An Apparent Time Study of (str) Retraction and /tɹ/ - /dɹ/ Affrication in Raleigh, NC English

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- NCSU Linguistics, especially Jeff Mielke and Robin Dodsworth
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Background

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- Investigations of vocalic chain shifts are well-represented in sociolinguistics
- Historical linguistics has approached this question diachronically (e.g., Grimm's Law, Verner's Law)
- But there's still a lot we don't know about the synchronic realization of linked consonantal changes (Thomas, 2001, p. 283)

Case Study

Today we present work from a project on two consonantal sound changes in progress in Raleigh, North Carolina English.

(str) Retraction
and
/tɹ/-/dɹ/ Affrication

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No investigation of these two processes in same corpus of speakers.

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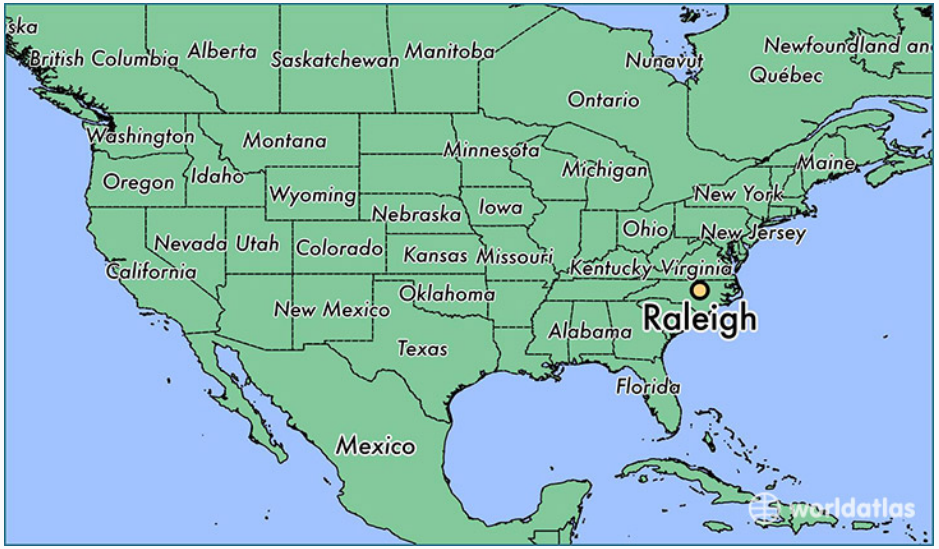
2. Individuals who are retracting /s/ should also be affricating /tɹ/

Raleigh, North Carolina (NC)



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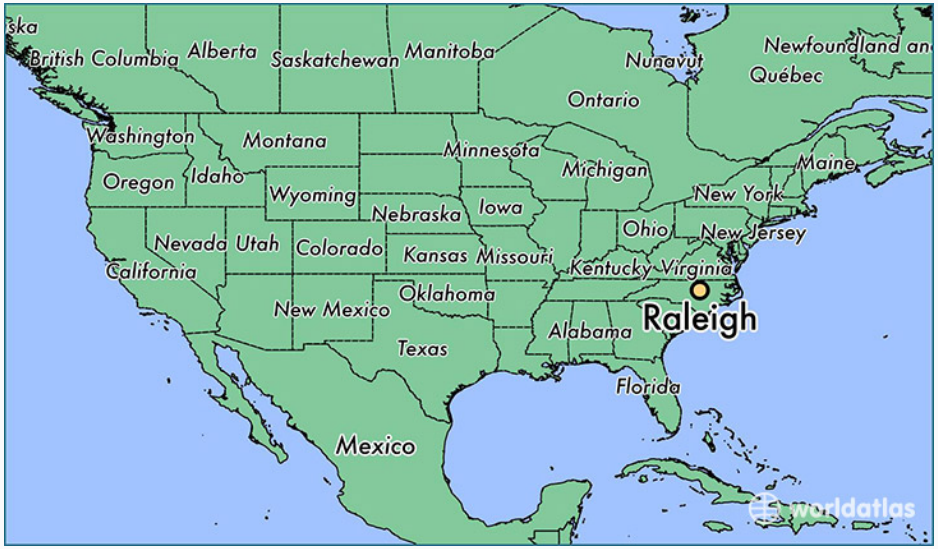
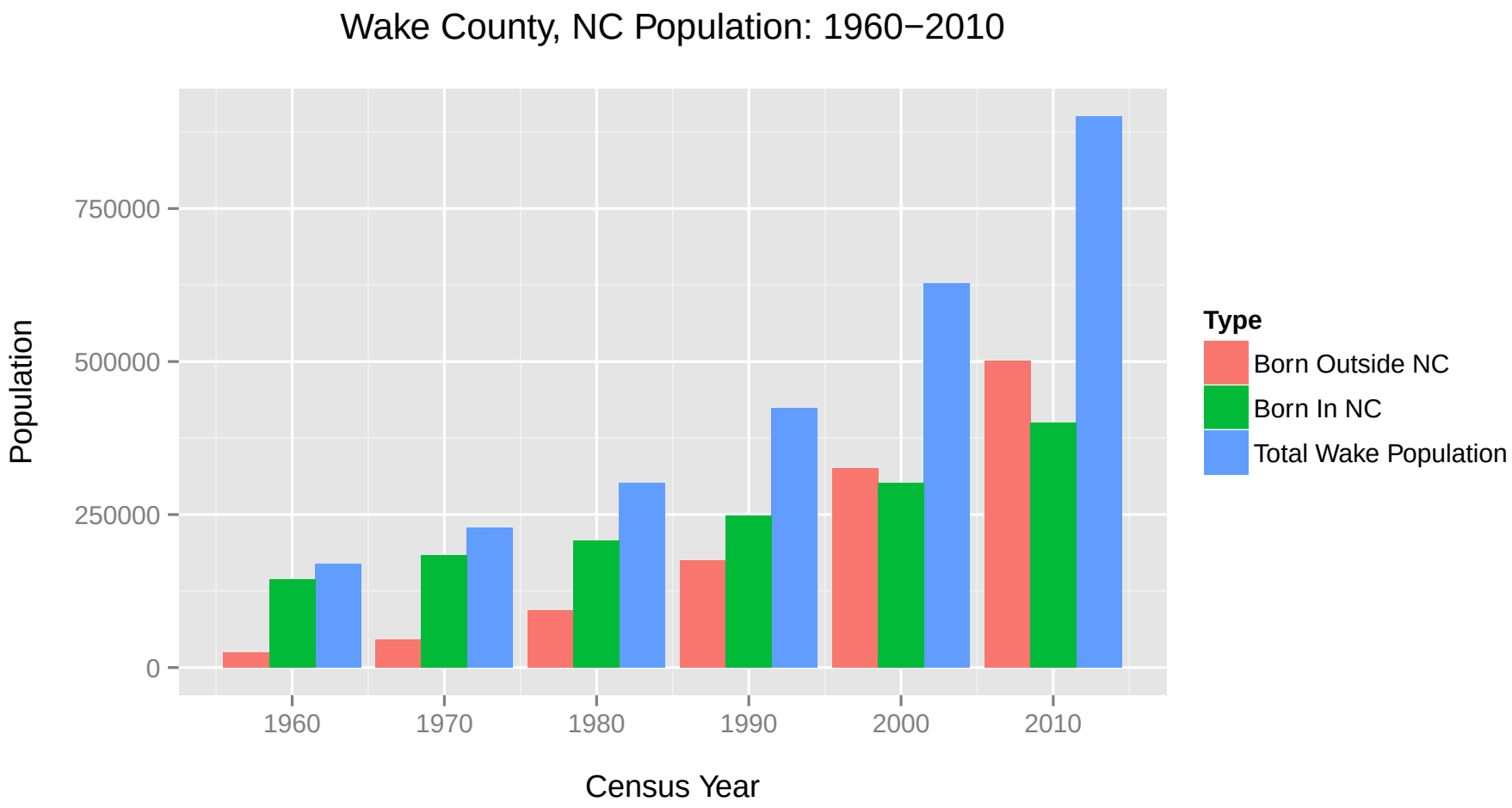


- Raleigh is a large urban center in the American South with a population of around 450,000
- Large influx of workers from the North during the tech boom of the 1960-70s

Rapid Demographic Shift



Ideal Testing Ground

- Area of intense dialect contact and leveling (Kerswill & Williams, 2005)

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- Rapid transition away from the SVS and other Southern features (Dodsworth & Kohn, 2012; Dodsworth, 2014)

Corpus Breakdown

In both analyses that follow, data come from **140 sociolinguistic interviews from a corpus of (300+) Raleigh, NC natives** (Dodsworth & Kohn, 2012).

