

## Schwa Experiment

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### RQ:

Japanese has a basic 5-vowel system, while English has around 13. In this project, I intend to explore how English phonemes are mapped onto Japanese phonemes in the process of incorporating loan words. Specifically, when Japanese speakers interpret English schwas, is the decision of which of the five vowels to use informed more by the orthographic or auditory information?

I selected 32 words with schwas in English to be pronounced in Japanese.

I hypothesize these 32 words can be grouped into 2 groups depending on whether the schwas, when they do not reflect the orthography, become a /u/ or /a/ in Japanese. Each group consists of examples of these words, as well as their minimal pairs (the same English orthography and schwa yields a Japanese pronunciation following the orthographic vowel)

These words fall in a range from well-established loanwords to words for which most Japanese speakers would use its Japanese counterpart but would nonetheless understand.

### Group 1: The /a/ sounds

Group 1 contains words with schwas whose orthographic vowels are “u” or “o”.

When the Japanese pronunciation does not reflect the orthography, these schwas are pronounced as the low vowel /a/. The vowels of concern are underlined.

### Orthography primes vowel

“u” → /u/	“o” → /o/
vir <u>u</u> s	Monr <u>o</u> e
magnesi <u>u</u> m	bot <u>o</u> tom
situ <u>u</u> ation	pot <u>o</u> ato
	com <u>u</u> mit
	carrot

Orthography does not prime vowel, becomes /a/

"u" → /a/	"o" → /a/
Connectic <u>u</u> t	t <u>o</u> bacco
nerv <u>o</u> s	freed <u>o</u> m
premi <u>u</u> m	butt <u>o</u> n
	access <u>o</u> ry
	<i>second</i>

### Group 2: The /ʌ/ sounds

Group 2 contains words with schwas whose orthographic vowels are "a", "i" or "o". When the Japanese pronunciation does not reflect the orthography, these schwas are pronounced as the unrounded, high back vowel /ʌ/. The vowels of concern are underlined.

### Orthography primes vowel

"e" → /e/	"i" → /i/	"o" → /o/
Bid <u>e</u> n	res <u>i</u> n	mel <u>o</u> n
pres <u>e</u> nt	kev <u>i</u> n	weap <u>o</u> n
prob <u>e</u> l <u>m</u>	comm <u>i</u> t	pers <u>o</u> n
boomer <u>a</u> ng		bot <u>o</u> tom
plan <u>e</u> t		carrot

### Orthography does not prime vowel

"e" → /ʌ/	"i" → /ʌ/	"o" → /ʌ/
ov <u>e</u> n	rais <u>i</u> n	less <u>o</u> n
sev <u>e</u> n		seas <u>o</u> n

**Methodology:**

I presented a list of 15 sentences to measure vowels in the 32 words or groups 1 and 2. (see Appendix.) Six participants were selected to read through the list.

All of the participants were native speakers of Japanese. Of the six, four were comfortable with, at least, conversational English. The design of the exercise assumed the Japanese speakers to be able to look at English orthography and read it phonetically in Japanese (or recognize the loan word and its common pronunciation).

The first and second formants of the 32 words, as underlined in the table above, were measured in Praat. The participants were grouped in three according to their resonant pitch, into “low”, “mid”, or “high” and measured with natural maximum formants of 5000 Hz, 5500 Hz, and 6000 Hz respectively.

Each F1 and F2 value was normalized using the Bark Frequency scale as to make the interpersonal measurements more comparable. These Bark values were plotted using the NORM The Vowel Normalization and Plotting Suite.

**Analysis:**

Colors in the tables above are used in the charts below.

The vowels measured are underlined in the chart above.

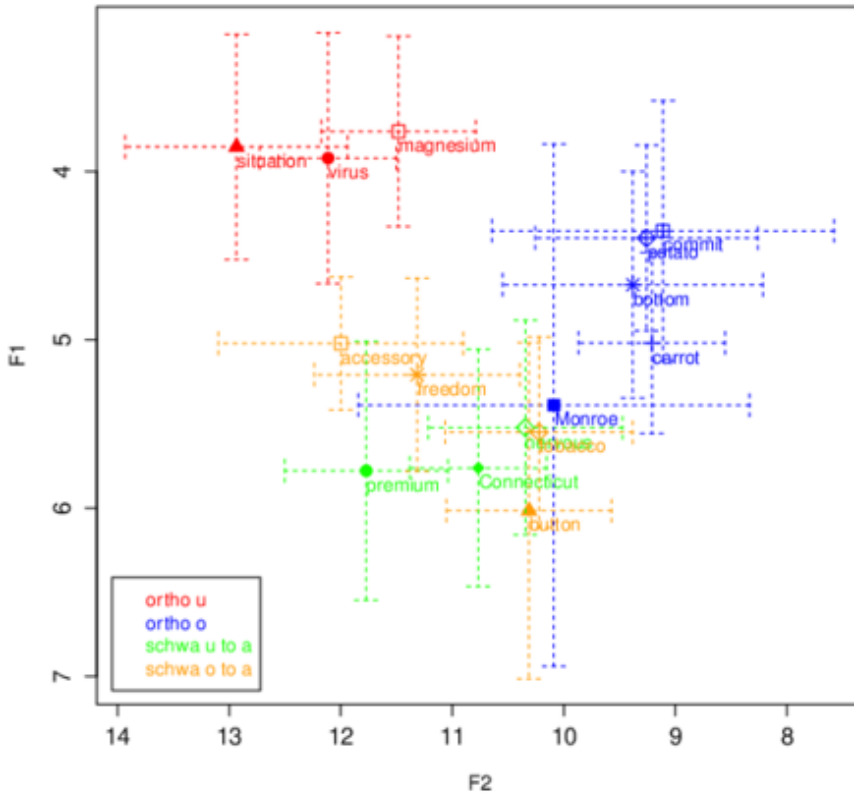
(Bars and ellipses show 1 std. deviation)

