

## Prosodic Typology: On the Dichotomy between *Stress-Timed* and *Syllable-Timed* Languages

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### 1. Introduction

In 1945 Kenneth L. Pike suggested a basis for the typological classification of languages which met with a widespread approval in phonological and prosodic studies. We are referring here to the dichotomy between *syllable-timed* vs. *stress-timed languages*. Both kinds of “linguistic rhythm” are characterised by the recurrence of a given element at regular intervals. However, in certain languages the element is a stressed vowel (accentuated feet of greater or lesser duration) whereas in other languages, the element is the limit of the syllable (syllables of greater or lesser duration). Both categories are regarded as being mutually exclusive.

English is the stress-timed language *par excellence* and Spanish is one of the languages that Pike refers to as a prototypically syllable-timed languages. Trubetskoy (1938) had already described this opposition between languages that count syllables and languages that count *morae*, but he didn't develop it. Much work in experimental phonetics is based on Pike's ideas, the objective of which is the classification of languages according to their rhythm, and the elaboration of a general rhythmic typology.

Important work done by Abercrombie (1967), Hockett (1958), Ladefoged (1967, 1975), Catford (1977), O'Connor (1973) and Allen (1975), among others, has contributed to the general acceptance of this theory. The language classifications proposed usually include English, Russian, all Germanic languages, and Arabic among the languages of accentual isochrony (*stress-timed*) (Pike 1945; Abercrombie 1967, Bolinger 1965, Hockett 1958, Halliday 1967, Ladefoged 1967, O'Connor 1973, Smith 1976, and Lehiste 1973, 1977. Among the languages of syllabic isochrony the usual prototypes tend to be French (Abercrombie

1967, Catford 1977, Ladefoged 1975, Smith 1976, and Delattre 1951, 1965), Spanish (Pike 1945, Hockett, 1958, O'Connor 1973), and Japanese (Smith 1975; Ladefoged 1975).

English is the clearest reference point in this classification. Curiously enough, neo-classic English metrics from Josuah Steele (1779) to Lanier (1880, 1898) was based on the idea that stress divides English verse in isochronic segments, similar to the musical bar. Daniel Jones (1918) also defends the isochrony of interstress spaces as one of the principal characteristics of the rhythm of the English language:

*There is a strong tendency in connected speech to make stressed syllables follow each other as nearly as possible at equal distances [...] (Jones 1918: 237-238).*

Jones illustrates this statement with musical transcriptions (as in the neo-classic metrics of Josuah Steele). For example, in a foot of many syllables, the syllables have a shorter duration in order for all the feet to be of similar length.

(1) I / brínge the / lífe of that un-/ háppy / Héñry / Jékýll to an / énd.

Halliday (1985: 272) expresses his opinion in almost identical terms:

*[...] there is a strong tendency in English for the salient syllables to occur at regular intervals; speakers of English like their feet to be all roughly the same length.*

Likewise, Bolinger (1981: 44) writes:

*Speakers do adjust accents, where it is practical to do so (that is, where the stress and vowel structure permits), in order to GET roughly equal intervals.*

Catford (1986: 182) states that: English speech tends to be delivered in a series of feet, and that feet tend to be isochronous and isodynamic. Ladefoged (1975: 103) points out the various factors that in his opinion are responsible for this phenomenon, the combination of which operates as though there were a conspiracy to have English maintain a regular

rhythm. This idea has also been criticised by Classe (1939), Faure (1980), Roach (1982) and Dauer (1983).

At the opposite pole, French is usually cited as being the perfect prototype of syllabic isochrony. However, Grammont, (1933; 1946:105) is an exception, since he claims that rhythm in French is accentual. Similarly, Wenck and Wioland (1982) observe the incompatibility between syllabic isochrony and the longer duration of stressed syllables, which, in their opinion, characterises accent in French:

*To say that French syllables are of relatively equal length is to deny the existence of accented syllables [...] to say that French has no accented syllables is to deny the existence of rhythm.*

Wenck and Wioland present research results, which seem to show that for the same number of sounds, stressed syllables are much longer than unstressed ones. They believe that rhythm in French comes from the segmentation of speech flow in accentual groups. However, the rhythm of these groups is raising with the stress falling on the end group, whereas in English, the opposite is the case. The rhythm is descending since the stress is at the beginning.

The status of other Romance languages is more controversial. Italian has been described by Bertinetto (1977, 1981, 1983) and Marotta (1983) as syllabic. In reference to Portuguese, Major (1981, 1982, 1985) favours accentual isochrony.

Depending on the author consulted, Spanish has been described as belonging to either group. Pike claims that Spanish is a prototype of syllabic rhythm, a view shared by Abercombie and Hockett. Gili Gaya (1940) points to the same characteristic, when he underlines the irregularity of accentual groups compared to the relative uniformity of syllabic duration. In contrast, Navarro Tomás (1916, 1917, 1918, 1922), on the basis of the results of a series of acoustic experiments, affirms just the opposite. According to him, Spanish is uneven in the duration of syllables, but accentuated feet remain stable.

Delattre (1965, 1966) rejects the validity of those experiments and claims that rhythm in Spanish is syllable-timed in contrast to English. Olsen (1972) agrees, as do Carrió and Ríos (1991), whereas Hoequist (1983ab) rejects this view.

