# Ethnolectal and generational differences in vowel trajectories:

## Evidence from African American English and the recession of the Southern Vowel System

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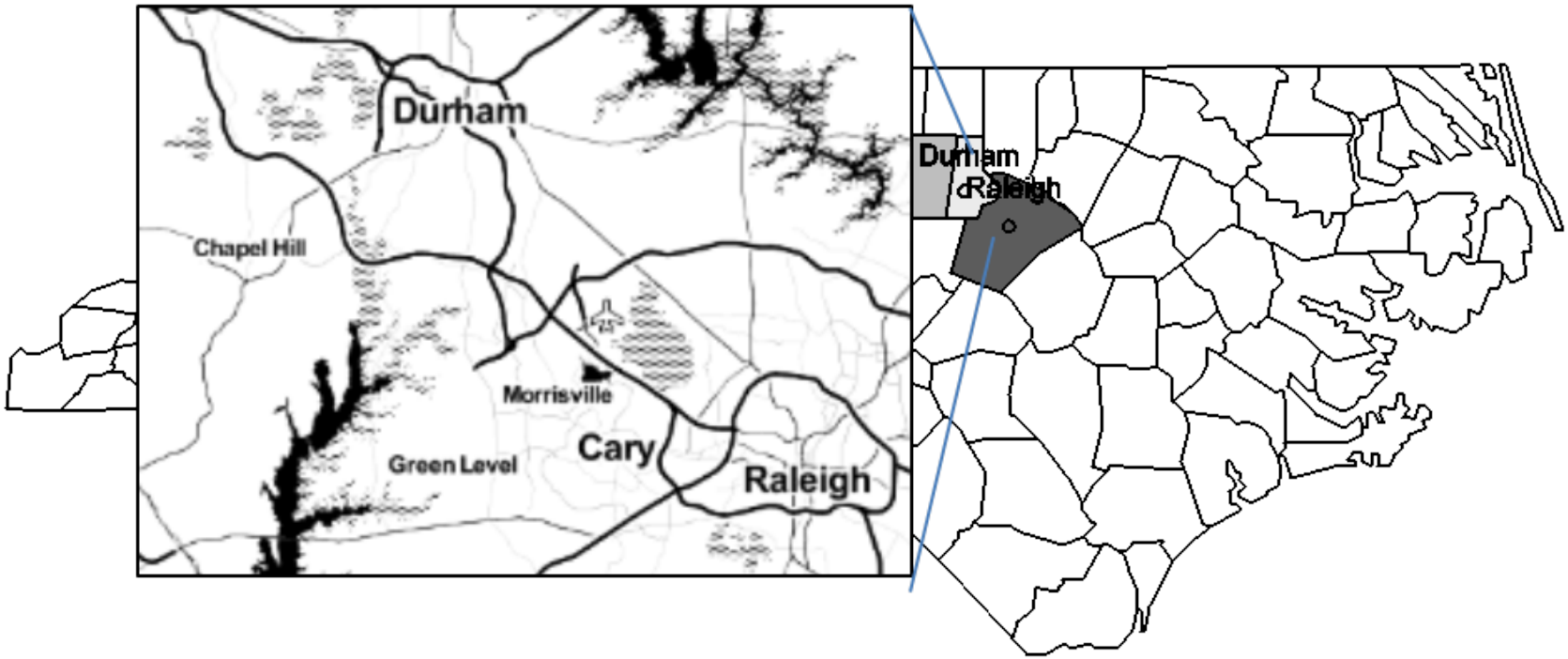
# Introduction

- Most vowel production studies focus on steady-state F1/F2 measurements, which have been useful for describing mergers and shifts, but:
  - Landmarks for measurement can be arbitrary and are chosen a priori.
  - This method doesn't incorporate dynamic information like formant trajectories or duration.
  - Dynamic information may be crucial for differentiating dialects.
- The present study demonstrates how using fine-grained acoustic analyses to make inter- and intra-community comparisons can reveal what it means to "participate in a vowel system."

# Research site: Piedmont, North Carolina



# Background

Vowel systems in Piedmont, North Carolina:

- Front lax vowels, BIT, BET, and BAT, of African American and older generation Southern Anglo-American speakers are thought to be aligned (raised and fronted) at midpoint and nuclei measurements respectively.
- These systems differ in that Southern Anglo-American vowels are more subject to breaking resulting in greater diphthongization than African American vowels (Risdal and Kohn, 2013; Koops, 2010).
- The African American vowel system has remained relatively stable for significant portions of the $20^{th}$ century in this region whereas the Southern Vowel Shift is receding in Raleigh, NC (Kohn, 2013; Dodsworth and Kohn, 2012).

# Stages of the Southern Anglo-American Vowel Shift (SVS)

Adapted from (Fridland, 2012; Labov et al., 2006; Labov, 1991):

- Stage 1 Monophthongization of BIDE [served as the trigger for the SVS]
- Stage 2 Centralization of BAIT and peripheralization of BET
- Stage 3 Centralization of BEET and peripheralization of BIT

- Stage 2 and 3 result in diphthongization of front lax vowels because raising/fronting primarily affects vowel nuclei.
- In Raleigh, stage 3—reversal of the front vowels BEET/BIT—never reached completion (Dodsworth and Kohn, 2012)

# The SVS and Front Lax Vowel Duration

Investigations of vowel duration in the SVS front lax vowels have largely taken place under controlled settings. Some general patterns are:

- The front lax vowels BET and BIT tend to be longer in duration compared to other regional dialects of American English (Clopper et al., 2005).
- Their nuclei become more peripheral, resulting in increased diphthongization, with duration (e.g., Koops, 2013).

