

# ACOUSTIC MEMORY IN L2 VOWEL PERCEPTION

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# Factors affecting L2 perception/production

- Age of L2 learning (Long, 1990; Flege *et al.*, 1995, 1999)
- L1 influence (Best, 1995; Flege, 1995)
- Quality and quantity of input (Flege, 2009; Moyer, 2009)
- Amount of L1/L2 use (MacKay *et al.*, 2001; Piske *et al.*, 2001)

Cannot explain remaining inter-subject variation in L2  
phonological development

## Individual differences in cognitive ability:

- musical aptitude (Gottfried, 2007; Slevk & Miyake, 2006)
- phonetic talent (Jilka *et al.*, 2007)
- phonological short-term memory (Cerviño-Povedano & Mora, 2011; MacKay *et al.*, 2001)
- aptitude for oral mimicry (Purcell & Suter, 1980)

Little is known: relationship between **these factors** and **L2 perception/production**

## Why explore?!

- Remain underresearched
- Examining relationship between cognitive abilities and L2 phonological acquisition
- May help to identify characteristics of learners
  - who struggle with L2 phonological acquisition
  - who successfully master L2 pronunciation

# The Present Study: Focus

- Inter-subject variation in L2 target-like perception  
(weighting of phonetic cues in speech perception)

# Problems with L2 perception

## 1. Cross-linguistic phonetic similarity affects:

- L2 perception through L1 - inaccurate formation of L2 categories

### Why?

- L1 phonetic prototypes - “magnets”
- Perceptual assimilation to the most similar L1 phoneme

## 2. Cue-weighting:

- Reliance on wrong cue

### Why?

- More salient (E.g. Duration)

### What to do?

- Discern phonetic differences between L1 and L2
- Rely on right phonetic cue

# The Present Study: Focus

- Inter-subject variability in L2 target-like perception  
(weighting of phonetic cues in speech perception)
- Spanish/Catalan EFL learners difficulty in target-like perception of English /i:/ and /ɪ/ contrast
  - **Single Category assimilation**  
English /i:/ - /ɪ/ to the Native /i/ category
  - **Overreliance** on duration when perceiving /i:/ and /ɪ/ contrast
- Individual differences in **Acoustic Memory (AM)**

# Acoustic Memory (AM)

Listeners must process acoustic phonetic features before speech becomes intelligible (can be understood and repeated):

- Voicing
- Duration
- Pitch

Acoustic Memory is the storage capacity for the auditory processing of acoustic phonetic features kept at a pre-lexical level, i.e. prior to phonological encoding (before intelligibility occurs).



# Acoustic Memory (AM)

<b>Phonological memory</b>	<b>Acoustic memory</b>
operates at the phonological level handles phonological units	acoustic/phonetic details of the speech signal (pitch, voicing, duration)
between-category discrimination	within-category vowel discrimination L2-L1 sound mapping

- Spanish/Catalan EFL: /i:/-/ɪ/ - within-category discrimination

**ASSUMPTION:** Individuals with greater AM capacity more sensitive to differences in acoustic information between perceptually similar L2 vowels and perceptually close L2-L1 vowel pairs.

# Acoustic Memory (AM)

How can we measure AM? (general auditory processing)

Stimuli should:

- be non-intelligible
- avoid phonological encoding
- be as acoustically complex as speech

Rotated Speech (through spectral inversion)

- non-intelligible (would require specific training)
- as temporally and spectrally complex as speech
- preserves most speech-like properties in the spectral and temporal domains  
(voicing, friction, pitch changes)

# The Present Study: Aim and RQ

## AIM:

- To investigate the extent to which Acoustic Memory is related to L2 vowel perception.

## RQ:

- Are L2 learners with higher acoustic memory capacity better able to rely on spectral information than lower ability learners in the perception of the English tense-lax /i:/-/ɪ/ contrast?

## Hypothesis

Individuals with higher acoustic memory capacity might be better able to rely on spectral information in the discrimination of English /i:/ and /ɪ/ because they would be more sensitive to the qualitative differences underlying this vowel contrast.

