Spectral Trajectories of Spanish /s/: Temporal Variability, Vowel Context, and Duration

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1. Introduction

Temporal dynamics of fricatives have received greater attention in recent years, with researchers demonstrating that these segments exhibit structured temporal patterns (e.g., Haley et al., 2010; Iskarous et al., 2011; Jesus and Shadle, 2002; Munson, 2001; Reidy, 2015; Shadle et al., 2008). Most work has been conducted on English and the temporal characteristics of fricatives in other languages is a promising line of investigation.

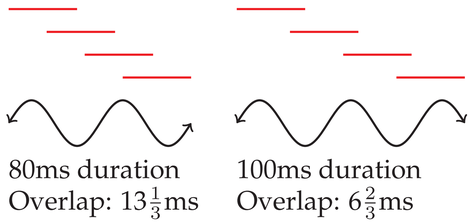
2. Research Questions

- What is the nature of the temporal variability of Spanish /s/?
- What patterns of adjacent vowel coarticulation can be observed?
- Can we observe sex-based differences in these fricative trajectories?

3. Methodology

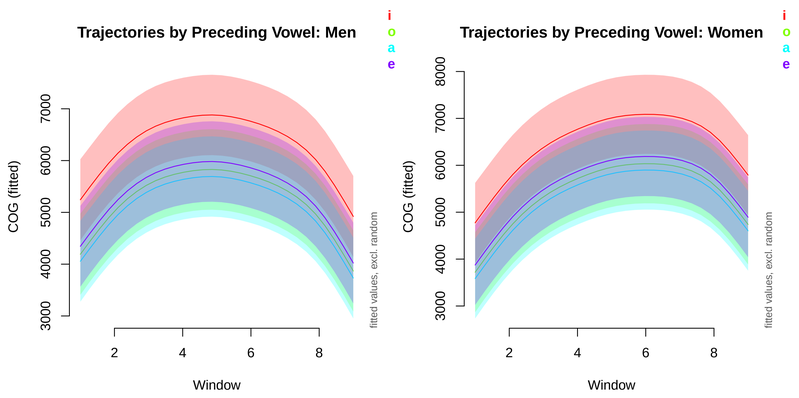
- Interviews with 20 native Spanish speakers from the Corpus del Español de Raleigh-Durham. 11 men and 9 women born 1957-1993.
- Speakers reside in North Carolina but are of Mexican or Salvadorian origin.
- Interviews force-aligned and all tokens of /s/ between vowels were extracted.
- This environment addresses /s/-aspiration (where /s/ reduces to [h] or elides completely), as /s/ tends to resyllabify as onset of following syllable and thus resists aspiration.
- Tokens in contact with /u/ excluded because of low count. Tokens of duration > 300ms or less than 60ms excluded. 2,797 tokens remain.

4. Windowing Procedure

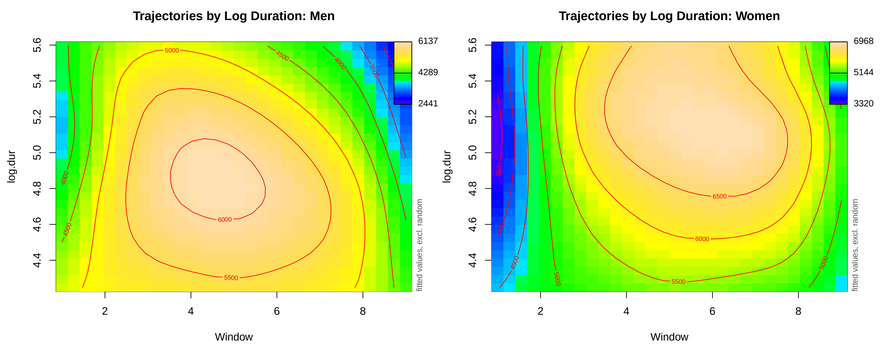


- Following Iskarous et al. (2011), nine 30ms windows with variable overlap.
- Bandpass-filtered (500-11000 Hz) and Center of Gravity (COG) calculated.
- Temporal variability of COG modeled using Generalized Additive Mixed Modeling.

5. Results



- Fitted COG values following /i/ significantly higher than other vowel contexts. This persists across the trajectory of the segment.
- Effect of following vowel (not pictured here) similar, but weaker.



- Summed effects plot excluding random effects
- Later peak for women
- Longer duration segments produced by women

6. Discussion

- **Spanish /s/ is characterized by dynamic acoustics**
  - Affected by vowel context with preceding (and following) /i/ conditioning higher COG.
- **As in English, peak of first spectral moment appears near midpoint.**
  - Unexpected: peak produced later by women.
  - Artifact of windowing technique? Perhaps, but no similar effect in Iskarous et al. (2011) with identical acoustic methodology.
- Women tend to produce longer duration /s/
  - Unclear whether this is due to articulatory or sociophonetic motivations.

7. Future Work

- **Articulatory Data**
  - Acoustics hide individual contributions of jaw, tongue body, and lip movement.
    - Dialectal variation in articulation: some Peninsular varieties have apical rather than laminal productions.
- **Relationship to /s/-aspiration**
  - Can we observe similar trajectories in environments which favor /s/-aspiration (pre-obstruents)?
    - Are peak location and temporal variability preserved as segments are aspirated or completely elided?
- **COG Peak Location**
  - With alternate approaches to windowing, does peak difference between sexes remain?
  - Are later peaks in COG salient sociophonetic cues for listeners?

Acknowledgments

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Selected References

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