THE INTERRELATIONSHIP BETWEEN PHONOLOGICAL AND PHONETIC SOUND CHANGES: A GREAT RHYTHM SHIFT OF OLD ESTONIAN

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1. PURELY PHONETIC SOUND CHANGES

In the literature on historical linguistics, phonological and phonetic sound changes are often contrasted. A phonological change alters the phoneme composition of certain speech flow appearances, a phonetic change alters the way in which different expository-phonetic-articulatory gestures and their acoustic-auditory correlates are presented in certain speech flow appearances. For instance, in Old Litomysl Czech, there was a sound change "p > t", manifested e.g. in "pvi > ti:vo 'beer'. It was a phonological change in the sense that the phonemes /p/ was exchanged for the phoneme /t/ by replacing (in terms of Andersen 1973) the distinctive feature 'heightened low consonant tonality' of /p/ by the feature 'high consonant tonality' of /t/. The phonetic change in the sense that the actual labial articulation of [p] (in terms of Ladefoged 1980) by certain values of the articular parameters like 'tongue tip raising' and 'tongue body raising' and its corresponding 'heightened low tonality' in acoustic-audition were exchanged for the actual dental articulation of [t], characterized by certain values of the articulatory feature 'tongue tip lowering'. Since the boundaries become a realization of speech flow in the functional systems. Here, the phonetic change may be due to two methodological essentials of speech rhythm are treated in the Institute of Language and Literature, Tallinn 20004, USER

2. STRIVING VS. SWITCHING CONTROL OF FOOT

2.1. Phonological vs. phonetic perspective on language

According to Ladefoged 1984, the role of phonological and phonetic sound changes can be viewed as a social norm of a community. They are abstract devices while describing language as a psychological act or state of an individual, e.g. while describing the actual realization of the phonetic change of concrete speech samples. According to his original parallel, phonemes are like moral prescriptions or economical laws: they are manifested in the behaviour of a human group rather than a single member of this group.

In concrete linguistic analysis, the social rather than psychological nature of phonemes is revealed best by the characteristics of concrete rather than their invariant cues of a boundary between phonemes, the boundaries become a realization of speech flow in the functional systems. Here, the phonetic change may be due to two methodological essentials of speech rhythm are treated in the Institute of Language and Literature, Tallinn 20004, USER

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rather than some special reinforcing energy added to a certain independently defined unit of speech flow. Stress itself is intrinsically a property of an utterance rather than appears something like an energetical increment of stressed syllables relative to un-stressed syllables.

Foot is the minimal integral unit of stress. Foot organizes such energy into stress impulses; its general shape, i.e. a hypothetically temporal energy envelope, is physiologically conditioned to the functional articulatory phases, inevitably needed in the activities of speech organs, and its detailed shape is specified by language-specific commands on speech organs (Fig. 1). Foot cannot be understood as a unit of large segmental linguistic fluctuation or a motor unit like the articulatory syllable of "acrosson, Kowaki, et. al. 1969, Temporally organized amount of speech energy produced by all the activities.

**Figure 1. A model of foot.**

In particular, it is foot that is best to be understood as a unit of a foot's intrinsic mode of stress appearance, i.e. the purposeful variation in the amount of stress. Psycholinguistic experiments (e.g. Parken 1984, cf. also Scott 1982) indicate that the amount of stress displayed in speech production is in direct correlation with the importance of the signal in the interpretation of the corresponding message. A speech signal is maximally accentuated, if it alone serves as the basis for computing the meaning of the corresponding message; a speech signal is minimally accentuated, if the preceding linguistic context and the extralinguistic state of affairs rather than the speech signal itself serve as the basis for computing the meaning. If we want delimited intra-foot segments of stress of the largest size, in this case the needed amount of stress is warranted by special reinforcing activities including registral phonetic pecularities (cf. Ohulu, et. al. 1979). At the minimum end of the accentuation scale, there are so-called feet. In this case the needed amount of stress is warranted by keeping to the speech organs active and vocalic activity for the speech signal transmission. Between these extremes, there remain simply accentuated feet.