In his review and analysis of the work carried out by Gili Gaya and Olsen, Pointon (1980: 302) deduces that Spanish does not belong to either of these isochronic schemas:

*The most probable solution seems to be that, on the evidence, Spanish has no regular rhythm in the sense of an isochronous sequence of similar events, be they syllables or stresses.*

In like manner, Toledo (1988) and Almeida (1997, 1999) consider that Spanish rhythm does not seem to correspond exactly to any of these isochronic schemas.

Regarding Italian, the same scepticism is shown by Vayra *et al* (1984), who claim that Italian cannot be classified as either type. The same opinion can be found in reference to English in the work of Faure *et al* (1980), which shows a clear anisochrony both of feet and of syllables.

Such results mark the beginning of a critical reaction towards the very concept of isochrony. For example, Crystal (1975) calls it *ingenuous*, while Roach (1982) is also openly critical. He verifies the total lack of accentual isochrony in English, which he affirms to be even more striking than in supposedly syllabic languages such as French or Yoruba. Loots (1987: 467) in his study of Dutch verse also comes to basically the same conclusion:

*We have been unable to demonstrate that rhythm imposes regularity on speech material at a concrete level.*

The most critical phonetician in this respect is probably Dauer (1983, 1987). This author ran a comparative experiment with a corpus consisting of a fragment of literary prose (with about 100 stressed syllables) read by several native speakers of English, Spanish, Italian and Greek. Stress intervals show an indisputable inequality of feet in those languages:

*[...] in addition, the increase in average duration of an interstress interval due to the addition of another syllable was similar in all speech samples (about 110ms) [...] Clearly the mean duration of interstress intervals is proportional to the number of syllables in the interval for all the languages*

*analysed, and there is no more tendency for interstress intervals to clump together in English than in the other languages.*

In our opinion, this criticism not only casts doubt on the typological assignment of certain languages, but also on the very principle of classification, since which English and French are not only examples but the prototypes used as a reference for establishing these categories. This leads to troubling paradoxes.

For example, if both kinds of rhythm coincide with the ones traditionally established by metrics for verse in these languages (accentual isochrony in English, syllabic in French etc.), how can the basis of normal speech rhythm be the same as that in verse? Why should the poet and the critic worry about the isochronic distribution of stress if it is an inherent property of the language in question? The very existence of poetic metrics is justified by the supposed existence of a speech "without rhythm" as opposed to other kinds of speech "with rhythm", which is the *raison d'être* of normative metrics.

As Comrie points out: *In science it is always necessary to establish hypotheses that, at first, can be a priori, but later they have to be verified to see how much they coincide with the principle that has to be explained* (1981, 1989: 20). Nevertheless, it is important to remember that even empirical research in the field is based on the above-mentioned set of *a priori*, thus experiments can be falsified before they are even carried out. In the case at hand, the first hypothesis is arbitrarily limited to two possible results. The concept of *stress-timed* vs. *syllable-timed*, raises a choice between two models that implicitly presupposes that rhythm is isochronic by definition. For example, Schane (1979a) refers to isochrony as the very notion of rhythm, and considers it obvious that the restriction is essential and universal.

In our opinion, in order to establish a typology based on rhythm it is necessary to consider two issues of great importance:

- The question of whether languages actually have rhythm
- The elaboration of a definition of *rhythm* which is objective and precise enough to be used as a possible linguistic universal.

Separately, any of these these questions could be approached with a provisional affirmative axiom, however, we cannot do it with both questions at the same time, this would create a vicious circle. If one

supposes that every language has rhythm and, at the same time, that rhythm is always isochronic, there is little left to investigate. Other logical possibilities are arbitrarily eliminated. The reductionism contained in the isochronic premises practically converts the question into a tautology: *What is the rhythm of language x like if all languages have rhythm and rhythm is always the recurrence of isochronic elements?*

From this perspective, we have carried out research in seven languages, some of which are regarded as *stress-timed* (English and Russian), others of which are regarded as *syllable-timed* (French, Italian, Catalanian), and still others of which have been assigned to both categories (Spanish, Portuguese). Our first aim is to obtain comparative data by using the same method. Secondly, we wish to provide a more appropriate methodology for studying this phenomenon, as the disagreement among phoneticians is largely due to the enormous diversity of research methods. Thirdly, we wish to approach both things: empirical research and its possible interpretation without initial preconceptions. In other words, we do not presuppose that languages necessarily belongs to one of these groups, nor that those are the only possible types of rhythm, and not even that the languages necessarily have to have any rhythm, because that is what experiments are supposed to "discover".

## **2. Methodology**

### **2.1. The corpus**

The first point of methodological divergence is the corpus selection. Most of the work cited in this article use a corpus of authentic data: Navarro Tomás uses a poem by Rubén Darío, Gili Gaya, the reading of an essay, Delattre and Olsen, spontaneous speech, while the bulk of work by Toledo (1988) includes spontaneous speech, essay, literary prose or poems read by the authors (Ernesto Sábato, García Márquez, Nicolás Guillén). The input in every case is quantitatively valuable, but qualitatively heterogeneous and therefore susceptible to uncontrolled variables that determine the result of the measurements.

