

# LARGE-SCALE ACOUSTIC CHARACTERIZATION OF MID-LOW VOWELS ACROSS AMERICAN, BRITISH, AND SINGAPOREAN CHILDREN



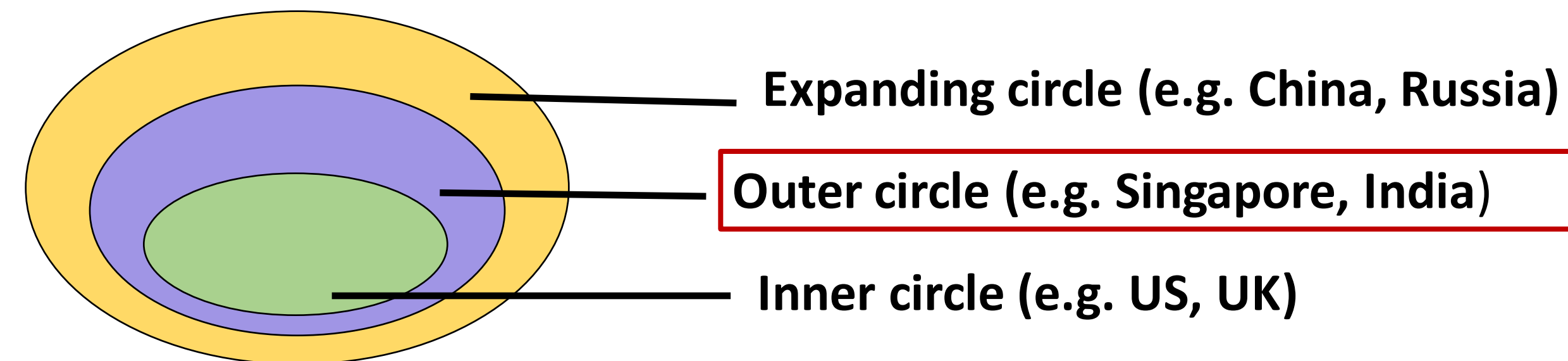
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## 1. MOTIVATION

English varieties



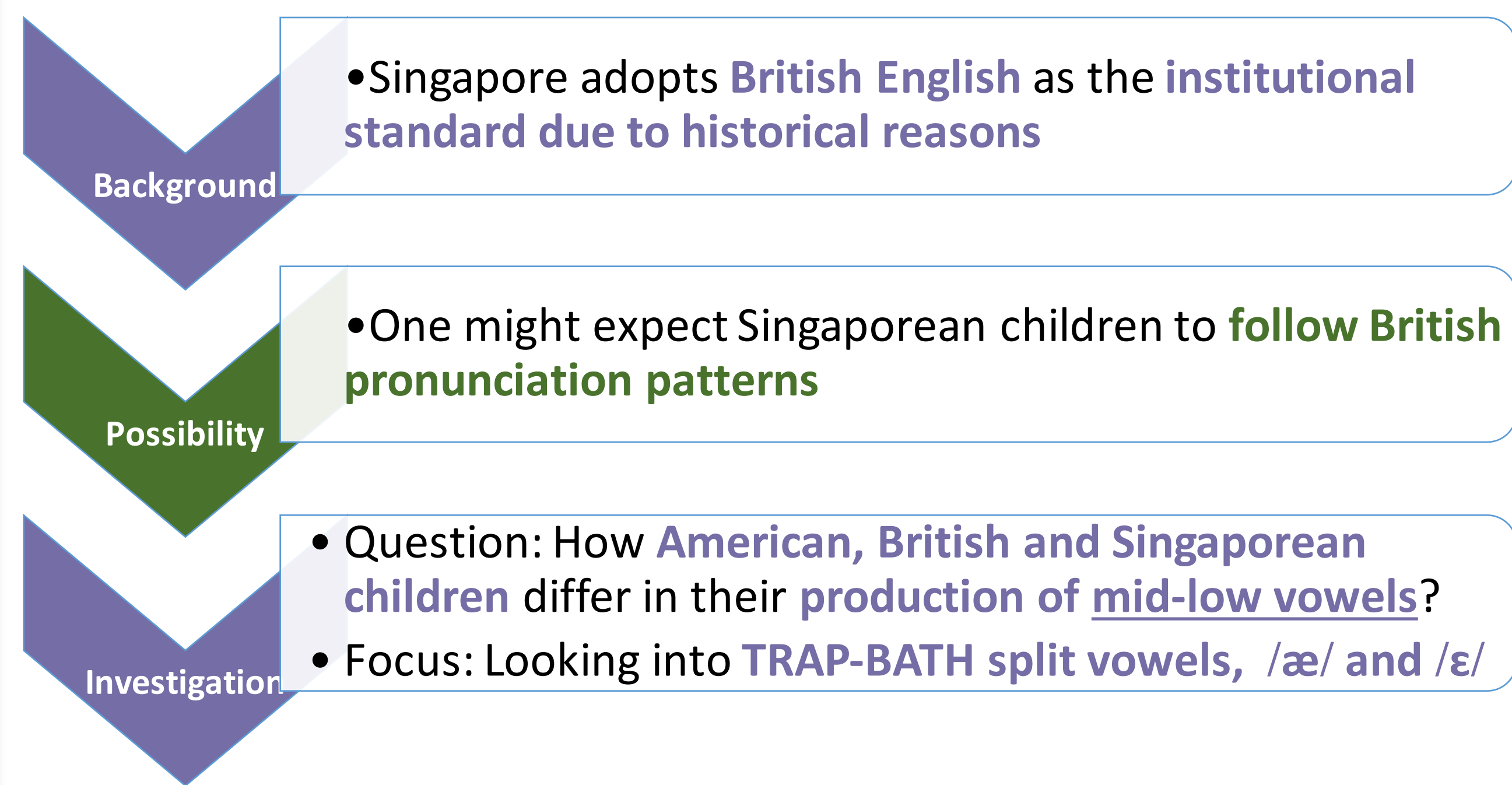
Prior work:

- American English, British English extensively studied
- Inner circle English pronunciations often compared
- English spoken in the outer circle: much less attention

Our study:

- Singaporean English pronunciations
- Children speech
- Speaker number(192) and utterance number(34,457) at least an order of magnitude greater than past work

## 2. OBJECTIVE



## 3. CORPUS MATERIAL

Speaker profile

- American children (140 speakers, 43,406 utterances),
- British children (82 speakers, 32,542 utterances), and
- Singaporean children (192 speakers, 34,457 utterances)
- 6-13 years old
- Gender ratio is balanced

Reading material

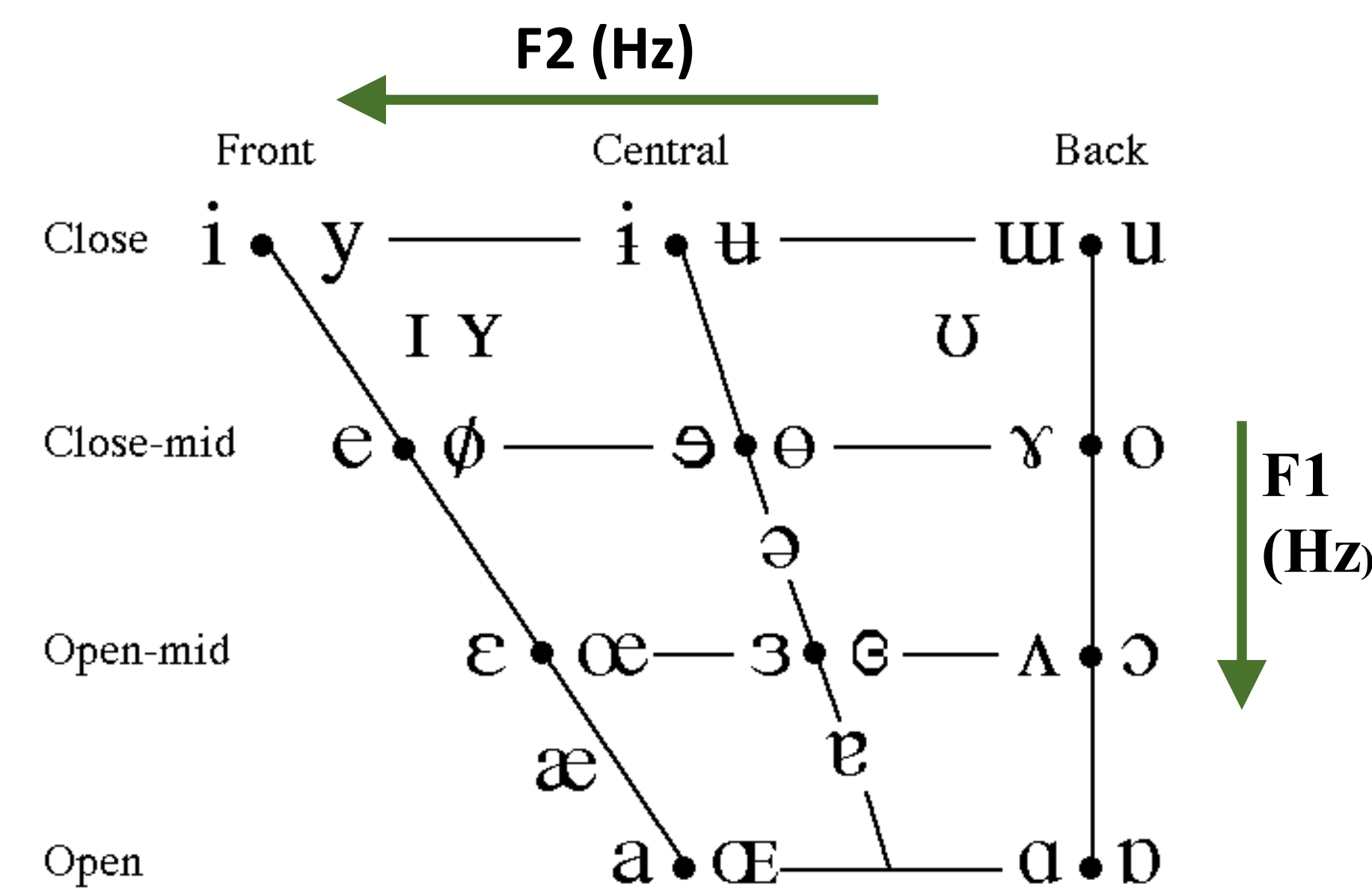
- Sentences from TIMIT[1], PF-STAR[2,3], GMU Speech Accent Archive[4]
- Minimal pairs of vowels - elicit possible acoustic and pronunciation differences
- Designed to be phonetically balanced (considerations laid out in [5])