Generation	Birthyear Range	Women	Men	Total
1	1923-1954	28	27	55
2	1955-1978	32	24	56
3	1979-1996	15	14	29
		75	65	**140**

Table 1: Demographic breakdown of Raleigh speakers under analysis

Orthographically transcribed and force-aligned using P2FA (Yuan & Liberman, 2008)

(str) Retraction

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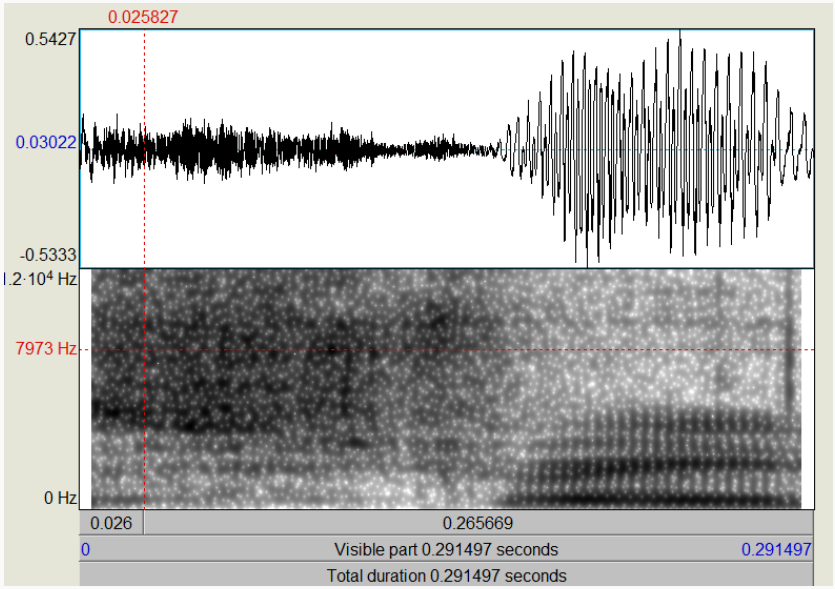
Background

(str) Retraction

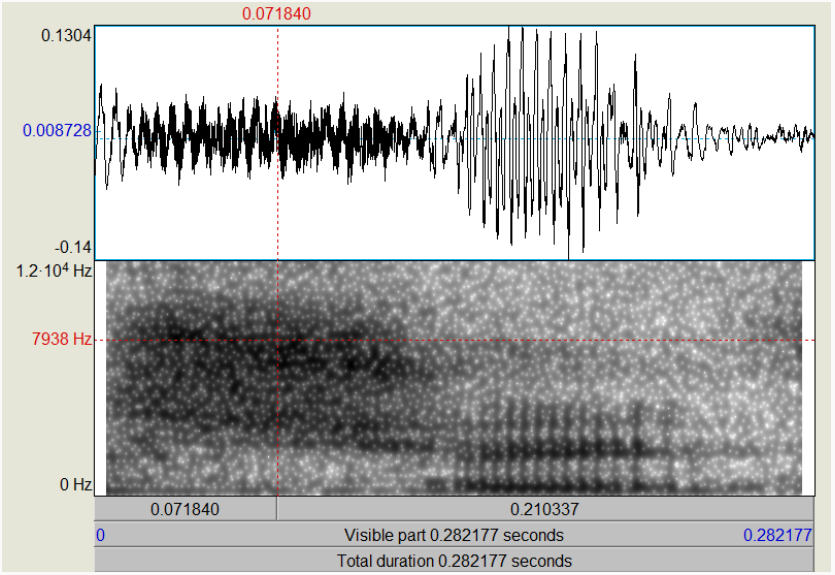
Female b. 1961

other part of the street
street
s



Female b. 1991

live down the street
street
s



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2. **The UK** (Bass, 2009; Glain, 2014)
3. **New Zealand** (Lawrence, 2000)

Linguistic and Social Factors

Common Factors conditioning retraction:

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2. **Age**: more retraction over apparent time. (Durian, 2007; Gylfadottir, 2015)
3. **Prosodic Structure**: more retraction phrase-initially (Phillips, 2016)

Linguistic and Social Factors (cont.)

Sex Differentiation:

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Linguistic and Social Factors (cont.)

Sex Differentiation:

- Rapid Anonymous Surveys suggest that retracted variants are produced more by men (Bass, 2009; Durian, 2007; Hinrichs et al., 2015)
- However, sociophonetic analyses of spontaneous corpora have not replicated a sex effect (Durian, 2007; Gylfadottir, 2015)
- Gylfadottir (2015) hypothesizes that in Philadelphia the change has advanced past a female-lead; retraction is characteristic of both sexes in younger speakers

(str) Retraction

Analysis

Measurement

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- Only speakers with > 4 (str) tokens considered
- 99,150 tokens remain for analysis
    - 81,437 /s/, 15,135 /ʃ/, 2,578 (str)

Retraction Ratio

Following Baker et al. (2011) we use **Retraction Ratio** as our dependent measure of (str), essentially speaker-internal Center of Gravity (COG) normalization.

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$$\textbf{Retraction Ratio} = \frac{(\text{speaker mean } /\int/ \text{ COG} - \text{Observed COG})}{(\text{speaker mean } /\int/ \text{ COG} - \text{speaker mean } /s/ \text{ COG})}$$

Token with Retraction Ratio closer to 1: more like /ʃ/
Token with Retraction Ratio closer to 0: more like /s/

Modeling

Linear mixed-effects modeling in R using *lme4* (Bates et al., 2015).

Models constructed in a nested fashion using AIC decrease to determine improved model fit Burnham & Anderson (2004)

Best fit model includes:

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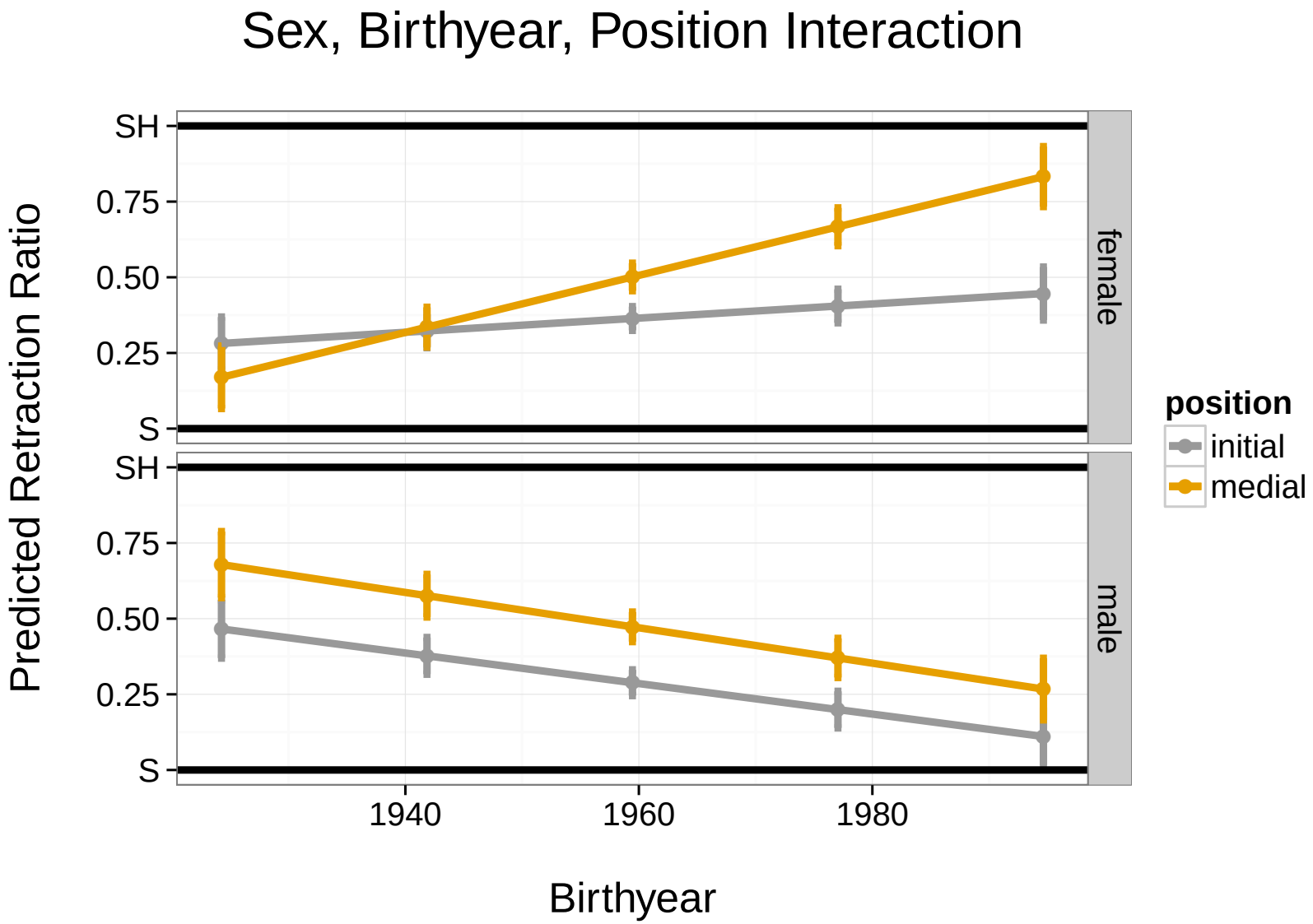
Best fit model includes:

- Four-way interaction between Word Position - Phone Type - Sex - Birthyear
- Fixed effects of phon. environment
- Random intercepts for Speaker and Word

---

lmer(cog.ratio.inv ~ left + right + position * phone * sex * birthyear.z + (log.dur|speaker_id) + (1|word),REML=F,data=df)

Model Coefficients: Just (str)



(str) Retraction

Interim Summary

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2. But only in medial position ('restructure')
3. If anything, men are becoming less retracted

/tɹ/ - /dɹ/ Affrication

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To our knowledge, there is no work investigating community level changes in this phenomenon.

