Stress-timed = word-based? Testing a hypothesis in Prosodic Typology

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Abstract

In recent research on cross-linguistic differences in linguistic rhythm, it has been hypothesized that the traditional dichotomy 'stress-timed' versus 'syllable-timed' might be recast with respect to which level of the Prosodic Hierarchy constitutes the most prominent domain for the organization of prosodic structure. In this paper, we test the prediction that 'stress-timed' languages are characterized by a dominance of the prosodic word against a typological sample of 58 languages. Although there is a slight cross-linguistic tendency in favor of the prediction, there is no statistical support for the proposed correlation. Since counterexamples include not only individual languages but also entire language families, we advocate a different view on prosodic word domain structure. The prosodic word profile of a given language is more reliably predicted by the family membership of that language than by universal correlations concerning its rhythm class membership. We substantiate this claim by a survey of Mon-Khmer's family signature on prosodic word domain structure in Mon, where sound patterns target either the monosyllabic stem or the maximally inflected disyllabic word.

Keywords: prosodic typology, linguistic rhythm, stress-timed language, prosodic word, Mon-Khmer, quantitative typology

1. Introduction

The distinction between 'stress-timed' and 'syllable-timed' languages is one of the best-known but at the same time also one of the most controversial notions in prosodic typology. In its original formulation, the rhythm class hypothesis predicts stress-bearing feet to be equal in duration in stress-timed and syllables to be isochronous in syllable-timed languages (Pike 1945, Abercrombie 1967). A third, often neglected, rhythm type, in which morae are said to be isochronous, has also been proposed (Bloch 1950). Although innumerous experimental studies have aimed at substantiating these claims, the phonetic evidence remains inconclusive, if not discouraging (Beckman 1982, Roach 1982, Dauer 1983, 1987, Auer & Uhmann 1988, Bertinetto 1989).[1] At the same time, cross-linguistic, rhythmic differences seem to be perceptually real, such that speakers are aware of isochrony and are able to distinguish their native rhythm from other forms of prosodic organization (Lehiste 1977, Donovan & Darwin 1979, Miller 1984, Couper-Kuhlen 1993). Further support for the rhythm-based language typology comes from language production, processing and acquisition, all hinting at some level of psycholinguistic reality (Cutler 1980, 1999, Cutler & Mehler 1993, Nespor et al. 1996, Ramus et al. 1999).

[1] More recent paradigms explore languages of different rhythm types in terms of the variability of consonantal and vocalic intervals in the speech signal (Ramus et al. 1999, Grabe & Low 2002, Ramus 2002, *inter alia*).

As a reaction to the lack of positive evidence in the speech signal, and bridging the gap between phonetics and psycholinguistics, various attempts have been made to revise the concepts of stress- and syllable-timing in terms of phonological profiles (BERTINETTO 1977, ROACH 1982, DAUER 1983, AUER 1993, 2001, DUFTER 2003). These enterprises make numerous predictions with respect to two aspects of prosodic structure. First, phonological features, such as, for instance, phonetically strong stress, vowel reduction in unstressed syllables and complex syllable structure, are hypothesized to cluster in a holistic 'stress-based' prosodically defined language type. Secondly, it has been proposed that languages formerly attributed to the different rhythm classes vary with respect to which level of the Prosodic Hierarchy (NESPOR & VOGEL 2007) constitutes the most prominent category of the prosodic system. In this line of thought, 'stress-timed' languages are said to be characterized by the saliency of the prosodic word, whereas the prosody of 'syllable-timed' languages centers on the syllable or the phonological phrase (AUER 1993, KLEINHENZ 1996, AUER 2001, DUFTER 2003). The most ambitious typology in this context has been formulated by AUER (1993), who induces about a dozen phonological properties of 'stress-timed' languages based on a tendency to keep the duration of prosodic words equal, and coins the term 'word-language' for this type.

The phonological reinterpretation of the traditional rhythm classes offers prosodic typology a number of hypotheses to test, especially since most research so far has focused on better known European languages (e.g. Germanic as 'stress-timed', Romance as 'syllable-timed'), plus Japanese as the prototype of 'mora-timing'. The first question to be asked from a cross-linguistic perspective then is whether phonological properties do really cluster in the predicted ways. Although AUER (1993) finds a continuum from 'word-language' to 'syllable-language' in his sample of 34 languages, more recent investigations detect only local correlations among stress-, syllable-, and mora-related parameters, respectively (SCHIERING 2006, 2007). The second key question brought up by the phonological approach to linguistic rhythm concerns cross-linguistic differences in prosodic domain structure: do languages really differ with respect to which domain in the prosodic hierarchy constitutes the most salient category for prosodic organization? Or, more specifically: are 'stress-timed' languages really characterized by a prominence of the phonological word?

