4aSCb8. Dynamic trajectories of tense vs. lax vowels in the American South

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1. Front vowel shifting in Southern American English

✧ Static measurements suggest that Southern front tense and lax vowels "swap places," as in *beet-bit*, *bait-bet*. Given their strong acoustic overlap, what maintains their distinctness?

✧ **Dynamic** trajectories are shown to diverge in position and shape across tense and lax pairs.

Research questions:

✧ How distinct are the trajectories of tense vs. lax vowels?

✧ Which socioindexical factors affect vowel trajectory shape?

✧ Can vowel trajectory modeling give insight into the spread of the Southern Shift?

2. The Digital Archive of Southern Speech

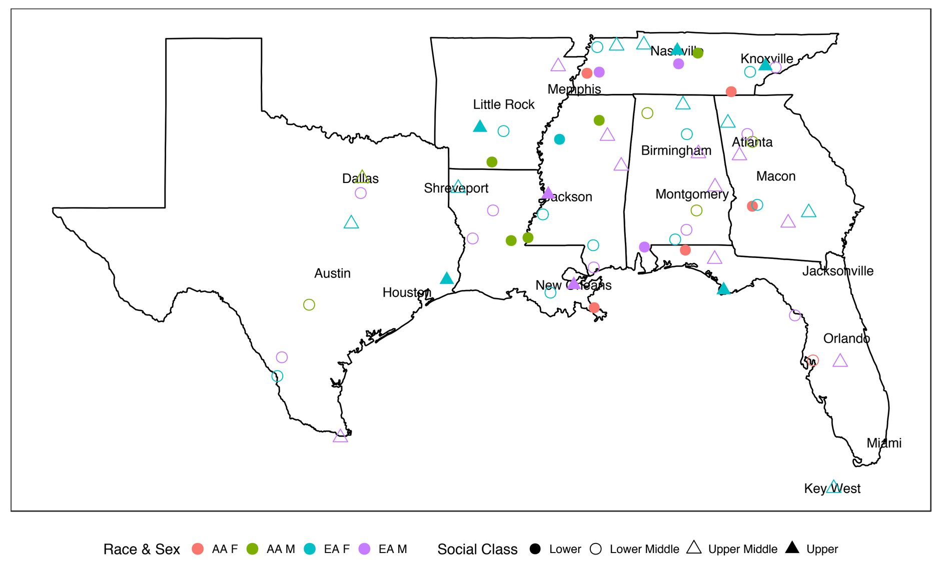
✧ Audio corpus of semi-spontaneous linguistic atlas interviews (Kretzschmar et al. 2012)

✧ 64 American speakers native to 8 Gulf States

✧ Speakers represent a mixture of ethnicities, social classes, education levels, ages

✧ DASS is being transcribed, aligned, and acoustically analyzed (Olsen et al. 2017)

✧ Data from **53 speakers** is currently available: 26 female (5 African American), 27 male (6 AA)



3. Data and data preparation

✧ **Vowels**: 426,682 total tokens aligned and measured with DARLA (Reddy & Stanford 2015)

