

# Age of onset of bilingualism and length of exposure in the production of Spanish consonantal contrasts

**Natalia Mazzaro<sup>1</sup>, Laura Colantoni<sup>2</sup> & Alejandro Cuza<sup>3</sup>**

**University of Texas, El Paso<sup>1</sup>, University of Toronto<sup>2</sup>, Purdue University<sup>3</sup>**

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# Introduction

- What is the psycholinguistic nature of bilingual speakers' grammar? Do HS of Spanish born and raised in the U.S. develop native-like knowledge of grammatical properties not present in their dominant language?
- To what extent do the differences found among bilingual and monolingual speakers stem from transfer from the other language, their age of onset of bilingualism, or both?
- Bi-directional influences have been observed at all levels, including phonetics and phonology (e.g. Antoniou *et al.*, 2011; De Leeuw *et al.*, 2010; Flege *et al.*, 2003; Fox *et al.* 1995; Morrison, 2006).

# Goals of the study

- To explore the differences in the production of Spanish voiced & voiceless stops between HS, LTIs and monolingual Spanish speakers (baseline group).
- To better understand the degree of interaction between the L1 & L2 in the phonology/phonetics of bilinguals.
- To explore the influence of AOA and frequency of language use (among other factors) on bilinguals phonological/phonetic system.

# English & Spanish stops

	English	Spanish
Voiceless stops	Long lag VOT	Short lag VOT
	Audible burst	No audible burst
Voiced stops	Short lag VOT	Voicing lead
	No manner alternation	Stop/Approximant alternation

Abramson & Lisker (1964); Hualde (2005); Martínez Celdrán (1985); Ortega Llebaria (2004)

# Previous research on **voiced** & **voiceless** stops in Spanish-English bilinguals

- Spanish / English bilinguals significantly **differ** from monolingual speakers of each language in terms of VOT
  - Voiced
    - Zampini (1994, 1998)
    - Kim (2012)
    - Williams (1979)
  
- Spanish / English bilinguals are **similar** to monolingual speakers of each language in terms of VOT
  - Voiced
    - Alvord and Christiansen (2012) with study abroad learners
    - Williams (1977)
    - Magloire and Green (1999)
    - Yavas (1996)

# Important differences between studies

- Heterogeneity of bilingual subjects
- Quality and quantity of L1 & L2 exposure
- Across the board comparisons are difficult due to differences in the stimuli (phonemes, phonetic contexts, use of cognates vs. non-cognates)
- Language mode
  - Some studies mix both English and Spanish stimuli in the same session (e.g. Magloire & Green 1999); others do it independently in each session.

# Previous research on AOA

- **Abrahamsson & Hyltenstam (2009):** Strong negative correlation between L2 native-like attainment and age of onset of bilingualism. L2 learners are unable to fully acquire L2 patterns not present in their L1 after certain age due to cognitive impairment
- **Hopp & Schmid (2011):** Comparable patterns of morphosyntactic and phonetic divergence between near-native L2 learners and long-term immigrants undergoing L1 attrition, casting doubts on **maturational constraints** in language learning.

# Research Questions

RQ1: Do Spanish HSs and LTIs differ in their **production** of voiceless/voiced stops? And if so...

RQ2: What is the role of AOA and bilingualism effects in this process?

RQ3: Will the difficulties occur across the board or will voiced stops be more affected than voiceless?



# Predictions

- ❑ If maturational approaches are correct, we expect HSs to behave as LTIs, since they were both exposed to Spanish from birth.
- ❑ If exposure and use of another language affect production of speech sounds,
  - ❑ HSs exposed to English from early childhood will differ from LTIs in their production of Spanish stops due to reduced exposure and use of Spanish in the lifespan.
  - ❑ LTIs exposed to English as adults will not differ from monolinguals but they will differ from HSs.
  - ❑ We predict voiced stops to be more vulnerable than voiceless stops given that (1) when realized as stops, they are prevoiced, in contrast with English; (2) they alternate with approximants.

# Directionality of the differences expected

- VOT
  - Voiceless stops: HSs >LTIs\*-monolinguals\*/LTIs-Mon (no\*)
  - Voiced stops: Positive VOTs for HSs and negative VOTs for LTIs & monolinguals
- Voiced stops
  - HSs: higher rate of stops in intervocalic position when compared to the other two groups
- Approximant realization
  - If HSs produce approximants, those are expected to be more constricted than the ones produced by the other two groups as reflected in higher CV intensity ratio and possibly longer durations.

# Methods

# The Study

## *Participants*

- We explore the issue of cross linguistic influence in the speech of two groups of bilinguals who spoke Spanish from birth but differ in their age of onset of acquisition of English :
- HSs (early bilinguals)
  - “individuals raised in homes where a language other than English is spoken and who are to some degree bilingual in English and the heritage language.” (Valdés, 2000)
  - Typically, they receive formal education in English
- LTIs (late bilinguals)
  - Participants exposed to English after maturation and educated in Spanish.
  - Participants born and raised in native Spanish context

# The study: 31 participants

	HSs (n=13)		LTIs (n=9)		Controls (n=9)
<b>Mean age at testing (SD)</b>	23 (2.6)		39 (13.35)		19.9 (4.31)
<b>Place of birth</b>	ELP, US (n=7)	Chi, Mx (n=6)	ELP, US (n=2)	Chi, Mx (n=7)	Chi, Mx (n=9)
<b>Mean AOA</b>	-	6	-	26	19.5
<b>Mean LOR</b>	-	19	-	15	7 months
<b>DELE (mean score)</b>	40/50		45/50		44.5/50

AOA= Age of acquisition

LOR = length of residency in the US

DELE= proficiency task, adapted from the *Diploma de Español como Lengua Segunda*

# Stimuli & Tasks

- Spanish words (N=88) read in carrier sentence:  
*Digo X para ti* ('I say X for you')
- Controlled for
  - place of articulation (labial, velar and coronal)
  - position in the word (initial vs. medial)
  - following vowel (/a, e, i, o/)
  - stress (stressed vs. unstressed)
- Stimuli presented using Power Point
- Stimuli were excised from carrier phrase and subsequently analyzed using Praat

# Stimuli examples

- Spanish voiced and voiceless stops/approximants

	Initial Position	Medial Position
<b>Stressed syllable</b>	<b>[b]</b> ata / <b>[p]</b> ata ("robe" / "foot")	pe <b>[ɣ]</b> ar / pe <b>[k]</b> ar ("to hit" / "to sin")
<b>Unstressed syllable</b>	<b>[b]</b> azar / <b>[p]</b> asar ("pound shop" / "pass")	pa <b>[ɣ]</b> a / lo <b>[k]</b> a ("s/he pays" / "crazy")

# Linguistic & Extra-linguistic factors

Linguistic	Extra-linguistic
<ul style="list-style-type: none"><li>• Place of articulation</li><li>• Stress</li><li>• Position in the word</li><li>• Following vowel</li></ul>	<ul style="list-style-type: none"><li>• AOA</li><li>• Length of residence (LOR)</li><li>• Frequency of Spanish use</li><li>• Self-proficiency in Spanish</li><li>• DELE (proficiency task, adapted from the <i>Diploma de Español como Lengua Segunda</i>)</li></ul>



# Acoustic parameters analyzed

Voiceless stops	Voiced stops/approximants
<ul style="list-style-type: none"><li>• VOT</li><li>• Percentage voicing (PV)</li></ul>	<ul style="list-style-type: none"><li>• VOT</li><li>• Percentage voicing (PV)</li><li>• Intensity (relative)</li><li>• Duration (relative)</li><li>• Bursts</li></ul>

