Analyzing rhythm I

Best Practices in Sociophonetics

2010 Workshop

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Rhythm in speech

- = *ordered repetition of contrasting elements in the speech flow*

- = *temporality*
- = *patterning*

What elements and what contrasts ?

- Metrical properties of some phonological unit above the phoneme
  - "the arrangement of spoken words alternating stressed and unstressed elements; "the *rhythm* of Frost's poetry" ..." (Free dictionary)
- Basic phonotactic characteristics, such as syllable structure and complexity, that define a language

What language would you…

…prefer to sing on if you were an opera singer:
Dutch or Italian?

Why?

CCVCCCC or CV ?

- Why study rhythm if you are a sociolinguist?
  - socially meaningful prosodic differences
  - languages and dialects come in "rhythm types"
    - metrical properties & syllable structure
  - measurable and perceptually relevant

For a long time, however…

- Rhythm = isochrony of certain salient events in speech

Stress-timed languages

- Typically English
  - *main rhythmic unit = **foot***
  - *regularities in the patterning of stressed syllables ("head" of the metrical foot)*
  - *unstressed syllables reduced*

Mississippi

```
(          )
(x    .) (x  . )
Mis  sis sip pi
```

Mississippi mud

```
(                 x )
(x          )  ( x )
(x    .) (x  . )  ( x )
Mis  sis  sip pi   mud
```

(x .) - trochee

Syllable-timed languages

- Typically French
  - *main rhythmic unit = **syllable***
  - *regularities in the patterning of "accented" syllables that are lengthened*
  - ***NO** unstressed syllable-reduction*

'photographique'

(x) word/ accentual phrase

(x .) (. x) pieds

pho to gra phique

(. X) - iamb

Mora-timed languages

- Typically Japanese
  - *main rhythmic unit* = ***mora***
  - ***heavy (bimoraic) vs. light (monomoraic) syllables, with each mora of roughly equal duration***
  - *Words lengthen as the N of morae increases*

  - # of morae (in each of the three sets – with ***ra***, ***ka***, and ***si***):

1	ra	ka	si
2	raku	kata	sita
3	rakuda	katana	sitaku
4	rakudaga	katanasi	sitakusu
5	rakudagata	katanarasi	sitakusuru
6	rakudagataka	katanarasida	sitakusuruka
7	rakudagatakasi	katanarasidake	sitakusurukana

- Strict isochrony of stressed-, syllable-, and mora-timed intervals could never be shown.

- Reconceptualize "rhythm"!

- What are the perceptually relevant cues that are "timed" in certain typical ways in the speech flow ?
  - attention to **phonotatics** and **metrical properties** of the language

Vocalic vs. consonantal intervals

- Ramus & al. 1999
  - More or less "noisy" intervals in speech (V%, C%, ΔV, ΔC)
  - Infant perception (+/- voiced)
  - → measures tap into typical syllable structures

