# THE CANADIAN SHIFT: ITS ACOUSTIC TRAJECTORY AND CONSEQUENCES FOR VOWEL CATEGORIZATION

Thomas Kettig

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# Aims of current study

1. Account for age- and gender-based variation in the pronunciation of non-high short vowels (æ, ɛ, ʌ, ɒ) in (Jewish) Montreal English

2. Situate apparent-time evidence within models of the Canadian Shift

3. Investigate the relationship between ongoing change in vowel production with inter-gender and inter-generational perceptual variation

# Notation used in this presentation

/ɛ/ = /e/ = BET
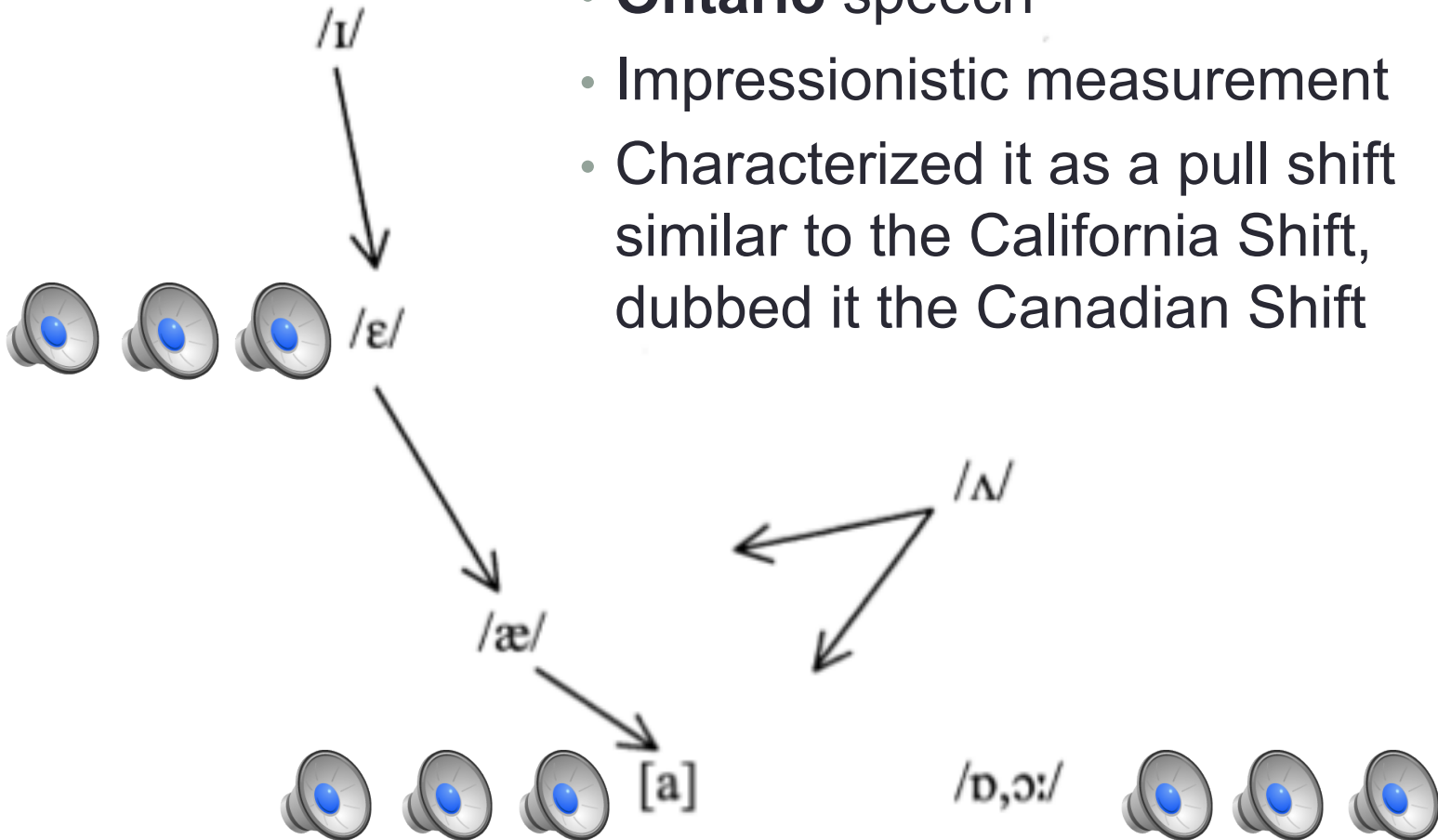
/ɪ/ = /i/ = BIT

/æ/ = /ae/ = BAT

/ɔ/ = /o/ = BOT=BOUGHT (merged low back vowel)

/ʌ/ = /u/ = BUT

# What is the Canadian Shift?

# Clarke, Elms and Youssef (1995)

- **Ontario** speech
- Impressionistic measurement
- Characterized it as a pull shift similar to the California Shift, dubbed it the Canadian Shift

/ɪ/

/ɛ/

/æ/

/ʌ/

[a]

/ɒ,ɔː/

Meanwhile, in the room next door, **Polly** had been listening. This was
Laughing, Polly **said**, we need to find a few nicknames for one of you two!
They used to let the puppy hopping, you stopped bumping along, you stopped

# Research subjects

- Have at least one Jewish parent
- Grew up speaking English as a first or home language
- Grew up in Montreal

|  | Female | Male |
|---|---|---|
| **Younger** | 1991 | 1995 |
|  | 1989 | 1992 |
|  | 1988 | 1992 |
|  | 1988 | 1991 |
|  | 1984 | 1989 |
|  |  | 1988 |
|  |  | 1987 |
| **Older** | 1961 | 1961 |
|  | 1957 | 1960 |
|  | 1952 | 1957 |
|  | 1950 | 1953 |
|  | 1937 | 1949 |
|  |  | 1949 |
|  |  | 1949 |
|  |  | 1949 |
|  |  | 1943 |
|  |  | 1940 |

# Two parts:

- Production experiment
  - Classic sociophonetic experiment
  - Participants read 44 sentences at their own pace
  - Vowel formant information extracted from key words in sentences
- Perception experiment
  - Participants listen to synthetic vowel sounds through headphones
  - Classify as BET, BAT, BUT, or BOUGHT by clicking on screen
  - Program reports their answer and their response time
- Data all taken within one interview

Group means, normalized (Lobanov method)
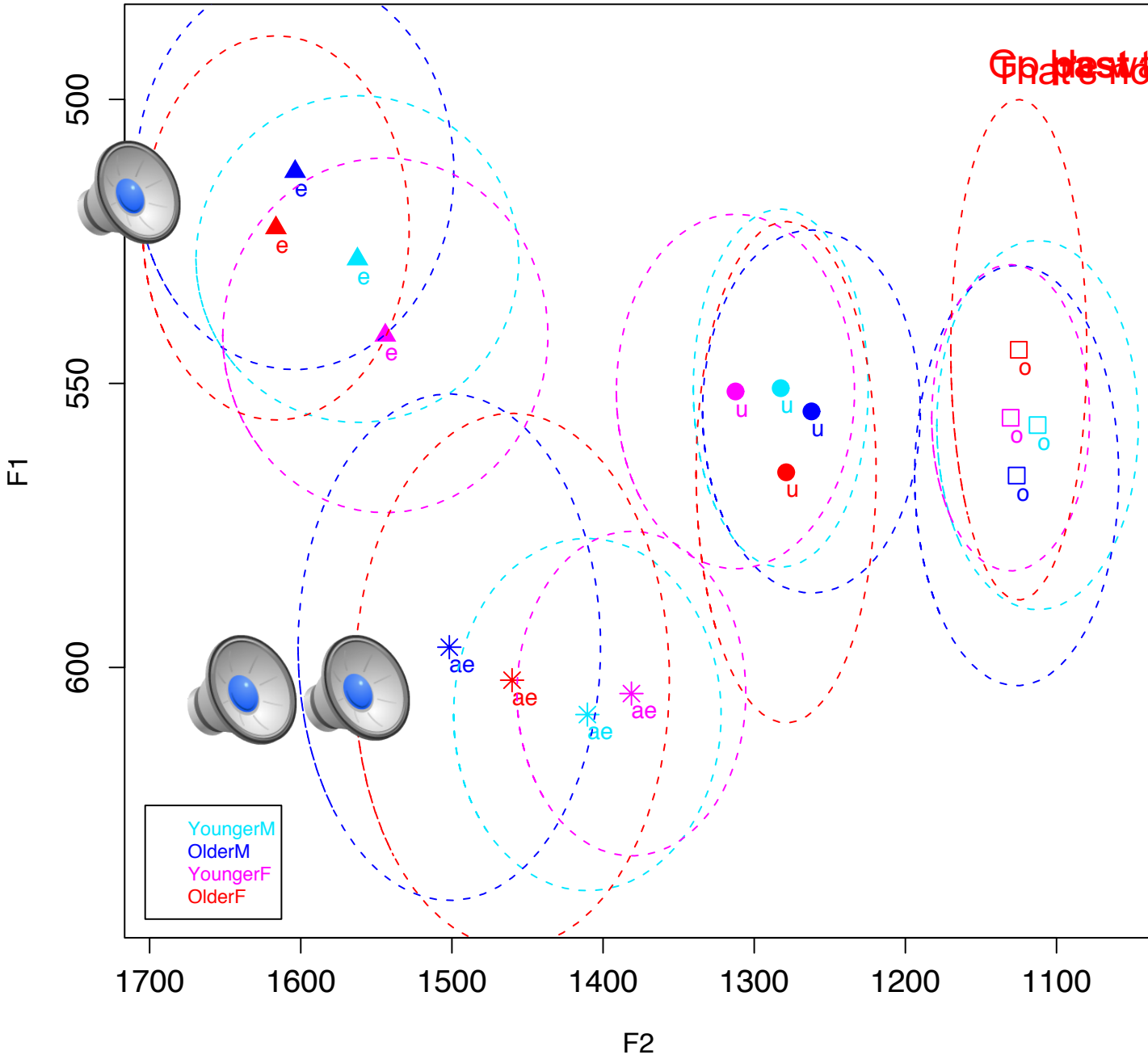
# Boberg (2005)