Instrumental Measure

Acoustic measures of affrication are difficult to apply to non-lab data.

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Measures used for distinguishing unaffricated and affricated /t/ in /tw/ clusters (Smith, 2013) **could not reliably distinguish between pre-vocalic /t/ and /tʃ/** in our conversational data, even after substantial correction and subsegmentation of automatic segment boundaries.

- Center of Gravity during burst
- Normalized rise time (from onset of burst to point of max intensity)
- Duration

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As such, we turn to a method based on Yuan & Liberman (2011).

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A(ffrication)-scores are calculated by subtracting likelihood scores of the affricate alignment by the likelihood scores of the stop alignment (normalized for duration).

Machine Classification - Example

'tree'

- Aligned as /tɹi/
- Aligned as /tʃɹi/

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- **Aligned as /tɹi/**
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- **Aligned as /tʃɹi/**
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A-score $= 1285.91 - 1254.72 = 31.19$
This token is more similar to /tʃ/ than /t/.

Positive A-Score = more affricate-like
Negative A-Score = more stop-like

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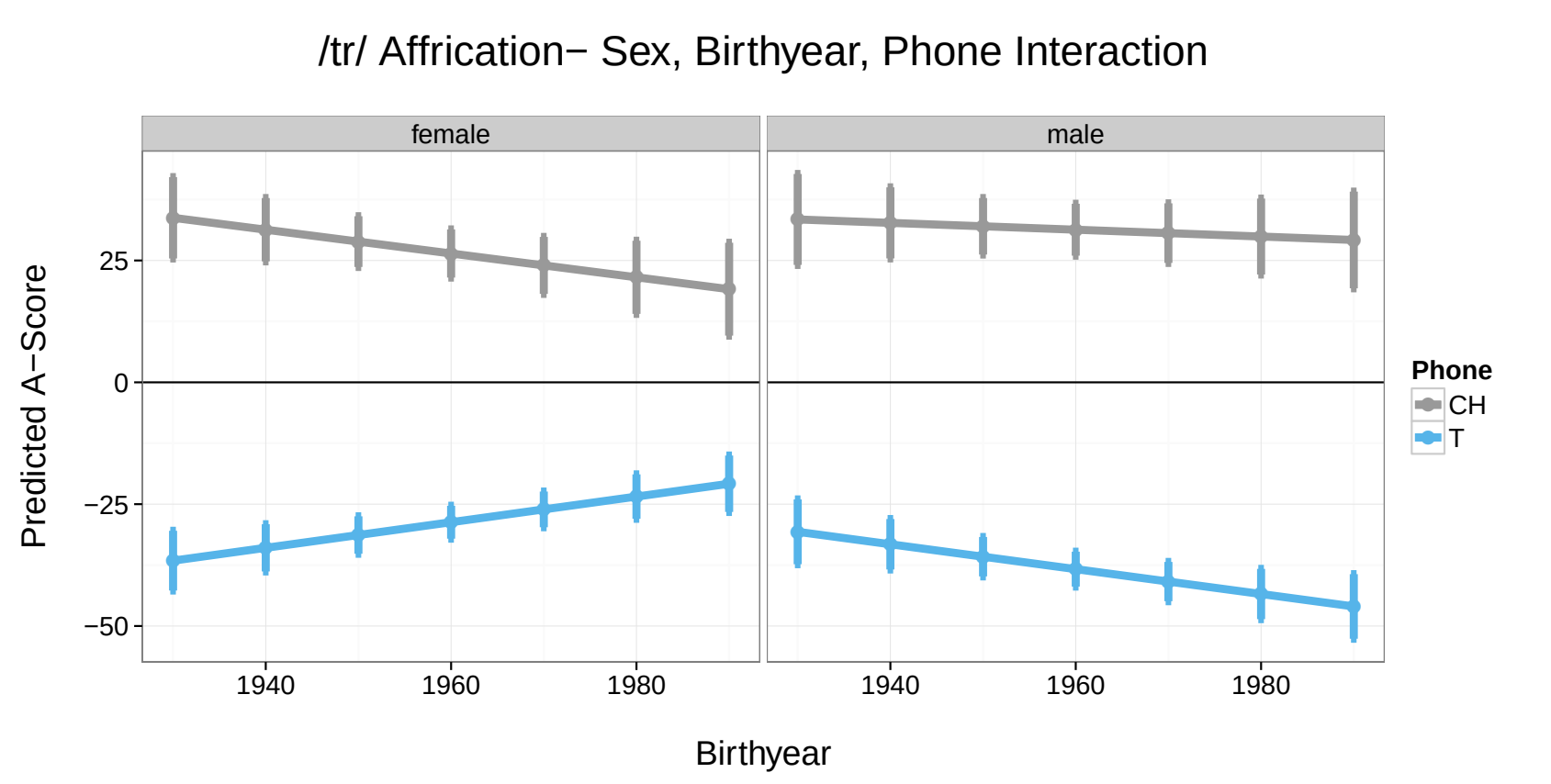
- As before, mixed effects linear models constructed in nested fashion using AIC as measure of improved fit

/tɹ/ - /dɹ/ Affrication

/tɹ/ Modeling

/tɹ/ Apparent Time



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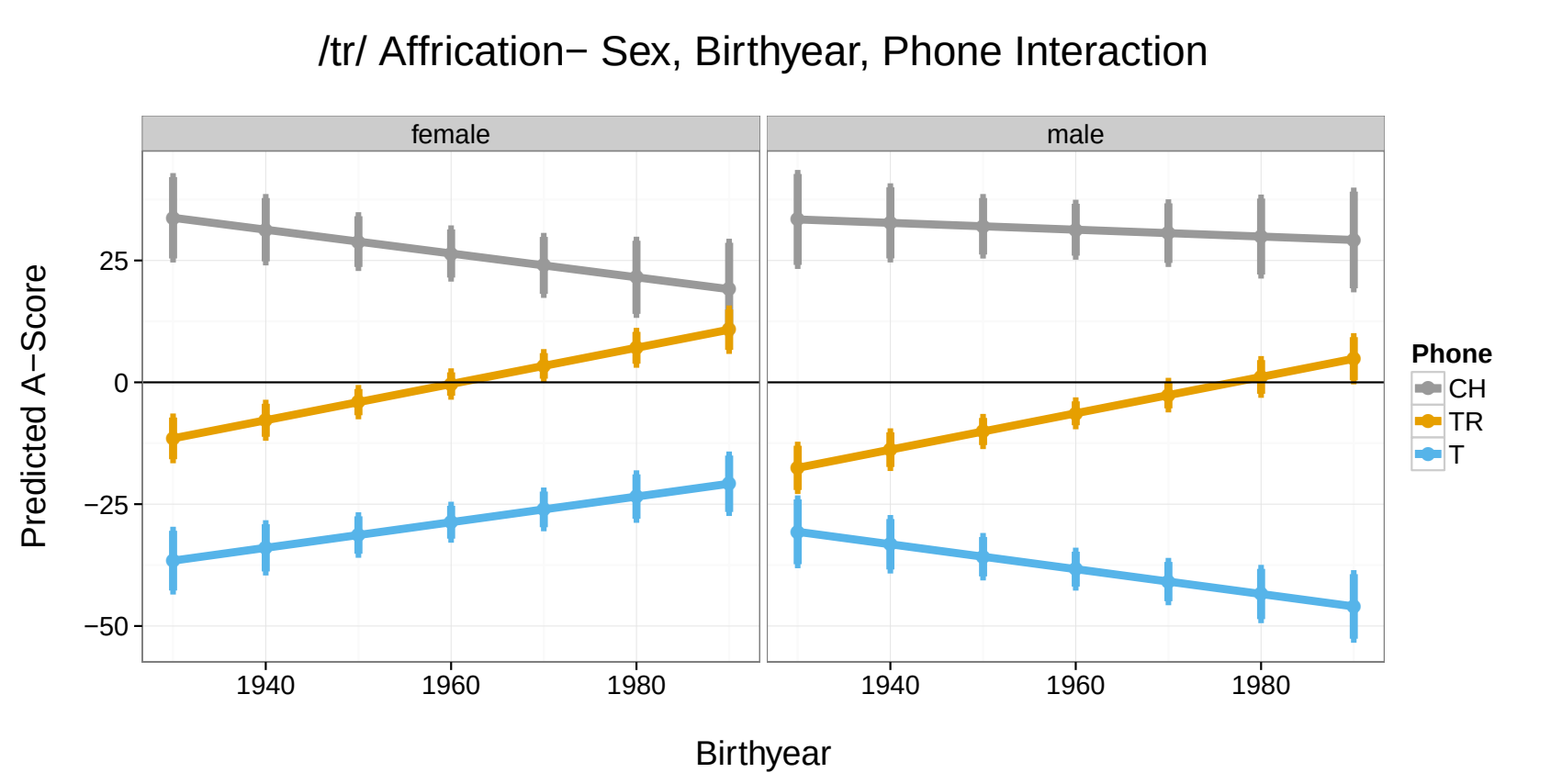

