Measuring rhythm. A quantified analysis of Southern Italian Dialects Stress Time Parameters

MICHELA RUSSO
Université Paris 8/ UMR 7023, CNRS
WILLIAM JOHN BARRY
University of Saarbrücken

1. Syllable-timed vs. Stress-timed?

Traditional dichotomy for language typology (Lloyd 1940; Pike 1945) is grounded on the claim of regular syllable intervals vs. regular stressed-syllable intervals (isochrony claim). This is based on the assumptions:

- No shortening or lengthening of syllables as a function of stress
- *vs*. shortening of unstressed and lengthening of stressed syllables.

Measurements have failed to find any support for the isochrony claim. Differing degrees of lengthening and shortening as a function of stress *have* been found, however. Defence of the isochrony claim has had to retire to the level of perceived regularity, *i.e.* from the objective to the subjective.
It is usually assumed that Italian is a syllable-timed language and German or English are stress-timed. This assumption is based on structural differences a), b) and c) between the languages (cf. *Table* 1):

	Italian	**German**
a) Syllable structure	Relatively simple CV, CCV, CVC	Varies: simple-complex (CCC)V(CCC)
b) Vowel quantity?	No	Yes
c) Vowel duration?	Allophonic length in [+stress] open syllables	No length distinctions with [-stress]

Table 1 Structural differentiation of Italian and German.

Differences a) and b) separate Italian and German; c) brings them closer together. Phonetic evidence is presented here to support the interpretation of Southern Italian dialects as a stress-timed language.

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Distributional observations and durational measurements of tauto- and heterosyllabic VC sequences show that make a syllable-timed rhythmic structure untenable:

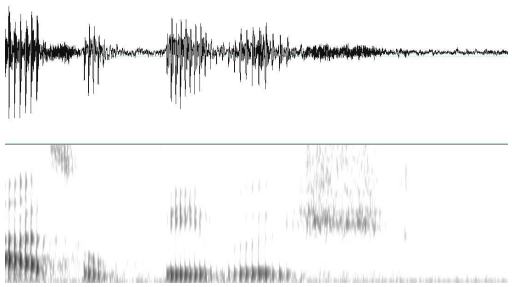
- The occurrence of complex codas (CVCC and CVCCC) with vowel timbre instability and clearly diphthongal vowels in all types of metrical structures, violating the single-branching rime principle with complex vocalic nuclei in closed syllables.
- The reduction and/or elision of unstressed vowels, in particular in final position.

1.1 Super-heavy Syllables in the Southern Italian Dialects

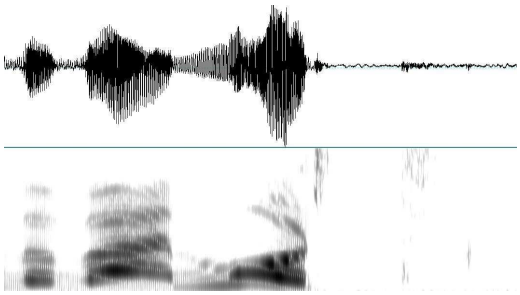
On the basis of this understanding of rhytmic type we examine the syllabic structure of several local dialects on the islands of Ischia and Capri, and the dialect of Pozzuoli (Naples). In this section we are examining mainly non-quantitative, word-based evidence for a tendency towards the 'stress-timed' end of the syllable-timed continuum according to the syllable-complexity criterium.

In particular, the consequences of final-syllable vowel reduction for the type of syllable structure in these dialects in contrast to standard Italian are considered in terms of where the dialects are situated on the continuum 'syllable-timed - stress-timed'.

Unstressed vowels in di- and polysyllabic words are often reduced to schwa or even deleted, finally. The standard context for schwa loss is intonation-phrase final, independent of whether the word is nuclear or not, see *Spectro 1*:



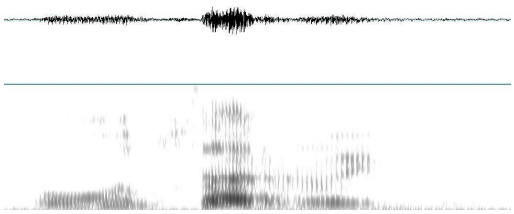
Spectrum 1: '(la zuppa di) pesci / fish (soup)' [vəɪɕː] (Pozzuoli) – [əɪ] = 179 ms., [ɕː] = 118 ms., phrase-final with schwa elision.



