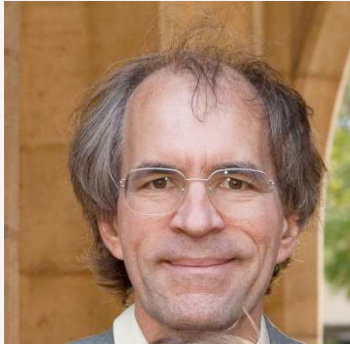

How universal is the boundary between vowels and consonants?

Anastassia Loukina, Greg Kochanski, Chilin Shih

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Vowels and Consonants

Airflow is not obstructed

Obstruction in the airflow

Highly periodic, high amplitude, no audible noise

Low periodicity, lower amplitude, audible noise

Syllable nucleus

Onset or coda

[j], [w]

[l], [ŋ]

Pike's solution (1943)

	Vocoid <i>"Central oral resonant"</i>	Contoid
Syllabic	Vowels	[l̩], [ɹ̩]
Non-syllabic	[j], [w]	Consonants

International Phonetic Alphabet

THE INTERNATIONAL PHONETIC ALPHABET (2005)

CONSONANTS (PULMONIC)

	LABIAL		CORONAL			DORSAL			NASAL		LABIODENTAL	
	Bilabial	Labio-dental	Dental	Alveolar	Palato-alveolar	Retroflex	Palatal	Velar	Uvular	Pharyngeal	Epi-glottal	Glottal
Nasal	m	ɱ	n	ɲ	ɳ	ɽ	ɲ	ŋ	ɴ	ɴ̠	ɴ̡	ɴ̟
Plosive	p b	ɸ β	t d	ʈ ɖ	ʈ̪ ɖ̪	ʈ̺ ɖ̺	c ɟ	k ɡ	q ɢ		ʔ	ʔ̰
Fricative	ɸ β	f v	θ ð	s z	ʃ ʒ	ʂ ʐ	ç ʝ	x ɣ	χ ʁ	ħ ʕ	ħ̠ ʕ̠	h ɦ
Approximant		ʋ	ɹ	ɻ			ɰ	ɰ		ʕ	ʕ̠	ɦ ɦ̠
Trill	ʙ		ʀ						ʀ			
Tap, Flap		ⱱ	ɾ									
Lateral fricative			ɬ ɮ									
Lateral approximant			l			ɭ	ʎ	ʟ				
Lateral flap			ɭ									

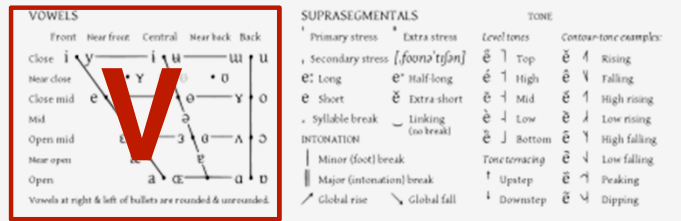
Where symbols appear in pairs, the one to the right represents a normally voiced consonant, except for murmured ɦ. Shaded areas denote articulations judged to be impossible. Light grey letters are auxiliary extensions of the IPA.

CONSONANTS (NON-PULMONIC)

Anterior click releases (require posterior stops)	Voiced implosives	Ejectives
ʘ Bilabial fricative	ɓ Bilabial	ɛ́ Ejective
ǀ Laminar alveolar fricative ("dental")	ɗ Dental or alveolar	ɔ́ Bilabial
ǃ Apical (postalveolar) abrupt ("retroflex")	ɟ Palatal	ɔ́ Dental or alveolar
ǁ Laminar postalveolar abrupt ("palatal")	ɰ Velar	ɔ́ Velar
ǂ Lateral alveolar fricative ("lateral")	ʄ Uvular	ɔ́ Alveolar fricative

CONSONANTS (CO-ARTICULATED)

- ʍ Voiceless labialized velar approximant
- ʋ Voiced labialized velar approximant
- ɥ Voiced labialized palatal approximant
- ç Voiceless palatalized postalveolar (alveolo-palatal) fricative
- ʒ Voiced palatalized postalveolar (alveolo-palatal) fricative
- ɧ Simultaneous x and f (disputed)
- kp ts Affricates and double articulations may be joined by a tie bar



DIACRITICS

Diacritics may be placed above a symbol with a descender, as ɰ̰. Other IPA symbols may appear as diacritics to represent phonetic detail: ɸ (fricative release), ɦ̥ (breathy voice), ʔ̚ (glottal onset), * (epenthetic schwa), ɔ̰ (diphthongization).

