

# The Role Of Phonological Short-term Memory In Spanish L2 Phonology: Exploring Vowel Quality And Duration Among English-speaking Learners

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# BACKGROUND: PSTM

# Phonological short-term memory (PTSM)

- Corresponds to the phonological loop of working memory (Baddeley & Hitch, 1974)
  - *Short-term phonological store* → 2 second decay
  - *Articulatory rehearsal, where sub-vocal rehearsal occurs*
- Thought to facilitate the long-term learning of the sound structures of new words and vocabulary acquisition

# PSTM and L2 abilities

- Documented correlations between PSTM and...
  - *Vocabulary knowledge*  
(Atkins & Baddeley, 1998; Gupta, 2003; Masoura & Gathercole, 1999, 2005; Speciale, Ellis & Bywater, 2004)
  - *Knowledge of collocations*  
(Skrzypek & Singelton, 2013)
  - *Listening comprehension*  
(Tsuchihira, 2007; Kormos & Safar, 2008)
  - *L2 sound perception*  
(Cerviño-Povedano & Mora, 2011, 2015; Mackay, Meador & Flege, 2001)
  - *L2 pronunciation*  
(Kondo, 2012; Nagle, 2013; Sleva & Miyake, 2006; Xiaochen et al., 2013)



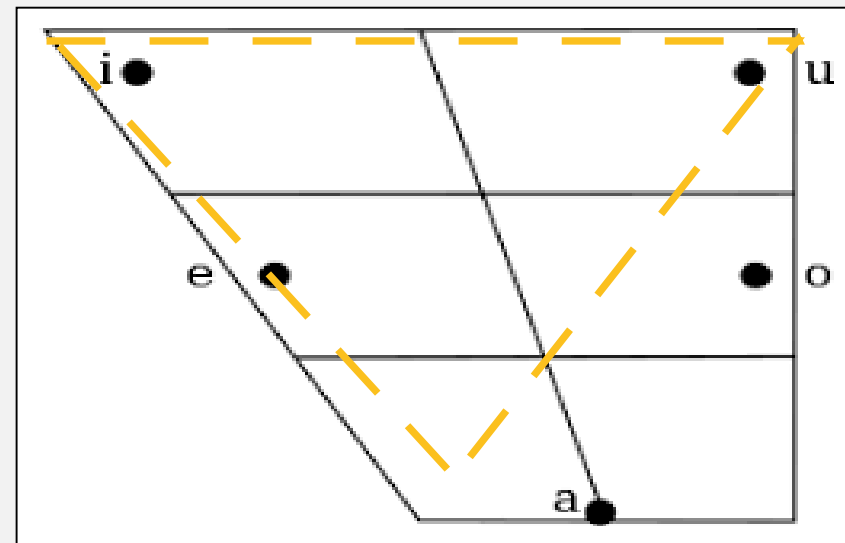
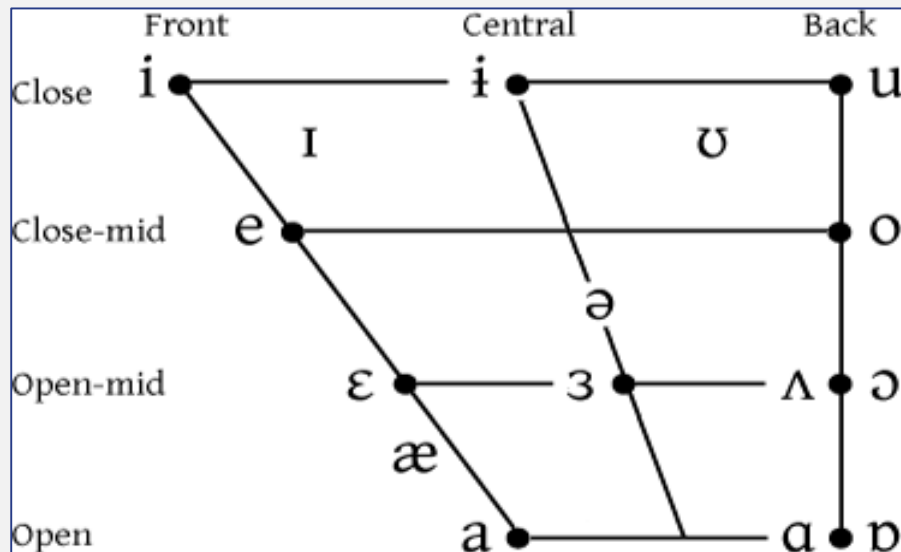
# BACKGROUND: L2 Vowels

# Vowel production in English and Spanish

- English and Spanish vowels differ significantly

(Bradlow, 1995; Delattre, 1965; Ladefoged, 2006; Menke, 2017; Stockwell & Bowen, 1965)

- English has more phonemes (9-14) than Spanish (5)
- Vowels differently located in the acoustic space
- Unstressed vowel centralization in English



