Dimensions of Phonemic Contrast in Romance Vowels

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LING LUNCH, PARIS DIDEROT
JUNE 18, 2015
Phonemic contrast

- In a language, two sounds are separate phonemes if they signal a difference in lexical meaning across two words.

- English:
  - *bait* vs. *bet*
    - [bet] vs. [bɛt]
  - *boat* vs. *bought*
    - [bot] vs. [bɔt]

- /e/, /ɛ/, /o/, /ɔ/ are separate phonemes.
Two sounds are **allophones** if they don’t signal a lexical difference, and if at least one has a predictable distribution.

- **English**
  - pit vs. spit
    - [pʰɪt] vs. [spɪt]
  - appalled vs. apple
    - [əˈpʰæld] vs. [ˈæ.pəl]

- [pʰ], [p] are allophones: [pʰ] is syllable-initial, stressed
Phoneme vs. allophone: Not so simple

- Italian has phonemes /e, ɛ/: 
  \(\text{venti} \quad [\text{venti}] \) ‘twenty’ \(\quad [\text{vɛnti}] \) ‘winds (n.)’

- but two speakers might choose different vowels: 
  \(\text{cento} \quad [\text{tʃento}] \) or \(\quad [\text{tʃɛnto}] \) ‘one hundred’

- What if speakers disagree on which phoneme to use?
Phoneme vs. allophone: Not so simple

• Romanian [ɨ] vs. [ʌ]
  ['vîna] ‘vein (def.)’    ['kasʌ] ‘house’
  ['lîna] ‘wool (def.)’    ['sutʌ] ‘hundred’
  ['kînd] ‘when’    [pʌˈtuts] ‘bed (dim.)’

• but    [riw] ‘river’ vs.    [rʌw] ‘bad’

• What if a sound is predictable… most of the time?
Today’s talk

- Phonological contrastiveness is complex
- Phonemic contrast has multiple dimensions

- Acoustic, perceptual & phonological data from Romance
  - Marginal contrast in Romanian
  - Phonological closeness in Italian
  - How many vowel phonemes does a language have?
Marginal contrast in Romanian
What is the nature of contrast?

- What affects whether a sound is phonemic?
- Lexical contrast in minimal pairs
- Some sounds are more phonemically robust than others
  - Lack of phonological conditioning
  - High functional load
  - Usage frequency
- Phonetic and perceptual distinctness & stability
Characterizations of intermediate contrastiveness

- Phonological closeness among sounds (Trubetzkoy 1969)
- Five-point scale of contrastiveness (Goldsmith 1995)
- Quasi-phonemic contrasts (Hualde 2004, Ladd 2006)
- Fuzzy phonemic contrasts (Scobbie & Stuart-Smith 2008)
- Probabilistic Phonological Relationship Model (Hall 2009)
The Multidimensional Model of Phonemic Robustness

Renwick (2012, 2014)
Romanian

- Heavy non-Romance influence
- Active morpho-phonological alternations
- Vowels unique to the Romance family
- Paucity of phonetic & phonological study
Romanian vowels

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Central</th>
<th>Back</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>/i/</td>
<td>/i/</td>
<td>/u/</td>
</tr>
<tr>
<td>Mid</td>
<td>/e/</td>
<td>/ʌ/</td>
<td>/o/</td>
</tr>
<tr>
<td>Low</td>
<td>/eə/</td>
<td>/a/</td>
<td>/oə/</td>
</tr>
</tbody>
</table>

Chitoran (2003) analyzes the diphthongs as phonologically low vowels.