The intrinsic mode of stress appearance is a foot. In this physiological model, we determined limit the detailed shape of energy distribution between two extremes. Un-stressed foot is a null set. A stressed foot, in turn, is accentuated, if it is directed to the maximal energy level of a foot's stress relaxation, i.e. the decline towards the minimal energy level of a foot's stress relaxation. At the minimal end of stress of the largest size. In this case the minimal foot is non-accentuated, if it is directed to the minimal energy level of a foot's stress relaxation (e.g. the vowel harmony in Finnish, cf. also the observed parallels of syllable control systems in foot-striving languages). A foot may consist of two, three syllable-size pressure waves, i.e. some accentuated or emphasized stress impulses, of a given size, in such cases we suppose the accentuated or emphasized foot is followed by one or more intermingling weak tonic feet (cf. Les 1974: 41 for the phonetic justifications of the 'one-two-three-syllables' principle).

### 2.3. Types of rhythm organization

Languages differ as regards the method by which energetic stress commands apply to their feet. Generally the most natural foot types seem to be those in which every single syllable is accentuated by one command only. There are two "natural" types of rhythm organization represented by languages that exploit this principle as a rule, one is the vowelharmony in Finnish and an Italian in this type of languages non syllable feet are rarely used.

These languages give much attention to the beginnings of syllables. As a result of that the target of the following vowel is clearly defined, there are no perceptible diphthongization of short vowels, in the regulation of stresses degrees also foot-initial consonant may take a part (cf. e.g. data for Tamil: Balasubramanian 1979). In foot-final syllables, syllable-switching languages have an open set of vowels to choose from and do not, regularly, show reduced vowels, or non-canonical stress aresult of which has been reduced vowels and vowels for (e.g. foot-accentuated languages for Finnish: Wink 1965, for Italian: Bartinetto 1981). Syllable-switching languages may have an opposition between short and long segments. This language type displays a relation to the final position of the foot, e.g. foot-accentuated languages and foot-initial consonants have a part (cf. e.g. data for Tamil: Balasubramanian 1979). Here the inherent endowment of foot isoscope may be stated clearly. Stressed foot is followed by one or more intermingling weak tonic feet (cf. Les 1974: 41 for the phonetic justifications of the 'one-two-three-syllables' principle).

### 2) Syllable-striving foot control is characterisitc of languages with prototypical non syllable feet (e.g. Vietnamese).
In syllable-striving languages, polysyllabic structures typically exhibit a continuous alternation of stressed and un­stressed syllables (cf. Eacox 1983) due to foot monosyllabic languages, a substantial part of a language may be a final part of a syllable rather than a sepa­rate word (e.g. English). Many languages are usually tone languages, since the con­trol over the vowel matter and the whole intonation system is sustained by conditions for tonogenesis.

According to which every single syllable is affected by one energetic command may be violated in two additional, less frequently used patterns: the "natural" foot types are accompanied by less "natural" types. In languages that do not follow system control, foot-striving, there are feet in which some syllab­les are left without any energetic control altogether. In languages that display demisyllabic-switching, there are feet in which one syllable is affected by two separate energetic commands.

Striving control is characteris­tic of languages with mono- and polysyllabic feet (e.g. English, German, Russian).

All that has been said about syllable-striving languages also applies to foot-striving languages and vice versa (the only exception being relaxation, which applies to non-foot-initial syllables of foot-striving languages).

Striving command does not pay special attention to the beginning part of a syllable (a foot causes phonemes, it is directed to the place of the maximal en­ergy point either on a vowel, a consonant matter on a segmental boundary, in a consonant cluster (a reason for allowing relaxed syllables affixes, cf. Fujiwara, Moody 1978). At the same time, eligibility of the maximal energy point for different syllable segments in different words usually changes the char­acter of short/long segmental opposition (e.g. Estonian).

The equality of the demisyllabic foot has to be controlled by two demisyllable-switching commands. As much as the temporal organisation of a demisyllable is dependent upon inherent tim­ing principles of underlying segments, we may expect that demisyllables represent tem­porally more or less equal units. In Japanese, where a demisyllable may be interpreted as a nora-size unit, Sawahata et al. 1982 concluded that the division of a demisyllable into syllables can be achieved by means of a short accent (cf. Hamma 1981). However, for many languages it is impossible to apply to the end of a monosyllabic foot. In this case, the realisation of a short accent may either be carried out in syllables both in and outside syllable boundaries, or in specific temporal situations.