Also of relevance is the well known relationship between vowel duration and vowel openness such that BIT $<$ BET $<$ BAT.

# Hypotheses about the SVS in Raleigh, NC

## Hypothesis 1

With respect to stages 2 and 3 of the SVS in Raleigh, we expect to see that BET will be more diphthongal than BIT among older-generation Anglo-Americans.

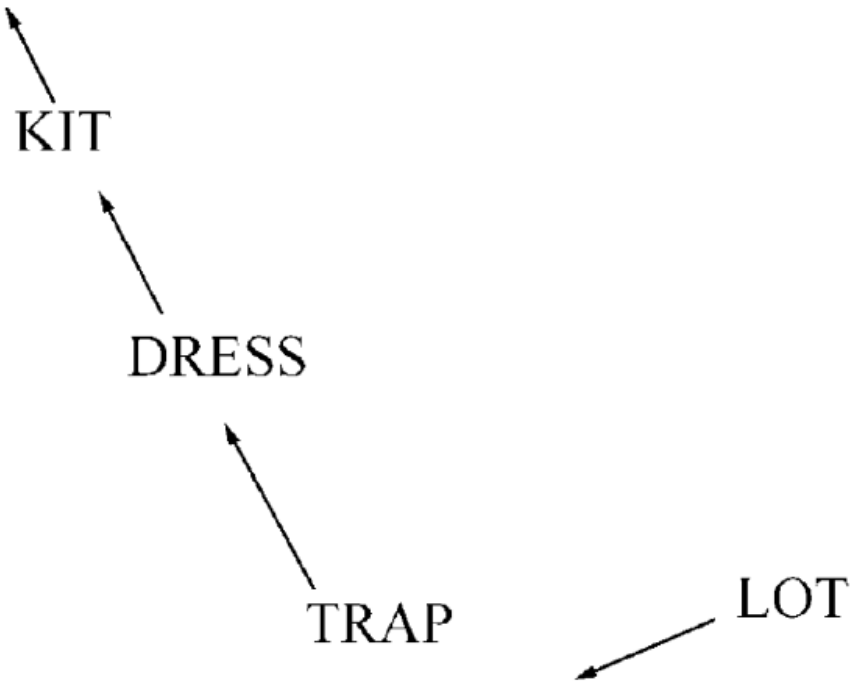
## Hypothesis 2

Increased vowel duration will be associated with more diphthongal (peripheral) formant trajectories.

# The African American Vowel System (AAVS)

- Front lax vowels raise and move forward along the vowel space diagonal. The raising of the front lax vowels in AAVS is associated with the SVS.
- Do AAVS front lax vowels undergo diphthongization in a manner similar to that of the SVS?

Reproduced from Thomas (2007, pg. 465):



# Participation in the AAVS

- Not all Southern African Americans participate in the AAVS to the same degree (Kohn and Farrington, 2013).
- In this study, we investigate how participation in the AAVS is realized by individual speakers in Piedmont, NC where this variety is present alongside the similar SVS.

# AAVS implicational scoring (Kohn and Farrington, 2013)

| Vowels | AAE (score 1, .5, 0) |
|---|---|
| BEET/BIT F1 | Reversed |
| BEET/BIT F2 | Reversed |
| BET/BAIT F1 | Reversed |
| BET/BAIT F2 | Reversed |
| BAT Raised | Closer to BET than BOT |
| BUT Raised | Above BOAT/BOWL |
| BOUGHT | Closer to BOAT than BOT |
| BOAT | Behind BOT on F2 |
| BOOK | Behind BOT on F2 |
| BOOT | Behind BOT on F2 |
| BIDE | Glide weakened |
| PIN/PEN | Merged |
| | Total possible score: 12 |

# Questions about the AAVS in Piedmont, NC

## Research Question 3

Do younger-generation African American speakers produce more monophthongal front lax vowels compared to Anglo-American speakers?

## Research Question 4

Do individuals differ in terms of front lax vowel trajectories according to their use of other phonological features of the AAVS?

# Data Collection

- Sociolinguistic interviews were done by researchers affiliated with the North Carolina Language and Life Project (NCLLP) (Anglo-American English) and the Frank Porter Graham longitudinal language study at UNC-Chapel Hill (African American English).
- Primary stressed vowel tokens $\geq$ 60ms were extracted from force-aligned TextGrids (P2FA; Yuan and Liberman, 2008) using a semi-automatic Praat script.[1]
- No preceding or following liquids, glides, nasals, or vowels.

[1] Written by Jeff Mielke and adapted for the present study.

# Data Collection

- 26 African American speakers born around 1991 from Piedmont, NC and 8 Southern Anglo-Americans born between 1941 and 1959 from Raleigh, NC.
  - AAVS scores ranged from 1 to 9.5 (M = 4.33). A subset of African American speakers divided into **high** (M = 6.12, n = 9) and **low** (M = 2.42, n = 7) AAVS groups.
- A total of 3906 vowel tokens extracted: 1121 BIT, 1010 BET, and 1775 BAT.
- 21 F1 and F2 equidistant measurements taken from each vowel from onset to offset which were then normalized using Lobanov's (1971) *z*-scoring method.

