

Acoustic Phonetics

Lesson 13

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What are suprasegmentals

What is linguistic rhythm

- rhythm measurements

- rhythm measurements & speech rate

Cross-linguistic differences in rhythmic patterns

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Suprasegmentals

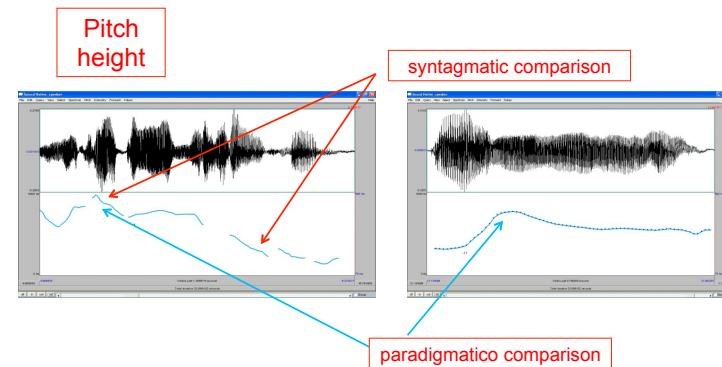
With **suprasegmentals** we mean all the phonetic properties that go beyond segments.

Suprasegmentals are defined through a comparison of more elements in a sequence

Pitch, duration, volume depend on the context

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For example



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The suprasegmental system

- Duration of vowels and consonants (quantitative measure)
- Syllable
- Stress
- Tone
- Intonation

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About suprasegmentals

- Suprasegmentals use the intrinsic properties of sounds to realize linguistic functions
- For ex.: All segments have a duration → this is used to distinguish linguistic sounds
 - In ital.: fato – fatto
 - In sved.: LONG SHORT
 - high /i y u/ 140 95
 - mid /e ʌ ɔ/ 155 103
 - low /æ oe a/ 164 111 (from Elert, 1964)

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Duration

- Vowel or consonant duration is used linguistically to create lexical distinctions (though phonemic contrasts).

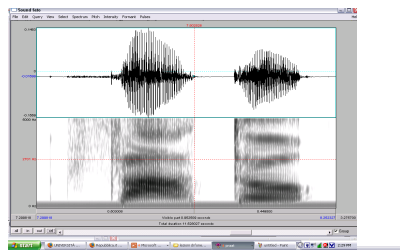
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Duration in Italian

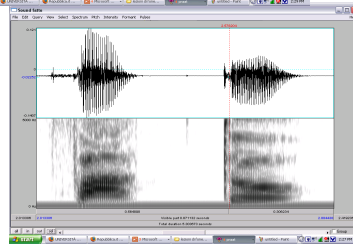
- differentiates simple from geminate consonants
Ex.: fato ~ fatto
- contributes to the perception of word stress
Ex. meta ~ metà

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Differences in consonant duration in Italian



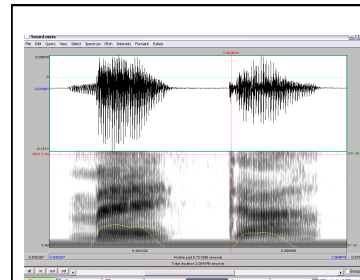
[fatɔ] “fato”



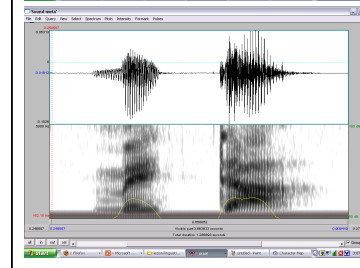
[fatːɔ] “fatto”

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Differences in duration and intensity contribute to the perception of the Italian lexical accent



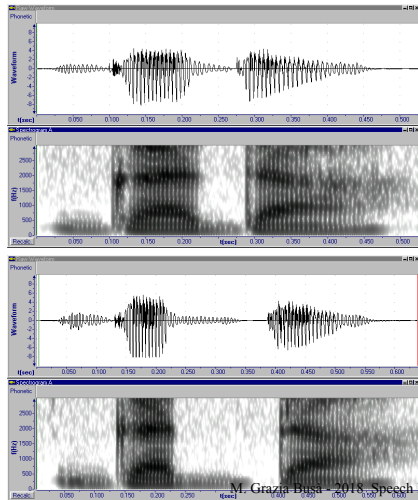
[ˈmeta] “meta”