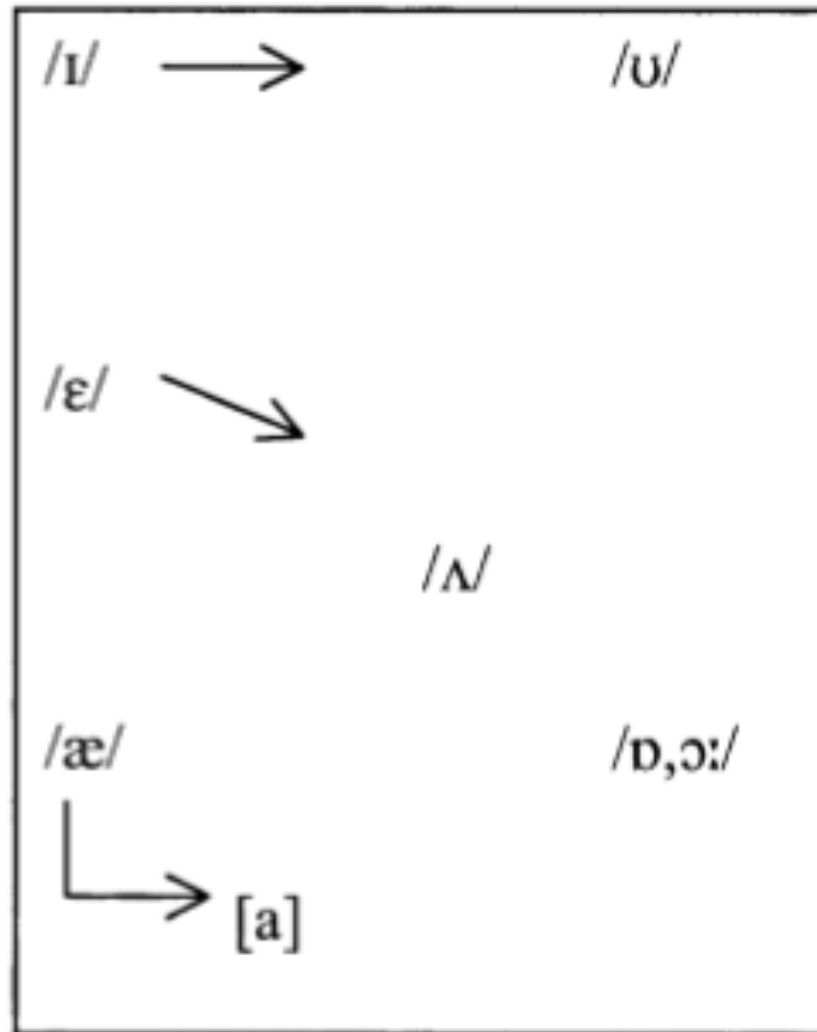FIGURE 4. The Canadian Shift in Montreal.

# Real-time change – Montreal

Boberg (2005):                                    Current study:

1919-1946        ɛ ⟶                                              ɛ

1946-1965        æ                    1937-1961

1965-1981        ↓ ⟶                                         æ ⟶

                                      1984-1995
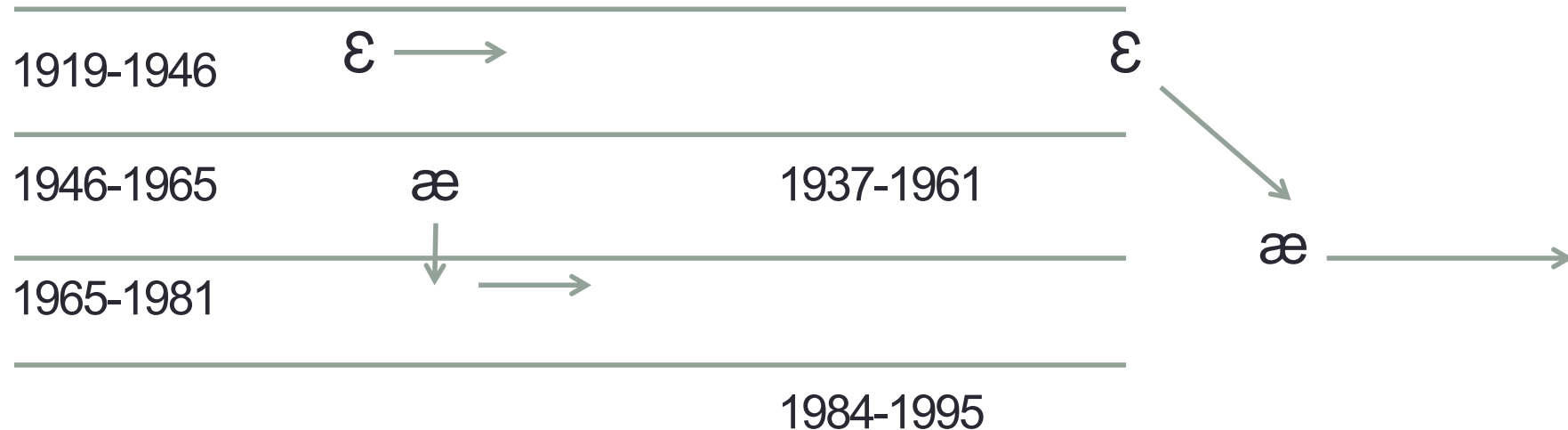
# Roeder and Jarmasz's (2010) proposal
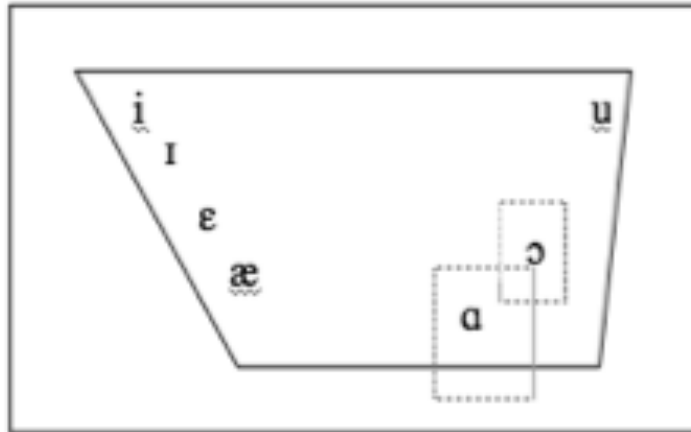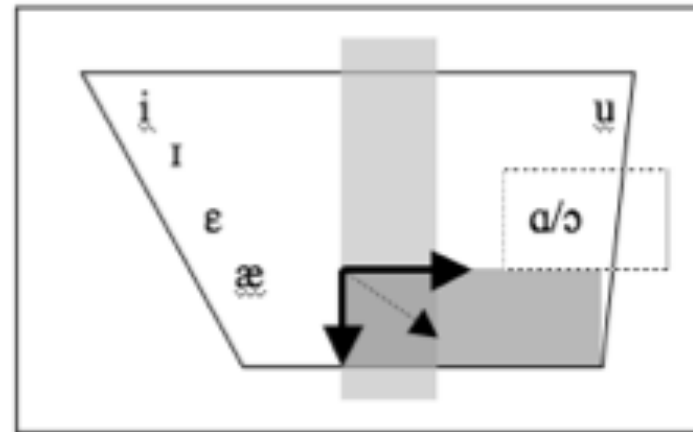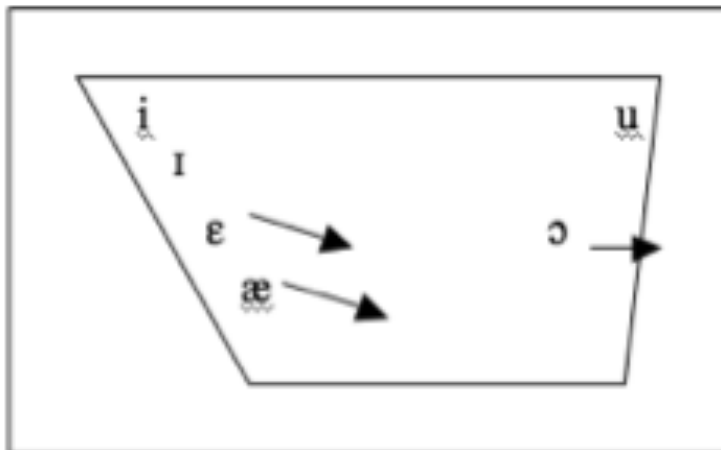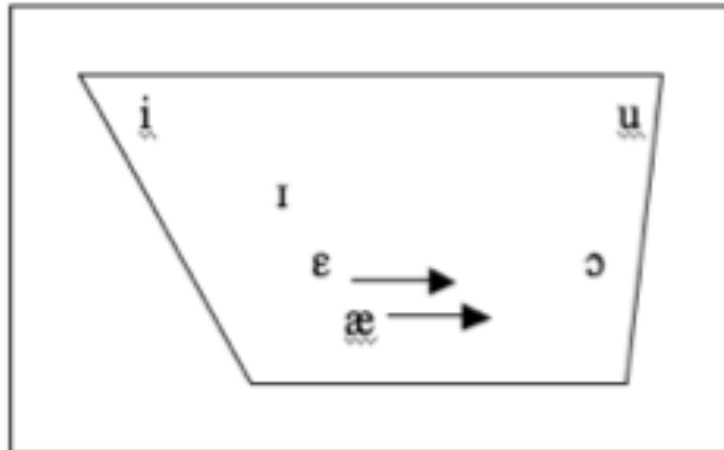
# My own proposal