/ʌ/ is often transcribed as /ə/. 
## Romanian central vowels

<table>
<thead>
<tr>
<th>/ʌ/</th>
<th>/i/</th>
</tr>
</thead>
</table>
| • **Unstressed**  
  - /ˈapʌ/ ‘water’  
  - /ˈkasʌ/ ‘house’  
  - /ˈkumpʌrʌ/ ‘buys’ | • **Stressed**  
  - Pre-nasal  
    - /ˈkimp/ ‘field’  
    - /ˈlînʌ/ ‘wool’  
  - Liquid-adjacent  
    - /ˈriw/ ‘river’ |
| • **Stressed**  
  - [kumpʌˈrʌm] ‘we buy’ | • **Unstressed**  
  - /tîrˈziw/ ‘late’ |
Marginally contrastive phonemes

- Phones which are not easily classified as strictly allophonic or contrastive

- Romanian /ʌ/ and /ɨ/
  - Distribution *nearly* predictable and complementary
  - Minimal pairs exist
  - Low type frequency

Renwick (2011a), *On the origins of /i/ in Romanian*
Renwick (2011b), *Phoneme Type Frequency in Romanian*
Minimal pairs demonstrate that although Romanian central vowels were historically allophonic, they are now separate phonemes.

What is the nature of this contrast?
Frequency and Distribution

- Corpus study of phoneme type frequency
  - Romanian spell-checking word list (88,000 wordforms)
  - Distribution of vowels vs. flanking phonological context

Romanian vowel frequencies

- i: 25.5%
- e: 20.4%
- a: 19.9%
- o: 12.1%
- u: 11.0%
- A: 5.5%
- ia: 1.8%
- ea: 1.8%
- ie: 1.4%
- oa: 0.7%
Contexts following central vowels

Percentage of vowel tokens

<table>
<thead>
<tr>
<th>Post-Vowel Context</th>
<th>After /ʌ/</th>
<th>After /ɨ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
<td>46%</td>
<td>74%</td>
</tr>
<tr>
<td>t</td>
<td>8%</td>
<td>1%</td>
</tr>
<tr>
<td>ts</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>m</td>
<td>5%</td>
<td>10%</td>
</tr>
<tr>
<td>n</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>r</td>
<td>18%</td>
<td>8%</td>
</tr>
</tbody>
</table>
Acoustic implications: /ʌ/ vs. /ɪ/

- Evidence for marginal contrastiveness
  - Few minimal pairs
  - Nearly-complementary distribution
  - Low type frequency

- Phonetic realization of /ʌ/ and /ɪ/
  - Evidence of marginal acoustic contrast?
  - Overlap in the vowel space?
Romanian vowels: A brief phonetic introduction

17 native speakers

Lexical items

60 monophthongs

Stressed and unstressed vowels

3 repetitions/speaker

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</tr>
<tr>
<td><strong>Low</strong></td>
<td>/eă/</td>
<td>/a/</td>
<td>/oă/</td>
</tr>
</tbody>
</table>
Measuring vowel quality

Spune urca de trei ori

Spune citi de trei ori

<table>
<thead>
<tr>
<th>u</th>
<th>r</th>
<th>k</th>
<th>a</th>
</tr>
</thead>
</table>

| tS | i | t | i |
the Romanian vowel space

F1-F2 Values: Romanian female speakers

F1 (Hz) vs F2 (Hz) plot showing the distribution of various Romanian vowels. The graph includes labels for different vowels such as /i/, /e/, /ʌ/, /i/, /ɨ/, /o/, and /u/. The vowels are color-coded for easy distinction.
the Romanian vowel space

Mean F1-F2 by Vowel: Female Romanian Speakers

- /a/
- /e/
- /ʌ/
- /ɨ/
- /i/
- /ɨ/
- /o/
- /u/
Perception of Marginal Contrast

- What is the effect of a near-complementary distribution on perception?