In this paper, we test this latter prediction against typological data on word domains. In section 2, we lay out the methodology we developed to do so. Section 3 presents our main results. The discussion in section 4 situates the somewhat inconclusive finding within the broader context of cross-linguistic differences in prosodic domain structure. Section 5 concludes the paper by re-evaluating the merits of a rhythm-based typology and by depicting prospects for future research in prosodic typology.

2. Method

2.1. Database

In order to test the prediction whether 'stress-timed' languages are characterized by the saliency of the prosodic word, we recruit cross-linguistic data from the typological database compiled in the Leipzig Word Project[2] (BICKEL et al. 2009, SCHIERING et al. 2011). The data-

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set contains information on those sound patterns that are delimited by some morphological structure (so as to exclude foot- or syllable-related patterns), include up to one stem (so as to exclude phrasal domains), and which apply generally across the lexicon and are not for example limited to individual affixes (a rationale usually followed in Prosodic Phonology). In total, exhaustive information on word domains in 58 languages with a world-wide coverage are included in the database.[3] The sample is stratified for three language families (Indo-European, Sino-Tibetan and Austro-Asiatic) and three linguistic areas (Europe, South and Southwest Asia and Southeast Asia), but it also includes a control set of a dozen languages from the rest of the world.

We present a summary table of our database in the appendix; more detailed information is available as an electronic database (http://www.spw.uzh.ch/autotyp).

2.2. Coding rhythm class

The respective languages of the sample have each been assigned to a rhythm class. In all cases, this has been done based on classifications offered in the literature (Abercrombie 1967, Roach 1982, Donegan & Stampe 1983, Auer 1993, Evans 1995, Ramus et al. 1999, Grabe & Low 2002, Dufter 2003, Steiner 2004). Whereas most of these classifications are based on phonetic and/or phonological research, some of them remain rather impressionistic. Nevertheless, attributing Dutch, English and German to the category 'stress-timed' seems to be an uncontroversial matter. The same seems to be true for the inclusion of Spanish into the 'syllable-timed' group. Other languages, like Finnish for example, are explicitly referred to as 'mora-timed' and we code them accordingly. Where languages are said to have a mixed profile, such as Khalkha Mongolian, or are still unclassified, as, for instance, Armenian, we do not force an assignment, but just keep record of their 'mixed' or 'unclassified' status. In cases of conflicting analyses, we opt for Auer's (1993) classification, since it is his hypothesis that we are testing.

This coding procedure leaves us with five categories of which we only consider 'stress-timed' as opposed to 'other' (i.e. 'syllable-' and 'mora-timed'). Since the typology tested does not make any prediction with respect to 'mixed' and 'unclassified' languages, we exclude them from our statistical analyses. This reduces our dataset to 33 languages (cf. the Appendix).

2.3. Measuring word prominence

Since there is no operationalized definition of word dominance, we recruit our own coding of word-related phonological domains for the present analysis (cf. Bickel et al. 2009: footnote 3). For each phonological process, we code whether or not it applies within a specific morpheme type (stem, suffix, enclitic etc.) and whether or not it applies to a specific boundary between such morpheme types (e.g. across a stem-suffix boundary). For

[3] We consider information exhaustive when we have surveyed all accessible descriptive work and have double-checked the information. This criterion is stricter than the one used in Bickel et al. (2009), where we were primarily interested in domain length and less so in catching all domains within each language.

illustration purposes, consider the phonological process of Primary Stress Assignment in Limbu, a Kiranti language of Nepal.

(1) Primary Stress Assignment in Limbu [van Driem 1987, Hildebrandt 2007][4]

(1a) /mɛ-ˈthaŋ-e=aŋ/
3ns-come.up-pst=and
'they come up and …'

(1b) /ˈku-la:p/
3poss-wing
'its wing'

(1a) presents a word form which consists of a prefix, a stem, a suffix and an enclitic particle. Primary stress is assigned once in this construction and is realized on the stem syllable. In (1b), where only a prefix and stem are present, primary stress shifts to the initial prefix syllable of the disyllabic word form. This state of affairs can be described by stating that primary stress is assigned once to the prosodic word, which in turn maps to a morphological string encompassing the prefix, stem, suffix and enclitic.