The apparently isochronic structure of a given speech may be due to its morphological regularity (for example, because the number of units in the rhythmic cells is almost the same). In that case homogeneity of duration would just be a consequence of a previous morphological homogeneity (e.g. if the number of sounds per foot varies very little). This might even be accidental, but in most cases it would only be an

example of a morpho-phonological rule. On the other hand, one must not forget that rhythmic homogeneity can be intentional, as in literature, especially poetry. Thus, when Navarro Tomás (1922) *proves* the accentual isochrony of Spanish by means of an acoustical analysis of the reading of Rubén Darío's *Sonatina*, he is committing a methodologically unacceptable tautology, as the poem is made up of regular anapaestic alexandrines<sup>1</sup>. This means that the author deliberately chose units that are isochronic by definition:

la prince/sa persi/gue en el cie/lo de Orie(nte) // la libé/lula va/ga de  
una va/ga ilusión/.

One way to avoid this problem would be by using a morphologically varied corpus so that the duration of cells would be comparable with the number of elements they consist of (two-syllable feet, three-syllable feet, etc.). An authentic corpus does not necessarily guarantee this comparability, and besides it is subject to other risks. The duration of a stressed vowel, eventually compressed in feet, would be proof of isochrony, if it did not depend on other factors that falsify any experiment. It is known that the duration of a stressed vowel is also influenced by the following<sup>2</sup>:

- intrinsic duration of every vowel
- consonant following the vowel (plosive or fricative, voiceless or voiced)
- type of syllable (open or closed);
- intonation pattern of the utterance.

An authentic corpus does not allow adequate control of this type of data, so any attempt to compare feet and syllables is very difficult. In this case we believe that a laboratory corpus, made up of several "artificial" utterances created *ad hoc* is more reliable, since it permits the isolation of the variables under study as well as the neutralisation of other factors.

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<sup>1</sup> The method of measurement used by Navarro Tomás, borrowed in turn from M. A. Príncipe, shows that these verses are not anapaestic but dactylic with anacrusis, because he places the bar just before the stress, but for practical purposes this makes no difference.

<sup>2</sup> Cf. Delattre (1965), Malmberg (1966), Lehiste and Peterson (1959), Peterson and Lehiste (1960), Lehiste (1970, 1976), Klatt (1973), Kuznetsov, Ott & Ventsov (1987) and Almeida, (1999).

Our study is based on series of utterances in which two accents progressively diverge (both at a reasonable distance from the final accent so they will not be affected by its final cadency). The utterances are similar, with the same stressed vowels followed by the same kind of consonants, and they have the same grammatical, semantic and pragmatic structure. Only the distance between stresses varies, which is exactly what we want to investigate.

The utterances were emitted by speakers of different dialects. However, at least two speakers from the same region pronounced the utterances and under similar conditions. As every utterance was pronounced separately, the last foot cannot be completed and naturally the final pauses cannot be measured either, as they are not a logical continuation of one another. (Moreover, utterances were recorded separately.) Though the results of this last stressed foot are not reliable because they are incomplete, the duration of these clipped feet and of final syllables have been measured (they appear in brackets), though they are not included as relevant data.

## **2.2. Data measurement**

We have measured the absolute duration of feet according to the traditional method of segmentation: from the onset of the stressed vowel until the next stressed vowel. The segmentation and measurement were carried out using the system of computational prosodic analysis C.E.C.I.L.

The criteria of absolute measurement are also factors that may complicate the comparability of the results and their subsequent interpretation. The problem of the absolute duration of vowels, syllables and feet is that, since the enunciation speed changes from one recording to another and from one speaker to another, the results are not directly comparable, especially in a small corpus. It was thus necessary to normalise the results.

There are mechanisms which can be used to apply the coefficients of correction of tempo of the enunciation, measured by syllables per second or by mean duration (phrase duration of utterance divided by the number of sounds or syllables) so that the variation in speed of each recording can be compensated. The only relevant item in a given rhythm is the proportion between units, not the absolute measurements in milliseconds.



In judgements of equality, the threshold naturally plays a very important role<sup>3</sup>. In our opinion, this threshold cannot be measured in milliseconds, as speech rate is variable. Absolute measures create dilemmas that lead to arbitrary decisions. For example, Bertinetto, or Faure and Rossi assume a difference of 140 and 160 ms respectively, in order to decide whether feet are equal or not, while Borzone de Manrique and Signorini establish a threshold of 100ms, though later admit that the unevenness of 200 ms (and even 800 ms) can be irrelevant. In these conditions, obviously, feet will hardly avoid the rule of isochrony.

If isochrony is a relative fact, thresholds of equality also have to be relative. This is how music works: it is proportion that opposes 2/4 to 3/4 bars. Metrics also confirms the same threshold establishing the difference between binary and ternary feet (iambic vs. anapaest, trochee vs. dactyl, etc. = 2:3, that is 1:1.5), as the basic opposition between different rhythms. This ratio of 1:1,5 is thus a reasonable and rather "generous" top beyond which any pretence of *equality* is already impossible. To calculate the *temporal ratio* normalised between stressed feet, we divide the duration of each foot by the shortest one in the utterance, functioning as a unit, which is compared to the *syllabic ratio*, (number of syllables per foot)<sup>4</sup>.

### **2.3. Interpretation of data**

Once the feet, syllables and sounds of every utterance are segmented, measured and normalised, we apply the following types of analysis to the information obtained:

First, global statistics of the feet durations are compared to the number of their syllables in order to establish a mean for the whole corpus. The same is done in regards to the relation between the syllable durations and the number of their sounds, though here it is just a raw approach that serves as a reference point, which is similar to other work carried out on a greater scale.