stress-timed

syllable-timed

mora-timed

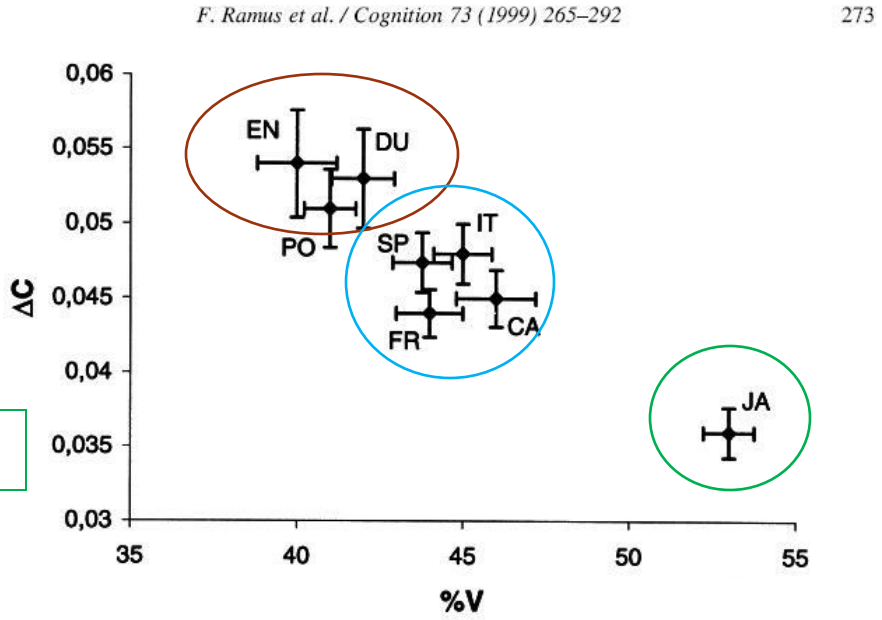
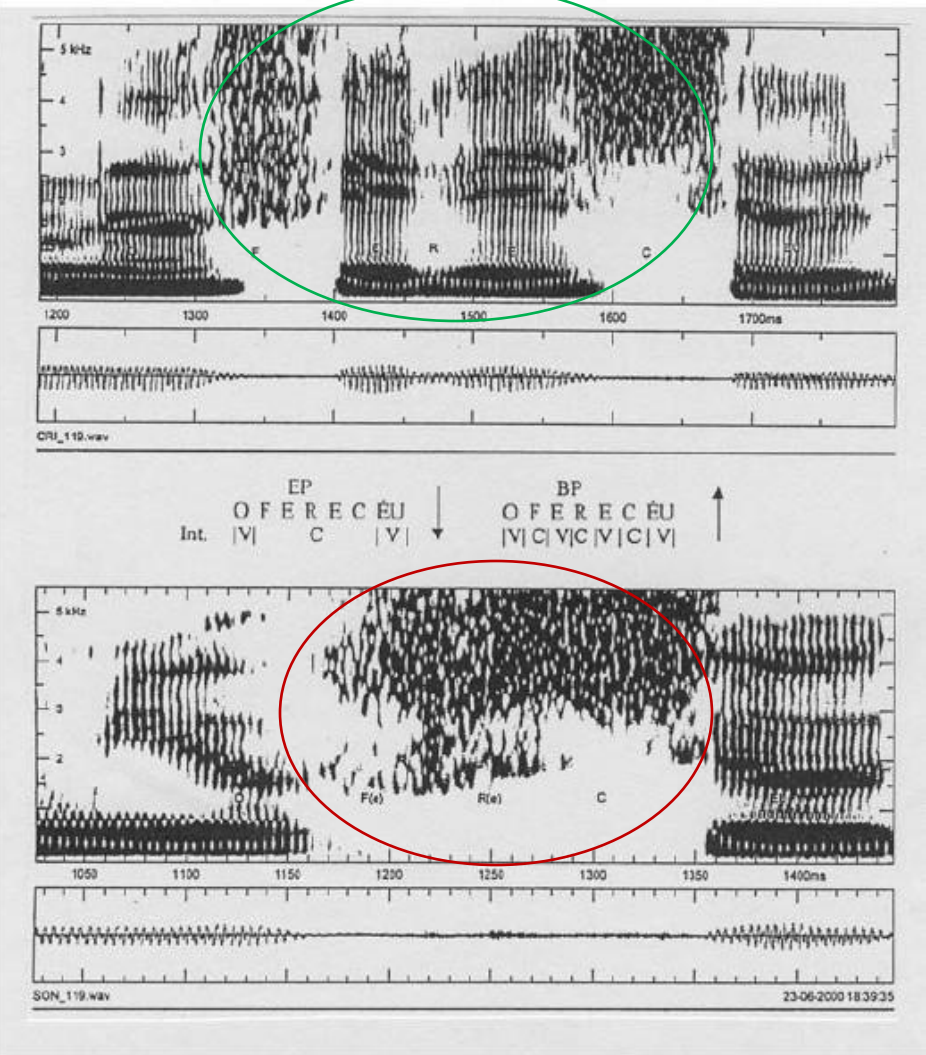


Fig. 1. Distribution of languages over the (%V, ΔC) plane. Error bars represent ±1 standard error.

Frota & Vigario, 2001 (I.)



Brazilian
Portuguese
(4 syll)
more “vocalic”

European
Portuguese
(2 syll)
more
“consonantal”

O investigador já me ***ofereceu*** *dinheiro .*
The researcher already to-me gave money.

Frota & Vigario, 2001 (II.)