Technically, we capture this insight in a bit string, represented vertically in the second column of (2):[5]

(2) Bit string for Limbu Primary Stress Word

– proclitic alone	NA
– proclitic-proclitic	NA
– proclitic-prefix	NA
– proclitic-stem	NA
– prefix alone	0
– prefix-endoclitic	NA
– prefix-prefix	1
– prefix-stem	1
– stem alone	1
– stem-infix	NA
– stem-suffix	1
– stem-endoclitic	NA
– stem-enclitic	1
– suffix alone	0
– suffix-suffix	1
– suffix-endoclitic	NA
– suffix-enclitic	1
– enclitic-enclitic	1
– enclitic alone	0

[4] The following abbreviations are used in the word-for-word glosses of the Limbu and Mon examples: 1 = first person, 3 = third person, caus = causative, nom = nominalizer, ns = non-singular, poss = possessive, pst = past, q = question marker, voc = vocative.

[5] For current and practical purposes, we define a clitic as a morpheme that is unable to form a grammatical word on its own (like affixes) and that is not restricted to a host with a unique part of speech category (unlike affixes). See Bickel & Nichols (2007) for discussion. Under this definition, the unrestrictedness (non-selectivity) of clitics may or may not follow from phrase-level attachment (although it often does).

For each attested morpheme type and for each logically possible combination of morpheme types, this coding defines whether the process includes the type ('1'), excludes the type ('0'), or whether the type does not occur in the language at all ('NA'). The first few lines in (2) are marked as NA because Limbu has no proclitics. The 'prefix alone' type is marked as '0' because prefixes alone do not form domains for Stress Assignment in Limbu, i.e. they are not independently stressed. Stress Assignment applies to a domain that includes prefix-prefix, prefix-stem, stem, stem-suffix, stem-enclitic, suffix-suffix, suffix-enclitic, and enclitic-enclitic boundaries, which are all marked as '1' in (2).

Cross-linguistically, prosodic domains tend to multiply at the word level (Bickel et al. 2009). This fact complicates our measurement of word prominence, because it raises the question of which of the attested word domains should be considered for the present analysis as the relevant one. Consider the example of Glottal Stop Insertion as an alternative word-related process in Limbu.

(3) Glottal Stop Insertion in Limbu [van Driem 1987, Hildebrandt 2007]

(3a) /k**u-e**ːk/ [k**uʔe**ːk] (3poss-back) 'his/her back'

(3b) /a-mph**u-e**ː/ [ʔamph**ue**ː] (1poss-brother-voc) 'Brother!'

(3c) /nu-b**a=i**ː/ [nub**ai**ː] (be.alright-nom=q) 'Is this OK?'

(3d) /**a-i**ːr-ɛ/ [ʔ**aʔi**ːrɛ] (1-wander-pst) 'We wandered.'

Glottal stop is inserted into the onset position of underlyingly vowel-initial syllables. However, as the data above demonstrate, the application of this rule is restricted to certain morphological contexts. In (3a), glottal stop is inserted at the left edge of a stem. Note that the rule does not apply at the left edge of suffixes (3b) or enclitics (3c). In the case of the vowel-initial prefix in (3d), we again find glottal stop insertion. We describe these facts with appeal to a prosodic word, which this time maps to a morphological string encompassing the stem, suffix and enclitic and which treats the prefix as its own domain. Glottal stop is inserted at the left edge of this prosodic word if it would be vowel-initial otherwise.

In terms of our bit string coding, the prefix domain and the stem-suffix-enclitic domain that together characterize the relevant prosodic word are captured as follows:

(4) Bit string for Limbu Glottal Stop Insertion Word

	Prefix domain	Stem-Suffix-Enclitic Domain
– proclitic	NA	NA
– proclitic-proclitic	NA	NA
– proclitic-prefix	NA	NA
– proclitic-stem	NA	NA
– prefix	1	0
– prefix-endoclitic	NA	NA
– prefix-prefix	1	0
– prefix-stem	0	0
– stem	0	1
– stem-infix	NA	NA
– stem-suffix	0	1
– stem-endoclitic	NA	NA
– stem-enclitic	0	1
– suffix	0	0

