V[ɛ]RY V[e]RIED VOWEL MERGERS IN THE PACIFIC NORTHWEST

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The West

"low homogeneity" and "low consistency"

(Labov, Ash, Boberg 2006:277)

cot-caught merger

fronting of /u/

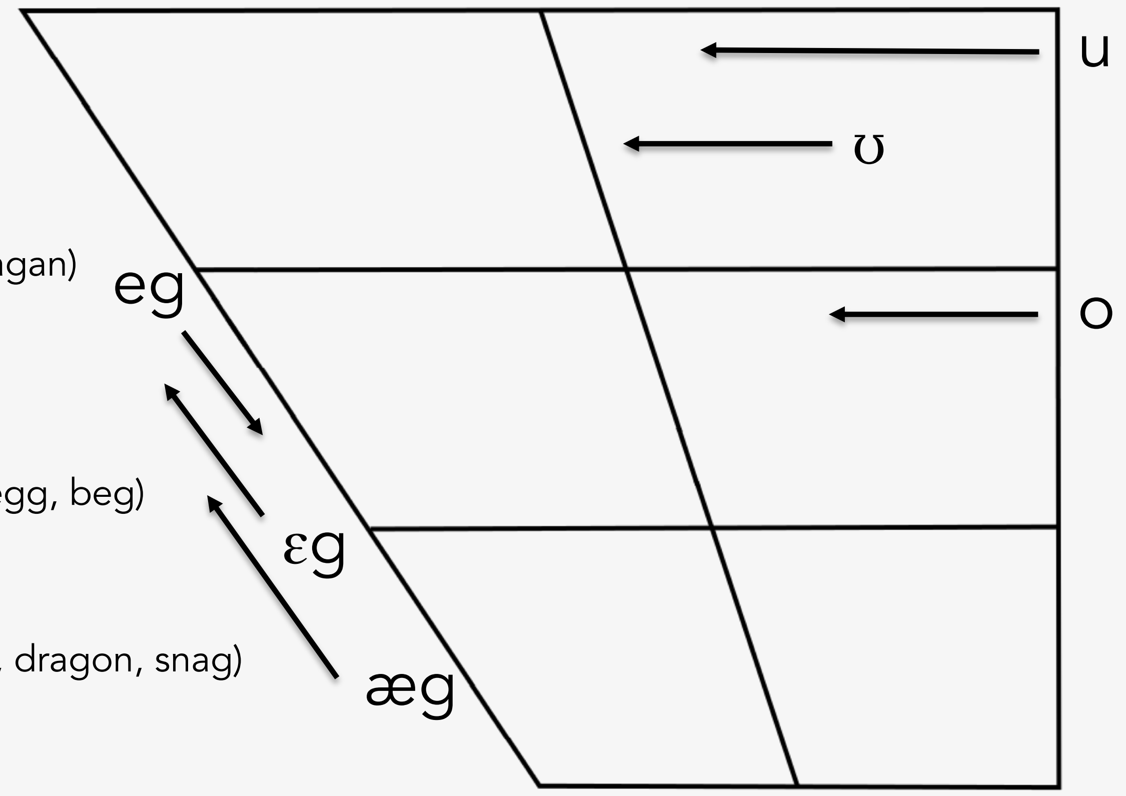
lack of Southern, Midland, and Canadian features

Pacific Northwest English

(vague, flagrant, Reagan)

(leg, egg, beg)

(bag, dragon, snag)



(Ward 2003, Becker et al. 2013, McLarty & Kendall 2014, Becker et al. 2016, etc.)

(Wassink *et al*. 2009, Freeman 2014, Riebold 2015, Wassink 2016, etc.)

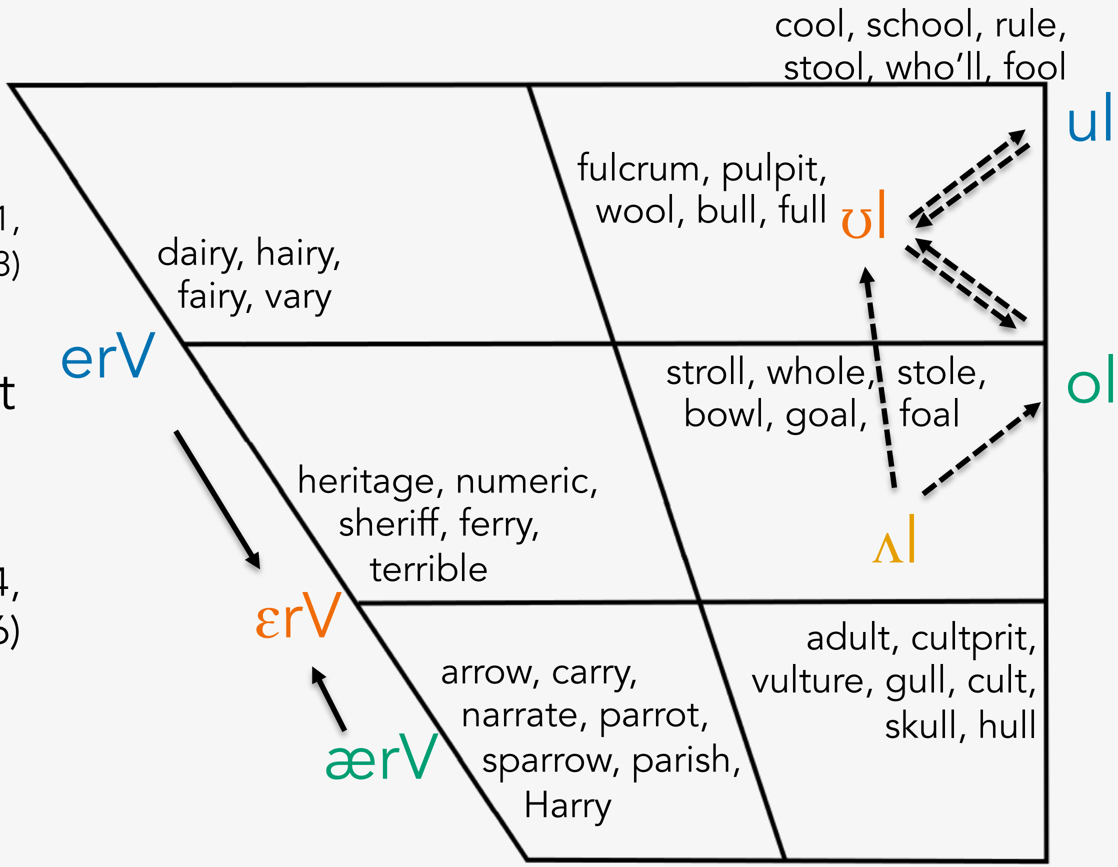
SAME VOWELS: OTHER MERGERS

MARY-MERRY-MARRY

variable in New England (Labov, Ash, & Boberg 2006, Nagy 2001, Coye 2009, Bauman 2013)

ANAE: "This query was not pursued in most areas of the West and Midwest." (Labov, Ash, & Boberg 2006:54, note 6)

Merging in PNW 1960s, but merged today (Reed 1961, Wassink 2016)



POOL-PULL, PULL-POLE, PULL-PULP, etc.

ANAE: "deserve further study" (Labov, Ash, & Boberg 2006:73)

variable in Maryland (Bowie 2000), Ohio (Arnold 2014), Missouri (Strelluf 2016), and Utah (Baker & Bowie 2010)

Variable in PNW 1960s (Reed 1961)

Overview

MARY-MERRY-MARRY historically variable, but likely merged today

Status of pre-lateral mergers is unknown, though impressionistically less clear cut