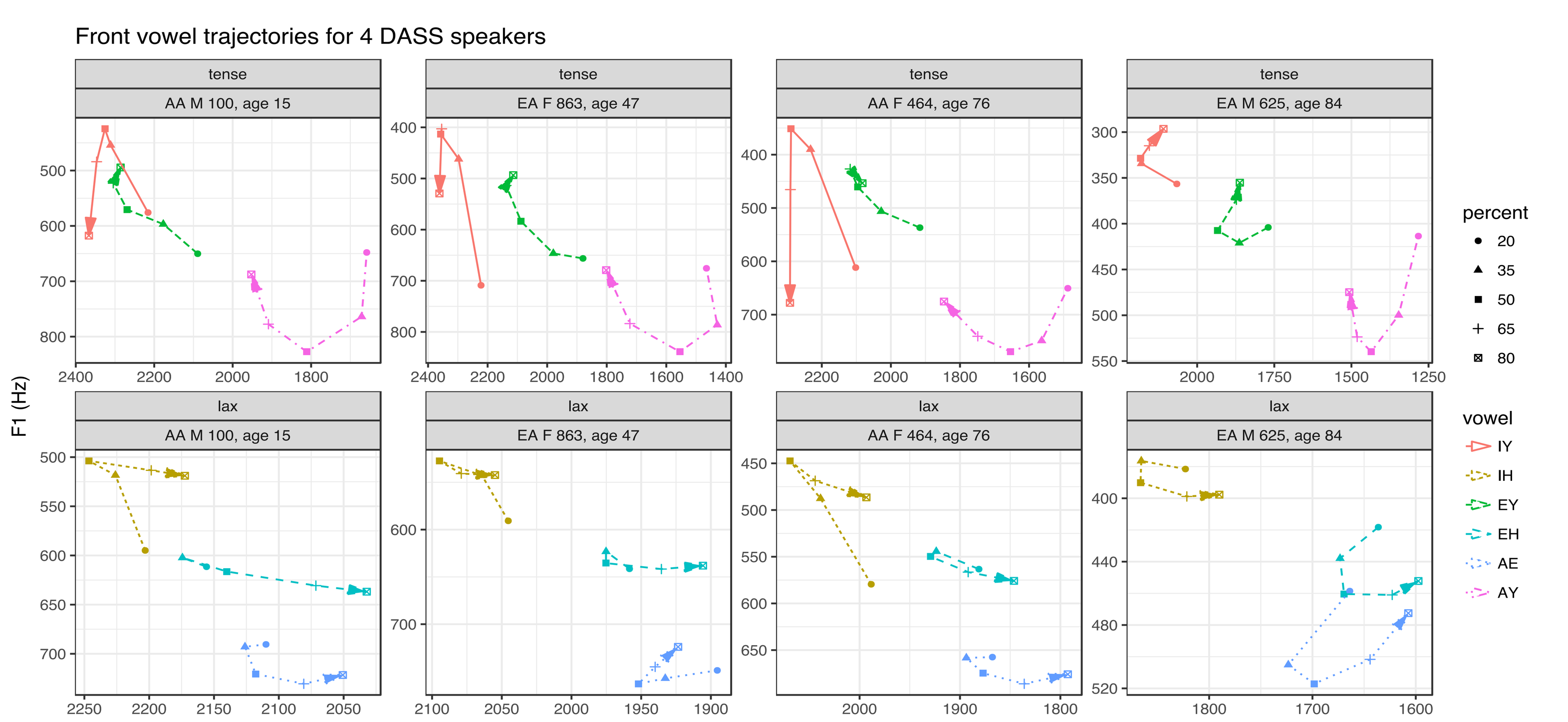
✧ Formant values: **F1, F2** extracted by DARLA at five time points: 20%, 35%, 50%, 65%, 80%

✧ Formant values normalized to speaker-specific *z*-scores (Lobanov 1971)