**Low-back merger**: Pre-WWII

**/æ/ lowering**: Sadlier-Brown & Tamminga (2010) (Halifax); Boberg (2005); Clarke, Elms & Youssef (1995)

**/æ/ retraction**: Esling & Warkentyne (1993); Hoffman (2010); Roeder & Jarmasz (2009); Boberg (2005); current study

**/ɛ/ retraction**: Hoffman (2010); Sadlier-Brown & Tamminga (2010) (both Halifax and Vancouver); Roeder & Jarmasz (2009); Boberg (2005); current study

"…front vowels are retracted in a set of parallel shifts, rather than rotating in a chain shift" (Boberg 2005)

ɛ

ɔ

ɒ

æ

ɑ

**/ɛ/ lowering**: Clarke, Elms & Youssef (1995); Sadlier-Brown & Tamminga (2010) (both Halifax and Vancouver); Hoffman (2010); current study

# Two parts:

- Production experiment
  - Classic sociophonetic experiment
  - Participants read 44 sentences at their own pace
  - Vowel formant information extracted from key words in sentences
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  - Participants listen to synthetic vowel sounds through headphones
  - Classify as BET, BAT, BUT, or BOUGHT by clicking on screen
  - Program reports their answer and their response time
- Data all taken within one interview

"The goals of sociophonetics include accounting for how socially-structured variation in the sound system is learned, stored cognitively, subjectively evaluated, and processed in speaking *and listening*" (704, emphasis added)

-Foulkes, Scobbie and Watt (2010)

# Previous studies of vowel perception in ongoing shifts

- Janson (1983, 1986)
  - Stockholm Swedish – ongoing change is shifting phonemic boundary between /a:/ and /o:/
  - Tested perceptual boundary among two age groups
    - 13-18 year olds
    - 33-70 year olds
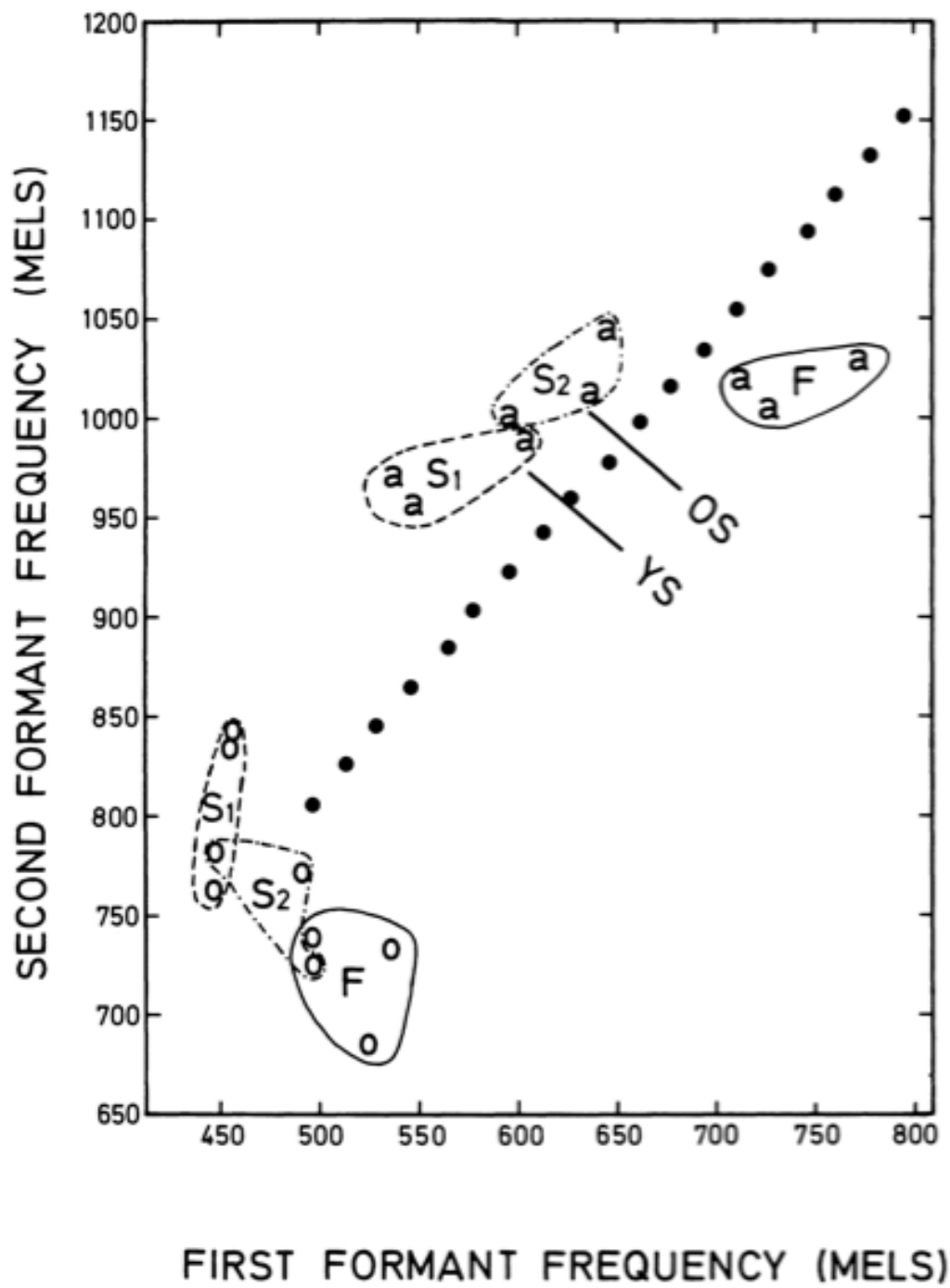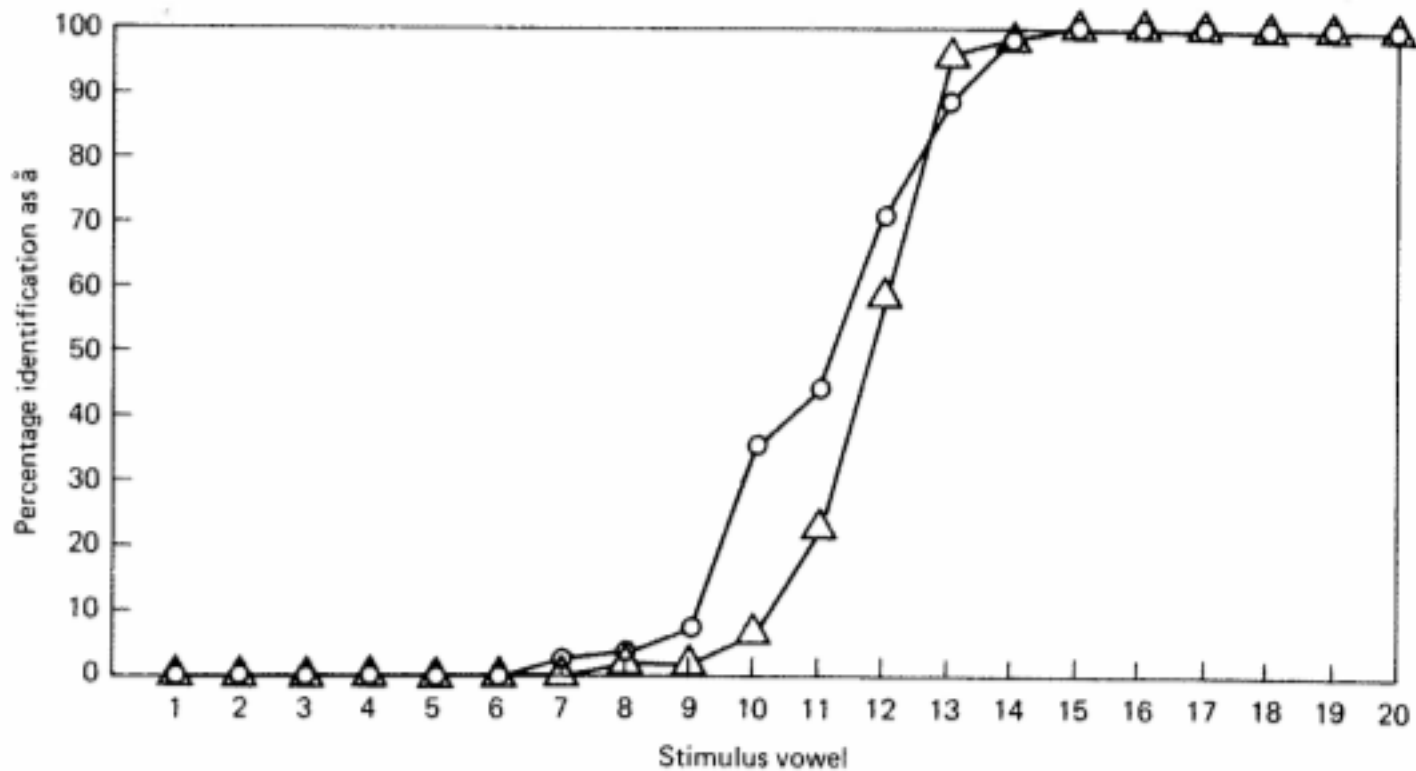
**Figure 14.1** Identification of stimuli 1 through 20 as *á* by young Stockholmers (Δ) and older Stockholmers (○).