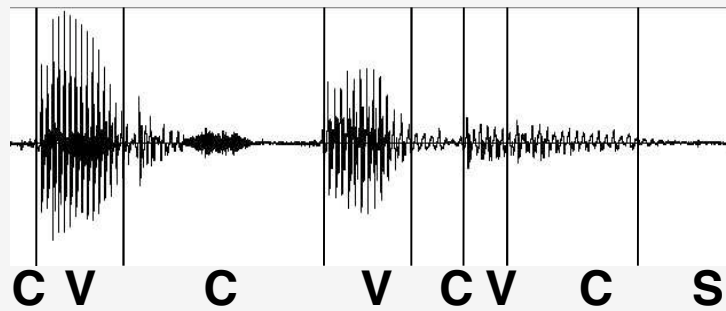
SYLLABILITY & RELEASES	PHONATION	PRIMARY ARTICULATION	SECONDARY ARTICULATION
ɰ̰̚	Syllabic	ɰ̰̚	ɰ̰̚
ɰ̰̚	Non-syllabic	ɰ̰̚	ɰ̰̚
ɰ̰̚	Pre-aspirated	ɰ̰̚	ɰ̰̚
ɰ̰̚	Nasal release	ɰ̰̚	ɰ̰̚
ɰ̰̚	Lateral release	ɰ̰̚	ɰ̰̚
ɰ̰̚	No audible release	ɰ̰̚	ɰ̰̚
ɰ̰̚	Lowered	ɰ̰̚	ɰ̰̚

The distinction between consonant and vowel is fundamental to the way segments are described in the framework underpinning IPA

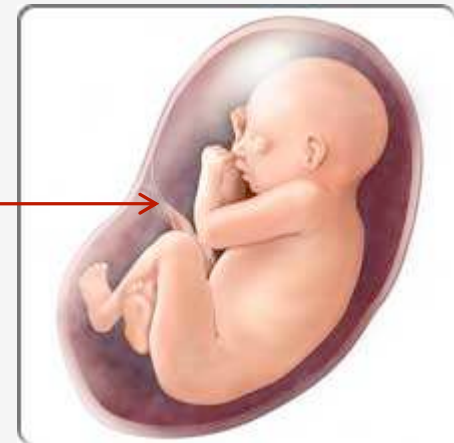
Handbook of the IPA (1999), p.6

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')

Results

Corpus

Segmentation

General agreement between labellers

Agreement on specific segments

Cohen's kappa

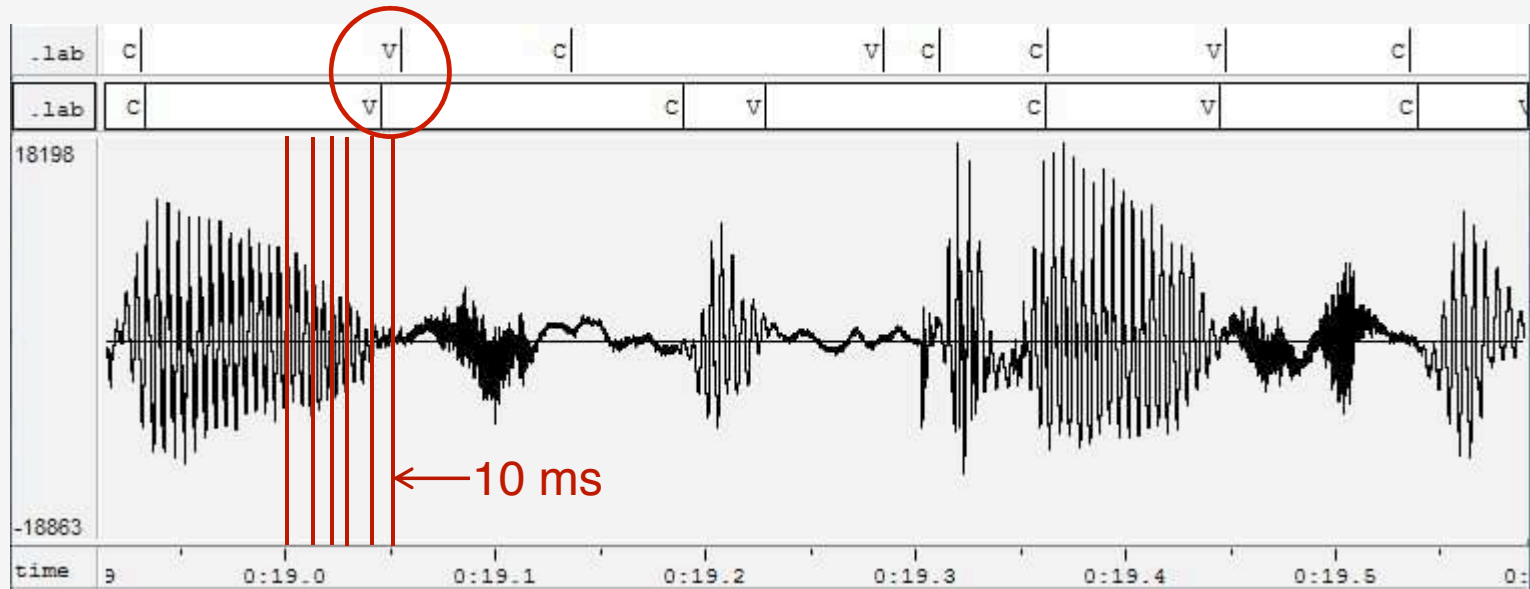
- What is relative inter-rater agreement in comparison to agreement expected by chance?