Spectrum 2: '(papà è) morto / dad is dead' [mu̯o̯ɾ̪ˈth] (Anacapri, Capri), [u̯o̯] = (falling metaphonic), [ɾ̪ˈth] = [4©ʲ] (frication - fricative1st part devoiced) = 70 ms., [th] = 339 ms.

1.2 Falling diphthongs in closed syllables

Contrary to assumptions for Standard Italian, closed syllables were found containing a heavy diphthong, see *Spectros 3*:



Spectrum 3 [rəɪm̥ː] '(il gozzo a) remi (fishing boat with) oars' (Pozzuoli) – [əɪ] = 230 ms., [m̥ː] = 107 ms. (*vs*. falling diphtong in open syllable [k̥aˈmœ̆ɪz̥i] 'camice di' – [œ̆ɪ] = 273 ms.).

According to the literature Italian falling diphthongs, which only occur in open syllables, are considered phonologically 'heavy'. The first element is the vocalic nucleus, and the second element is considered non-vocalic, in effect forming a coda element. This analysis would lead maximally to a CVCCC structure in our dialects. Alternatively, the diphthong could be analysed as a branching nucleus, giving CVVCC. Both analyses represent a radical deviation from what is assumed to be the rule for Italian phonology.
Together with the tendency for durational and spectral reduction (centralisation) in other, non-final non-tonic vowels, these observations indicate a general tendency towards *variation* in phonetic syllable weight (= number of segments, duration and spectral definition of the vowel).

Thus, the evidence discussed above points to a position on the syllable- to stress-timed continuum of these Southern Italian Dialects which is further towards the stress-timed pole than can be expected for Standard Italian.
Quantitative analysis and instrumental confirmation of our hypothesis is done on our recordings in sections 3 and 4.

2. Are there objective, measurable differences?

In recent studies of rhythmic properties of languages (Ramus et al. 1999; Low et al. 2000; Grabe-Low 2002; Barry et al. 2003), variation measures have been shown to differentiate languages along a syllable- to stress-timed continuum. Both variation in syllabic nuclei and variation in the intervocalic period appear to play a role. New ways of measuring rhythmic differences have been proposed (Ramus 1999; 2002; Ramus et al. 1999; Low 1998; Grabe-Low 2002; Barry et al. 2003). These are derived from syllable structure and prosodic differences between languages (Nespor 1990; Dauer 1983; 1987).
The measurements are all *durational*. They reflect the effects of syllable-complexity on the timing of syllable sequences (= inter-vowel variability), vocalic lengthening and shortening (= inter-consonantal variability).

3. Measurements

Rhythm measures are calculated according to Ramus 1999; 2002; Ramus et al. 1999; Low et al. 2000; Grabe-Low 2002; Barry et al. 2003.

The Ramus' measures are:
%V – Proportion of vowels within ips ('inter-pause stretches')
ΔV – Standard deviation of vowel durations within ips
ΔC – Standard deviation of consonant durations within ips

The Grabe and Low' measures are:
PVI-V and PVI-C (PVI = **P**airwise **V**ariability **I**ndex):
The average durational difference from one vowel to the next vowel or one consonant to the next consonant.

The *Basic Formula* is as follows:
(i) Non-normalized consonantal PVI:

$$r\ PVI = \left\lceil \sum_{k=1}^{m-1} \left| d_k - d_{k+1} \right| / (m-1) \right\rceil$$

(ii) Normalized vowel PVI (for vowels to correct for tempo fluctuations):

$$n_{PVI} = 100 \times \left\lceil \sum_{k=1}^{m-1} \left| \frac{d_k - d_{k+1}}{(d_k + d_{k+1})/2} \right| / (m-1) \right\rceil$$

Before the application of 'interval-based' instrumental analysis methods, we looked first for structural evidence to support the interpretation of these variants as more stress-timed (see §§ 1, 1.1, 1.2). The scalar model of rhythm implied by the measures just discussed is theoretically grounded in the structural discussion made by Dauer (1983, 1987), in which rhythm is seen as the total effect created by the interaction of a number of phonetic and phonological segmental and prosodic properties.

4. Measuring rhythm: results on this method for Southern Italian Dialects

The step is now to quantify data from Italian dialects spontaneous speech recordings to illuminate the relationship between the structural criteria assumed to underlie rhythm type and the rhythm measures employed to differentiate rhythmic types.

