Acoustic and perceptual study of Romanian palatalization: Challenge to a cross-linguistic generalization?*

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Secondary Palatalization (SP)

- Presence of secondary articulation:
  - accompanies the primary articulation of a consonant
  - tongue body raised towards hard palate
  - typical in Slavic, Celtic languages; phonemic

  e.g. Russian
  
SP in Romance

- Secondary Palatalization NOT typical in Romance languages
  - Only found in Romanian
  - Generally predictable morphologically

N/Adj pl  po[m]/po[mʲ]  “tree/trees”
V/2p sg pres ind  sa[r]/sa[rʲ]  “I jump/you jump”
Cross-linguistic palatalization patterns
(cf. Kochetov 2002)

• palatalized coronals unmarked as compared to labials
  – Frequency
  – Underlying status (Czech, Ukrainian)
  – Neutralization patterns (Polish, Belorussian)

• palatalized consonants favored in onsets vs. codas
  – Frequency
  – Neutralization patterns
Palatalization and Perception

• perception of palatalized Cs influenced by primary POA (Kochetov 2002)
  
  – Russian and Japanese
    • higher rates of correct identification for palatalized coronals (unmarked) than for labials ([t] vs. [p])
  
  – Romanian (Spinu 2007, to appear)
    • more sensitive to palatalization in labials than coronals ([p] vs. [ts] and [ʃ]; [v] vs. [z])
Present Study

Two Experiments

• More extensive perception study
  – uses recordings made for the acoustic study
  – permits direct comparison of perceptual and production (acoustic) patterns

• Acoustic analysis of Romanian secondary palatalization

Additional Properties of Romanian SP
Perception Study

• Question:
  • To what extent do Romanian speakers distinguish between different types of plain and palatalized consonants?

• 5 fricatives (plain and palatalized)
  • (labial) \([f, v]\)
  • (alveolar) \([z]\)
  • (postalveolar) \([ʃ]\)
  • (dorsal) \([h]\)
Test Items

• Real words of Romanian
  – Disyllabic
  – stress on final syllable
    e.g. kartóf, kazáh, kodáʃ, zugráv, kinéz

• For each fricative:
  – 8 target words
    • half ending in plain consonant: C (= singular)
    • half ending in palatalized consonant: Cʃ (= plural)

  e.g. kartóf ‘potato’/ kartófʃ ‘potatoes’
Test Items

• Target words inserted in two sentence types
  • Matched context
    – Additional singular morphological cue with plain C
    – Additional plural morphological cue with palatalized C

  e.g. ‘After doing the laundry, I couldn’t find one sock / four socks, as you well know.’

  • Mismatched context
    – Additional singular morphological cue with palatalized C
    – Additional plural morphological cue with plain C

  e.g. ‘After doing the laundry, I couldn’t find *one socks / *four sock, as you well know.’
Procedure

• Recording of stimuli
  40 target sentences + 80 fillers; 3 repetitions
  • recorded by 15 speakers
  • read only in matched contexts for naturalness
  • targets spliced out and inserted in context
    (for both matched & mismatched stimuli)

• Presentation of stimuli in perception experiment
  – 40 targets x 15 speakers x 2 contexts = 1200 sentences
  – subjects heard matched OR mismatched sentence involving the same target item
    => TOTAL per subject: 600 sentences
Subjects and Task

• 31 subjects
  – Native speakers of Romanian (standard)
  – Mean age = 24.2
  – 11 M, 20 F

• Task
  – Listen to sentences over headphones
  – Indicate whether they are acceptable or not
    • Matched Context $\rightarrow$ perceived as “acceptable”
    • Mismatched Context $\rightarrow$ perceived as “unacceptable”
Analysis

- Subject responses examined with respect to
  1. Percent accuracy (correct responses)
  2. Sensitivity to plain-palatalized contrast (d prime)
Results: percent accuracy

Proportion correct identification of plain and palatalized consonants
Results: sensitivity (d prime)
Production Study

• Question: what are the acoustic properties of plain vs. palatalized consonants in Romanian?

• Stimuli
  – same target words as in perception experiment
  – 40 targets + 80 fillers = 120 sentences
  – 3 repetitions = 360 sentences per subject
Carrier Sentence

- Am să aleg cuvântul **pantof** când voi fi gata.
  ‘I will choose the word pantof (=‘shoe’) when I'm ready.’

- Am să aleg cuvântul **pantofi** când voi fi gata.
  ‘I will choose the word pantofi (=‘shoes’) when I'm ready.’