– suffix-suffix	0	1
– suffix-endoclitic	NA	NA
– suffix-enclitic	0	1
– enclitic-enclitic	0	0
– enclitic	0	0

In cases like these, where there are several word domains referenced by phonological patterns in the prosodic system, we make the assumption that a domain can be said to be prominent in a language the more phonological patterns there are that reference the domain. In other words, a domain is prominent to the extent that the phonology is frequently sensitive to it. The most prominent domain in a language is that domain that is most frequently referenced, i.e. the 'modal' domain. The strength of this prominence can then be measured quantitatively by the actual frequency of the modal domain. We illustrate by Limbu again:

In Limbu, six word domains are detectable in the prosodic system. Their respective frequencies are given in (5) (now with bit strings printed horizontally; the bit position follows the order in 2 and 4 above):

(5) Limbu word domains and the frequency they are referred to by phonological processes

NANANANA0NA111NA1NA101NA110	3
NANANANA0NA000NA1NA000NA000	2
NANANANA0NA001NA1NA101NA100	2
NANANANA0NA010NA0NA000NA000	1
NANANANA0NA110NA1NA000NA000	1
NANANANA1NA100NA0NA000NA000	1

Whereas most domains are referenced only once, i.e. by only one phonological pattern, three stick out as attracting several processes. The most frequently referenced domain in Limbu is the one motivated, among other processes, by Primary Stress Assignment. The domain evidenced by, among others, Glottal Stop Insertion turns out to be the second most frequently referenced domain. For the purposes of our statistical analysis, the word domain encoded in the bit string NANANANA0NA111NA1NA101NA110 with 3 processes referencing it constitutes the relevant measurement of word prominence in Limbu.

Some languages have no modal domain, because their most frequent word domains are referenced by exactly the same number of processes (e.g. one domain by two processes and another domain again by two processes). Such a split of the top frequencies between different domains represents one particular way in which the phonological word may lack prominence in a language. We capture this by taking the highest frequency found in the language (i.e. taking '2' as the measurement in the example).

3. Results

On the basis of the coding detailed above we examined whether word dominance correlates with the distinction between stress-timed vs. other types. Figure 1 plots the rhythm classifications and the frequencies of the most frequent domain for five individual languages (panels 1–5) and for the three language families stratified in our sample (panel 6–8).

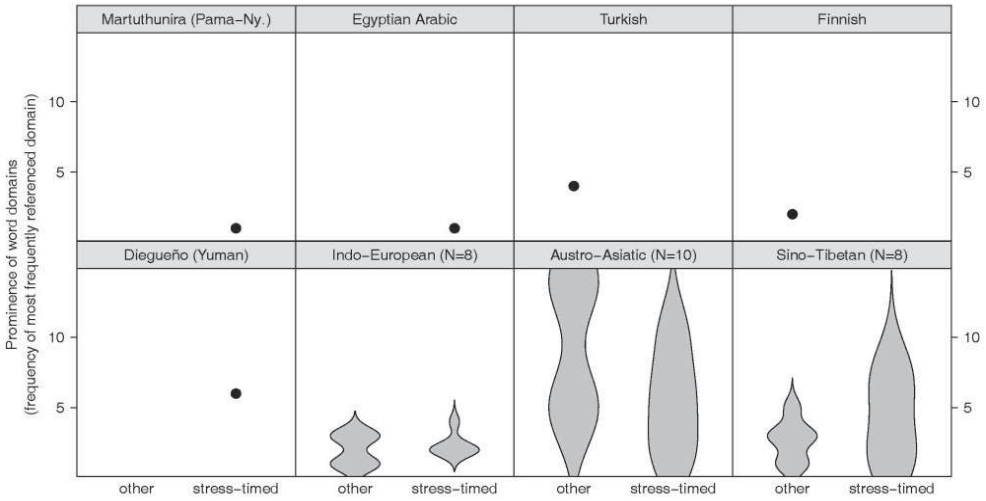

Figure 1: Strength of evidence for prosodic words plotted against rhythm classifications. Panel 1–5: individual languages, panel 6–8: language families

The individual languages do not reveal a clear picture as both syllable-timed languages like Turkish and stress-timed languages like Diegueño show a relatively high word prominence, accumulating 4 and 6 counts of their most-frequently referenced domains, respectively. The other languages have lower prominence degrees, again regardless of their rhythm type.

