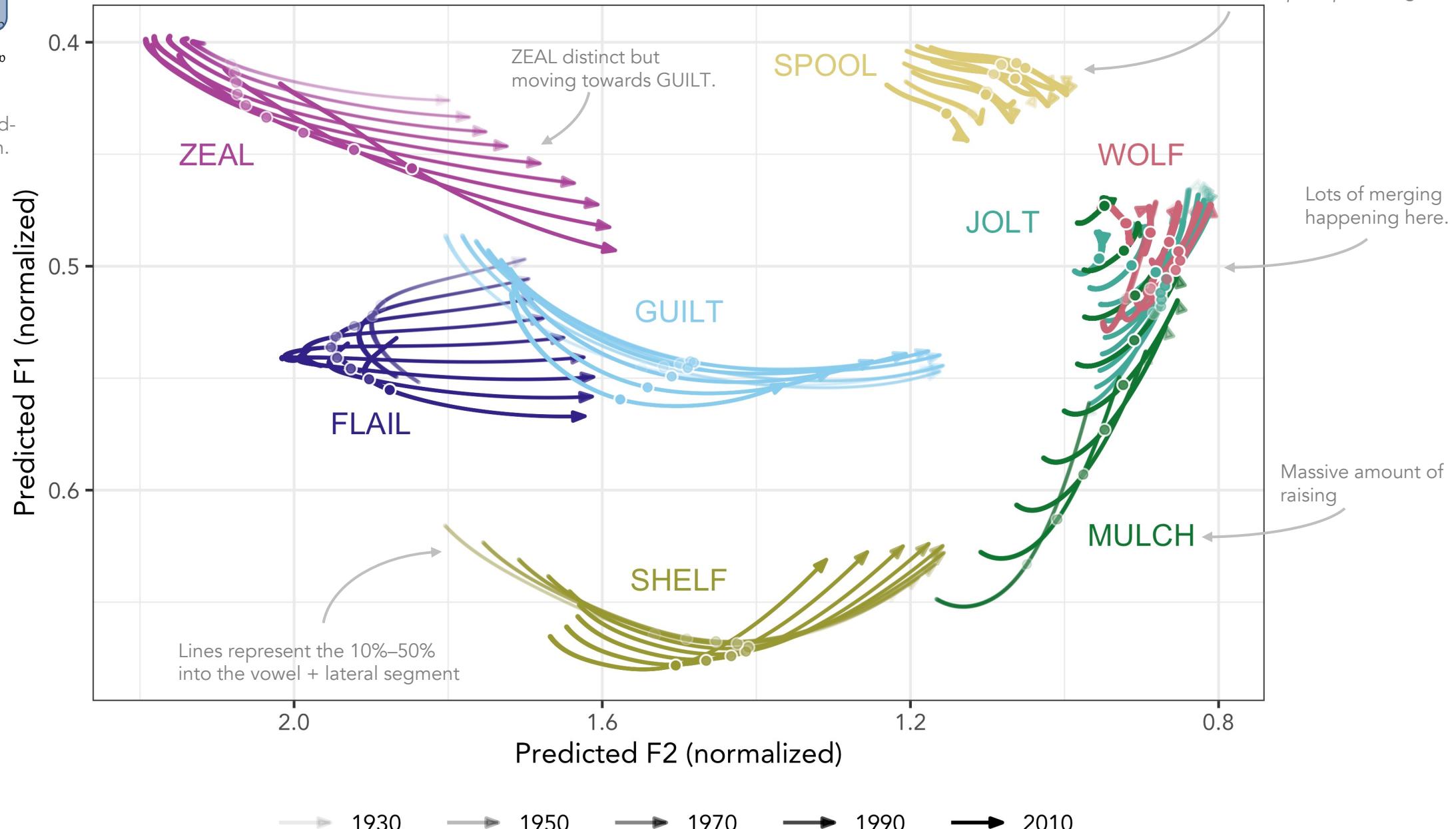
I can make some sweet plots.