# Previous studies of vowel perception in ongoing shifts

- Willis (1972)
  - Not intergenerational, but between two regional dialects
  - High school students in Fort Erie, ON and Buffalo, NY – separated by just a river, but quite distinct vowel systems
  - Looking at two-way phoneme distinctions (*bet vs. bat*, *hot* vs. *hat*), but in a two-dimensional grid rather than just along one continuum

Willis (1972)

/E/ "bet"

F1 values in Hertz

500
600
700
800

•25
•40

Ontario

85  62  •70

29  74  88  77

/æ/ "bat"

74  92  85  74

100  92  •100  •92

Buffalo

2500  2000  1500
F2 values in Hertz



F1 values in Hertz

700

800

Buffalo    Ontario

/æ/ "hat"

/a/ "hot"

2000  1500  1000
F2 values in Hertz
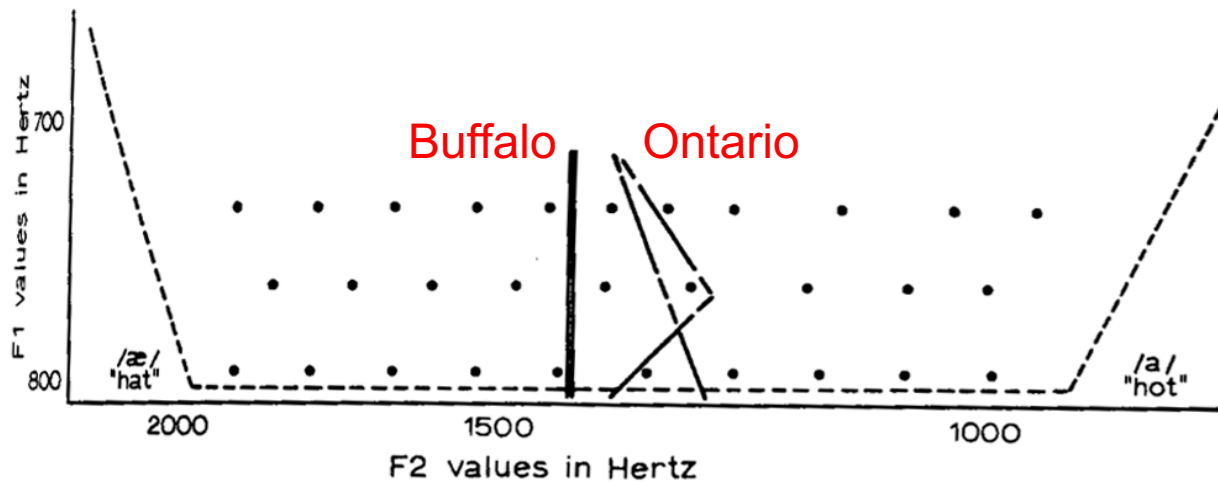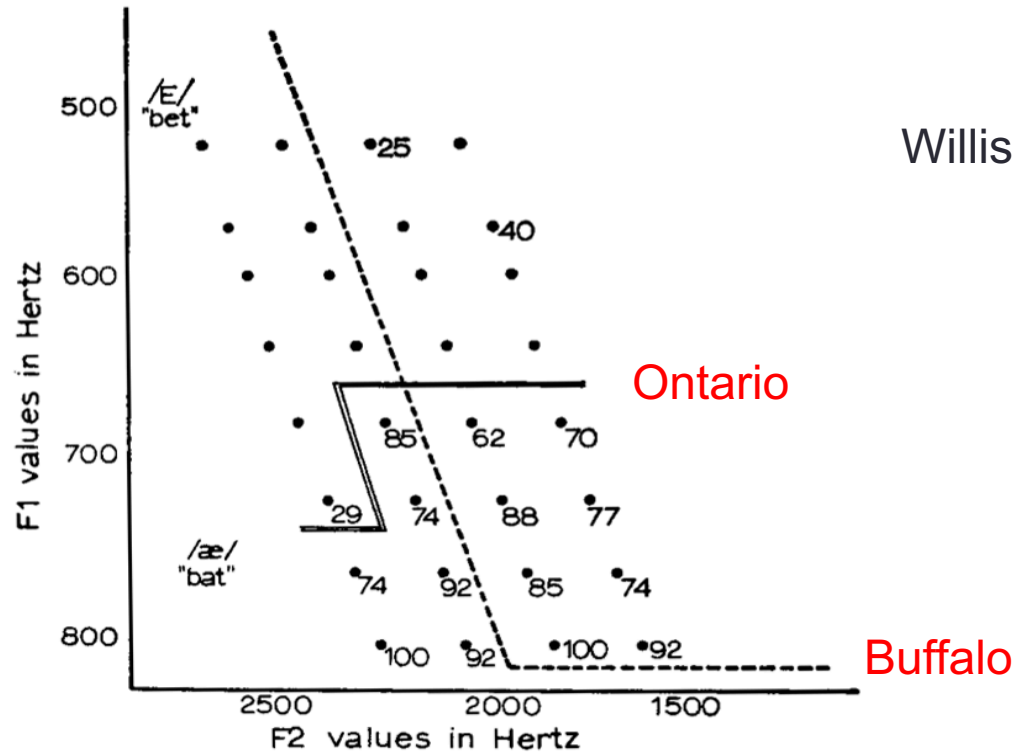
# Previous studies of vowel perception in ongoing shifts

- De Decker (2010)
  - Vowel assignments of *sack* vs. *sock* in Ontarians
  - Found significant gender differences, not very much age difference

/æ/-categorization by Gender in the youngest age group.