# Spanish L2 vowels

- English-speaking L2 learners of Spanish...
  - *Frequently produce Spanish vowels with differing acoustic properties from native speakers of Spanish*
    - /u/ is often fronted at lower levels
    - /e/ demonstrates large degrees of variation
    - etc.
  - *Often centralize unstressed vowels*
- These differences persist even at advanced levels
  - *Although performance generally improves as proficiency increases*

*(Cobb & Simonet, 2015; Díaz & Simonet, 2015; Menke & Face, 2010; Simões, 1996; Menke, 2015)*



# CURRENT STUDY





# Research questions

- **Do second language Spanish learners with differing PSTM abilities produce the five Spanish monophthongs with differing acoustic properties?**
  - *High PSTM learners will demonstrate acoustic properties that more closely approximate those of natives*
  - *High PSTM learners will centralize their unstressed vowels less than those with low PSTM*
  - *High PSTM learners will produce shorter vowels than those with high PSTM*
- **If so, does the effect of PSTM change across levels?**
  - *Differences according to PSTM will be larger in the 4000-level than the graduate-level*

# Tasks

[Part of a larger corpus of tasks designed to elicit free response speech and examining cognitive individual differences]

- DELE grammar test

- *20-item grammar cloze test*

- (Embajada de España, Washington, DC; cf. Duffield & White [1999])*

- Lextale-ESP Spanish Vocabulary task

- (Izura, Cuetos & Brysbaert, 2014)*

- Serial non-word recognition task

- Oral response task

# Measure of PSTM

- **Serial non-word recognition task [L3 (Russian)]**
- 24 pairs of sequences containing between 5-7 Russian CVC words and non-words
  - *Eight each of 5, 6 and 7 non-words*
    - Identical (i.e. A,B,C,D,E; a,b,c,d,e)
    - Different (i.e. A,B,C,D,E; a,c,b,d,e)
    - Recorded by female speaker in a carrier phrase
- **Response: same or different?**
  - *1000ms for response*
- **Presented in OpenSesame**  
(Mathôt, Schreij & Theeuwes, 2012)
- **Practice block of 4 sequences preceding the test phase**

# Oral response task

- Participants presented with prompts for an oral response (via PowerPoint)
  - *10 prompts, 10-15 minutes total*
- Topics designed to promote a range of discourse types (hypothetical, narrative, description)
- Responses recorded with a TASCAM DR-40 4-Track portable digital recorder with a Shure WH20XLR dynamic headset microphone

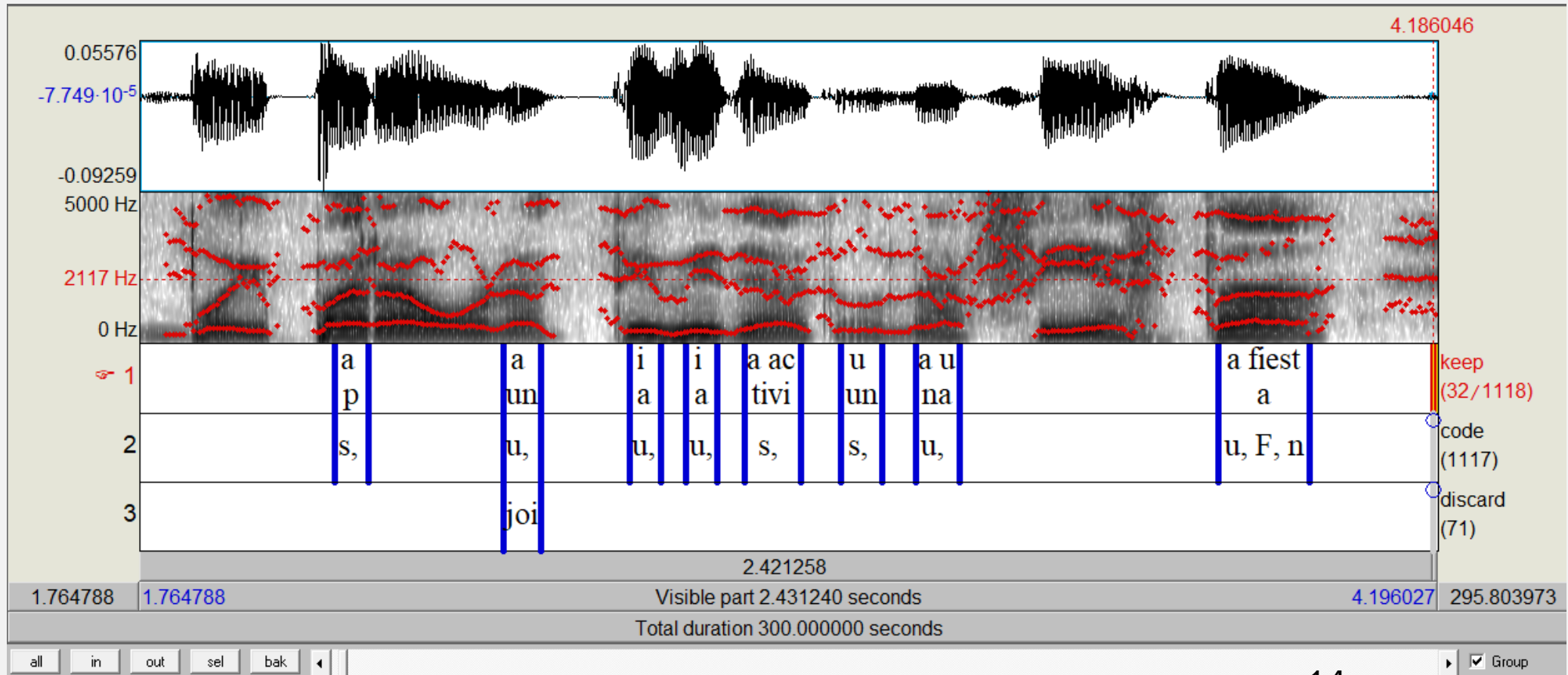
“Cuéntame tus planes para este fin de semana.”