(b)

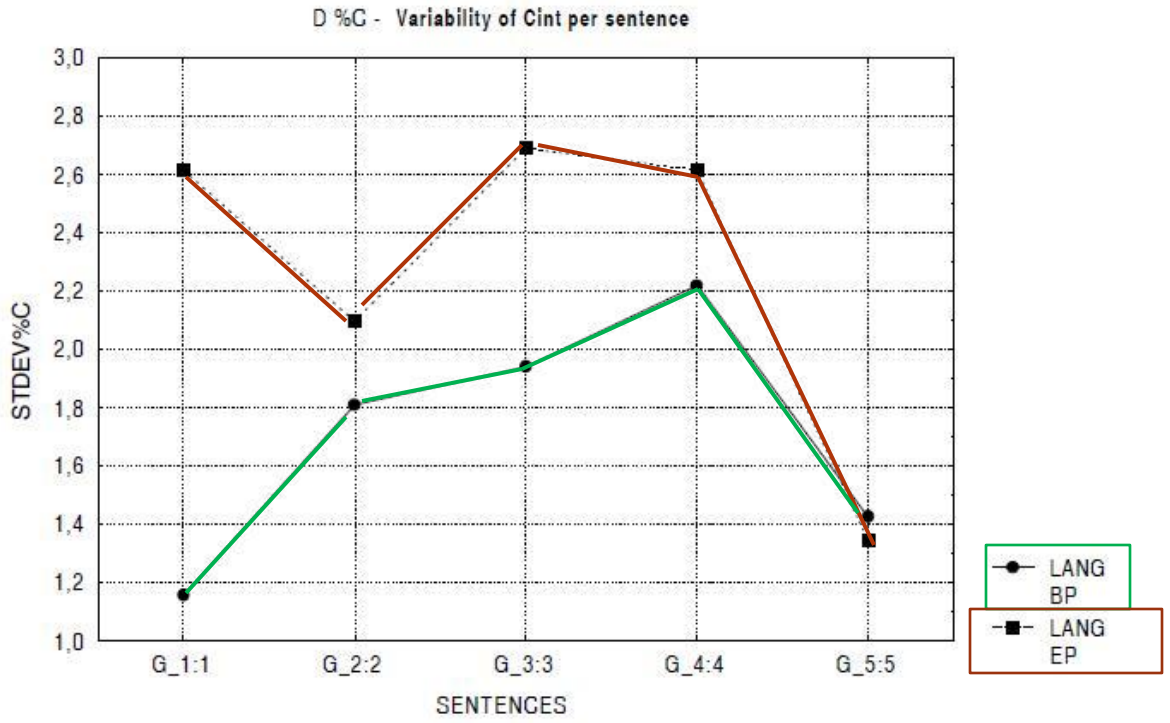


Figure 4. Variability of consonantal interval duration per language. Each data point represents one sentence from the Rm corpus.

What you see is: standard deviations of %C in the signal per target sentence

Pairwise Variability Index

- Idea: **pairwise comparisons of successive V or C intervals** (Grabe and Low 2002)
- Check: how much vowels and consonants vary with respect to their durations in the text/sentences
- "Catch" variability in:
  - dipthongues vs. monophtongues
  - long vs. short consonant clusters
  - **Vocalic** = nPVI
  - **Intervocalic** = rPVI

Vocalic nPVI formula

$$nPVI = 100 \times \left[\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1) \right],$$

→we take the absolute value of the difference between successive interval measures

