

*(paper originally published in **Linguistic Controversies**, ed. D. Crystal, 1982, pp. 73-79. The paper is now badly out of date, but since it is still frequently cited I feel it is worth making it available in electronic form. The main point of the paper is that it is practically impossible to devise an objective test that will distinguish between "stress-timed" and "syllable-timed" languages just on the basis of measuring time intervals).*

On the distinction between 'stress-timed' and 'syllable-timed' languages

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One of the most familiar distinctions in phonetics is that between STRESS-TIMED and SYLLABLE-TIMED languages. Many textbooks refer to this, but nowhere is the distinction as explicitly made as in Abercrombie (1967, p. 97), who writes: 'As far as is known, every language in the world is spoken with one kind of rhythm or with the other . . . French, Telugu and Yoruba . . . are syllable-timed languages, . . . English, Russian and Arabic . . . are stress-timed languages'. Most teachers of phonetics are used to being asked by students how one can tell if a particular language is syllable-timed or stress-timed; it is easy enough to construct and perform examples, such as a comparison between an English sentence:

'this is the 'house that 'Jack 'built

and a French one:

c'est absolument ridicule.

However, it is much more difficult to set out clear rules for assigning a language to one of the two categories. Within the traditional way of teaching phonetics such a question does not necessarily need to be answered with a statement that can be tested experimentally. The question might be answered in the same way as others such as 'how can you tell if a vowel is centralized?', by saying that the ability to make such decisions comes through undergoing a certain amount of training with an expert phonetician. Consequently Abercrombie's statement that the phonetician needs 'empathy with the speaker' to apprehend speech rhythm, and his claim that 'it is necessary to learn to listen differently in order to be able to analyse speech rhythm, whether of one's mother tongue or another language, and to describe it in general terms' suggest that the distinction between stress-timed and syllable-timed languages may rest entirely on perceptual skills acquired through training. It can be objected to this that there is an infinite regression involved in saying that one can only decide whether X should be assigned to Category A or to Category B when one has been trained by someone who knows how to do this.

Is it possible to establish some experimental test, based on instrumental techniques, which would make it possible to assign a language to one category or the other? Two claims made by Abercrombie in the same work appear to offer some chance of this (ibid., 98):

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

In the experimental work described below, tape-recordings of the six languages listed by Abercrombie (French, Telugu and Yoruba as syllable-timed and English, Russian and Arabic as stress-timed) were examined to see if it was possible to assign languages to one of the two categories by means of tests based on the above claims. If such tests could be devised they would be useful not only in the study of rhythm but also in the broader study of phonetic differences between languages. Intensity meter traces were made from the tape-recordings and were segmented by hand. This is very time-consuming work and only one speaker of each

language was studied. It was felt that it would be most suitable to examine spontaneous, unscripted speech, so speakers were given simple pictures to talk about but left free to say what they wanted. About two minutes of this speech was measured for each speaker.

Claim (i), that syllable length is more variable in stress-timed languages, is easy enough to test. However, it is not easy to see why syllable length should tend to be equal in a syllable-timed language. It is possible to imagine a language in which realizations of vowel phonemes displayed little variability, but which contained phonemically long and phonemically short vowels. This language would then contain syllables that differed considerably from each other in length, but it would not as a consequence have to have the 'regular stress beat' that is commonly ascribed to stress-timed rhythm.

A simple measure of variability in this case is the standard deviation of the syllable durations (measured in milliseconds). The measures from the six speakers are given below:

French: 75.5	English: 86
Telugu: 66	Russian: 77
Yoruba: 81	Arabic: 76

This set of figures does not appear to support claim (i).

Claim (ii) is a more complex matter. This relates to the 'regular stress beat' that is said to be characteristic of English, and to be characteristically absent in languages such as French. It is necessary in the first place to distinguish between the subjective impression of regular stress beats as perceived by the listener, and the information about time intervals that can be derived instrumentally from an acoustic signal. Considerable attention has been given recently to ISOCHRONY in English speech (i.e. the occurrence of regular stress beats), and it has been shown that the regularity of the stresses is more apparent than real, in that listeners tend to perceive isochrony even in sequences of inter-stress intervals that are manifestly far from equal (Allen 1975; 1979; Lehiste 1977; 1979; Donovan and Darwin 1979). This finding does not invalidate the claim that some languages sound 'stress-timed', but it suggests that finding isochrony in measurements of speech is unlikely to be straightforward. A test based on native speakers' responses to auditorily presented material would not be a practical means to providing an answer to the question 'how can you tell whether a language is stress-timed or syllable-timed?'. The only objective way of answering this question must be one based on measurements derived from acoustic or articulatory information.