# Modeling formant contours with functional analysis

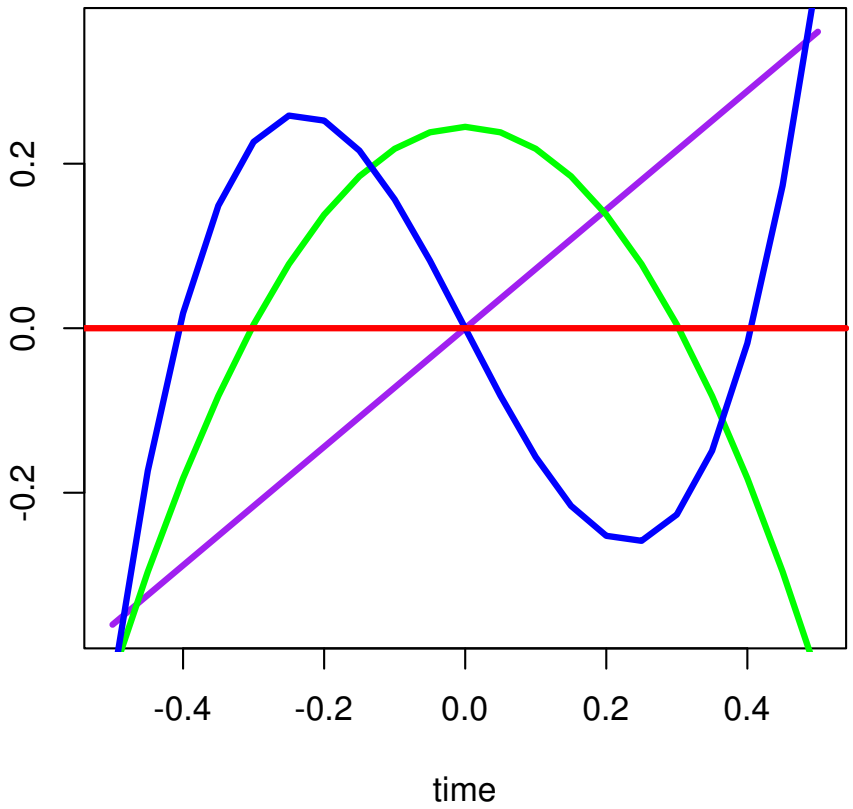
- We fitted measurements from each time-series vowel token to an orthogonal cubic polynomial. We then extracted the coefficients (i.e., parameters) from each function to make independent comparisons of contour shapes.
- Previous studies have used functional analysis to compare coefficients of similar data:
  - pitch contours (Grabe et al., 2007);
  - formant trajectories (Mielke, 2013; Morrison, 2009);
  - eye-tracking data (McMurray et al., 2010)—all of which follow smooth curves.
- Median $R^2$ values of .92 and .91 were achieved for F1 and F2 respectively indicating successful fits to the data.

# Orthogonal polynomial functions and coefficients

Coefficients (parameters of the curves):

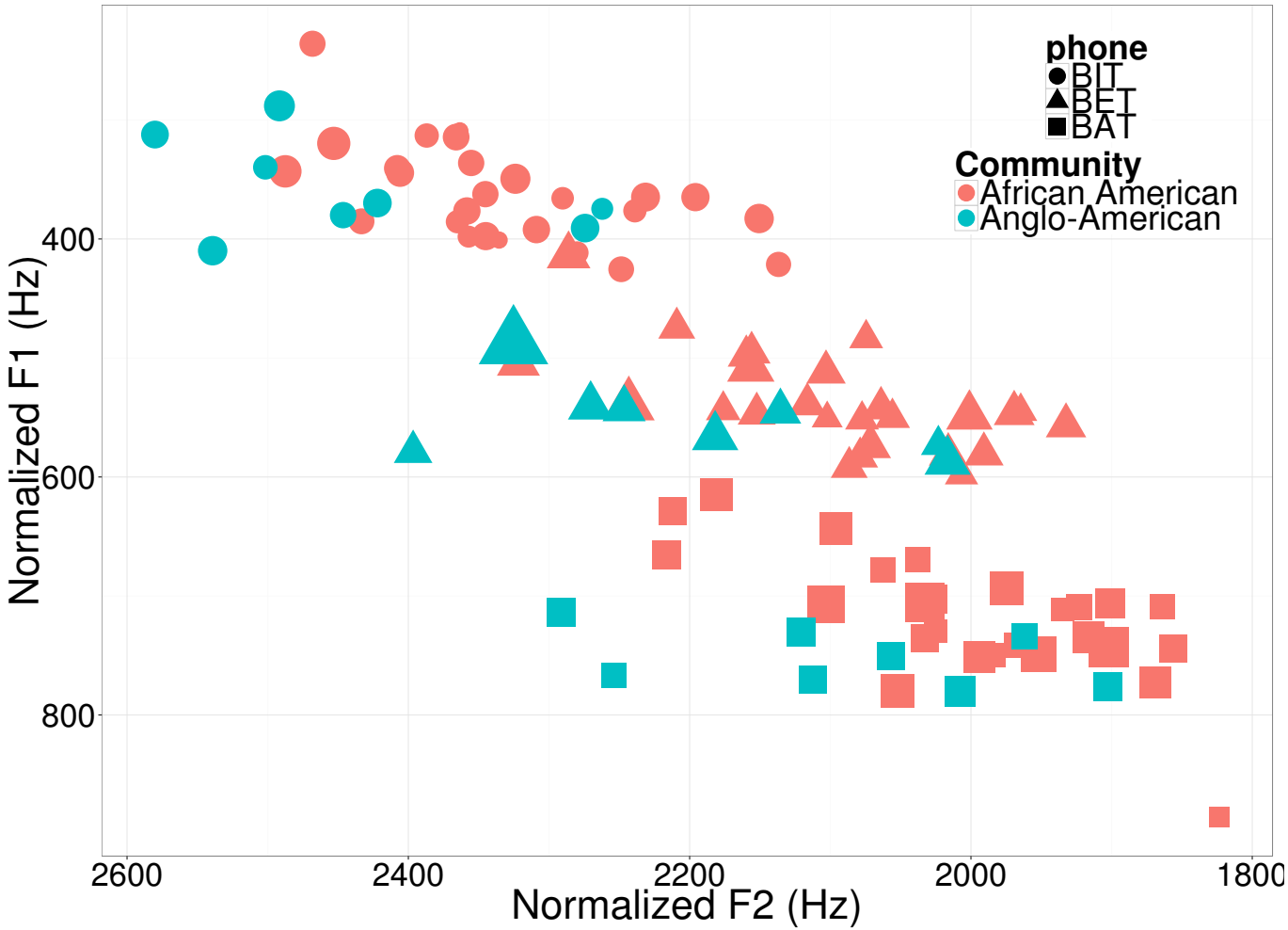
0. Constant: *Equivalent to F1/F2 values at midpoint*
1. Linear: *Slope*
2. Quadratic: *A single "curve" (with one turnpoint)*
3. Cubic: *The "curvilinear" shape of the formant contour (with two turnpoints & one inflection point)*