% *sack* categorization

Continuum point: Left = /æ/ Right = /ɑ/
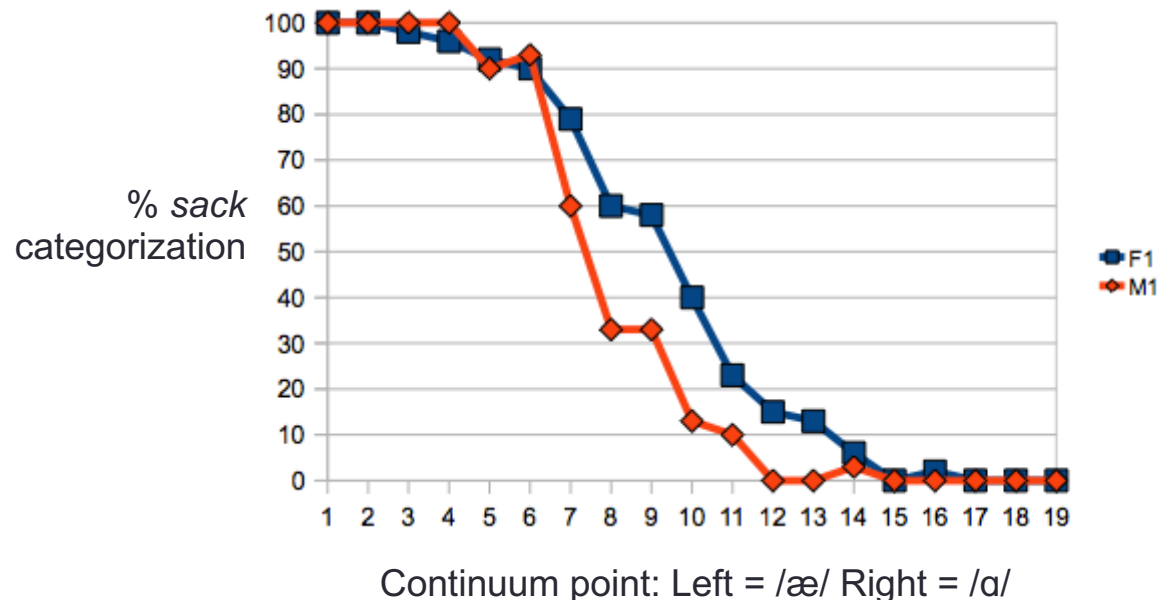
# Current study
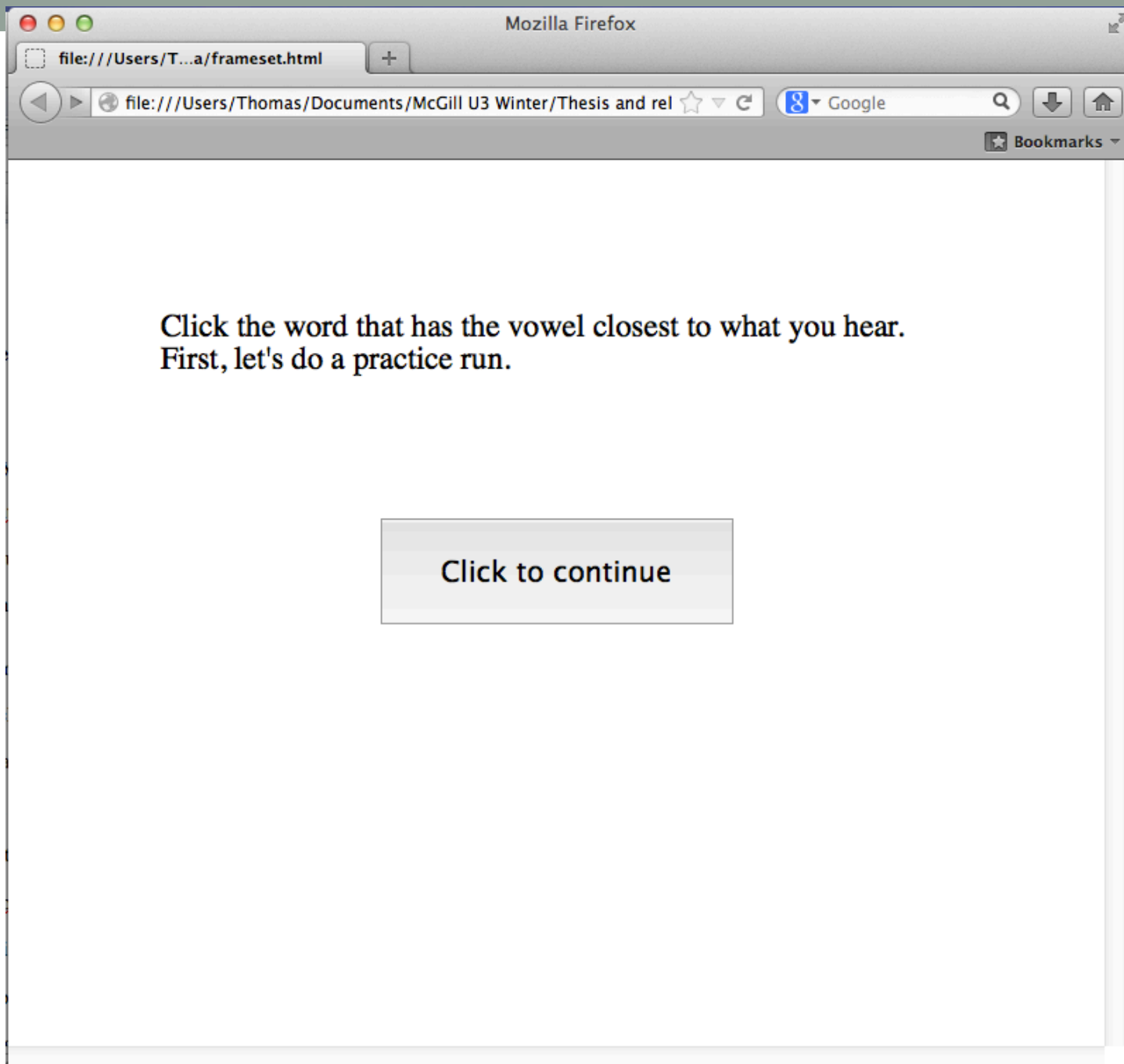
Click the word that has the vowel closest to what you hear.
First, let's do a practice run.

Click to continue
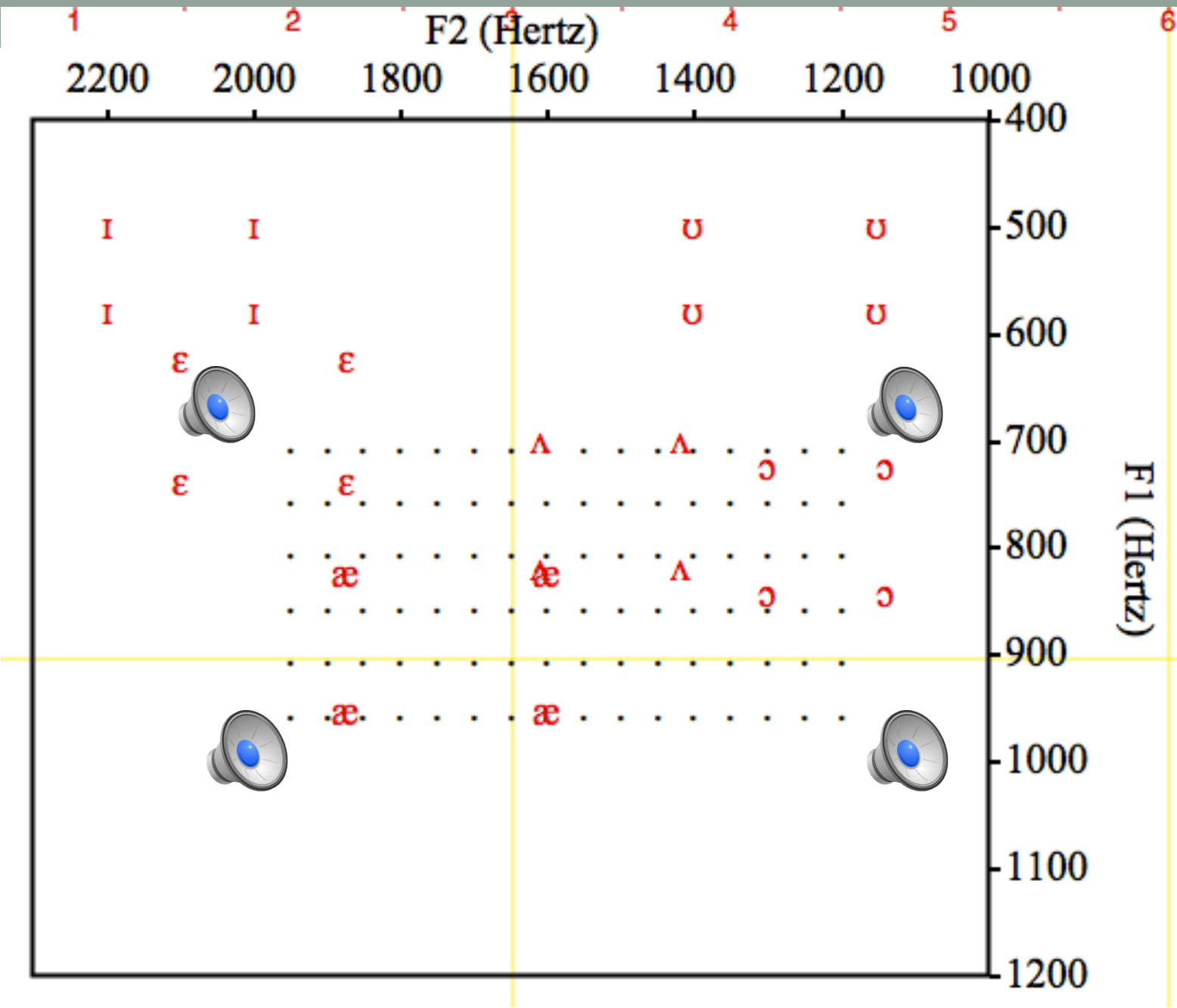
Red letters show approximate distribution of Montreal short vowels based on Boberg (2005)

## Older Listeners

F1

| F1 \ F2 | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| 700 | ɛ ɛ ɛ ɛ | ɛ ʌ ʌ | ʌ ʌ ʌ | ʌ ʌ | ʌ | ɔ | | ɔ |
| 750 | ɛ ɛ ɛ ɛ ɛ ɛ | | ʌ ʌ | ʌ ʌ | ʌ ʌ | | ɔ | ɔ |
| 800 | ɛ ɛ ɛ | ɛ æ ʌ | ʌ ʌ | ʌ ʌ | ʌ ʌ | ɔ | ɔ | ɔ |
| 850 | ɛ æ æ æ æ | æ æ | æ æ | | | | ɔ ɔ | ɔ |
| 900 | æ æ æ æ æ æ | æ æ | æ æ | æ æ | | | ɔ | ɔ |
| 950 | æ æ æ æ æ æ | æ æ | æ æ | æ æ | æ æ | ɔ | | ɔ ɔ |