Information about the perceptual reality of stress-timed rhythm has been produced mainly in relation to English, and there is no comparable information about syllable-timed languages. A few languages, however, have been investigated with measurements of inter-stress intervals, including some reputedly syllable-timed languages. The best-known study of English based on the acoustic signal is Uldall (1971), in which the material measured was a recording of a passage of written English read by Abercrombie. The measured inter-stress intervals did not show marked regularity. Spanish is claimed by, among others, Pike (1945) and Hockett (1955) to be syllable-timed; doubt is cast on this claim by Pointon (1973, 1980) and a detailed study of Chilean Spanish by Alvarez de Ruf (1978) showed that for this variety of Spanish at least, the label "syllable-timed" is not appropriate. A similar conclusion is reached for Tamil by Balasubramanian (1980). Such information is, however, hard to find and often carried out on rather disparate material. Abercrombie's claim (ii) needs to be tested on several languages under conditions as nearly as possible, identical. This was attempted with the recordings mentioned above (French, Telugu, Yoruba, English, Russian and Arabic).

Considerable problems arise in designing a measurement-based test of the kind envisaged. The first of these is the identification of stresses: clearly, if the phonetician were unable to identify which syllables in a speech recording were to be counted as stressed and which as unstressed there would be no possibility of measuring inter-stress intervals. Since no instrumental technique for identifying stressed syllables automatically has yet been devised, it appears that syllable and stress identification must be done auditorily, presumably by the

phonetician since it would be impossibly difficult to use native speaker reactions in a coordinated way in a test involving a number of different languages. Several of the speakers recorded were, in fact, asked for their opinions on stress placement when the material was being analysed, but appeared to find it an impossibly difficult task. (This is no doubt partly the result of using spontaneous speech instead of the reading of carefully constructed sentences.) As is well known, disagreements arise among phoneticians about syllabification even of their native language; such disagreements occur more frequently over stress and even more so over the division of speech into intonation units. In analysing foreign languages the phonetician is subject to a variety of influences. His native-language intuitions may influence decisions as may experience with other languages. Judgements of stress may be influenced by various prosodic characteristics such as vowel length and pitch height that may be relevant in his own language but irrelevant in the language being examined. It could, for example, happen that in analysing a tone language an unwary phonetician might judge all high-tone syllables to be stressed. An additional problem is that in working with an informant one may be unwittingly influenced by the informant's idealized view of what he thought he said on the tape, or by his mental picture of how what he said would appear in his orthography. In spite of these difficulties, it was felt to be worth persisting in attempting to measure inter-stress intervals for the six languages, and the recordings were therefore transcribed with stress-marks placed on those syllables which sounded stressed (i.e. which constituted peaks of prominence).

The next problems arise in measuring inter-stress intervals. First, from where should one measure the beginning of an inter-stress interval? Some researchers have measured from the intensity peak of the vowel in the stressed syllable to the corresponding following peak. If it were possible to identify what have been called P-centres (Morton et al. 1976) from the production side of speech (something that may be theoretically possible) there would be much to be said for measuring from these. However, in the present state of our knowledge it is felt to be intuitively more satisfying to aim to measure as nearly as possible from the *phonological* beginning of the syllable which carries the stress, so that if the syllable begins with a consonant cluster, one measures from the beginning of that cluster.

A further problem is that measurements carried out over long stretches of spontaneous speech are likely to be heavily influenced by tempo variations. To take an extreme example, if one had a recording of a speaker of English repeating the sentence "This is the house that Jack built" many times over with perfectly regular rhythm and timing, one would expect that the variance in inter-stress intervals would be very low. However, if in another recording the speaker continued to produce the sentence with perfectly regular rhythm but changed the tempo from each repetition to the next, the inter-stress intervals would exhibit a quite misleadingly high variance. It seems reasonable to suppose that the kind of temporal regularity being discussed is a property of a unit of speech smaller than the entire text, the tone-unit; this is proposed by Rees (1975). Hence it is assumed that tempo changes will usually be manifested in terms of differences between the tempo of one tone-unit and another, and will not usually be found within the tone-unit (though since Crystal and Quirk (1964) have pointed out the phenomena of ACCELERANDO and RALLENTANDO we must accept that this does sometimes happen). Some way therefore has to be found of removing the effect of tempo differences between one tone-unit and another. The beginnings and ends of tone-units create measurement problems. Tone-units often begin with unstressed syllables that could only be counted as belonging to an inter-stress interval if the implausible notion were adopted that they were preceded by a 'silent stress' (Abercrombie 1968) or 'silent ictus' (Halliday 1967). These 'pre-head' syllables were discarded in the present work. Syllables which are final in the tone-unit are commonly lengthened considerably, both in English and in other languages (Oller 1979), so if one included the interval between the last stress and the end of the tone-unit in the measurements one would often be introducing values that were unusually large in comparison with other intervals. Syllables between the last stressed syllable and the end of the tone-unit were therefore discarded.

