

# Vowel variation across English dialects

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# Introduction

- Variation *within* languages
  - Differences between dialects & speakers
  - E.g., t/d deletion, stop VOT
- Structure of variation for speech perception
- How can similar phonological systems differ in phonetic realisation?

# Introduction

- Most studies on single varieties
  - Also often laboratory speech
  - Some cross-dialectal work mainly on vowel quality
- Recent work using ‘large-scale’ analysis
- Allows us to ask questions about the scale and scope of variability across English

Labov et al. (2006, 2013), Clopper et al. (2005), Yuan et al. (2006, 2007), Yuan & Liberman (2014), Coleman (2016), Renwick & Olson (2017), Liberman (2018)

# Today

- Voicing effect
- Vowel dynamics

# Voicing effect (VE)

- *beat vs bead; mace vs maze*
- Driven by voicing of C following the vowel
- Large difference in English:
  - ~1.5 times longer
  - Cue for consonant voicing
- VE compared cross-linguistically
  - May differ both in phonetic and phonological structure

House & Fairbanks (1953), Denes (1955), Peterson & Lehiste (1960), House (1961),  
Chen (1970)

# Voicing effect (VE)

- Studied extensively in lab speech
  - isolated words, carrier sentences, reading passages
  - Smaller VE for shorter vowels
    - Speech rate? Frequency?
  - Stops > fricatives

*(1) How large is the VE in spontaneous speech?*

# Voicing effect (VE)

- Most work on General American
  - Scottish Vowel Length Rule
  - African American English (AAE): expect larger VE
  - North American Englishes vary 1.02-1.33
- No work on differences between speakers

*(2) How much does the VE vary across English dialects and speakers?*

Aitken (1981), Hewlett et al. (2009), Tauberer & Evanini (2009), Rathcke & Stuart-Smith (2016), Holt et al. (2016), Farrington (2018)

# VE: Data

- 30 English dialects from 15 corpora
  - 16 North American & 14 UK & Ireland
- Force-aligned vowel duration
  - Utterance-final
  - < 50ms removed
- ~230k tokens
  - 1,964 speakers
  - 1,485 word types



# VE: Predictions

- *How large is the VE in spontaneous speech?*
  - {Fricatives, faster speech, high frequency} = smaller VE
- *How much does the VE vary across English dialects and speakers?*
  - Scottish and AAE may show small and large VEs respectively; not clear otherwise
  - Speakers = ?

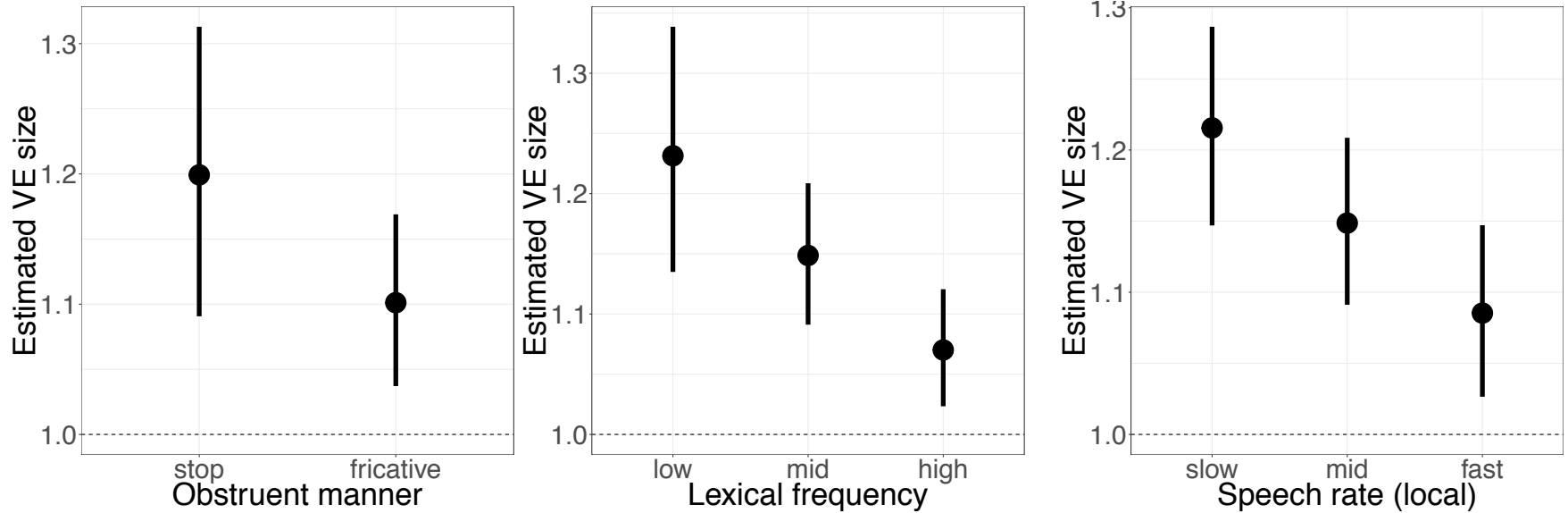
# VE: Analysis

- Goal = *estimate* VE size in different contexts
  - Spontaneous speech, dialects, speakers
- Bayesian multi-level regression
  - Provides a range (distribution) of possible VE sizes
  - Controls for effects of other factors
- Dialects and speakers treated as random effects