## 4. METHOD : ACOUSTIC ANALYSIS

- Force-aligned the utterances to produce time boundaries
- Small sample manually inspected (accurate within 50ms)
- Praat[6] software: extract acoustic features (per phoneme basis)

Formant frequencies of vocal tract

- Higher F1: lower tongue position
- Higher F2: more fronted tongue position



Source of vowel chart:  
Ladefoged Peter and Johnson Keith. 2010. A Course in Phonetics, Sixth Edition. Cengage Learning, Inc

## 5. RESULTS & ANALYSIS

### 5.1 TRAP-BATH Split Vowels

E.g. *bath* pronounced with /a/ instead of /æ/ as in *trap*

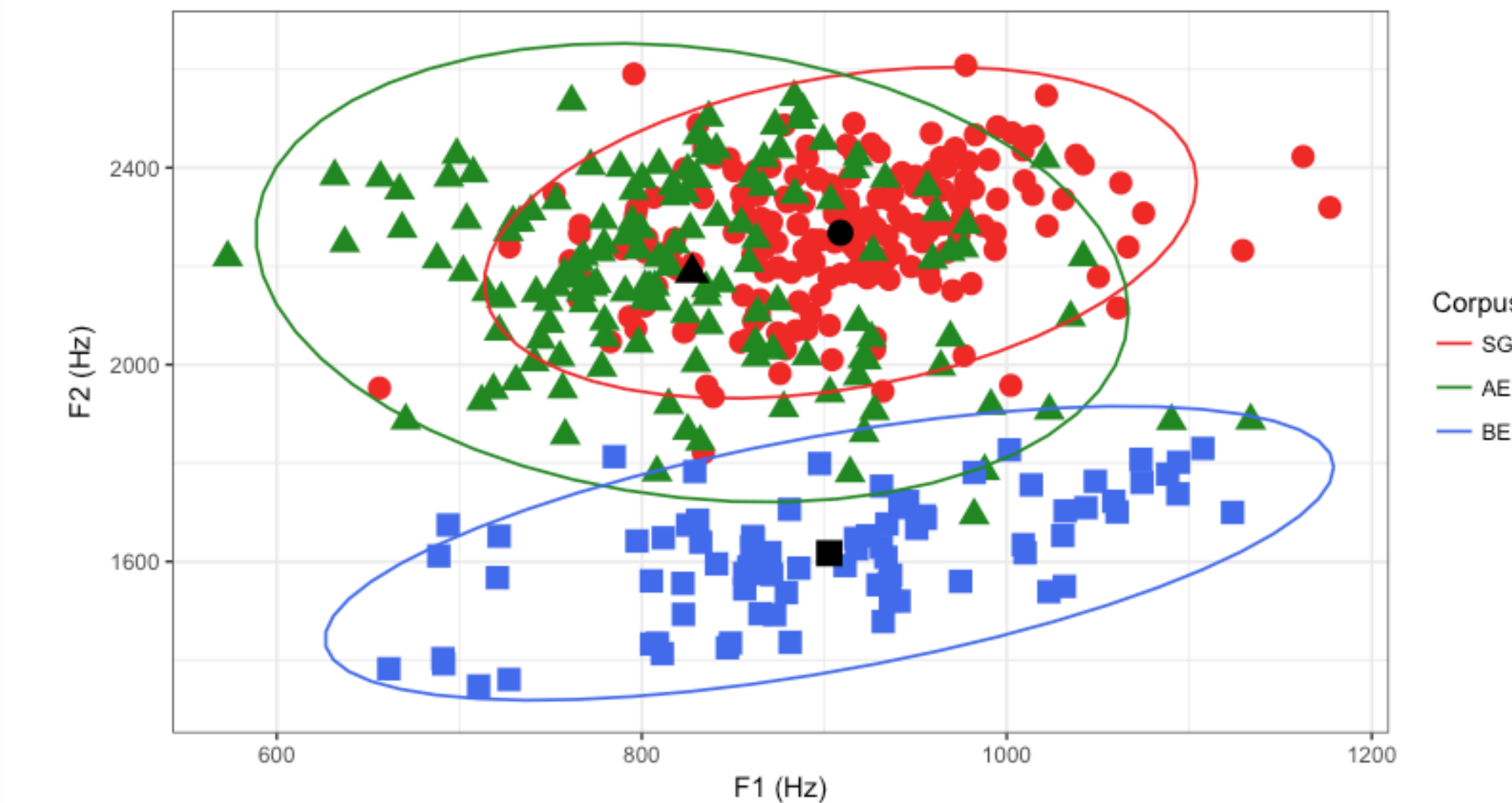


Figure 1: F1 and F2 estimates of TRAP-BATH split vowels across speakers

### 5.2 /æ/ and /ɛ/ contrast

/ɛ/ has slightly higher F2 and lower F1 estimates than /æ/

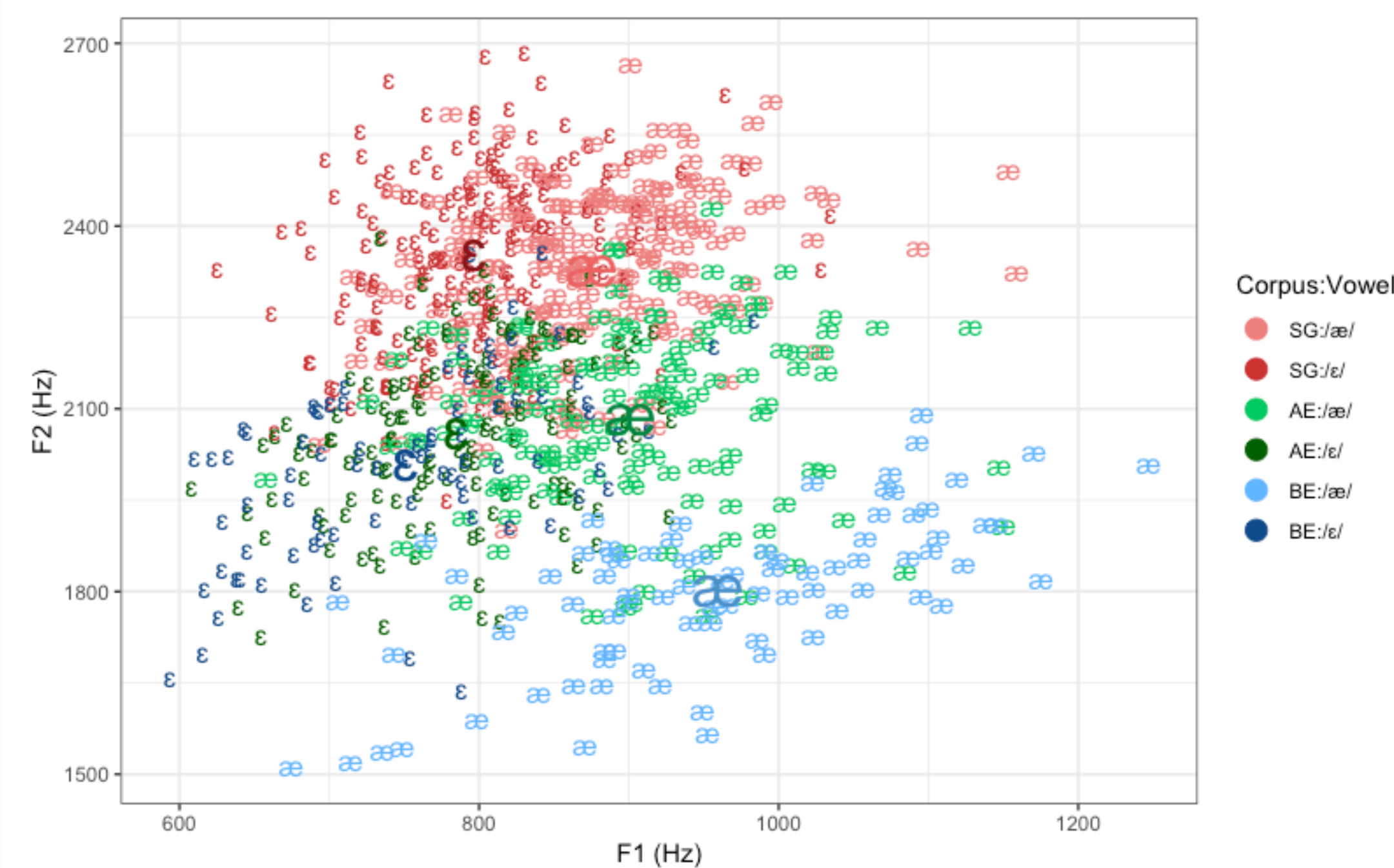


Figure 2: F1 and F2 estimates across speakers for /æ/ and /ɛ/.

- BE: clearest distinction
- AE & SG: /æ/ more acoustically similar to /ɛ/