Rater 1	Rater 2
A	A
B	A
A	B
A	A

$$\kappa = \frac{Pr_{agreement} - Pr_{chance}}{1 - Pr_{chance}}$$

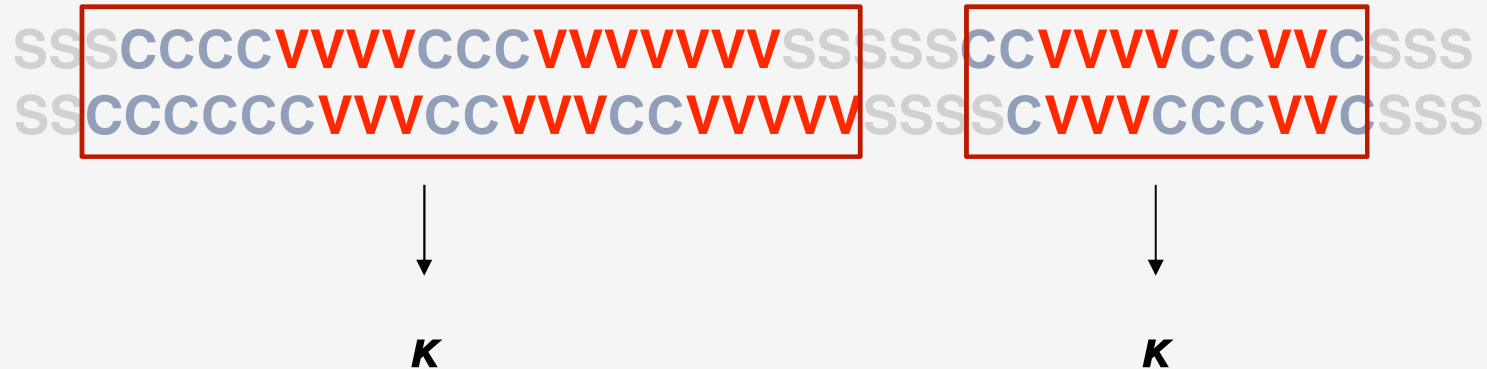


Cohen's kappa



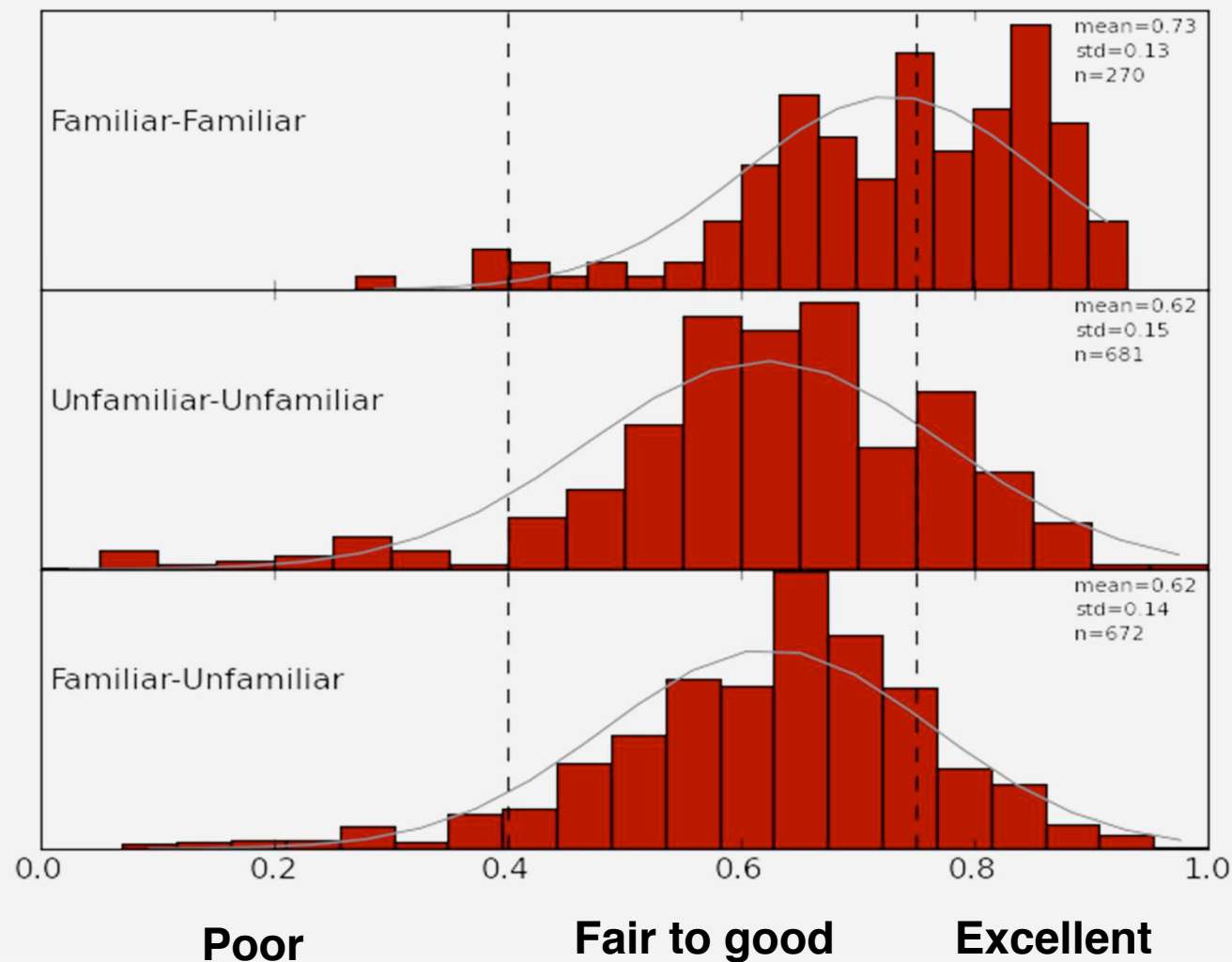
Time stamp	19:00	19:01	19:02	19:03	19:04	19:05
Labeller 1	V	V	V	V	V	V
Labeller 2	V	V	V	V	V	C