[mɛˈta] “meta”

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Distinctive consonant duration in Hindi



[gəḍa]
"mace" (weapon)



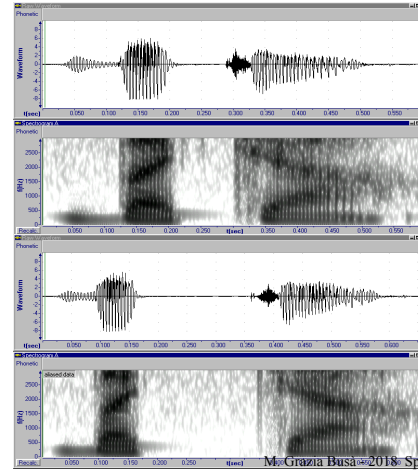
[gəḍːa]
"mattress"



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http://trill.linguistics.berkeley.edu/PhonLab/classes/ling110/lecturesslides_2003.html

Affricates with distinctive duration have a longer phase of obstruction but not a longer frication phase. An example from Hindi



[bətʃa] "save"



[bətʃːa] "child"



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http://trill.linguistics.berkeley.edu/PhonLab/classes/ling110/lecturesslides_2003.html

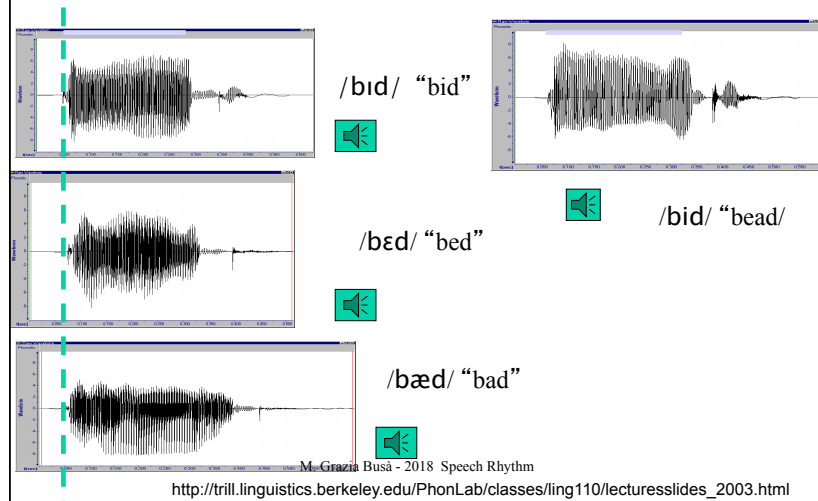
Vowel Duration

- In English listeners perceive differences in vowel, not consonant duration

– bid bead
 – beg bag
 – cap cab

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Differences in vowel duration in English



Language Rhythm

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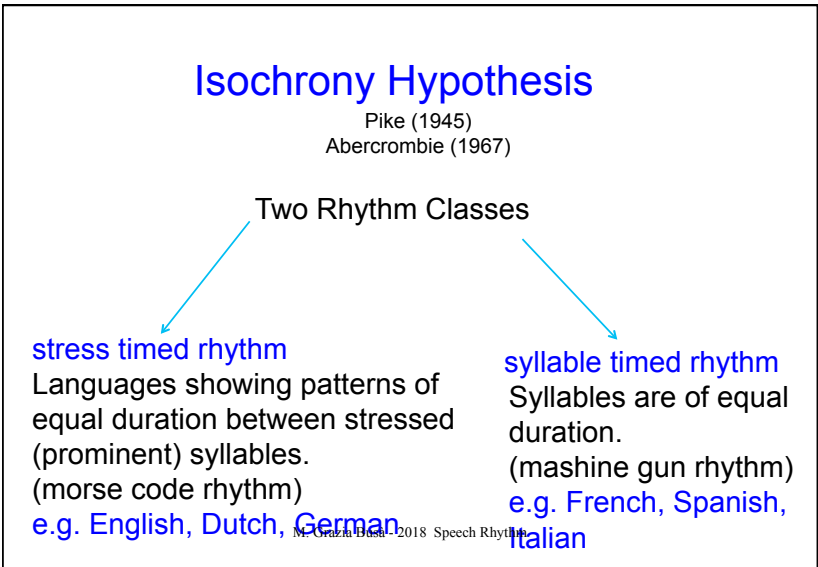
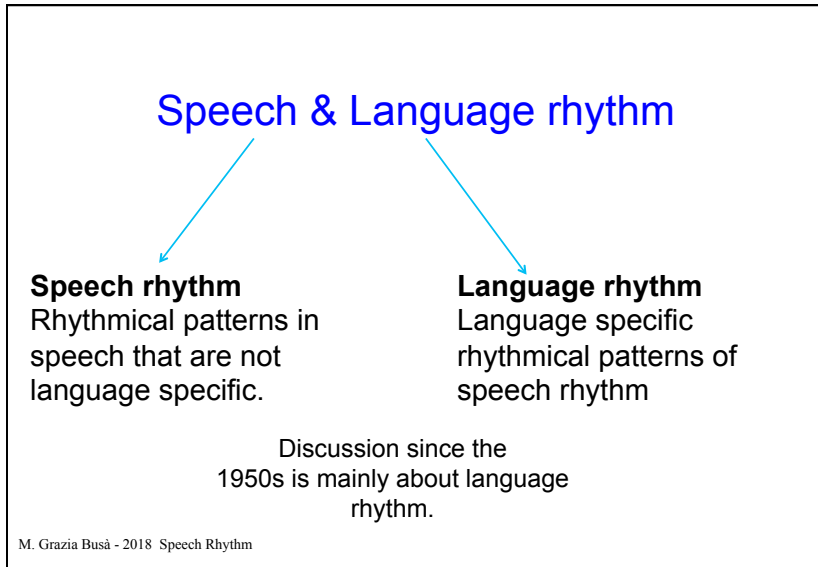
Possible definition of rhythm:

Rhythm is the systematic organization of prominent and less prominent speech units in time.

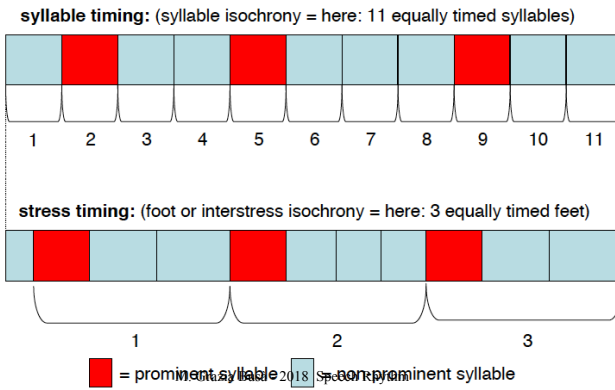
Speech units:
e.g. syllables,
vocalic intervals

Prominence:
higher fundamental frequency
higher duration
higher intensity

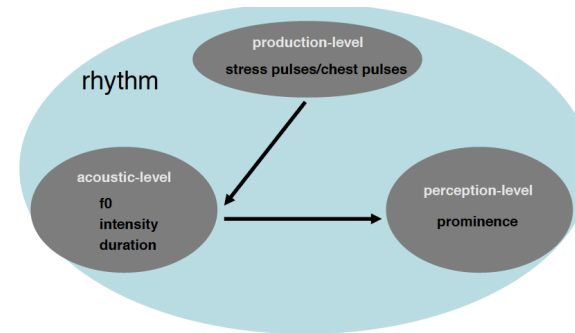
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The nature of syllable & stress timing



Rhythm



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MAIN PROBLEM:

finding experimental evidence

i.e.:

- finding acoustic correlates of language rhythm in the speech signal

(since the late 1960s researchers have been trying that with more or less success...)

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Early Rhythm Measurements

Roach (1982) – hypotheses:

- If isochrony-theory holds then...

- (i) ...there is considerable variation in syllable length in a language spoken with stress-timed rhythm whereas in a language spoken with syllable-timed rhythm the syllables tend to be equal in length.
- (ii) ...in syllable-timed languages stress pulses are unevenly spaced.

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Roach (1982) – method:

- syllable-timed languages
 - French
 - Telugu
 - Yoruba
 - stress-timed languages:
 - English
 - Russian
 - Arabic
- (i) Calculate & compare variation of relative syllable duration
- (ii) Calculate & compare variation of relative foot duration

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Roach (1982) – results:

- (i) Syllable variation is not significantly different between stress-timed and syllable-timed languages.
- (ii) High variability in foot variation for stress timed languages (especially for English).