## Calculations:

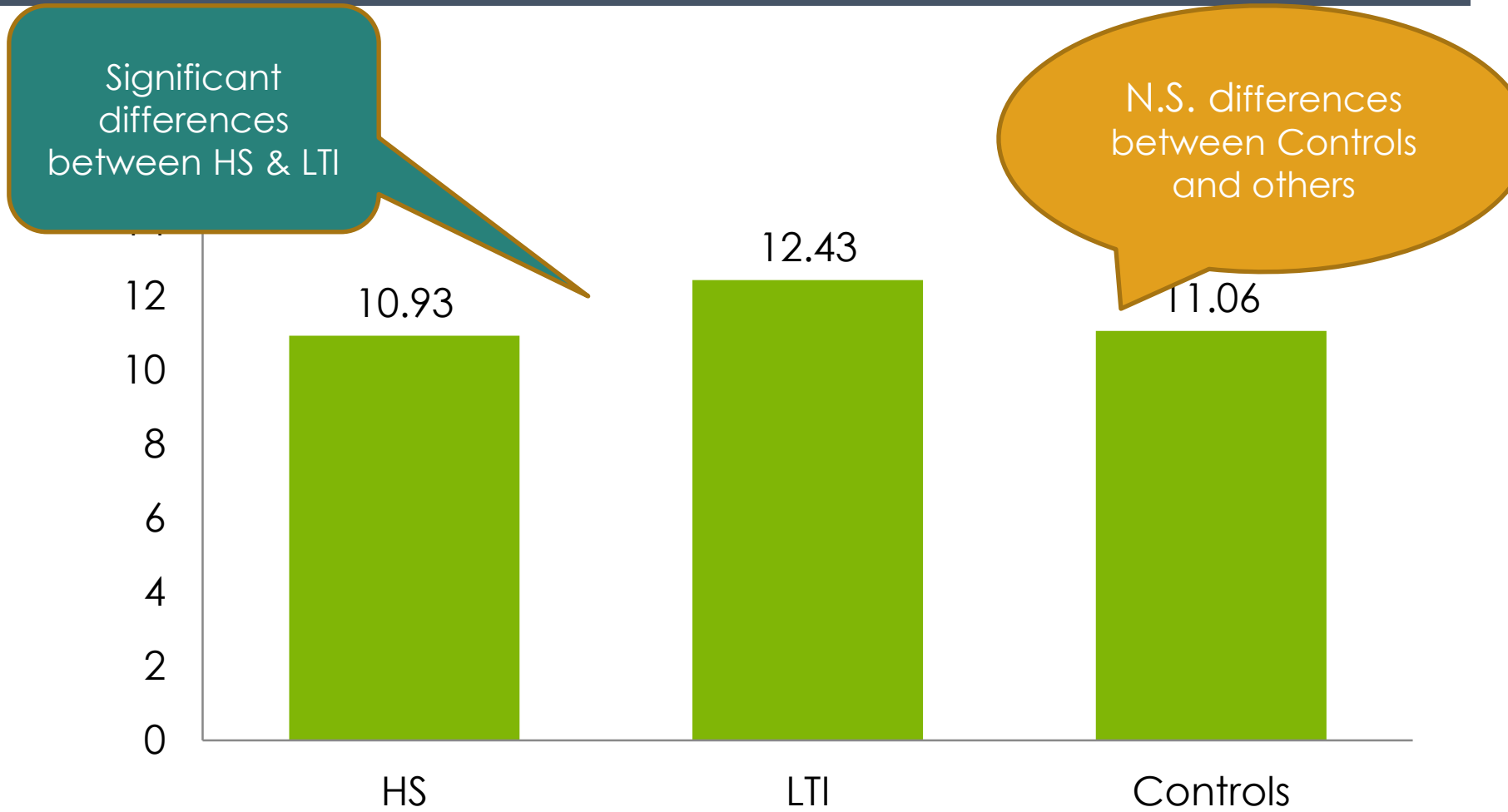
VOT: log (base 10) of the VOT measured in milliseconds

PV: also transformed logarithmically. For voiceless stops, only in medial position

Relative duration: ratio of the duration of the consonant to the duration of the following vowel.