$$f(x) = ax^3 + bx^2 + cx + d$$



# Speaker front lax vowel means and standard deviations

A traditional comparison of these two systems illustrates static differences in nuclei (Anglo-American) and midpoint (African American) measures, but does not capture dynamic differences.



# Hypotheses about the SVS in Raleigh, NC

## Hypothesis 1

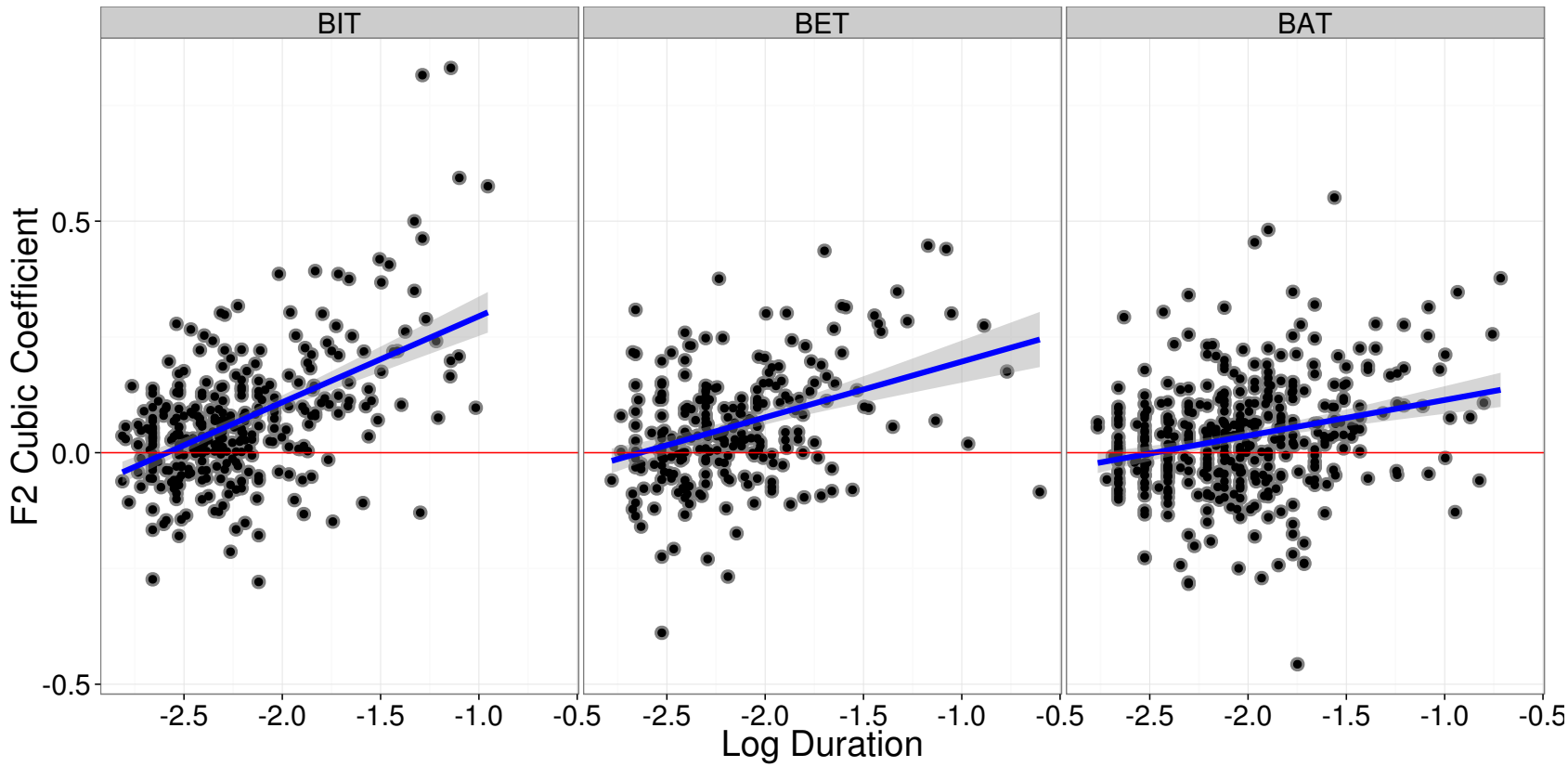
BET will be more diphthongal than BIT among older Raleigh Anglo-Americans due to the advancement of stage 2 (BAIT/BET reversal) of the SVS relative to stage 3 (BEET/BIT reversal).