Corpus	F1 mean	F1 se	F2 mean	F2 se
SG	908.84	5.71	2,267.79	9.84
AE	827.55	8.17	2,186.58	15.91
BE	902.73	12.24	1,617.13	13.22

Table 1: Mean and standard error (se) for each speaker group

- BE & SG: higher F1 (lowered tongue height)
- AE & SG: higher F2 (more fronted tongue position)

Corpus	Phone	F1 mean	F1 se	F2 mean	F2 se
SG	/æ/	875.11	5.40	2,327.39	9.77
	/ɛ/	796.35	4.64	2,353.92	10.02
AE	/æ/	901.59	7.39	2,082.68	12.36
	/ɛ/	785.44	5.87	2,059.39	11.55
BE	/æ/	959.93	13.40	1,802.39	13.89
	/ɛ/	751.79	9.80	2,009.81	16.36

Table 2: Mean and standard error (se) for each speaker group for /æ/ and /ɛ/

## 6. DISCUSSION

- Singapore English: changing beyond British historical influence
- Embodying American pronunciation characteristics
- Other potential characteristics or influences? (Check out my poster on approximants!)

## References

[1] J. S. Garofolo and et al., "TIMIT Acoustic-Phonetic Continuous Speech Corpus LDC93S1," 1993  
 [2] M. Russell, "The PF-STAR British English Children's Speech Corpus," The Speech Ark Limited, December 2006.  
 [3] A. Batliner, M. Blomberg, S. D'Arcy, D. Elenius, D. Giuliani, M. Gerosa, C. Hacker, M. Russell, S. Steidl, and M. Wong, "The PF STAR Children's Speech Corpus," in INTERSPEECH 2005, Eurospeech, 9th European Conference on Speech Communication and Technology, Lisbon, Portugal, September 4-8, 2005, pp.2761-2764.

[4] S. Weinburger, "Speech Accent Archive," 2015. [Online]. Available: <http://accent.gmu.edu>  
 [5] N. F. Chen, R. Tong, D. Wee, P. Lee, B. Ma, and H. Li, "SingaKids-Mandarin: Speech Corpus of Singaporean Children Speaking Mandarin Chinese," in INTERSPEECH 2016, 17th Annual Conference of the International Speech Communication Association, San Francisco, USA, September 8-12, 2016, pp. 1545-1549.  
 [6] P. Boersma, Praat, a system for doing phonetics by computer, Glot International 5 (9/10) (2001) 341-345.