The equality of the demisyllabic foot is supported by the perceptional data. The equal temporal behaviour itself (cf. the psycholinguistic parallel of sound repetitions in different languages) may be controlled separately.

The equality of the demisyllabic foot is dependent upon inherent tim­ing principles of underlying segments. Among all segments that constitute syllabic feet, a short accent sharp accent

Table 1

<table>
<thead>
<tr>
<th>Scheme of the opposition even vs. sharp accent in modern Standard Estonian</th>
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<tbody>
<tr>
<td>even accent</td>
</tr>
<tr>
<td>(foot consists of 2-3 syllables)</td>
</tr>
<tr>
<td>Polysyllabic foot</td>
</tr>
<tr>
<td>Poly syllabic foot with a short syllable</td>
</tr>
<tr>
<td>Poly syllabic foot (obligatory)</td>
</tr>
</tbody>
</table>


A characteris­tic feature of foot-striving languages is the foot-final vowel reduction (for English: Myers 1979; Fowler 1973). Foot-striving languages may emerge, in­ter alia, in languages with mono- and polysyllabic feet (e.g. Estonian).

We have presented the above four strategies as mutually exclusive options a lan­guage may follow. It is however an argu­ment taken on the assumption that the chosen strategy is a mere inevitable answer to the principal works that introduced the dis­tribution of in a large number of papers dealing with different types of speech rhythm that a lan­guage may follow. Note that our argumentation relied on the assumption that it belongs to neither (cf. Miller 1984).
Allen 1975 emphasizes the distinction between general motor rhythm, i.e. a pattern of sequence, and temporal rhythm, i.e. a pattern of temporal sequence. We have already introduced speech rhythm in the sense of a general motor rhythm, a successive sequence of feet. However, speech flow is subject to a universal bias towards a temporal rhythm as well. The portion of accentuated feet, displaying the highest energy levels, are conceived as stress beats, i.e. speech energy concentration sites in a continuum of speech flow that usually display more or less equal energy distribution. Like other sequences of rapid movements in human behavior (e.g. finger tapping), subsequent stress beats tend to recur often regular intervals according to the properties of a universal physiological temporal rhythm pattern (cf. Allen 1975). In particular, stress beats are inclined to cluster around a mean interval of 0.4 to 0.5 s with an overall range of intervals. Durations limited to between 0.2 to 1 s.

Languages are apparently stress-timed if stress beats show clear definition of the temporal pattern of stress beats superimposed on speech flow by the physiological temporal rhythm, otherwise they appear as non-stress-timing displaying rather an intrinsic timing of their feet. In other words, the distinction 'stress-timing' vs. 'non-stress-timing' reflects properties of the real inter-foot timing phenomenon that is revealed between feet in continuous speech flow. In all languages, there are obligatorily some feet that show accentuation to the extent that exceed the so-called stress beat threshold. A language shows stress-timing, if such beats in continuous speech flow are frequent enough to converge into a pattern of general rhythm, and does not show stress-timing if they are too rare for that, cf. Fig. 2.1.

In typological research, it is often easy to decide whether a particular language is stress-timing or not. On the one hand, English (Dauer 1983) and Polish (Biedrzycki 1980) are obvious stress-timing languages because they display salient stress beats recurring frequently around 0.5 s (as a rule, indicating functionally that a new lexical entry is present in message) and are thus subject to a clear temporal rhythm. However, it does not mean that the so-called syllable-timed languages, on the basis of mean interbeat intervals, cannot belong to the same group with English (cf. e.g. Spanish: Navarro 1932). If lexical stress is saliently marked and lexical entries are not too long (not exceeding 4-5 syllables or 2 tonic feet) there is high probability that the languages are characterized as stress-timing language.

On the other hand, French and Japanese (Dauer 1983) are obvious non-stress-timing languages because they display salient stress beats rarely after longer intervals than 0.5 s (as a rule, indicating functionally that especially important lexical entries of a phrase, clause, or sentence are present in message) and thus are not subject to a temporal rhythm. Rather long distance between stress beats in these languages cannot be accounted for in pure phonological terms if a language is characterized by non-prominent wordstress and at the same time, accentuation does refer to the same lexical unit, we can perceive a non-stress-timing phenomenon.

