How universal is the boundary between vowels and consonants?

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# Vowels and Consonants

<table>
<thead>
<tr>
<th>Airflow is not obstructed</th>
<th>Obstruction in the airflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly periodic, high amplitude, no audible noise</td>
<td>Low periodicity, lower amplitude, audible noise</td>
</tr>
</tbody>
</table>

Syllable nucleus

- [j], [w]
- [l], [ŋ]

Onset or coda
Pike’s solution (1943)

Vocoid
“Central oral resonant”

Syllabic
Vowels

[j], [w]

Non-syllabic

[!] , [ŋ]

Contoid

Consonants

[j], [w]
The distinction between consonant and vowel is fundamental to the way segments are described in the framework underpinning IPA.

*Handbook of the IPA (1999), p.6*
How did we get into this?

Linguistic rhythm

Rhythm measures: %V, ΔC, VnPVI etc.
Question:

How universal is the perceptual boundary between vowels and consonants?

OR:

To which extent familiarity with the language influences segmentation into vocalic and consonantal intervals?
Methodology and Results

Corpus
Segmentation
General agreement between labellers
Agreement on specific segments
Methodology

Corpus

Segmentation

General agreement between labellers

Agreement on specific segments
Oxford Aesop Corpus

- Languages: Mandarin, Modern Greek, Russian, French, British English.

- 10+ speakers in each language (20-28 y.o.)

- Each speaker read 45 short texts and re-told “Cinderella”

- >2000 sound recordings

www.phon.ox.ac.uk/corpus
Methodology

Corpus

Segmentation

General agreement between labellers

Agreement on specific segments
Segmentations

- 762 Greek syllables and 439 Mandarin syllables
- 2-3 fluent speakers (full phonetic segmentation)
- 2-3 phoneticians not familiar with the languages (‘V’, ‘C’, ‘N’, ‘S’)

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Results

Corpus
Segmentation

General agreement between labellers
Agreement on specific segments
Cohen’s kappa

- What is relative inter-rater agreement in comparison to agreement expected by chance?

<table>
<thead>
<tr>
<th>Rater 1</th>
<th>Rater 2</th>
<th>$\kappa$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>$Pr_{agreement} - Pr_{chance}$</td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>$\frac{Pr_{agreement} - Pr_{chance}}{1 - Pr_{chance}}$</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td></td>
</tr>
</tbody>
</table>

$0$ $0.2$ $0.4$ $0.6$ $0.8$ $1$

- Poor
- Fair to good
- Excellent
Computing Cohen’s kappa: inter-pause stretch

Familiar – Familiar
Unfamiliar – Unfamiliar
Familiar - Unfamiliar

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Cohen’s kappa for different groups

Familiar-Familiar

Unfamiliar-Unfamiliar

Familiar-Unfamiliar

Poor  Fair to good  Excellent

mean=0.73  std=0.13  n=270

mean=0.62  std=0.15  n=681

mean=0.62  std=0.14  n=672

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Differences between languages

- Linear regression: significant interaction between group and language.
- Higher agreement between fluent Greek speakers
- Lower agreement on Greek data for those unfamiliar with the language.
General agreement: conclusions

- There is excellent agreement between those familiar with the languages they label.
- They do not always agree with phoneticians who are unfamiliar with the language is lower: top-down vs. bottom-up processing?
- The agreement between those unfamiliar with the language is also moderate.
- There appear to be differences between languages: differences in phonological systems or writing systems? (cf. Port 2007).
Results

Corpus

Segmentation

General agreement between labellers

Agreement on specific segments
Agreement on specific segments

Phonetic labels

Vowels

Consonants

Voiceless obstruents

Voiced obstruents

Sonorants and approximants

Pauses

C V S
Agreement on specific segments

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Vowels

[diagram showing percentage comparison between Greek and Mandarin for [i], [u]]

Voiceless obstruents

[diagram showing percentage comparison between Greek and Mandarin for [p], [x]]
Sonorants and approximants

Greek

[j], [l], [r]

Mandarin

[l], [m]

Voiced obstruents

[γ], [b], [v]

Greek

Mandarin

[z]

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Overview

Greek

Mandarin

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Conclusion

- Labellers familiar with the language show similar pattern of agreement across all categories of segments.

- Trained phoneticians unfamiliar with the language agree on vowels and voiceless obstruents but show less consistency in labelling voiced obstruents and sonorants.

- There are cross-linguistic differences.
Summary

- Top-down and bottom-up labelling produce different results: acoustics generally does not map consistently onto phonology.
- These differences go beyond traditional ‘problem categories’ such as approximants or syllabic consonants.
- Bottom-up segmentation produces lower agreement: acoustical information is ambiguous.
Summary

Speech is a continuum between sonority peaks and valleys with fuzzy acoustic boundaries between phonological vowels and consonants.

The location of the perceived categorical boundary depends on linguistic background.
Thank you!

Further information:
www.phon.ox.ac.uk/speech_rhythm

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