
***Phonetics & Linguistics***
***Speech Sciences***

# Speech & Language Rhythm

# Content:

1. Introduction
2. Language rhythm/ rhythm classes
3. Early rhythm measurements
4. Recent rhythm measurements
5. Rhythm measurements & speech rate
6. Conclustion

# 1 Introduction

**What is rhythm?**

Rhythm in music?

Rhythm in speech?

# 1 Introduction

## Possible definition of rhythm:

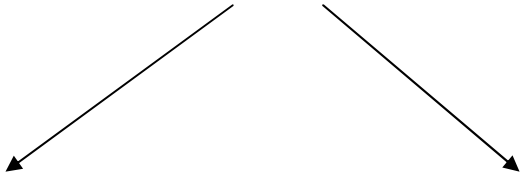
Rhythm is the systematic organization of prominent and less prominent speech units in time.

**Speech units:**
e.g. syllables, vocalic intervals

**Prominence:**
higher fundamental frequency
higher duration
higher intensity

# 1 Introduction

## Speech & Language rhythm



**Speech rhythm**
Rhythmical patterns in speech that are not language specific.

**Language rhythm**
Language specific rhythmical patterns of speech rhythm

**Discussion since the 1950s is mainly about language rhythm.**

# 2 Language Rhythm

**Isochrony Hypothesis**

Pike (1945)
Abercrombie (1967)

Two Rhythm Classes

**stress timed rhythm**
Languages showing patterns of equal duration between stressed (prominent) syllables.

(morse code rhythm)

**e.g. English, Dutch, German**

**syllable timed rhythm**
Syllables are of equal duration.

(mashine gun rhythm)

**e.g. French, Spanish, Italian**

# 2 Language Rhythm

## **Abercrombie (1967):** Language rhythm related to the physiology of speech production:

**chest pulses:** puffs of air to produce a syllable

**stress pulses:** reinforced chest pulse

**foot:** unit of a stress pulse and the following chest pulses

**stress-timed languages:**

- stress pulses are equally spaced – chest pulses are not
- no isochrony between feet measurable

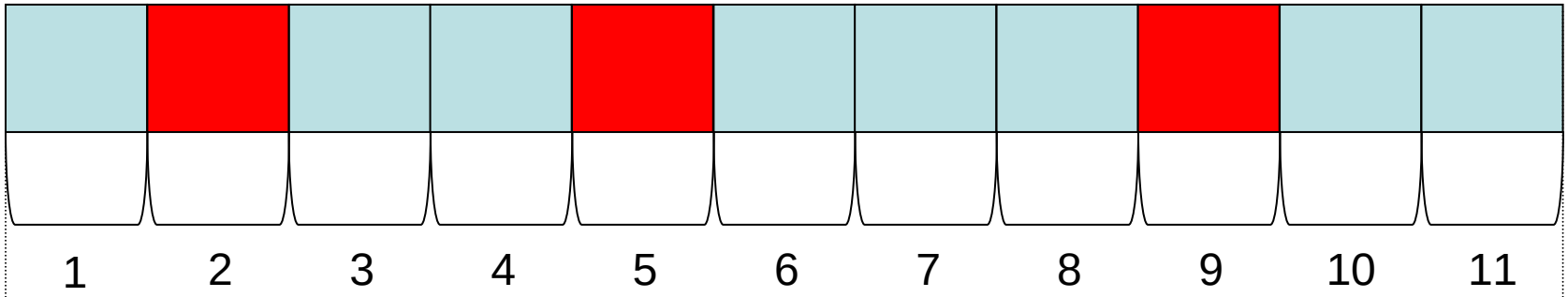
**syllable-timed languages:**

- chest pulses are equally spaced – stress pulses are not
- no isochrony between syllable durations measurable