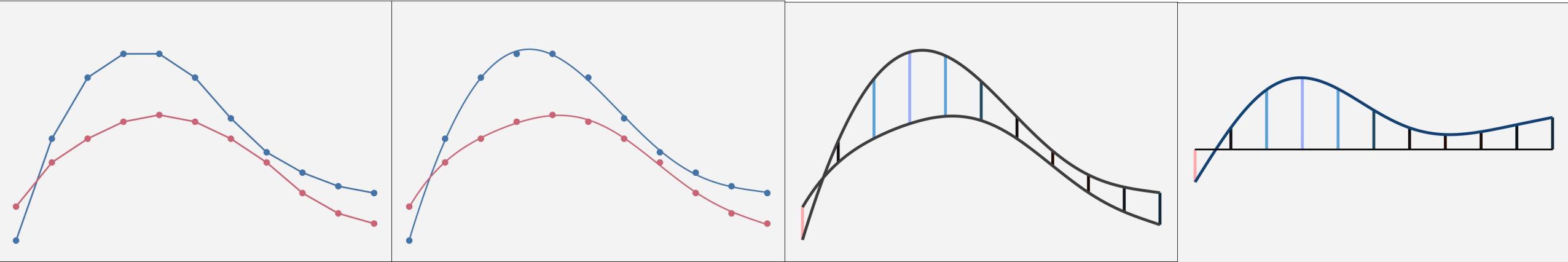
Birth year modeled as a continuous, nonlinear variable.



Predicted prelateral vowel trajectories in Heber City, UT

What you should see: Lots of change!



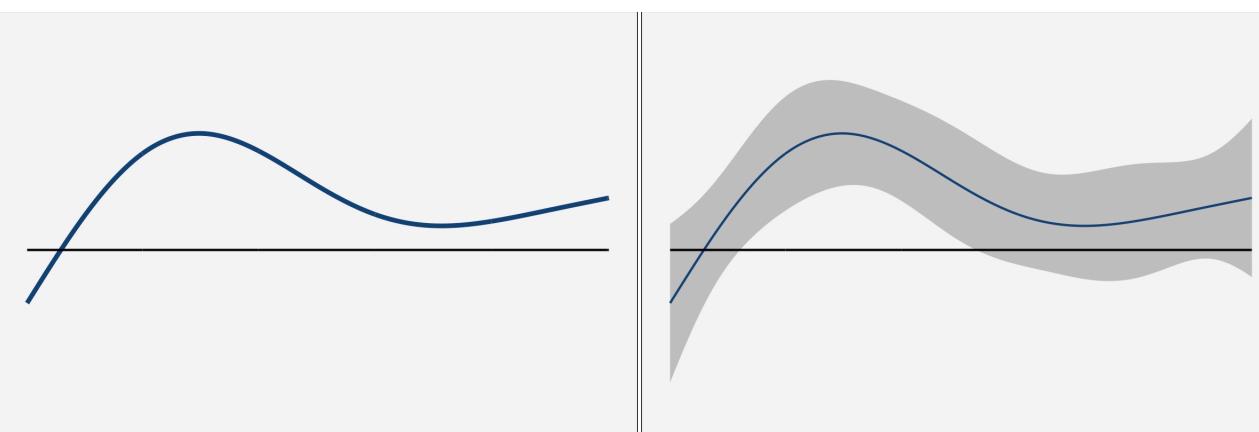


The raw data

Raw data connected smoothly via GAMM.

Difference between the smooths. Larger = bluer.