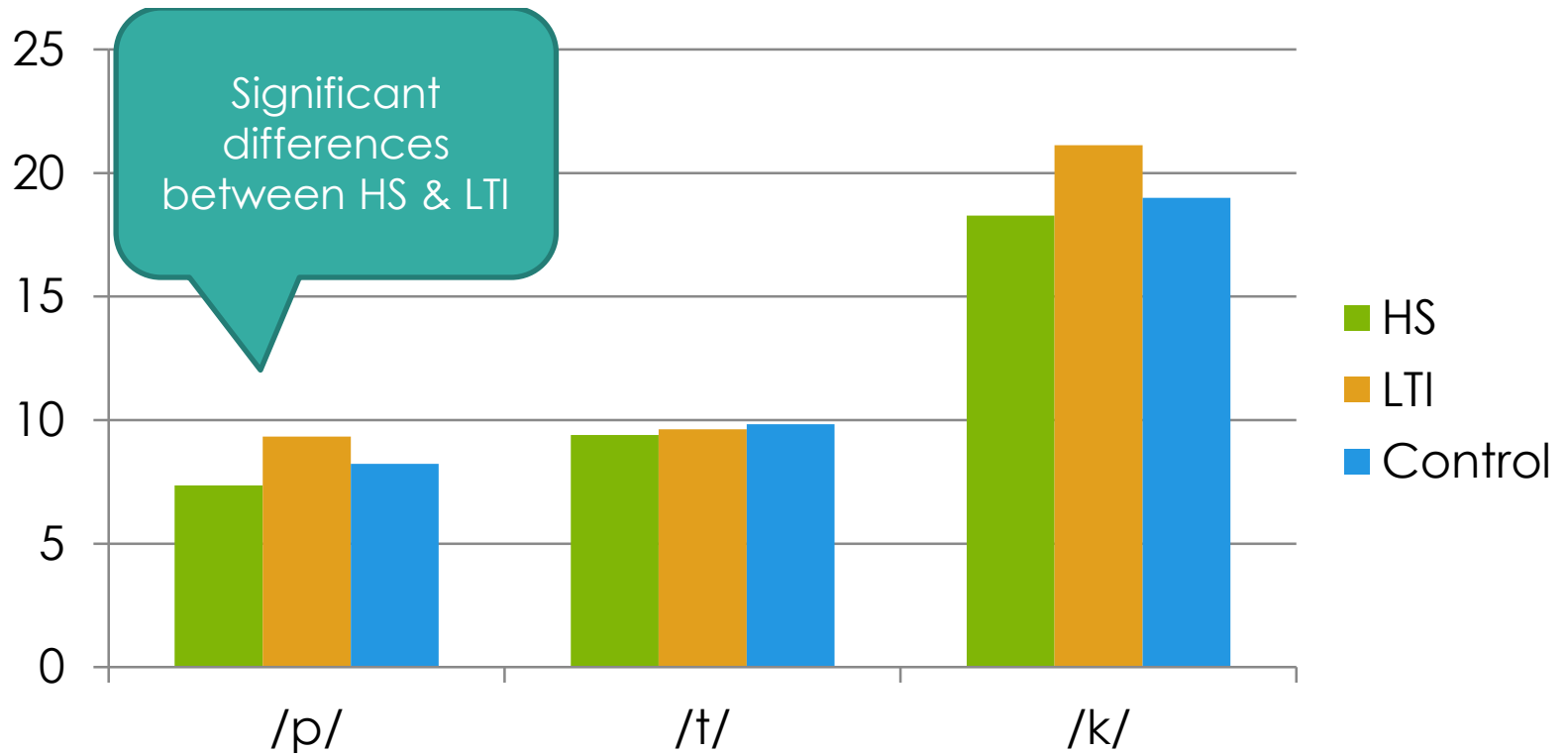
# Results for /p, t, k/

# VOT means x group

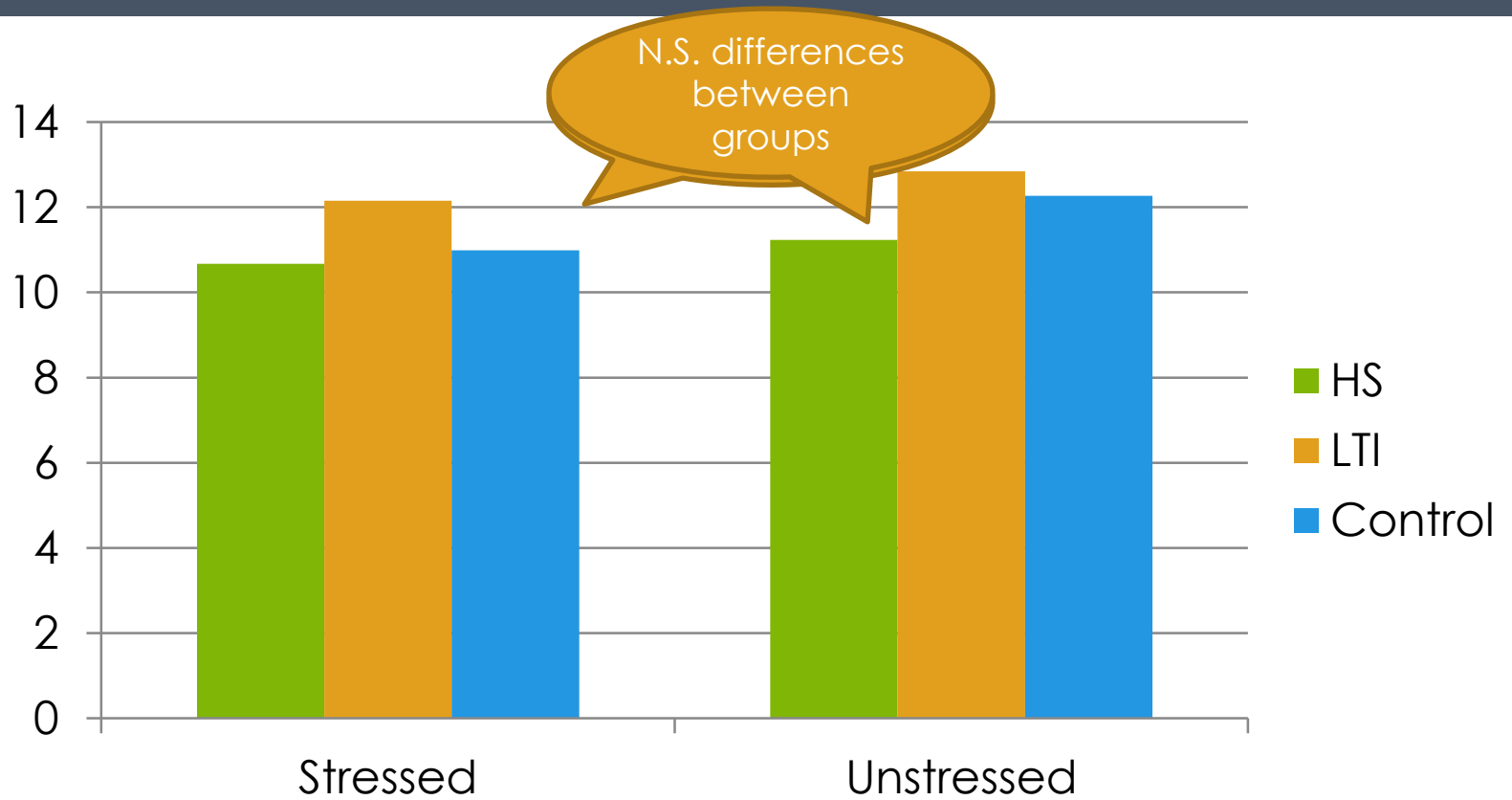


Total N of tokens: 1435

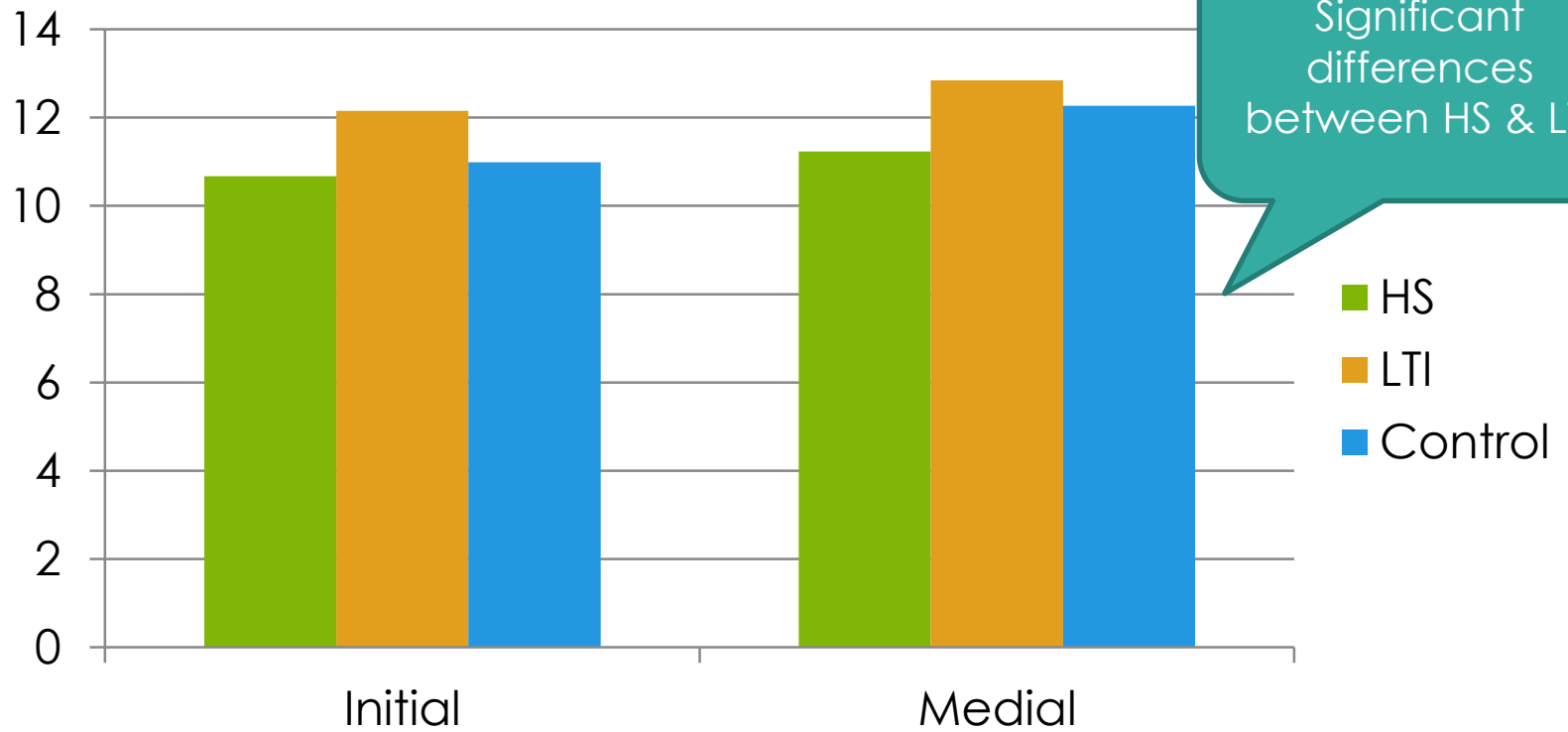
# VOT x group x place of articulation



# VOT x group x stress



# VOT x group x position

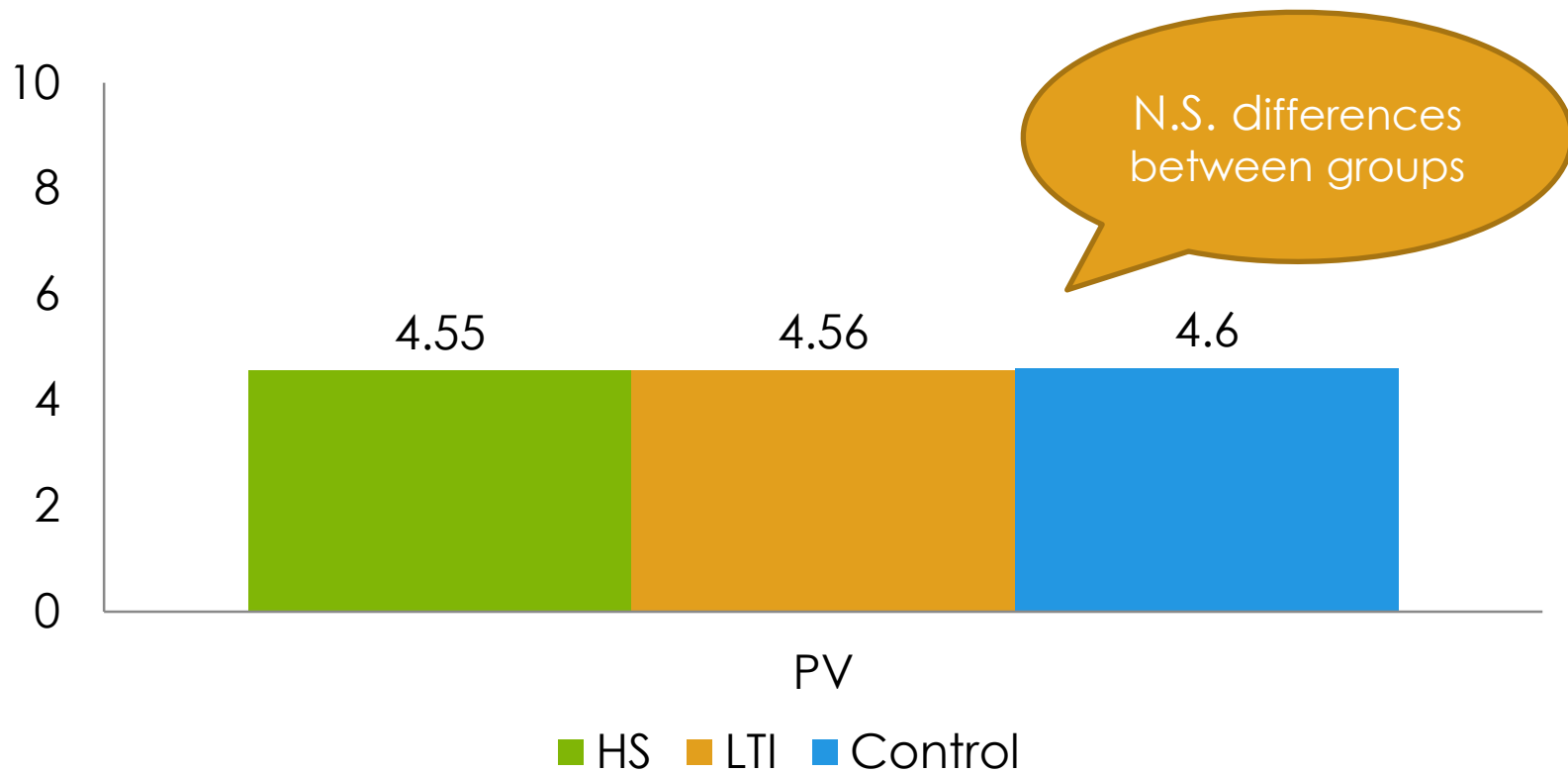


# Influence of linguistic and extra-linguistic factors on VOT

- Linguistic
  - Place of articulation
  - Position of the consonant in the word
- Extra-linguistic
  - + frequency of Spanish use → shorter VOT (expected)
  - + Proficiency score (DELE) → longer VOT (unexpected)
  - + Self-proficiency in Spanish → longer VOT (unexpected)
  - + LOR → shorter VOT (unexpected, but consistent w/ HS)

Results of a GLM model

# Percentage voicing (PV) x group



\* Medial position only






# Summary for /p, t, k/

- HSs tend to produce shorter VOTs than LTIs, with Controls not differing from either group.
  - Significant differences with /p/
  - Significant differences in medial position
  
- When analyzing **bilinguals only**:
  - AOA does not play a significant role in predicting VOT.
  - LOR seems to influence VOT, but in the opposite direction (a longer LOR leads to shorter VOT). This is in line with the finding that HS (who have a longer LOR) have shorter VOT.