Note: choice of **când voi fi gata** in carrier
  - 3 possibilities tested in pilot experiment
  - **când voi fi gata** - no anticipatory coarticulation effects on preceding target segments
Subjects and Procedure

• 30 subjects
  – Native speakers of Romanian (standard)
  – mean age 21.6
  – 11 M, 19 F

• Procedure
  – Subjects read and recorded sentences displayed on computer screen
    • 3 blocks (randomized)
  – Total sentences for analysis: 3600

(InvTool Software for display and recording; Bunnell et al.)
Analysis

- C and Cʲ segments examined with regard to:
  - Segment length
  - Spectral properties in terms of Bark Cepstral coefficients

- Linear discriminant (LD) function
  - Fitted to acoustic data
  - Determine to what extent acoustic properties predict segment TYPE (i.e. plain or palatalized) independently of place of articulation
Typical Spectrograms
Overall Results

• Repeated measures ANOVA
  – Effects on dependent variables
    • Length, Cepstral coefficients
  – Significant at .01 level
    • Palatalization
    • Consonant
    • Interaction of Palatalization x Consonant
Linear Discriminant Analysis

– classified 80% of the tokens correctly
– based on acoustic properties:
  • Duration
  • 6 Cepstral coefficients

Proportion correct fit

<table>
<thead>
<tr>
<th></th>
<th>[f]</th>
<th>[v]</th>
<th>[z]</th>
<th>[ʃ]</th>
<th>[h]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plain C</td>
<td>0.98</td>
<td>0.85</td>
<td>0.68</td>
<td>0.20</td>
<td>0.99</td>
</tr>
<tr>
<td>Pal C</td>
<td>0.66</td>
<td>0.82</td>
<td>0.69</td>
<td>0.97</td>
<td>0.98</td>
</tr>
</tbody>
</table>
Duration – by consonant

- Palatalized segments longer than plain
- Differences quite similar across segments, but only significant for [v] and [h]
Cepstral coefficients

<table>
<thead>
<tr>
<th></th>
<th>Plain-pal sig.different at .05 level</th>
</tr>
</thead>
<tbody>
<tr>
<td>f</td>
<td>c1, c2, c3, c4, c5</td>
</tr>
<tr>
<td>v</td>
<td>c1, c3, c4, c5</td>
</tr>
<tr>
<td>z</td>
<td>c3, c4</td>
</tr>
<tr>
<td>j</td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>c1, c2, c3, c4, c5</td>
</tr>
</tbody>
</table>

Table 1: coefficients which differed significantly between the plain and palatalized form of each segment
Summary

• **Production:**
  – Duration: palatalized longer than plain Cs at all POAs; differences significant for [v] and [h]
  – Cepstral coefficients: significant differences between plain and palatalized Cs except [ʃ]
  – Overall:
    • [h] most successfully distinguished
    • [ʃ] least successfully distinguished
    • [f] , [v] distinguished better than [z]

• **Perception:** parallel to acoustic findings
Discussion: Is Romanian Different?

• The answer appears to be “yes”
  – Typological Claim:
    • palatalization is least marked at coronal place of articulation
    • manifested in various ways, including perception
  – Romanian:
    • perception and production studies show that both labial and dorsal places of articulation exhibit more salient effects of palatalization than coronal (at least for fricatives)
    • [z] is least well distinguished – except for [ʐ] - in both perception and production
Why is Romanian Different?

• Methodology (perception study)
  • Russian and Japanese – nonce words
  • Romanian – real words

• Consonant Type
  • Stops vs. fricatives
  • BUT markedness patterns pertain to stops AND fricatives

• Phonemic status
  • Predictable – not underlying contrast
  • BUT same for Japanese

• Position within syllable
  • Only in word-final position (not syllable onset)

• Morphology
  • Palatalization associated with plural/2nd person
In Progress

• Perception study in the absence of morphological information

• Perception of nonce items (cf. Kochetov 2002)

• Analysis of additional acoustic properties (e.g. preceding V, spectral moments for fricatives)
Conclusions

• Both acoustic and perceptual analyses of SP parallel earlier perceptual findings regarding Romanian.

• Thus, we find that Romanian continues to exhibit SP patterns that appear to conflict with what we would expect if CORONAL is the unmarked POA.

• Language specific properties may cause over-riding of markedness patterns; in Romanian:
  – morphological conditioning
  – limitation of SP to codas
References