Hypothesis 1: complete MARY-MERRY-MARRY merger

Hypothesis 2: separation of POOL, PULL, POLE, and PULP

Methodology

Data Collection

40 natives of Cowlitz County, ages 18–70s

Number of tokens

	word list	minimal pairs	total
pre-laterals	376	842	1,218
pre-rhotics	342	509	851
total	718	1,351	2,069

word list (23) and minimal pairs (14)

list in appendix slides

intuition of own minimal pairs

forced aligned with DARLA (Reddy & Stanford 2015), which uses ProsodyLab (Gorman, Howell, & Wagner, 2011) and FAVE (Rosenfelder, Fruehwald, Evanini, & Yuan 2011)

hand-corrected boundaries and extracted formants myself

Formant Extraction

boundaries can be arbitrary

formants extracted at 25% into the vowel+liquid duration

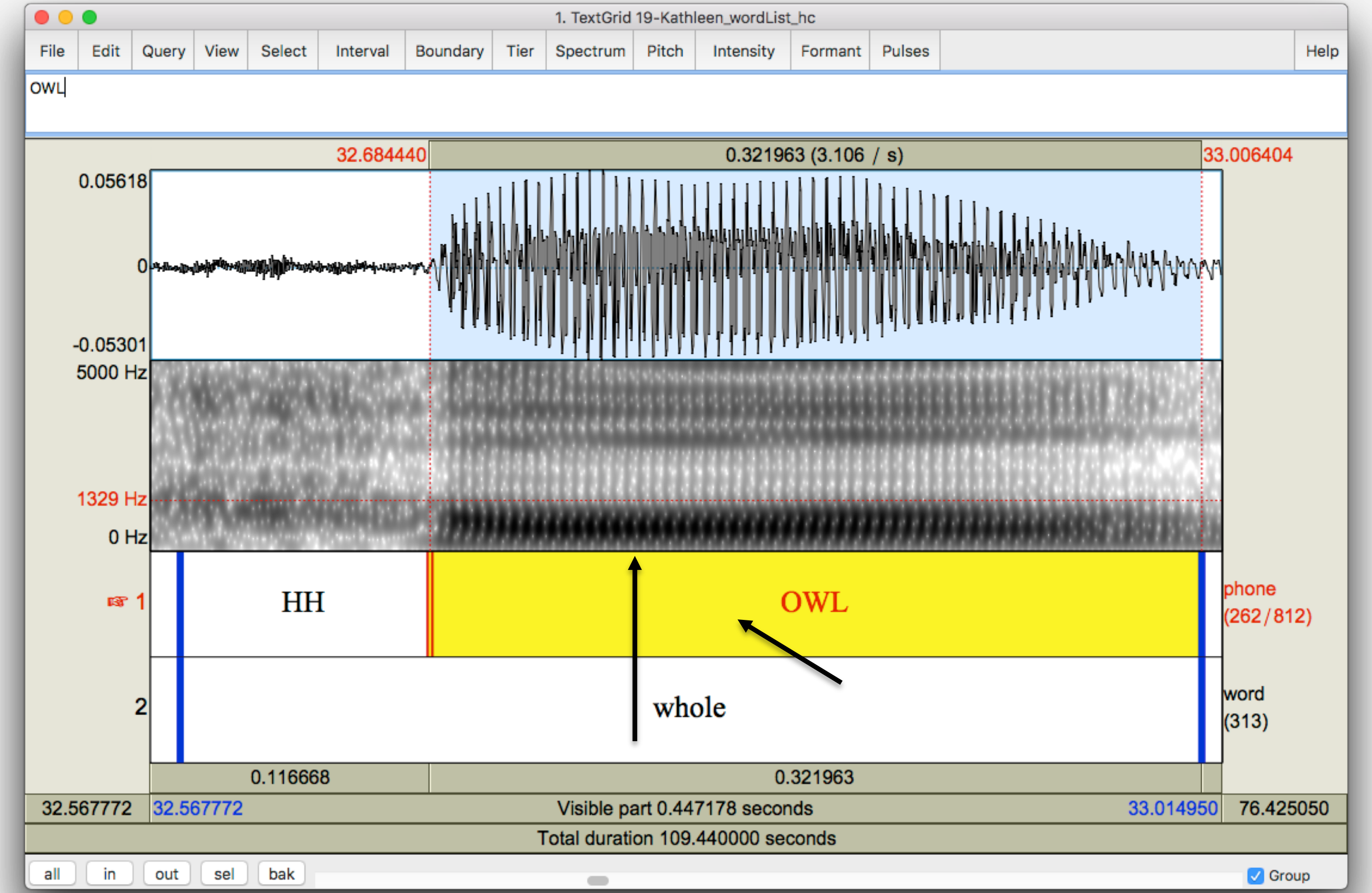
(cf. Arnold 2015)

Bark normalized

(Traunmüller 1997)

Lobanov not ideal since not all vowels are present

(Thomas & Kendall 2015)



Analysis

Mixed-effects models (Baayen 2008, Levshina 2015)

`lme()` in R package `nlme` (Pinheiro *et al.* 2016)

`glmer()` in the R package `lme4` (Bates *et al.* 2015)

Overlap measured with Pillai scores (Hay, Warren & Drager 2006; Hall-Lew 2010; Nycz & Hall-Lew 2013)

Effects are reported significant if $p<0.01$.

Appendix slides:

more detailed explanation of statistical methods

all model outputs

interpretation of each mode.