## Younger Listeners

F1

| F1 \ F2 | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| 700 | ɛ ɛ ɛ | ɛ | ɛ ɛ | | | ʌ ɔ | ɔ ɔ | ɔ |
| 750 | ɛ ɛ ɛ ɛ ɛ ɛ ɛ | | ʌ | | ʌ | | ɔ ɔ | ɔ |
| 800 | ɛ ɛ ɛ ɛ ɛ æ ɛ | ʌ ʌ | | | | ɔ æ | | ɔ |
| 850 | æ æ | æ | æ æ æ æ | | | | ɔ | ɔ |
| 900 | æ æ æ æ æ æ | æ æ | æ æ | æ æ | æ æ | ɔ ɔ | ɔ | ɔ |
| 950 | æ æ æ æ æ æ | æ æ | æ æ | æ æ | æ æ | | ɔ | |

**Male Listeners**

F2

|  | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| **700** | ɛ ɛ ɛ ɛ | | ʌ ʌ ʌ | ʌ ʌ ʌ | ɔ | | ɔ | ɔ |
| **750** | ɛ ɛ ɛ ɛ | ɛ ɛ ɛ | ʌ | ʌ ʌ ʌ | ʌ | ɔ ɔ | ɔ |  |
| **800** | ɛ ɛ ɛ | ɛ æ | ʌ | ʌ ʌ ʌ | ʌ | ɔ ɔ | ɔ |  |
| **850** | ɛ æ æ æ | æ æ æ | æ æ æ | | ɔ | | ɔ | ɔ |
| **900** | æ æ æ æ | æ æ æ | æ æ æ | æ æ æ | æ | ɔ | ɔ | ɔ |
| **950** | æ æ æ æ | æ æ æ | æ æ æ | æ æ æ | æ | ɔ | ɔ | ɔ |

F1

**Female Listeners**

F2

|  | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| **700** | ɛ ɛ ɛ ɛ | ɛ | ɛ | ʌ ʌ ʌ | ʌ | ɔ | ɔ |  |
| **750** | ɛ ɛ ɛ ɛ | ɛ ɛ ɛ | ʌ | ʌ ʌ ʌ | ʌ | | ɔ |  |
| **800** | ɛ ɛ ɛ ɛ | ɛ æ | ʌ | ʌ | ɔ | | ɔ |  |
| **850** | æ | æ ɛ æ | ɛ æ | æ æ æ | | | ɔ |  |
| **900** | æ æ æ æ | æ æ æ | æ æ æ | æ æ æ | æ | | ɔ | ɔ |
| **950** | æ æ æ æ | æ æ æ | æ æ æ | æ æ æ | æ | | æ | ɔ |

F1

Percent /ɛ/, /ɔ/, and /ʌ/ categorization, F1 = 700: Older Listeners
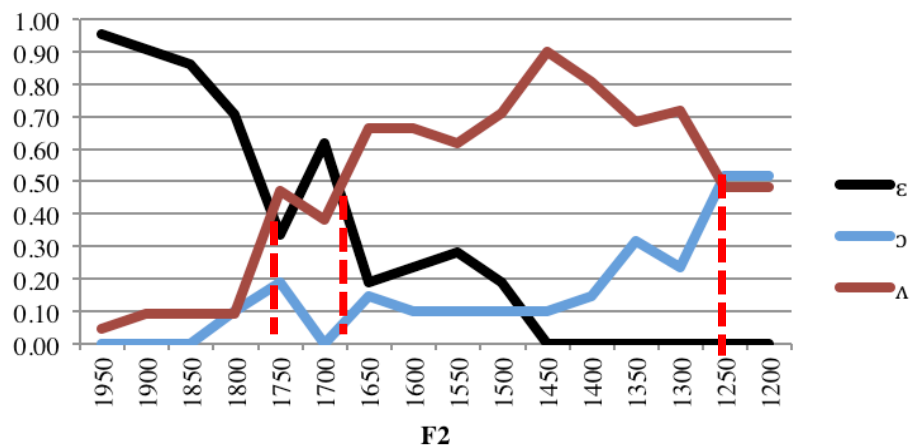


Percent /ɛ/, /ɔ/, and /ʌ/ categorization, F1 = 700: Younger Listeners
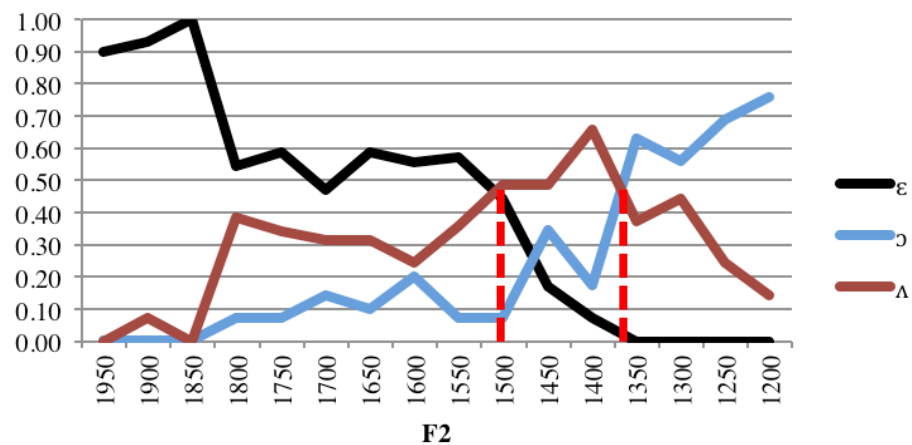
| Vowel | Gender | Age | Gender/Age |
|---|---|---|---|
| F2 ʌ | 0.0206 | 0.0814 | 0.2989 |
| F2 ɛ | 0.1980 | 0.1530 | 0.3770 |
| F2 ɔ | 0.0097 | 0.0398 | 0.0328 |

Binomial logistic regression for responses along the F1=700Hz axis (p-values)

Percent /ɛ/, /ɔ/, and /ʌ/ categorization, F1 = 700: Male Listeners



Percent /ɛ/, /ɔ/, and /ʌ/ categorization, F1 = 700: Female Listeners

| Vowel | Gender | Age | Gender/Age |
|---|---|---|---|
| F2 ʌ | 0.0206 | 0.0814 | 0.2989 |
| F2 ɛ | 0.1980 | 0.1530 | 0.3770 |
| F2 ɔ | 0.0097 | 0.0398 | 0.0328 |

Binomial logistic regression for responses along the F1=700Hz axis (p-values)

**Older Listeners** — F2

| F1 | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|----|------|------|------|------|------|------|------|------|

F2 (left→right): 1950, 1800, 1700, 1600, 1500, 1400, 1300, 1200

700: ɛ ɛ ɛ ɛ   ɛ ʌ ʌ ʌ ʌ ʌ ʌ ʌ ʌ ɔ ɔ
750: ɛ ɛ ɛ ɛ ɛ ɛ   ʌ ʌ ʌ ʌ ʌ ʌ   ɔ ɔ
800: ɛ ɛ ɛ   ɛ æ ʌ ʌ ʌ ʌ ʌ ʌ ʌ ɔ ɔ ɔ
850: ɛ æ æ æ æ   æ æ æ æ   ɔ ɔ ɔ
900: æ æ æ æ æ æ æ æ æ æ æ æ   ɔ   ɔ
950: æ æ æ æ æ æ æ æ æ æ æ æ ɔ   ɔ ɔ

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**Younger Listeners** — F2

F2 (left→right): 1950, 1800, 1700, 1600, 1500, 1400, 1300, 1200

700: ɛ ɛ ɛ   ɛ   ɛ ɛ   ʌ ɔ ɔ ɔ ɔ
750: ɛ ɛ ɛ ɛ ɛ ɛ ɛ   ʌ   ʌ ɔ ɔ ɔ
800: ɛ ɛ ɛ ɛ ɛ æ ɛ ʌ ʌ   ɔ æ ɔ
850: æ æ   æ   æ æ æ æ   ɔ ɔ
900: æ æ æ æ æ æ æ æ æ æ æ æ æ ɔ ɔ ɔ
950: æ æ æ æ æ æ æ æ æ æ æ æ   ɔ

**Male Listeners**

F2

| F1 | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| 700 | ɛ ɛ ɛ ɛ | | ʌ ʌ | ʌ ʌ | ʌ ʌ | ɔ | | ɔ ɔ |
| 750 | ɛ ɛ ɛ ɛ | ɛ ɛ ɛ | | ʌ ʌ | ʌ ʌ | ʌ ɔ | ɔ | ɔ |
| 800 | ɛ ɛ ɛ | ɛ æ | | ʌ ʌ | ʌ ʌ | ʌ | ɔ ɔ | ɔ |
| 850 | ɛ æ æ æ | æ æ | æ æ | æ æ | | | ɔ | ɔ ɔ |
| 900 | æ æ æ æ | æ æ | æ æ | æ æ | æ æ | æ æ | æ ɔ | ɔ ɔ |
| 950 | æ æ æ æ | æ æ | æ æ | æ æ | æ æ | æ æ | ɔ | ɔ ɔ |