Group 1 key:

Orthography primes vowel	
“u” → /u/	“o” → /o/
vir <u>u</u> s	Monr <u>o</u> e
magnesi <u>u</u> m	bot <u>o</u> tm
situ <u>u</u> ation	p <u>o</u> tato
	co <u>o</u> mmit
	carro <u>o</u> t

Schwa becomes /a/	
“u” → /a/	“o” → /a/
Connecti <u>u</u> cut	to <u>u</u> bacco
nervou <u>u</u> s	freed <u>u</u> m
premi <u>u</u> m	but <u>u</u> ton
	access <u>u</u> ry
	sec <u>u</u> nd

### Group 1



### Group 1:

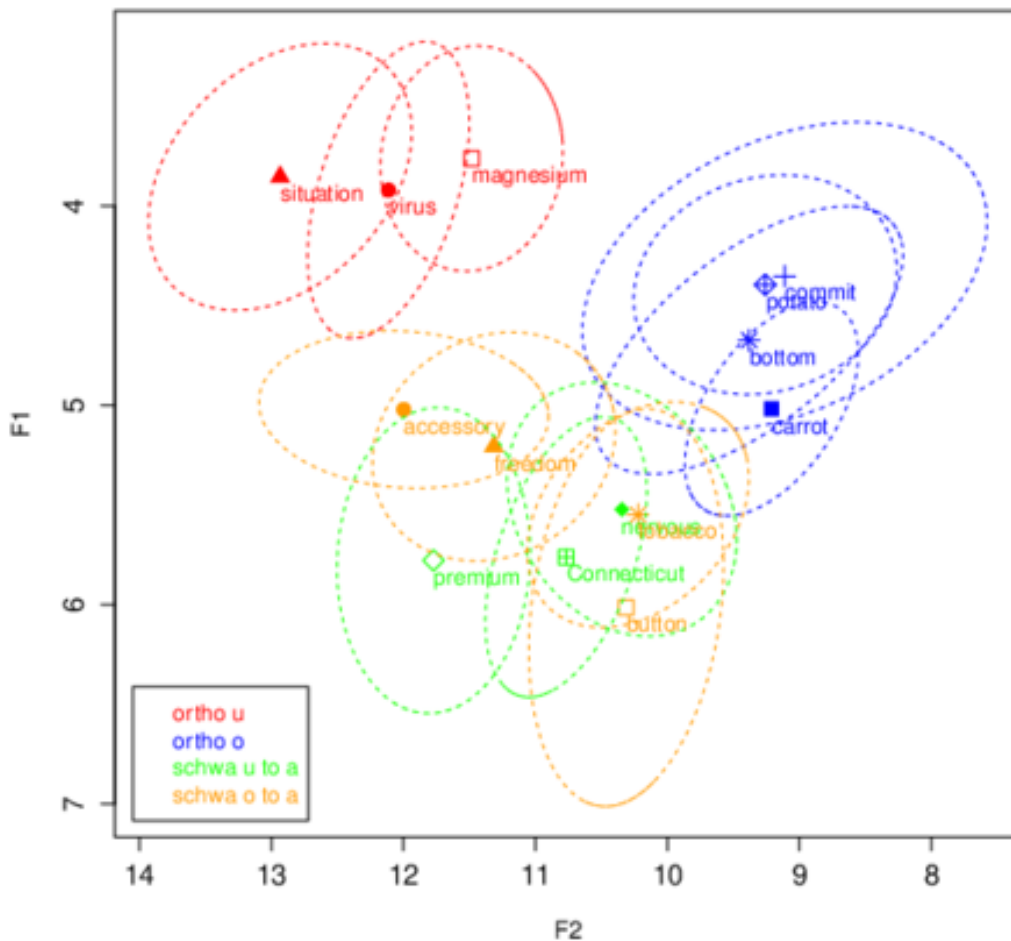
As per my hypothesis, words that follow the orthography congregate in the /u/ and /o/ areas, respectively.