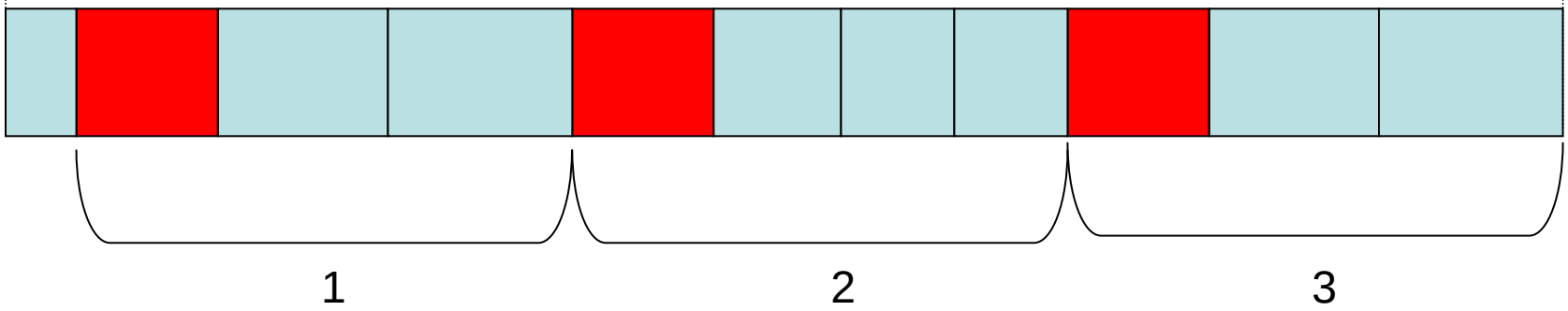
# 2 Language Rhythm

## The nature of syllable & stress timing

**syllable timing:** (syllable isochrony = here: 11 equally timed syllables)



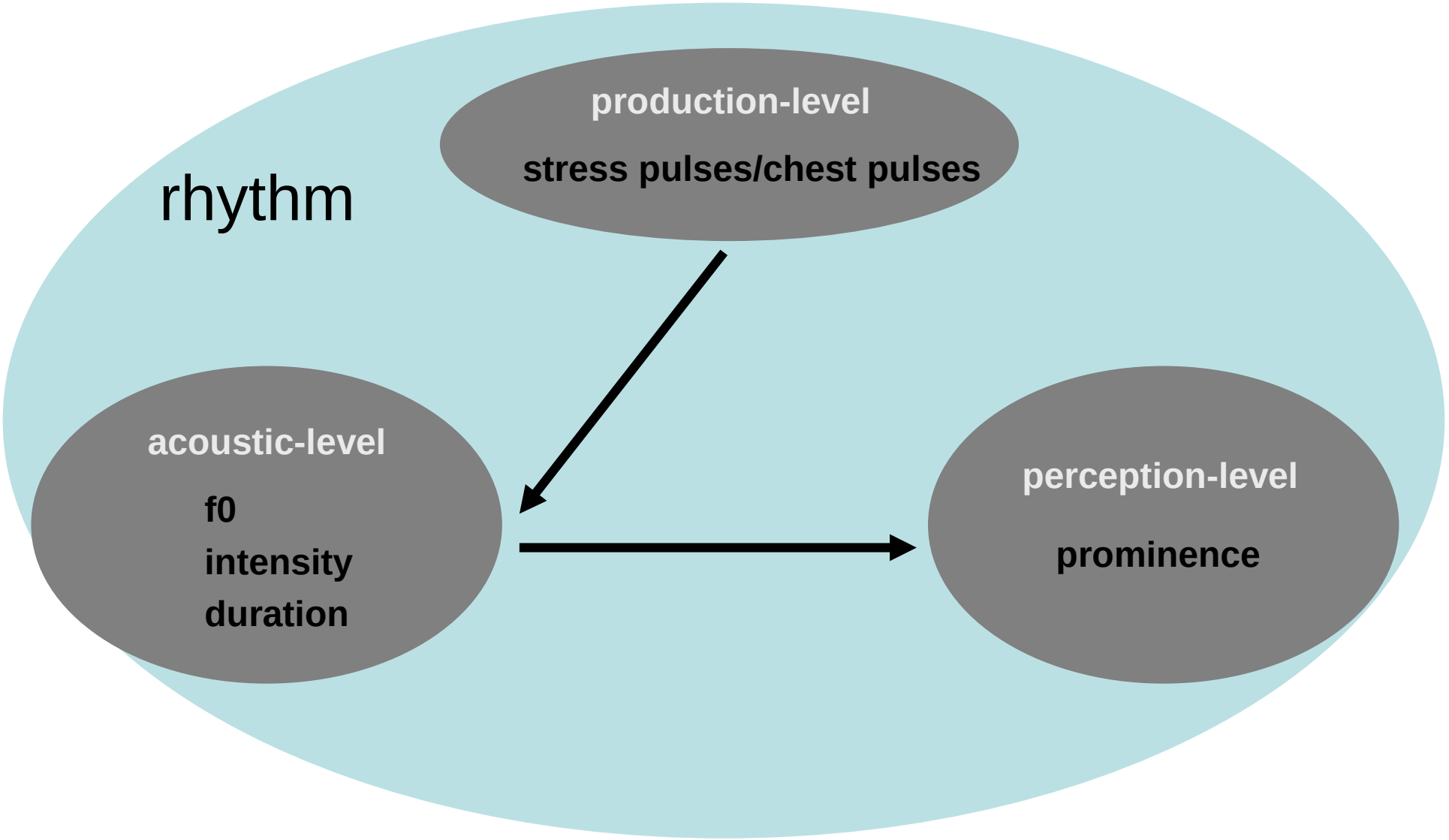

**stress timing:** (foot or interstress isochrony = here: 3 equally timed feet)




= prominent syllable = non-prominent syllable

# 2 Language Rhythm

## Conclusion:



# 2 Language Rhythm

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...

# 2 Language Rhythm

... suggestions!?

# 3 Early Rhythm Measurments

## 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.

# 3 Early Rhythm Measurments

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

# 3 Early Rhythm Measurments

## Roach (1982) – results:

(i) Syllable variation is not significantly different for between stress-timed and syllable-timed languages.

(ii) High variability in foot variation for stress-timed languages (especially for English).

# 3 Early Rhythm Measurments

Problem:

Where is rhythm in the speech signal?