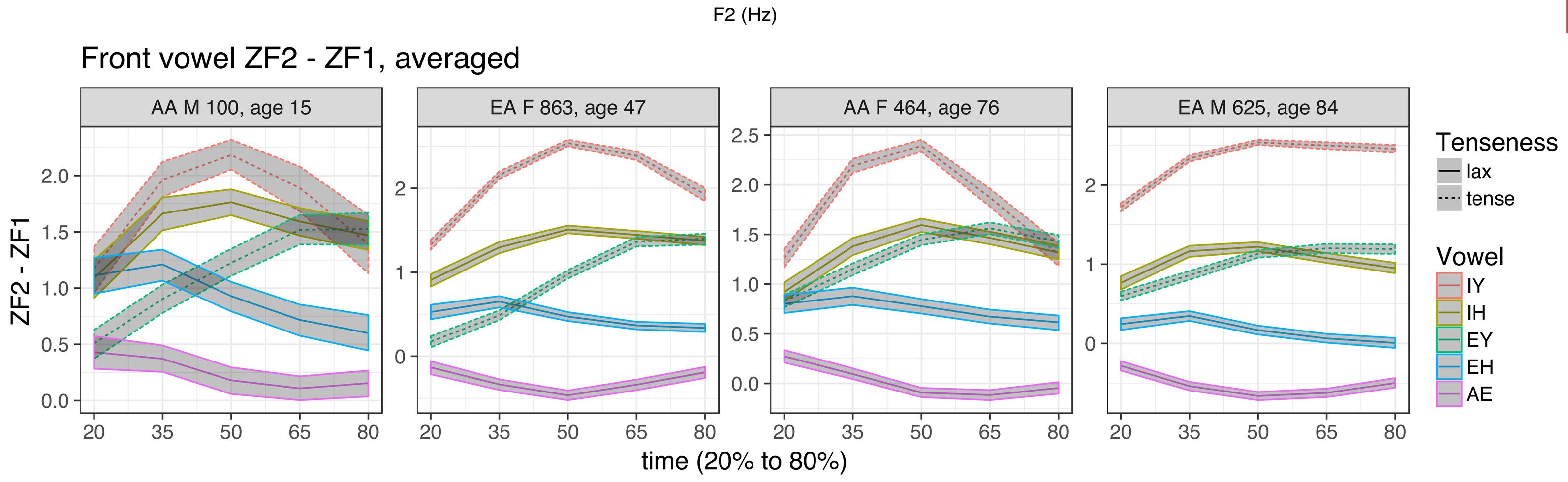
✧ Acoustic **filtering**: at the 50% F1, F2 values of each token, Mahalanobis distance (Mahalanobis 1936) is calculated, relative to a speaker- and vowel-specific centroid. Tokens with high distance (based on 95% quantile of a χ^2 distribution) are excluded as outliers

✧ Tokens **analyzed**: Stressed front vowels that do *not* precede nasals or liquids

✧ **Position on vowel diagonal**: ZF2 − ZF1 is calculated for each vowel measurement (Dodsworth 2013) and plotted across time. Higher values indicate higher, fronter nuclei (Labov et al. 2013).



Vowel	Symbol	Tokens
/i/	IY	17354
/eɪ/	EY	22863
/ɪ/	IH	15071
/ɛ/	EH	16896
/æ/	AE	23977
	Total	96161



4. Generalized Additive Mixed Models

✧ GAMMs are useful for **dynamically variable** data (Soskuthy ms.)

✧ Linear predictors depend linearly on smooth functions (Wood 2017a); models can account for temporal autocorrelation (Baayen et al. 2017), and detect significant differences in smoothed curve shapes

GAMMs fit to vowel data

✧ Separate model fitted for each vowel (`mgcv`; Wood 2017b)

✧ Dependent variable: ZF2 − ZF1 (5 values per vowel token)

✧ Autoregressive error model seeded with ρ from identical ML model

Predictor variables

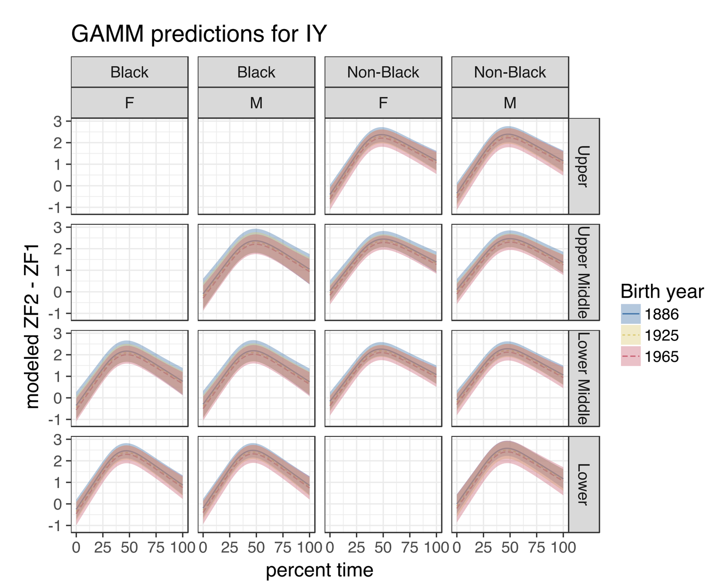
✧ Phonological and random factors (not shown in Results table)