Results

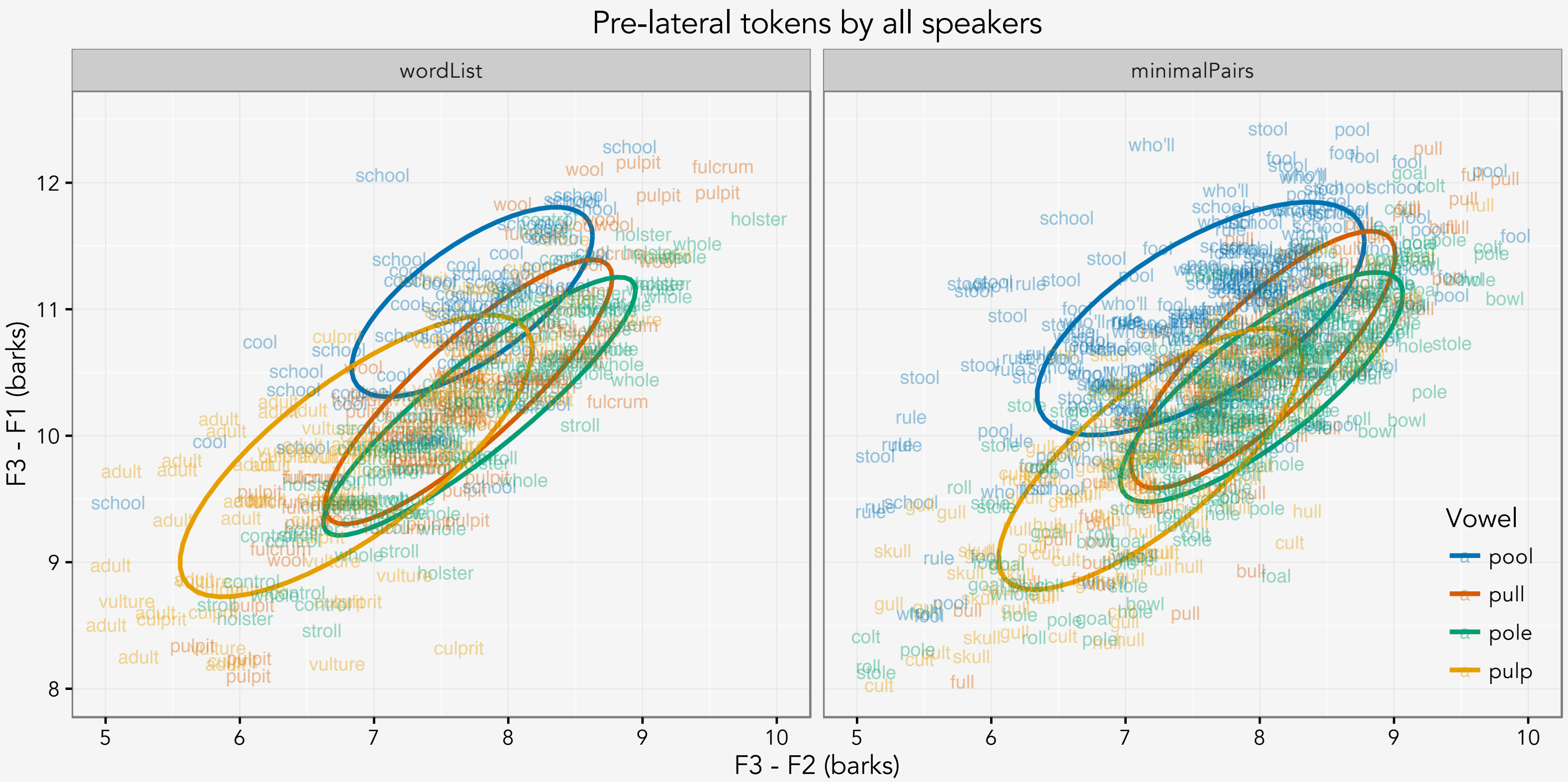
Pre-Laterals: Means

POOL significantly higher

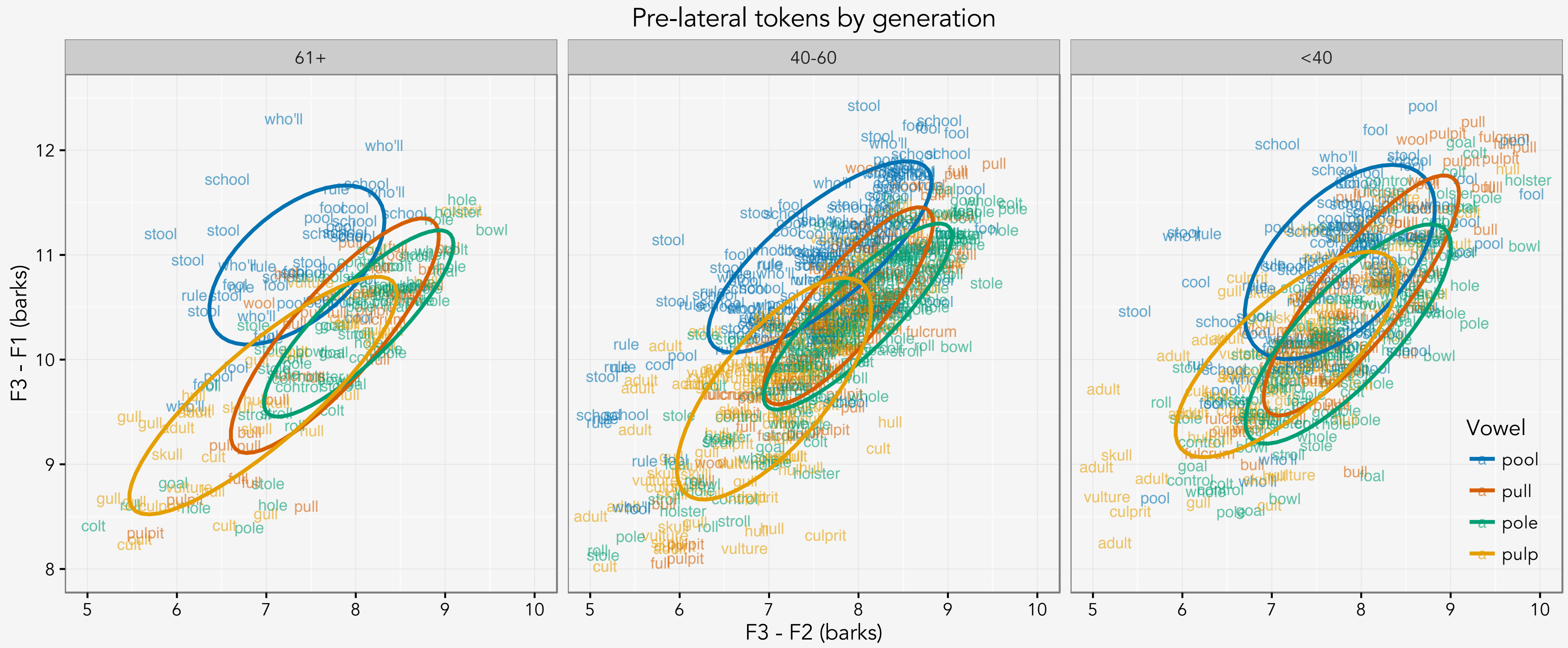
PULP significantly lower and fronter

PULL fronter than POLE in word list, but higher than POLE in minimal pairs

Generation and sex not significant



PRE-LATERALS: OVERLAP



POOL converging with PULL, POLE, and PULP while

PULL, POLE, and PULP are becoming more distinct from each other in apparent time.

Pre-Laterals: Speaker Intuition

hesitation, deliberation, uncertainty

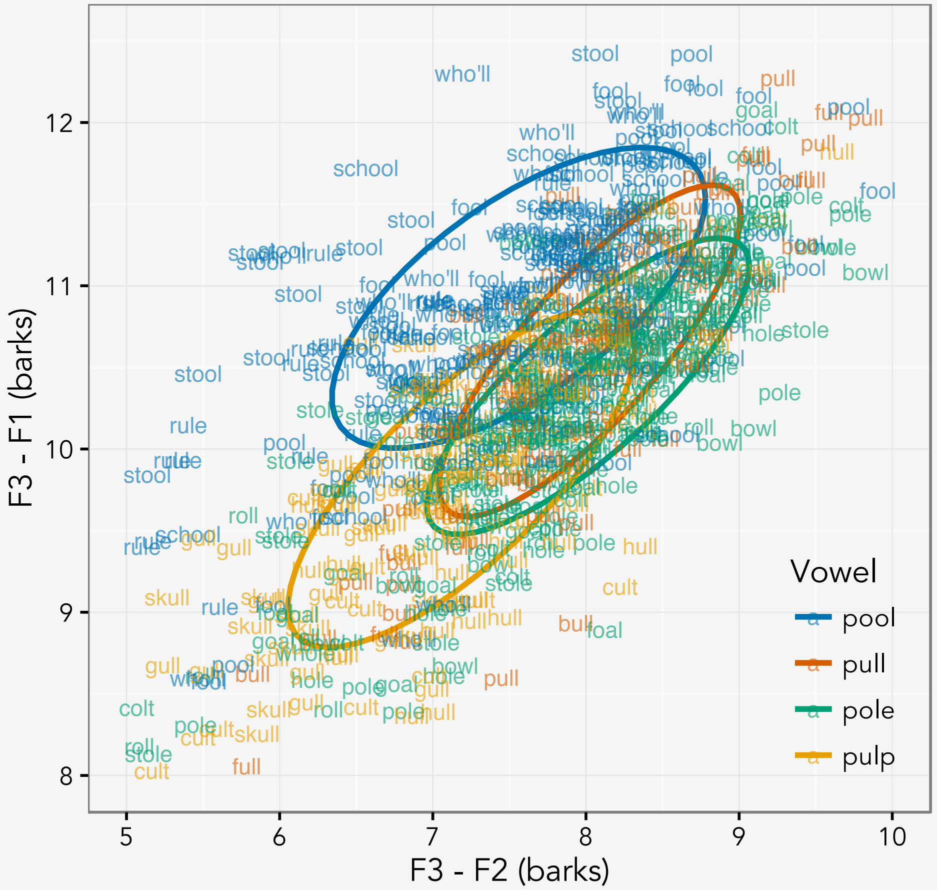
PULL-POLE (23.4% reported merged)
(bull-bowl > pull-pole > full-foal)

POLE-PULP (13.9% reported merged)
(goal-gull > colt-cult, hole-hull)

slight correlation between degree of merger and reported merger

POOL-PULL (16.7%), POOL-POLE (3.3%), POOL-PULP (2.6%)—no correlation with production

Pre-lateral tokens by all speakers (minimal pairs)



Pre-Laterals in other Regions

Cowlitz County, WA

PULL-POLE most common

more overlap over time

Utah County, UT

(Baker & Bowie 2010)