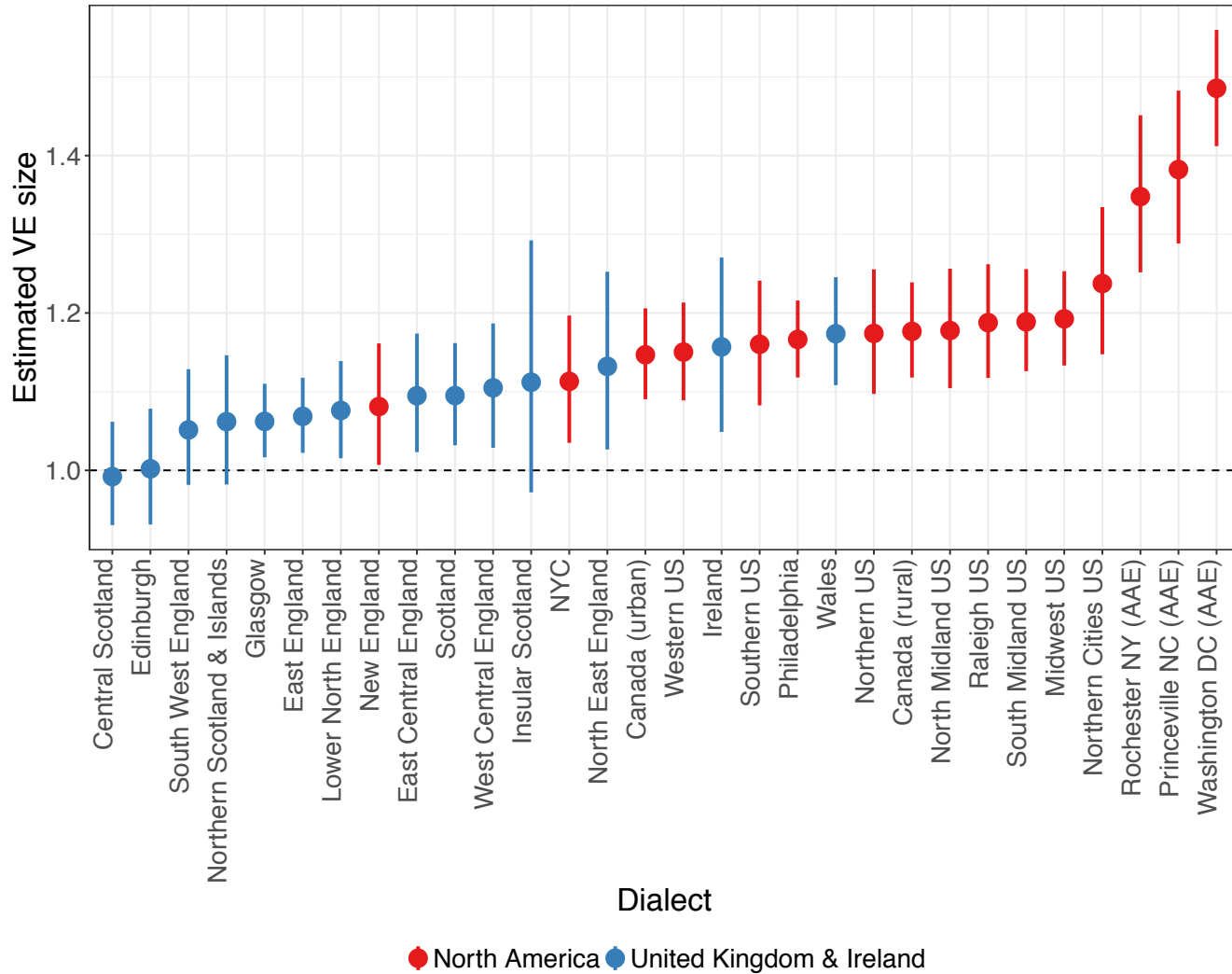
# VE: Analysis

- VE size reported as *marginal* effect
  - Averaging over all other predictors
- Effect size
  - median + 95% credible interval
- Probability of the effect's direction