Words that do not follow the orthography are realized as /a/, whether the word was orthographically “u” or “o”.

(hypothesis was for yellow and green to occupy same vowel space, while blue and red are distinct)

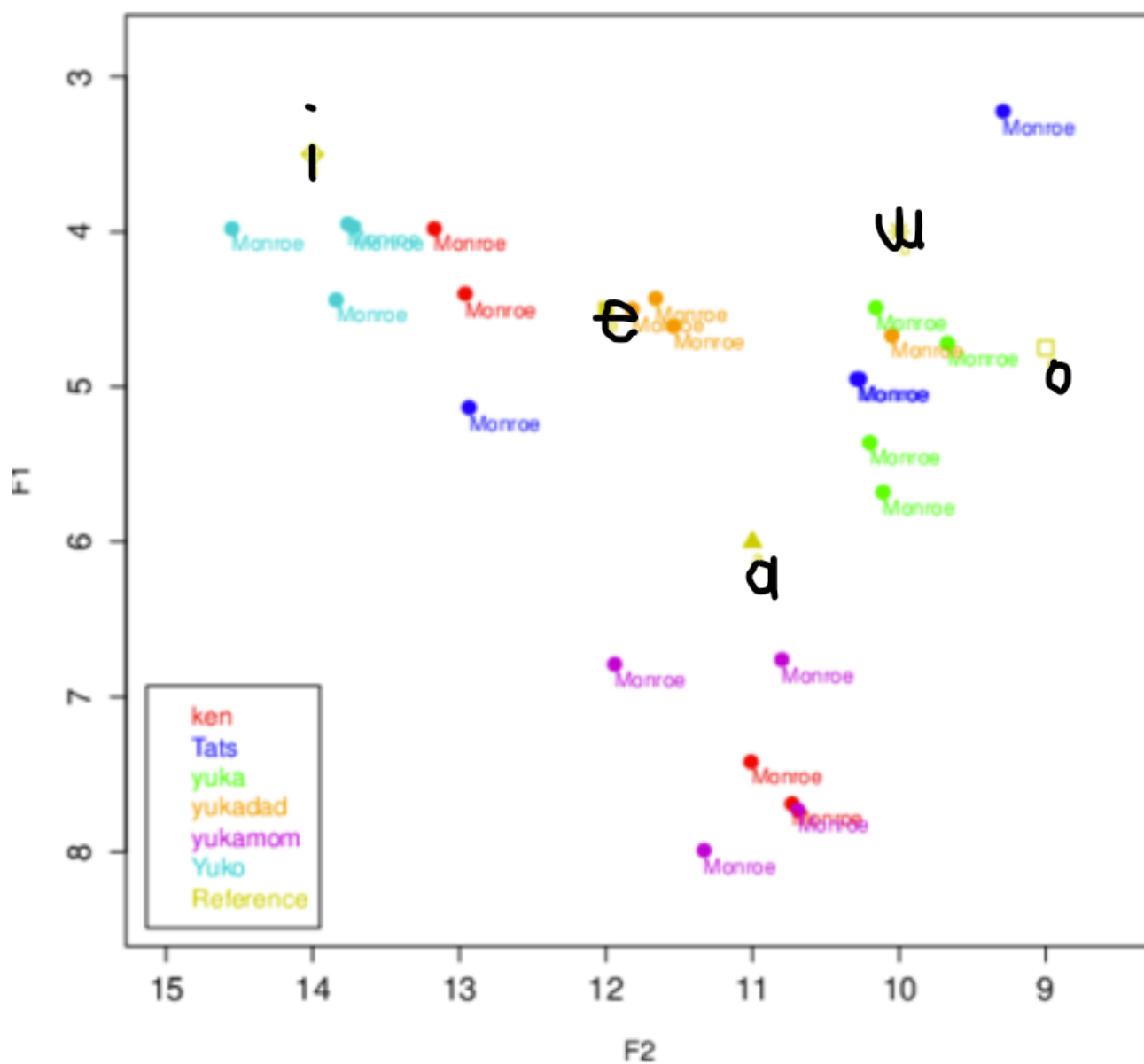
The exception was with the word “Monroe”.