POOL-PULL-POLE

and PULL-PULP

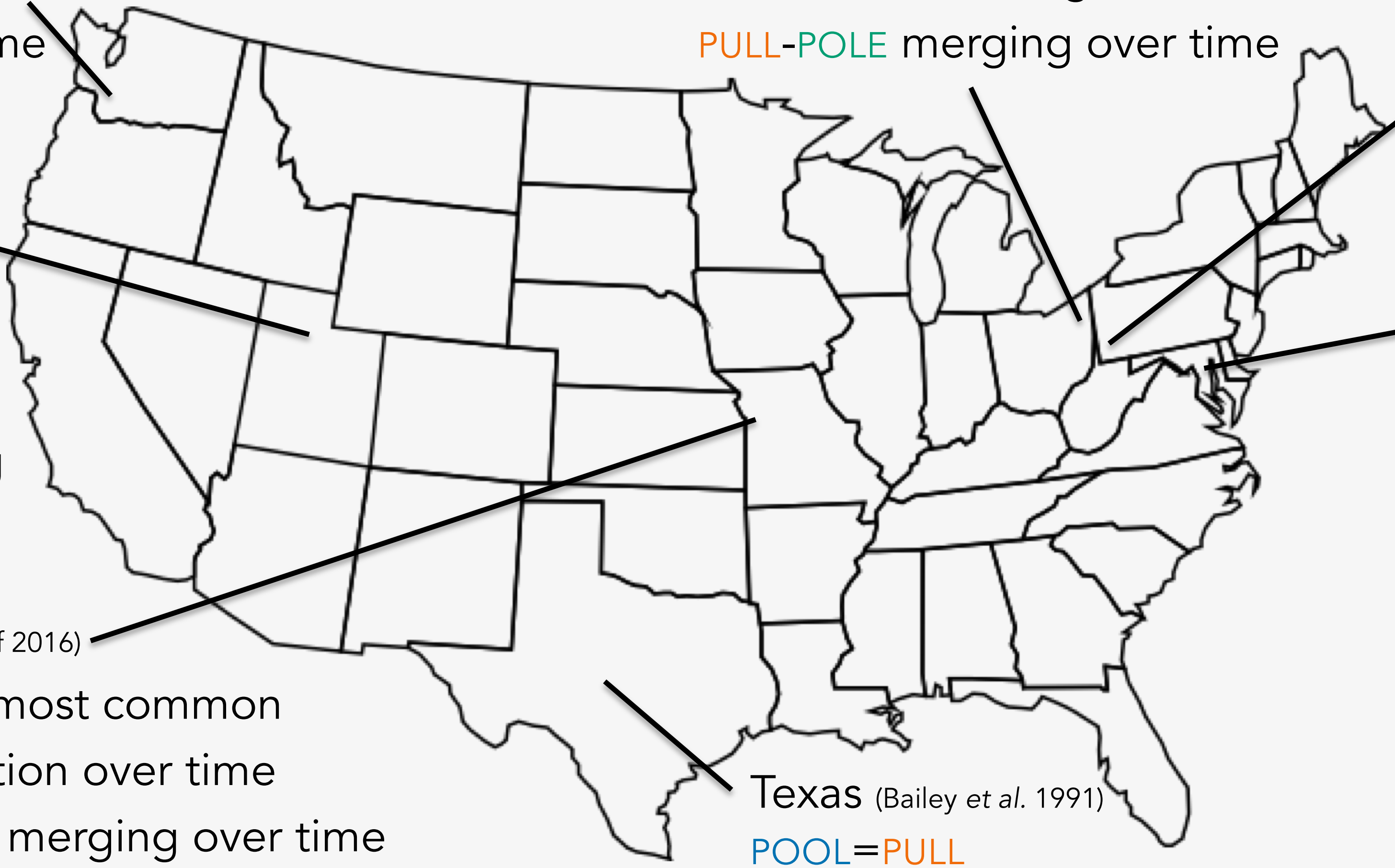
more merged among Mormons

Kansas City, MO (Strelluf 2016)

PULL-POLE, POLE-PULP most common

no change in production over time

increased perceptual merging over time



Youngstown, OH (Arnold 2015)

POOL-PULL receding over time

PULL-POLE merging over time

Pittsburg area

(Labov *et al.* 2006)

POOL=PULL

Waldorf, MD (Bowie 2000)

POOL-PULL, PULL-POLE

distinct in production

merged in perception (esp. for younger speakers)

Texas (Bailey *et al.* 1991)

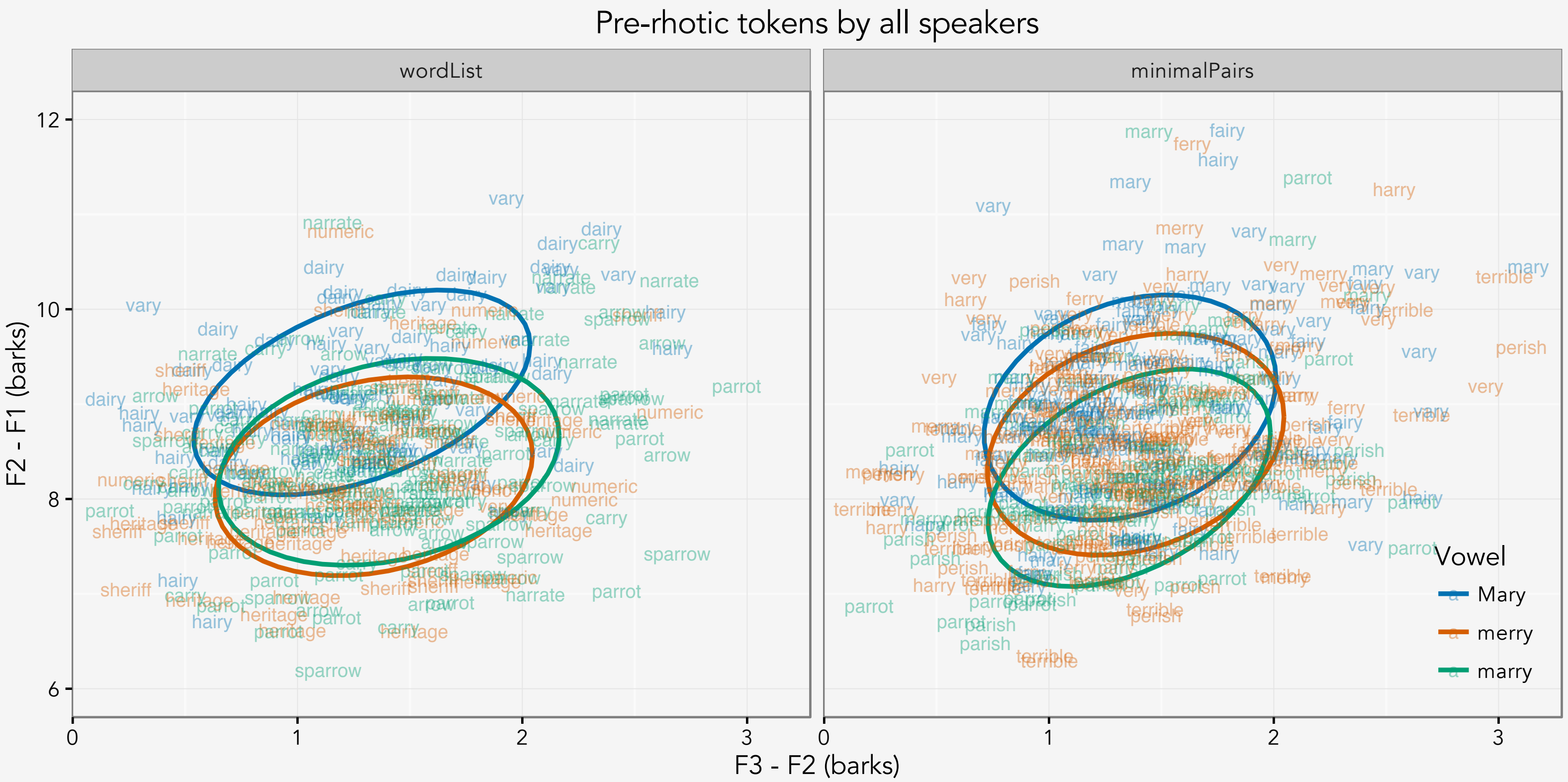
POOL=PULL

PRE-RHOTICS: PRODUCTION

MERRY = MARRY in the word list

MARY higher than MERRY and MARRY in the word list

three-way split in the minimal pairs



Pre-Rhotics: Speaker Intuition

quick, confident, no hesistation

MARY-MERRY (98% reported merged)

(vary-very, fairy-ferry, Mary-merry)

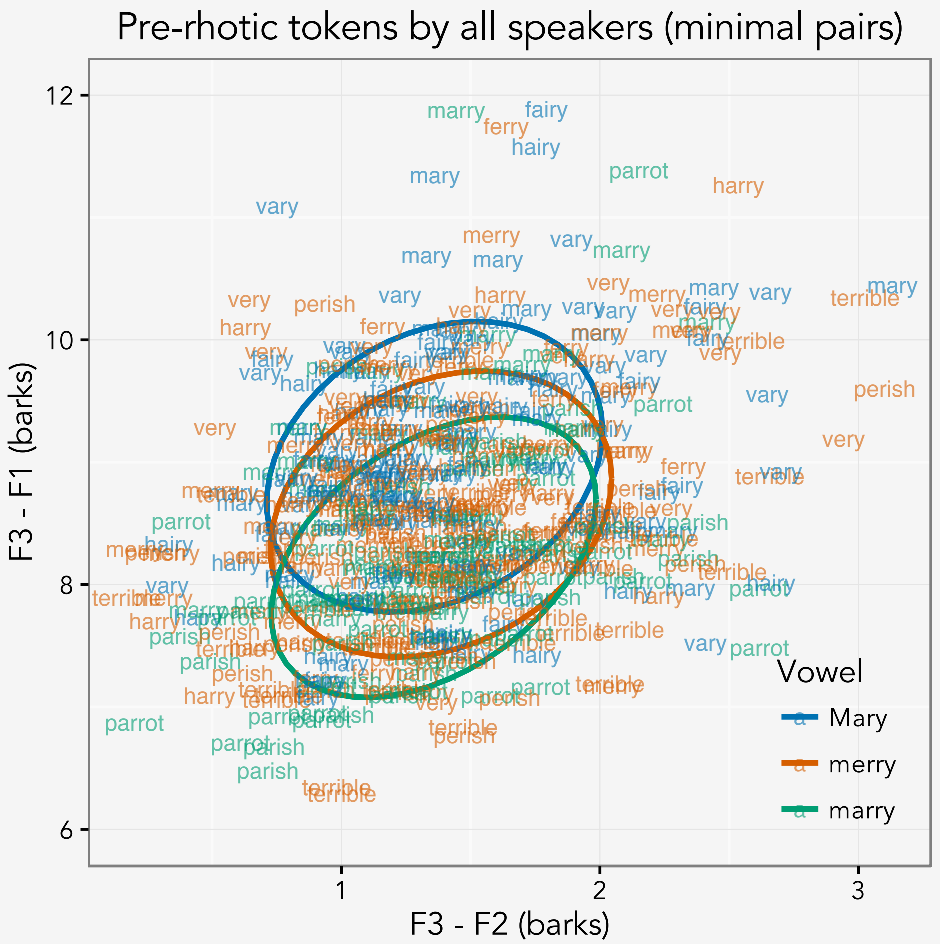
MARY-MARRY (99% reported merged)

(hairy-Harry, Mary-merry)

MERRY-MARRY (97% reported merged)

(perish-parish, merry-marry)

No correlation between production and speaker intuition.