## Hypothesis 2

Increased vowel duration will be associated with more diphthongal formant trajectories (earlier & more peripheral F2 peaks).

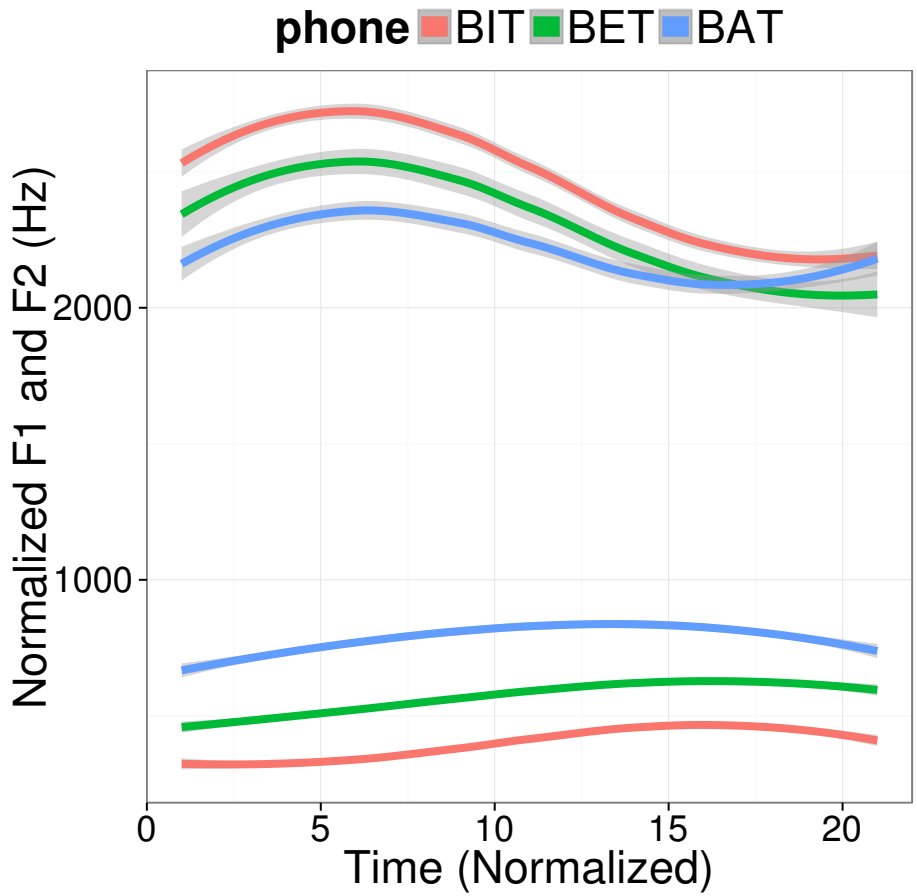
# F2 spectral movement and duration

Anglo-American speakers show a positive relationship between F2 cubic coefficients and log vowel duration for BIT, BET, and BAT meaning the curvilinear shape of F2 increases with duration.



# Trajectories with high durations/cubic coefficients

- Vowel tokens with high cubic coefficients correspond with formant trajectories with clear diphthongal shapes.
- Duration $>$ 150ms and F2 cubic coefficient $>$ 0.2 ($n$ tokens $=$ 69).



# F2 cubic coefficients & duration: Linear model

A linear regression model confirms hypothesis 2, but shows that BET is not significantly more diphthongal than BIT where duration is an interaction term.[2]

| Variable | Estimate | Std Error | *t*-value |
|---|---|---|---|
| duration | 0.881 | 0.098 | 8.925*** |
| BET:duration | −0.216 | 0.152 | −1.419 |
| BAT:duration | −0.437 | 0.126 | −3.473*** |
| | Adjusted $R^2 = 0.12$ | | *p*-value $< .001$ |

*Reference level* = BIT; *** = *significant at* $p < .001$

[2] Hypothesis 1 not confirmed.