### Group 1 (no Monroe, ellipses)



(The same graph as above, except without the data for “Monroe”, to show the clear grouping of the rest of the words)

### Just Monroe (Individual vowels)



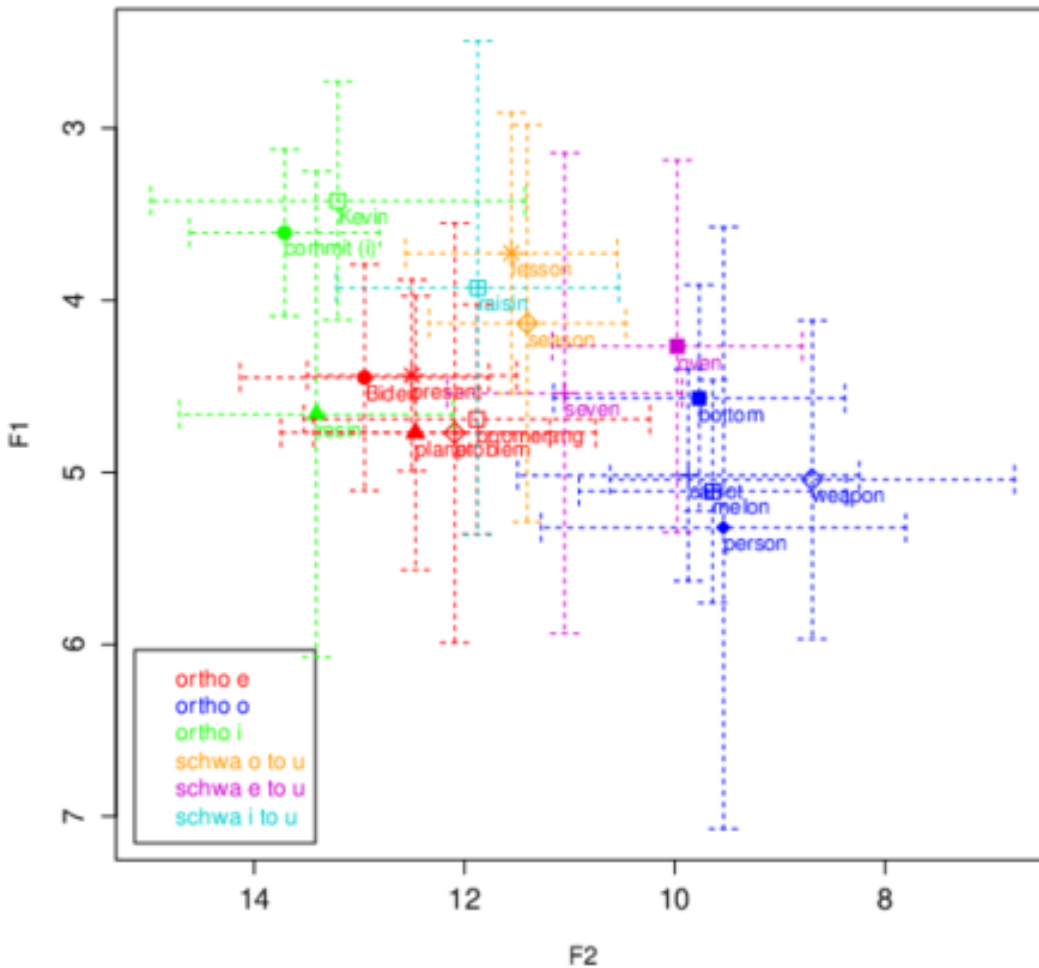
Above is a graph charting every instance of the word by each speaker, with reference points of typical positions for /u/, /a/, and /o/. It is clear that speakers (and even the same speaker for multiple instances) were split between /man:ro:/, /mun:ro:/ and /mon:ro:/.

Group 2 key

Orthography primes vowel		
"e" → /e/	"i" → /i/	"o" → /o/
Bid <u>e</u> n	res <u>i</u> n	mel <u>o</u> n
pres <u>e</u> nt	kev <u>i</u> n	weap <u>o</u> n
prob <u>e</u> m	comm <u>i</u> t	pers <u>o</u> n
boomer <u>a</u> ng		bot <u>o</u> m
plan <u>e</u> t		carrot

Schwa becomes /ʊ/		
"e" → /ʊ/	"i" → /ʊ/	"o" → /ʊ/
ov <u>e</u> n	rais <u>i</u> n	less <u>o</u> n
sev <u>e</u> n		seas <u>o</u> n

Group 2



Group 2:

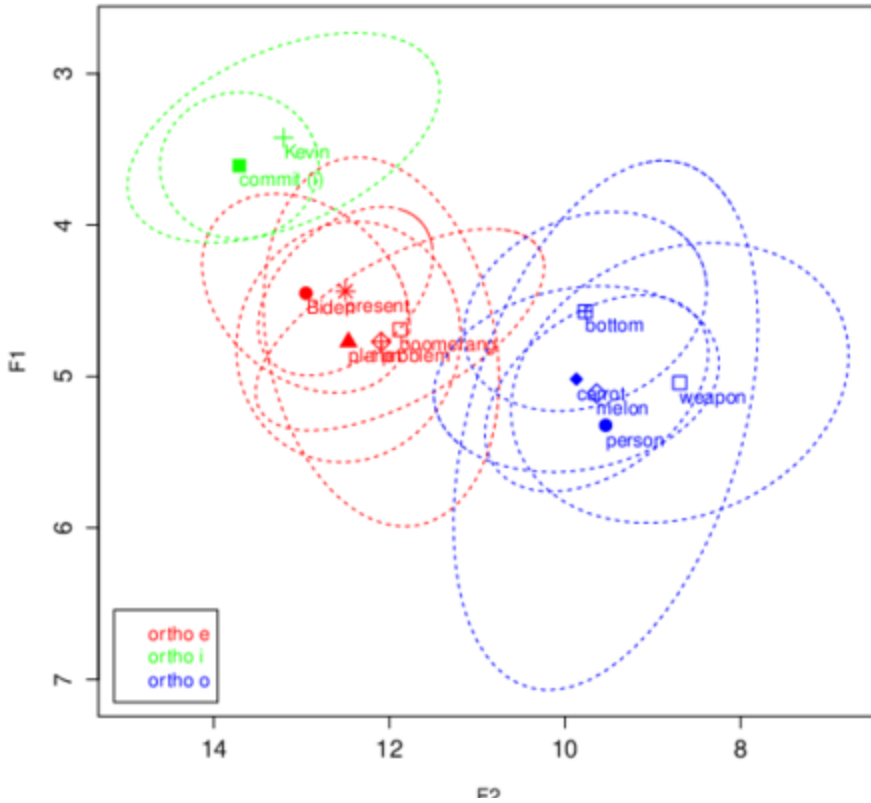
As per my hypothesis, words that follow the orthography congregate in the /e/, /i/, and /o/ areas, respectively.

Words that do not follow the orthography are realized as /ʊ/, whether the word was orthographically "e", "i", or "o".

(hypothesis was for yellow, pink, and cyan to occupy same vowel space, while blue, green, and red are distinct)

There seems to be a large spread with raisin.

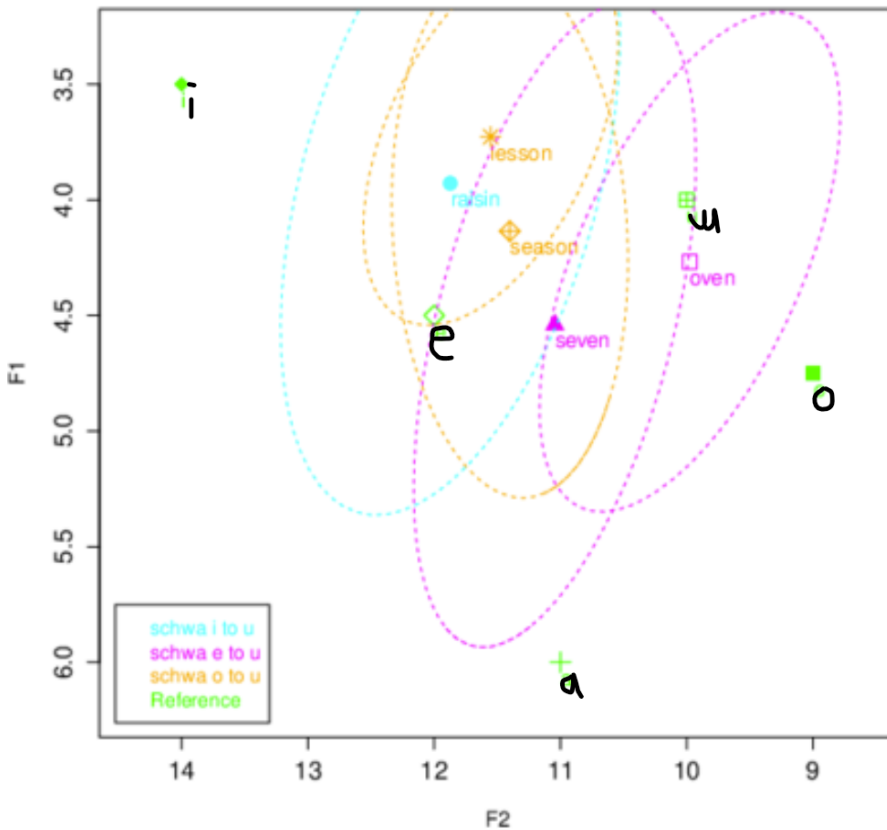
Group 2 (only ortho)



When the group of words that follow its orthography and the ones whose schwas become /u/ are isolated, the left graphs are produced.

Here, it's clearer that the vowel regions are distinct for the top graph and not for the bottom one.

Group 2 (only schwa)



The above graph shows the distribution of “resin” (red) and raisin” (blue). Approximate vowel locations for the other vowels are indicated for reference.

While I expected speakers to make a distinction between the two words as “resin” /re<sub>3</sub>in:/ and raisin” /re:zʌn:/, it is clear that some speakers made no distinction between the two. (As shown by the overlap of blue and red, especially for the same shapes). Seeing as how some speakers did clearly distinguish the two words, the issue was more with speakers mistaking the less prevalent word “resin” as “raisin”.