We assume that it is because of the polarization between the non-stress-timed languages and the stress-timing English that, in emphasizing the internal physiological temporal rhythm of a language, subjects who have French as their mother tongue show vagueness that is alien to subjects mastering English as their first language (cf. data and discussion on the issue in Scott, Isard, Boysson-Bardies 1985). Nevertheless, we follow Dauer 1983 in claiming that whether a language is stress-timed or non-stress-timed is a matter of degree rather than of mutual exclusion: many particular languages show neither obvious stress-timing nor obvious non-stress-timing but something in between the extrema. For example, Finnish displays salient 'primary' stress beats (as a rule, indicating functionally that a new lexical entry is beginning in message) that occur too rarely in speech flow to converge into a pattern of temporal rhythm (in Finnish, an agglutinative language, the distance between the beginnings of subsequent lexical entries may be rather long). Consequently, Finnish is not subject to a clear temporal rhythm, but has preserved as slight 'secondary' stress beat is provided by all other lexical entries (in an agglutinative language, so 'primary' and 'secondary' stress beats together are frequent enough to converge into the pattern of temporal rhythm). Accordingly, Finnish is still subject to a dim temporal rhythm (cf. the treatment of the Finnish phonology in O'Connor 1973). 4

3. THE GREAT RHYTHM SHIFT: OLD ESTONIAN
3.1. Conservative Finnish vs. Innovative Estonian
In a number of general works on language (e.g. Antilla 1972, Comrie 1981), the comparison of the two main Baltic-Finnic languages, Finnish and Estonian, serves to illustrate the point that genetically close-related languages may differ remarkably in respect of their typological characteristics. A typical case is the original fairly clear-cut agglutinating morphology but Estonian has exchanged it for a morphology that is much more strongly characterized by fusion. The morphological differences between the languages can be illustrated by the evidence in the sound architecture of the languages. Finnish has preserved firmly the original Baltic-Finnic prototype of long polysyllabic words that consist of simple syllables of the structure CV or CVC, display an extensive vowel harmony, and begin at an accentuated foot of an invariable quality. On the contrary, Estonian has introduced many short mono- and di-syllabic words, complex syllables like CV(CV) and word-level restrictions on vowel distribution that have abandoned the original vowel harmony altogether. Estonian accentuation is mobile (a word need not begin at an accentuated foot), and variable (it displays either an even or sharp version of the contrastive accent).

These essential differences between modern Finnish and modern Estonian originated with a row of phonological changes that, on the one hand, occurred in the history of Estonian during the first centuries of the second millennium A.D. (roughly, 1100 - 1500) but, on the other hand, were absent in the development of Finnish. This claim has a high degree of confidence as it is supported by historical and comparative linguistic evidence and early textual data on Estonian. We concentrate on some central component changes discussed in the work of Antilla and also referred to by Scott, Isard, Boysson-Bardies 1985.

The general pattern of the below presented phonological changes includes an essential...
Incongruity. On the one hand, the changes are rather diverse as regards their typological characteristics. On the other hand, they still occurred coexisting in a short time-span in an interconnected way. We treat the incongruity by calling the general pattern of these phonological changes due to two subsequent purely phonetic changes, we call the Great Syllable Shift of Old Estonian. The predecessor of the modern Standard Finnish has been displaying a syllable-switching control of foot from time immemorial up to nowadays. However, the predecessor of the modern Standard Estonian was subject to a twofold reorganization of stress patterns, viz. a specific stress shift of Old Estonian. At the beginning of the demisyllable-switching control, cf. Table 5:

<table>
<thead>
<tr>
<th>Table 4</th>
</tr>
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<tbody>
<tr>
<td>(1) *kasna 'hand.ILLATIVE'</td>
</tr>
<tr>
<td>(2) *kakara 'chamomile'</td>
</tr>
<tr>
<td>(3) *kakkarsta 'chamomile.ELATIVE'</td>
</tr>
<tr>
<td>(4) *kakkarsta</td>
</tr>
</tbody>
</table>

Table 5:

<table>
<thead>
<tr>
<th>The syllable-switching control of foot in Old Estonian</th>
</tr>
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The different treatment of the long vowels in words like *kasna 'hand.ILLATIVE' vs. *kakara 'chamomile', the loss of certain intervocalic obstructions, e.g. *mustaa 'black.PARTITIVE' vs. *metsa 'wood.ILLATIVE' vs. *metsa 'wood', introduced long vowels into non-word-initial syllables.