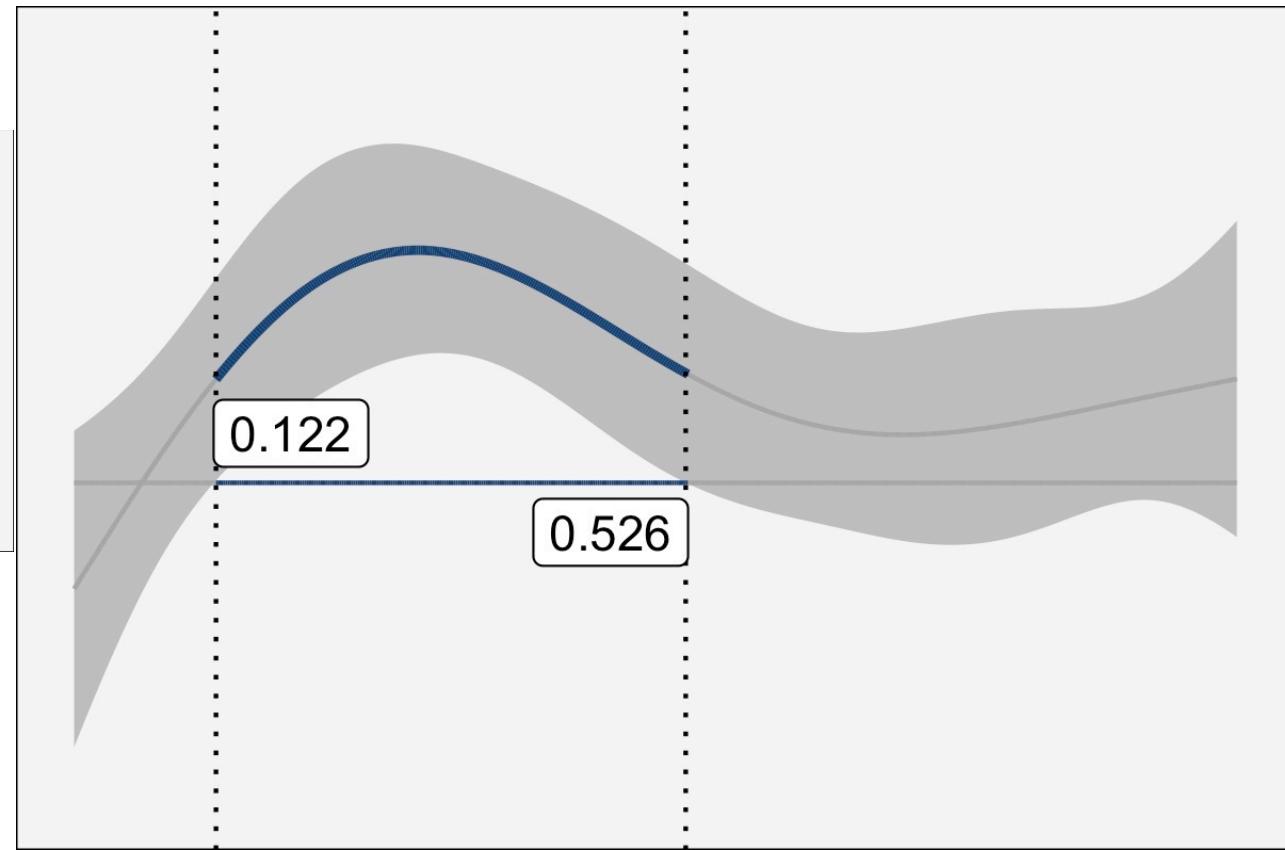
Flatten one of them; keep vertical lines consistent.



Extract just the top line. This is the **difference smooth**.