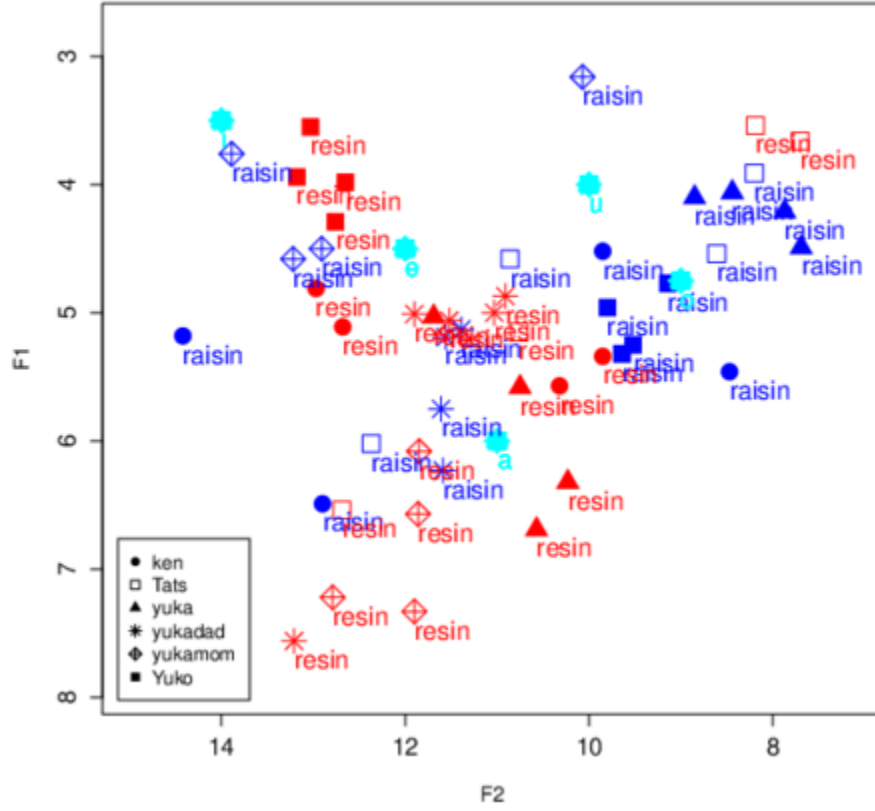
The six graphs below show each participants’ pronunciations of resin” and raisin”.

The first three speakers make a distinction between the two words, whereas the latter three do not.

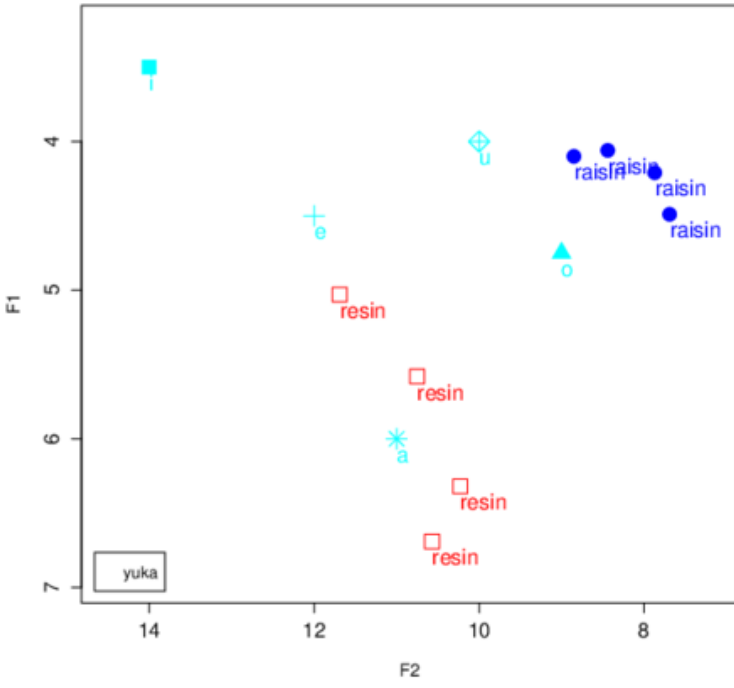
The first two speakers followed my hypothesis of “resin” /re<sub>3</sub>in:/ and raisin” /re:zʌn:/, and the last three speakers perceived the two words as being the same.