PRE-RHOTICS IN OTHER REGIONS

Cowlitz County, WA
MARY higher / all distinct
merged in perception
no change over time

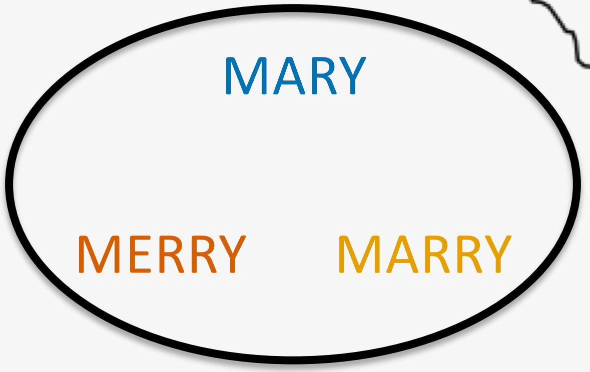
Vermont (Stanford *et al.* 2012)
all merged

New Hampshire (Nagy 2001)
generally merged, with stable variation

Massachusetts (Nagy 2001)
generally distinct

New Jersey (Coye 2009)
3 patterns: all merged, all distinct, and MARY=MERRY *or* MARRY

East and South (scattered)
(Labov et al. 2006)
MARY=MERRY, MARRY different



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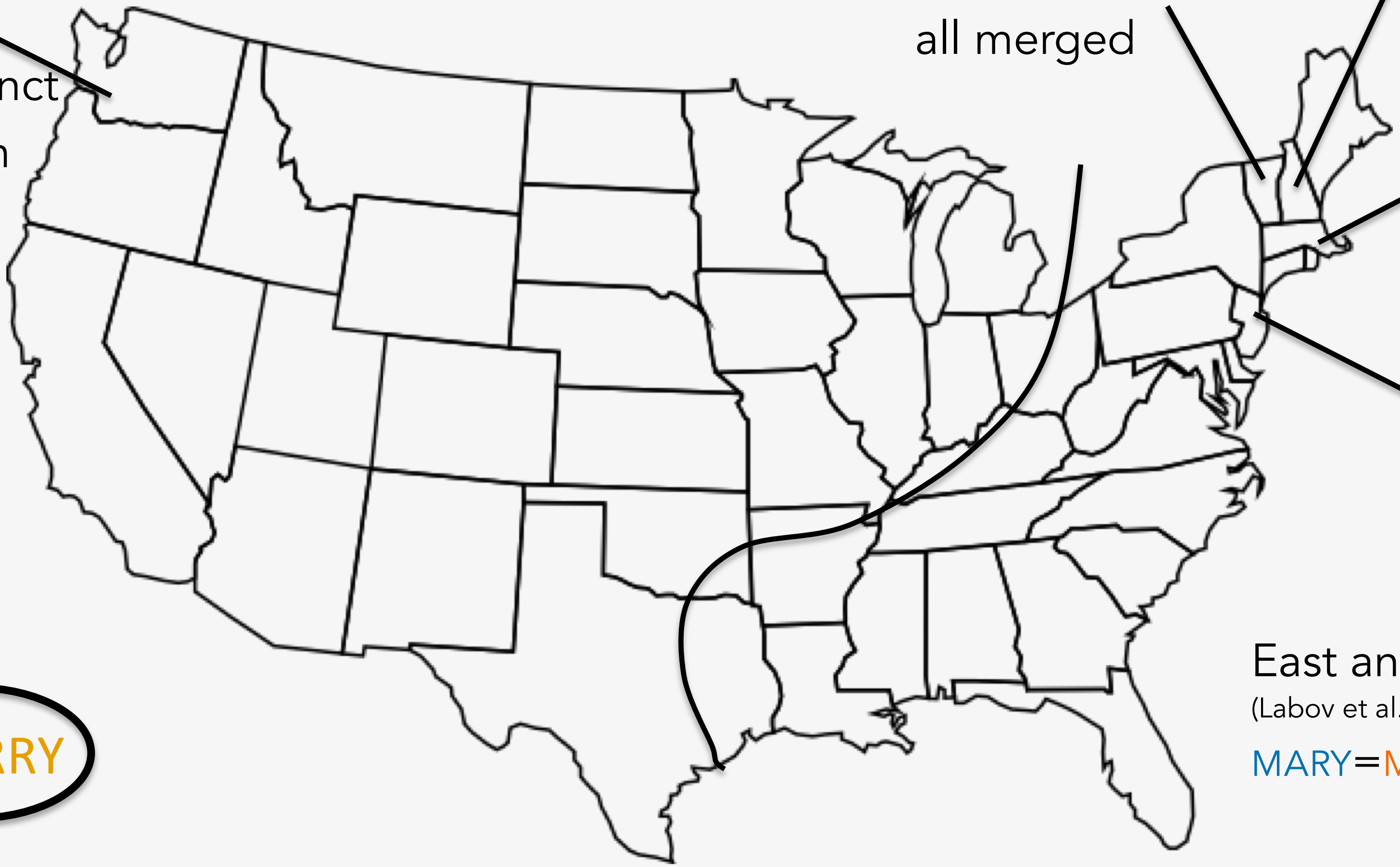

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MARY

MERRY MARRY

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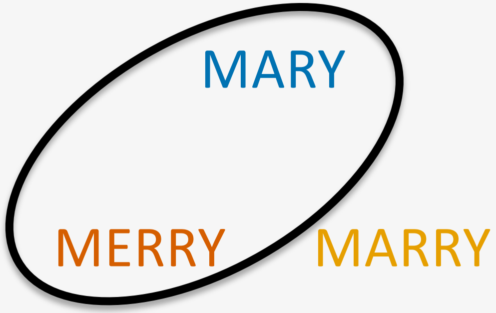