What level has so far been neglected in rhythm studies?

# 3 Early Rhythm Measurments

## The perception of rhythm:

### Benguerel and D‘Arcy (1986):

- Acoustically irregular sequences of syllables are rated as being regular

### Beckman (1992):

- Stress-timing is a perceptual product more than an acoustic or production phenomenon.

### O‘Connor (1965):

- Stress units are not produced regularly
- Irregularly produced stress units are perceived regularly

# 3 Early Rhythm Measurments

## 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.

# 4 Recent Rhythm Measurments

New idea already put forward in Roach (1982):

a.) stress-timed languages allow complex consonant clusters

→ higher variation or content of complex consonant clusters

b.) stress-timed languages allow vowel reduction

→ higher variation or content of vocalic intervals

# 4 Recent Rhythm Measurments

Ramus (1999):

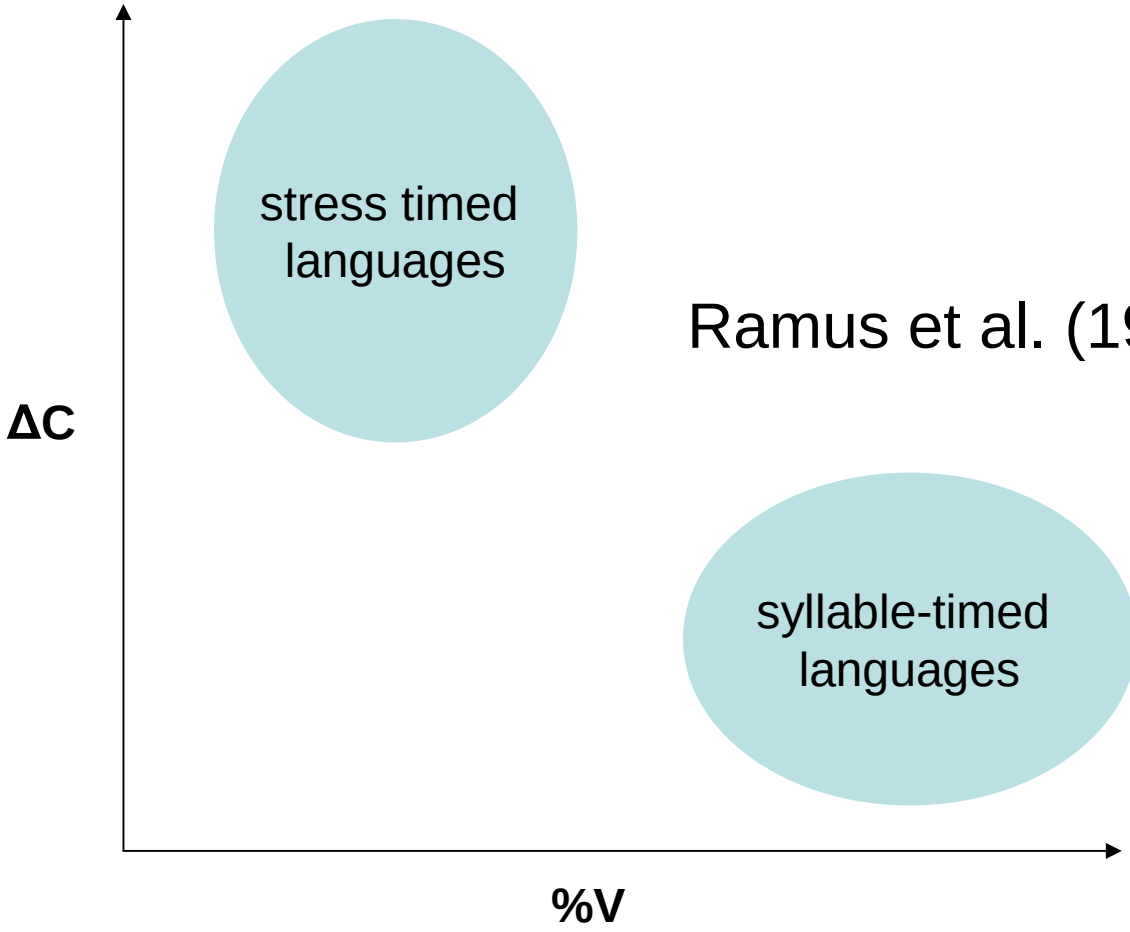
**ΔC** = standard deviation of consonantal intervals