# Addressing questions about the AAVS & SVS

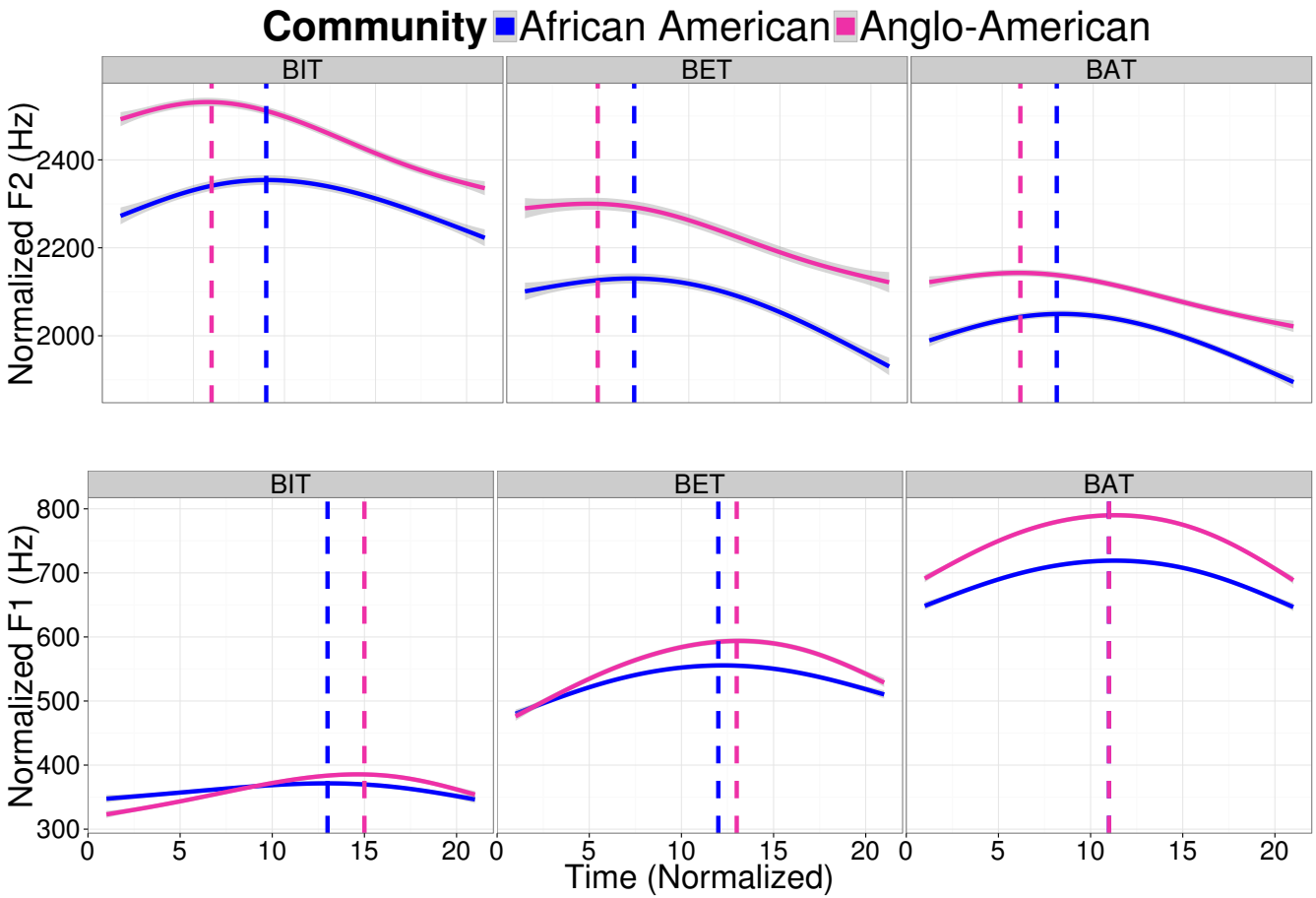
- We use cubic polynomial fits to compare the locations of F1 and especially F2 peaks along vowel trajectories for each community where an earlier F2 peak corresponds with greater peripherality at the nucleus of the vowel versus the midpoint.

**Research Question 3**

How do younger-generation African American speakers' front lax vowel contours compare to those of Anglo-American speakers?