The violin plots in the last three panels of Figure 1 present the results for the three language families of which we have data from many languages. In both Indo-European and Sino-Tibetan (each represented by 8 languages), stress-timed languages show a slightly higher density bulk in word prominence than other languages. In Austro-Asiatic, however, the picture is less clear since non-stress-timed languages show increased densities in both lower and higher ranges of word prominence; if anything, there appears to be a slight trend towards higher degrees of word prominence when languages are not stress-timed.

To summarize, we find only a very slight cross-linguistic tendency for stress-timed languages to have more phonological processes referencing their most frequent word domains, with many counterexamples. Notable exceptions include not only individual languages, e.g. Turkish, but also entire language families, i.e. Austro-Asiatic. In line with this, a permutation-based *t*-test (as suggested by Janssen et al. 2006) reveals no significant effect.

4. Discussion

With respect to the feasibility of the rhythm-based typology, our results remain inconclusive, though it might not be a coincidence that the proposed correlation is overall borne out in Indo-European, and within Indo-European especially in Europe. After all, the original formulation of the dichotomy 'stress-timed' versus 'syllable-timed' has been formulated for Germanic and Romance languages. The fact that Austro-Asiatic as a whole shows a different profile than Indo-European or Sino-Tibetan suggests to us that 'word

prominence' is better predicted by diachronic signatures than by universal correlations (see also BICKEL et al. 2009 on the factor family in the cross-linguistic distribution of prosodic word domains). In what follows, we substantiate this claim by a survey of prosodic word domain structure in Mon, a representative of the stress-timed Mon-Khmer branch of Austro-Asiatic.

In Mon, phonological patterns target either the monosyllabic stem or the maximally inflected disyllabic word. The generalization revolving around the sesquisyllabic word structure (cəC**CV**C)$_{\omega}$ encompasses several aspects of phonological structure, ranging from minimality and maximality to stress assignment. Consider the data in (6) and (7).

(6) The minimal/maximal word in Mon [JENNY 2005, BAUER 1982]

(6a) /ʔa/ → ([ʔaː])$_{\omega}$ 'go'

(6b) /tɔʔ+nɔʔ/ → ([tənɔʔ])$_{\omega}$ 'these'

(6c) (hə-làc)$_{\omega}$ (CAUS-break.down) 'blast away'

(6d) (k-ə-lɒʔ)$_{\omega}$ (cross-CAUS-over) 'take across'

(7) Stress in Mon [BAUER 1982: 99 ff.]

(7a) (ˈtɛm)$_{\omega}$ 'to know'

(7b) (pə-ˈtɛm)$_{\omega}$ (CAUS-know) 'to inform'

(7c) (k-ə-ˈlɒʔ)$_{\omega}$ (cross-CAUS-over) 'take across'

(7d) (ˈpaʔ)$_{\omega}$ (ˈkɒ)$_{\omega}$ (ˈklɒʔ)$_{\omega}$ (do CAUS cross.over) 'make cross over'

(6a) illustrates minimality effects evidenced with monomoraic stems. When such a form constitutes a prosodic word on its own, its vowel is lengthened to provide a second mora, filling up the minimally bimoraic word shell. A process resulting in the sesquisyllabic maximal word shell is instanced in (6b). Here, the concatenation of deictic elements to yield the word 'these' triggers a rule of contraction, which reduces the first morpheme in the compound to a reduced initial syllable. The maximal word is also encountered in morphologically complex verbs, like the prefixed and infixed causative derivatives in (6c–d). In each case, the addition of an additional morpheme adheres to the prosodic maximality constraints imposed by the sesquisyllabic word.

Stress assignment, as exemplified in (7), is also sensitive to this prosodic word structure. In (7a), we see a monomorphemic, monosyllabic stem, which receives word-level stress. The morphologically complex forms in (7b–c) take stress on their final main syllable, leaving the initial affix syllable unstressed. Crucially, in constructions composed of several main syllables, such as (7d), each formative constitutes its own prosodic word, pointing to the fact that the maximally sesquisyllabic word structure needs to be respected by stress assignment in these cases.