**ΔV** = standard deviation of vocalic intervals

**%C** = percentage of consonantal intervals

**%V** = percentage of vocalic intervals

# 4 Recent Rhythm Measurments




Ramus et al. (1999) findings

# 4 Recent Rhythm Measurments

Grabe & Low (2002):

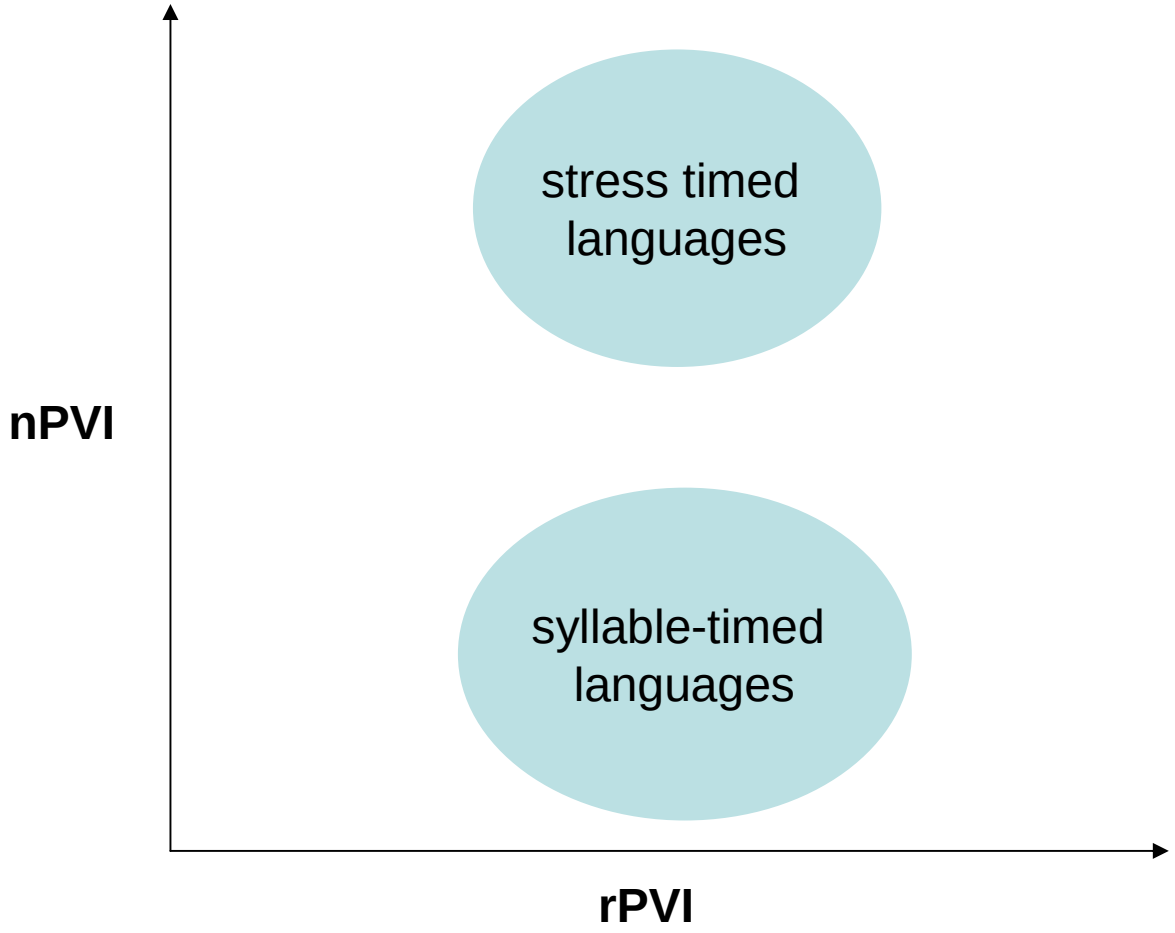
raw & normalized pairwise variability index