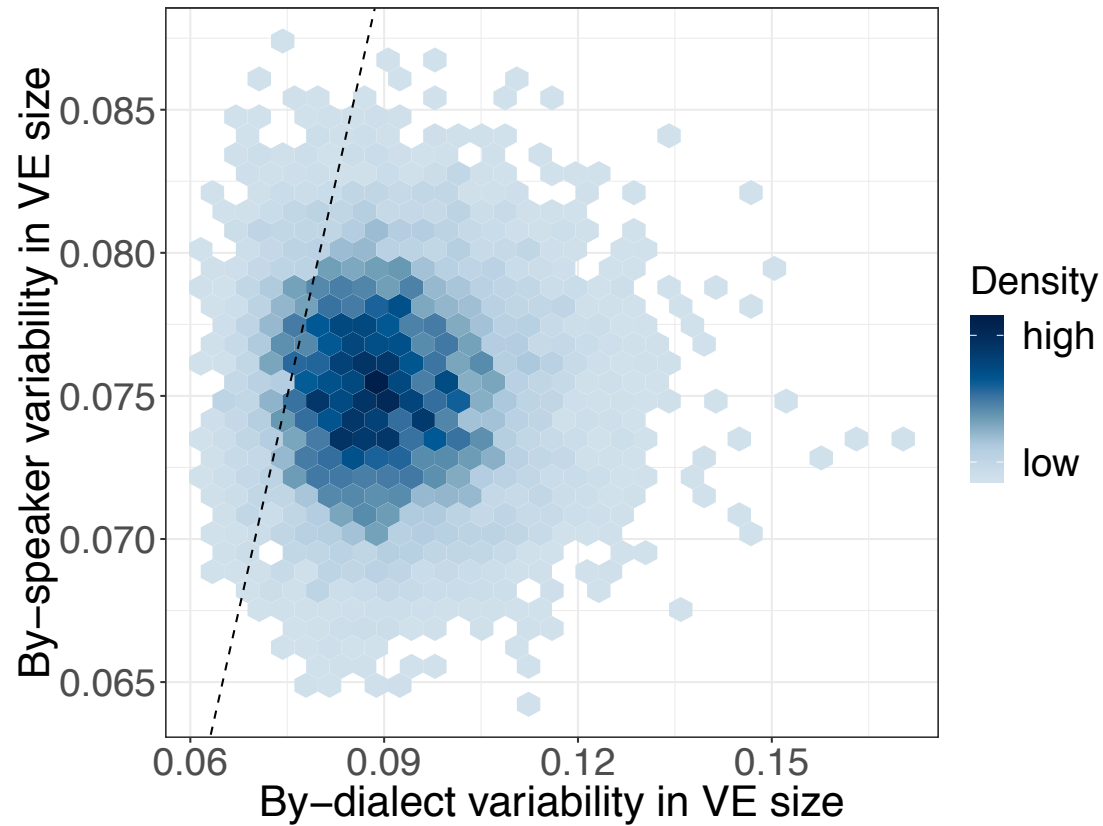
# VE in spontaneous speech



# VE across dialects



# VE across speakers



# VE: Discussion

- VE smaller in spontaneous speech compared with laboratory studies
  - Is English still larger than other languages when looking at spontaneous speech?

# VE: Discussion

- Large variation across dialects
  - Scottish and & AAE show null & large VEs as expected
  - Other dialects show *gradient* difference
  - North American > UK & Ireland?
- Little speaker variation within dialects
  - Speakers do not deviate from dialect-specific baseline



# VE: Conclusion

- Large-scale analysis can reveal previously unobservable scope of variability
- Caveats
  - Impossible to check all force-aligned durations
  - Phonological segment labels
  - Broad dialect groupings

# Today

- Voicing effect
- Vowel dynamics

# Vowels

- Vowels differ in a number of dimensions
  - F1 x F2
  - Duration (e.g., tense vs lax)
  - Dynamic shape and trajectory
- What combination of these dimensions best describes vowel variation?

Peterson & Barney (1952), Fant (1960), House (1961), Watson & Harrington (1994),  
Jacewicz et al. (2007)

# Vowels

- Substantial literature on differences within + across dialects in static *quality*
- Work on dynamics literature on 1 or 2 dialects
  - Points to a large amount of variation beyond quality
- *In what ways could vowels vary across dialects across these dimensions?*

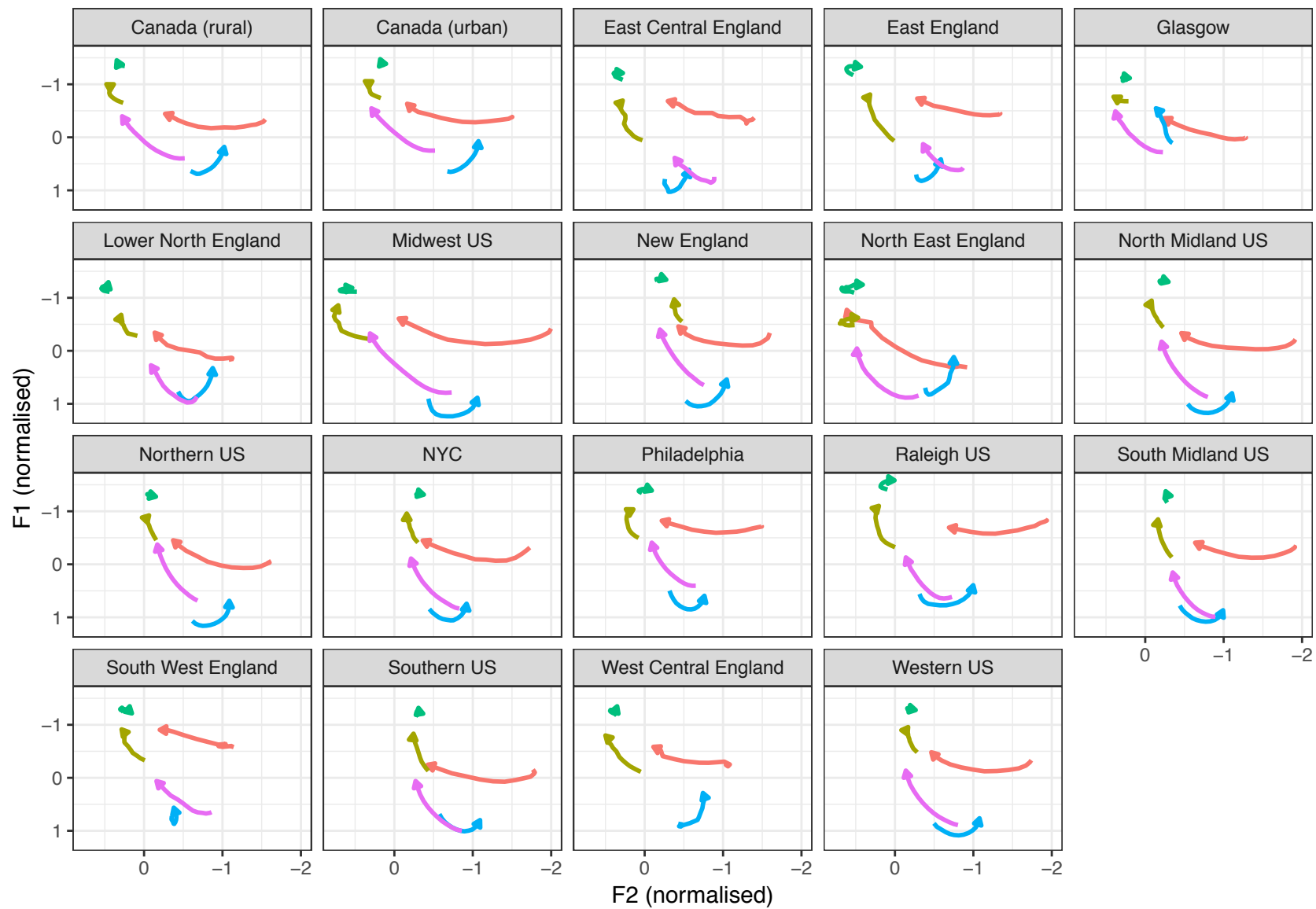
Labov (1972, 1991), Watson & Harrington (1999), Thomas (2001), Clopper et al. (2005), Labov et al. (2006), Jacewicz & Fox (2013), Fridland et al. (2014), Williams & Escuardo (2014), Risdal & Kohn (2014), Boberg (2018), Farrington et al. (2018), Renwick & Stanley (2020)