Secondly, we use a more accurate method of calculation for this kind of corpus. We compare the temporal ratio between formally similar feet that start having more and more syllables in utterances that are similar

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<sup>3</sup> Cf. Lehiste (1977), Bertinetto (1980), Solé (1984), Pamies (1996), and Almeida (1999).

<sup>4</sup> As previously mentioned, the last foot is not taken into account.

in every other way. This allows us to observe the behaviour of the same cells submitted to the increase of their number of internal units when the other factors are almost ideally neutralized.

We also study the time variation of stressed vowels in relation to the increase of syllables per foot. This criterion is fundamental, as an eventual isochrony would necessarily imply a compression of sounds inside the feet when new syllables are added. That should mainly affect the stressed vowel, as when new syllables are added, only the ones present before can become compressed<sup>5</sup>. In ideal conditions the verification of this phenomenon could be decisive for its own sake and in any case it is the most indicative parameter.

When measuring durations as brief as a single vowel, we used a criterion even more precise than with syllables and feet: a *durative coefficient* where the unit is the percentage rate (over a scale based on the difference between the longest and the shortest vowel of the enunciation, divided by one hundred)<sup>6</sup>. This allows us to obtain a relative value which is perfectly comparable to the same vowel in another utterance, and more reliable when calculating the average between different speakers who spoke at a different speed in every recording. If the durational coefficient of the stressed vowel diminishes when new syllables are added, it means that compression exists, a clear indication of accentual isochrony.

### 3. Results

Next we offer a detailed account of the data obtained for Spanish and a briefer summary for other languages, since all languages were studied using the same method.

#### 3.1. Spanish

In Spanish we recorded eight utterances of speakers of different geographical origin (Almería, Cuenca, León, La Rioja, and Córdoba, Argentina).

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<sup>5</sup> Daniel Jones (1918: 237) uses the argument of compression as a proof of the accentual isochrony of English: (...) *the greater the number of following unstressed syllables, the shorter is the stressed vowel*. Toledo (1988:13) also points out this fact in agreement with Noteboom (1972), Lindblom (1975), Fowler (1981), and Hoequist (1983).

<sup>6</sup> Bertinetto (1981) used an almost identical system in his investigations on vowel duration. The only modification introduced here was not to include the "dying" unstressed syllables at the end of the utterance and dividing by 100 instead of 10.

First group: *-beb/er v/ino desata la lengua & beb/erse un vin/illo des/ata la l/engua; -comer c/erdo es pec/ado para un á/rabe & com/er como un c/erdo est/á m/al v/isto.*

Second group: *-Com/í fr/esas pero sin n/ata & Com/imos fr/esas pero sin n/ata & Com/imos en la m/esa de un carden/al & Com/imos unos entrem/eses para empez/ar.*

The duration and number of syllables per foot are normalised in relative terms as to the shortest foot of the utterance.

(beb-)	<i>er v-</i>	<i>ino des-</i>	<i>ata la l-</i>	( <i>engua</i> )
time ratio (average)	1	2.52	1.86	(1.59)
Syllables per foot (ratio)	1	3	3	(2)
(beb-)	<i>erse un vin-</i>	<i>inillo des-</i>	<i>ata la l-</i>	( <i>engua</i> )
time ratio (average)	1	0.99	0.79	(0.73)
syllables per foot (ratio)	1	1	1	(0.75)

(com-)	<i>er c-</i>	<i>erdo es pec-</i>	<i>ado para un</i>	( <i>árabe</i> )
time ratio	1	2.45	2.18	(1.49)
syllables/ foot	1	3	4	(3)
(com-)	<i>er como un c-</i>	<i>erdo est</i>	<i>á m-</i>	<i>al v</i> (isto)
time ratio	4.47	3.18	1	1,5 (3.11)
syllables/ foot	3	2	1	1 (2)

(com-)	<i>í fr-</i>	<i>esas pero sin n-</i>	<i>ata</i>
time ratio	1	3.49	(1.36)
syllables/ foot	1	5	(2)
(com-)	<i>imos fr-</i>	<i>esas pero sin n-</i>	<i>ata</i>
time ratio	1	2.13	(0.82)
syllables/ foot	1	2.5	(1)
(com-)	<i>imos en la m-</i>	<i>esa de un carden-</i>	<i>al</i>
time ratio	1	1.41	(0.37)
syllables/ foot	1	1.25	(0.27)
(com-)	<i>imos unos entrem-</i>	<i>eses para empez-</i>	<i>ar</i>
time ratio	1	0.92	(0.2)
syllables/ foot	1,1	1.2	(0.2)

### 3.1.1. Global analysis

The results obtained show accentual isochrony in a rather unfavourable light. Feet show remarkable inequalities. For example, in the same utterance there are feet that are three or four times longer than the others. (In fact, there is even one that is 4.7 times more). If we compare the syllabic ratio with the mean temporal ratio for all stressed feet in the corpus, we obtain the following results:

syllable.ratio	time ratio
1	1
2	1.87
3	2.70
4	3.15
5	3.99
6	3.94

The duration of the stressed intervals increases with the number of syllables they include, a fact that makes them contrary to accentual isochrony, since they surpass the minimum threshold of 1:1.5 (which, as previously mentioned, is very generous since music proves that the ear can be sensitive to minor differences).

