From devoicing to apocope: an acoustic study of poststressed high vowel lenition in Brazilian Portuguese

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High vowel devoicing in unstressed position

- Vowel reduction with devoicing: a common cross-linguistic phenomenon
  - Appearing in many languages (e.g., Tsuchida, 1997; Torreira & Ernestus, 2010).

- **Highly variable** (Gordon, 1998; Chitoran & Marsico, 2010):
  - Across linguistic contexts;
  - Intra and inter-languages;
  - Intra and inter-speakers.

- Investigated under different theoretical perspectives:
  - Autosegmental phonology: delinking or deletion;
  - Articulatory Phonology (Browman & Goldstein, 1989): variation in gestural overlap and magnitude (Chitoran & Iskarous, 2008).

Meneses & Albano, PaPI 2013
Apocope and devocing in Brazilian Portuguese

- **Brazilian Portuguese** (henceforth BP): reported to have **final V deletion**, especially with /i/ and /u/, after a **voiceless C** (Rolo & Mota, 2012), i.e., “apocope”.

- **Meneses (2012)**: a **production experiment** to bring out the **gradient side** of this “apocope”
  - Acoustic analysis of **poststressed vowels** between **voiceless consonants**;
  - **Partially devoiced** and **fully devoiced** vowels: over 50%.

Meneses & Albano, PaPI 2013
Aims

To address the following questions:

- **Extreme vowel lenition:**
  - Apocope x devoicing?
  - Are there vowel traces in the acoustic signal?

- **What about perception?**

- **What kind of theoretical account?**
  - Categorical?
  - Gradient?

Meneses & Albano, PaPI 2013
Hypotheses

- There is an **ongoing lenition change** that takes place in **three steps**:
  - Vowel **reduction**;
  - Partial or total **overlap** with **preceding consonant**;
  - Perceptually-driven apocope.

- All three steps **coexist** in **synchronic variation**.

Meneses & Albano, PaPI 2013
Method

- Six female speakers
  - Northeastern BP dialect.

- Post-stressed syllables in ‘CVCV disyllables:
  - Target syllables: /si, sa, su/;
  - Carrier sentences: “O passe parecia resultar em gol”.

- Measurements:
  - Experiment 1 (production):
    - Duration;
    - First spectral moment;
    - Formant Centralization Ratio (FCR) x Vowel Space Area (VSA).
  - Experiment 2 (perception):
    - 5 point forced choice procedure;
    - Reaction time.

- Praat & Statistica used for data analysis.

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**Experiment 1**

- **Segmentation and annotation** of target words and syllables with Praat;
- **Manual labeling** of unstressed syllables.
- **Automatic extraction:**
  - Vowel formants;
  - First spectral moment;
    - Fricative noise above 4 kHz in syllables “without” vowel.
  - **Duration of unstressed units:**
    - Syllable;
    - Fricative noise.

- **Computation:**
  - $\text{FCR} = (F2u+F2a +F1i+F1u)/(F2i+F1a)$;
  - $\text{VSA} = \text{ABS }((F1i *(F2a –F2u)+F1a *(F2u–F2i)+F1u*(F2i–F2a ))/2)$.

- **Statistics:**
  - ANOVA;
  - Pearson correlation.

Meneses & Albano, PaPI 2013
Vowel space area and correlation between FCR and VSA

Note the clear **vowel space reduction**: voiced vowels **more centralized** in **devoicing contexts** (right panel).

High **negative** correlation \( r(11) = -0.77, \ p = 0.002 \) between FCR and VSA: **incompletely devoiced vowels lose gestural magnitude in devoicing contexts.**

Meneses & Albano, PaPI 2013
Centroid of fricative noise above 4 kHz in syllables with and “without” vowel

When the vowel is apparently absent, a lower average centroid indicates its presence within the [s] noise (e.g., for [i], $t(2) = -6.64, p < 0.02$).
Syllable duration (A-B) and duration of [s] noise (C-D) with voiced V, partially devoiced V, and totally devoiced V.

Mean length of [s] noise: significantly greater with V devoicing than with voicing, total or partial (Tukey post hoc test).

“Compensatory” lengthening of [s] where vowel is fully devoiced.

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Experiment 2

- **Subjects**: 4 of the subjects from Experiment 1;
- **Materials**
  - **Recordings**:
    - ás [’as]/aço [’a.su], paz [’pas]/passe [’pa.sl], lãs [lãs]/lance [lã.sl].
  - **Stimuli**: words with devoiced/partially devoiced vowels.
- **Procedure**:
  - Subjects instructed to listen and choose from a five point scale:
    - 1 – without vowel
    - 5 – with vowel
  - **Measurement**:
    - Mean percentage of each rating.
  - **Statistics**:
    - Spearman correlation: mean percentage x mean reaction time.

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Auditory Identification

Longer times for words with devoiced vowel (Sperman’s $r(58) = -0.64$, $p < 0.0001$).
Summary

- Production
  - Lower average centroid: presence of vowel when it is apparently absent;
  - [s] lengthened where vowel is fully devoiced.

- Perception
  - Ratings of fully devoiced vowels variable;
  - Definite bias for vowelless words (70% of cases);
  - Partial voicing sufficient for vowel recovery (100% of cases).
Conclusions

- Poststressed vowels: no categorical apocope, but, rather, gradient lenition, with increased gestural overlap, and devoicing.

- What about “compensatory” lengthening of [s]?
  - Poststressed position in weak prosodic boundaries: extreme vowel reduction;
  - Reduction: enhanced in devoicing contexts;
  - Overlap: increased in devoicing contexts.
  - But why does [s] lengthen?

- A possible theoretical interpretation:
  - Syllable oscillator: tendency to preserve beat strength (Byrd & Saltzman, 1998; Saltzman et al., 2010);
  - Consonantal closure: increased magnitude and duration.
Conclusions

- Partial voicing sufficient for vowel recovery;
- Full devoicing leading to misidentification;
- Completely overlapped and thus devoiced vowels: likely trigger of listener-based change of vowel apocope (Ohala, 1981).
THANKS FOR YOUR ATTENTION!
References