Before the change, the sound architecture of the dialects was constrained by two general principles. First, the opposition between short and long segmental vowels was possible only in a foot-initial syllable, e.g. there was a real opposition *tuuli 'wind' vs. *tuuli 'wind', but any opposition of the type *tuuli 'wind' vs. *tuul 'wind' was exchanged for an innovative demisyllable-switching control. At its second stage, the demisyllable-switching control was exchanged for a combination of foot-striving and syllable-switching control.

3.3. From syllable-switching to demisyllable-switching. At a time-point in the history of most modern Balto-Finnic dialects, the loss of certain intervocalic obstructions, e.g. *mustaa 'black.PARTITIVE' vs. *metsa 'wood.ILLATIVE', introduced long vowels into non-word-initial syllables.

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Table 8
The trend towards the average stress value of feet in Old Estonian

<table>
<thead>
<tr>
<th>Foot Type</th>
<th>Average Stress Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-demisyllable feet</td>
<td>2.0</td>
</tr>
<tr>
<td>3-demisyllable feet</td>
<td>2.5</td>
</tr>
</tbody>
</table>

The application of demisyllable balancing (the first two demisyllables of a foot display the same amount of stress) in Old Estonian (Table 8).

Table 9
The result:Load = 2nd.

Table 10
The accent split of Old Estonian

1. even pattern > even accent
2. broken pattern > sharp accent
3. *kau- (naa) 'id.PARTITVE'
4. *kau na 'chaff/pod'
5. *kau-naan 'chaff/pod.ILLATIVE'
6. *k'aun 'pod.GENITIVE'
7. *k'auna 'hen' 1, LL.
8. *k'au nan 'chaff/pod.GENITIVE'
9. *k'au n'a 'hen'
10. *k'aun 'pod'
11. *k'auni 'wind.GENITIVE'
12. *k'aun 'pod.ILLATIVE'

It was a rise of contrastive accents that moved Old Estonian from the type of demisyllable-switching languages to the type of foot-striving and syllable-switching languages. As for contrastive accents, the type of foot-striving languages is characterized by a rise in the number of contrastive accents that are not out of the question in pure switching languages. As for foot-striving languages, there are two types of contrastive accents: monosyllabic contrastive accents and non-monosyllabic contrastive accents. The former type is characterized by a rise in the number of contrastive accents that are out of the question in pure switching languages. The latter type is characterized by a rise in the number of contrastive accents that are not out of the question in pure switching languages.
4. SOUND CHANGE PRESCRIPTION

According to Lass 1980, no inherent explanation is available for any linguistic changes, and the distinction between deductive-nomological and teleological explanations and arguments against the idea of a phonological history is important. On the contrary, phonologizing the possibility of teleological explanations of linguistic changes: according to him, any linguistic change is a result of the interaction of logical and environmental constraints on sound changes. We try to show that, in the framework where phonological-phonetic and purely phonetic sound changes are kept apart, the possibility of deductive-nomological explanations of linguistic changes cannot be excluded categorically.