Computing Cohen's kappa: inter-pause stretch

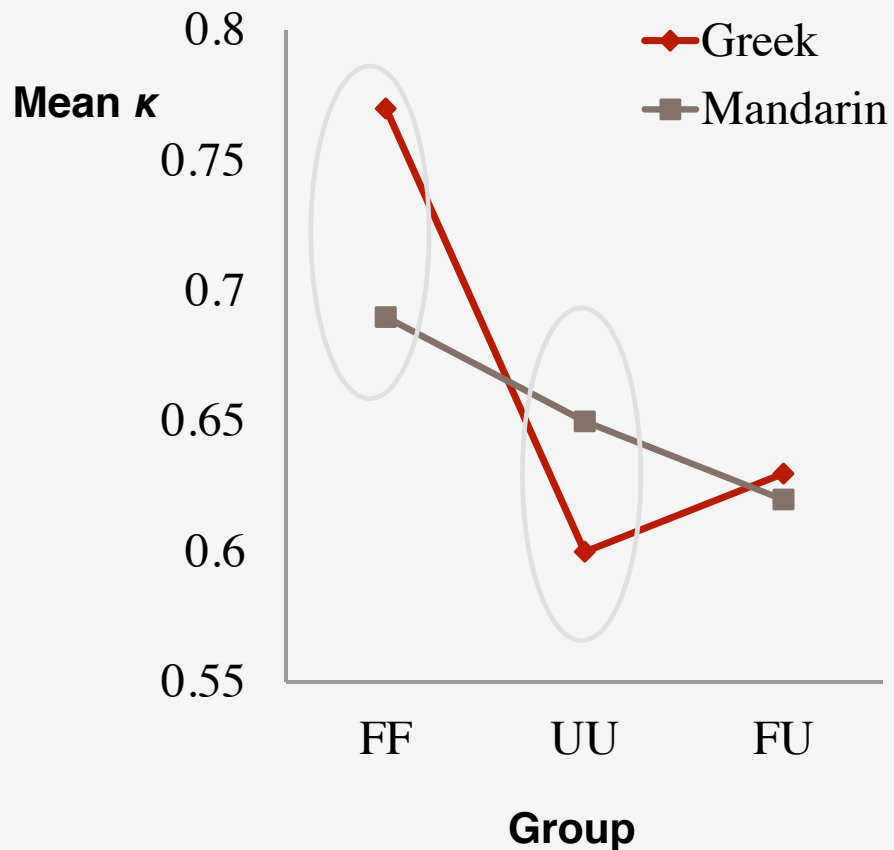


Familiar – Familiar
Unfamiliar – Unfamiliar
Familiar - Unfamiliar

Cohen's kappa for different groups