/tɹ/ - /dɹ/ Affrication

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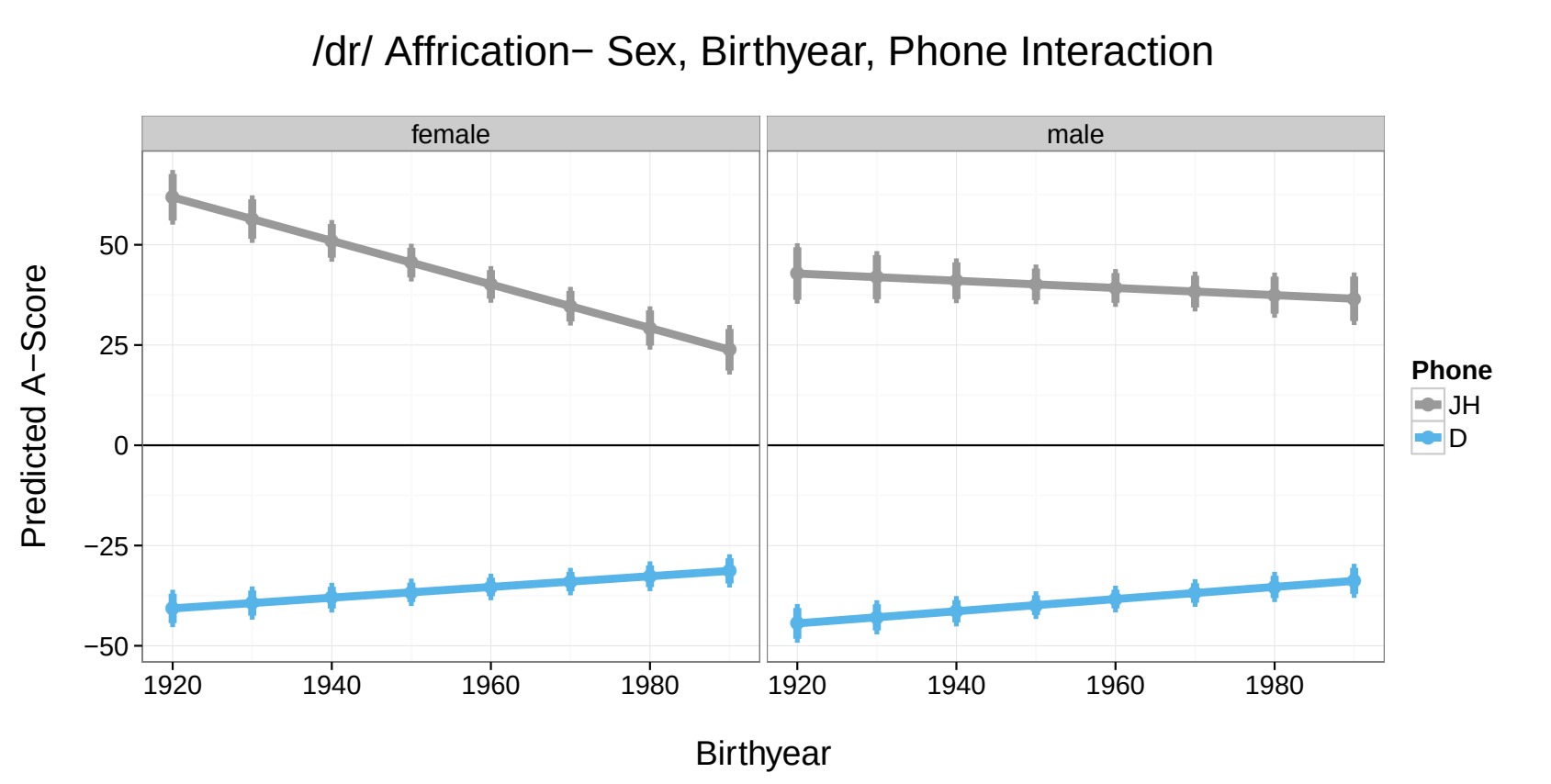
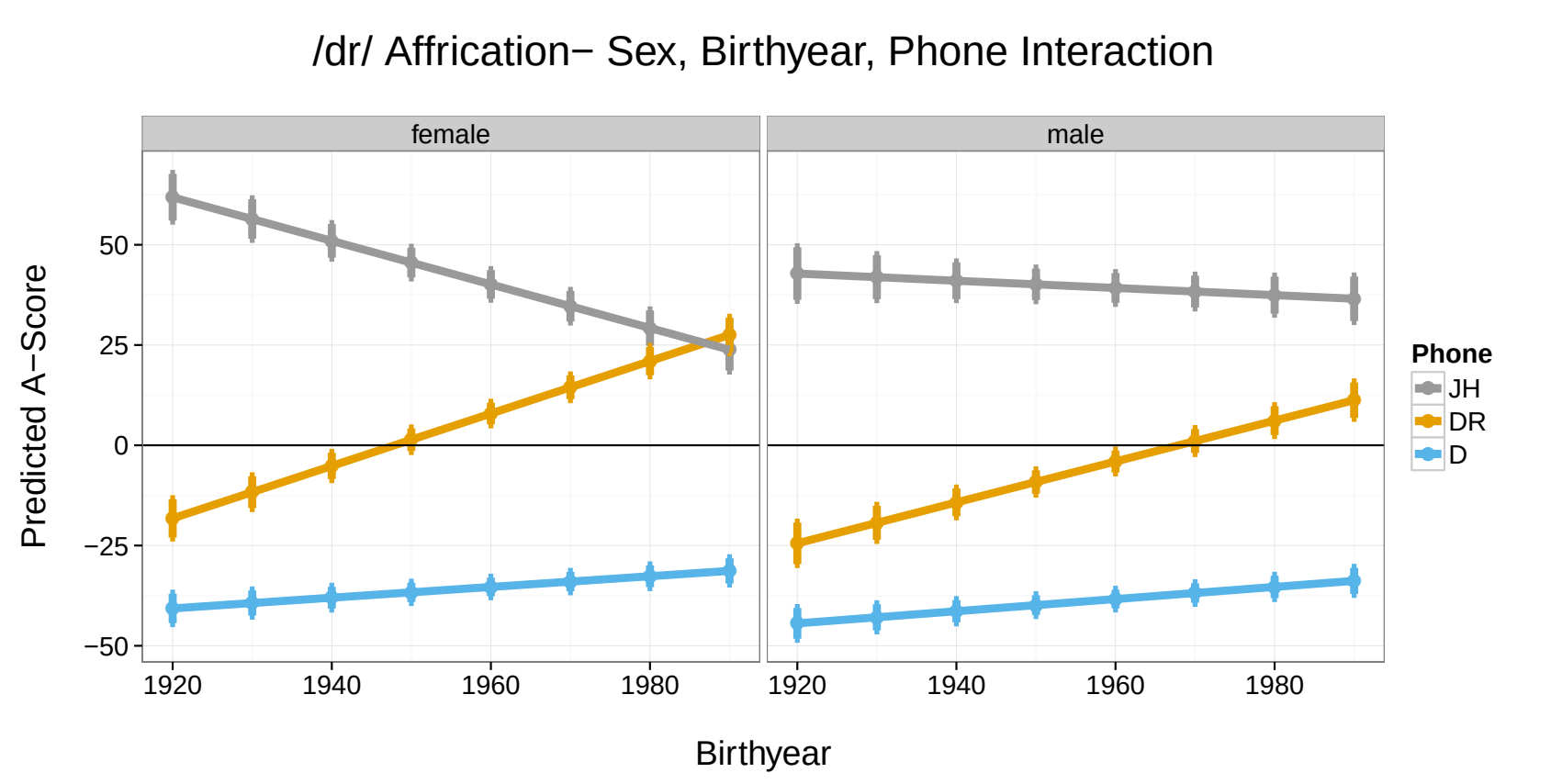
/dɹ/ Apparent Time



/dɹ/ Apparent Time



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Link Between Retraction and Affrication