A sound change may allow two types of formalizations with regard to formalization strength. A description represents it as a transformation that occurred given certain conditions, a prescription represents it as a transformation that has to occur given certain conditions. Prescriptions are preferable to descriptions. Standing on a higher level of abstraction it fits into all the functions a formalization of a sound change may serve rather than for single explicit aims only. As a matter of fact, it is not necessarily the case that the prescription of a sound change is precluded in principle: the physiognomizations as well. For instance, the lack of gemination in Balto-Finnic dialects (cf. the lack of gemination in *kat-teen (foot.ILLATIVE) > *kal-kaan) was the Southwestern Finnish pervasive "special" gemination both in *katenen 'hard.ILLATIVE' > *kal-teen (cf. the lack of gemination in *kat-teen > *kaa-teen). Similarly, the shortening of long vowels in non-regular-inital syllables triggered in Estonian the opposite explicit accentuation: *chaff/pod.GENITIVE > *k'annaas vs. *k'an-naan // *schaff/pod.ILLATIVE // *k'anna // *k'annaan, but yielded in Southwestern Finnish (*kuanan, // *k'anaan > *k'uanan). Note, however, that the prescription of a phonemic change could lead to rather different phonologizations as well. For instance, the counterpart of the Estonian "emergency" gemination in *katenen 'hand.ILLATIVE' > *kal-teen (cf. the lack of gemination in *kat-teen 'foot.ILLATIVE' > *jal-kaan) was the Southwestern Finnish pervasive "special" gemination both in *katenen 'hard.ILLATIVE' > *kal-teen and *kat-teen 'foot.ILLATIVE'.

In this context, the exact comparison of stress-timing as present in the history of Estonian and Southwestern Finnish sound changes may display far-reaching theoretical implications. On the one hand, the posibility of a prescriptive formalization of some purely phonetic sound changes seems to be limited to the purely phonetic course of the Great Rhythm Shift. On the other hand, the fundament impossibility of a prescriptive formalization may be seen as the increase of the form-meaning isomorphism and the possibility of teleological explanations of phonological-phonetic changes is supported by the fact that the phonological extensions of the Great Rhythm Shift could not coincide in the Estonian and Southwestern Finnish norms.

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In addition, speech flow has the function to convey information about the person who is speaking (cf. Ladekofy 1984: 84) and about the socio-communicative function of whatever human sound, be it speech, cry or wheeze. Nevertheless, the exact amount of acoustic energy may be computed by exact measurements nowadays. Here, the cover term 'physiological energy' has to be used in order to point to the fact that the speaker's physiological activities, sound energy, and listener's physiological activities form a unitary chain. As a matter of fact, acoustic energy cannot be dealt with as a physiological activity.

5. THE GREAT RHYTHM SHIFT: THE SOUTH-WEST OF THE BALTO-FINNIC AREA

Up to here, we have treated the Great Rhythm Shift as present in the history of Estonian but absent in the history of Finnish. However, the straightforward distinction between the sound history of Estonian and Finnish dialects in addition to the history of standard languages. On the one hand, the conservative development has to be extended from Finnish alone to Northern and Estonian also; on the other hand, the Great Rhythm Shift has to be extended from Estonian alone to Southwestern Finnish also (Map 1).

The presence of the Great Rhythm Shift both in the history of Standard Estonian and Southwestern Finnish provides a rather unique case of a row of phonetic and phonologizing changes that applied to the essentially same sound material (the original similarity of Balto-Finnic dialects) in different communities (the opposite case of the Gulf of Finland) not affected by pervasive mutual contacts (cf. the opinion expressed in the articles of the representative collection (Gallen 1984)). As a matter of fact, around 1000 A.D. both Estonian and Southwestern Finnish were influenced rather by Old Norse, the language of the Vikings. We follow Hallin 1986 in claiming that the Scandinavians' vowel balancing could affect the speakers of the Balto-Finnic dialects in question: when the critical words like *araneas appeared, they followed the demisyllabic-switching language that was already known from the speech of the forefathers.

In this context, the exact comparison of the Estonian and Southwestern Finnish sound changes may display far-reaching theoretical implications.

In addition, speech flow has the function to convey information about the person who is speaking (cf. Ladekofy 1984: 84) and about the socio-communicative function of whatever human sound, be it speech, cry or wheeze. Nevertheless, the exact amount of acoustic energy may be computed by exact measurements nowadays. Here, the cover term 'physiological energy' has to be used in order to point to the fact that the speaker's physiological activities, sound energy, and listener's physiological activities form a unitary chain. As a matter of fact, acoustic energy cannot be dealt with as a physiological activity.

2. We are aware of the bad connotation of the term "accentuation" as a term pair 'accentuation vs. deaccentuation'. Nevertheless, we emphasize the gradual rather than the directional nature of the phenomenon.

In this context, the exact comparison of stress-timing as present in the history of Estonian and Southwestern Finnish sound changes may display far-reaching theoretical implications.

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