

Acoustics of Spanish and English coronal stops

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Introduction

Coronal stops (VOT)

- English and Spanish contrast *fortis* with *lenis* stops
- One acoustic correlate of contrast is VOT

	Lead	Short-lag	Long-lag
Spanish	d	t	
English		d	t

- English uses [spread glottis] while Spanish uses [voice] [1]

Spanish	[voice]
English	[spread glottis]

Place of articulation

- Spanish /d/ and /t/ are “dental”
- English /d/ and /t/ are “alveolar”

Research questions

- What are the acoustic correlates of place in coronal stops?
- Can we measure the acoustics of the articulatory difference?
- How are short-lag stops manifested acoustically?
 - Question not addressed for Spanish *vs.* English
 - Coronal stop acoustics studied for French *vs.* English [2]

Goal of present study

Provide acoustic measurements of Spanish and English coronal stops to investigate further questions regarding these stops in different populations (bilinguals)

Method

Materials

- Consonants in utterance-initial position
- Consonant** (/d t/) × **Language** (English, Spanish) × **Stress** (stressed, unstressed) [$^{\prime}\sigma.\sigma$] vs. [$\sigma.^{\prime}\sigma$]:
- 6 (items) × 2 (consonants) × 2 (stress) = 24 words

Speakers (N = 14)

Language	Origin	N
Spanish	Majorca, Spain	8
English	Arizona, US	8

Procedure

- Auditory stimuli: 6 ‘talkers’ (3 Eng., 3 Sp.) each word produced 3 times. 24 words × 3 iterations × 2 languages = 144 stimuli
- ‘Talkers’ are male, experiment participants are female
- Delayed repetition: “_ is the word” or “_ es la palabra”

Acoustics

- 144 (observations) × 14 (participants) = 2016 tokens
- Acoustic metrics (VOT, Relative intensity, Spectral moments)

VOT	Relative intensity	Center of gravity
Standard deviation	Skewness	Kurtosis

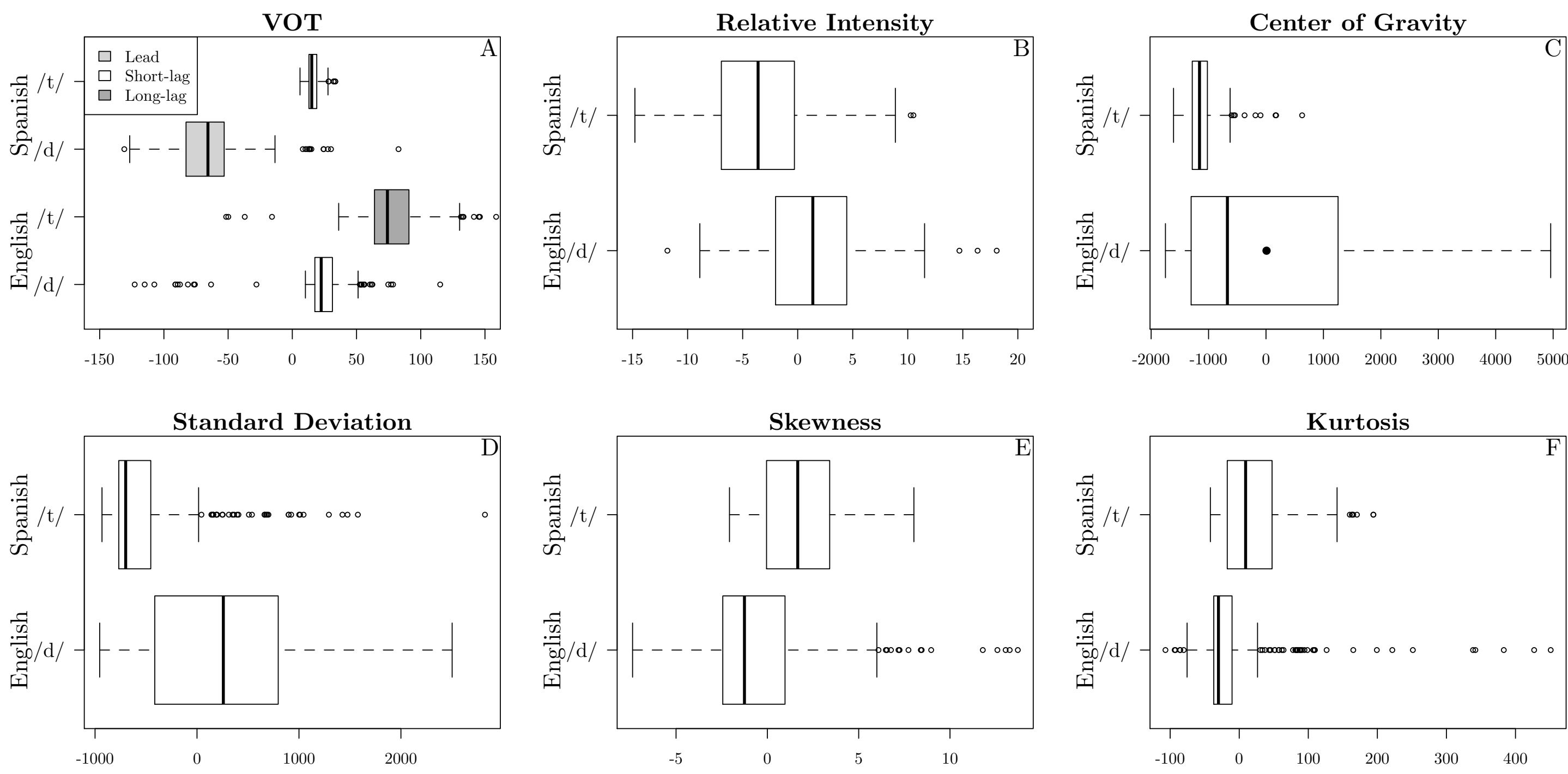
Note: Spectrum of burst (20 ms Gaussian window left-aligned)