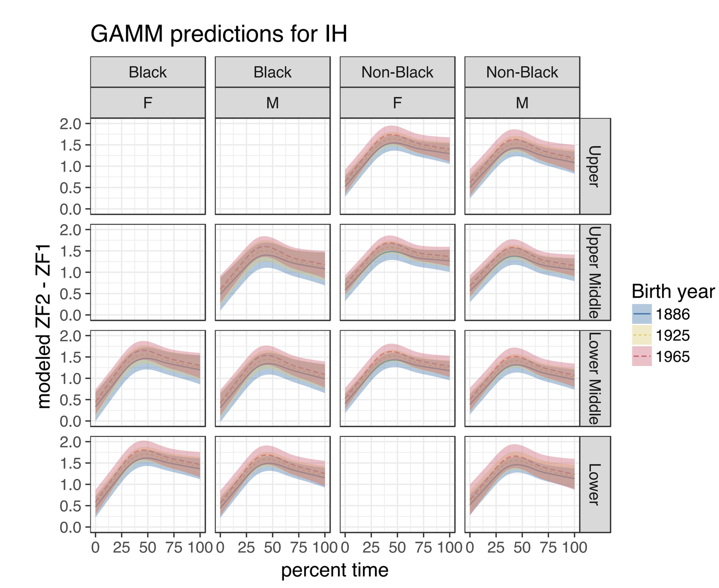
- ✧ Following consonant place of articulation
- ✧ Vowel context within word, indicating syllable structure
- ✧ Vowel duration (smooth, and tensor product with Percent)
- ✧ Speaker (random smooth)

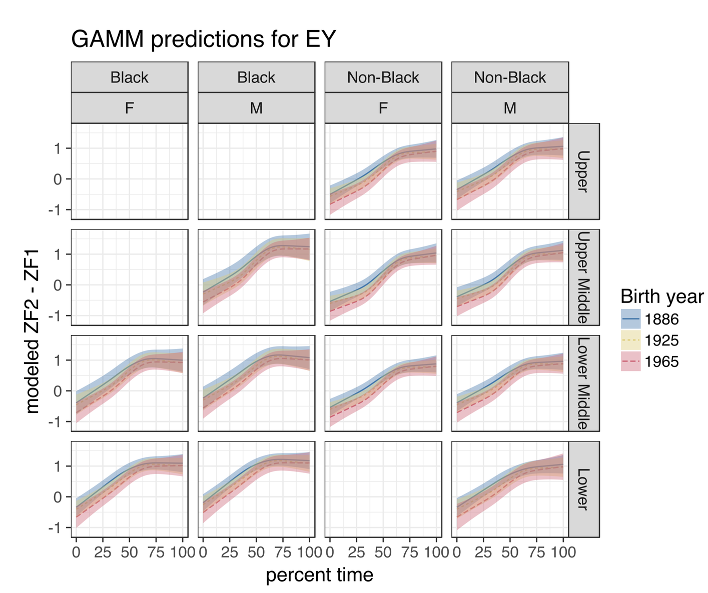
✧ Socioindexical factors

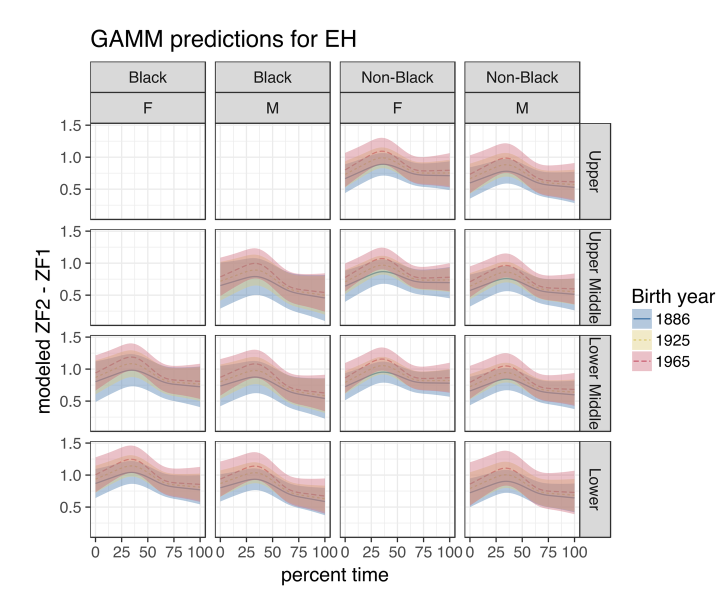
- ✧ Birth year (relativized: 1886 = 0; 1965 = 79)
- ✧ Ethnicity (reference = Non-Black)
- ✧ Sex (reference = Female)
- ✧ Social Class: Upper (reference), Upper Middle, Lower Middle, Lower
- ✧ State: AL (reference), AR, FL, GA, LA, MS, TN, TX