# Participants

Level		PSTM ( / 144)	DELE ( / 20)	Vocab. (-30 - 60)	Sex	Study Abroad
4000-level	Low PSTM (N =5)	65	10.6	13	M = 3 F = 2	Yes = 2 No = 3
	High PSTM (N = 5)	116.4	11.2	20.4	M= 1 F = 4	Yes = 2 No = 3
Graduate-level	Low PSTM (N = 5)	51.4	15	44.2	M = 2 F = 3	Yes = 5
	High PSTM (N = 5)	120.2	14	28.6	F = 5	Yes = 5
Native	N=2	74	18	60	F = 5	Spain = 2 Mexico = 1 Puerto Rico = 1 Colombia = 1

# Analysis (1)

- Minutes 2-7 excerpted for all participants
- All monophthong vowels marked in Praat



# Analysis (2)

- Praat scripts used to extract:
  - *Vowel duration (in ms)*
  - *F1 and F2 vowels (at midpoint)*
- Data normalized using the Neary1 formula in NORM Suite (Thomas & Tyler, 2007); Neary values then scaled to produce normalized formant values

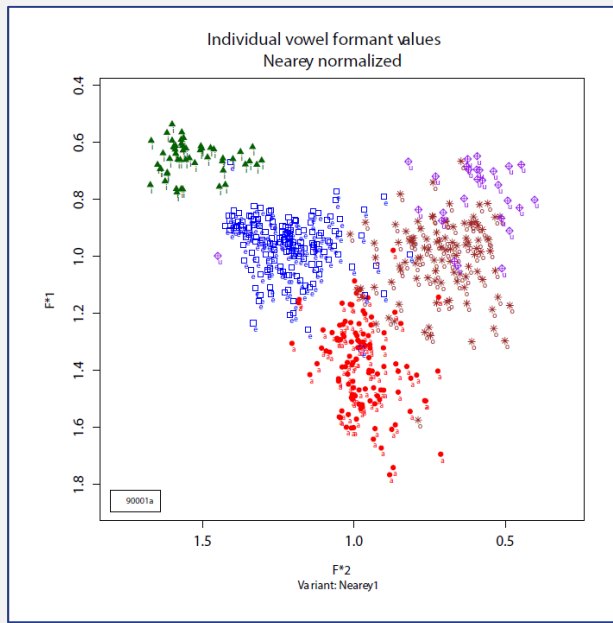
	4000-level	Graduate-level	Native speakers	Total
Exclusions	177	197	125	<b>499</b>
Final tokens	3774	5721	2694	<b>12,189</b>