# The Present study: Method

## ■ Participants:

- 53 Spanish/Catalan EFL learners (mean age: 20,9)
- 13 NS – baseline data
- No speech disorders or hearing problems
- Self-estimated proficiency level: from intermediate to advanced

## ■ Tasks and Procedure:

- Linguistic Background Questionnaire
- Acoustic memory (Serial Nonword Recognition task)
- Cue-weighting in L2 vowel perception (Vowel Discrimination Task)

DmDx display  
software  
(Foster & Foster, 2003)



# The Present Study: Materials

- Acoustic memory task:
- SNWR task adapted:  
Same or different

## 3-item length sequence:

Original



Rotated



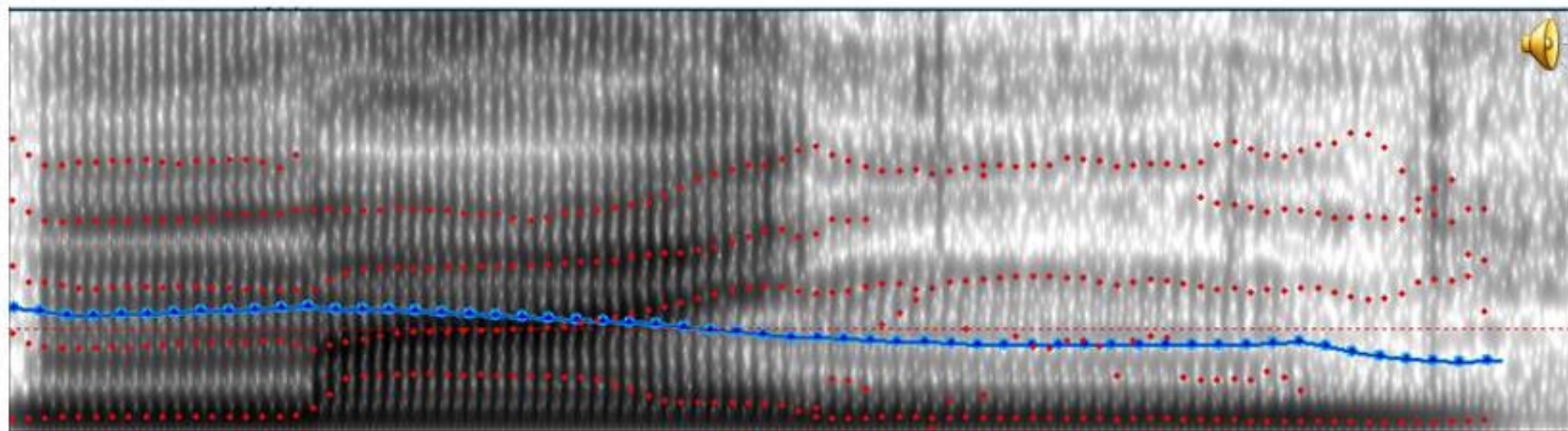
## Spectrally Rotated Speech

- temporal and spectral complexity of ordinary speech, but NOT intelligible
- cannot be phonologically encoded, understood, repeated or sub-vocally rehearsed (Scott *et al.*, 2000)
- subjects are forced to rely only on the acoustic information