- Perception studies
  - Do listeners depend on context for /ʌ/ vs. /ɨ/?
  - Are marginally-contrastive vowels more difficult to identify?
Methodology

- Vowel identification task
- Forced selection with confidence ratings
- Romanian words in a frame sentence (‘Spune [mʌrul] de trei ori’)
- Four vowels: /ʌ/, /ɨ/, /e/, /i/ (e.g., mʌ(rul), mi(rij), me(re), mi(re))
- Stimuli of four varied lengths
Results

- Study #1 (Romania): 32 x 5 identifications by 39 participants
- Study #2 (Cornell): 112 x 5 identifications by 7 participants

<table>
<thead>
<tr>
<th>Vowel</th>
<th>i</th>
<th>ï</th>
<th>ʌ</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>99%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>ï</td>
<td>&lt;1%</td>
<td>89%</td>
<td>4%</td>
<td>7%</td>
</tr>
<tr>
<td>ʌ</td>
<td>&lt;1%</td>
<td>10%</td>
<td>87%</td>
<td>3%</td>
</tr>
<tr>
<td>e</td>
<td>&lt;1%</td>
<td>4%</td>
<td>4%</td>
<td>92%</td>
</tr>
</tbody>
</table>
### Perception results: short vs. long stimuli

#### 1/3

<table>
<thead>
<tr>
<th>Vowel</th>
<th>/i/</th>
<th>/ɨ/</th>
<th>/ʌ/</th>
<th>/e/</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>99%</td>
<td>&lt;1%</td>
<td>0%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>ɨ</td>
<td>&lt;1%</td>
<td>89%</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>ʌ</td>
<td>0%</td>
<td>12%</td>
<td>83%</td>
<td>5%</td>
</tr>
<tr>
<td>e</td>
<td>0%</td>
<td>4%</td>
<td>4%</td>
<td>92%</td>
</tr>
</tbody>
</table>

#### FULL

<table>
<thead>
<tr>
<th>Vowel</th>
<th>/i/</th>
<th>/ɨ/</th>
<th>/ʌ/</th>
<th>/e/</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>99%</td>
<td>0%</td>
<td>0%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>ɨ</td>
<td>0%</td>
<td>89%</td>
<td>2%</td>
<td>9%</td>
</tr>
<tr>
<td>ʌ</td>
<td>&lt;1%</td>
<td>6%</td>
<td>91%</td>
<td>3%</td>
</tr>
<tr>
<td>e</td>
<td>0%</td>
<td>3%</td>
<td>5%</td>
<td>92%</td>
</tr>
</tbody>
</table>
Perception results: 
Confidence ratings and statistics

- **Modeling accuracy**
  - **Fixed effects**
    - Vowel (***)
    - Word[Vowel] (***)
    - Length (*)
  - **Random effects**
    - Participant
    - Block

- /i/ most easily identified

Confidence ratings: 1 (low) to 5 (high)
Marginal contrastiveness in Romanian

- Romanian /i/ and /ʌ/
  - Former allophones
  - Low type frequency & functional load
  - Nearly-complementary distribution
  - Acoustically distinct
  - Perceptually (mostly!) distinct
Phonemic contrast is multidimensional

Renwick (2012, 2014)
Phoneme vs. Allophone: Not so simple

- Romanian /ɨ/ vs. /ʌ/
  - Distributionally, **near-allophonic**
  - Phonetically distinct
  - Perceptually, /ʌ/ may be confused with /ɨ/

- Next: What if speakers disagree on phoneme selection?
Phonological closeness in Italian

COLLABORATOR:
D. R. LADD, UNIVERSITY OF EDINBURGH
Vowel contrasts in Italian

Rogers & d’Arcangeli (2004)
Italian mid vowel contrasts

- Minimal pairs
  - e and o chiuso: /peska/ pesca ‘fishing’ /foro/ foro ‘hole’
  - ē and ō aperto: /pesca/ pesca ‘peach’ /fɔɾo/ foro ‘forum’

- No orthographic distinction
- Marginal contrast between high & low mids (Vincent 1988)
- Prescriptive works describe proper pronunciation…
- …But it’s non-problematic to ignore the distinction (Rebora 1958)
- Stressed mid vowel quality may be variable
“[T]here is a special relation of partial similarity between higher and lower mid vowels. Somehow these vowels do not contrast with each other as completely as most other pairs of phonemes.”
- Ladd (2006: 16)

“From a purely phonetic point of view, the difference between French $i$ and $e$ is not greater than the difference between $e$ and $\varepsilon$. But the closeness of the relationship between $e$ and $\varepsilon$ is apparent to any Frenchman, while in the case of $i$ and $e$ there can be no question of any particular closeness.”
- Trubetzkoy (1969: 78)
What kind of contrast does Italian have?