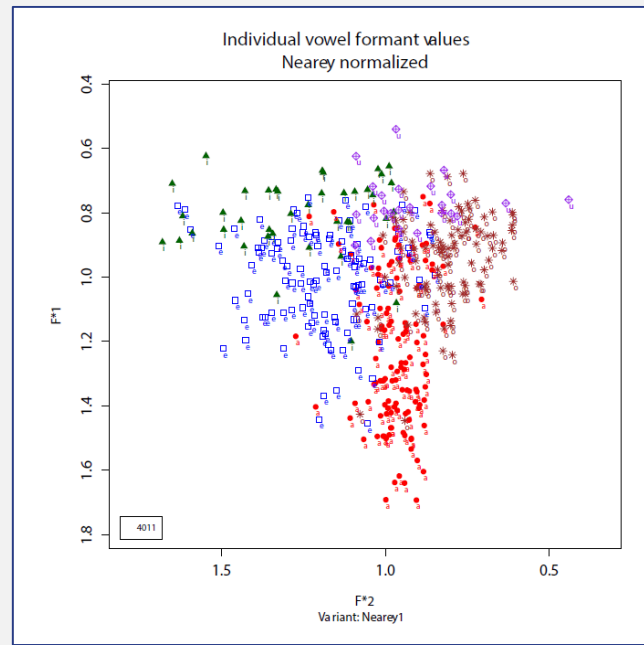
# RESULTS: Vowel Quality



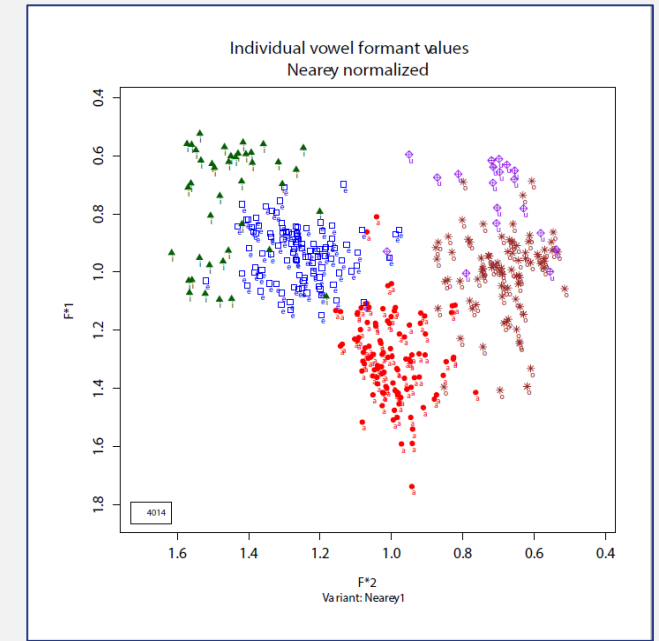




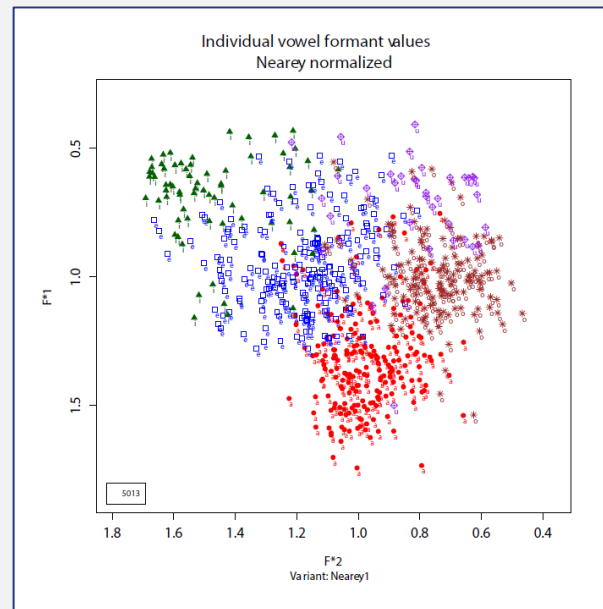
Native



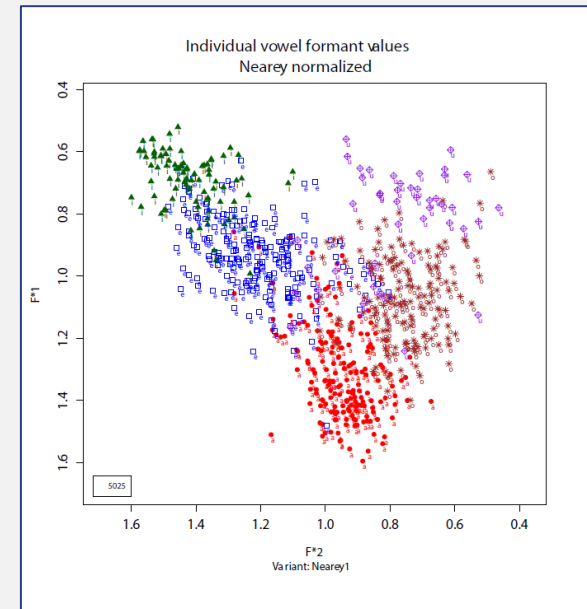
4000, low PSTM



4000, high PSTM