**Female Listeners**

F2

| F1 | 1950 | 1800 | 1700 | 1600 | 1500 | 1400 | 1300 | 1200 |
|---|---|---|---|---|---|---|---|---|
| 700 | ɛ ɛ ɛ ɛ | | ɛ | ɛ | ʌ ʌ | ʌ ʌ | ɔ | ɔ |
| 750 | ɛ ɛ ɛ ɛ | ɛ ɛ ɛ | ɛ | | ʌ ʌ | ʌ ʌ | ʌ | ɔ |
| 800 | ɛ ɛ ɛ ɛ | ɛ æ | | ʌ | | ʌ | ɔ | ɔ |
| 850 | æ | æ ɛ | æ ɛ | æ æ | æ | æ | | ɔ |
| 900 | æ æ æ æ | æ æ | æ æ | æ æ | æ æ | æ æ | æ | ɔ ɔ |
| 950 | æ æ æ æ | æ æ | æ æ | æ æ | æ æ | æ æ | æ æ | ɔ |

# Collapsing top three F1 rows together

**Younger group, F1=700,750,800**
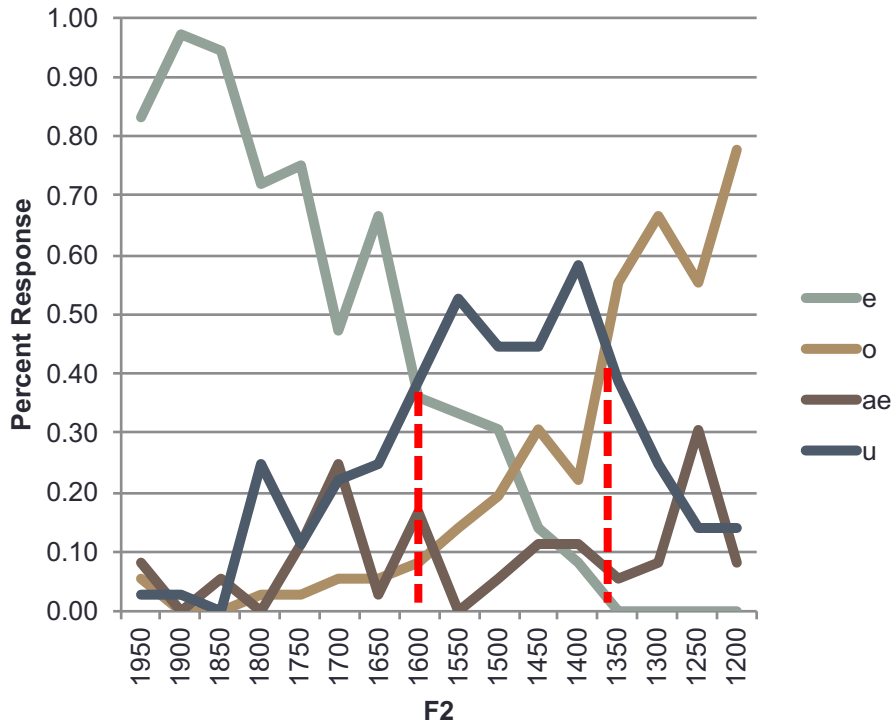


**Older group, F1=700,750,800**
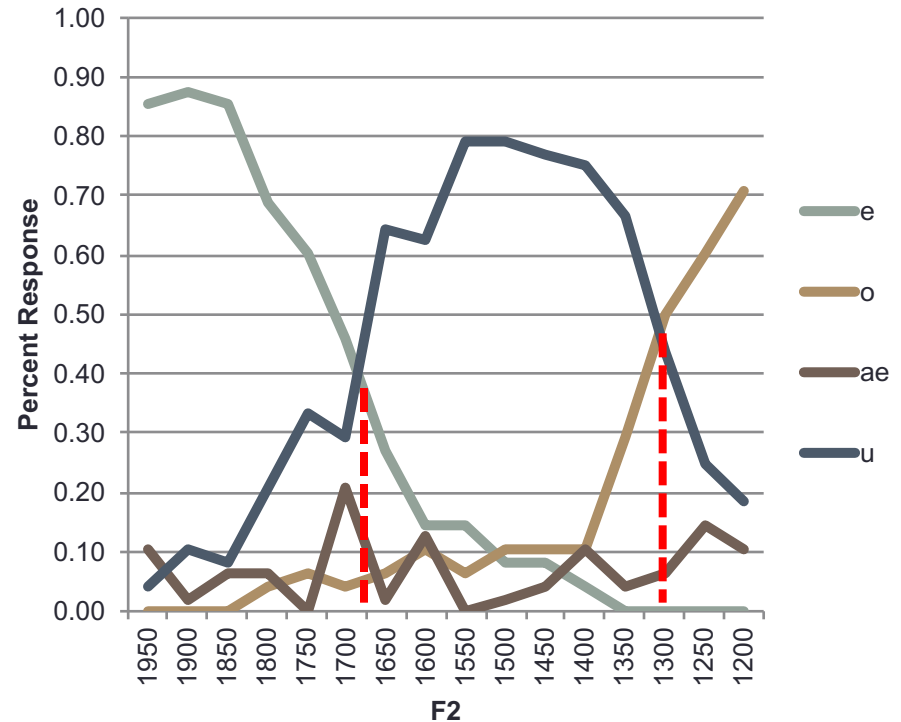


Mixed-effects logistic regression for responses in the F1 = 700, 750, and 800 Hz axes: predictor of **age** on **F2**, all possible by-subject random effects (intercept and slopes) included

| Vowel | z-value | p-value |
|---|---|---|
| ɛ | 2.204 | 0.028 |
| ʌ | -3.013 | 0.003 |
| æ | 1.177 | 0.239 |
| ɔ | 0.931 | 0.352 |

# Collapsing top three F1 rows together

**Males, F1=700,750,800**
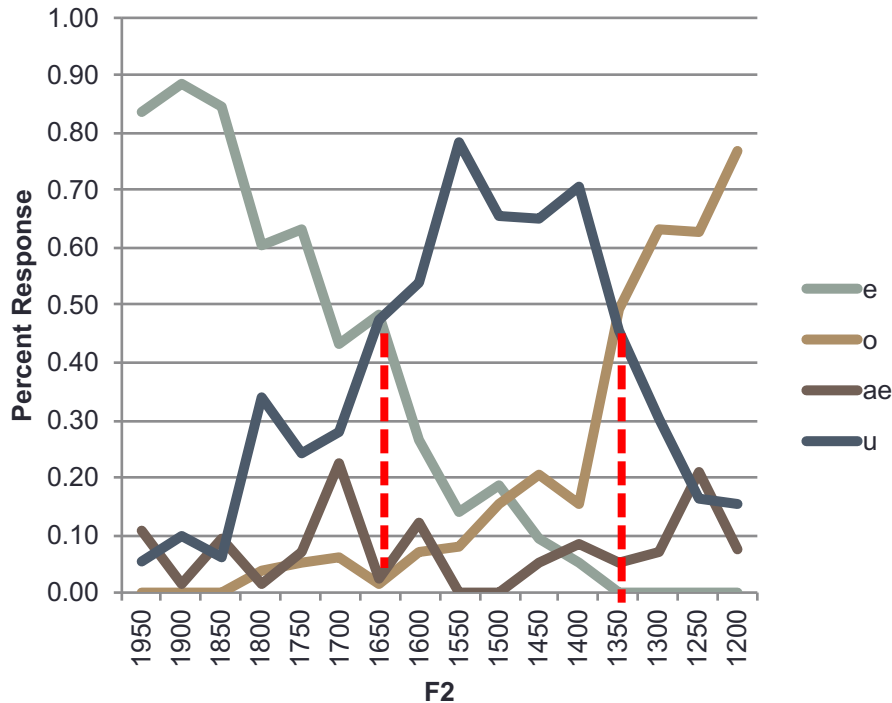


**Women, F1=700,750,800**
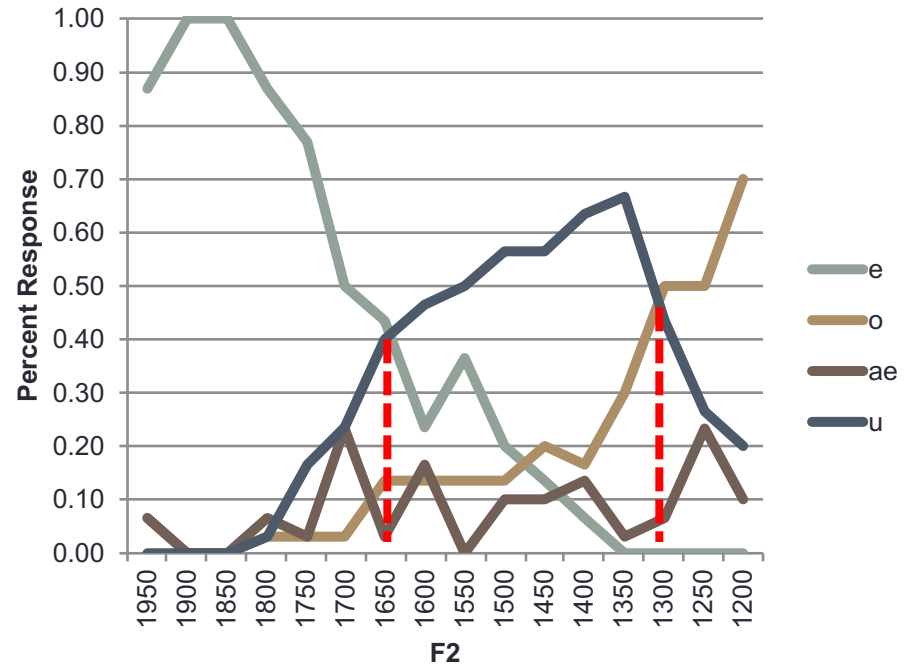


Mixed-effects logistic regression for responses in the F1 = 700, 750, and 800 Hz axes: predictor of **gender** on F2, all possible by-subject random effects (intercept and slopes) included

| Vowel | z-value | p-value |
|-------|---------|---------|
| ɛ | -0.644 | 0.519 |
| ʌ | 1.307 | 0.191 |
| æ | -0.268 | 0.789 |
| ɔ | 0.127 | 0.899 |