**nPVI** = normalized PVI for vocalic intervals

**rPVI** = raw PVI for consonantal intervals

# 4 Recent Rhythm Measurments

Grabe & Low (2002) findings



# 4 Recent Rhythm Measurments

**Problem:**

Ramus (1999) and Grabe & Low (2002):

- only one speaker per language
- speech rate not well controlled

**Idea:**

Checking the measure on a large database at different speech rates.

# 5 Rhythm & Speech Rate

## Barry et al. (2003):

- ΔC & ΔV decrease with an increase in speech rate
- nPVI does not normalise for speech rate

## Dellwo & Wagner (2003):

- ΔC decreases with an increase in speech rate
- %V is constant over all speech rates

# 5 Rhythm & Speech Rate

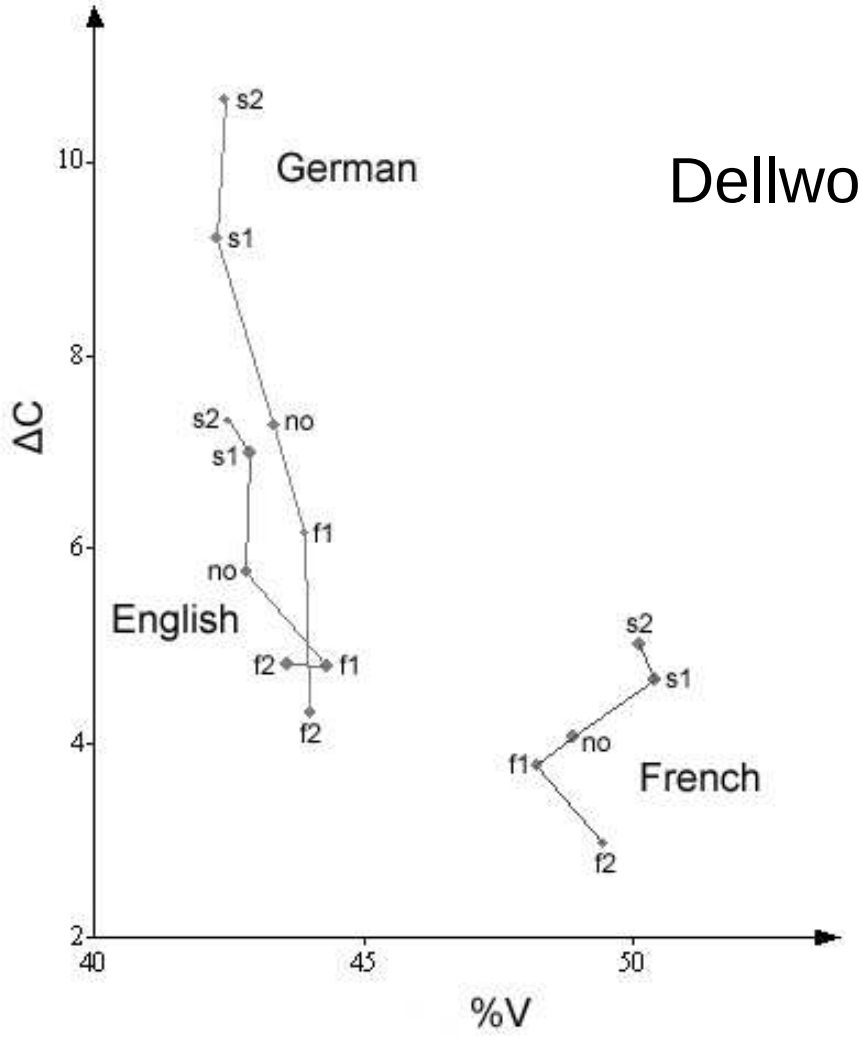



**Diagram 1**: Results for %V and ΔC under different intended speech rate conditions (s2, s1, no, f1, f2) for the languages English, French, and German.