- /e, ɛ/ and /o, ɔ/ neutralize to /e, o/ in unstressed position
  - Is the “particular closeness” a product of neutralization?
  - Not necessarily: cf. pretonic neutralization in Catalan, Portuguese

- Is it a near-merger (Labov, 1994)?
- Is it a case of allophone awareness (cf. German [x]/[ç])?

- Where do these vowels fit in phonemic theory?
Acoustics vs. Intuition

- Acoustics from vowel production data
- Intuitions from speakers’ vowel judgments
- Comparison: prescriptive mid vowel quality (six-volume dictionary by De Mauro 2000)

- Does vowel quality match the dictionary?
- Does vowel quality match across speakers?
- Do speakers’ productions match their own intuitions?
Mid vowel quality based on De Mauro (2000).
We excluded any words acknowledged as variable by De Mauro.
Methods: Acoustics

- 7 vowels x 5 items x 6* contexts
- 200 total target vowels
- Items randomly embedded in 5 prosodically similar frame sentences, e.g. “Scrivete *decimo* sul foglio.”
- 3 repetitions per item
- 17 speakers (14F, 3M)
- Phone boundaries aligned with SPPAS (Bigi 2013)
- First & second formant (F1, F2) values extracted
- 10,161 tokens (5,571 mid vowels)
Methods: Intuitions

• Word list: 100 words containing a stressed mid vowel
  ○ All words also used in acoustic study
  ○ Balanced for prescriptive mid vowel quality (25 each)

• Speakers labeled each stressed vowel as *chiuso* or *aperto*

• Responses compared with
  ○ Prescriptive quality: Rate of agreement with prescriptive quality
  ○ Speaker’s own acoustics: Captures speaker’s awareness of usage
Vowel acoustics don’t match prescriptive expectations.
Acoustics by speaker vowel judgment
Italian has 7 distinct vowel categories
Speakers with vowel cloud overlap
Pretonic mid vowels are [e] and [o]
Speakers are aware of the vowel they produce.
Regional variation in mid vowels is widespread.

Does a speaker’s dialect region affect mid vowel acoustics and judgments?
### Regional variation in mid vowel judgments

#### Front vowel judgments

<table>
<thead>
<tr>
<th>Region</th>
<th>/e/</th>
<th>/ɛ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>North-Central</td>
<td>84%</td>
<td>16%</td>
</tr>
<tr>
<td>Tuscany</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Rome</td>
<td>56%</td>
<td>44%</td>
</tr>
</tbody>
</table>

#### Back vowels

<table>
<thead>
<tr>
<th>Region</th>
<th>/o/</th>
<th>/ɔ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>North-Central</td>
<td>55%</td>
<td>45%</td>
</tr>
<tr>
<td>Tuscany</td>
<td>53%</td>
<td>47%</td>
</tr>
<tr>
<td>Rome</td>
<td>59%</td>
<td>41%</td>
</tr>
</tbody>
</table>
Evidence from acoustics

Italian Vowels: Speaker ItF14 (Bologna)

Stress
- DA-da
- da-DA-da
- DA-da-da
- DAD-da
- DAN-da
- pre-tonic

deM
- a
- e
- E
- i
- o
- O
- u
### Regional variation in mid vowel judgments

#### Front vowel judgments

<table>
<thead>
<tr>
<th>Region</th>
<th>/e/</th>
<th>/ɛ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>43%</td>
<td>57%</td>
</tr>
<tr>
<td>Tuscany</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>Rome</td>
<td>56%</td>
<td>44%</td>
</tr>
</tbody>
</table>