→ divide it by the mean duration of each pair

→at the end: differences summed up and divided by the N of differences

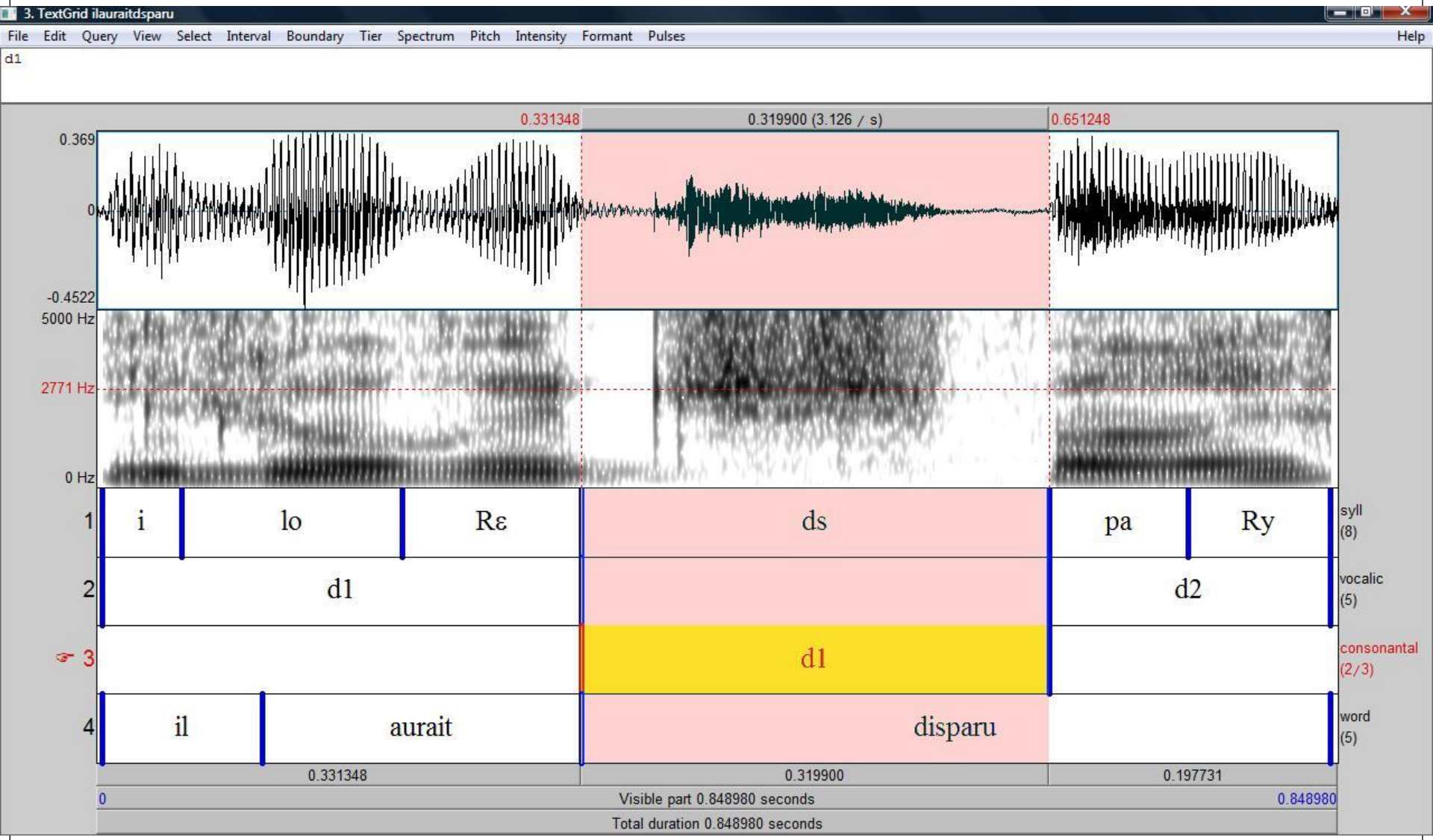
- **m**= N of vocalic intervals measured in an utterance
- **d** = duration of the *k*th item
- **ABS function** in Excel allows us to take the absolute value of a number (two vertical bars)
- 1st step: middle portion of the formula
- 2nd step: summing and dividing by n-1