Dellwo & Wagner (2003) findings

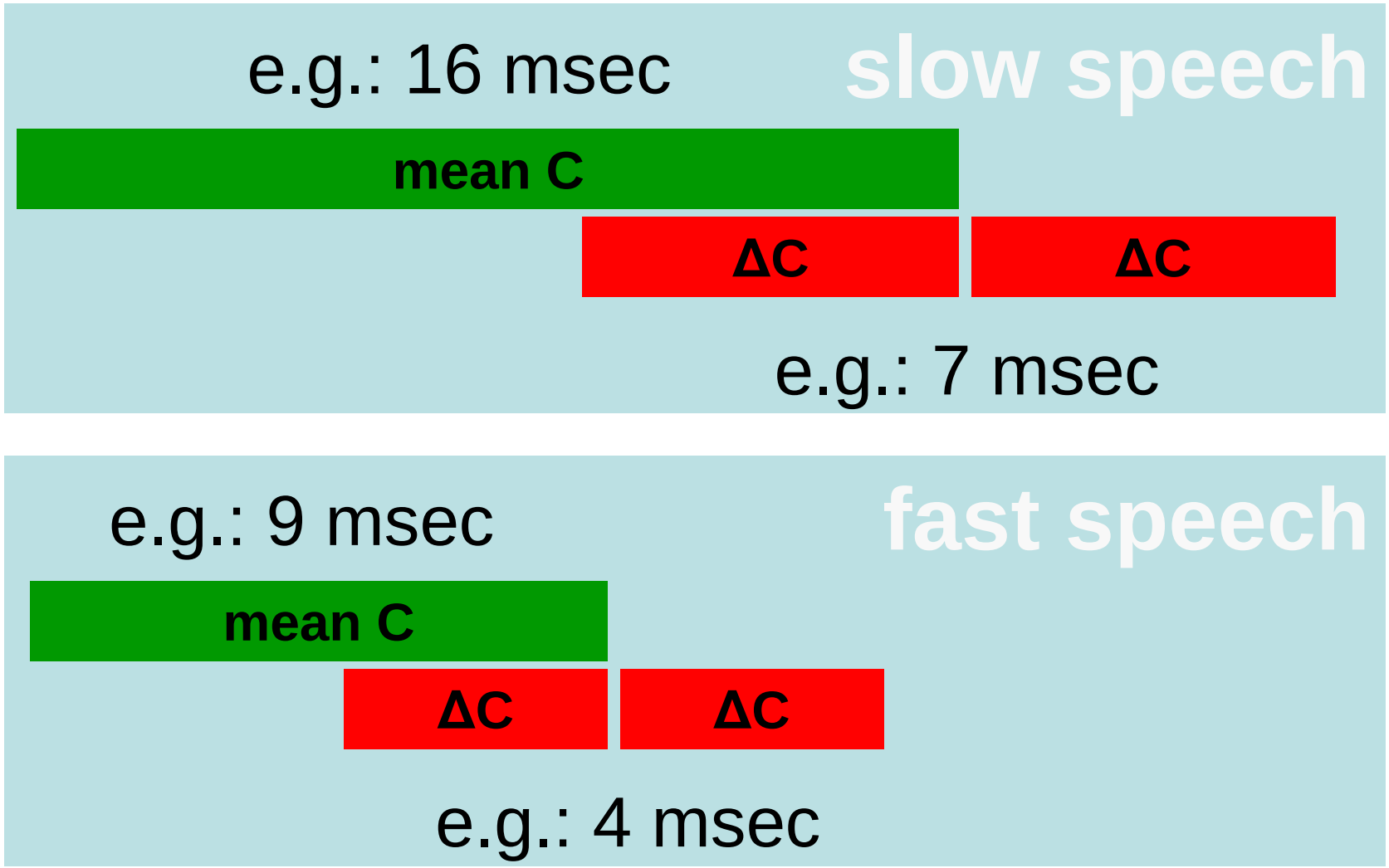
# 5 Rhythm & Speech Rate

Dellwo (forthcoming):