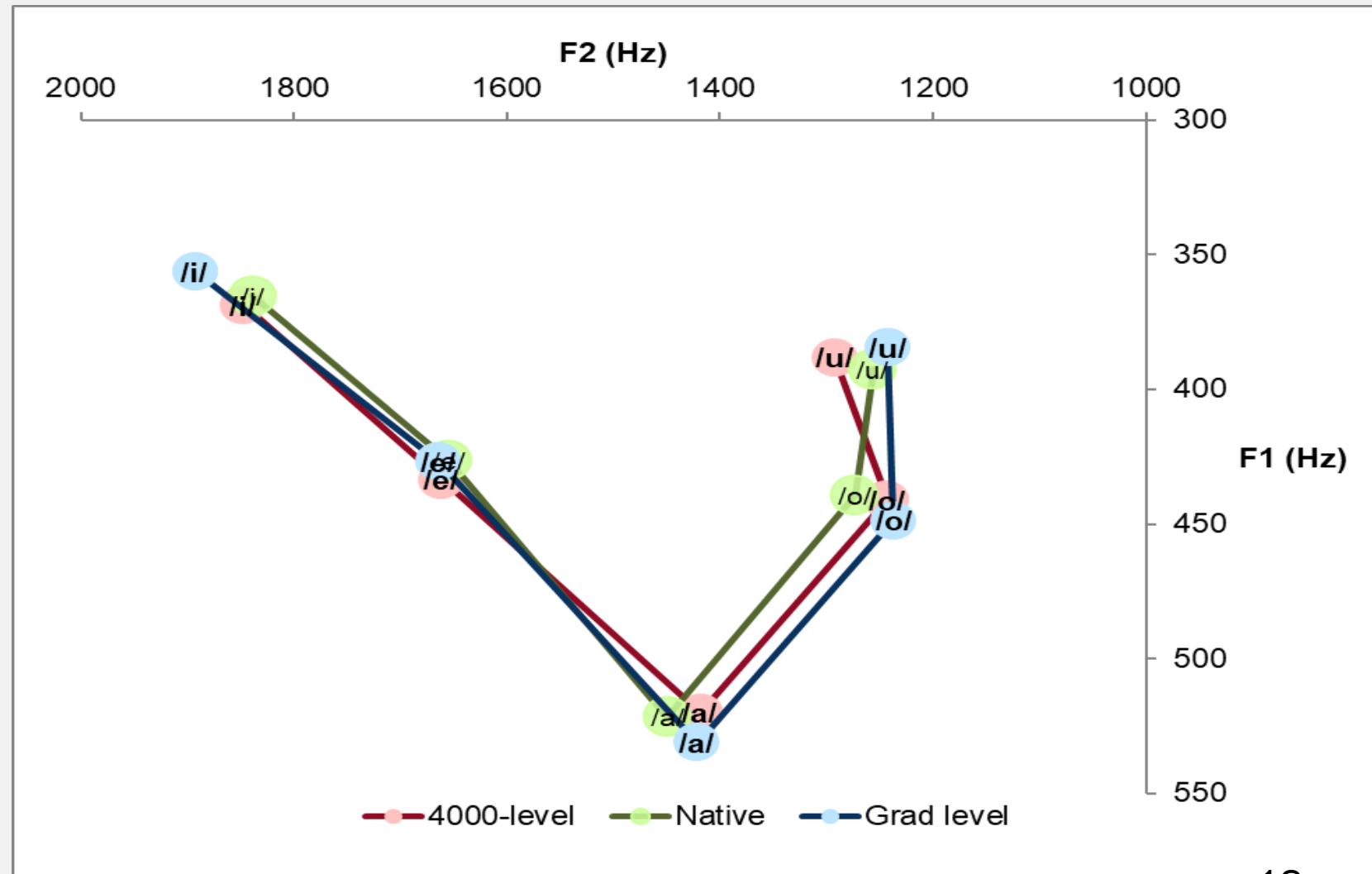


Grad, low PSTM

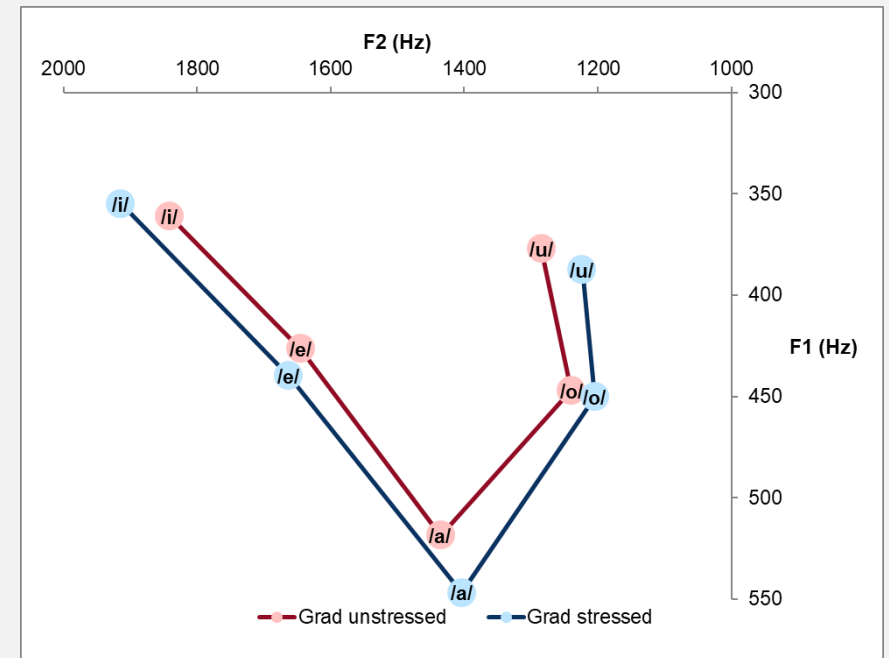
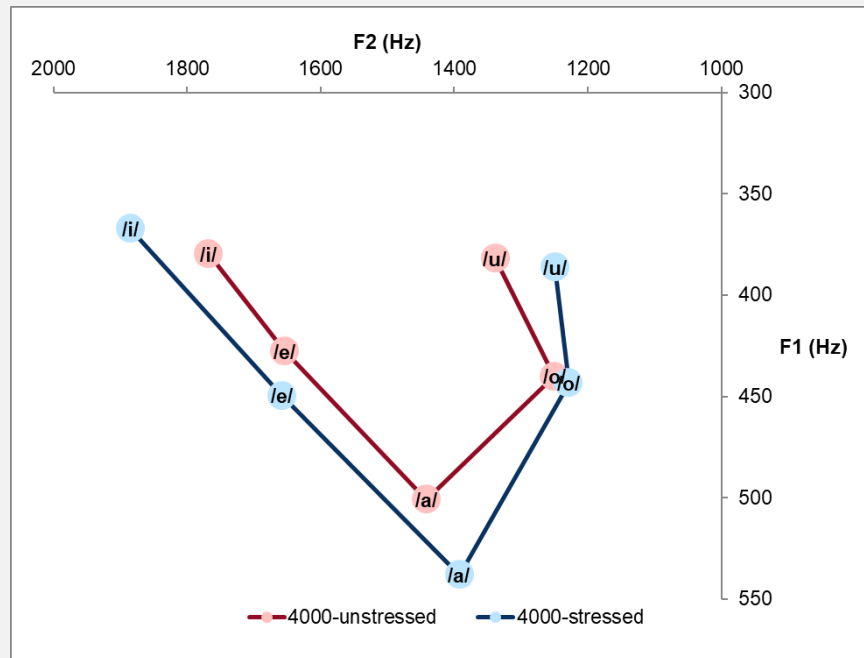
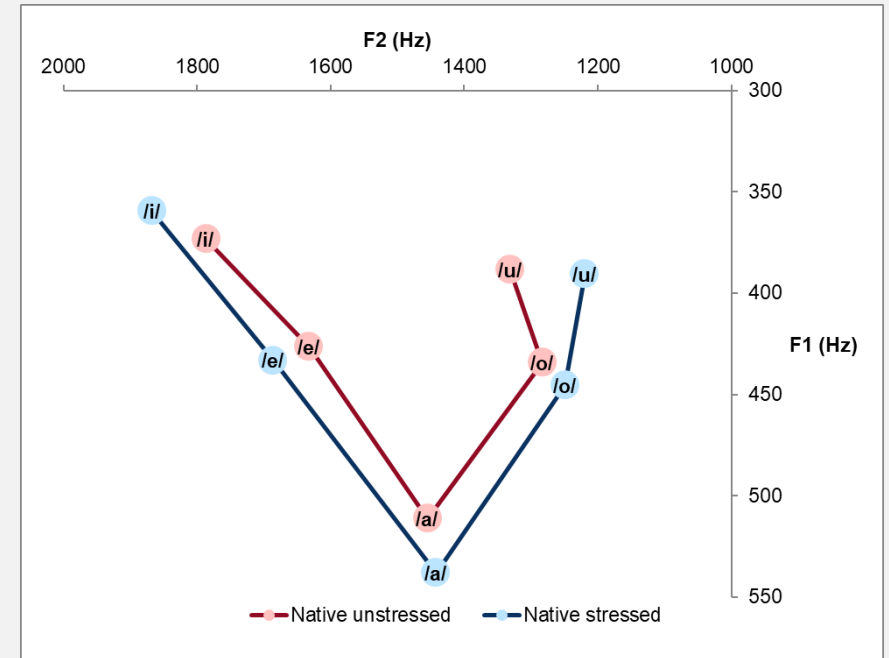


Grad, high PSTM

- Only natives have a /u/ that is posterior to /o/
- 4000-level learners show the most /u/ fronting



- All participants (incl. natives) show tendency to centralize
  - 4000-level learners centralize the most in unstressed syllables, particularly /u/ and /a/