The list of problems involved in setting up a procedure for measuring inter-stress intervals in a controlled way would not be complete without mention of the problem of identifying tone-

unit boundaries, which is difficult enough even for English (Brown et al. 1980); as far as possible, pauses were taken as the most reliable boundary points. However, the identification problem raised here constitutes another serious weakness in any procedure for measuring aspects of rhythm in continuous speech.

The procedure that was tried for eliminating tempo effects was to look at durational differences and irregularities in percentage terms (expressed as a percentage of the inter-stress interval) rather than in absolute terms. Each tone-unit (minus any discarded syllables at the beginning and end) was measured, and this measurement was divided by the number of inter-stress intervals it contained. This gives a hypothetical figure for each inter-stress interval that would be expected in a perfectly stress-timed language, in that every inter-stress interval would be of the same duration irrespective of the number of syllables it contained. Such regularity is not, of course, expected in natural speech but it is now possible to compare the measured duration of each inter-stress interval with its predicted value and calculate the percentage deviation. We must hypothesize that syllable-timed languages would exhibit a wider range of percentage deviations in inter-stress intervals than would stress-timed (the latter being more nearly isochronous), and this can be tested by calculating the variance of the percentage deviation figures for each language. The variance figures are given below:

French: 617	English: 1267
Telugu: 870	Russian: 917
Yoruba: 726	Arabic: 874

It can be seen that the right-hand column (the stress-timed languages) has higher values than the left-hand, which is contradictory to the hypothesis. It seems likely that the English figure is an extreme value resulting from studying a single speaker, and that the figures as a whole are better taken just as grounds for rejecting the hypothesis, rather than as proof that stress-timed languages typically have greater variance in their inter-stress intervals. The significance of the difference between individual languages in terms of their variance can be tested by the Variance-Ratio (F) test (Robson 1973). This shows the English data to have a significantly higher variance ($p < .05$) than French, Telugu, Yoruba and Arabic (the last-named being a stress-timed language), but apart from these the only other difference reaching the 5 percent significance level is that between Russian and French.

Another test can be tried, again bearing on Abercrombie's claim (ii): it can be hypothesized that in syllable-timed languages inter-stress intervals will tend to be longer in proportion to the number of syllables they contain, whereas such a tendency should be absent (or weaker) in stress-timed languages. This hypothesis can be tested by calculating a Pearson correlation coefficient for the association between percentage deviation (as set out above) and the number of syllables per inter-stress interval for each language. The results of this calculation are set out below:

French: .41	English: .53
Telugu: .61	Russian: .61
Yoruba: .62	Arabic: .57

It is not possible to separate the two groups of languages on this basis. The results reported here give no support to the idea that one could assign a language to one of the two categories on the basis of measurement of time intervals in speech. Consequently one is obliged to conclude that the basis for the distinction is auditory and subjective—a language is syllable-timed if it sounds syllable-timed. A thorough examination of the factors that might be responsible for languages sounding syllable-timed or stress-timed would be beyond the scope of this chapter, but clearly it would be necessary to consider possibilities such as that languages classed as syllable-timed may tend to have simpler syllable structure (Smith (1976) suggests this as a factor in the case of Japanese and of French), and that languages classed as stress-timed may be more likely to exhibit vowel reduction in unstressed syllables.

It seems reasonable to conclude with the following claims, though these go beyond what may legitimately be concluded from the small experiment reported above. Firstly, as suggested by Mitchell (1969), there is no language which is totally syllable-timed or totally stress-timed - all languages display both sorts of timing; languages will, however, differ in which type of timing predominates. Secondly, different types of timing will be exhibited by the same speaker on different occasions and in different contexts; attention is drawn to this by Crystal and Quirk (1964) and Crystal (1969) with the introduction of the prosodic feature RHYTHMICITY, which may well be relevant in languages other than English. Finally, the stress-timed/syllable-timed distinction seems at the present to depend mainly on the intuitions of speakers of various Germanic languages all of which are said to be stress-timed; examination of the subjective feelings of speakers of languages usually classed as syllable-timed should be carefully studied if the distinction is to be maintained as a respectable part of phonetic theory.

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