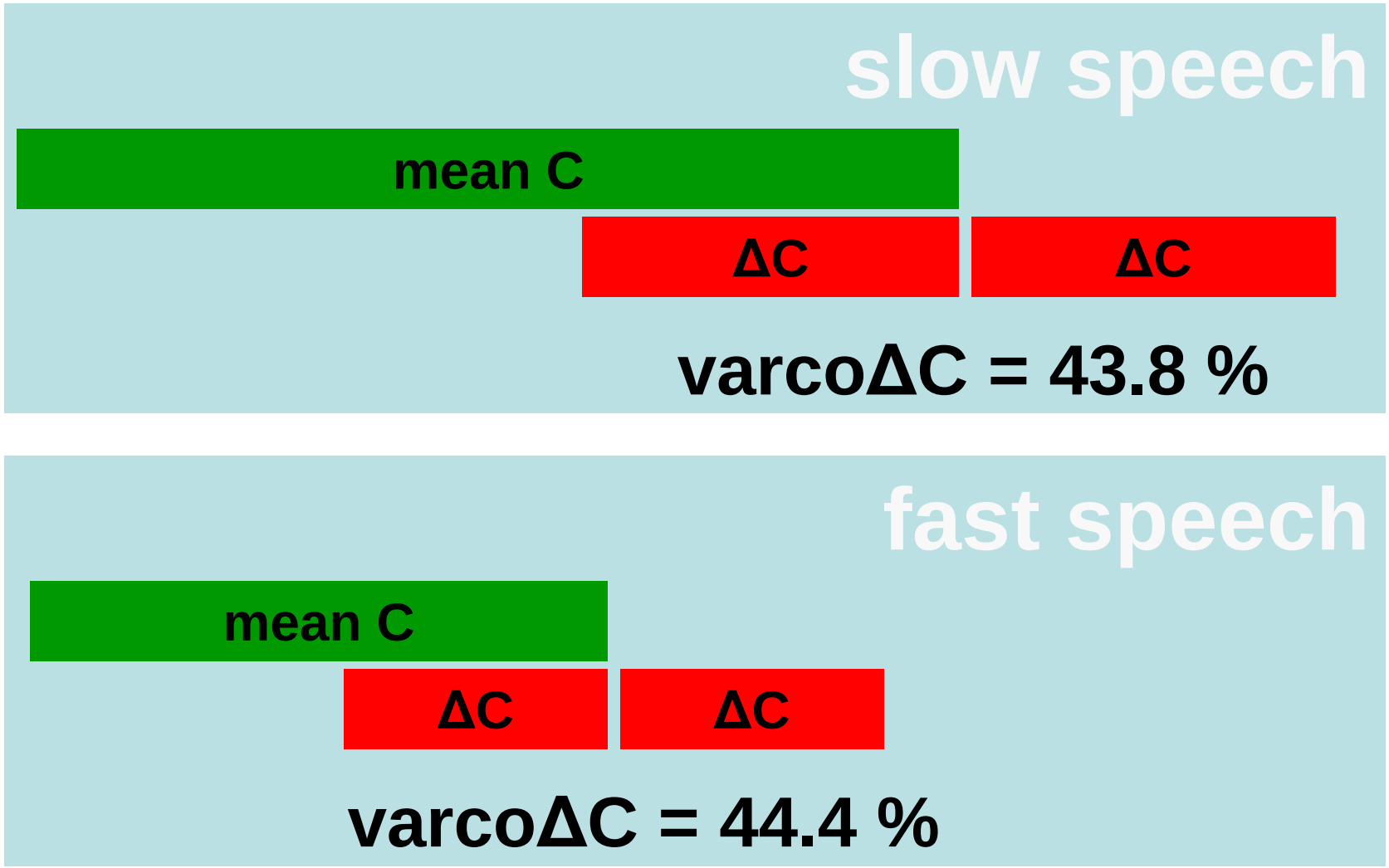
Decrease of ΔC and ΔV to be expected since shorter intervals in fast speech will cause lower standard deviation

p.t.o.