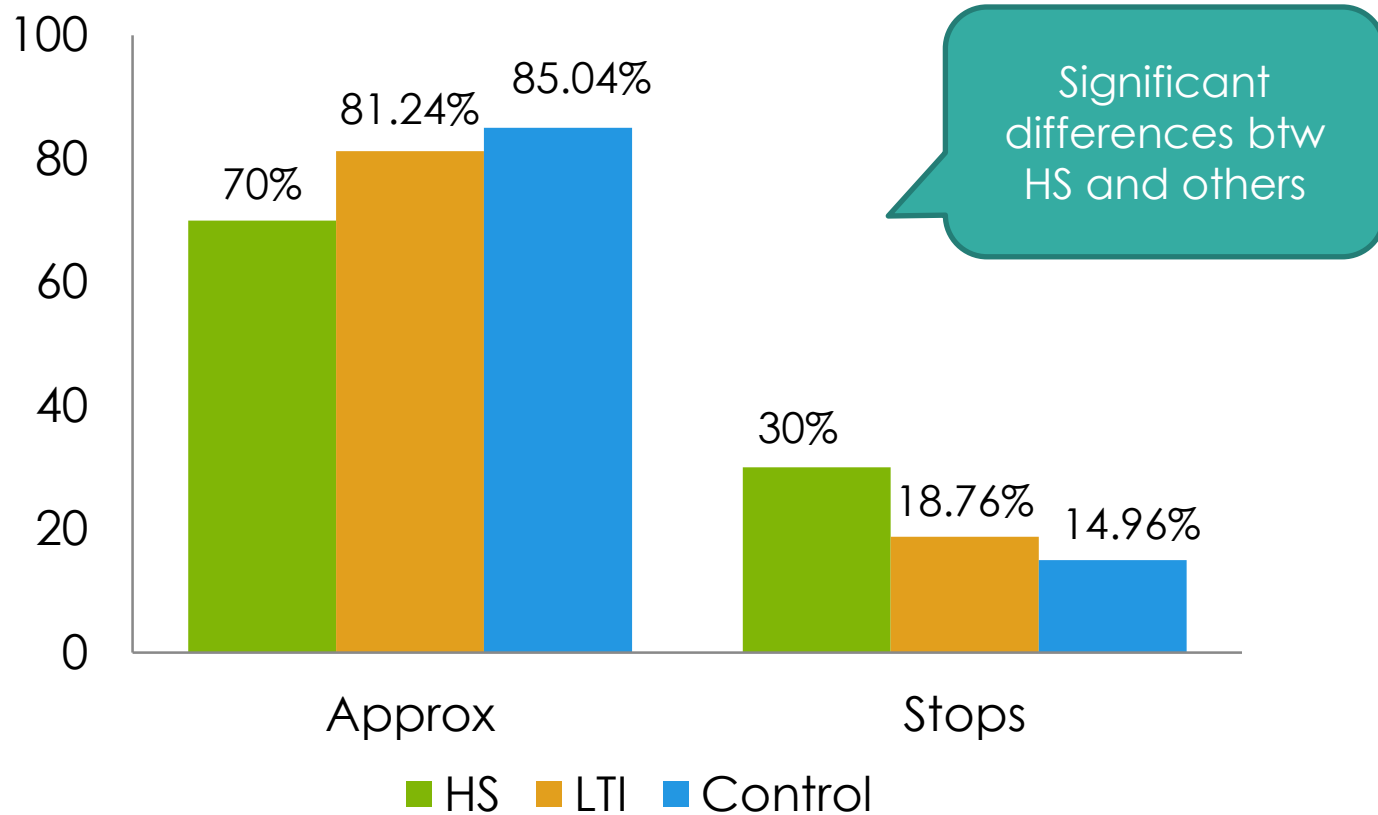
Results for /b, d, g/

# Percent Voicing

- Most tokens (98.5 %) were produced as voiced (1527/1551)
- 24 tokens were realized as voiceless
  - 87.5 % by HS 
  - 60 % with /g/ 
  - 50% followed by /i/
  - 100% of voiceless realizations occurred in initial position 

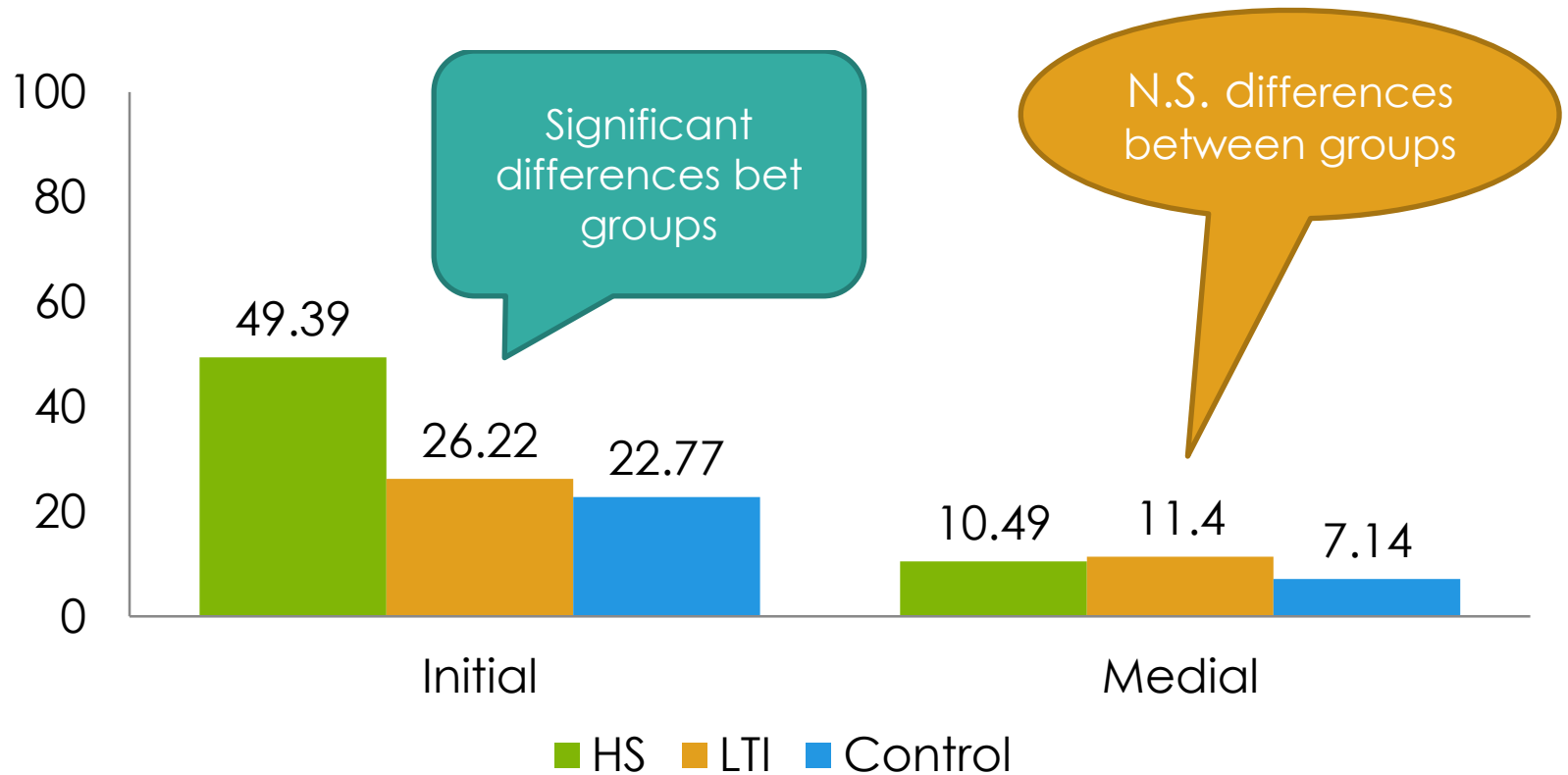
Significant factors in binary logistic regression analysis