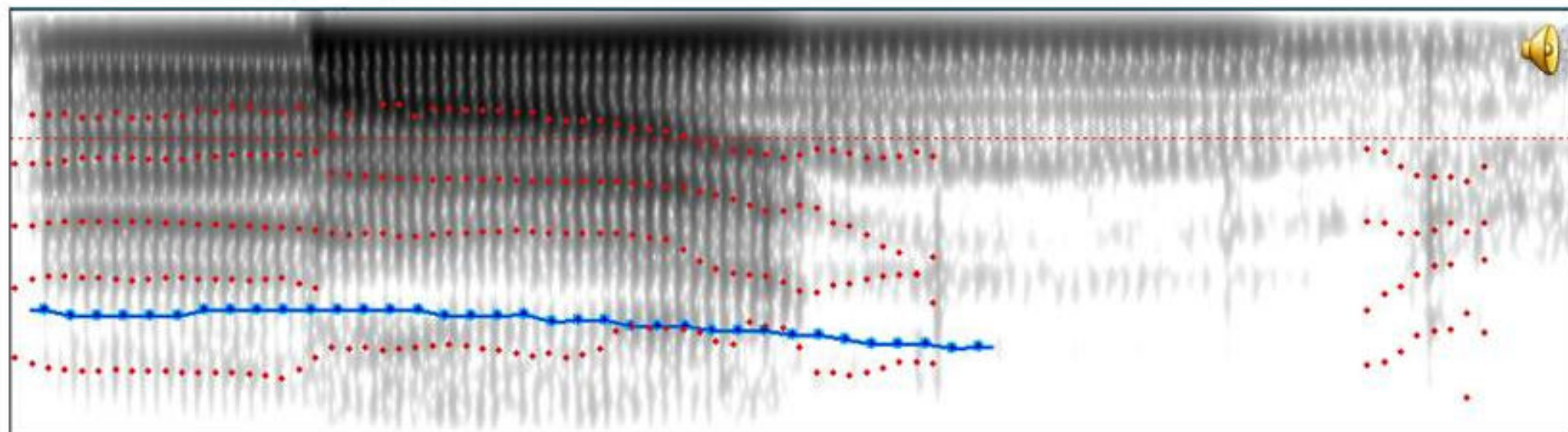
# The Present Study: Materials



[map]











Rotated [map]



# The Present Study: Materials

- Stimuli
- Catalan nonwords (144 nonwords) spectrally rotated using Praat
- 3-, 4-, 5- and 6-item length sequence pairs
- 32 testing trials and 2 initial warm-up trials

Sequence	SAME	DIFFERENT
3-item length 		
4-item length 		
5-item length 		
6-item length 		

**Measure:** weighted score (out of 144) (O'Brian *et al.*, 2007)

# The Present Study: Materials

## ▪ Vowel Discrimination Task

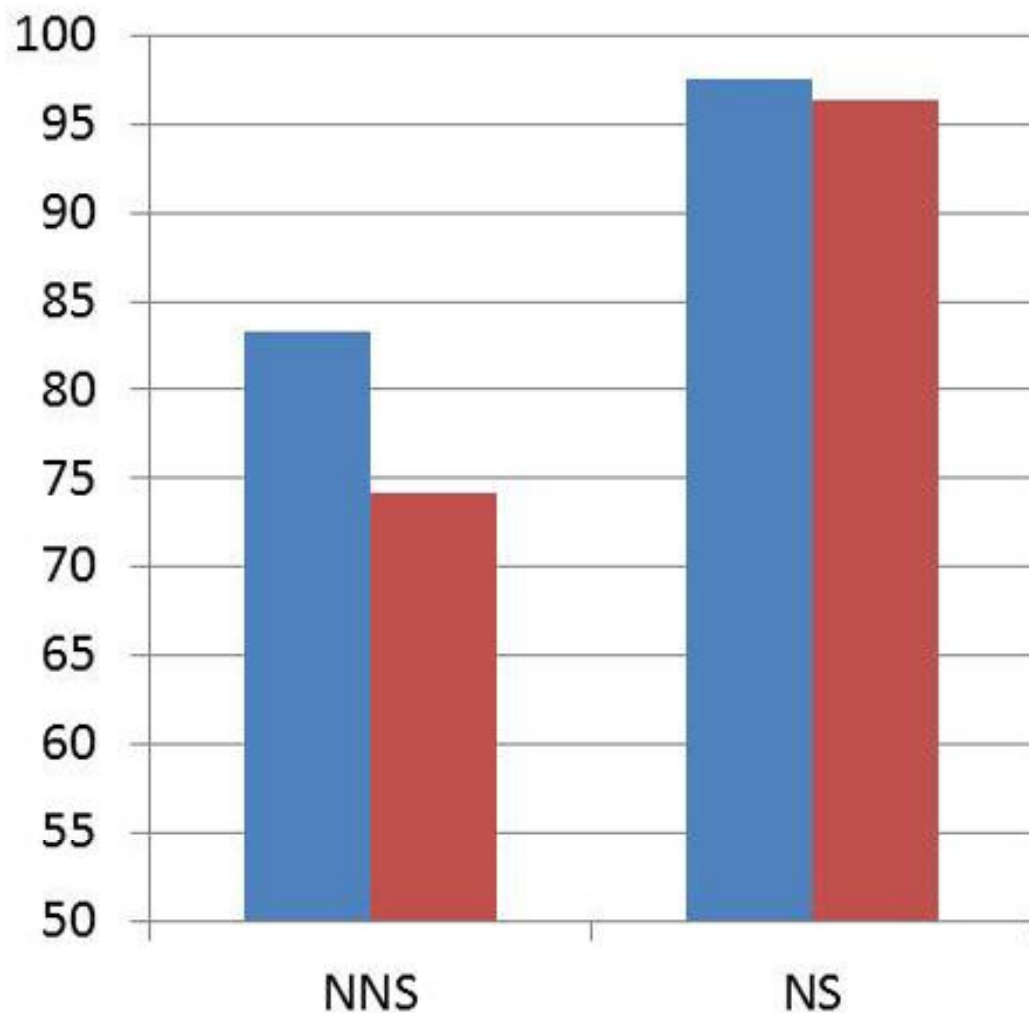
FC AXB Categorical Discrimination Test (Moya-Galé & Mora, 2011)