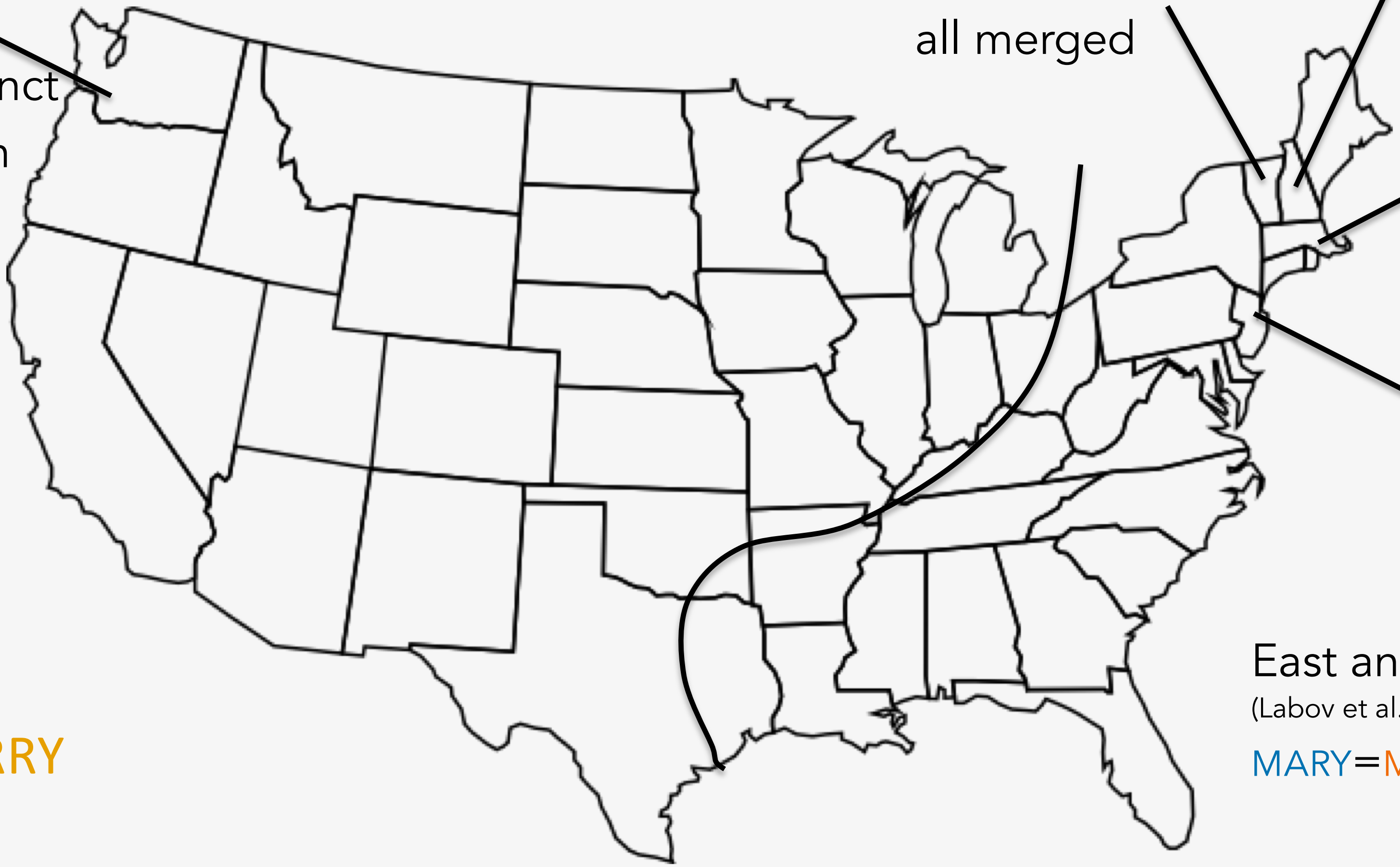

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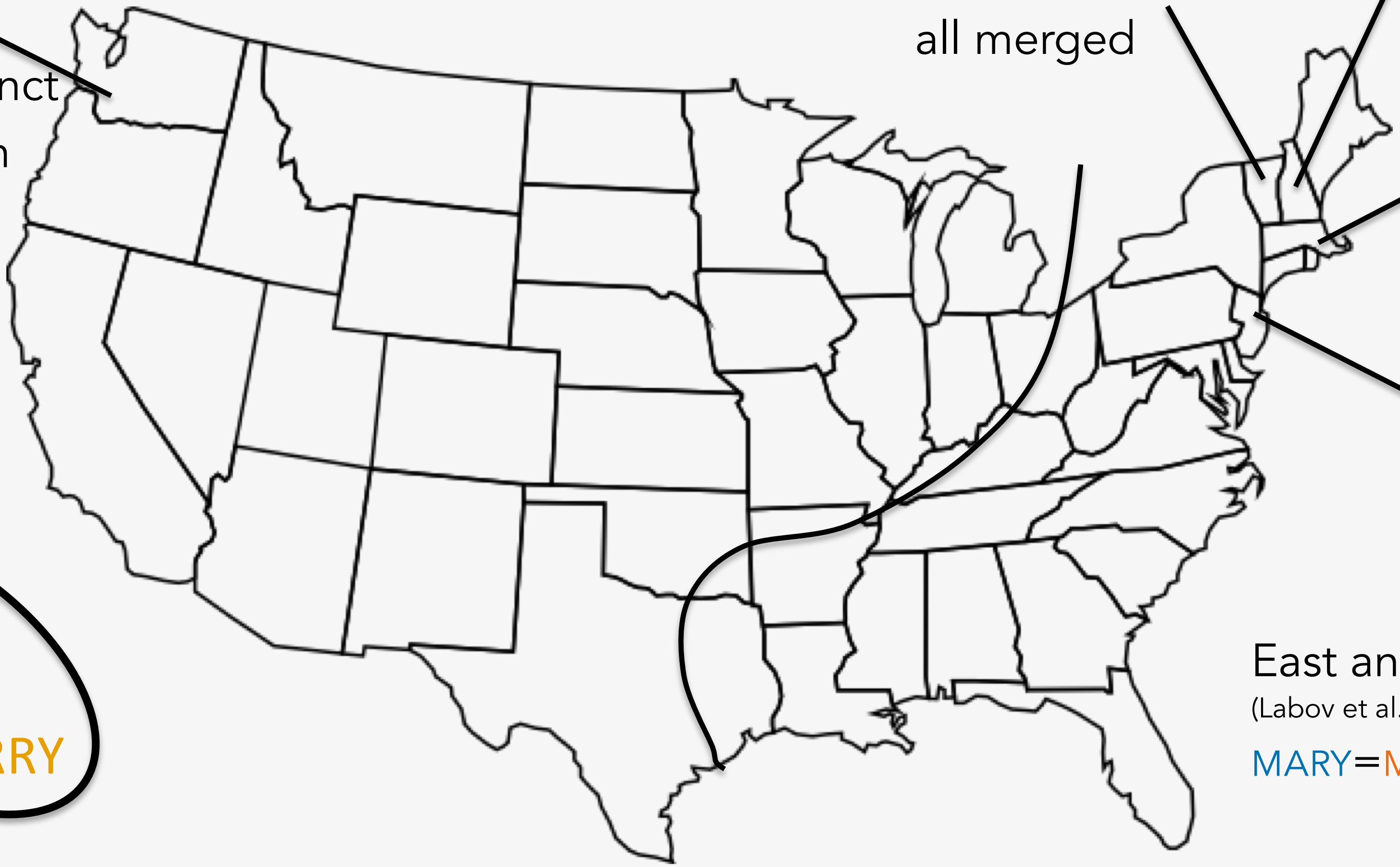

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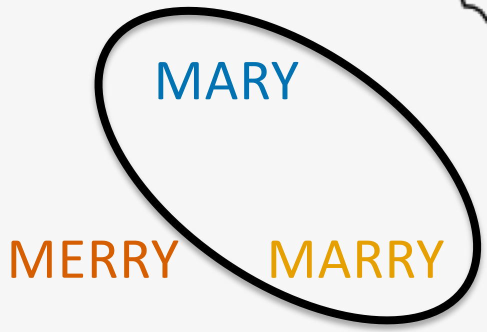

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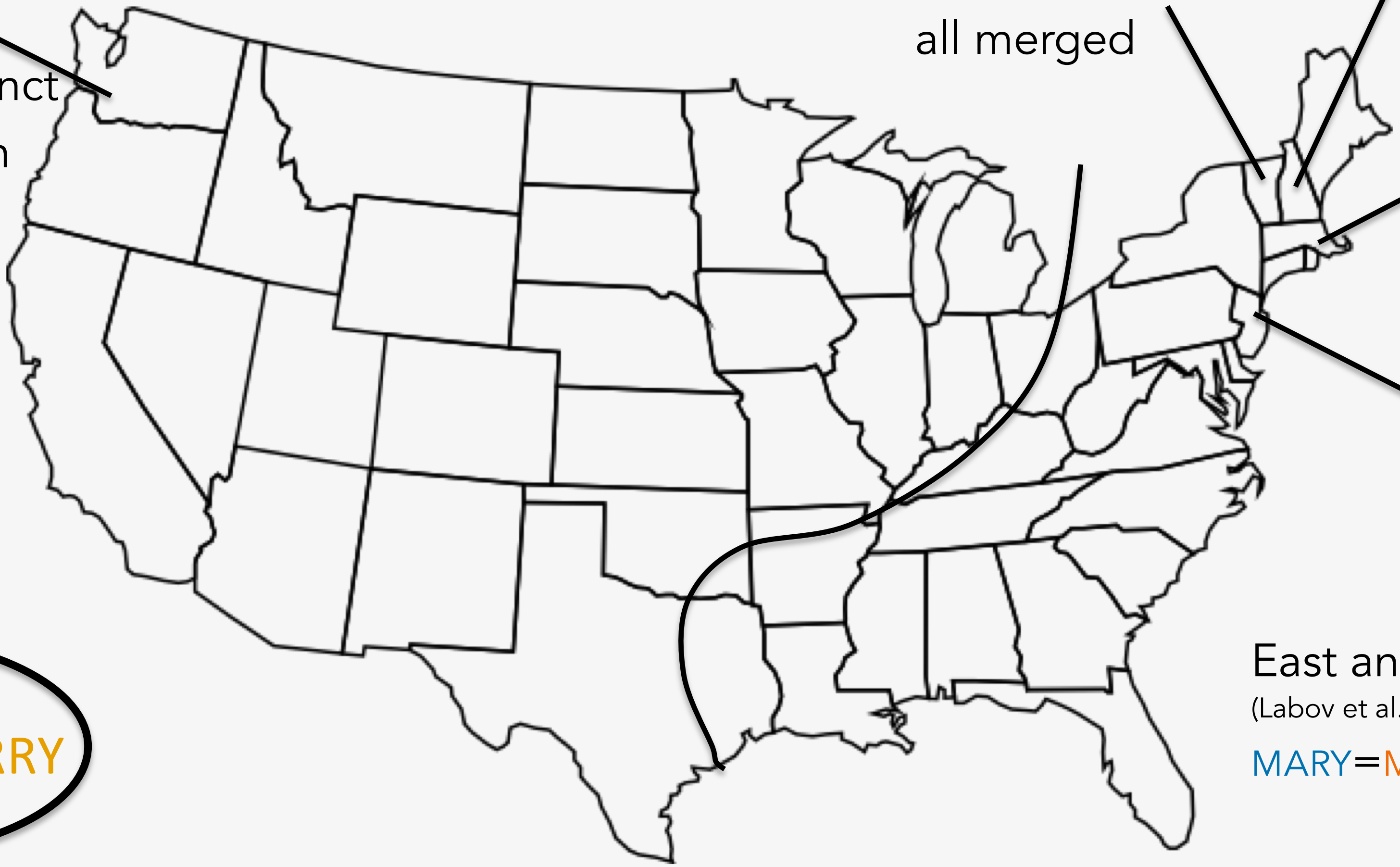