# Approximants vs. stops

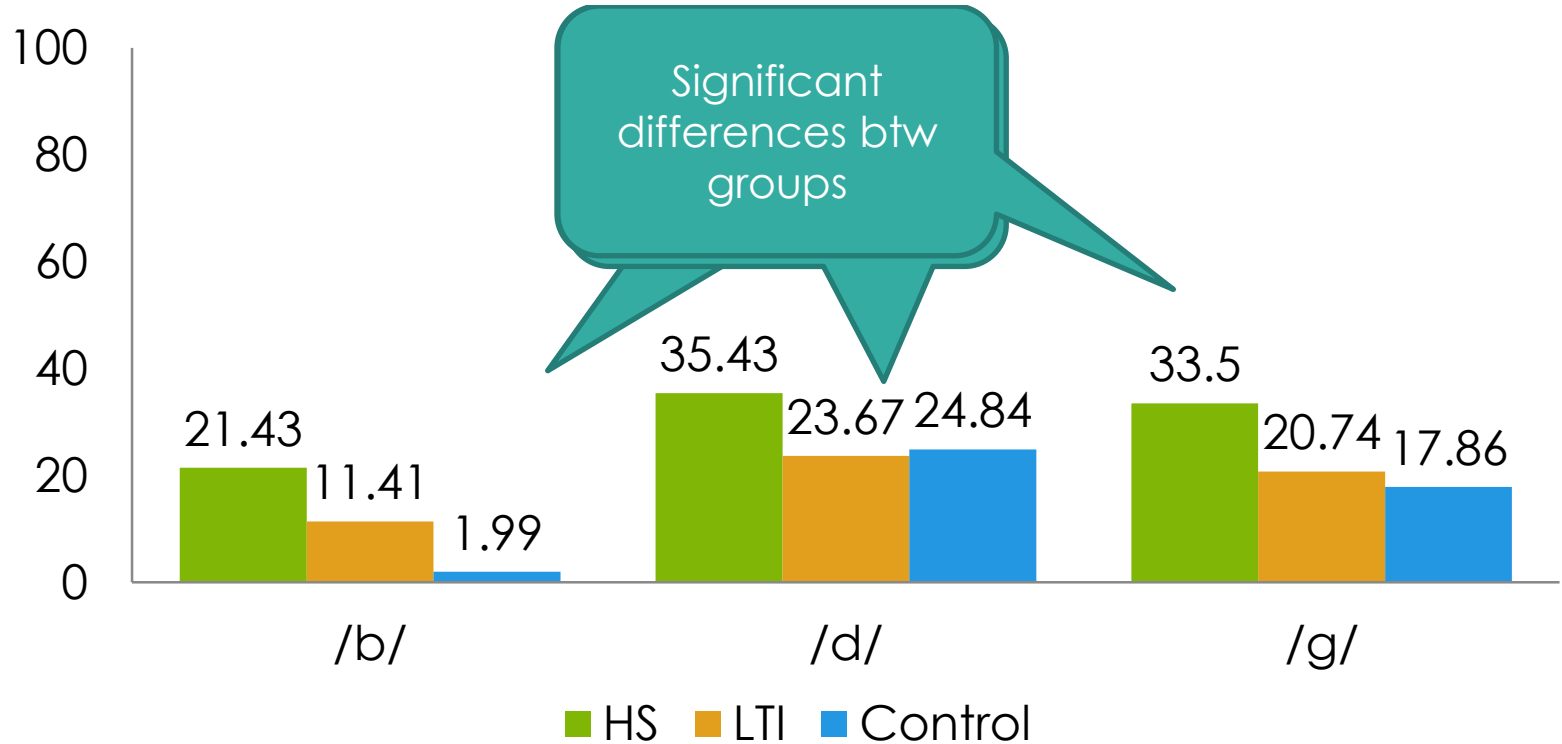


Total N: 1551

# Stops x position



# Stops x place

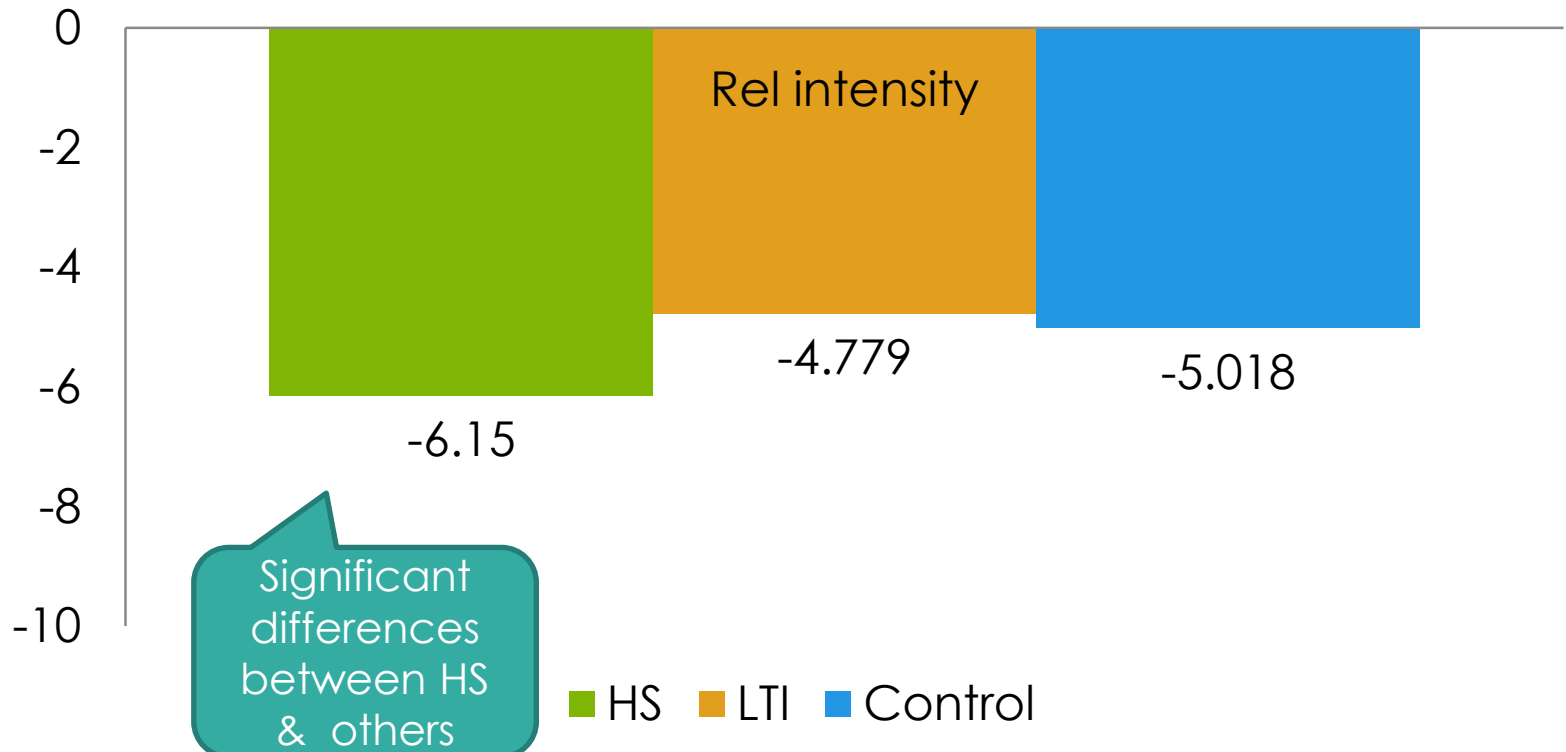


# Influence of linguistic and extra-linguistic factors on stop realizations

- Linguistic
  - Position (initial)
  - Place (/d/ & /g/)
  - Stress (stressed syllable)
  
- Extra-linguistic
  - LOR (higher LOR more stops)
  - Proficiency (lower proficiency more stops)