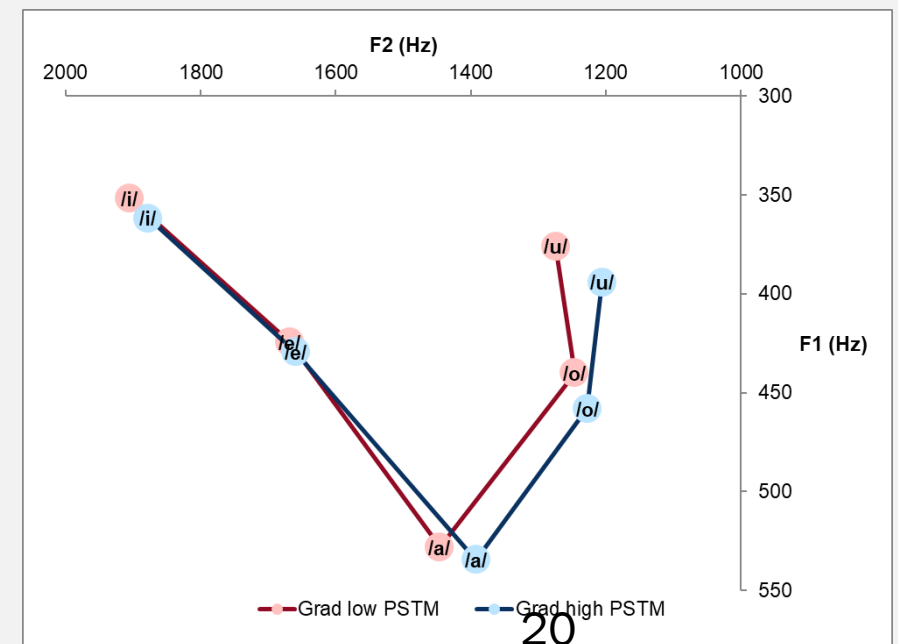
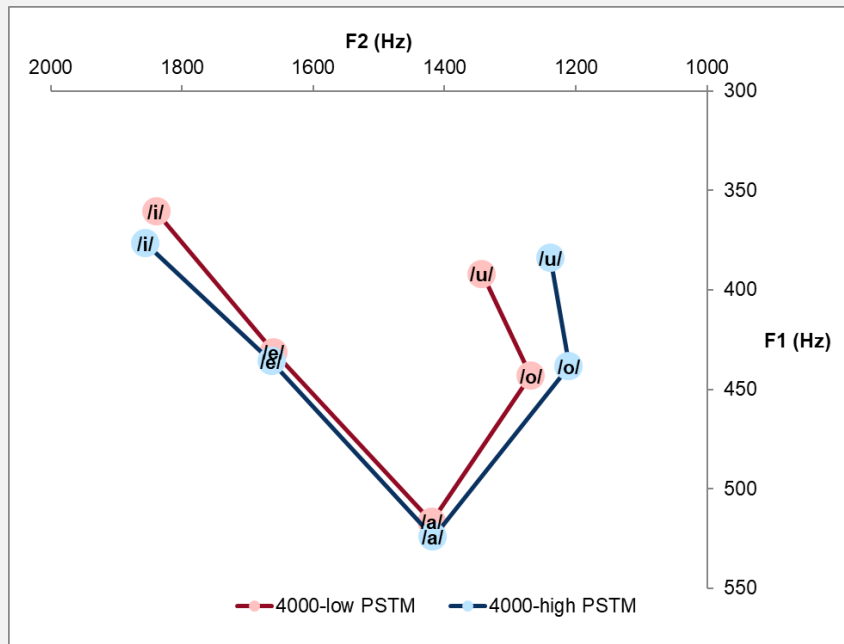
# ■ Differences between low PSTM and high PSTM learners:

## – 4000-learners:

- Low PSTM learners have a more fronted /u/ and /o/
- Low PSTM learners have a higher, higher /a/ and /i/

## – Graduate-learners:

- Significant F1 differences for /i/, /a/, /o/, /u/; Significant F2 differences for all 5 vowels
- High PSTM grad learners only group with /u/ posterior to /o/