#### Back vowels

<table>
<thead>
<tr>
<th>Region</th>
<th>/o/</th>
<th>/ɔ/</th>
</tr>
</thead>
<tbody>
<tr>
<td>South</td>
<td>96%</td>
<td>4%</td>
</tr>
<tr>
<td>Tuscany</td>
<td>53%</td>
<td>47%</td>
</tr>
<tr>
<td>Rome</td>
<td>59%</td>
<td>41%</td>
</tr>
</tbody>
</table>
Speaker from the South

Italian Vowels: Speaker ItF11 (Matera)

Stress
- DA-da
- da-DA-da
- DA-da-da
- DAD-da
- DAN-da
- pre-tonic

deM
- a
- e
- E
- i
- o
- O
- u
But compare…

Italian Vowels: Speaker ItF15 (Arezzo)

Stress
- DA-da
- da-DA-da
- DA-da-da
- DAD-da
- DAN-da
- pre-tonic

deM
- a
- e
- E
- i
- o
- O
- u
Hierarchical clustering analysis based only on speaker judgments

100 data points/speaker: 1 = matches dictionary; 0 = does not match dictionary

Results group speakers approximately by dialect area and pronunciation patterns
Speaker misclassifications

- Cases of mismatch between speaker judgment and vowel acoustics
- All speakers make at least 1 misclassification
  - Some are widespread, e.g. in Southern/Sardinian speakers
  - Some are “random” or rare
- Therefore mid vowels are confusable for native speakers: /i, a, u/ are not!
Conclusions

- Lexical variability in production and judgment
  - Difficult to reconcile with standard versions of phonological contrast

- cf. Kiparsky’s (2014) classification:

<table>
<thead>
<tr>
<th></th>
<th>contrastive</th>
<th>non-contrastive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>distinctive</strong></td>
<td>phoneme</td>
<td>‘quasi-phoneme’</td>
</tr>
<tr>
<td><strong>non-distinctive</strong></td>
<td>‘near contrast’</td>
<td>allophone</td>
</tr>
</tbody>
</table>
Where do Italian mid vowels fit?

- Italian /e, ɛ/ and /o, ɔ/
  - Vowels are distinctive and apparently contrastive, *per speaker*
  - No evidence for a (near) merger
  - Possible, regionally-restricted change in progress
  - Distinctions are *stable* within a speaker, yet *variable* across speakers

- A phonemic contrast that makes few lexical distinctions
  - May indicate regional accent
  - Few minimal pairs & low functional load
Conclusions

DIMENSIONS OF PHONEMIC CONTRAST IN ROMANCE VOWELS
Insights from Romanian vowels

- Marginal contrast in Romanian vowels: /ɨ/ vs. /ʌ/
  - Gradient phonological, lexical contrast
  - Acoustically, perceptually distinct
  - Implications for models of phonemic contrast

- How does phonological context affect perception?
Contrast among Italian mid vowels

- Italian /e, ɛ/ and /o, ɔ/ are contrastive
  - Minimal pairs exist
  - Most speakers of Standard Italian distinguish [e] – [ɛ] and [o] – [ɔ]
  - Speakers are (generally) aware of their own productions

- For a particular word, speakers’ vowel choice can vary
  - Speakers disagree with prescriptive vowel quality & each other
  - Some effects of regional variation

- The ‘particular closeness’ among mid vowels remains
Dimensions of phonemic contrast

• Romanian /ɨ/ is marginally contrastive with /ʌ/
  ○ (+) Clear acoustic & perceptual differences
  ○ (−) Low type frequency, high predictability, low functional load

• Italian /e, o/ vs. /ɛ, ɔ/
  ○ (+) High frequency, phonetic distinctiveness (for some speakers)
  ○ (−) Phonological conditioning ([e, o] w/o stress), low functional load

• Phonological contrasts are complex
  ○ For speakers & listeners, multiple factors may affect the sounds we select in production, and those we decode in perception.
Thank you.

Questions?