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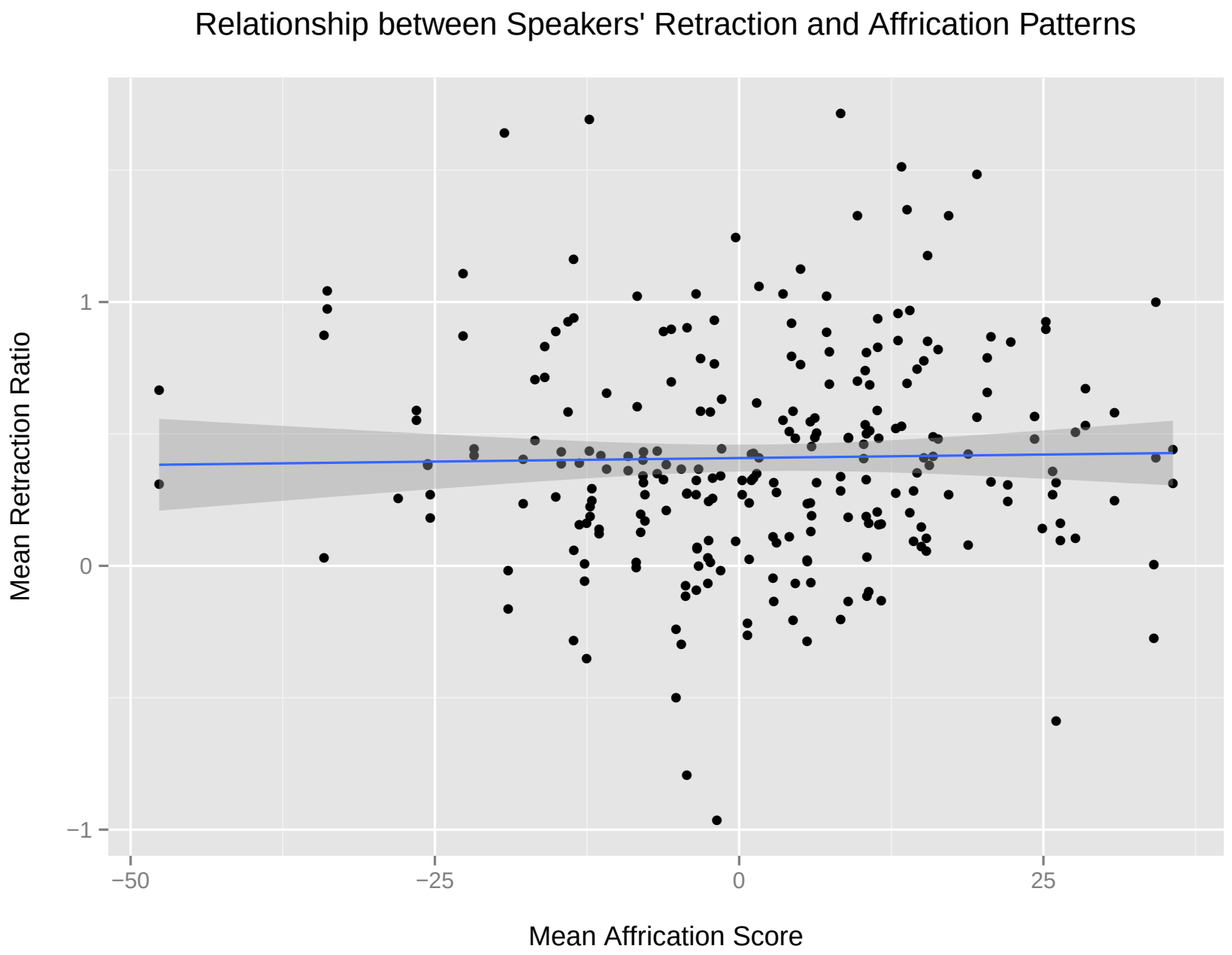
Speaker Means for Retraction and Affrication



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Takehome Points

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Takehome Points

1. (str) Retraction beginning in Raleigh, currently emerging in speech of young women in medial environments
2. /tɹ/ – /dɹ/ A-Scores nearly identical to phonological affricates for women. Men not far behind.
3. No correlation between speaker's affrication patterns and their retraction patterns. Suggests that /tɹ/ affrication is not cause of retraction

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Thank you!

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#NWAV45slides — @eric_wilbanks

Future Work

- Articulatory data analysis ongoing: relative timing of lip-rounding, tongue body retraction, link to /ɹ/ articulation
- Perceptual work; almost nothing except for Stevens & Harrington (2016)
    - Consider esp. the link between women as leaders in this change and sexual dimorphism/sibilant acoustics.
- Role of medial position in these changes: perception? articulation? prosody?