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Problem:

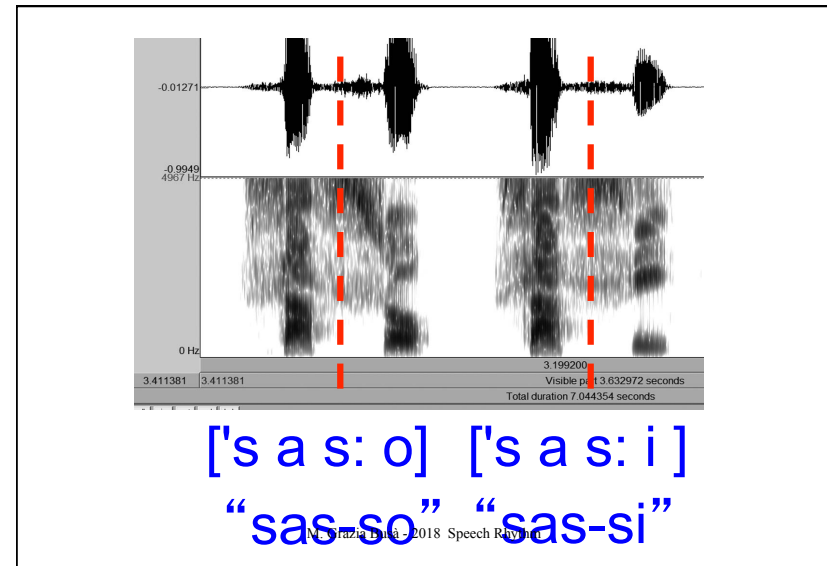
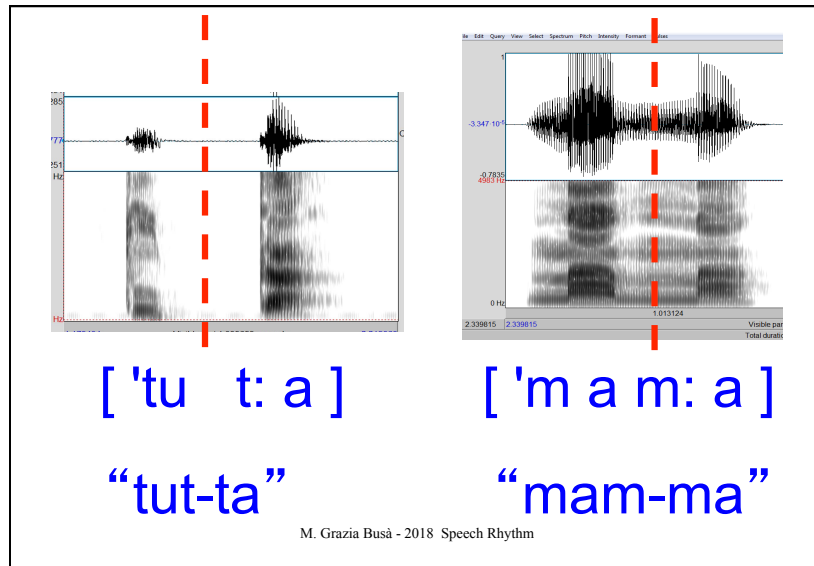
- Where is rhythm in the speech signal?
- What level has so far been neglected in rhythm studies?

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An example

- How do you decide how to separate the syllables here?

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Conclusion:

At the beginning of the 1990s the discussion about rhythm classes stopped with the result:

- Rhythm cannot be measured in the speech signal.
- Rhythm is a mere perceptual phenomenon.

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What creates the perception of rhythm?

Compared to syllable-timed languages, stress-timed languages allow for:

- **complex consonant clusters**
 - higher number or variation of consonant clusters
- **vowel reduction**
 - higher variation or content of vocalic intervals

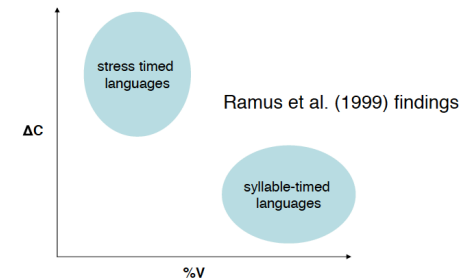
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Recent Rhythm Measurements

Ramus (1999):

- %C = percentage of consonantal intervals
- %V = percentage of vocalic intervals
- ΔC = standard deviation of consonantal intervals
- ΔV = standard deviation of vocalic intervals

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Different languages can discriminate the speech signal not in syllabic intervals, but in vocalic and consonantal portions

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Recent Rhythm Measurements

Pettorino

- %C = percentage of consonantal intervals
- %V = percentage of vocalic intervals
- V-to-V = time from the onset of V1 to the onset of V2

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Rhythm is the regular succession of prominences in time (Marotta 2011), linked to the recurrence of audible signal discontinuities.