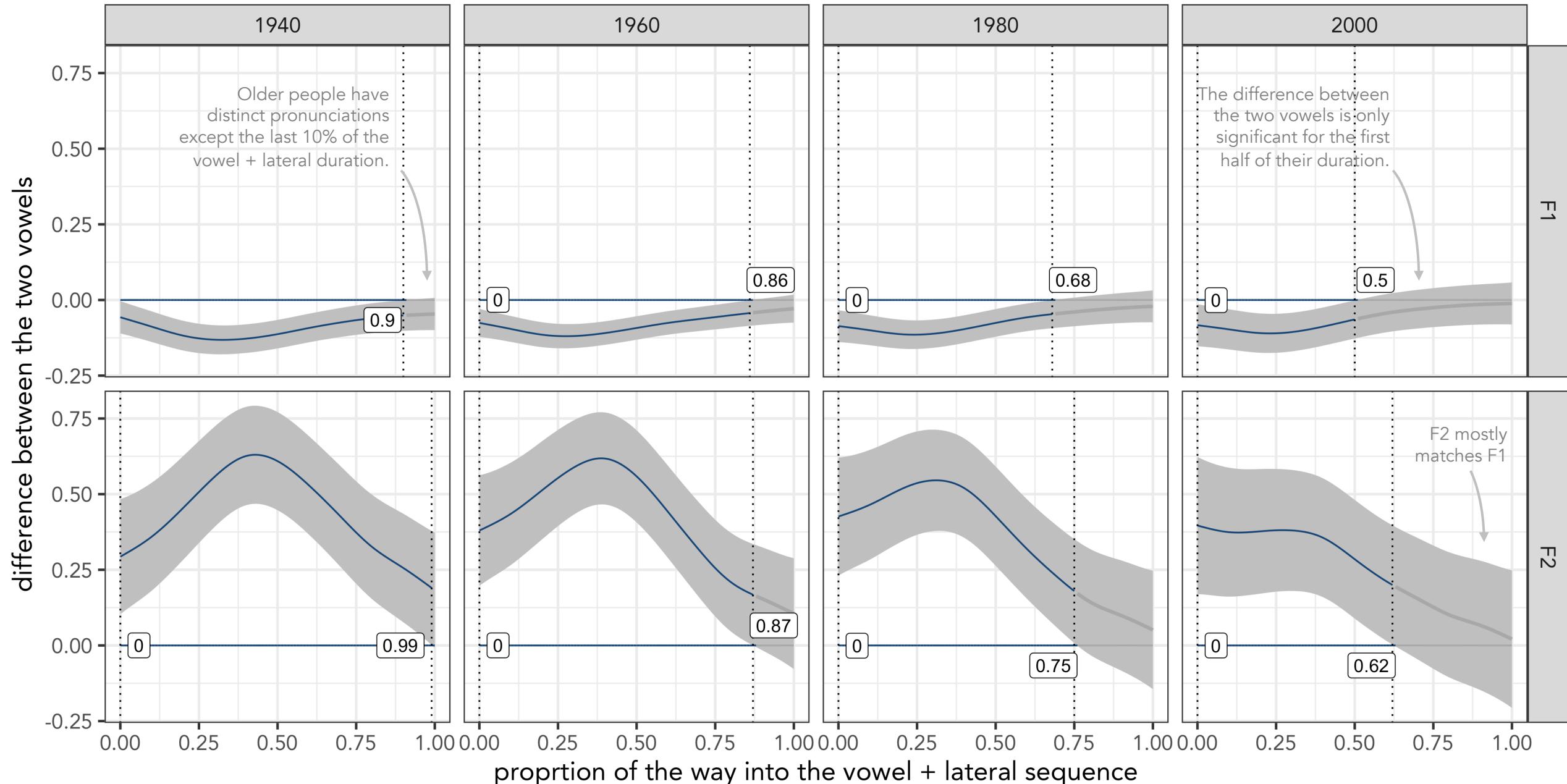
Add confidence intervals.

Indicate where confidence intervals do not include 0. ►



Difference smooths between ZEAL and GUILT over time in Heber City, UT

What you should see: Merge happens leftward from the lateral.



ZEAL-GUILT

F1

yob

2000

1980

1960

1940

1920

0.00

Onset of vowel

0.25

0.50

0.75

1.00

Offset of lateral

percent

ZEAL-GUILT

F2

Blank areas mean the difference between the two vowels is not significant.



Darker colors means greater difference.



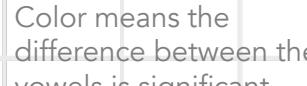
difference



Pink means ZEAL is less than GUILT. Purple is the other way.



Color means the difference between the vowels is significant.



So what?

- The vowel plot suggests a merger by approximation
 - ZEAL and GUILT are gradually getting closer in apparent time.
 - ... at least based on the midpoints.
- Expanding to trajectories gives greater insight into this type of merger.
 - In this sample, offsets are ahead of the curve than midpoints.
 - Kinda like a zipper.



Conclusion

Summary

- Changes in trajectory may accompany vowel shifts
 - With BAT in Washington, trajectories changed as the vowel lowered.
 - With GOAT in the South, trajectories were more stable as the vowel fronted.
- Trajectories are involved in vowel mergers.
 - With ZEAL and GUILT in Utah, the lateral has more and more influence on the vowel.

Conclusion

- Trajectories illuminate greater detail in sociophonetic change.
- We now have the ability to analyze trajectories.
 - Let's ditch the (phonetic) monophthong vs. diphthong distinction (at least in methods).
 - Let's reanalyze existing theories about phonetic change.
 - Let's discover new ways that language changes.
- What kind of sociolinguistic meaning is encoded in trajectories?

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