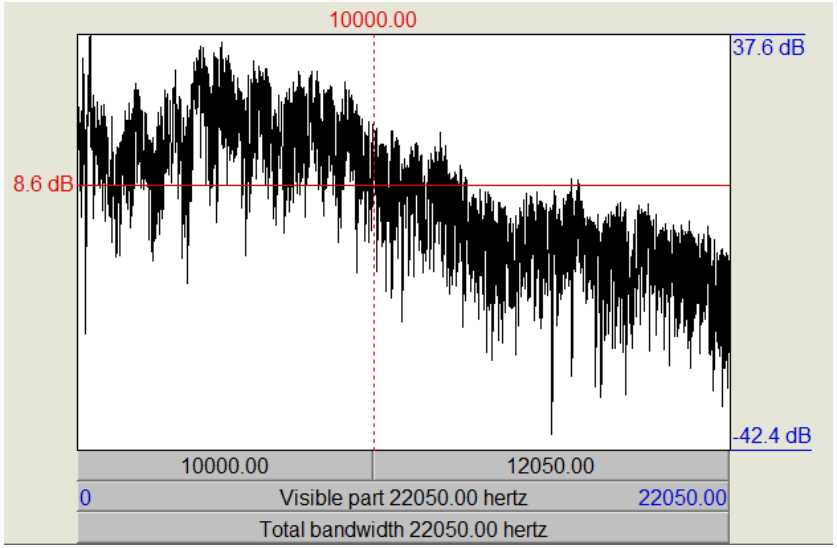
(str) Retraction

Female b. 1961

other part of the street

street

s

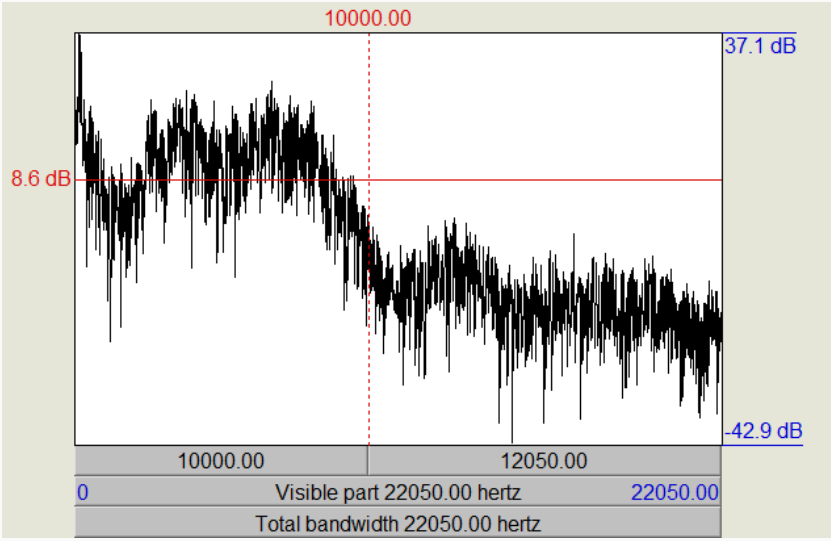


Female b. 1991

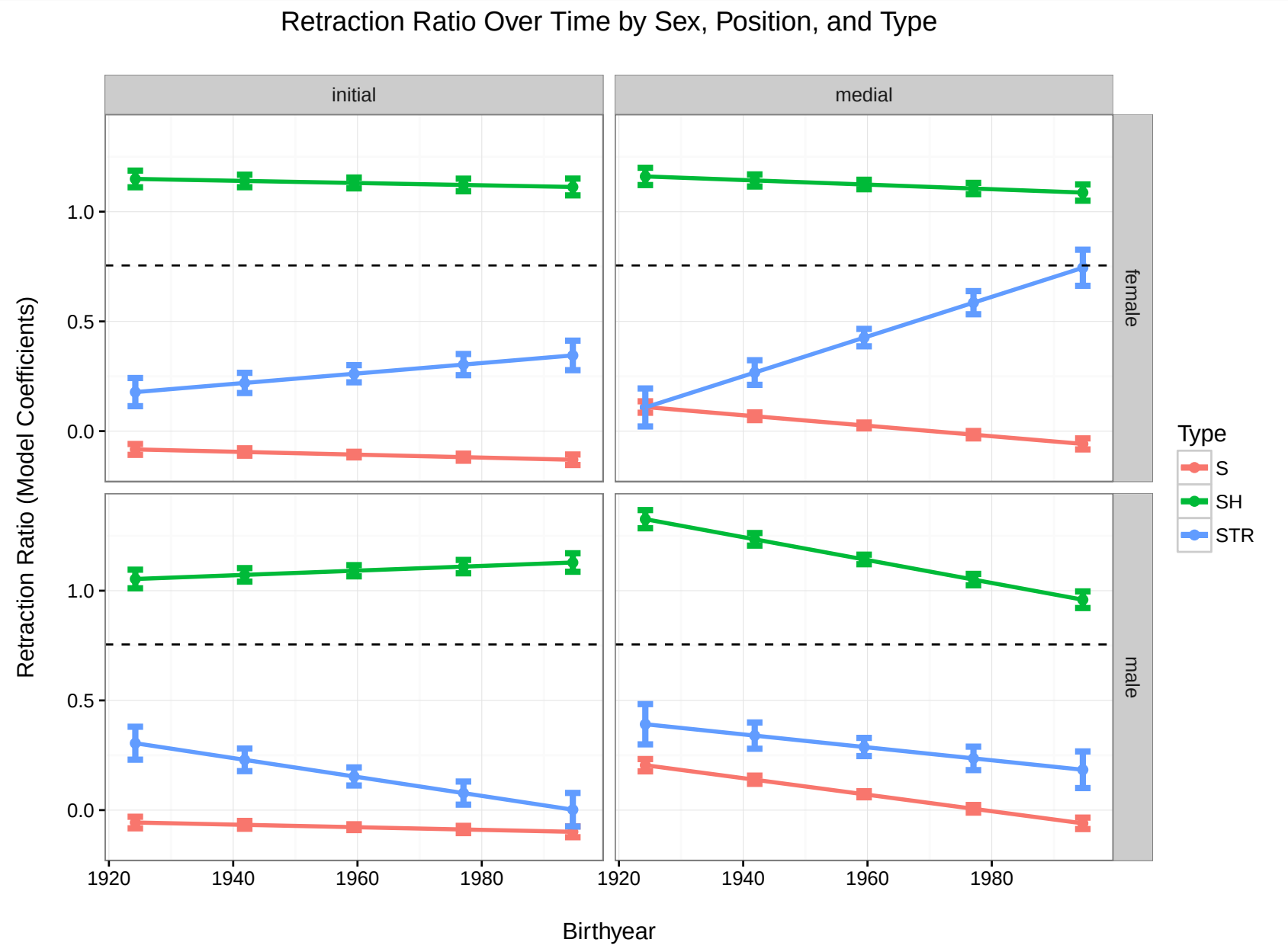
live down the street

street

s



Four-Way Interaction



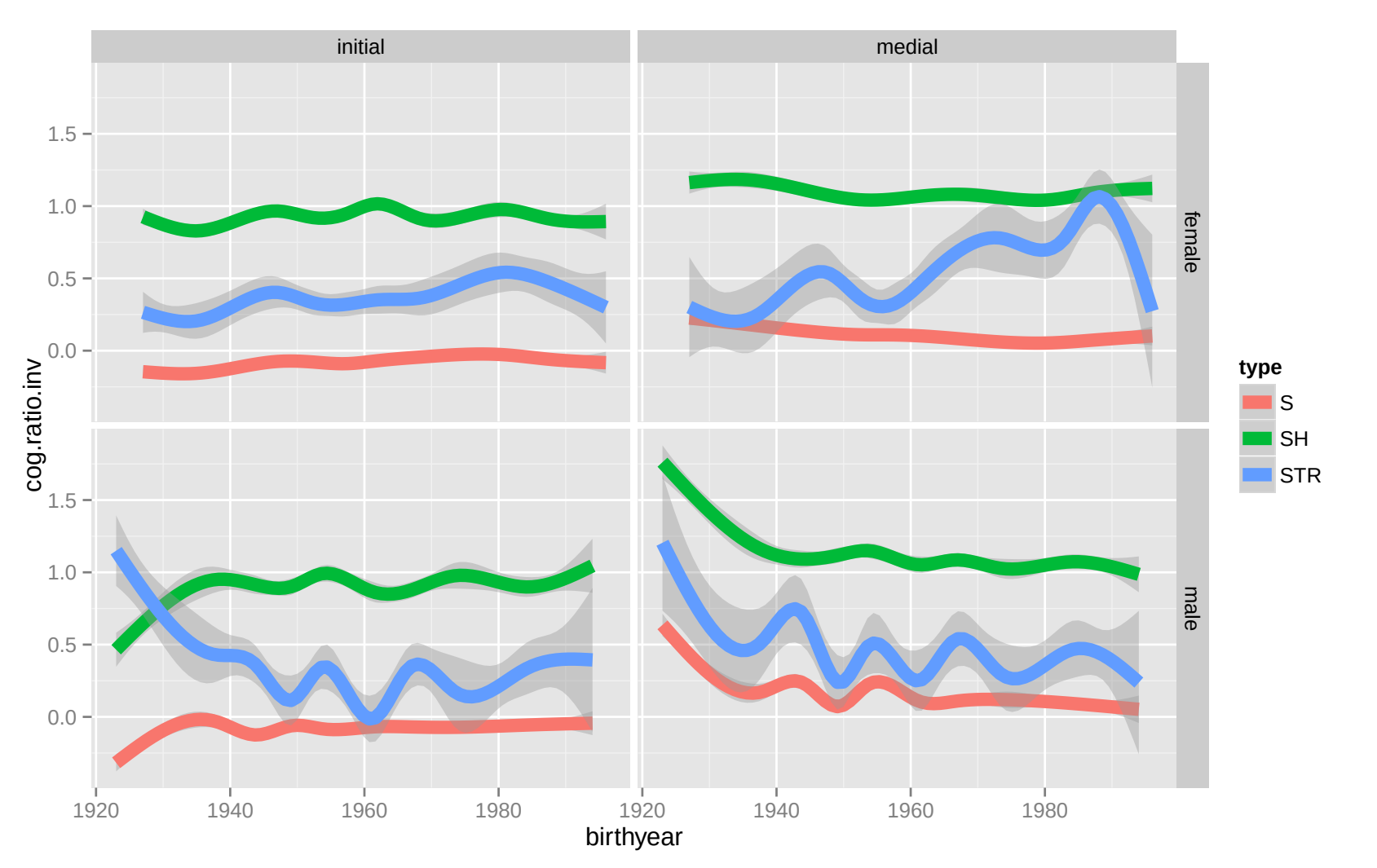
Male b. 1923

``Nothing is like it **used** to be, I mean, the only thing **constant** in life is change. And Raleigh has changed but it has changed in a good, positive **fashion**."

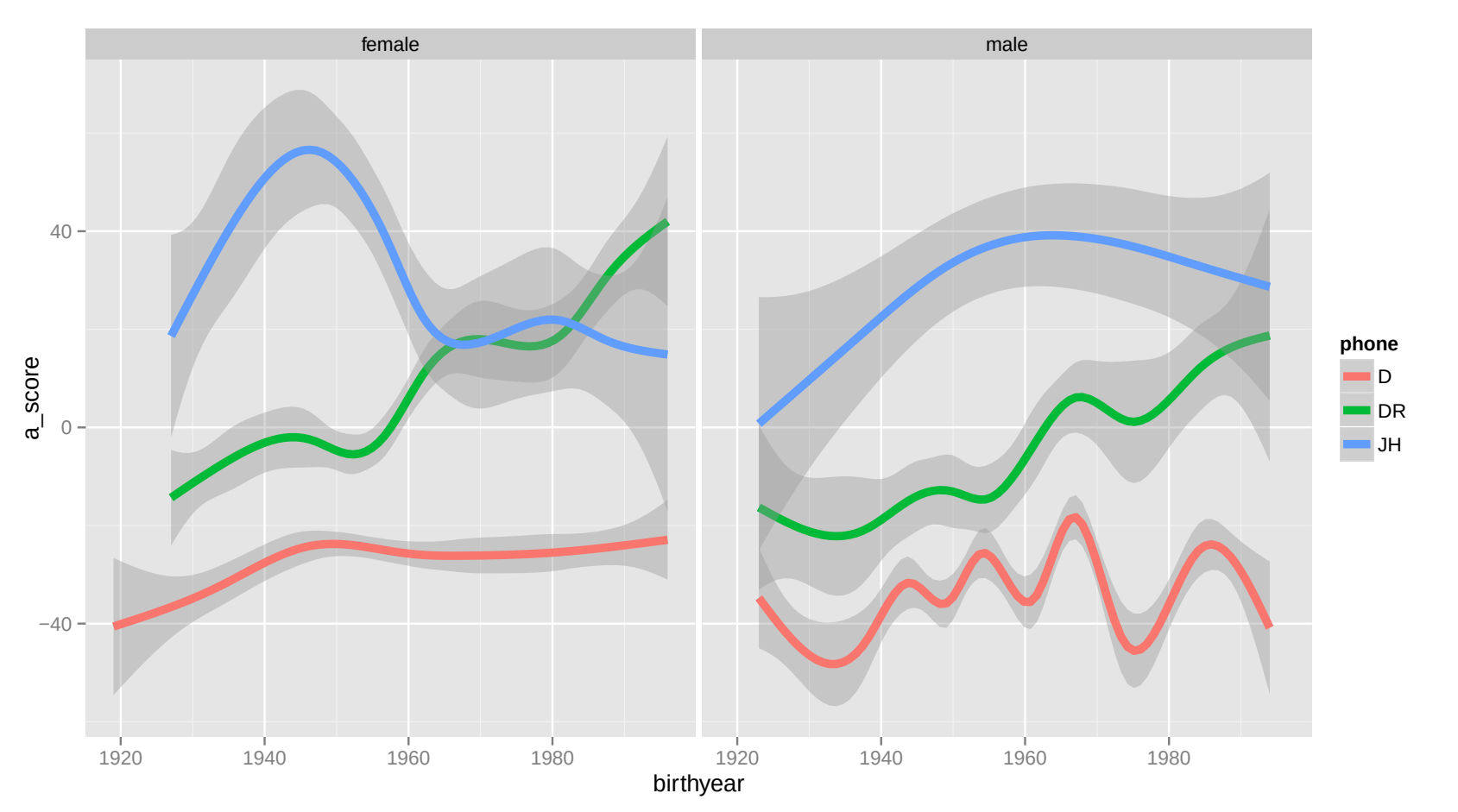
/str/ Extended Methods

1. Excluding tokens in contact with sibilants
2. Excluding tokens word or phrase finally
3. Band-pass filtered: 500-11000Hz
4. Power spectrum on 30ms window centered on midpoint of segment