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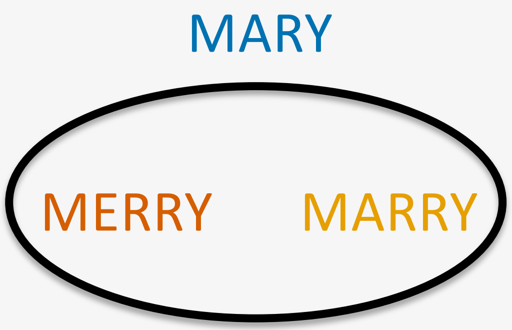

Conclusion

Conclusion

✗ Hypothesis 1: complete MARY-MERRY-MARRY merger

Not only distinct, but unusual pattern of MARY being the different one

✗ Hypothesis 2: separation of POOL, PULL, POLE, and PULP

PULL-POLE most merged, and POOL becoming less distinct in apparent time

Vowel mergers are indeed v[ɛ]ry v[e]ried in the Pacific Northwest

Not all of the Pacific Northwest is the same (urban/rural divide)

Don't make assumptions about a community's spech

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These slides available at
joeystanley.com/divar1

Appendix A: Word List and Minimal Pairs

Word List Items

These were embedded psuedorandomly in a 160-item word list, with words targeting other research questions acting as fillers.

Participants often commented on how random the words seemed, so they likely did not catch on to the research questions these words targeted.

/er/	dairy, hairy, vary
/ɛr/	heritage, numeric, sheriff
/ær/	arrow, carry, narrate, parrot, sparrow
/ul/	cool, school
/ʊl/	fulcrum, pulpit, wool
/ol/	control, holster, stroll, whole
/ʌl/	adult, culprit, vulture

The following words were excluded because they did not satisfy the required syllable type for their particular merger (open syllables for *Mary-merry-marry* and closed syllables for the pre-laterals), which was only learned after data-collection:

bullet, (*Coca-*)*Cola*, *gullible*, *hooligan*, *polar* (*bear*), *pulley*, *sullen*, *tulips*, *yuletide*,

Minimal Pairs & Triplets

/er/	/ɛr/	/ær/
fairy	ferry	
	perish	parish
vary	very	
	terrible	
hairy		Harry
Mary	merry	marry

/ul/	/ʊl/	/ol/	/ʌl/
rule		role	
stool		stole	
	bull	bowl	
		goal	gull
		colt	cult
		whole/hole	
		bolder/boulder	
school			skull
who'll		hole	hull
pool	pull	pole	
fool	full	foal	

The pairs *bear~bare*, *hair~hare*, and *stares~stairs* were excluded because the targeted vowel was not before an *intervocalic* /r/.

The word *terrible* was paird with the invented word "tear-able" (as in 'able to be torn'), but participants didn't respond well to that, and it was excluded.

Pairs from the same class are assumed to be homophonous for all speakers and were included to test speakers' attention.

Appendix B: Statistical Tests

Analysis

Restricted maximum liklihood (REML) mixed-effects model (Levshina 2015) using the function `lme()` in R package `nlme` (Pinheiro *et al.* 2016) for predicting *categorical* variables (*i.e.* vowel class distinctions).

Generalized linear mixed-effects model (Baayen 2008) using the function `glmer()` in the R package `lme4` (Bates *et al.* 2015) for predicting *continuous* variables (degree of height/backness). Generation, sex, place of articulation (aveolar/non-alveolar), and vowel class as fixed effects.

Speaker as random effect in these models. If adding this random effect did not improve the model, a simple linear regression was used instead.

Overlap measured with Pillai scores, an output of MANOVA tests (Hay, Warren & Drager 2006; Hall-Lew 2010; Nycz & Hall-Lew 2013)

Effects are reported significant if $p<0.01$.

All model outputs are in appendix slides.

(1) Linear mixed-effects model fit by REML of bark-normalized height of all pre-lateral vowels (both styles) with variable (POOL*, PULL, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.493	0.650

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	10.510	0.204	1170	51.575	< 0.001
variable: pull	-0.494	0.059	1170	-8.366	< 0.001
variable: pulp	-1.159	0.056	1170	-20.779	< 0.001
variable: pole	-0.590	0.049	1170	-12.122	< 0.001
sex: M	-0.312	0.165	36	-1.888	0.067
generation: 40–60	0.219	0.225	36	0.975	0.336
generation: <40	0.269	0.239	36	1.124	0.268
prevPlace: non-alveolar	0.339	0.049	1170	6.987	< 0.001

Interpretation: POOL significantly higher than PULL, POLE, and PULP with sex and generation as non-significant factors.

* Underlined values are the reference levels

(2) Linear mixed-effects model fit by REML of bark-normalized height of all pre-lateral vowels (both styles) with variable (POOL, PULL, POLE, PULP*), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.493	0.650

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	9.350	0.206	1170	45.424	< 0.001
variable: pool	1.159	0.056	1170	20.779	< 0.001
variable: pull	0.666	0.060	1170	11.047	< 0.001
variable: pole	0.570	0.052	1170	10.922	< 0.001
sex: M	-0.312	0.165	36	-1.888	0.067
generation: 40–60	0.219	0.225	36	0.975	0.336
generation: <40	0.269	0.239	36	1.124	0.268
prevPlace: non-alveolar	0.339	0.049	1170	6.987	< 0.001

Interpretation: PULP significantly lower than POOL, PULL, and POLE with sex and generation as non-significant factors.

(3) Linear mixed-effects model fit by REML of bark-normalized backness of all pre-lateral vowels (both styles) with variable (POOL, PULL, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.558	0.761

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	6.019	0.234	1170	25.704	< 0.001
variable: pool	0.599	0.065	1170	9.177	< 0.001
variable: pull	0.807	0.071	1170	11.441	< 0.001
variable: pole	1.060	0.061	1170	17.356	< 0.001
sex: M	-0.283	0.187	36	-1.509	0.140
generation: 40–60	0.270	0.255	36	1.059	0.297
generation: <40	0.367	0.271	36	1.355	0.184
prevPlace: non-alveolar	0.879	0.057	1170	15.476	< 0.001

Interpretation: PULP significantly fronter than POOL, PULL, and POLE with sex and generation as non-significant factors.

* Underlined values are the reference levels

(4) Linear mixed-effects model fit by REML of bark-normalized height of pre-lateral vowels in the word list with variable (POOL, PULL*, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.505	0.653

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	9.945	0.296	336	33.642	< 0.001
variable: pool	0.567	0.107	336	5.300	< 0.001
variable: pole	0.117	0.101	336	1.157	0.248
variable: pulp	-0.479	0.101	336	-4.752	< 0.001
sex: M	-0.187	0.202	28	-0.927	0.362
generation: 40–60	-0.117	0.303	28	-0.387	0.701
generation: <40	0.014	0.314	28	0.044	0.965
prevPlace: non-alveolar	0.565	0.091	336	6.203	< 0.001

Interpretation: PULL not significantly different in height from POLE in the word list, with sex and generation as non-significant factors.