# Vowels

- Vowels vary continuously in *quality* space
- Less clear of dynamic variation is binary (e.g., monophthongs vs diphthongs) or exist a continuum of shapes
- Look at vowels that differ in dynamicity
  - monophthongal = FLEECE
  - diphthongal = CHOICE, PRICE
  - Variable = FACE, MOUTH

# Vowels: data

- 19 dialects from 10 corpora
- 2248 speakers; ~480k tokens
- F1 & F2 automatically extracted from 21 points in each vowel
  - Trajectory with points at 5% intervals
  - Exclude first & last 20%
- Lobanov normalised



Lexical set → CHOICE → FACE → FLEECE → MOUTH → PRICE

# Vowels: measures

- What measures capture the dimensions of interest?
  - Position
  - Direction
  - Curvature
  - Length
  - Duration

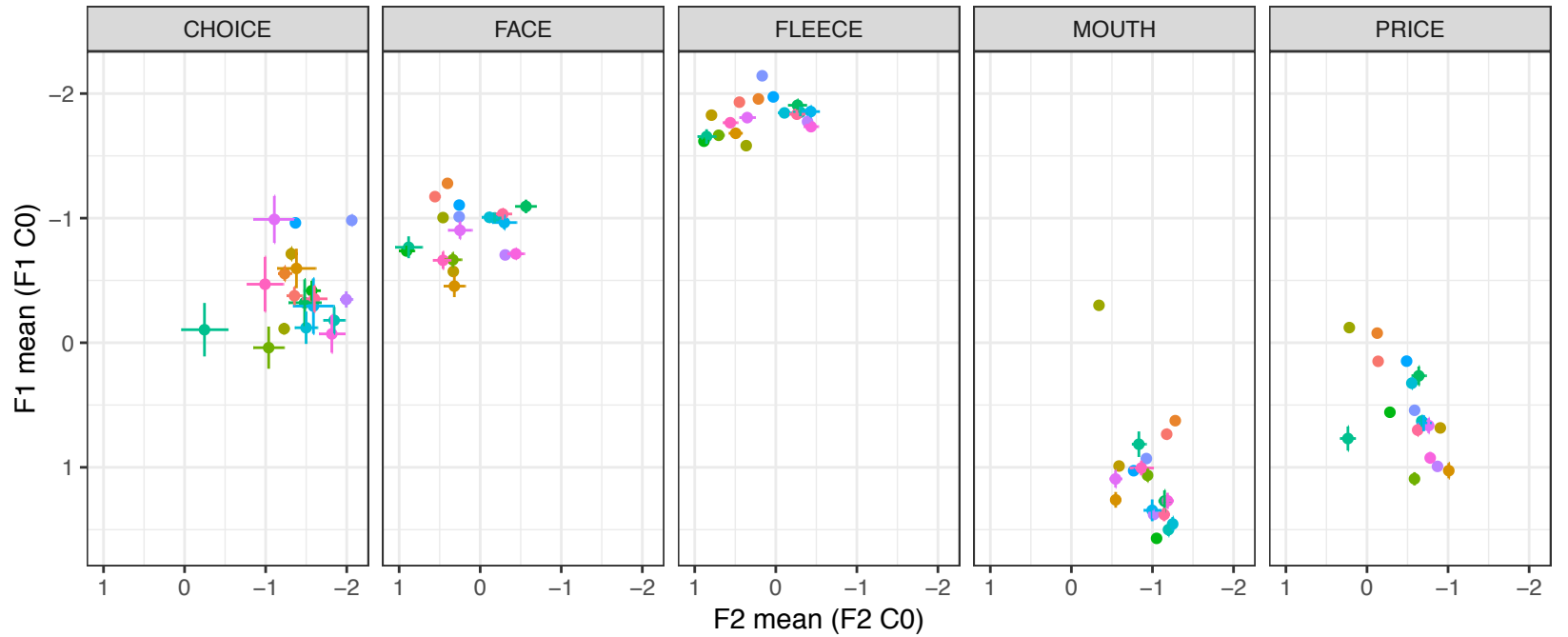


# Discrete Cosine Transform (DCT)

- Coefficients that describe properties of the trajectory
  - $C_0$  = mean
  - $C_1$  = slope/degree of change
  - $C_2$  = degree of curvature