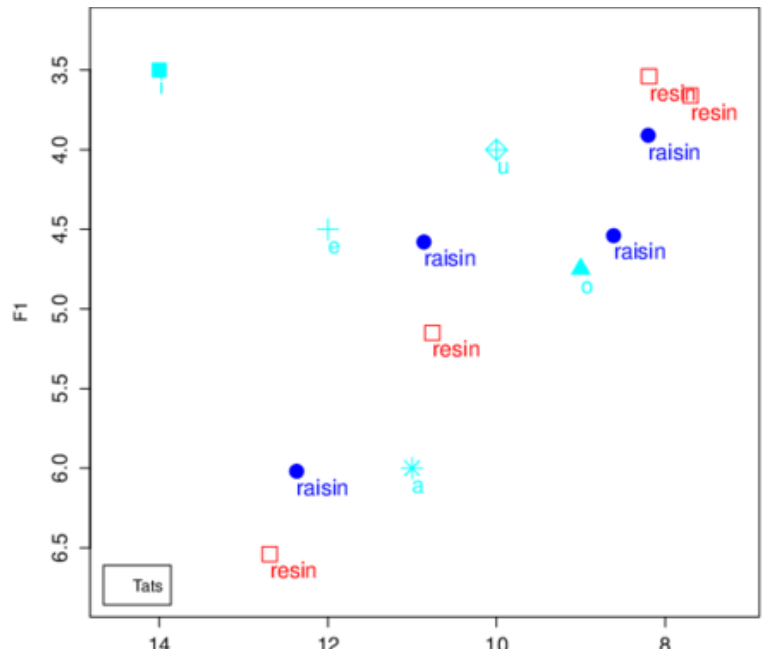
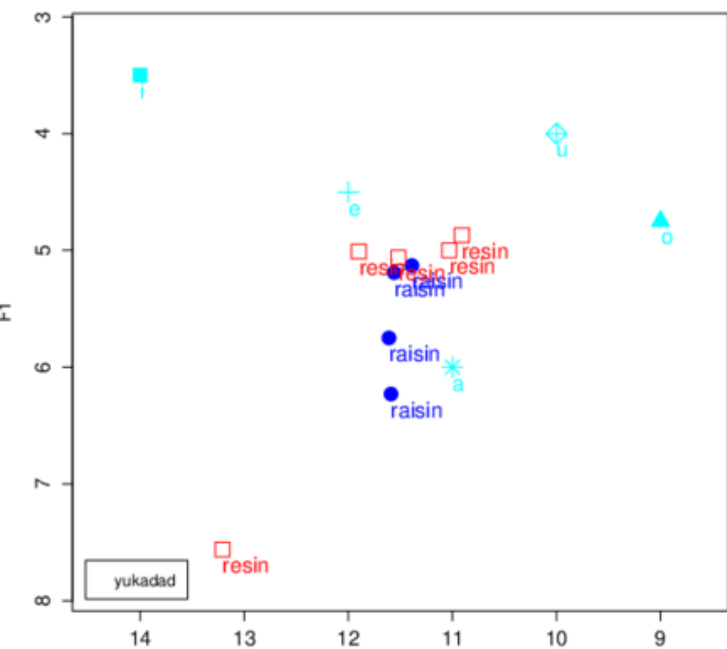
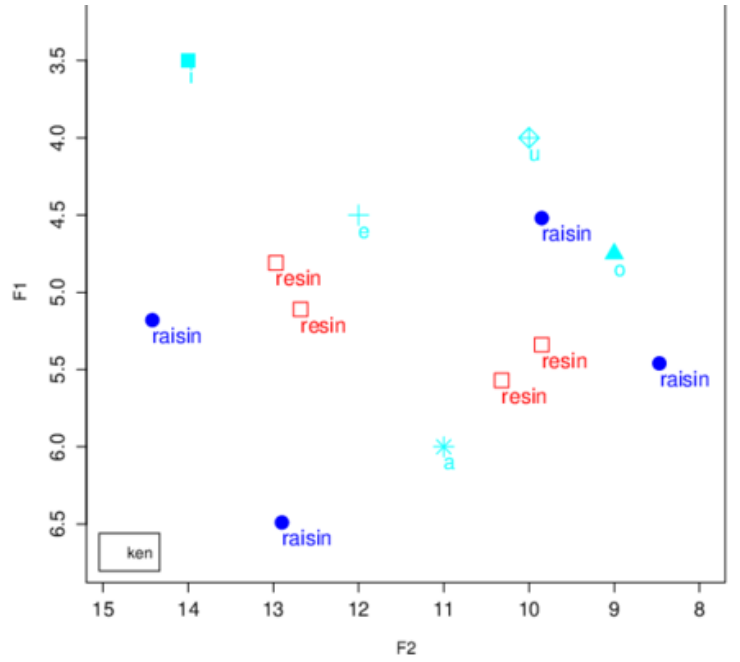
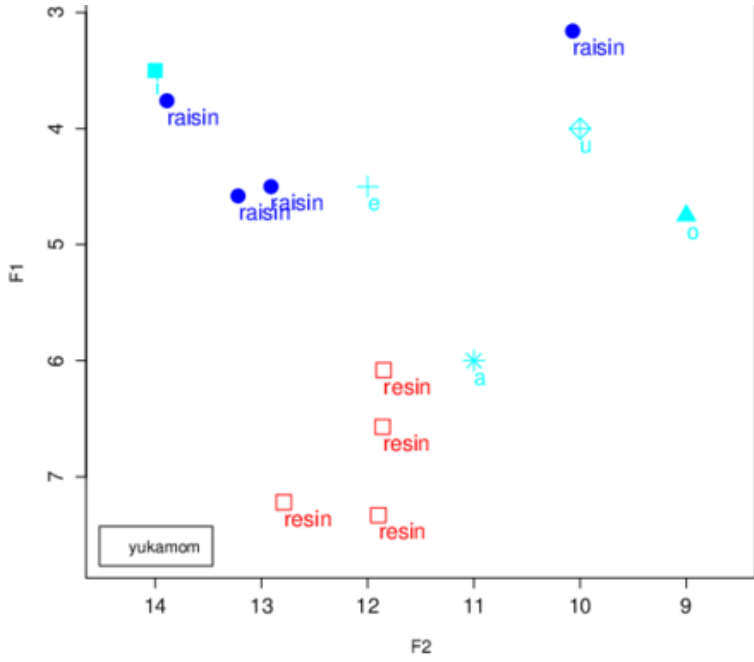
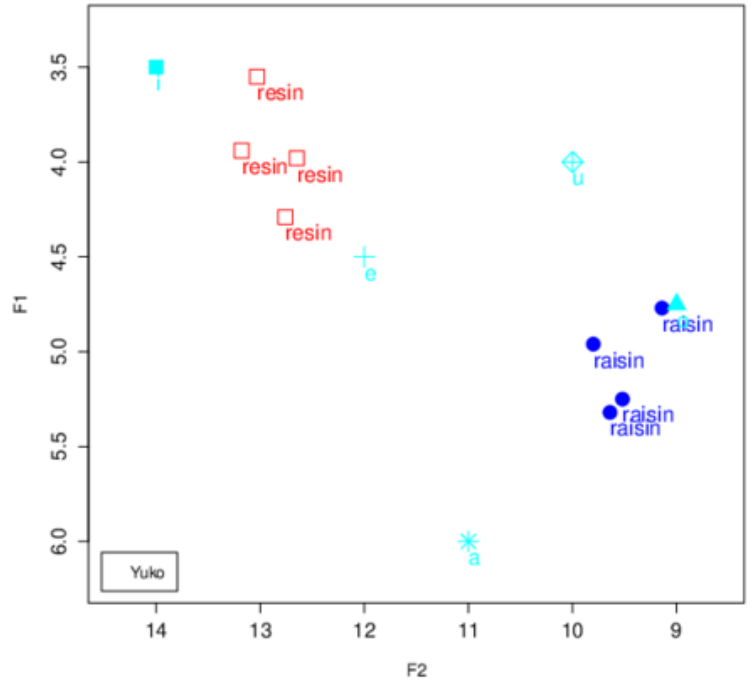
### raisin and resin