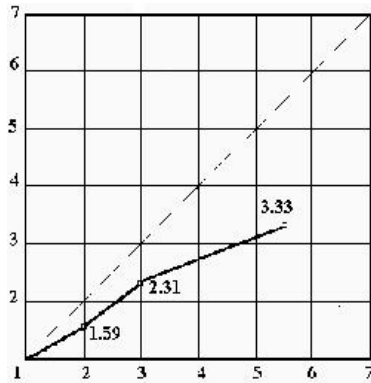
### 3.1.2. Comparative analysis between similar utterances (controlled environment)

The comparison of utterances in each group, more concretely the foot to which we add syllables<sup>7</sup>, permits us to observe its relative duration in an environment more fitting to our purpose.

Foot	syllables	time ratio
com/ <b>ifr</b> /esas per sin nata	1	1
com/ <b>imosfr</b> / esas pero sin nata	2	1.59
com/ <b>imos en la m</b> /esa de un cardenal	4	2.31
Com/ <b>imos unos entrem</b> /eses para empezar	6 (@)	3.33

<sup>7</sup> The @ sign means that a synaloepha was made by some speakers. Thus, the real number of syllables per foot was lower than in standard expected structure, and the number of sounds per syllable was higher. This should have favoured accentual isochrony over syllabic isochrony.

This type of analysis confirms the lack of accentual isochrony in Spanish. The curve is clearly ascending, which shows that the duration of the foot is very sensitive to the increase of its syllables.



(vertical axis: feet duration; horizontal axis: syllables per foot)

### 3.1.3. Syllable duration

Since the increase of foot duration is almost parallel to its syllabic volume, it might be thought that this is proof of syllabic isochrony, the other pole of the dichotomy. To find out if this is really the case, it is necessary to observe the duration of syllables. In order to better summarise the results, only the average of all speakers is included below:

Average duration of syllables

*co/ mí / fre / sas / pe / -ro / sin / na- / ta*  
**1** 1.89 2.90 2.66 1.77 1.28 2.87 2.14 2.62  
*co/ mi / mos/ fre / sas / pe / -ro / sin / na / ta*  
**1** 1.94 2.40 2.24 2.40 1.64 1.23 2.91 2.29 2.38  
*co/ mi/ -mo/ sen/ la / me- /sa /deun/ car/-de/-nal*  
**1** 1.61 1.34 2.2 1.31 1.62 2.33 2.02 2.02 1.4 3.27  
*co/ mi/ mo/ s u- / -no / sen- / tre- / me/ ses / pa- / raem / -  
 pe / -zar*  
**1** 1.36 1.53 1.57 1.03 2.23 1.62 1.4 1.97 1.56 1.67 1.56  
 3.15  
*be / -ber / vi- / no / de- / sa- / -ta / la / len- / gua*

<b>1</b>	1.37	1.32	1.23	0.98	1.39	0.99	1.03	1.74	1.6
	<i>be</i>   -ber   <u>seu</u> n vi ni-  llo   de-   -sa-   -ta   la   len-								
	-gua								
	1.31	1.26	2.36	<b>1</b>	1.86	1.45	1.21	1.88	1.58
	<i>co</i>  mer  cer-  <u>doe</u> s pe-  ca-  -do   pa-  <u>rau</u> -  ná-  ra-								
	-be								
<b>1</b>	2.22	2.86	2.17	2.42	2.16	1.19	1.44	1.66	1.81
	1.63								
	<i>co</i>  mer co-  <u>mou</u> n cer  <u>doe</u> s -tá   mal  vis -to								
<b>1</b>	1.99	1.54	2.45	2.64	1.83	1.72	2.29	2.4	2.43

As previously mentioned, we have not considered the duration of the last foot nor its syllables. Nevertheless, if we had taken them into account, they would only have served to confirm the general tendency. Even without the results of the last foot, it is clear that there are remarkable inequalities between syllable durations (averages from 0.98 to 2.9).

On the other hand, the results of the tables clearly show the syllables tend to last longer when they contain more sounds, a phenomenon that is incompatible by definition with syllabic isochrony. Stressed syllables of three phonemes have a mean durational coefficient of 2.38 compared to 1.49 of 2 unstressed phonemes (proportion of 1:1.6), not to mention the more extreme cases (e.g. comparing unstressed syllables of one phoneme and stressed syllables containing four phonemes). The ratio between syllables containing two and three phonemes exceeds the threshold ratio (1:1.5), which is incompatible with syllabic isochrony characteristic of a *syllable-timed* language.

### 3.1.4. Stressed vowel compression

As a final criterion of verification, we have studied the duration of stressed vowels that act as the nucleus of the foot, which in the case of accentual isochrony should decrease as the number of its components increases. This is probably the most reliable criterion as it allows the verification not only of isochrony, but also of even a slight tendency towards it. Only the mean duration of the stressed vowel of different speakers (normalised by the relative duration coefficient, given in percentages) is given below<sup>8</sup>:

<sup>8</sup> Individual data is available in Pamies (1994a).

Foot	stressed vowel duration
Com/er c/erdo...	38
Com/er como un c/erdo...	45
Beb/erv/ino.....	45
Beb/erse un vin/illo	49
Com/í fr/esas...	61
Com/imos fr/esas...	46
Com/imos en la m/esa...	75
com/imos unos entrem/eses....	64

Obviously, vowel duration does not decrease as the number of syllables increases.