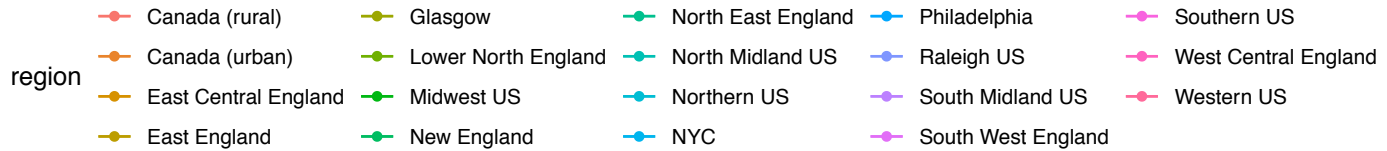
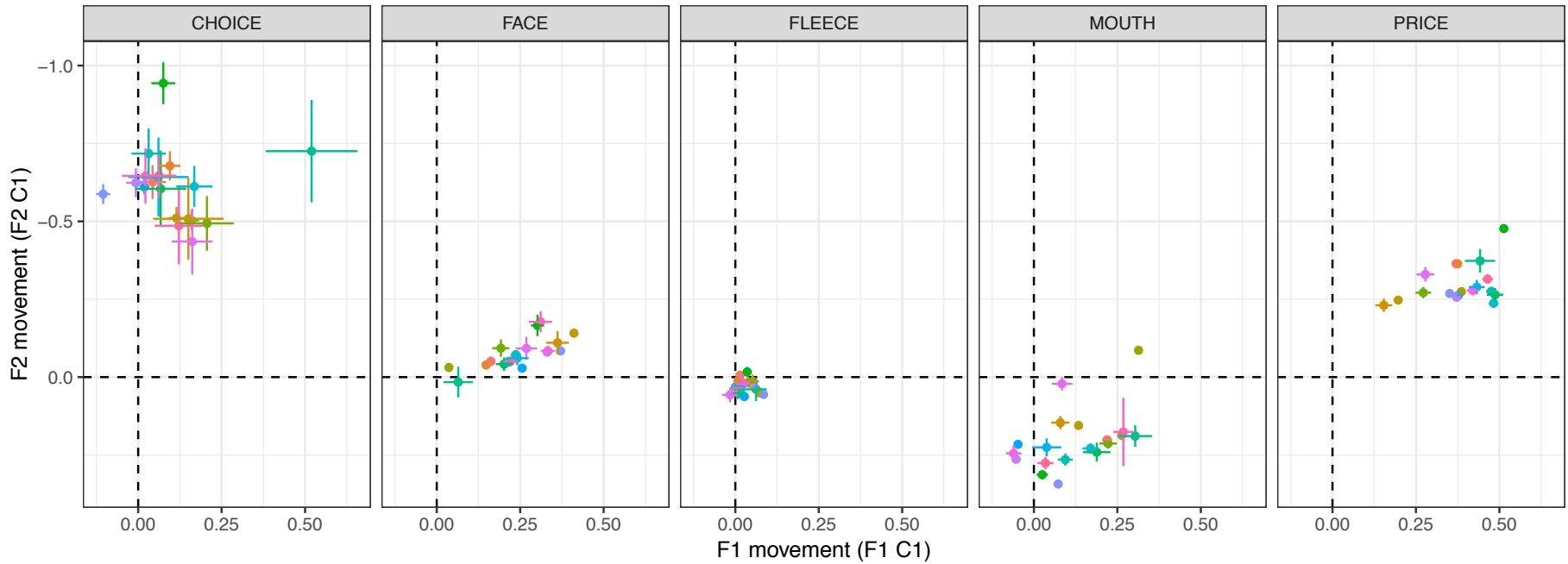
Zahorian & Jagharghi (1993), Harrington & Cassidy (1994), Watson & Harrington (1999), Morrison (2009), Williams & Escudero (2014)