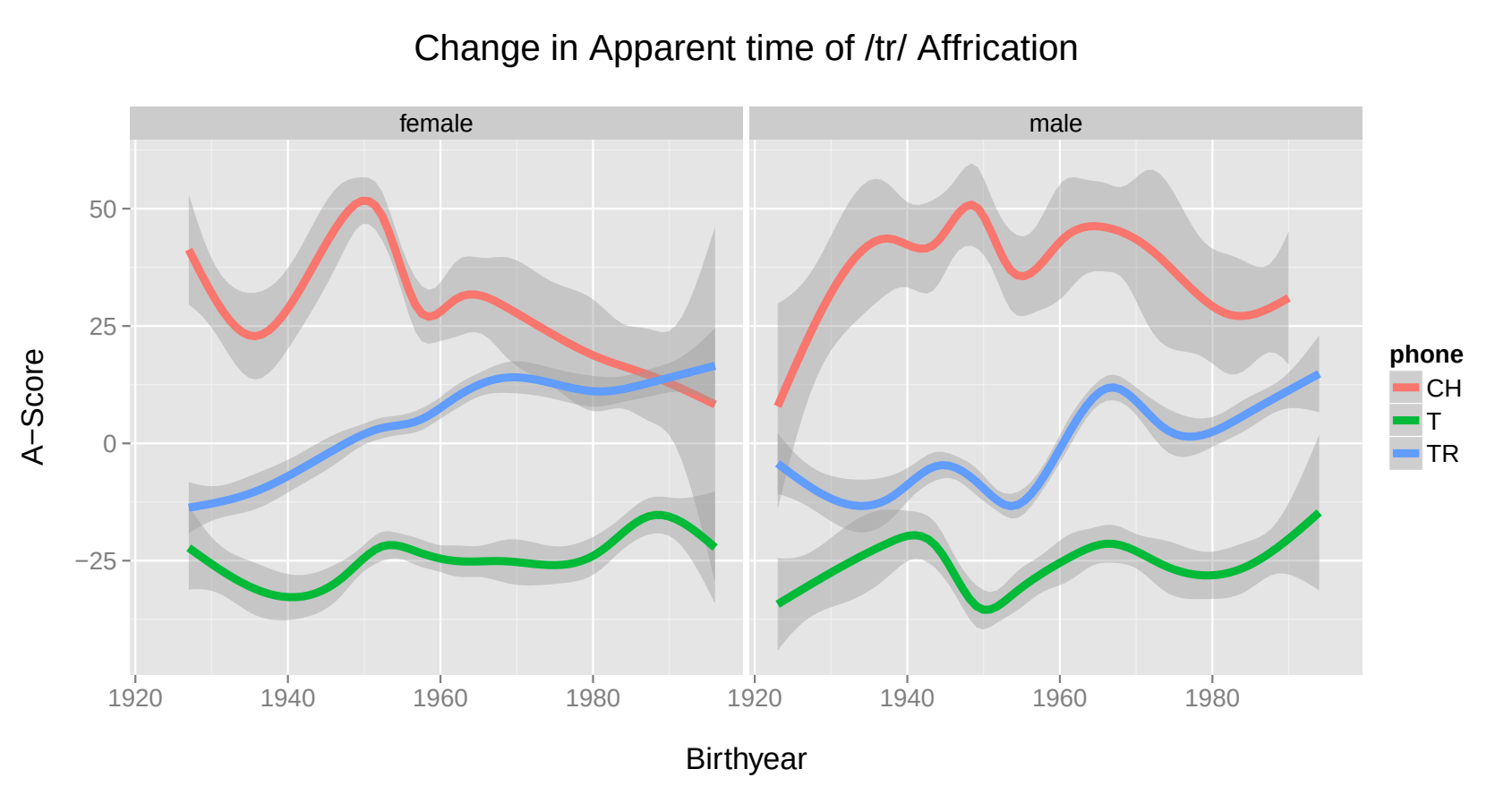
(str) Retraction (Raw data)



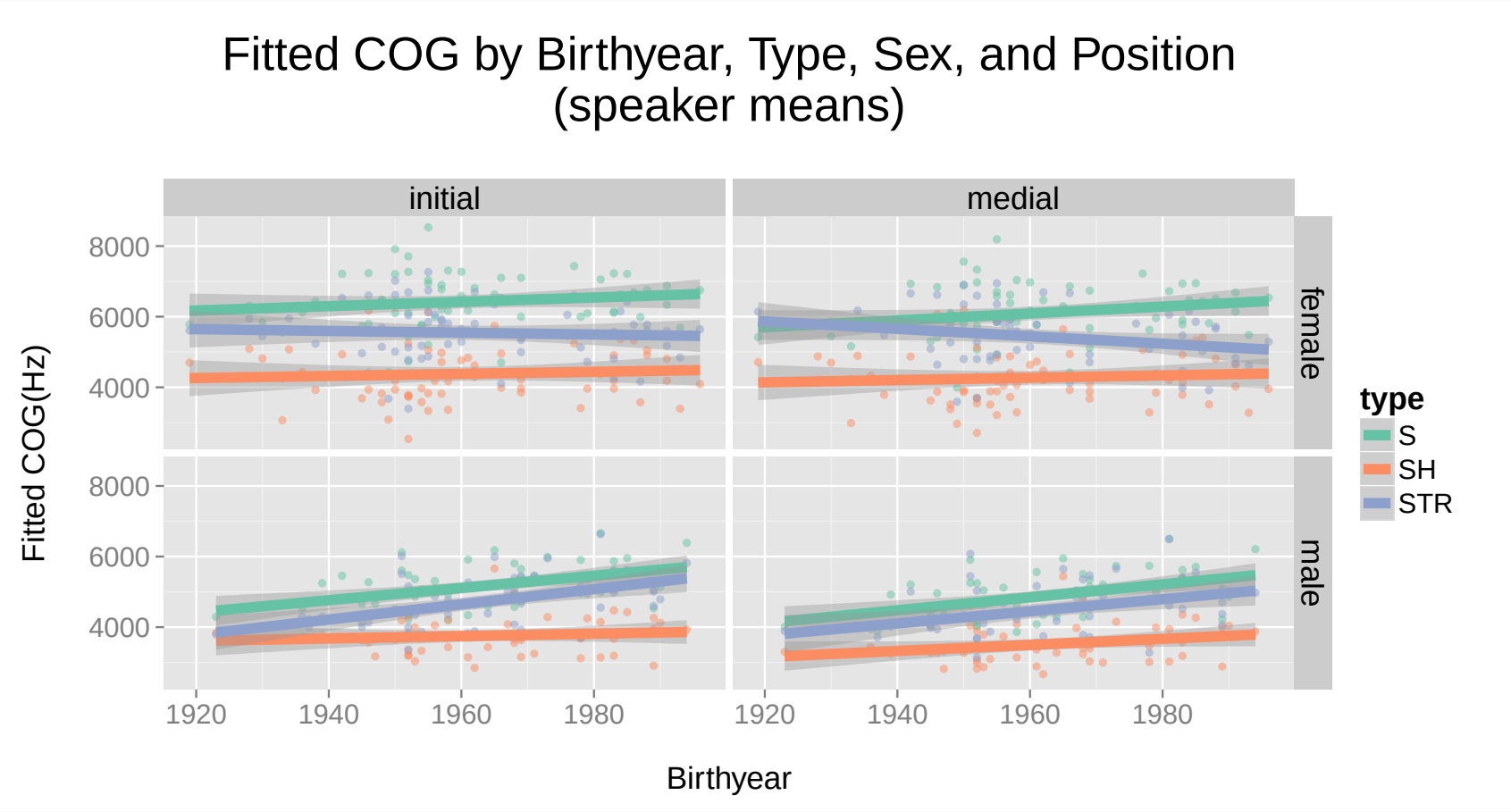
/dr/ Affrication (Raw data)