Prosodic words in Mon thus typically reference the monosyllabic, monomerphemic stem or the disyllabic, maximally inflected word. Essentially, this bimodal distribution is retrievable throughout the Mon-Khmer family (cf. SCHIERING et al. 2009). We are thus inclined to believe that Mon reveals sesquisyllabic word structure as inherited from Mon-Khmer rather than as the result of some universal effect of 'stress-timing'. Or, in other words, the chances of predicting something about the prosodic word structure of a given

language are higher when we consider its language family membership compared to appealing to its rhythm type.

5. Conclusions

To answer the question formulated in the title of the paper, are stress-timed languages characterized by the salience of the word in the prosodic system, we conclude that they are presumably not. Although there seems to be a slight cross-linguistic tendency in favor of the prediction, it does not withstand the scrutiny of statistical testing. Under closer inspection, we find family profiles which are more likely predictors of the prosodic structures found in individual languages. For a typology of prosodic domains, the traditional distinction between 'stress-timed' and 'syllable-timed' languages is thus of little use. Nevertheless, we think research initiated by the phonological re-interpretation of rhythm classes offers at least two fruitful routes for future research in prosodic typology.

As noted in section 1, attempts to find cross-linguistic clusterings of properties like strong stress, vowel reduction, syllable complexity, etc. were unable to verify the holistic typology that was originally proposed in reaction to the lack of evidence for phonetic timing differences in the two language types. However, more local correlations on stress-related parameters have been detected. Schiering's (2007) *stress cline*, for instance, expresses the following cross-linguistic generalization: the stronger stress is realized phonetically, the higher its impact on the phonological system. This means that for a language with strong phonetic stress, expectations are high that it will also show segmental effects of stress (vowel reduction in unstressed syllables, vowel lengthening in stressed syllables, and consonant changes triggered by the absence or presence of stress), and that stress will impose restrictions on the distribution of tones or the size of vowel harmony domains. It thus turns out that the question of traditional prosodic typology which asks which prosodic category, e.g. stress, quantity, tone, etc., is central to a given system is in the focus again.

With respect to the cross-linguistic differences in prosodic domain structure, several typological questions arise as soon as we accept that we encounter more variation than predicted by current theories. We already alluded to the fact that language families exhibit prosodic signatures which suggests that prosodic structure is stable over time. However, there are also structural universals about prosodic domains which can be explored in the languages of the world. For instance, Bickel et al. (2009) have found evidence for the statistical universal that stress-related domains tend to be universally larger than other domains, again hinting at the special status of stress phonologies.

Appendix: Language sample

Note: this appendix only includes our summary measure of word prominence and only languages coded as 'stress-timed' or as 'syllable-timed' or 'mora-timed' (called 'other' here). For more detailed information and the entire dataset, see the electronic database at http://www.spw.uzh.ch/autotyp.

Language	Stock	Rhythm Type	Word Prominence
Arabic (Egyptian)	Semitic	stress-timed	1
Belhare	Sino-Tibetan	other	3
Cambodian	Austroasiatic	stress-timed	6
Cantonese	Sino-Tibetan	other	1

Chrau	Austroasiatic	stress-timed	5
Diegueño	Yuman	stress-timed	6
Dutch	Indo-European	stress-timed	4
Finnish	Uralic	other	2
French (colloquial)	Indo-European	other	1
German	Indo-European	stress-timed	2
Hayu	Sino-Tibetan	other	5
Irish	Indo-European	stress-timed	2
Jahai	Austroasiatic	stress-timed	1
Kharia	Austroasiatic	other	5
Khasi	Austroasiatic	stress-timed	2
Khmu	Austroasiatic	stress-timed	10
Limbu	Sino-Tibetan	other	3
Manange	Sino-Tibetan	stress-timed	1
Mandarin	Sino-Tibetan	other	3
Martuthunira	Pama-Nyungan	stress-timed	1
Mon	Austroasiatic	stress-timed	2
Pacoh	Austroasiatic	stress-timed	7
Persian	Indo-European	stress-timed	2
Polish	Indo-European	stress-timed	2
Santali	Austroasiatic	other	14
Semelai	Austroasiatic	stress-timed	11
Spanish	Indo-European	other	3
Swedish	Indo-European	stress-timed	2
Tibetan (Dege)	Sino-Tibetan	stress-timed	8
Tibetan (Kyirong)	Sino-Tibetan	stress-timed	2
Tibetan (Lhasa)	Sino-Tibetan	stress-timed	6
Turkish	Turkic	other	4
Wu	Sino-Tibetan	other	1

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