

GENERATIVE PERFORMANCE RULES AND FOLKSONG PERFORMANCE

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1. INTRODUCTION

In Western European tradition, musical works generally exist in the form of written notation, or score, which has been produced by a composer and which must be converted into sound by a (group of) performer(s). The recent decades have witnessed an increase in empirical studies on musical performance (Gabrielsson 1999). There is a general agreement regarding the fact that if the score is transmitted into sound without any modifications, this would result in the so-called deadpan version, i.e. something musically unacceptable. It is believed that expressive devices complementary to the score are used by performers mainly for two purposes. First, to make it easier for the listener to differentiate between musically relevant categories in the domains of pitch and duration and, second, to provide for a better grasp of the hierarchical structure of musical work (Sundberg 1999b).

Friberg (1991) has successfully modelled the performance of musical work by some twenty-odd generative rules that automatically convert input note files into sound performance on a synthesizer. The rules introduce into the performance micropauses, lengthenings and shortenings of tone duration as well as long and short-term increases and decreases of sound level. The system of rules should be understood as a generative grammar of musical performance, reflecting the musical competence available to its authors.

There exist other cultures in the world, however, which do not resort to prescriptive notation in the process of musical communication. An absolute majority of musical folklore, as well as much of popular music (e.g. jazz) belongs to the oral tradition. Performance in such traditions is the result of improvisation, i.e. spontaneous (re)creation of music from memory. If notations exist for folk music performance, these must be regarded as descriptive, in the sense that they have been produced *post factum* by an ethnomusicologist or anthropologist, rather than in advance by a composer. (One can thus hardly think of the category 'composer' in folk music.) Due to the fact that notation in such cases aims at describing what is happening in the performance, as opposed to recreating the music anew, the target of such notation is thus research and not performance.

The old Baltic-Finnic folksongs are an example of such an oral musical tradition (Lippus 1995). This tradition has been shared by native speakers of most of the Baltic-Finnic languages: the Finns, Estonians, Karelians, Votes, and Izhorians. The other two Baltic-Finnic ethnic groups, the Vepsians and Livs (Livonians), do not evidence it. (There are about five million speakers of Finnish and about one million of Estonian in the world; both of these succeeded in establishing nation states upon World War I. The other Baltic-Finnic languages have significantly fewer speakers left.) The old folksongs are also called Kalevala songs (after the famous Finnish epic) or runic songs. In this paper the three terms will be used as synonyms. The old folksongs are estimated to be two to three thousand years old. Although preserved in a relatively extensive body of archival recordings, they have been fading from daily circulation since the 18th century. The written part of the recordings has mainly been collected during the second half of the 19th and the first half of the 20th century; the majority of sound recordings come from the years 1930 to 1970.

In the present study, we will look into the extent of similarity between musical competence in the performance of works of the professional musical tradition of Western Europe and that of the old Baltic-Finnic folksongs. We will be restricting ourselves to the domain of duration, i.e. we will not study pitch, sound level or the timbral characteristics of musical performance. The majority of musical performance studies have so far been concentrating on the European classical piano repertoire from the 19th century, their favourite objects of study being shorter compositions by e.g. Fryderyk Chopin or Robert Schumann (e.g. Repp 1998 and, 1999a and b). No doubt there are substantive differences between the performative situations of such piano pieces and runic folksongs. We see the following two differences to be the most significant.

1. A 19th century piano work is performed from a score, while a folksong is improvised. At a first glance, the conversion of note values from the score into acoustic events of certain duration seems to have no equivalent in folksong performance. We have to take it into account, however, that the runic folksong melodies are mostly isochronous, i.e. consisting of note durations of (nearly) equal value. This enables us to compute the average note duration value over a certain portion of the musical work (provided that the tempo remains constant) and to hypothesize that deviations from the average note duration value are used by the performer for expressive goals, in a similar way to that in which the performer of a piano piece by Chopin employs deviations from normative durational values for expressive purposes.