# Mean values

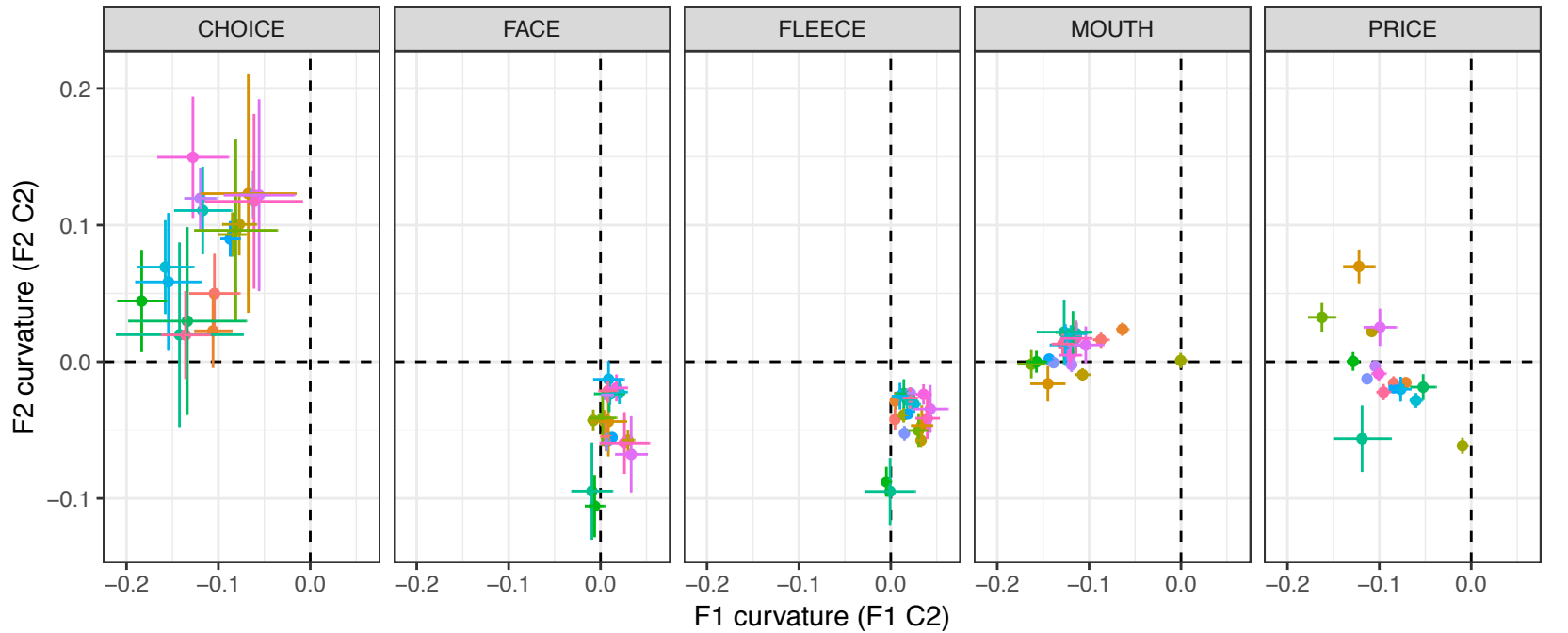


- region
- Canada (rural)
  - Canada (urban)
  - East Central England
  - East England
  - Glasgow
  - Lower North England
  - Midwest US
  - New England
  - North East England
  - North Midland US
  - Northern US
  - NYC
  - Philadelphia
  - Raleigh US
  - South Midland US
  - Southern US
  - West Central England
  - Western US