(5) Linear mixed-effects model fit by REML of bark-normalized backness of pre-lateral vowels in the word list with variable (POOL, PULL, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.545	0678

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	6.879	0.316	336	21.777	< 0.001
variable: pool	-0.146	0.111	336	-1.316	0.189
variable: pole	0.572	0.105	336	5.464	< 0.001
variable: pulp	-0.690	0.105	336	-6.598	< 0.001
sex: M	-0.056	0.217	28	-0.257	0.799
generation: 40–60	-0.243	0.325	28	-0.747	0.461
generation: <40	-0.270	0.336	28	-0.803	0.429
prevPlace: non-alveolar	1.115	0.095	336	11.782	< 0.001

Interpretation: PULL is significantly fronter than POLE, though it's not different from POOL. Sex and generation are not significant factors.

* Underlined values are the reference levels

(6) Linear mixed-effects model fit by REML of bark-normalized height of pre-lateral vowels in the minimal pairs with variable (POOL, PULL*, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.489	0.644

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	10.186	0.214	798	47.658	< 0.001
variable: pool	0.381	0.073	798	5.198	< 0.001
variable: pole	-0.202	0.069	798	-2.929	0.004
variable: pulp	-0.749	0.076	798	-9.799	< 0.001
sex: M	-0.313	0.166	36	-1.890	0.067
generation: 40-–60	0.251	0.225	36	1.116	0.272
generation: <40	0.298	0.239	36	1.248	0.220
prevPlace: non-alveolar	0.234	0.061	798	3.814	< 0.001

Interpretation: PULL significantly higher than POLE in the minimal pairs, with sex and generation as non-significant factors.

(7) Linear mixed-effects model fit by REML of bark-normalized backness of pre-lateral vowels in the minimal pairs with variable (POOL, PULL, POLE, PULP), sex (F, M), generation (61+, 40–60, <40), and previous place of articulation (alveolar, non-alveolar) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.571	0.766

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	7.023	0.251	798	28.026	< 0.001
variable: pool	-0.346	0.087	798	-3.961	< 0.001
variable: pole	0.085	0.082	798	1.028	0.304
variable: pulp	-0.852	0.091	798	-9.355	< 0.001
sex: M	-0.322	0.194	36	-1.663	0.105
generation: 40–60	0.326	0.263	36	1.237	0.224
generation: <40	0.498	0.280	36	1.779	0.084
prevPlace: non-alveolar	0.756	0.073	798	10.347	< 0.001

Interpretation: PULL is not significantly different in backness with POLE, with sex and generation as non-significant factors.

* Underlined values are the reference levels

(8) Linear regression model of the overlap between POOL and PULL (measured by individuals' Pillai scores) in both styles with number of pairs reported merged (0*, 1), generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.701	0.016	44.503	< 0.001
pairs merged: 1	0.047	0.021	2.233	0.026
generation: 40–60	-0.053	0.018	-2.929	0.003
generation: <40	-0.121	0.018	-6.636	< 0.001
sex: M	0.050	0.014	3.69	0.000

Adjusted $R^2 = 0.06171$

$F(4, 1153) = 20.04$

$p < 0.001$

Interpretation: The overlap between POOL and PULL increases with each successive generation, with women leading the change. Reporting more merged pairs did not mean there was more overlap.

(9) Linear regression model of the overlap between POOL and POLE (measured by individuals' Pillai scores) in both styles with number of pairs reported merged (0, 1, 2), generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.676	0.016	42.52	< 0.001
pairs merged: 1	0.082	0.019	4.389	< 0.001
pairs merged: 2	-0.176	0.028	-6.304	< 0.001
generation: 40-60	-0.022	0.018	-1.197	0.232
generation: <40	-0.130	0.019	-6.999	< 0.001
sex: M	0.090	0.014	6.273	< 0.001

Adjusted $R^2 = 0.1629$

$F(5, 1152) = 46.03$

$p < 0.001$

Interpretation: The overlap between POOL and POLE is the same for the oldest and middle generation, but significantly increases in the youngest group, with women leading the change. Speakers who reported one pair as merged actually had greater separation than those who reported none, but speakers who reported two merged pairs did have greater overlap.

(10) Linear regression model of the overlap between POOL and PULP (measured by individuals' Pillai scores) in both styles with number of pairs reported merged (0, 1), generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.800	0.014	56.594	< 0.001
pairs merged: 1	0.004	0.034	0.133	0.895
generation: 40-60	-0.051	0.016	-3.196	0.001
generation: <40	-0.178	0.017	-10.394	< 0.001
sex: M	0.051	0.012	4.328	< 0.001

Adjusted $R^2 = 0.1225$

$F(4, 1153) = 41.37$

$p < 0.001$

Interpretation: The overlap between POOL and PULP increases with each successive generation, with women leading the change. Reporting more merged pairs did not mean there was more overlap.

* Underlined values are the reference levels

(11) Linear regression model of the overlap between PULL and POLE (measured by individuals' Pillai scores) in both styles with number of pairs reported merged (0*, 1, 2, 3), generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.318	0.015	21.326	< 0.001
pairs merged: 1	-0.216	0.028	-7.666	< 0.001
pairs merged: 2	-0.123	0.019	-6.576	< 0.001
pairs merged: 3	-0.108	0.020	-5.342	< 0.001
generation: 40-60	0.089	0.017	5.306	< 0.001
generation: <40	0.074	0.018	4.220	< 0.001
sex: M	0.031	0.012	2.626	0.009

Adjusted $R^2 = 0.1278$

$F(6, 1151) = 29.06$

$p < 0.001$

Interpretation: The overlap between PULL and POLE increases with each successive generation, with women leading the change. If speakers reported one or more pairs merged, there was more overlap in their production.

(12) Linear regression model of the overlap between PULL and PULP (measured by individuals' Pillai scores) in both styles with generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.618	0.017	35.441	< 0.001
generation: 40-60	0.057	0.020	2.88	0.004
generation: <40	-0.019	0.021	-0.908	< 0.001
sex: M	0.095	0.014	6.733	< 0.001

Adjusted $R^2 = 0.0577$

$F(3, 1210) = 25.74$

$p < 0.001$

Interpretation: The middle generation had the greatest overlap between PULL and PULP, followed by the oldest group, and then the youngest, with women having more overlap overall. Since there are no known minimal pairs contrasting these vowels in English, speaker intuition was not included.

(13) Linear regression model of the overlap between POLE and PULP (measured by individuals' Pillai scores) in both styles with number of pairs reported merged (0, 1, 2), generation (61+, 40–60, <40), and sex (F, M) as predictor variables.

Coefficients

	Estimate	Std. Error	*t* value	*Pr*(>|t|)
(Intercept)	0.371	0.019	19.721	< 0.001
pairs merged: 1	-0.124	0.021	-5.777	< 0.001
pairs merged: 2	0.060	0.029	2.066	0.0391
generation: 40-60	0.165	0.021	7.736	< 0.001
generation: <40	0.028	0.023	1.215	0.2245
sex: M	-0.003	0.016	-0.166	0.8685

Adjusted $R^2 = 0.1188$

$F(5, 1175) = 32.81$

$p < 0.001$

Interpretation: There is less overlap between POLE and PULP in the middle generation compared to the oldest and youngest groups. People who reported one merged pair had greater overlap. There was not difference between the sexes.

* Underlined values are the reference levels

(14) Linear mixed-effects model fit by REML of bark-normalized height of all pre-rhotic vowels in the word list with variable (MARY, MERRY*, MARRY), sex (F, M), and generation (61+, 40–60, <40) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.517	0.704

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	8.186	0.292	303	28.014	< 0.001
variable: Mary	0.878	0.105	303	8.344	< 0.001
variable: marry	0.164	0.094	303	1.751	0.081
generation: 40-60	0.029	0.314	28	0.093	0.927
generation: <40	0.352	0.325	28	1.083	0.288
sex: M	-0.144	0.209	28	-0.687	0.498

Interpretation: MARY is significantly higher than MERRY and there's no difference in height between MERRY and MARRY, with sex and generation as non-significant factors.

(15) Linear mixed-effects model fit by REML of bark-normalized height of all pre-rhotic vowels in the minimal pairs with variable (MARY, MERRY, MARRY), sex (F, M), and generation (61+, 40–60, <40) as fixed effects and speaker as a random effect.

Random effect

	(Intercept)	Residual
StdDev:	0.554	0.731

Fixed effects

	Value	Std.Error	DF	*t*-value	*p*-value
(Intercept)	8.732	0.232	467	37.560	< 0.001
variable: Mary	0.379	0.076	467	5.014	< 0.001
variable: marry	-0.305	0.083	467	-3.675	< 0.001
generation: 40-60	-0.107	0.262	36	-0.408	0.686
generation: <40	0.174	0.278	36	0.625	0.536
sex: M	-0.333	0.192	36	-1.734	0.092

Interpretation: There is a three-way split in the height of MARY, MERRY, and MARRY, but there is no difference between the generations or the sexes.

* Underlined values are the reference levels