raisin and resin



raisin and resin



Appendix:

Text presented to participants:

英語の部分は日本語(カタカナ英語)で読み上げてください。

(例)Wine を drink した。 → 「ワイン をドリンクした。」

1. Columbus が Columbus (Ohio州都) で melon と raisin を食べた。
2. Premium な magnesium と tobacco が他の planet で見つかったらしい。
3. Resin で作った orange の accessory を present としてあげます。
4. Seven 時まで virus の対策案を考えれば Biden さんに boomerang を差し上げます。
5. Bottom にあるこの button を押すと oven が 1 second 後に 温まる。
6. 今 season の lesson は Connecticut州 における freedom についてでした。
7. Kevin という person は Satan に carrot と potato を渡した。
8. Monroe 宣言に commit するまでガバメントは nervous な situation にあった。
9. Magnesium 製の boomerang には problem があることを Kevin が lesson で教えてくれた。
10. Columbus は Connecticut 州の先住民に present として tobacco と virus と weapon を渡した。
11. Columbus (Ohio州都) に着いた Biden 氏は、nervous そうに planet の climate problem について演説した。
12. 「Premium な potato と carrot のダイエットに commit すればズボンの second の button を止められるようになる」と Satan が言った。
13. この situation を解決するために Reagan は Monroe の freedom についてのスピーチを参考にした。
14. Seven 月の season でおいしいのは、oven の bottom で焼いた melon と raisin です。
15. Problem 1: Reagan 大統領 は resin の accessory を持っていたでしょうか。

English translation:

Read English parts in Japanese (*Katakana* English).

(例) Wine を drink した。 → 「ワイン を ドリンク した。」

1. Columbus ate melon[s] and raisin[s] in Columbus (Ohio state capital).
2. Premium magnesium and tobacco was found on another planet.
3. I will give you a piece of orange accessory (jewelry) made of resin as a present.
4. Seven 時までに virus の対策案を考えれば Biden さんに boomerang を差し上げます。
5. Bottom にあるこの button を押すと oven が 1 second 後に 温まる。
6. 今 season の lesson は Connecticut 州 における freedom についてでした。
7. Kevin という person は Satan に carrot と potato を渡した。
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