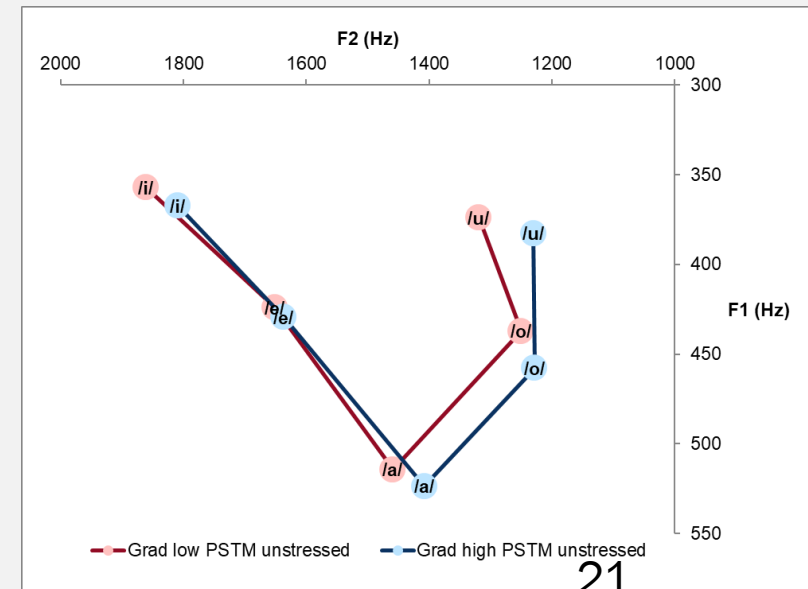
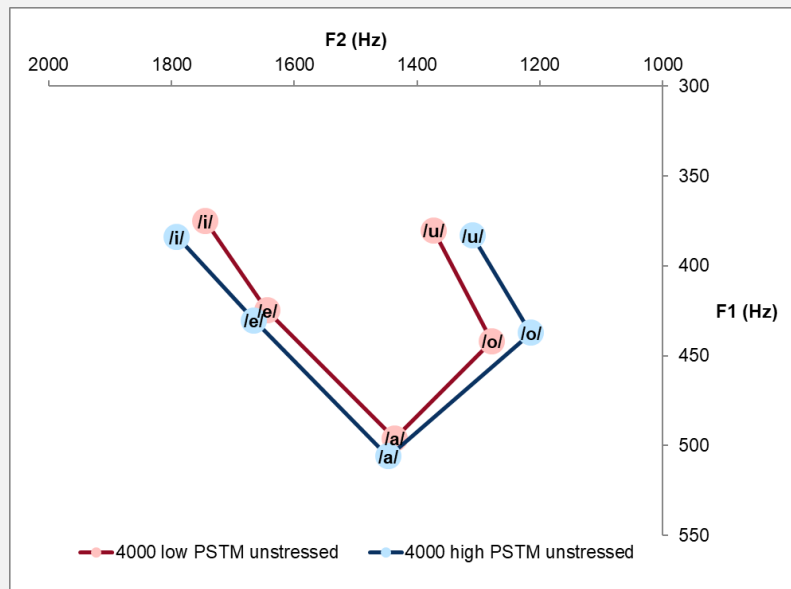
# ■ Unstressed vowels in 4000-level and grad PSTM groups

## – 4000-learners:

- More centralization in unstressed syllables for low PSTM
- /a/ is significantly raised; Significant F2 differences for /e/, /i/, /o/ and /u/

## – Graduate-learners:

- More fronting of /u/ in unstressed syllables for low PSTM





# RESULTS: Vowel Duration



## ■ Durations compared to native speakers:

- *4000-level learners produce all five vowels with longer durations than both other groups*
- *Graduate-level learners produce /a/, /e/, /i/ and /o/ with longer durations than NSs*

Level	/a/	/e/	/i/	/o/	/u/
4000-level	134.1	129.8	160.8	139.9	102.0
Graduate-level	112.1	105.0	132.0	102.0	83.0
Native	93.9	83.9	99.0	86.3	75.4

## ■ Differences between low PSTM and high PSTM

- *4000-level: high PSTM learners produce all vowels with longer durations than low PSTM learners*
- *Graduate-level: high PSTM learners produce /e/, /i/ and /o/ with longer durations than low PSTM learners;*

Level	/a/	/e/	/i/	/o/	/u/
4000-low PSTM	129.8	121.7	147.9	123.7	86.3
4000-high PSTM	140.4	138.8	173.88	160.6	118.8
Graduate-low PSTM	114.4	98.0	126.0	97.0	83.1
Graduate-high PSTM	109.3	114.0	139.7	108.0	83.7
<b>Natives</b>	<b>93.9</b>	<b>83.9</b>	<b>99.0</b>	<b>86.3</b>	<b>75.4</b>





# DISCUSSION



# Research questions REVISITED

- Do second language Spanish learners with differing PSTM abilities produce vowels with differing acoustic properties?



– *High PSTM learners will demonstrate acoustic properties that more closely approximate those of natives*



– *High PSTM learners will centralize their unstressed vowels less than those with low PSTM*



– *High PSTM learners will produce shorter vowels than those with low PSTM*

- If so, does the effect of PSTM change across levels?



– *Differences according to PSTM will be larger in the 4000-level than the graduate-level*

# Comparison with previous literature

## PSTM

- Effect of PSTM in both advanced levels for vowel quality, centralization and duration
- Differs from previous literature on advanced learners (Sleve & Miyake, 2006; Xiaochen et al., 2013):
  - *Task type: reading v. free response*
  - *Analysis: global pronunciation v. specific class of sounds*

## L2 vowels

- Similarities
  - *Learners produce different qualities*
  - *Often centralize unstressed vowels*
- Differences
  - */u/ in our study is much more fronted than in Menke & Face, 2010*
  - ***BUT*** *oral speech v. reading task*

# Future Work

- Control for rate of speech
- Further examine relationship with stress
- Examine relationship between duration and vowel quality
- Investigate outliers

**Thank you.**

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