# Degree of change



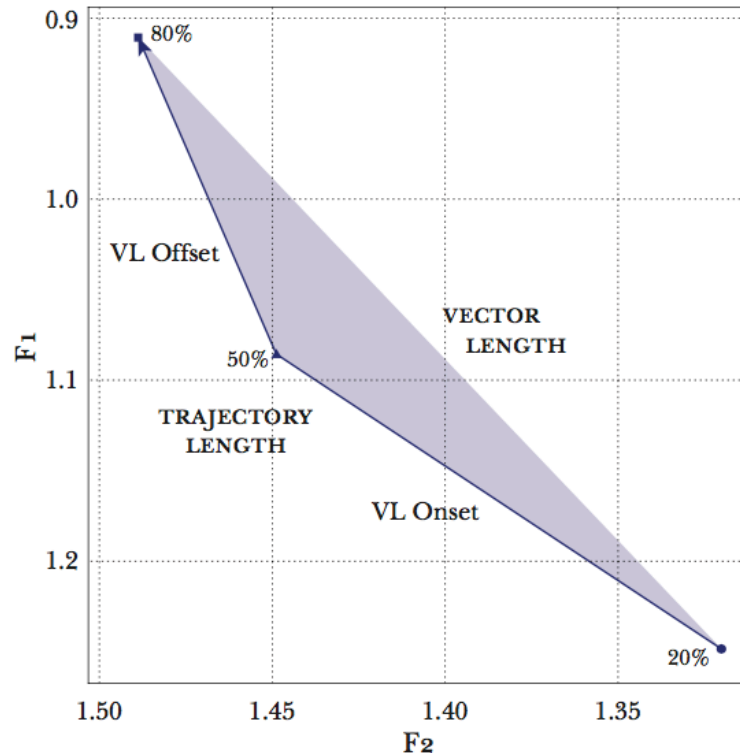
# Degree of curvature



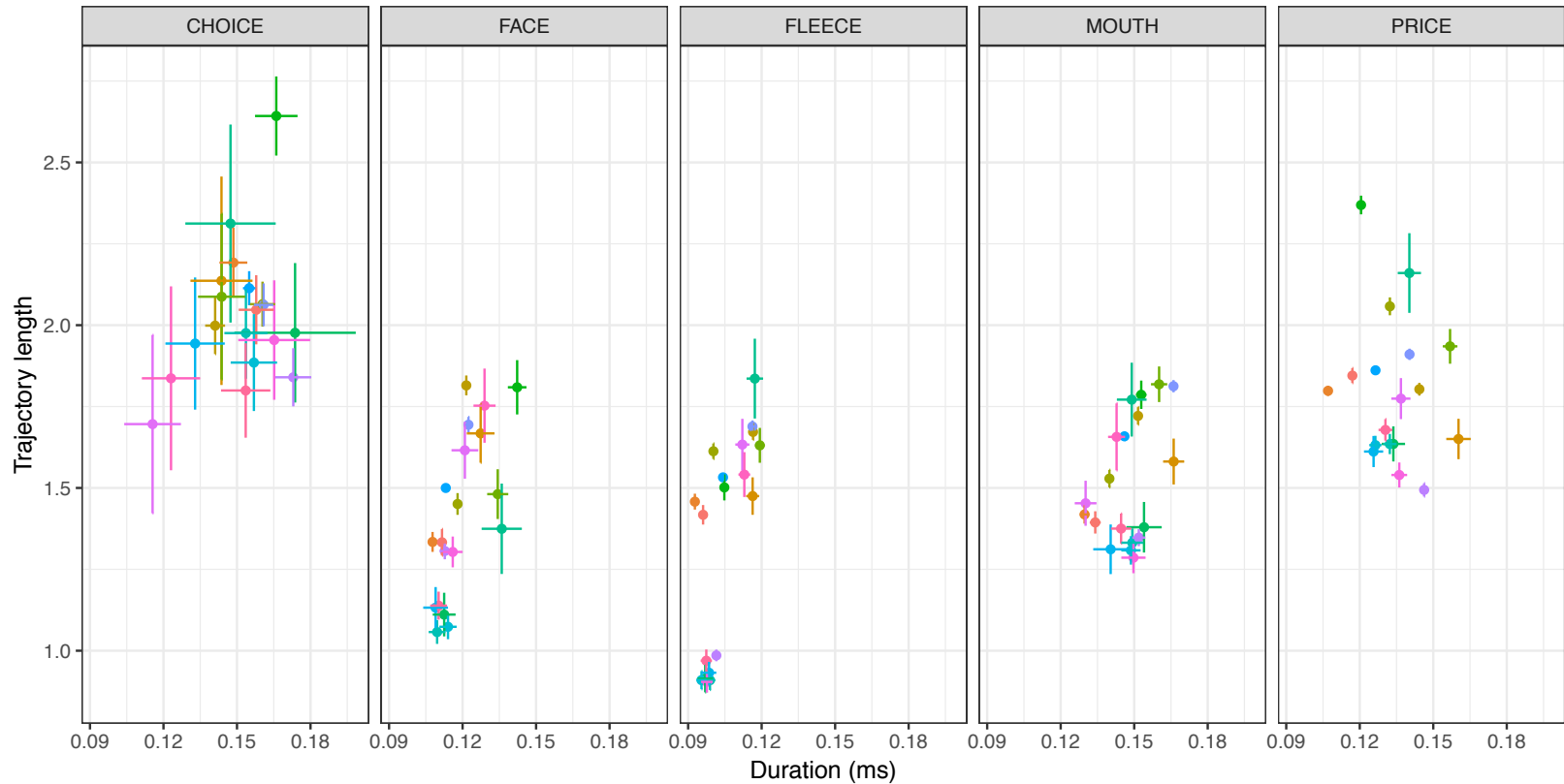
- region
- Canada (rural)
  - Glasgow
  - North East England
  - Philadelphia
  - Southern US
  - Canada (urban)
  - Lower North England
  - North Midland US
  - Raleigh US
  - West Central England
  - East Central England
  - Midwest US
  - Northern US
  - South Midland US
  - Western US
  - East England
  - New England
  - NYC
  - South West England

# Vector & trajectory length

- Formant change at multiple points & sums difference
- How 'long' the trajectory is



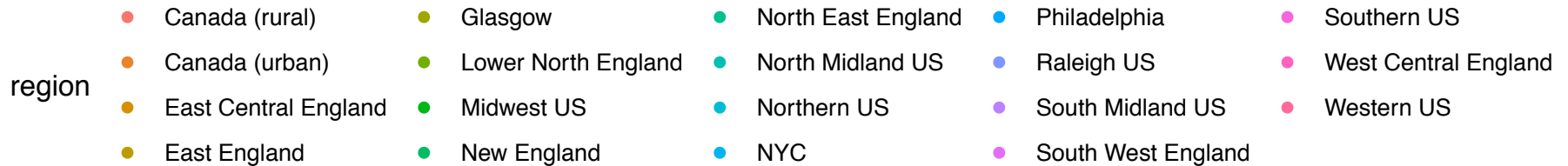
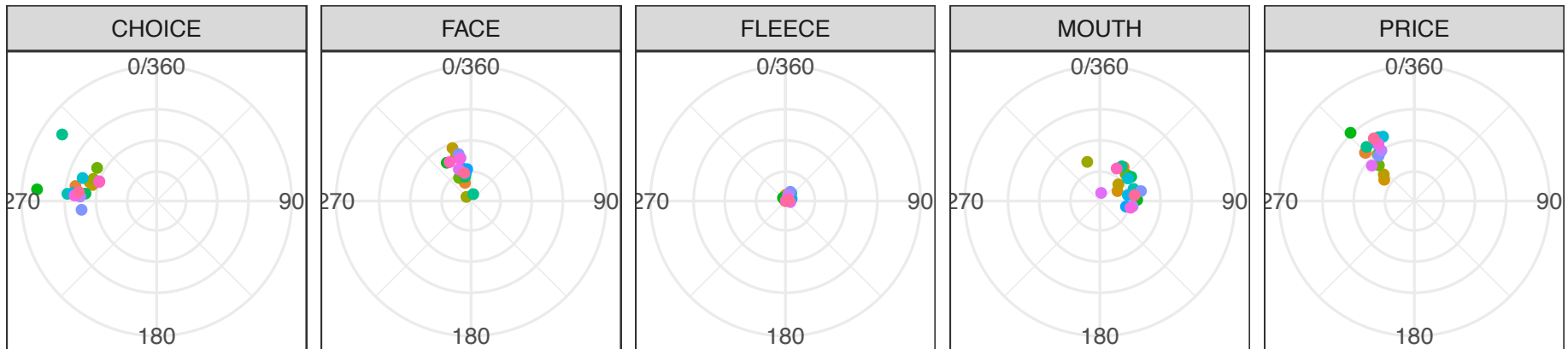
# Trajectory length & duration