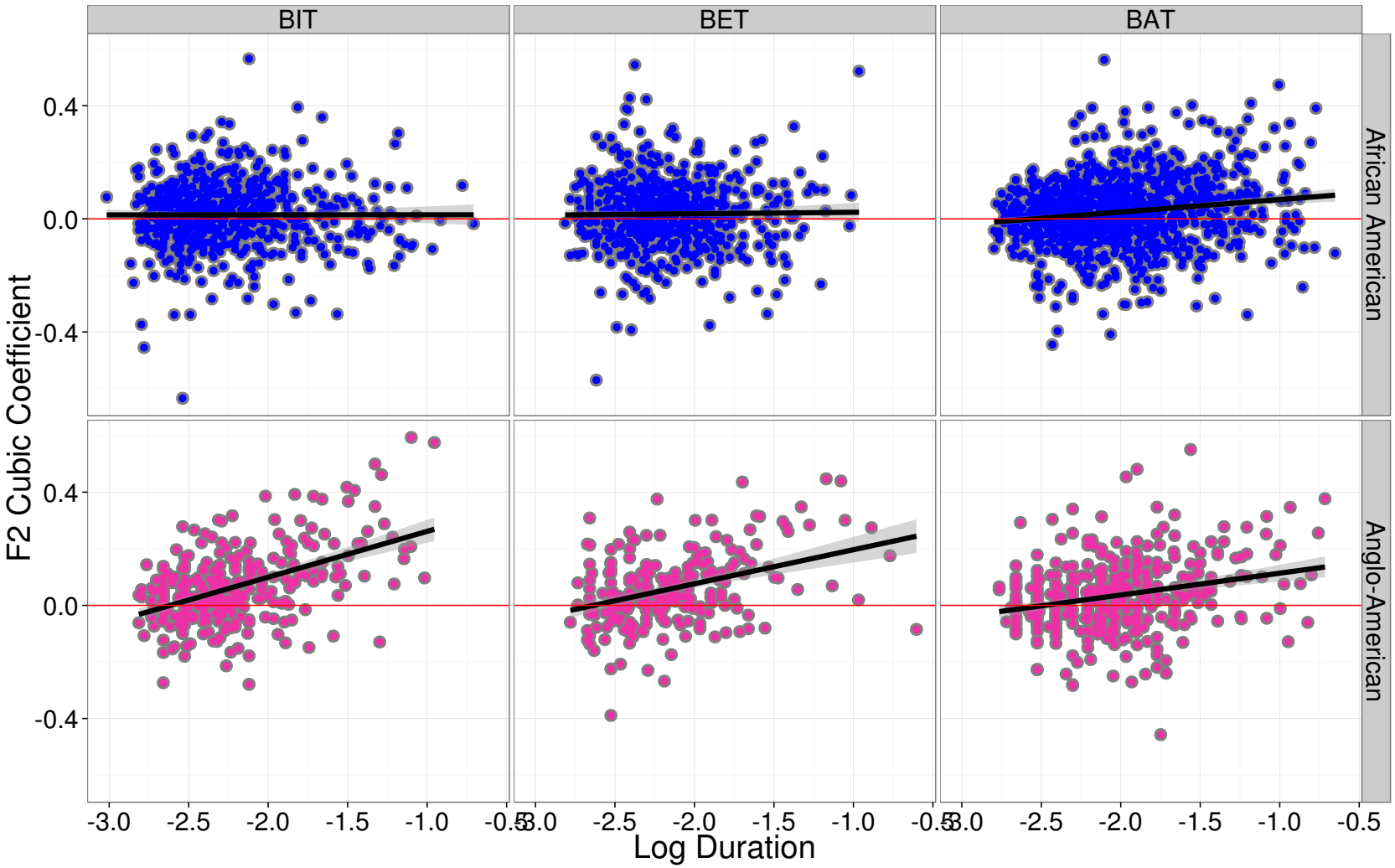
# High AAVS speakers (n = 9) and Anglo-Americans

Anglo-American speakers show earlier, more peripheral, F2 peaks for BIT, BET, and BAT, compared to African American speakers who participate in the AAVS.



# F2 spectral movement and duration: Group comparison

Curvilinear shape of front lax vowels increases along with duration for Anglo-Americans, but not African Americans.