- /i:/ and /ɪ/ in 6 CVC minimal pairs /b\_d/, /d\_d/, /s\_d/, /b\_t/, /p\_k/, /p\_t/
- 6 native English speakers (3 males, 3 females)
- 72 natural and 72 duration manipulated stimuli
- Different tokens within trial
- Different speakers within trial

bead – **bid** – bid   
(male<sup>1</sup> - female<sup>3</sup> - male<sup>2</sup>)



# Results: AXB discrimination



■ Natural  
■ Manipulated

## Non-Native

NAT  $M=83,34$

MAN  $M=74,19$

$t(52)=7.14, p<.001$

## Native

NAT  $M=97.50$

MAN  $M=96.35$

$t(12)=1.39, p=.190$

# Results: Correlations



	AM	DIS (NAT)	DIS (MAN)
AM		.499** .291*	.441** .299*
DIS (NAT)			.758** .716**

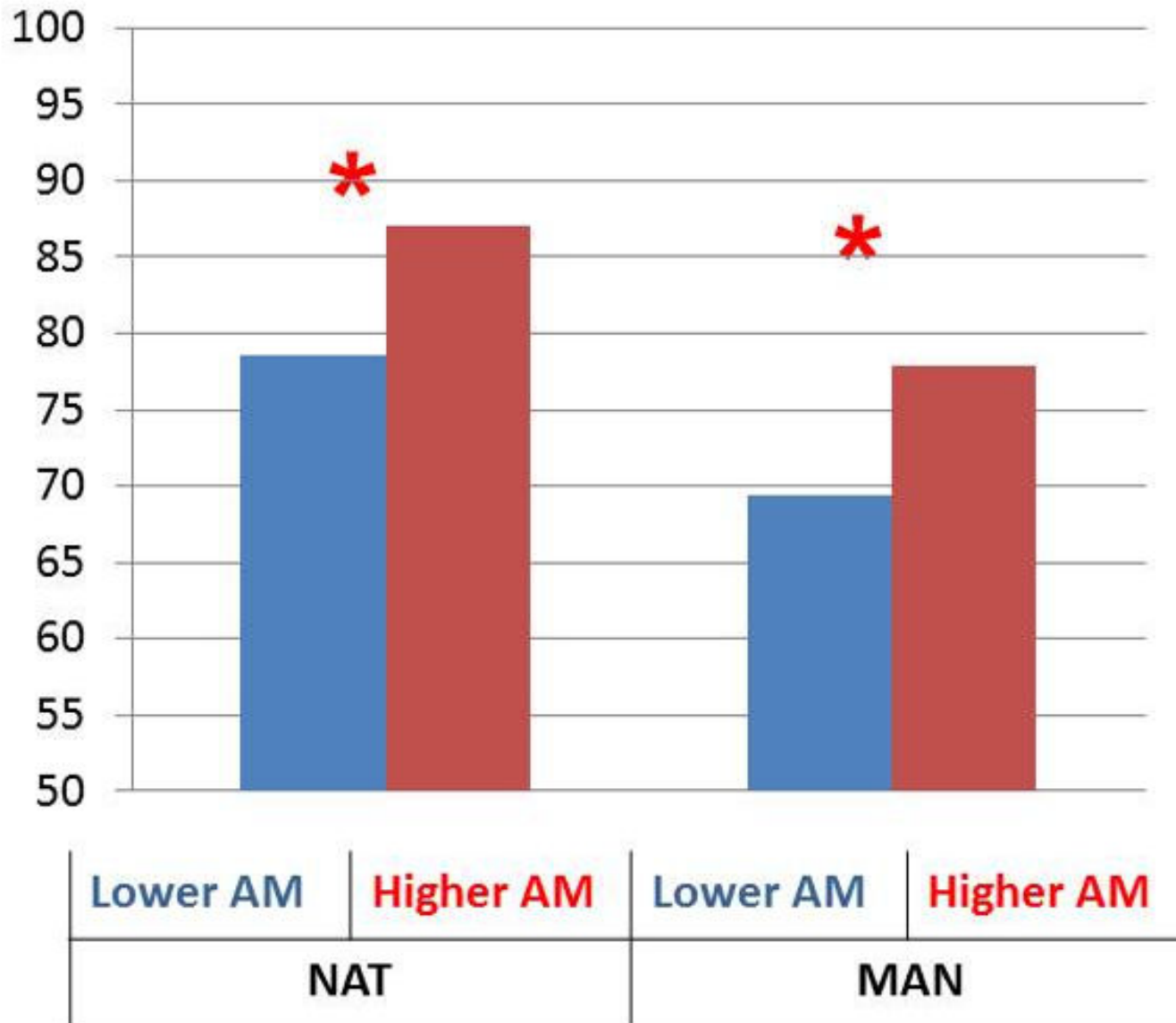
\*\* Correlation is significant at .001 level