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

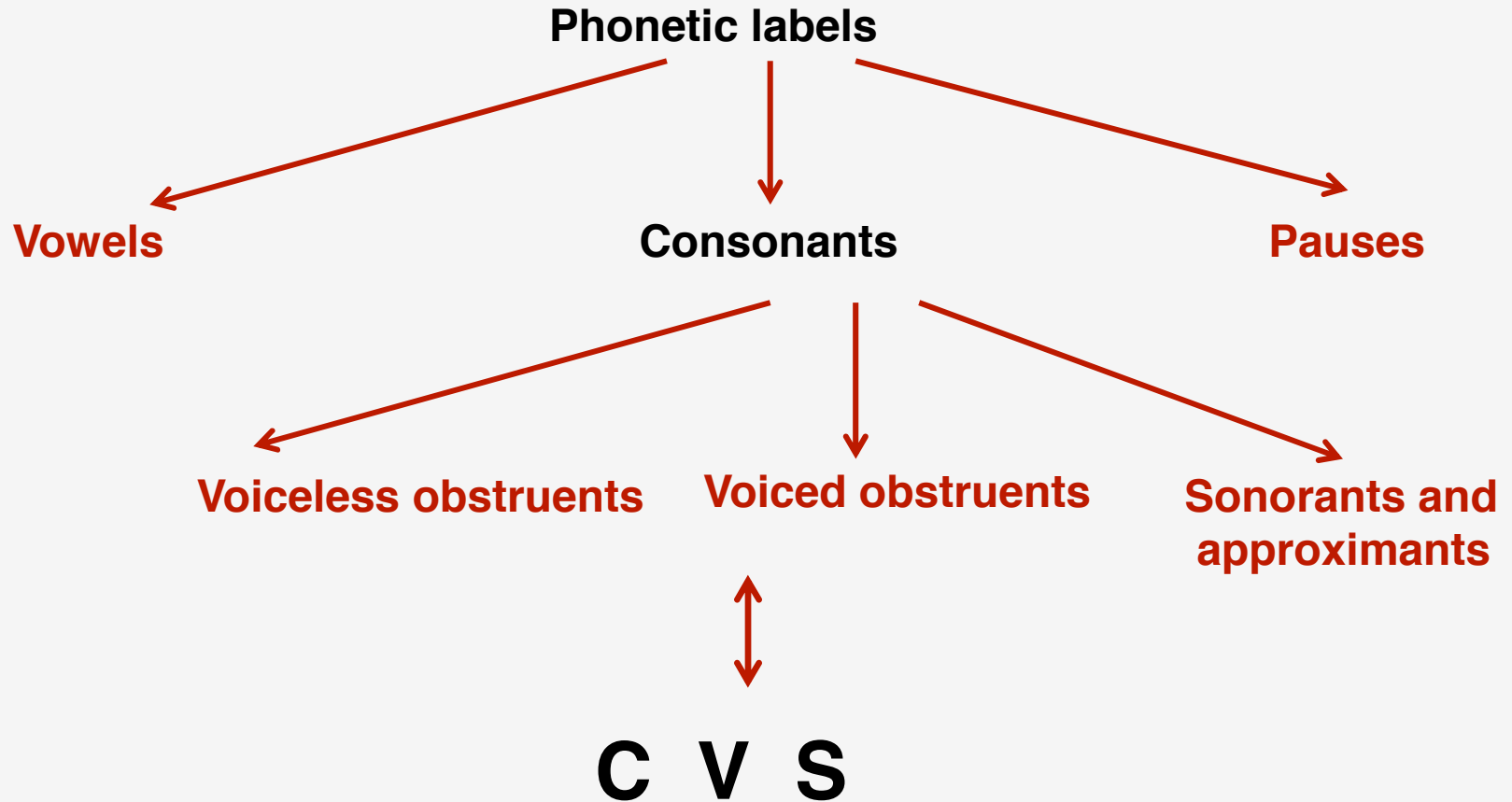
Corpus

Segmentation

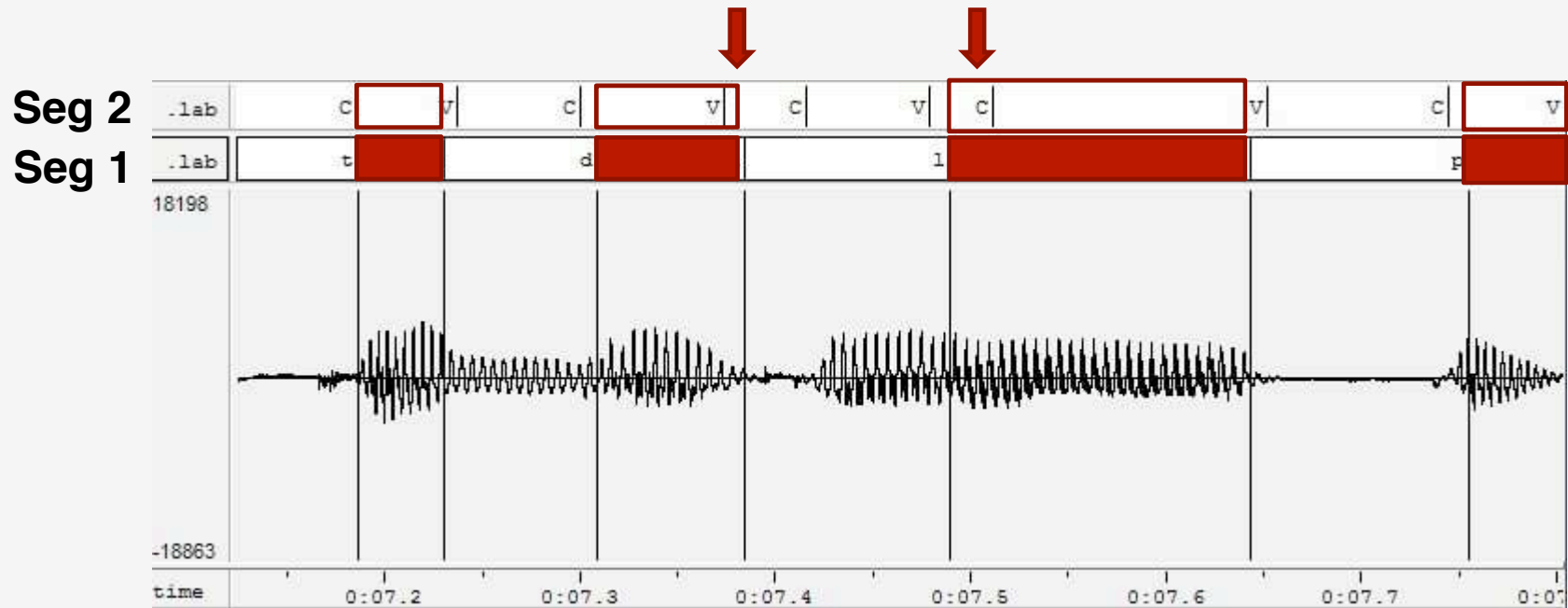