5. Estimated trajectories from fitted GAMMs







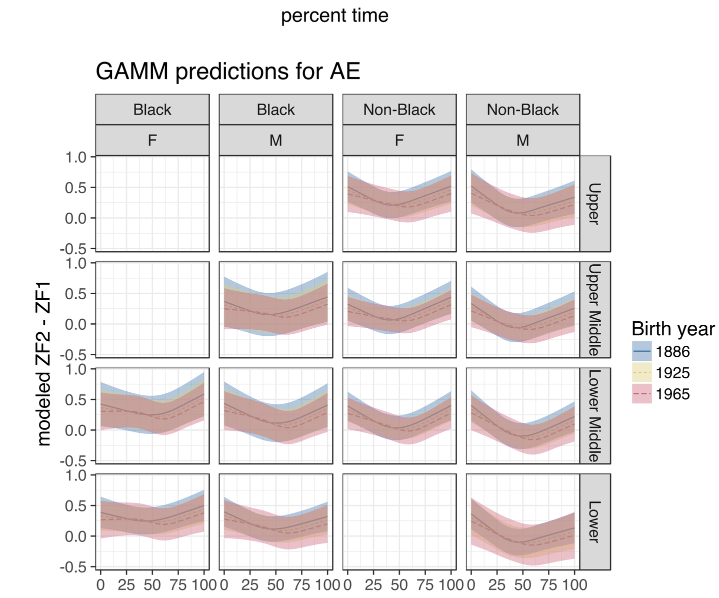


✧ Model predictions extracted, plotted (`itsadug`: van Rij et al. 2017)

✧ Plots are left blank where no DASS speaker fits that specification

✧ Other factors set to reference levels

✧ Effect of birth year indicates intergenerational vowel shifting



6. Results of statistical modeling

✧ Significance tested via conservative model comparison with dropped factors (`compareML`; van Rij et al. 2017)

✧ * indicates factor is significant in model `summary` alone

Factor	IY	EY	IH	EH	AE
`Birth year (relative)`	*	$p < 0.001$	*	*	$p < 0.001$
`Ethnicity`	*	$p < 0.001$			$p < 0.05$
`Sex`		$p < 0.05$	$p < 0.05$	*	$p < 0.05$
`Class`	*	$p < 0.001$			
`State`	$p < 0.05$	$p < 0.01$	$p < 0.001$	$p < 0.01$	$p < 0.05$
Adjusted R^2	0.278	0.29	0.173	0.132	0.205

7. Conclusions

✧ Tense and lax front vowels have distinct dynamic trajectories

IY vs. IH

✧ IY starts higher, fronter than IH

✧ IY has more extreme trajectory, finishes more centrally

✧ Both vowels reach peak ZF2 − ZF1 near their 50% point

✧ GAMM trends suggest IY lowering, IH raising across generations

EY vs. EH

✧ EY is heavily centralized in first half, thus lower, backer than EH

✧ EH is most central at its start and end

✧ EY raises and fronts over its timecourse; shows greatest variation across time, ethnicities, sexes, classes and states

AE

✧ AE is highest and most fronted in its first half

✧ Over generational time, the shape of AE's trajectory changes, and its lowest point shifts later in vowel

✧ Young, African American females have a distinct trajectory suggesting increased raising, and strongest shifting for AE

✧ Future research will test precisely at what points, and factor levels, trajectories are significantly different

Acknowledgments & References

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