Three steps

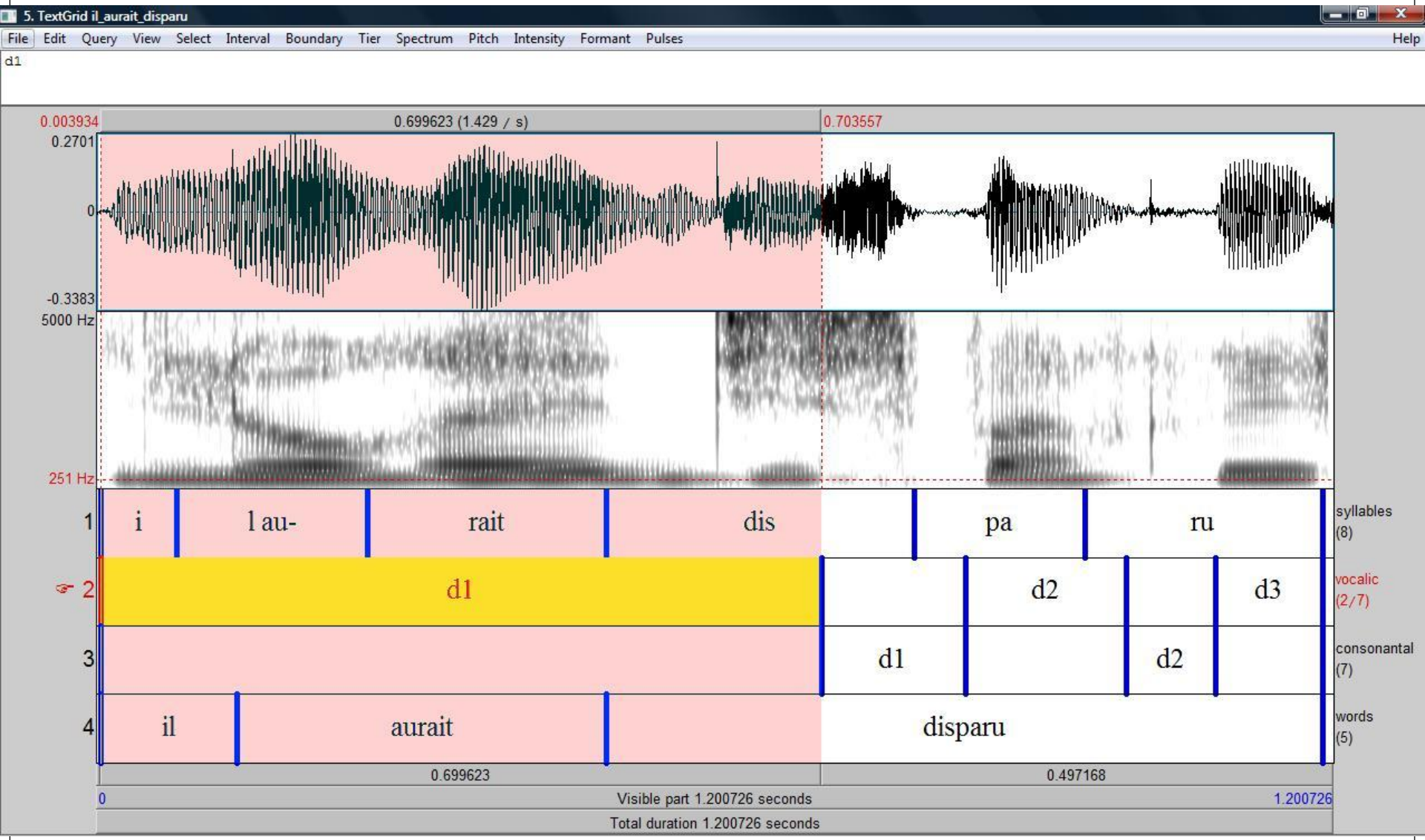
- **1.** Segment all vocalic and consonantal intervals (liquids that have formants count as 'vocalic')
  - NOTE: noise vs. voicing (not C vs. V)
- **2.** Run a Praat script to get duration measurements of intervals (d1, d2, d3…etc.) in each tier
- **3.** Record results in an Excel file and use the formula on the previous slide to calculate nPVI and rPVI values.