Prominent instants in the speech signal are perceptually more salient than others. These instants, **Perceptual Centres** or **P-Centres** (Morton et al. 1976), correspond to a particular point within the syllable that indicates its “moment of occurrence” (Marcus 1981).

Physical correlates of **P-Centres** have not been firmly established (Villing 2003 and 2010) and their exact location is a current matter of experimental verification.

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P-Centres are probably located **very close to Vowel Onset Points (VOP)**

Therefore VOPs represent those audible signal **discontinuities** that would guide listeners in the perception of rhythm.

As a consequence, **the interval between two consecutive vowel onset points (VtoV interval)** seems to be the perceptual cue enabling listeners to identify the rhythmic pattern of a language.

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- VtoV and deltaC are strictly correlated.
- English presents VtoV values that are higher than those in French and Italian.

→ **in English there is a greater distance between vowels than in Italian or French**












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A study by Pettorino et al. (2014)

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the corpus

11 Languages

	French		English
	Italian		German
	Spanish		Dutch
	Portuguese		Russian
	Romanian		
	Hungarian		Japanese

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Styles of speech

- TV news
- acted speech

30 minutes

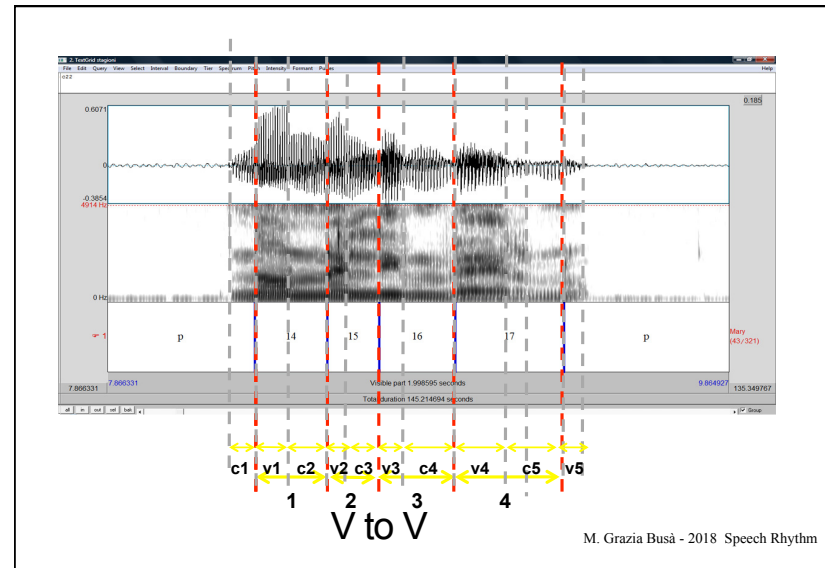
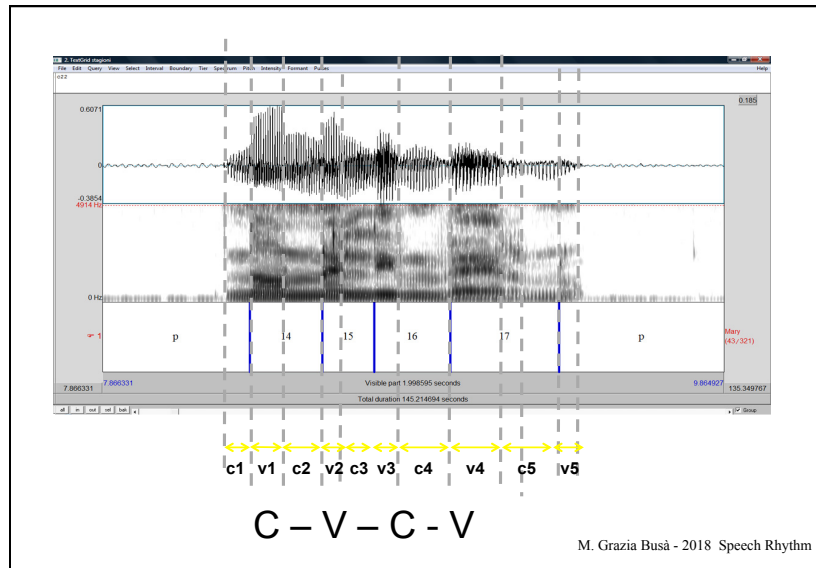
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ACTED SPEECH