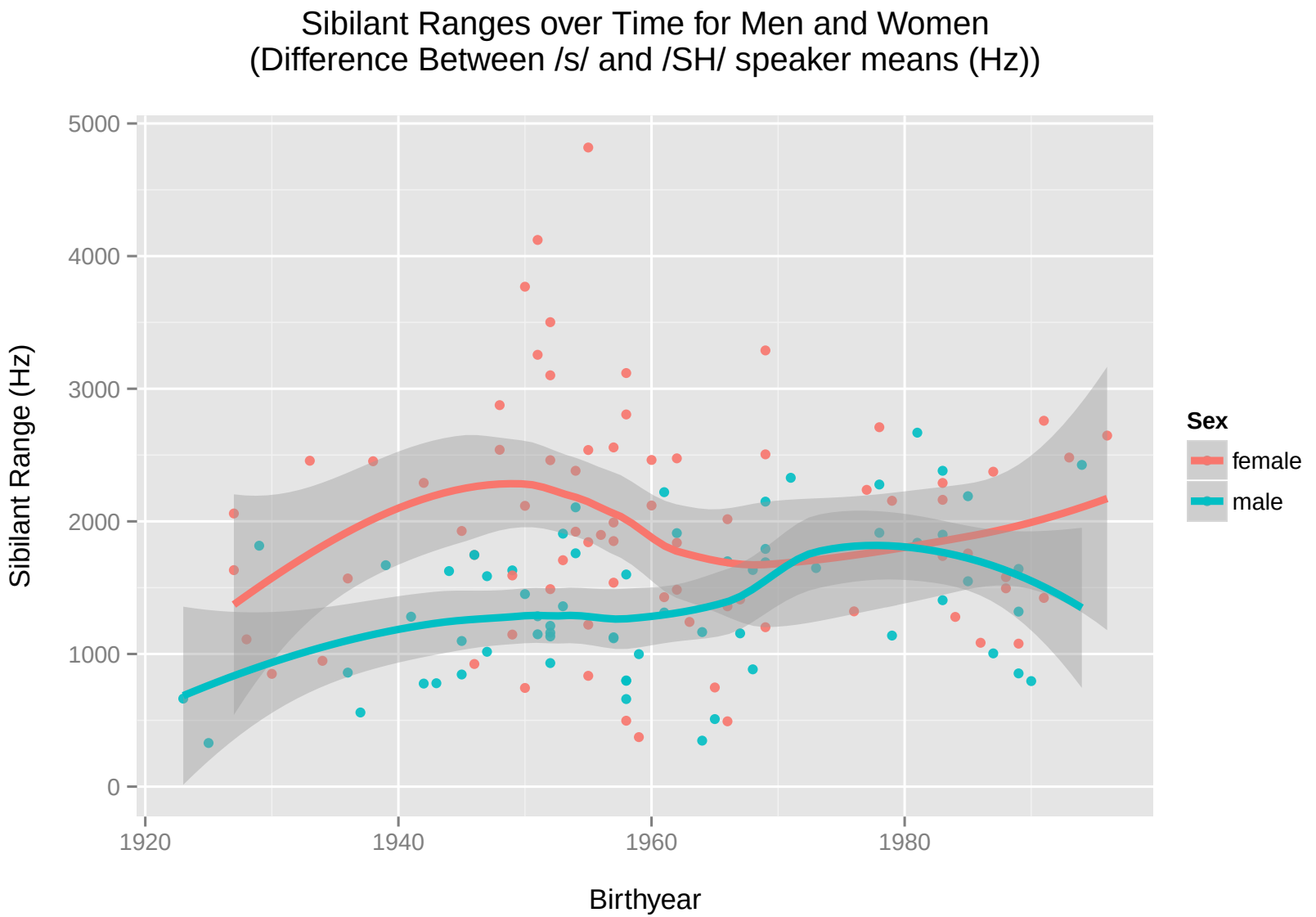
/tr/ Affrication (Raw data)



Center of Gravity Models- (phone|speaker)



Sibilant Space Change (Observed, not Fitted)



AIC model comparisons - All Sibilants

	K	LL	AIC	ΔAIC_{top}	ΔAIC_{each}	Factors Added
M10	160	-110542	221404.6	0	102.0	Sex : Birthyear : Type : Position
M9	149	-110604	221506.6	101.95	54.2	Sex : Birthyear : Type
M8	143	-110637	221560.8	156.16	-1.1	Sex : Birthyear
M7	142	-110638	221559.7	155.08	9.8	Birthyear (scaled)
M6	141	-110644	221569.5	164.89	-0.4	Sex
M5	140	-110644	221569.1	164.52	120.2	Position
M4	139	-110705	221689.3	284.65	909.4	Right Phone
M3	74	-111225	222598.7	1194.04	1529.8	Left Phone
M2	8	-112056	224128.5	2723.83	4948.6	Type (/s/, /ʃ/, or (str))
M1	6	-114533	229077.1	7672.51	NA	Random Effects

Table 2: AIC model comparisons - All Sibilants

AIC model comparisons - only (str)

	K	LL	AIC	ΔAIC_{top}	ΔAIC_{each}	Factors Added
M9e	47	-2335.88	4767.60	-10.68	NA	Sex : Birthyear : Position : Occ.
M9d	33	-2345.90	4758.78	-1.86	NA	Occupation (Occ.)
M9c	39	-2342.60	4764.48	-7.56	NA	Sex : Birthyear : Position : Frequenc
M9b	32	-2346.78	4758.42	-1.50	NA	Frequency
M9a	38	-2343.56	4764.33	-7.41	NA	Sex : Birthyear : Position : Duratio
→ M8 ←	31	-2347.06	4756.92	0	5.26	Sex : Birthyear : Position
M7	28	-2352.76	4762.18	5.26	7.71	Sex : Birthyear
M6	27	-2357.64	4769.89	12.97	12.32	Position
M5	26	-2364.82	4782.21	25.29	-2.04	Birthyear (scaled)
M4	25	-2364.82	4780.17	23.25	-0.48	Sex
M3	24	-2365.60	4779.69	22.77	27.95	Log(Duration)
M2	23	-2380.60	4807.64	50.72	82.37	Previous Phone
M1	6	-2438.99	4890.01	133.10	NA	Random Effects

Table 3: AIC model comparisons

(str) Model Coefficients

	Dependent variable:
	cog.ratio.inv
Log(Duration)	−0.294*** (0.052)
Sex- Male	−0.076 (0.056)
Birthyear (scaled)	0.041 (0.039)
Position- Medial	0.137*** (0.044)
Sex- Male : Birthyear	−0.130** (0.058)
Sex- Male : Position- Medial	0.047 (0.053)
Birthyear : Position- Medial	0.125*** (0.038)
Sex- Male : Birthyear : Position- Medial	−0.139** (0.056)
Constant	−0.337*** (0.120)
Observations	2,499
Log Likelihood	−2,347.057
Akaike Inf. Crit.	4,756.113
Bayesian Inf. Crit.	4,936.646
Note:	*p<0.1; **p<0.05; ***p<0.01

AIC model comparisons - /tɹ/

	K	LL	AIC	ΔAIC_{top}	ΔAIC_{each}	Factors Added
M6	15	-51498.74	103027.5	0.60	-0.06	PHONE:BIRTHYEAR:SEX
→M5←	10	-51503.45	103026.9	0.00	4	SEX
M4	9	-51506.43	103030.9	3.95	7.1	PHONE:BIRTHYEAR
M3	7	-51512.00	103038.0	11.09	6.8	BIRTHYEAR
M2	6	-51516.38	103044.8	17.84	132.7	PHONE
M1	4	-51584.74	103177.5	150.55	NA	Random Effects

Table 4: AIC model comparisons

lmer(a_score ~ phone * birthyear * sex + (1|speaker) + (1|word), REML=F,data=df)

/tɹ/ coefficients

	Dependent variable:
	a_score
phoneT	−449.038 − t = −1.080
phoneTR	−1,061.517 − t = −2.803***
birthyear	−0.154 − t = −0.828
sexmale	−5.869 − t = −2.484**
phoneT:birthyear	0.198 − t = 0.932
phoneTR:birthyear	0.525 − t = 2.719***
Constant	333.661 − t = 0.914
Observations	8,773
Log Likelihood	−51,503.450
Akaike Inf. Crit.	103,026.900
Bayesian Inf. Crit.	103,097.700
Note:	* p<0.1; ** p<0.05; *** p<0.01

AIC model comparisons - /dɹ/

	K	LL	AIC	ΔAIC_{top}	ΔAIC_{each}	Factors Added
→M6←	15	-63277.25	126584.6	0.00	11.5	Phone:Birthyear:Sex
M5	10	-63288.06	126596.1	11.59	8.3	Sex
M4	9	-63293.20	126604.4	19.86	71.9	Phone:Birthyear
M3	7	-63331.14	126676.3	91.75	7.3	Birthyear
M2	6	-63335.78	126683.6	99.02	272.9	Phone
M1	4	-63474.23	126956.5	371.91	NA	Random Effects

Table 5: AIC model comparisons

lmer(a_score ~ phone * birthyear * sex + (1|speaker) + (1|word), REML=F,data=df)

/dɹ/ coefficients

	Dependent variable:
	a_score
phoneDR	−975.579 – t = −4.722***
phoneJH	1,402.403 – t = 5.927***
birthyear	0.134 – t = 1.887*
sexmale	−37.708 – t = −0.190
phoneDR:birthyear	0.520 – t = 4.927***
phoneJH:birthyear	−0.677 – t = −5.604***
phoneDR:sexmale	307.297 – t = 1.024
phoneJH:sexmale	−852.080 – t = −2.380**
birthyear:sexmale	0.018 – t = 0.175
phoneDR:birthyear:sexmale	−0.161 – t = −1.053
phoneJH:birthyear:sexmale	0.436 – t = 2.385**
Constant	−297.541 – t = −2.141**
Observations	11,713
Log Likelihood	−63,277.250
Akaike Inf. Crit.	126,584.500
Bayesian Inf. Crit.	126,695.000
Note:	* p<0.1; ** p<0.05; *** p<0.01