# 5 Rhythm & Speech Rate



# 5 Rhythm & Speech Rate



# 5 Rhythm & Speech Rate

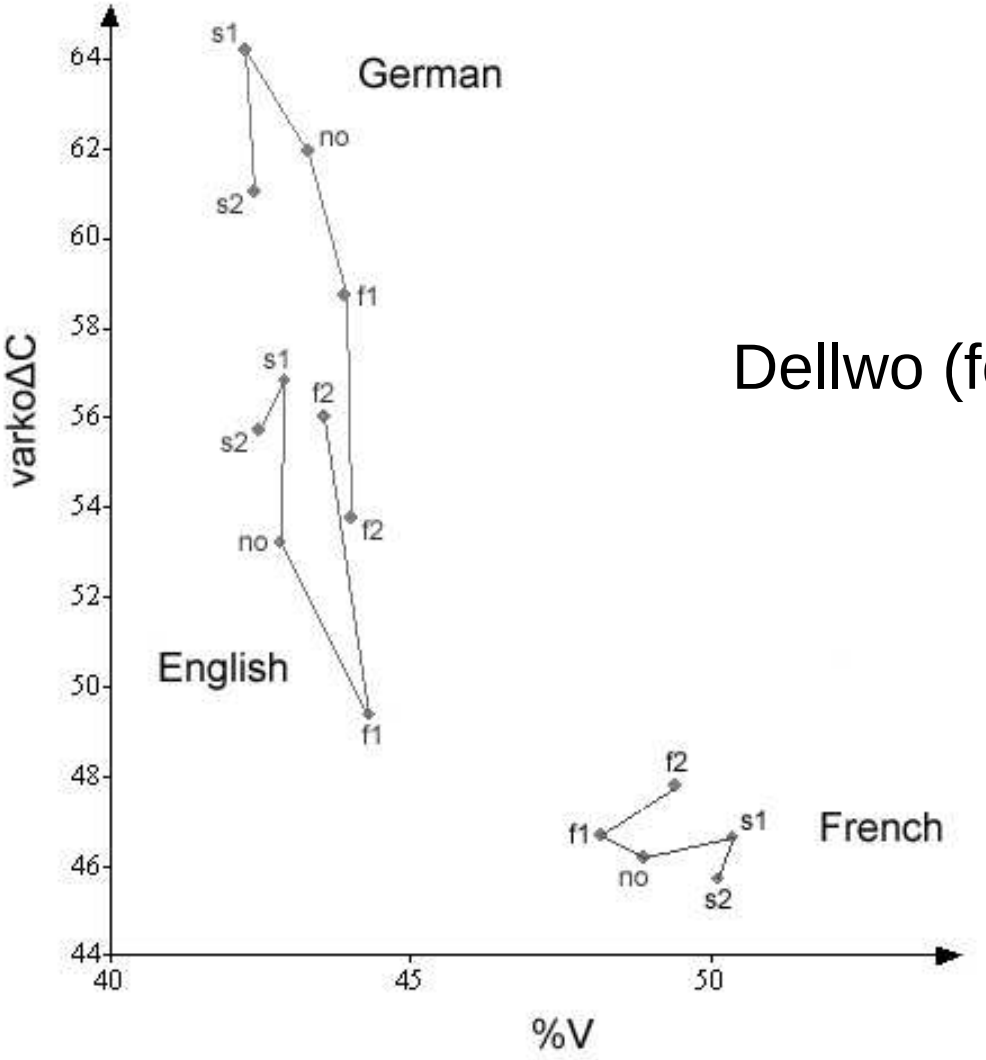



**Diagram 2**: Results for %V and varcoΔC under different intended speech rate conditions (s2, s1, no, f1, f2) for the languages German, French, and English.

Dellwo (forthcoming) findings

# 6 Conclusion

1.) The major questions in language rhythm still remain untouched:
Perceptual evidence
for stress- and syllable-timing

2.) We seem to be still far from a satisfying description of rhythm.

# 6 Conclusion

Question for discussion:

Why do we need to study rhythm at all?

# 7 Literature


**Abercrombie, D. (1967)** *Elements of general phonetics*. Aldine: Chicago.

**Barry, W. J., B. Andreeva, M. Russo, S. Dimitrova, and T. Kostadinova (2003):** *Do rhythm measures tell us anything about language type?* In: *Proceedings of the 15th ICPhS*, Barcelona, 2693-2696.

**Beckman, M. E. (1992)** *Evidence for speech rhythm across languages*. In: Y. Tohkura, E. Vatikiotis-Bateson & Y. Sagisaka (eds.) *Speech Perception, Production and Linguistic Structure*. IOS Press: Amsterdam, 457-463.

**Dellwo, V (forthcoming)** *Rhythm & Speech Rate: A variation coefficient for deltaC*. In: *Proceedings of the 38. linguistic Colloquium*, Budapest 2003.

**Dellwo, V. and P. Wagner (2003)** *Relationships between speech rate and rhythm*. In: *Proceedings of the ICPhS*, pp.

**E. Grabe and E. L. Low (2003)** *Durational variability in speech and the rhythm class hypothesis*. In: *Papers in laboratory phonology* (7), 515-546.

**O'Connor, Joseph (1965)** The perception of time intervals. In: UCL Working Papers in Phonetics and Linguistics (2) 10-15.

**Pike, K. L. (1945)** *The intonation of American English*. University Press: Michigan.

**Ramus, F., M. Nespor, J. Mehler (1999):** *Correlates of linguistic rhythm in the speech signal*. In: *Cognition* (73), 265-292.