Thus, the four complementary methods of interpretation of data lead us to the same conclusion: Spanish does not fulfil any of the requirements either of accentual or syllabic isochrony. There is no compensation nor compression in the foot nor in the syllable. All the rhythmic cells are necessarily unequal insofar as the duration is closer to being proportional to the number of their components.

### 3.2. Other languages

For the other six languages, similar results were obtained.

#### 3.2.1. French

The prosodic analysis of the recordings of our six speakers (Paris, Toulouse, Poitiers, Paris, Liège, and Geneva) shows the same balance.

General average	
syllables per foot	time ratio
1	1
2	1.84
3	3.49
4	3.88

Controlled context		
utterance	syllable / foot	time ratio
un ois/ <b>eau</b> m/ort, c'est tragique	1	1

un ois/ <b>eau</b> qui m/ord, c'est énigmatique	2	1.9
un ois/ <b>eau</b> multicol/ore, c'est fantastique	4	3.29
un ois/ <b>eau</b> m/orne et tragique	1	1
un ois/ <b>eau</b> des b/ords de l'Adriatique	2	1,78
un ois/ <b>eau</b> multicol/ore et fantastique	4	3.55

As can be observed, the feet are very unequal and, parallel to the number of syllables, become progressively longer.

The mean syllabic duration is not uniform either. Some last an average of 4.76 times longer than others, even not considering the last syllable that can last 6.26 times more than the shortest one in the same utterance. The stressed syllable of three phonemes has a mean coefficient of 3.29 while that of unstressed sounds is as high as 2.17. The mean inequality is 1:1.51.

There is no compression of stressed vowel inside feet when new syllables are added:

Foot	stressed vowel duration
ois/ <b>eau</b> m/ort, c'est...	43
ois/ <b>eau</b> qui m/ord, c'est	47
ois/ <b>eau</b> multicol/ore, c'est...	41
ois/ <b>eau</b> m/orne et...	44
ois/ <b>eau</b> des b/ords...	50
ois/ <b>eau</b> multicol/ore et....	54

As a result, French does not correspond to either of the prototypical schemas.

### 3.2.2. Portuguese

The results our six speakers (São Vicente [Cabo Verde], Lisbon, Lisbon, Alentejo, Alentejo, Rio de Janeiro) are the following:

General average	
syllables per foot	time ratio
1	1
2	2.83
3	3.39



4	4.18
5 @	5.64
6 @	6.32

Controlled context		
utterance	syllable/ foot	time ratio
ach/ <b>ou</b> /ouro na ilha deserta	1	1
O m/ <b>ou</b> ro desesper/ou-se no deserto	5	6.13
ocult/ <b>ou</b> -se atrás do bebed/ouro do corral	6	9.21

It is hard to relate syllable duration to the number of phonemes as in the same utterance, Portuguese speakers suppress phonemes that the Brazilian speaker pronounces (cases noted with @). This phenomenon should have favoured feet isochrony, since stressed vowels are never suppressed, but this was not the case. Neither did it favour syllabic isochrony since mean syllabic duration is very unequal, reaching 1: 4.38 in the same utterance. The stressed vowel in the foot does not seem to be compressed either when more syllables are added:

Foot	stressed vowel duration
ach/ <b>ou</b> /ouro...	49
O m/ <b>ou</b> ro desesper/ou-se	84
ocult/ <b>ou</b> -se atrás do bebed/ouro...	80

### 3.2.3. Italian

In Italian, we recorded more utterances, since there were fewer speakers. All of the subjects were from Northern Italy (Piamonte, Emilia-Romagna) and were monolingual since none of them spoke any local dialect:

General average	
syllables per foot	time ratio
1	1
2	2.02
3	2.99
4	3.22
5	3.97
6	4.94

Controlled context		
Utterance	syllable/.foot	time ratio
Mangi/ar r/ettili non è comune in Europa	1	1
Mangi/ar conf/etti può farti male	2	1.95
Mangi/ar dei conf/etti può farti male	3	2.64
Viaggi/ar sul vapor/etto è molto economico	4	2.73
Manger/ò m/ale se dovrò farlo al sacco	1	1
Far/ò del m/ale se ne sarò costretta	2	2.26
Non legger/ò dei giorn/ali nelle vacanze	3	3.48
Comprer/ò degli anim/ali per la fattoria	4	3.58
Comprer/ò degli origin/ali di Picasso	5	4.38

Syllabic mean duration is rather unequal as well. As can be seen, a syllable can last as much as 2.27 times longer than another in the same utterance<sup>9</sup>. A stressed syllable of three phonemes lasts 1.93 compared to the unstressed of two phonemes, the mean inequality can be 1:1,62 in individual results.

There is nothing to prove that the stressed vowel is compressed when new syllables are added to the foot. If anything, it increases.

Foot	stressed vowel duration
mangi/ar conf/etti...	20
mangi/ar dei conf/etti...	40
manger/ó m/ale...	32
far/ò del m/ale....	60
non legger/ó dei giorn/ali...	53
comprer/ò degli anim/ali...	39
comprer/ò degli origin/ali...	35

### 3.2.4. Catalanian

In Catalanian there are two kinds of examples carried out by two different groups of speakers from the two main dialectal areas (eastern and western). The initial data obtained was not sufficient, so we recorded

<sup>9</sup> Individual data presents even more striking inequalities.

a second group, but as the first speakers had left on their holiday, we had to find new ones.