2. In folksongs, the durations of sound events may also depend on the sung text (lyrics) and the verse metre. In the Baltic-Finnic languages, quantity plays an important role in speech prosody. Duration differences in these languages serve the semantic function, i.e. distinguish the meanings of words. In the Estonian language, one and the same disyllabic sequence may have three different meanings depending on whether the approximate ratio of its constituent syllables equals 0.66, 1.5 or 2.0 (Lehiste 1997). Also the metre in Estonian folksongs, defined as trochee, uses oppositions not only between the stressed and unstressed syllables but also between the long and short syllables for contrasting the ictus and off-ictus positions in verse lines (Tampere 1983). The issue to what extent the requirements of word prosody and metre are combined or contrasted in the musical realisation still remains open to a significant extent. If the former were supported by musical rhythm in folksongs, it would certainly enhance the intelligibility of words to the listener. What cannot be ruled out, however, is that it may be difficult for the performer to meet the structural requirements coming from three separate domains—speech, metre and music—at the same time. Nor can it be ruled out that possible conflicts between the three systems may be creatively used by performers for aesthetic purposes.

2. MATERIAL

Seven one-voiced folksongs from the repertoire of the female singer LK were used for analysis in this study. All recordings had been made in 1937

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when the singer was 64 years old. She was recorded in a professional studio according to top audio standards of the time. LK lived on the northern coast of Estonia. The archival recordings of old folksongs of her district (Haljala), including texts and (where available) melodies have been published by Laugaste (1989); the *post factum* notations of folksongs in the volume have been accomplished by the ethnomusicologist Udo Kolk.

In old Estonian folksong tradition, words and melodies are in principle interchangeable (one and the same melody may be sung with different lyrics and vice versa). This is made possible by the rigid structure of the songs. The main element in the structure of the songs is the verse line. It consists of eight positions, divided between four trochaic feet. In most cases, each of the eight positions holds one syllable and one melody note. As an exception, two syllables may fit one note, or a syllable (usually a diphthong) may be divided between two notes.

From the point of view of musical rhythm, the majority of old folksong melodies are roughly isochronous, i.e. consisting of notes of about the same duration. There are some exceptions to this rule in the overall song repertoire (such as the swing songs, the rhythm of which imitates the movement of a swing); the seven songs analysed in this study do not belong to these exceptions.

The words in old folksongs may vary but the musical structure remains repetitive. In simple cases, the repeated melody consists of a single line of eight notes (syllables); in more elaborate songs, the original musical material may be extended to two, three or four lines, or 16, 24 or 32 notes (syllables) respectively.

The acoustical durations of the syllables (notes) were measured by the first author of this paper in collaboration with Ilse Lehiste (Ohio State University, Columbus, USA), using parallel narrow and wide-band spectrographic representations of sound signal. The sound was fed to the computer from the cassette tape, a copy of the original recording stored at the Estonian Folklore Archives in Tartu. The sampling frequency was 10 kHz. For the spectrographic representation of the material, a Kay Elemetrics Workstation model 4300 was used. Decisions regarding locations of segment boundaries were made on the basis of both visual and auditory cues.

Measurements of syllable (note) durations in seven songs yielded approximately two thousand sound events. The results of measurements may be represented as a matrix of 8 columns and about 250 rows, the columns corresponding to verse line positions and the rows to verse lines. Each cell in such a matrix could be read as a sound event duration x_{ij} , measured in milliseconds, where $i=1, 2 \dots 8$, and $j=1, 2 \dots 250$.

3. SEGMENTATION

From the structural point of view the shortest meaningful sound events in the runic songs are syllables (defined on the phonetic basis), or notes (defined on the basis of the melody). Provided that the number of syllables in a verse line equals the number of notes, the question would be: Do the boundaries between successive syllables in old folksongs coincide with the boundaries between successive notes? The answer to this question need not necessarily be affirmative. Sundberg (1999a) argues that in sung performances, the tone (note) is expected to start with the onset of a vowel. The use of quantity in spoken Estonian, however, occurs in differentiating the length of vowels as well as consonants. Thus the lengthening of a stop consonant yields a geminate which, by definition, consists of two parts belonging to neighbouring syllables. The problem Sundberg (id.) is pointing to concerns the segmentation of Estonian words, e.g. [saakki]: either to [saak-ki] as two syllables, or [(s)aakk-i] as two tones (notes).