General agreement between labellers

Agreement on specific segments

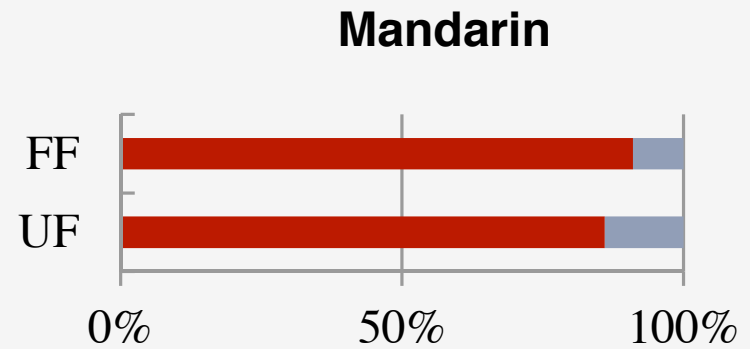
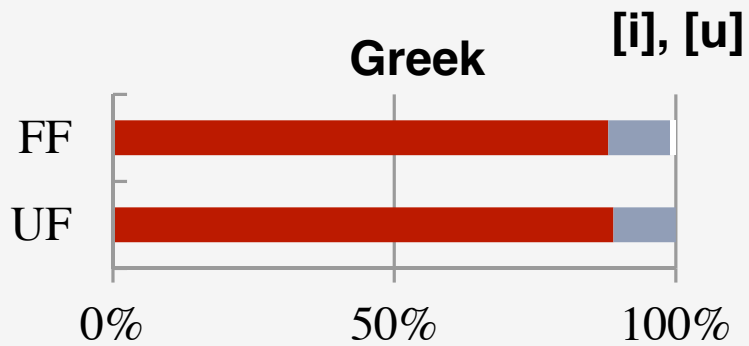
Agreement on specific segments



