

A contrastive acoustic analysis of dental and alveolar stops in Spanish and English

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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

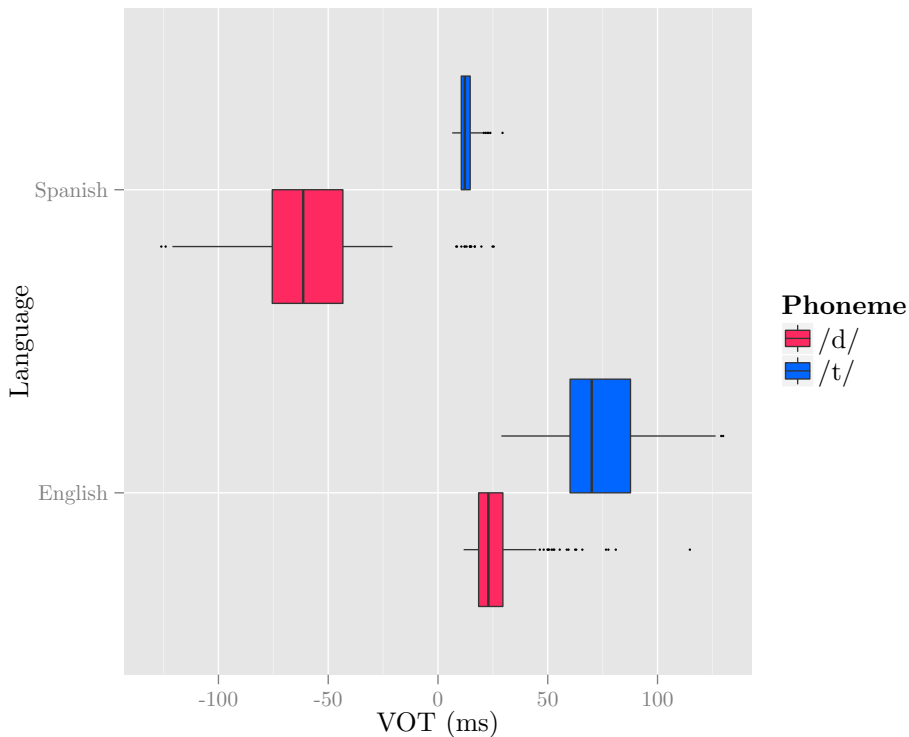
- Spanish /d/ and /t/ are “dental”
- English /d/ and /t/ are “alveolar”

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/English
 - Coronal stop acoustics studied for French/English [2]

Goal of present study

Provide acoustic measurements of Spanish/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) [‘σ.σ] vs. [σ.‘σ]:
- 6 (items) × 2 (consonants) × 2 (stress) = 24 words

Speakers (N = 14)

Language	Origin	N
Spanish	Majorca, Spain	7
English	Arizona, US	7

Procedure

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

Acoustics

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

Center of gravity	Standard deviation	Skewness
Kurtosis	Central moment	Mean intensity

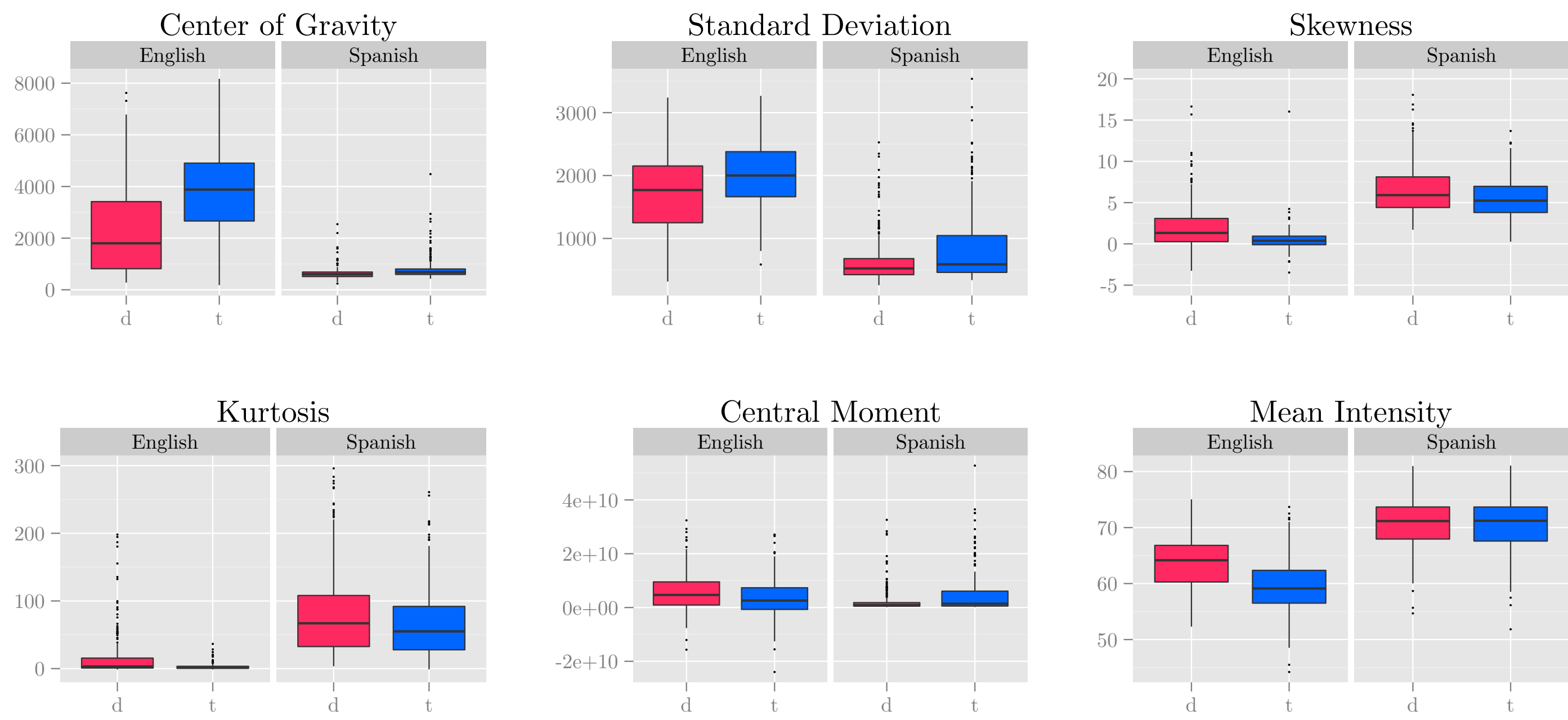
Note: Spectrum of burst (20 ms Gaussian window left-aligned)