First series = Barcelona, Barcelona, Elche, Ibi

*Menjar porc es pecat per a un àrab/ menjar com un porc es molt lleig/ viatjar desde Menorca es més car.*

Second series = Barcelona, Lérida, Barcelona

*Ha comprat cases per especular, s'ha canviat de casa per estalviar, ha pecat com un ase per aprovar, ha comprat unes carbasses per a fer el sopar).*

General average	
syllables per foot	time ratio
1	1
2	1.83
3	2.53
4	2.76
5	4.10
6	4.96

These data, unfavourable to accentual isochrony, are confirmed in a more detailed analysis, showing an almost perfect antithesis of the *stress-timed* schema.

Controlled context		
utterance	syllable/ foot	time ratio
menj/ar p/orc es pecat per a un àrab	1	1
menj/ar com un p/orc es molt lleig	3	3.05
viatj/ar des de Men/orca es més car	4	2.77
Ha compr/at c/ases per especular	1	1
s'ha canvi/at de c/asa per estalviar	2	1.46
Ha penc/at com un /ase per aprovar	3	2.41
Ha compr/at unes carb/asses per a fer el sopar	4	3.07

Syllabic duration is not uniform either. The mean inequality is as high as 1:3.44 in the same utterance and the mean duration of an unstressed syllable of two phonemes is 1.42, compared to 2.37 in the three-syllable stressed ones. The proportion is thus 1:1.66.

There are no signs of compression of the stressed vowel when new syllables are added to the foot.

Foot	stressed vowel duration
menj/ <b>ar</b> p/orc...	50
menj/ <b>ar</b> com un p/orc...	52
ha compr/ <b>at</b> c/ases...	22
s'ha canvi/ <b>at</b> de c/asa...	25
ha penc/ <b>at</b> com un /ase...	32
ha compr/ <b>at</b> unes carb/asses...	33

None of the two types of isochrony is compatible with these results.

### 3.2.5. English

Our recordings of native speakers (Liverpool, Pennsylvania, Cardiff, Liverpool) provide the following results:

General average	
syllables per foot	time ratio
1	1
2	1.56
3	1.87
4	2.57

Controlled context		
utterance	syl../foot	tm/rat.
R/ <b>ed</b> b/eans are very expensive	1	1
J/ <b>elly</b> b/eans are very cheap	2	1.11
That was a h/ <b>ell</b> of a dr/ <b>eam</b> I had last night!	3	1.93
"Y/ <b>ellow</b> submar/ <b>ine</b> " was a big hit	4	2.43
A w/ <b>ise</b> n/ <b>ation</b> is hard to find	1	1
A w/ <b>ise</b> cre/ <b>ation</b> needs careful thought	2	1.37
It was a w/ <b>ise</b> observ/ <b>ation</b> that you made yesterday	3	1.88
It was a surpr/ <b>ising</b> demonstr/ <b>ation</b> that we saw yesterday	4	2.20

Syllable duration shows convincing inequalities, some of 1: 5.76. The mean relative duration of an unstressed syllable of two phonemes is 1.64 compared to 3.57 for the stressed ones of three phonemes, a proportion even higher than 1:2.

Neither could we verify the compression of the stressed vowel when the rhythmic cells increased.

Foot	stressed vowel duration
r/ed b/eans...	16
j/elly b/eans...	23
h/ell of a dr/eam...	33
y/ellow submar/ine...	14
w/ise n/ation...	70
w/ise cre/ation...	79
w/ise observ/ation...	96
surpr/ising demonstr/ation...	97

English does not seem to fit either of the rhythmic schemas.

### 3.2.6. Russian

Since Russian was the first language we worked with, we needed to add a second set of utterances to correct some weak aspects of the first recordings. There is thus a change of speakers from one series to another. The first series (three speakers: Kazan', Moscow, Moscow) did not neutralize enough factors, so another series was designed in order to enhance the reliability of our data. The second series (three speakers: Ivanovo, Minsk, Kiev<sup>10</sup>) is for this reason more varied though both series point in the same direction..

First series: *“Nós” Gógolia, zanimátelnoe proizvedénie /“Nós” byl napísan Gógolëm v deviatnátsatom véke /mne xóchetsia pít’ sók so l’dom i solóminkoi /xochú pít’ vinográdniü sók xolodniü.*

Second Series: *kák ne liubít’ chókánie bokálov shampánskogo?/ xoroshó by napít’sja sókom s l’dom i vódkoi/ lechíte vysókoie davlénie zanimáias’ spórtom/ núzhno pít’ na pososhók pered darógi.*

In the second series the stresses that diverge correspond to the same vowels in syllables closed by the same consonants (t-k), a soundless plosive in both cases. Since the first series was somewhat less adequate, we did not wish to use it as the sole source of data.

<sup>4</sup> The speakers of Minsk and Kiev were Russian and monolingual, on the other hand the recordings date from 1993 when Ukraine and Belorussia had recently become independent.