\* Correlation is significant at .05 level (control for proficiency)

# Results: Acoustic Memory



# Results: Acoustic Memory



**ANOVAs**

within: Nat/Man

$p < .001$

between: Low/High

$p < .05$

**Group differences:**

Low AM ( $N=23$ )

High AM ( $N=30$ )

Nat:  $p = .008$

Man:  $p = .030$

# Results: Regression

- $R^2 = .343$  (34%);  $p = .002$  (DIS)
- $R^2 = .330$  (33%);  $p = .003$  (NAT)
- $R^2 = .283$  (28%);  $p = .01$  (MAN)



	% Unique variance explained	$p =$		AXB Discrimination  <b>18.4%</b>
Acoustic Memory	<b>19,7%</b>	$=.001$	NAT	
	<b>13,3%</b>	$=.007$	MAN	

## THE PRESENT STUDY

### Acoustic Memory:

- ✓ IS RELATED to L2 vowel perception
- ✓ L2 learners with higher acoustic memory are better able to rely on spectral information than lower ability learners in the perception of the English tense-lax /i:/-/ɪ/ contrast

### THUS it may:

- facilitate target-like cue-weighting
- explain inter-learner variation in L2 phonological attainment
- provide learners with an advantage in phonetic training involving backgrounding and foregrounding of L2-specific acoustic features

## Methodological issues to be solved:







- improve the task
- control saliency of consonants
- control difficulty of the items (sequence length, ISI)
- validate the task

## ONGOING RESEARCH: Task Validation

- **Original Task (3-6 item length):** Cronbach's alpha = 0,160
  - Catalan CVC
  - 3-6 item length
  - ISI 200ms and 750ms
- **Version 2:** Cronbach's alpha = 0,375
  - Catalan CVC
  - 4-6 item length
  - ISI 150ms and 1000ms
- **Version 3:** Cronbach's alpha = 0,632
  - Catalan VCV nonwords
  - 3-5 item length
  - ISI 150ms and 1000ms



# Discussion and Conclusions

Item length	Same	Different	Cronbach's alpha
3-item length			0,424
4-item length			0,470
5-item length			0,189

## FUTURE RESEARCH:

- Solve methodological issues
- Improve and Validate the task (stimuli need revision)
- Reliable proficiency measure
- Other cognitive abilities: E.g. ability for oral mimicry
- Focus on both: L2 speech perception and production

# Thank you!

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