1.A

Devoiced /i/ and affricate /dʒ/

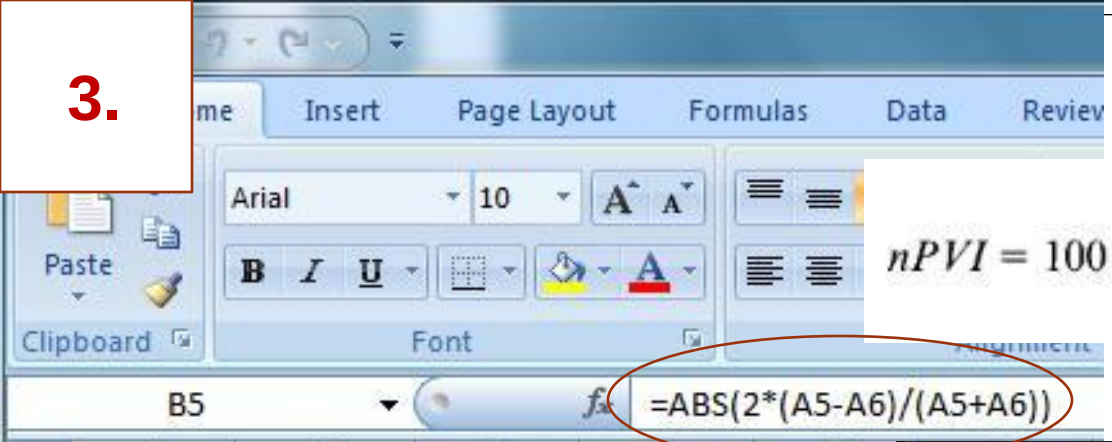


1.B Long voiced interval and non-devoiced /i/

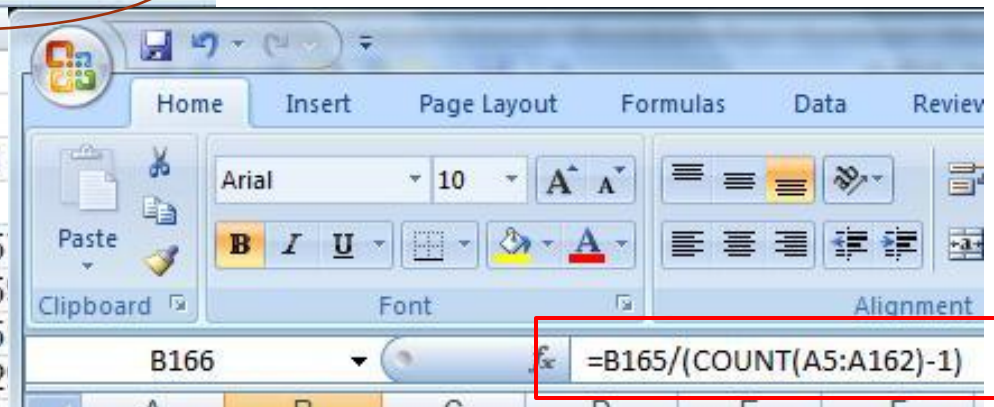


3.

$$nPVI = 100 \times \left[\sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1) \right],$$



	A	B	C	D	E
1	DURATION VALUES WITH nPVI NORMALIZATION				
2					
3	original	normalized	original	normalized	original
4					
5	137.96	0.6063383	151.66	0.724268	37.5
6	73.77	1.1243137	71.02	0.1467806	38.5
7	263.2	1.2609571	82.27	0.5082317	140.5
8	59.65	0.9146652	48.93	0.2281369	80.2
9	160.19	0.5959023	61.53	0.086605	109.4
10	296.16	0.5622148	67.1	0.7101735	79.
11	166.19	0.5747928	140.99	1.3197551	296.5
12	91.99	0.1238018	28.89	0.0654155	87.9