Statistics

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

Results

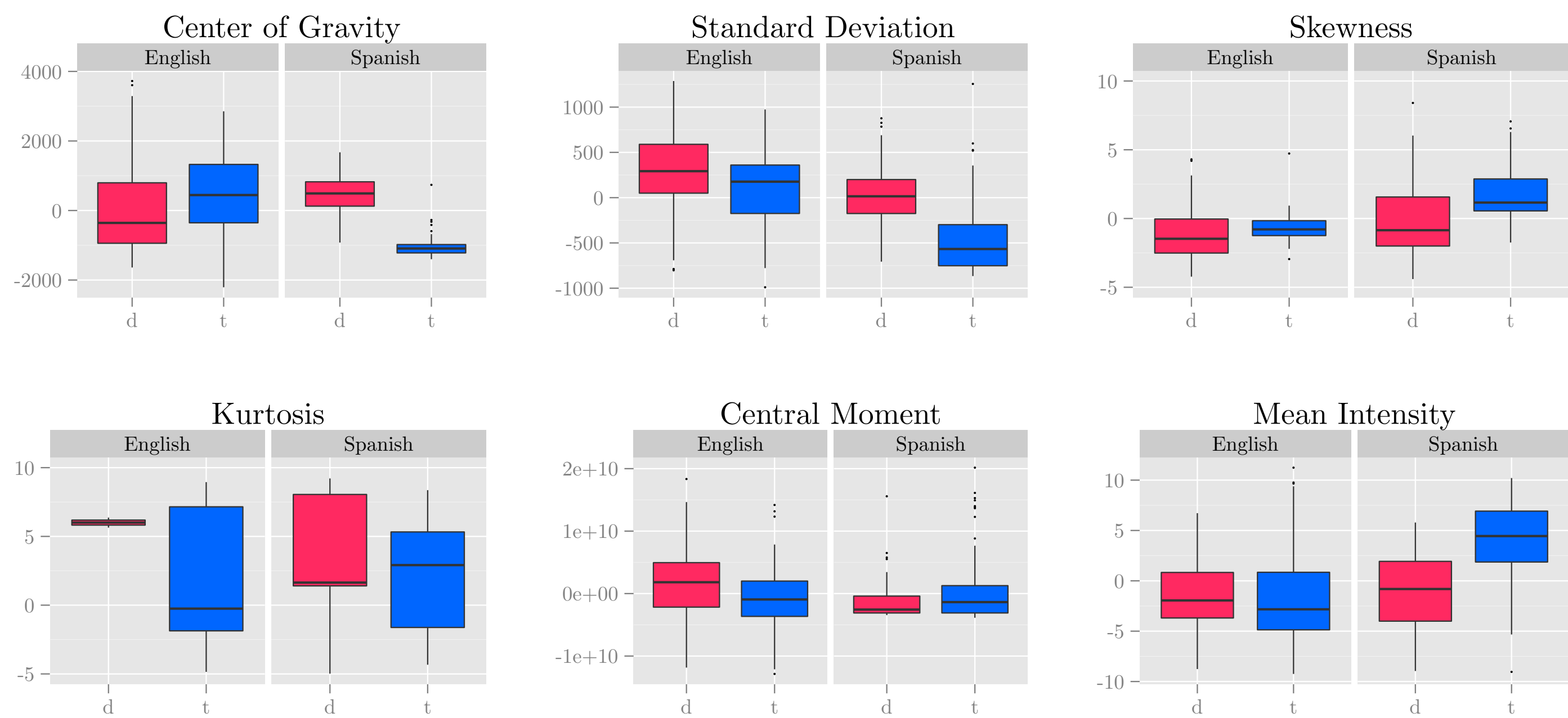
Factorial analysis of spectral moments and mean intensity



ANOVA	COG	SD	Skewness	Kurtosis	CM	Mean Intensity
Language	✓	✓	✓	✓		✓
Voicing	✓	✓	✓	✓		✓
L × V	✓				✓	✓

DV ~ Language (Spanish, English) × Voicing (/d t/)

1. Residuals used as criterion in factorial analysis



ANOVA	COG	SD	Skewness	Kurtosis	CM	Mean Intensity
Language		✓	✓			
Voicing	✓	✓	✓			✓
L × V	✓				✓	✓

resid(DV) ~ Language (Spanish, English) × Voicing (/d t/)

2. Residuals used as predictors in logistic regression

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

	COG	Mean Intensity	SD	Skewness	Central Moment
R ²	.67	.54	.51	.47	.0

Consonant ~ {COG, Mean intensity, SD, Skewness, Central moment}

Conclusion

- Spanish and English coronals differ in spectral envelope of burst
- Effects of spectral envelope above and beyond VOT
- Center of gravity explains 67% of variance in short-lag stops
- Center of gravity is available as correlate for future studies

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.