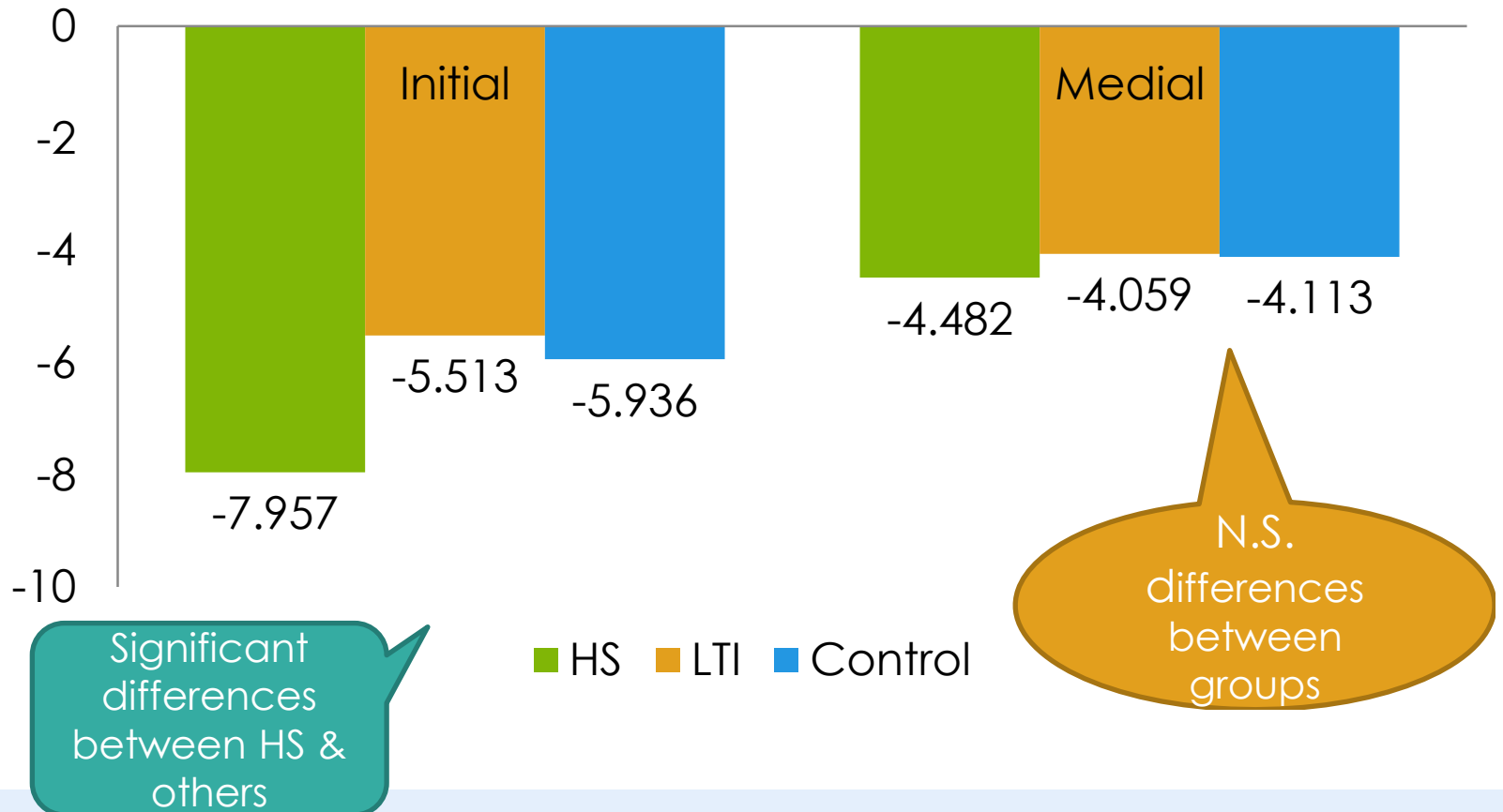
Results of a binary logistic regression

# Rel intensity x group

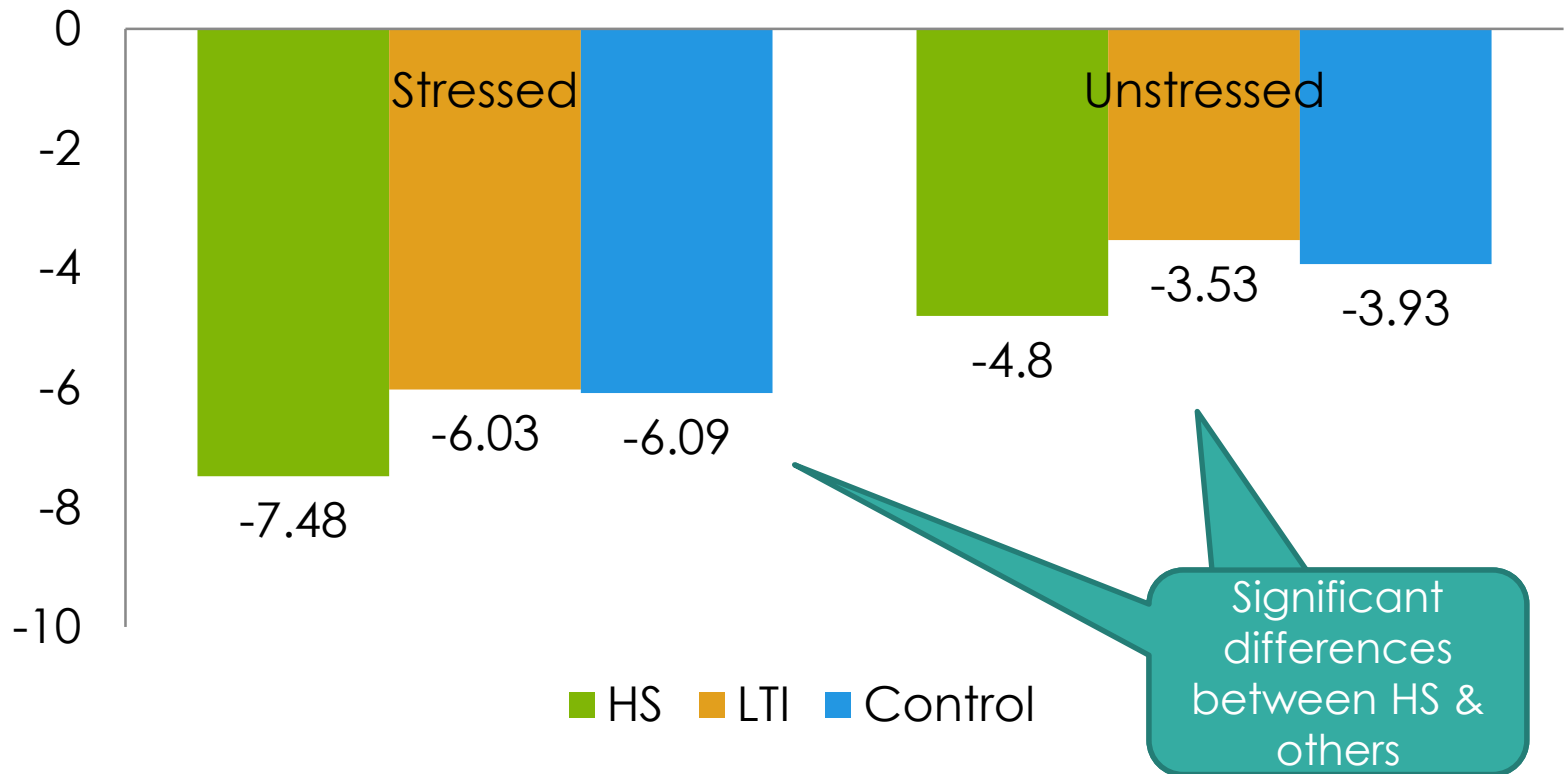




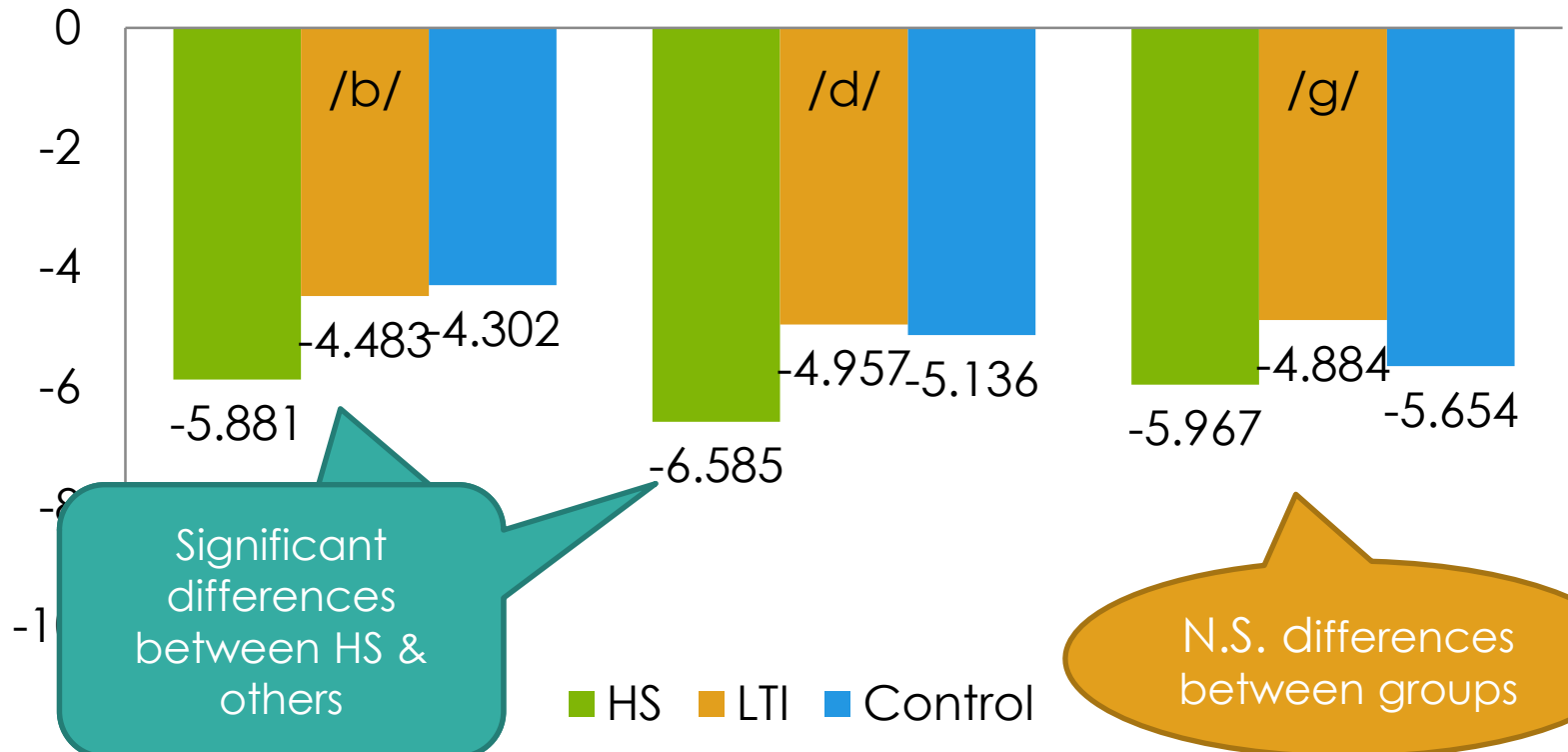
# Rel intensity x group x position



# Rel intensity x group x stress



# Rel intensity x group x place



# GLM to investigate the influence of linguistic and extra-linguistic factors on intensity

- Linguistic
  - Stress
  - Position
  
- Extra-linguistic
  - LOR (+ LOR → - int)
  - Proficiency (+ proficiency → + int)
  - AOA (+ AOA → + int)

# Summary for /b, d, g/

- In initial position, results showed differences in manner of articulation in HSs.
  - Higher percentage of voiceless realizations
  - More stop realizations
- HS produced more constricted approximants
- LOR & proficiency were relevant factors
- LTIs' production of /b, d, g/ closely resembled the control group, except in their higher rates of stops, yet lower than HS's.

# Discussion

# Discussion

- Do HSs differ in the **production** of voiceless/voiced stops from LTIs?
  - Yes, but not always in the directions expected
  - Voiceless stops → shorter VOTs than the other two groups
  - Voiced stops
    - HSs show higher proportion of stops
    - HSs show produced more constricted approximants
  
- Early exposure to an L2 does not affect all structures equally