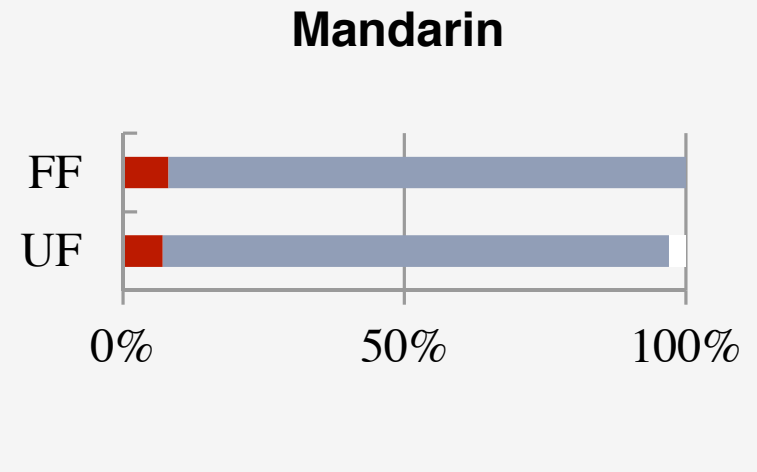
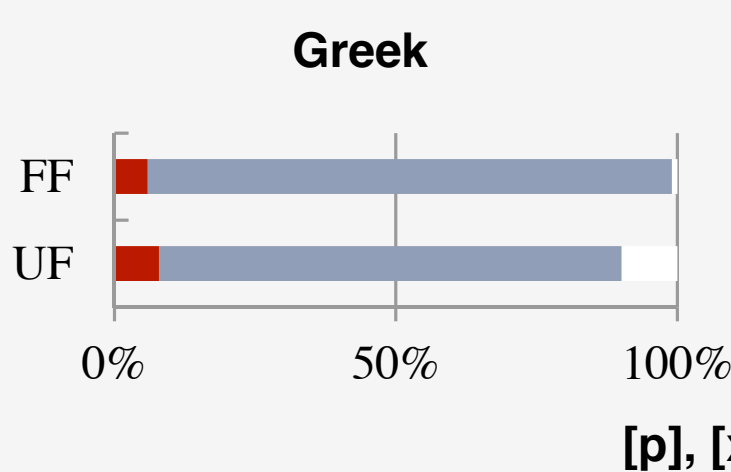
Agreement on specific segments



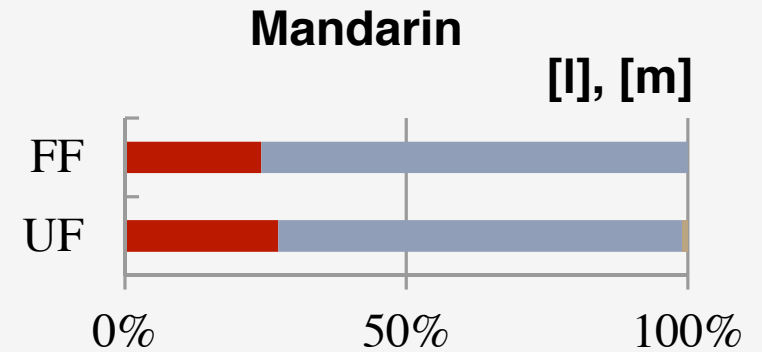
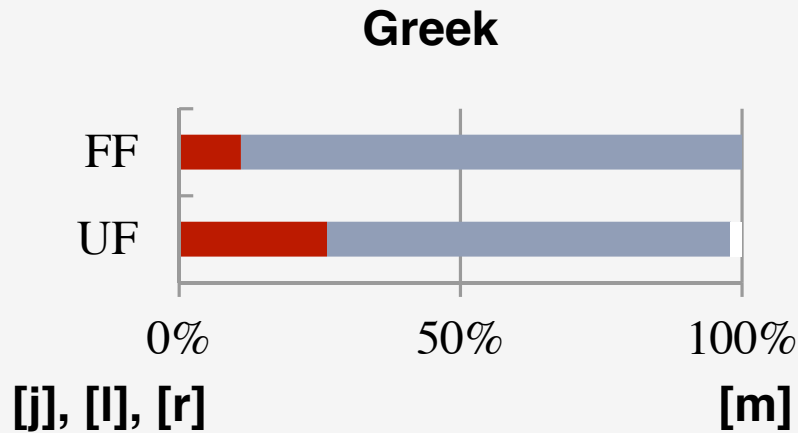
Vowels



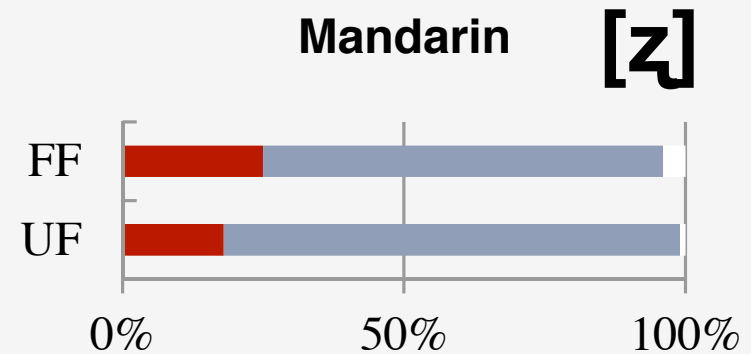
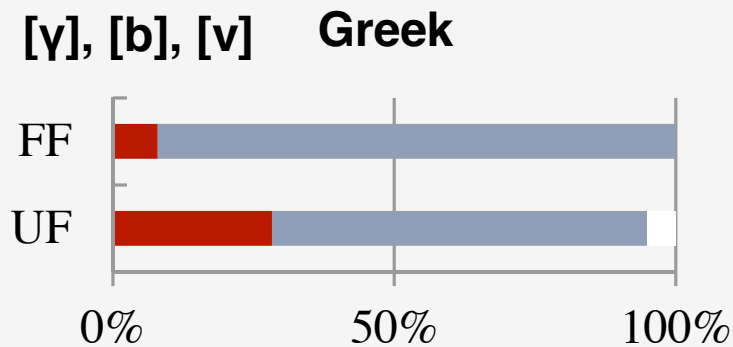
Voiceless obstruents