- region
- Canada (rural)
  - Canada (urban)
  - East Central England
  - East England
  - Glasgow
  - Lower North England
  - Midwest US
  - New England
  - North East England
  - North Midland US
  - Northern US
  - NYC
  - Philadelphia
  - Raleigh US
  - South Midland US
  - South West England
  - Southern US
  - West Central England
  - Western US

# Vector length & angle

- Represents the direction of the glide



# Vowels: discussion

- Realisation of each vowel across dialects differ to some extent for each dimension
- Variably diphthongal vowels (e.g., FACE) appear to differ *gradiently* in degree of F1 change
- FLEECE varies in curvature but little overall change



# Conclusion

- Data from multiple sources & dialects
  - Possible to ‘scale up’ scope of investigation of linguistic variability
- Demonstrates how vowel realisation can vary within a single language
  - *Is there a single ‘English’ VE size?*
  - *How much can speakers vary from their dialect baseline?*

# Acknowledgements

- SPADE Data Guardians
- SPADE Team, esp Michael McAuliffe & Rachel MacDonald
- Audiences at MCQLL, 2019 MOT Workshop, & UK LVC 12
- Calcul Quebec & Compute Canada
- Centre for Research on Brain, Language, and Music



Region	Dialect	n speakers	n tokens	Corpus	n speakers	n tokens
North America	Canada (rural)	52	9313	Canadian Prairies	44	8316
				ICE-Canada	8	997
	Canada (urban)	64	12124	Canadian Prairies	56	11939
				ICE-Canada	8	185
	Midwest US	40	5567	Buckeye	40	5567
	New England	24	1336	Santa Barbara	7	174
				Switchboard	17	1162
	North Midland US	46	3084	Switchboard	46	3084
	Northern Cities US	21	1377	Santa Barbara	21	1377
	Northern US	58	3086	Switchboard	58	3086
	NYC	25	1477	Santa Barbara	6	158
				Switchboard	19	1319
	Philadelphia	371	59581	PNC	371	59581
	Princeville NC (AAE)	71	6759	CORAAL	17	6759
	Raleigh US	92	3282	Raleigh	92	3282
	Rochester NY (AAE)	14	6308	CORAAL	14	6308
	South Midland US	108	8188	Switchboard	108	8188
	Southern US	44	2738	Santa Barbara	6	345
				Switchboard	38	2393
	Washington DC (AAE)	50	21205	CORAAL	50	21205
Western US	100	5456	Santa Barbara	50	2900	
			Switchboard	50	2556	
United Kingdom & Ireland	Central Scotland	24	2426	SCOTS	24	2426
	East Central England	51	2544	Audio BNC	51	2544
	East England	229	20727	Audio BNC	132	6622
				Doubletalk	5	726
				Hastings	44	12642
				ModernRP	48	737
	Edinburgh	18	1148	SCOTS	18	1148
	Glasgow	177	33938	Brains in Dialogue	23	9210
				SCOTS	27	2294
				SOTC	127	22434
	Insular Scotland	8	351	SCOTS	8	351
	Ireland	19	624	Audio BNC	19	624
	Lower North England	60	3325	Audio BNC	60	3325
	North East England	17	488	Audio BNC	17	488
	Northern Scotland & Islands	33	2280	SCOTS	33	2280
	Scotland	70	3468	Audio BNC	65	2633
				Doubletalk	5	835
	South West England	50	2067	Audio BNC	50	2067
	Wales	41	2524	Audio BNC	41	2524
	West Central England	41	2615	Audio BNC	41	2615
Total		1964	229406			

	region	corpus	speakers	tokens
	Canada (rural)	Canadian-Prairies	44	20061
	Canada (rural)	ICE-Can	9	2769
	Canada (urban)	Canadian-Prairies	69	38081
	Canada (urban)	ICE-Can	10	900
0	East Central England	AudioBNC-Northern	91	4230
1	East England	AudioBNC-Southern	189	14003
2	East England	Hastings	49	25535
3	East England	IViE-Cambridge	12	972
4	East England	IViE-London	11	993
5	East England	ModernRP	48	2811
6	Glasgow	SOTC	163	45665
7	Lower North England	AudioBNC-Northern	94	5837
8	Lower North England	IViE-Bradford	11	891
9	Lower North England	IViE-Leeds	10	760
0	Midwest US	Buckeye	40	17674
1	New England	Switchboard	18	2872
2	North East England	AudioBNC-Northern	29	1026
3	North East England	IViE-Newcastle	12	1018
4	North Midland US	Switchboard	47	7181
5	Northern US	Switchboard	58	7581
6	NYC	Switchboard	19	3185
7	Philadelphia	Penn-Neighborhood	771	168533
8	Raleigh US	Raleigh	100	64772
9	South Midland US	Switchboard	109	20395
0	South West England	AudioBNC-Southern	70	3680
1	Southern US	Switchboard	38	5619
2	West Central England	AudioBNC-Northern	77	4706
3	Western US	Switchboard	50	6454