  - Consistent with previous studies on L2 showing larger differences in voiced than in voiceless stops
    - Lead voicing is less perceptually salient than lag voicing (Deuchar & Clark 1996)
    - Merged categories incorporating properties of the L1 & L2 (MacKay et al. 2001)

# Discussion (cont.)

- VOT
  - Voiceless stops: HSs > LTIs > monolinguals ✗
  - Voiced stops: Positive VOTs for HSs and negative VOTs for LTIs & monolinguals ✓
  
- Voiced stops: alternations
  - HSs: higher rate of stops in intervocalic position when compared to the other two groups ✓
  - Spanish input and intense contact with English seems to affect the production of voiced stops
  - HSs fail to approximantize more often across words than within words, where their approximantization rate is closer to those of LTI & Controls.



# Discussion (cont.)

- Intensity of approximant
  - If HSs produce approximants, those are expected to be more constricted than the ones produced by the other two groups (reflected in higher CV intensity ratio and possibly longer durations) ✓

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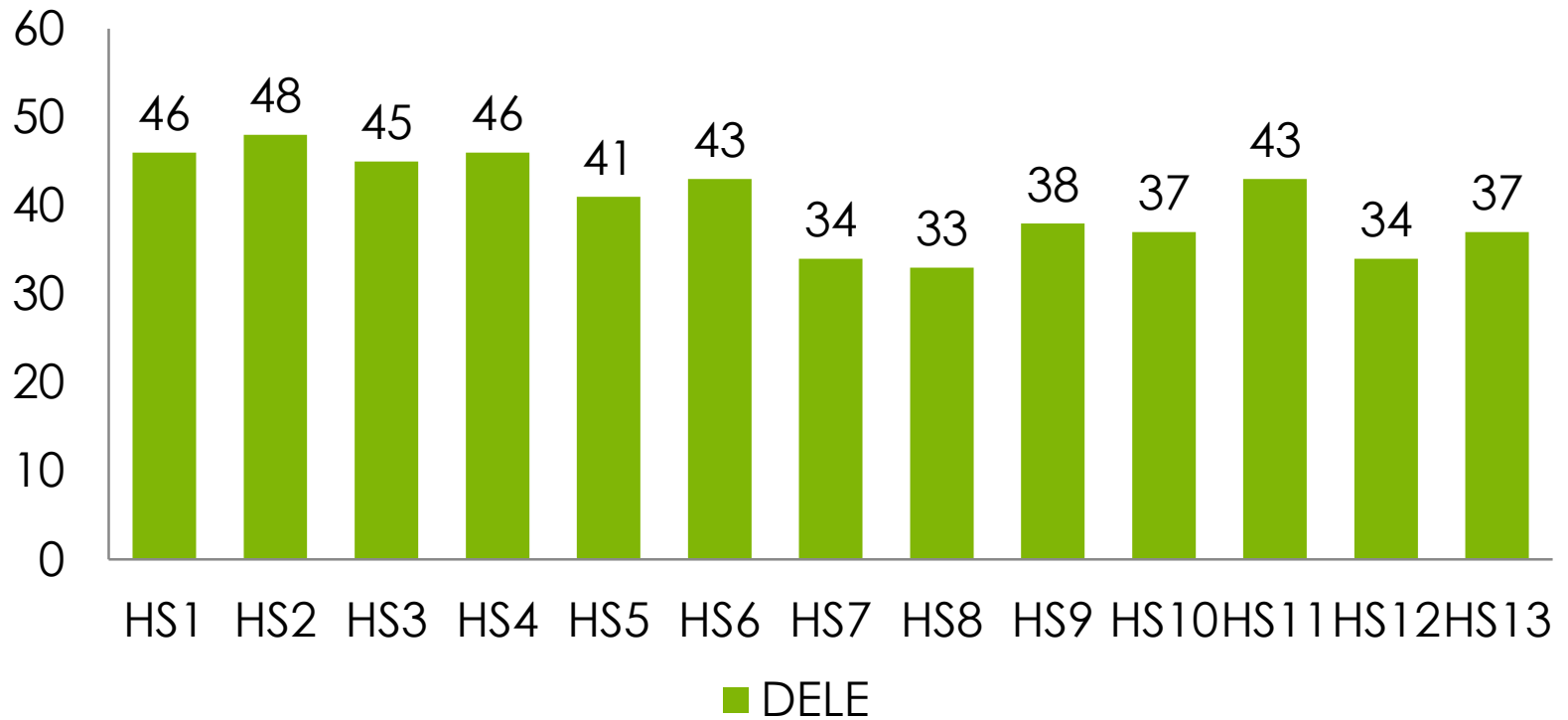
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- The speakers who participated in this study

# Effect of linguistic and extra-linguistic variables

- Voiced stops
  - Linguistic variables:
  - Extra-linguistic variables: reduced

# HS DELE ranges



# LTI DELE ranges