French
Italian
Spanish
Portugues
Romanian
English
German
Dutch
Russian Japanese
Hungarian

TV NEWS

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They measured:

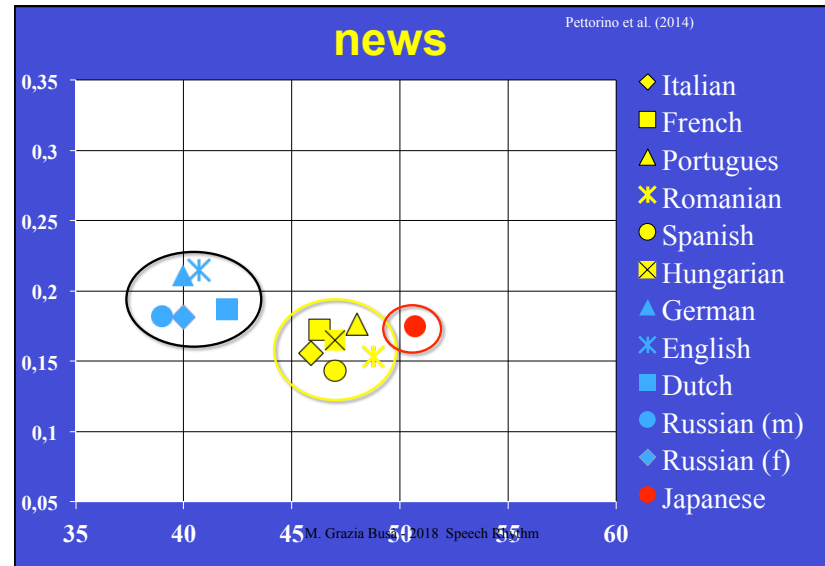
VtoV

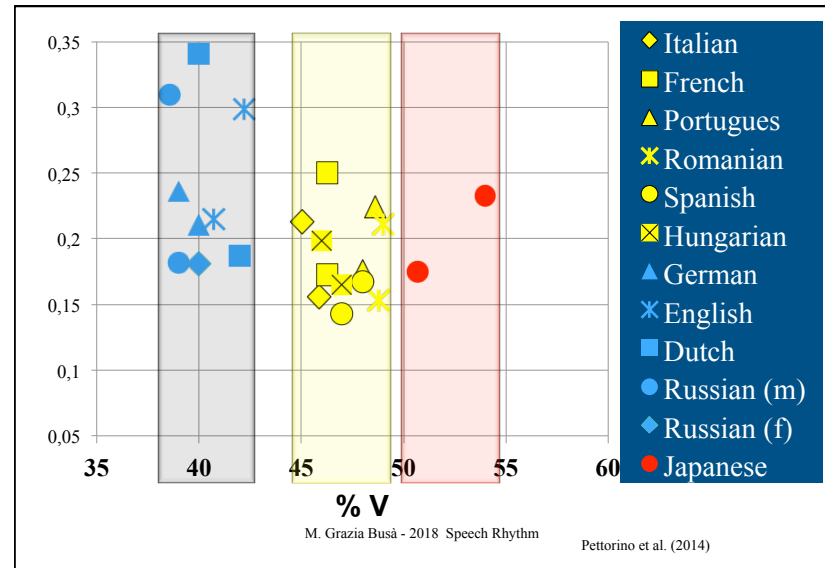
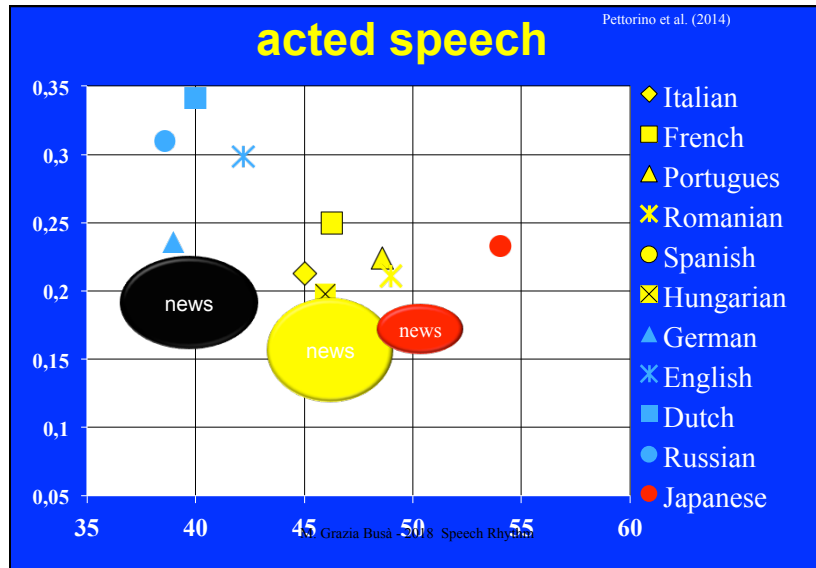
% V