Statistics

- Spectral moments and relative intensity regressed on VOT
 - Residuals used as criterion in factorial analysis
 - Residuals used as predictors in logistic regression

Results

1. Residuals used as criterion in factorial analysis



Metric	R^2	p -value
Relative Intensity	0.66	< 0.02
Center of Gravity	0.68	< 0.03
Standard Deviation	0.61	< 0.01
Skewness	0.45	< 0.03
Kurtosis	0.26	= 0.07

resid(DV) ~ Short-lag stop (Spanish /t/, English /d/)

2. Residuals used as predictors in logistic regression

Data subset = short-lag VOT stops (Spanish /t/, English /d/)

Metric	R^2	R^2_{change}	χ^2_{change}	p -value
Standard Deviation	.353	.353	175.39	< 0.01
Center of Gravity	.376	.023	14.01	< 0.01
Relative Intensity	.425	.049	30.01	< 0.01
Skewness	.426	.001	0.08	> 0.05
Kurtosis	.432	.006	4.36	< 0.04

Short-lag stop(DV) ~ SD + COG + RI + SK + KT

Conclusion

- VOT accounts for differences between all coronal stops except for English /d/ and Spanish /t/.
 - English /d/ and Spanish /t/ do not differ in VOT.
- Phonetically voiceless coronal stops of English and Spanish can be distinguished by relative intensity and by the spectral shape of the stop burst.
- With regard to the spectral shape of stop burts, place of articulation differences described for Spanish /t/ and English /d/ are best accounted for using measures of standard deviation and center of gravity.
 - ✓ Center of Gravity, Standard Deviation
 - ✗ Skewness, Kurtosis
- Present study contributes language-specific acoustic characteristics of bursts in the short-lag coronal stops in two monolingual varieties of English and Spanish.
- It provides base acoustic descriptions for future studies on Spanish-English bilinguals.

Selected references

- Beckman, J and Helgason, P and McMurray, B and Ringen, C. Rate effects on Swedish VOT: Evidence for phonological overspecification. *Journal of Phonetics*, 39:39–49, 2011.
- Megha Sundara. Acoustic-phonetics of coronal stops: A cross-language study of Canadian English and Canadian French. *The Journal of the Acoustical Society of America*, 118:1026, 2005.