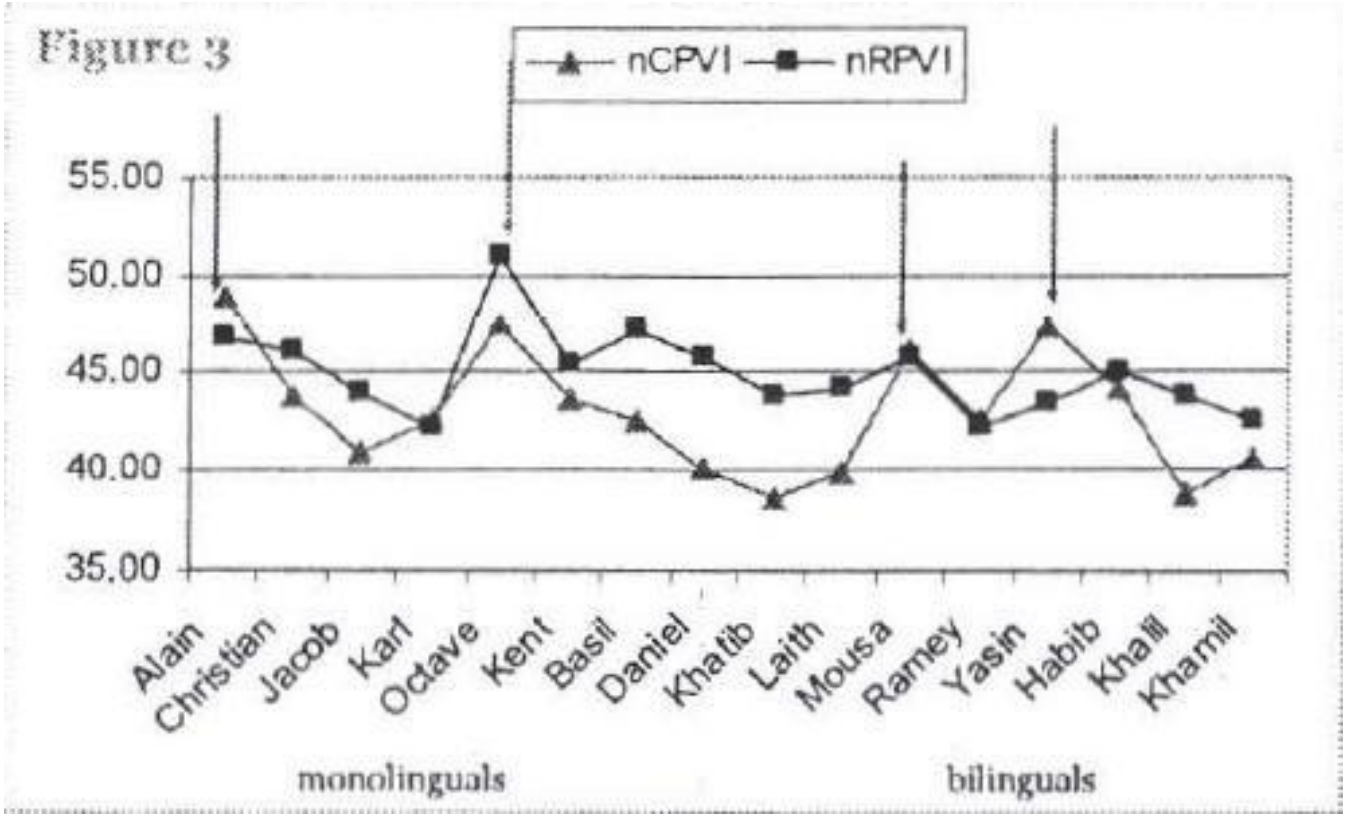


	A	B	C	D	E	F
153	76.91	0.6222401	162.19	0.8679546	89.27	0.1227065
154	146.38	0.0403527	64.02	0.8130707	100.94	1.5712011
155	140.59	0.3083865	151.73	0.3292014	12.12	1.2926758
156	191.85	0.7357313	108.84	0.1866045	56.42	0.7238181
157	88.66	0.5159643	131.24	0.2156963	120.42	0.5721151
158	150.31	1.1365225	162.97	0.2538464	66.85	0.4067211
159	41.38	0.6756281	126.26	0.4979721	100.98	0.1657909
160	83.6	0.0396295	75.92	0.378817	85.52	1.0065038
161	86.98	0.1021086	111.4	0.9189048	28.26	1.1791446
162	78.53	2	41.26	0.4732655	109.45	0.4425351
163			66.84	0.1486047	69.79	0.0162024
164			77.57	0.1657602	70.93	0.7039423
165		71.74666	91.59	0.2381456	147.98	0.3586046
166		0.4569851	116.35	0.4310489	212.64	0.6432967
167			75.09	0.1538903	109.14	0.1189147

sum of intervals

multiply by 100

Then plot the values (spontaneous speech samples)



oui, j'suis né à Aubervilliers_**ch**
'yes, I was born in Aubervilliers_ch' (Octave)

ah oui: **ft** des mères
'oh yes, mother's day' (Mousa, Yasin)

(from Fagyal 2010)

References

- Grabe, Esther, and Ee Ling Low. 2002. Durational variability in speech and the rhythm class hypothesis. In Carlos Gussenhoven and Natasha Warner (eds), *Laboratory Phonology* 7. Berlin: Mouton de Gruyter, 515–546.
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- Ramus, Frank, Nespor, Marina, & Mehler, Jacques. 1999. Correlates of linguistic rhythm in the speech signal. *Cognition, 73*(3), 265-292.