% C

Pettorino et al. (2014)

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Conclusion

- Languages can be distinguished on the basis of %V and VtoV

Pettorino et al. (2014)

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Does rhythm change with age?

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Age related changes in the speech signal

- increased jitter and shimmer
- increased breathiness
- lowering of formant frequencies
- altered vowel formant frequency patterns
- altered resonance pattern
- lengthening of vowels and stop consonants
- lowering of speech rate

Linville 1987, Jacques and Rastatter 1990, Traunmüller and van Bezooijen 1994, Ramig and Ringel 1983, Dehqan et al. 2012, Amiguet and Pell 1992.

The corpus

Pettorino et al. (2013)

- In 2007, a 79-year old Italian anchorman was asked to read a script that he had read in a 1968 TV news, acting as if he were hosting a real TV news broadcast.



- Recording at RAI TV studios in Rome to maintain the same communicative situation.

The corpus

- This procedure allows to have:
 - Same speaker
 - Same communicative situation
 - Same text

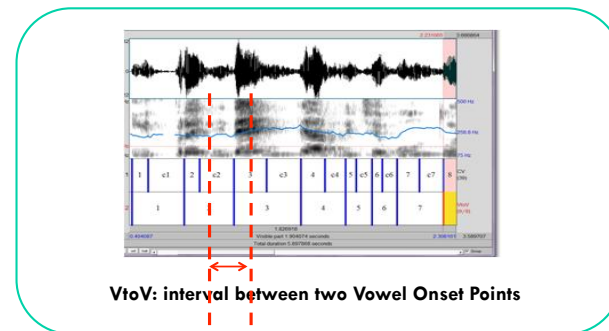
BUT

Different age
-40 years old
-79 years old

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Pettorino et al. (2013)

%V and rhythmic variations



Pettorino, M., et al. "VtoV: A perceptual cue for rhythmic identification," in M. Mertens and I.C. Simon (Eds.), Proceedings of the Prosody-Discourse Interface Conference, 101-106, 2013

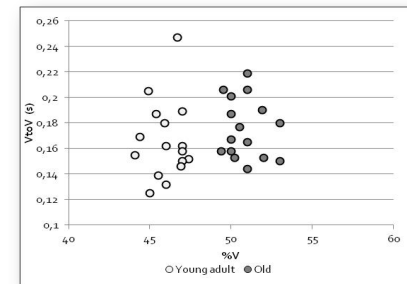
- Results put together with those of two groups of speakers (4 young (20-25 years old) – 4 old (75-80 years old))

BUT Different age
-40 years old
-79 years old

Pettorino et al. (2013)

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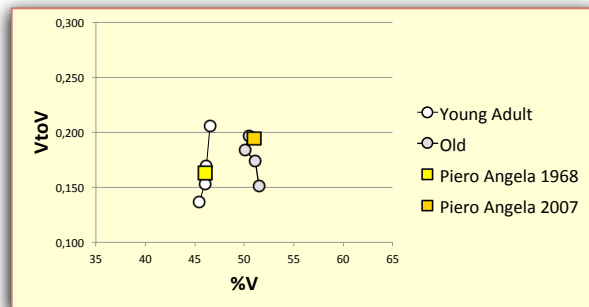
Results



- **Intergroup differences**
% V is statistically different between Young adult and Old speakers ($p < 0.01$)
- There are **no intragroup differences** ($p > 0.05$)
- These findings confirm the strict **relationship** between **speaker age** and %V

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Results



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