# Question about individual variation & the AAVS

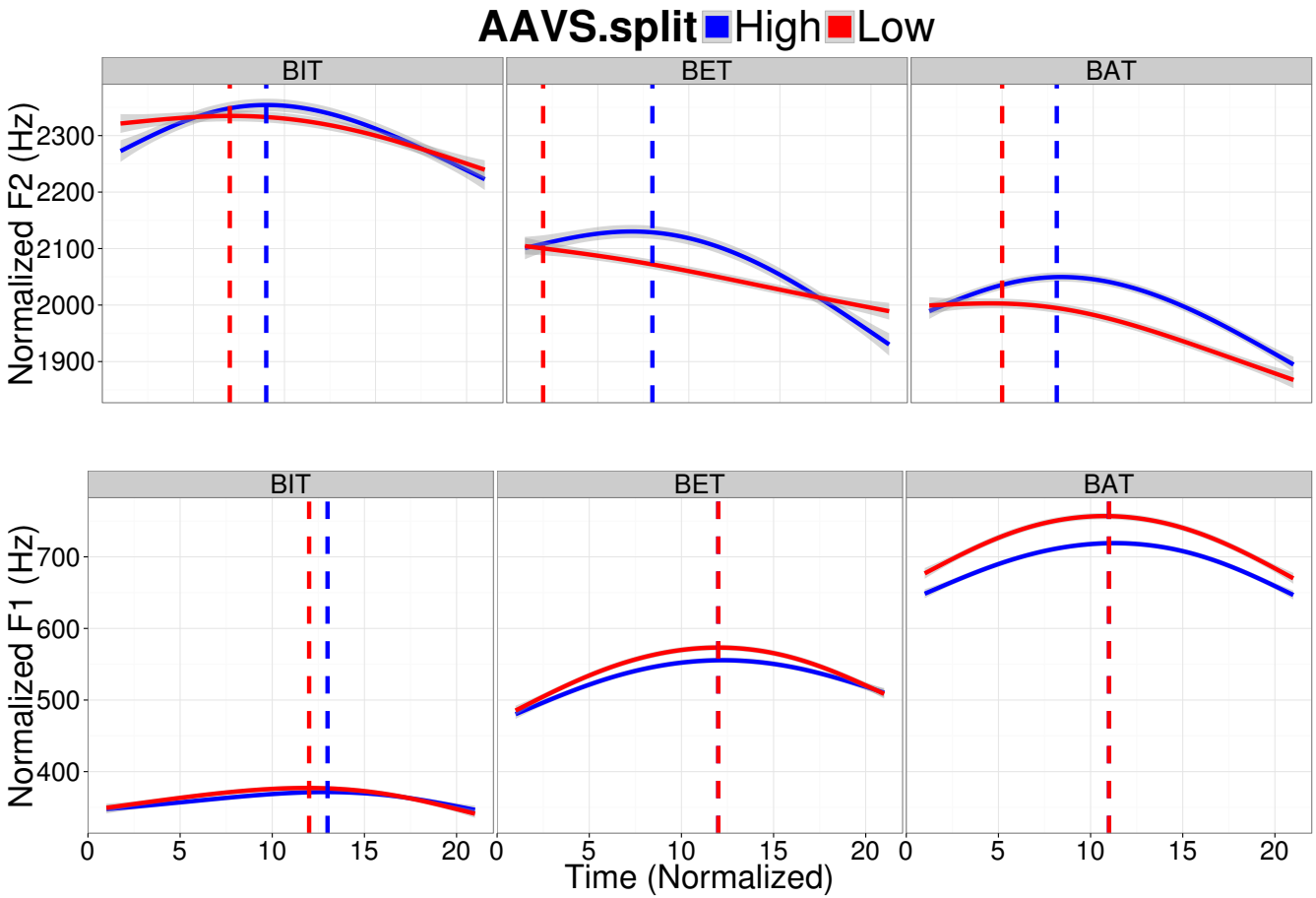
## Research Question 4

Do individuals differ in terms of front lax vowel monophthongization according to their use of other phonological features of the AAVS?

- We compare F2 contour fits to assess peripherality and peak locations among AAE speakers and use quadratic (curviness) and linear (slope) polynomial coefficients to compare trajectory shapes.

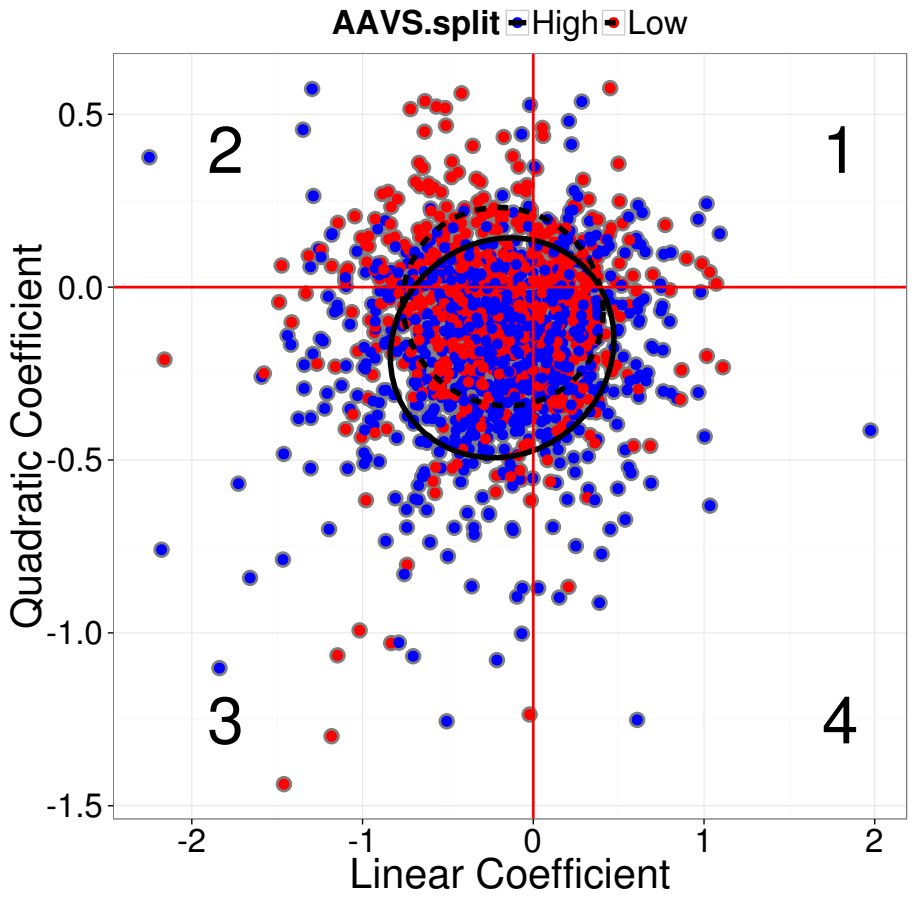
# Within-group variation in formant contours

F2 peaks are consistently earlier for African American speakers who participate less in the AAVS; in this respect they pattern with the older Anglo-Americans, although trajectory shapes differ.



# F2 Quadratic & linear coefficients: Within-group variation

- High AAVS speakers' front lax vowels are more curved & have negative slopes (greater number of coefficients in the 3rd quadrant).
- Low AAVS speakers' vowel token quadratic coefficients are negative, but lesser in magnitude.



# Conclusions

Complex relationships between formant contour shape, vowel duration, and locations of trajectory peaks emerge:

- BIT and BET are equally diphthongal among Anglo-American speakers. All front lax vowels are diphthongal at longer durations.
- African American and Anglo-American English speakers differ in formant contours and this difference is captured by F2 cubic polynomial coefficients and F1/F2 trajectory peaks.
- Differences in F1/F2 peaks exist between African Americans speakers participating in the AAVS and those who don't; differences in formant contour are revealed by the quadratic & linear coefficients.

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