Sonorants and approximants



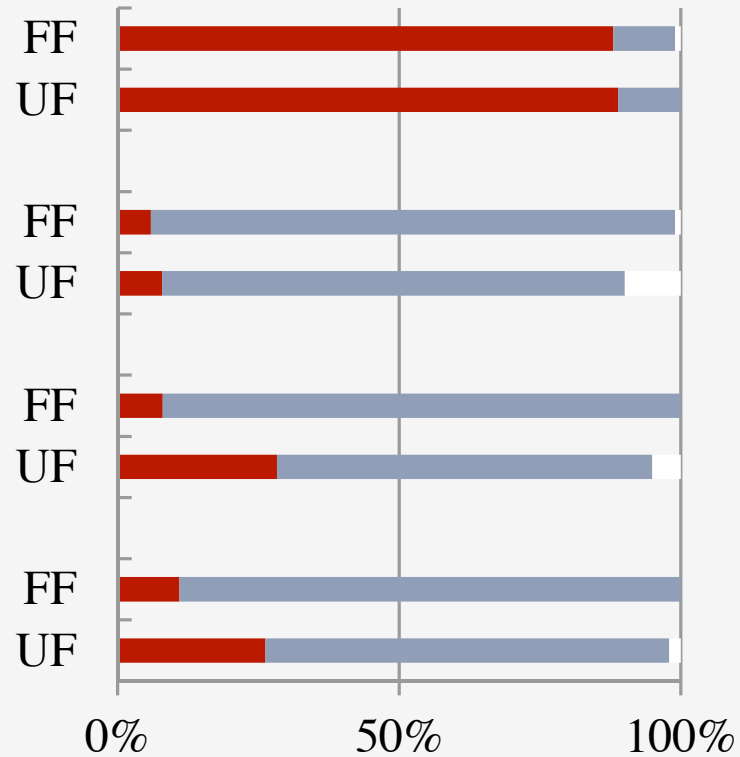
Voiced obstruents



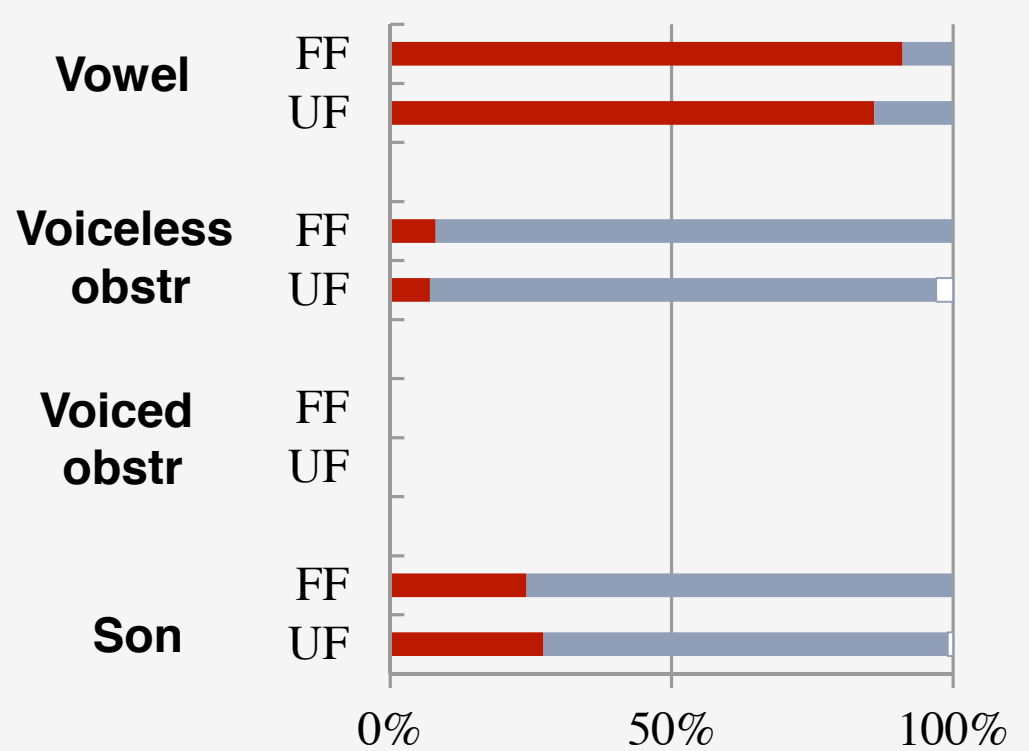
Overview



Greek



Mandarin



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

anastassia.loukina@stx.oxon.org