We give here measures for 10 fluent sections of spontaneous speech from the Neapolitan dialect of Ischia (Forío, a total of 33.62 sec.). The average PVI scores for one speaker is: Raw PVI (Consonant interval) 52.52, Normalized PVI (Vowel interval) 55.98. The average percentage vocalic interval in the utterances is 54.9%. Compared to our earlier data (Barry et al. 2003; Barry-Russo 2003; Russo-Barry 2004a) and to data in the literature these measures are different to some extent, but only in the consonantal measure: the %V value of 54% is clearly equivalent to the Italian values we got for Bari, Pisa and Napoli and much higher than any of the German or Bulgarian values (they never reached 50%, even at the fastest tempo, cf. Barry et al. 2003). Our values for Bari, Pisa and Napoli are (from the AVIP/API corpus, see Barry et al. 2003; Barry-Russo 2003; Russo-Barry 2004a): Raw PVI-C Bari 61.6, Pisa 58.4, Napoli 56.0; Norm V-PVI Bari 41.6, Pisa 43.2, Napoli 38.4. So the speaker consonant variability is lower (there is no support for 'stress timing'), but the vowel variability is considerably higher (pushing the vowels away from syllable timing). For comparison, our German values were: Raw PVI-C - German 68; Norm PVI-V - German 55. The values from Grabe-Low 2002 are: German 59.7/55.3, English 64.1/57.2, French 50.4/43.5, Spanish 57.7/29.7. In terms of text-dependent variation in the values, Grabe-Low 2002 publish the following values for 3 different parts of their material: PVI-C German 52.1/57.0/55.9; English 65.6/65.0/54.4; French 49.3/49.7/44.3; Spanish 60.3/56.9/54.7; PVI-

V German 57.6/65.3/58.7; English 55.2/53.6/56.1; French 39.4/38.7/42.0; Spanish 26.4/27.7/26.0. We compare these values with the variation over 10 utterances of the dialectal speaker's: Raw PVI-C: 1) 56.4, 2) 37.1, 3) 44.6, 4) 36.7, 5) 54.6, 6) 71.7, 7) 55.3, 8) 44.8, 9) 49.7, 10) 74.3; Norm PVI-V: 1) 45.2, 2) 52.7, 3) 63.7, 4) 64.5, 5) 51.3, 6) 55.6, 7) 60.2, 8) 65.7, 9) 51.2, 10) 49.7. Here it is the mapping onto the two-dimensional rhythm-typology chart of the C-PVI (x-axis) and V-PVI (y-axis) values for – from left to right at y = 55 or above - italian dialectal speaker, German (Grabe-Low 2002), English (Grabe-Low 2002) and our German (spontaneous speech). The lower group (y = 45 or lower) are French, Napoli, Spanish, Pisa and Bari (from left to right):

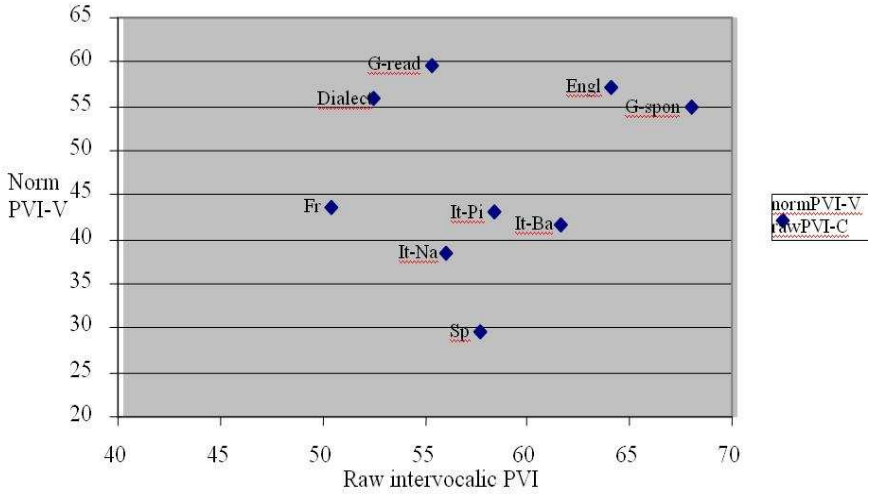


Figure 1 Norm PVI-Vowel and raw PVI-Cons (interconsonantal interval) values for an Italian dialectal speaker from (Ischia, Naples) compared to regionally accented speakers of Standard Italian from Bari, Naples and Pisa, and compared to English, French and Spanish read speech (from Grabe-Low 2002) and to German read and spontaneous speech.

The values above and the *Figure 1* show a 'rhythm plot' in which the PVI-V groups the dialectal speaker with 'stress-timed' languages against the traditional typology expectation.

Similar recordings of conversations with inhabitants of other areas (Pozzuoli and Capri) provide comparable data, in rhythmic terms, for this island dialect.

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