## Older Listeners

|  | 1950 |  |  | 1800 |  | 1700 |  | 1600 |  | 1500 |  | 1400 |  | 1300 |  | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **700** | ɛ | ɛ | ɛ | ɛ |  | ɛ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ | ɔ |
| **750** | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ |  | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ |  | ɔ | ɔ |
| **800** | ɛ | ɛ | ɛ |  | ɛ | æ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ | ɔ | ɔ |
| **850** | ɛ | æ | æ | æ | æ |  | æ | æ | æ | æ |  |  |  | ɔ | ɔ | ɔ |
| **900** | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ |  | ɔ |  | ɔ |
| **950** | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ |  | ɔ | ɔ |

(F1 = rows; F2 = columns; the 1950 column group is highlighted)

## Younger Listeners

|  | 1950 |  |  | 1800 |  | 1700 |  | 1600 |  | 1500 |  | 1400 |  | 1300 |  | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **700** | ɛ | ɛ | ɛ |  | ɛ |  | ɛ | ɛ |  |  |  | ʌ | ɔ | ɔ | ɔ | ɔ |
| **750** | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ |  | ʌ |  |  | ʌ |  | ɔ | ɔ | ɔ |
| **800** | ɛ | ɛ | ɛ | ɛ | ɛ | æ | ɛ | ʌ | ʌ |  |  |  |  | ɔ | æ | ɔ |
| **850** |  | æ | æ |  | æ |  | æ | æ | æ | æ |  |  |  | ɔ |  | ɔ |
| **900** | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ | ɔ |  | ɔ |
| **950** | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ |  | ɔ |  |  |

(F1 = rows; F2 = columns; the 1950 column group is highlighted)

**Male Listeners**

F1 (rows) × F2 (columns, Hz)

| F1 |  | 1950 |  | 1800 |  | 1700 |  | 1600 |  | 1500 |  | 1400 |  | 1300 |  | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | ε | ε | ε | ε |  |  | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ |  | ɔ | ɔ |
| 750 | ε | ε | ε | ε | ε | ε | ε |  | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ | ɔ | ɔ |
| 800 | ε | ε | ε |  | ε | æ |  | ʌ | ʌ | ʌ | ʌ |  | ʌ | ɔ | ɔ | ɔ |
| 850 | ε | æ | æ | æ | æ | æ | æ | æ | æ | æ |  | ɔ |  |  | ɔ | ɔ |
| 900 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ | ɔ | ɔ |
| 950 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ |  | ɔ | ɔ |

**Female Listeners**

F1 (rows) × F2 (columns, Hz)

| F1 |  | 1950 |  | 1800 |  | 1700 |  | 1600 |  | 1500 |  | 1400 |  | 1300 |  | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | ε | ε | ε | ε |  | ε |  |  |  | ε |  | ʌ | ʌ | ʌ | ɔ | ɔ |
| 750 | ε | ε | ε | ε | ε | ε | ε |  | ʌ | ʌ | ʌ | ʌ | ʌ |  |  | ɔ |
| 800 | ε | ε | ε | ε | ε | æ |  | ʌ |  |  |  | ʌ |  | ɔ |  | ɔ |
| 850 | æ |  | æ | ε | æ | ε | æ | æ | æ | æ |  |  |  |  |  | ɔ |
| 900 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ |  | ɔ | ɔ |
| 950 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ |  | æ | ɔ |

# Few significant perceptual differences in /æ/-/ɛ/ categorization in front of vowel space

Mixed-effects logistic regressions for responses in the F2 = 1850, 1900, and 1950Hz axes: predictor of **gender** and **age** on F1, all possible by-subject random effects (intercept and slopes) included:

| /æ/ | z-value | p-value |
|---|---|---|
| **Gender** | 0.854 | 0.393 |
| **Age** | -1.506 | 0.132 |

| /ɛ/ | z-value | p-value |
|---|---|---|
| **Gender** | -2.024 | 0.043 |
| **Age** | 0.916 | 0.359 |

**Older Listeners** — F2 (columns), F1 (rows)

| F1 | 1950 | | | 1800 | | 1700 | | 1600 | | 1500 | | 1400 | | 1300 | | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | ɛ | ɛ | ɛ | ɛ | | ɛ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ | ɔ |
| 750 | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ | | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | | ɔ | ɔ |
| 800 | ɛ | ɛ | ɛ | | ɛ | æ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ʌ | ɔ | ɔ | ɔ |
| 850 | ɛ | æ | æ | æ | æ | | æ | æ | æ | æ | | | | ɔ | ɔ | ɔ |
| 900 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | | ɔ | | ɔ |
| 950 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ | | ɔ | ɔ |

(The F1 = 850, 900, 950 rows are highlighted/shaded.)

**Younger Listeners** — F2 (columns), F1 (rows)

| F1 | 1950 | | | 1800 | | 1700 | | 1600 | | 1500 | | 1400 | | 1300 | | 1200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 700 | ɛ | ɛ | ɛ | | ɛ | | ɛ | ɛ | | | | ʌ | ɔ | ɔ | ɔ | ɔ |
| 750 | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ | ɛ | | ʌ | | | ʌ | | ɔ | ɔ | ɔ |
| 800 | ɛ | ɛ | ɛ | ɛ | ɛ | æ | ɛ | ʌ | ʌ | | | | | ɔ | æ | ɔ |
| 850 | | æ | æ | | æ | | æ | æ | æ | æ | | | | | ɔ | ɔ |
| 900 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | ɔ | ɔ | ɔ |
| 950 | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | æ | | | ɔ | |

(The F1 = 850, 900, 950 rows are highlighted/shaded.)

# Few significant perceptual differences in /æ/-/ɛ/ categorization in front of vowel space

Mixed-effects logistic regressions for responses in the F1 = 850, 900, and 950Hz axes: predictor of **gender** and **age** on F2, all possible by-subject random effects (intercept and slopes) included:

| /æ/ | z-value | p-value |
|---|---|---|
| **Gender** | 0.854 | 0.393 |
| **Age** | -1.506 | 0.132 |

| /ɔ/ | z-value | p-value |
|---|---|---|
| **Gender** | -1.302 | 0.193 |
| **Age** | -0.773 | 0.440 |

# Issues

- Methodology
  - Consonantal context around vowel tokens
    - Though Strange et al. 1976, Strange, Edman, and Jenkins 1979, Rakerd 1984, and Fox 1989 indicated that a CVC stimulus improves accuracy in vowel categorization tests, Macchi (1980) "failed to provide evidence that vowels spoken in consonantal context are better identified than naturally produced isolated vowels"
    - Diehl, McCusker, and Chapman (1980) and Strange, Jenkins, and Johnson (1983) found that error rates in phoneme mapping with isolated short vowel stimuli were relatively low
  - Presentation of perception buttons
    - Clopper, Hay, and Plichta (2011) say this opens the door to participant response bias, as subjects tend "to respond with the leftmost (or topmost) item"
    - Diehl, McCusker, and Chapman (1980) note that "anything that enhances the stability of the stimulus representation in short-term memory should also enhance identification performance"

# Issues

- Aimed to record "default" categorization, but is this really possible?
  - **Gender** (Johnson, Strand, and D'Imperio 1999, Strand 1999), **age** (Drager 2010), **knowledge of origin** (Niedzielski 1999), and **stuffed animal presence** (Hay and Drager 2010) can affect categorization
  - Listeners specifically denied any information on the identity of the "speaker" of the stimuli they were categorizing
  - Stimuli themselves were all produced by a single synthesizer script, controlled for any non-F1/F2 phonetic features such as the values of F0, F3, and breathiness
- Statistics
  - Sample size of 28
  - Uneven distribution: 5 older females, 5 younger females, 7 younger males, 11 older males

# Conclusions

- /æ/ is retracting, while /ɛ/ is lowering and retracting in apparent time in Montreal
- Among same participants who supplied data for production experiment, significant age effects were shown along the /ɛ/-/ʌ/ continuum, but not along the /ɛ/-/æ/ continuum or the /æ/-/ɔ/ continuum
- /ɛ/-/ʌ/ shift is a more recent development of the Canadian Shift than /æ/-/ɔ/ shift, but retraction of /ɛ/ towards /æ/ is most recent