General average	
syllables per foot	time ratio
1	1
2	1.71
3	1.88
4	2.31
5	3.01

The results of the second series are the following:

Controlled context		
utterance	syllable/foot	time ratio
Kák ne liub/ít' ch/ókanie bokálov shampánskogo?	1	1
xoroshó by nap/ít' sja s/ókom s l'dom i vódkoï	2	1.79
Lech/íte vys/ókoe davlénie zanimáias' spórtom	3	2.04
núzhno p/ít' na pososh/ók pered darógoï	4	2.92

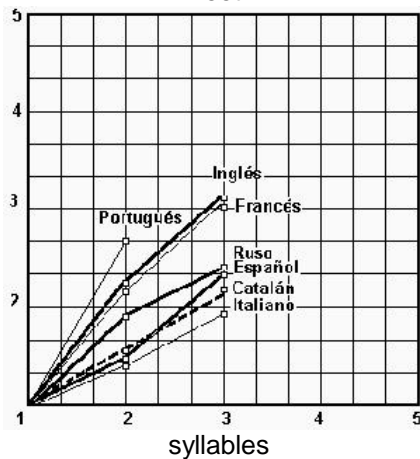
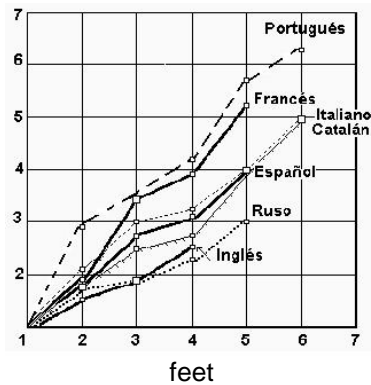
The longer the foot lasts, the more syllables it has, which is by definition contrary to the schema of stress-timed rhythm. Syllable duration is very irregular as well. The mean duration for a syllable can be over three times longer than another one in the same utterance, and the mean duration of unstressed syllables of two phonemes is 1.38, compared to 2.73 for the stressed ones of three phonemes. The ratio is almost 1:2, which also rules out *syllable-timed* rhythm. Neither do we see any sign of compressing the stressed vowel when the number of syllables in the foot increases in both series:

Foot	stressed vowel duration
N/ós G/ógolia...	77
N/ós byl nap/ísan...	89
p/ít' s/ók...	66
p/ít' vinogr/ádnii...	71
liub/ít' ch/ókanie...	38
nap/ít' sia s/ókom...	47
lech/íte vys/ókoe...	23
p/ít' na pososhók...	45

As a result, Russian does not seem to fit in either of the two rhythmic types.

### 5. Conclusion

On the basis of the data presented, it follows that languages considered *stress-timed*, and others considered *syllable-timed* give a rather similar response to the three tests, with results that openly contradict the typological models they are supposed to represent. There is no compensation at all to balance the duration of the units composed of different number of elements. On the contrary, the rhythmic units not only demonstrate a strong temporal inequality, but even certain parallels with their morphological inequality, a phenomenon which is the antithesis of both rhythmic types.



Since our experimental results are so clearly unfavourable towards both of the hypotheses under study, we should explain the discordance between the data and the validity of these metalinguistic categories. We thus return to the initial paradox:

Speech rhythm was analysed by metrics many centuries before the birth of phonetics. The conception of rhythm in all European models of versification is used to justify different types of euphonic strategies (syllabic metrics, syllabo-tonic, quantitative-musical, generative, etc.), and all these theories share a basic postulate: Rhythm seems to be the regular recurrence of an event (stress or syllable boundary), a principle inherited from the normative Greco-Latin versification, more concretely from Greek hexameter, which does not have much in common with descriptive phonology of common speech, not to mention the controversies about isochrony in poetics. (cf. Pamies 1995ab).

In linguistics, the word *rhythm* is a metaphor, borrowed from music. Though sometimes we like to confuse metaphors with reality, this brings us to another vicious circle, since Greek musicology had previously imported it from poetry (measuring music in spondees, dactyls, iambs, etc.). If the "model" is musical, the first thing to be considered is that music has rhythms alien to the regular recurrence principle (which is just one possibility among various others). From Monteverdi, Mozart, Tchaikovsky, Mussorgski, to European folk music, Arabic or Indian music, not to mention Stravinsky or African and Afro-American music, rhythm is not necessarily isochronic (cf. Sachs, 1953; El Mahdi, 1972; Danielou, 1985; Sadie et al., 1980; Salazar, 1991; Pamies 1994a). Music even possesses symbols to transcribe all kinds of anisochronic phenomena: Tempo changes, syncope, off-beats, accents that do not coincide with the bar, changes of bar, and mixed types of bars like 5/4, 7/4, 9/8, 11/8. The musical model *per se* does not justify this simplistic view.

If empirical data regarding music and poetry, the source-domain of this metaphor applied to phonology, does not support the identification *a priori* between isochrony and rhythm, such an idea has only in its favour the inherited dogma of normative aesthetics. Those criteria, besides being artificial, are limited to a very reduced sphere both in time and in space. This vision of rhythm, inherited from a normative tradition, contradicts empirical musical, poetical and phonological data, but underlies the diffusion and the *a priori* establishment of isochrony.

The stress-timed vs. syllable-timed language dichotomy is a direct offshoot of this heritage, that applied the concept of *rhythm* to



ordinary speech, starting from a simplistic, normative and old fashioned definition of it, perhaps for the sake of symmetry, which is always an attractive thing for phonologists but that, in this case, is far from reality.

In our opinion, it is necessary to reflect more carefully on the background of rhythm studies before accepting it as a metalinguistic category. If the aim of our investigations is to discover the relevant aspects of rhythm in language, one must include and consider all possibilities, from the existence of anisochronic rhythms (polyrhythmic structures), to the absolute lack of any kind of rhythm.

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