The determination of the onset of tone as coinciding with the onset of vowel, however, seems to be related to the theory of P-centers in phonetics (see e.g. Pompino-Marschall, Tillmann and Kühnert 1987). According to this theory, in alternating sequences of monosyllables the perceived onset (P-center) of a syllable as a rule does not correspond to its acoustic onset. Generally, the syllable onset (the beat) is highly correlated with the onset of syllable nucleus (the vowel), while being somewhat displaced as a function of both the initial consonant(s) and the length of rhyme.

The method of segmentation adopted by Sundberg would be hard, if not impossible, to combine with the theory of quantity in spoken Estonian (Lehiste 1997). According to Lehiste's theory, the quantity in spoken Estonian utterances is determined on the level of disyllabic sequences because a strong tendency of these to isochronism. For the disyllabic sequence there are three contrastive duration degrees called the short, the long and the overlong. The three durational degrees may be applied to the first syllable in a disyllabic sequence, while the duration of the second syllable depends on the duration of the first. If the first syllable is longer, the second syllable must be shorter and vice versa. Therefore the best device for an acoustical description of the functioning of the Estonian quantity is the duration ratio of the syllables in disyllabic sequences (see above).

The present study has adopted the 'phonetic' method of segmentation, which establishes boundaries according to the syllable structure of Estonian.

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In this section we will analyse the possible effect of seven primary generative rules (Friberg 1991) applicable in the domain of duration on the performance of old folksongs. The denotation of the rules appears as in the original.

1. Durational Contrast (DDC1). Short notes are made shorter than their nominal values, i.e. the durational contrast between long and short notes is increased. Notes of duration between 30 and 600 ms are shortened. Since practically all notes in old folksongs are of about equal duration shorter than 600 ms, this rule is not relevant for the music tradition concerned.
2. Double Duration (DDC2B). A tone half as long as the preceding one is increased in duration, while the preceding tone is shortened by the same amount of time. No such rhythmical patterns occur in the runic songs. The rule is not applicable.
3. Melodic Charge (DPC2A). This rule stems from the assumption that the structure underlying the music is tonal, i.e. that there exists a hierarchical relationship between the tones of the scale used for melodies, and that this relationship is patterned according to three primary functions called the tonic, the subdominant and the dominant. Each note of the scale receives a charge reflecting its harmonic distance from the tonic. For the tonic itself the value of the distance is zero. In the diatonic scale, this value is the largest for the leading note ($d=5$) and in the chromatic scale, it is the largest for the diminished 2nd step of the scale ($d=6.5$).
4. Leap Tone Duration (GMI1B). This rule modifies the duration of tones in singular leaps. Since it is untypical for such leaps to occur in the runic songs, this rule seems to be irrelevant.
5. Faster Uphill (GMI1C). This rule progressively shortens tone durations in ascending melodic sequences, such as ascending scales. It may have

some effect on the performance of runic songs.

6. InegallesInegales (GMI3). In sequences of paired tones of equal duration, the duration of the tone appearing in a metrically stressed position is lengthened, and of the following tone shortened by the same amount. This rule has wide application in old folksongs because the songs consist of tones of equal duration.

7. Phrase (GMA1). The last tones of structural units are lengthened in accordance with the position of the unit in the hierarchy. The rule is applicable in folksongs as well as any other musical genre characterised by structures.

In conclusion, there are three rules of the seven in Friberg's (1991) set expected to be relevant for runic song performance: Faster Uphill, InegallesInegales, and Phrase. In addition, the fourth rule, Melodic Charge, is expected to be relevant if the runic song tradition is to be regarded as relying on the tonal music idiom. We do not think that it is possible to give an unambiguous answer to the last question because in those runic songs which are thought to be of more recent origin the ambitus reaches an octave, implying relatively strong underlying elements of tonal structure. In older melodies, on the contrary, the employed pitch range may be much more narrow and the number of scale steps used more limited, implying a tonal structure not so well developed. The three remaining rules-Durational Contrast, Double Duration and Leap Tone Duration-are irrelevant for old folksong performance.

5. MODELLING OF SYLLABLE (NOTE) DURATIONS

On the whole, we assumed all event durations x_{ij} in the analysed material to be equal. The average event duration across seven songs was 291 ms. The deviations from the average were in each individual case presumed to be caused by a set of contextual factors which in our opinion may originate in domains such as musical expression, speech prosody and verse metre. The following variables were defined for the model.

1. Syllable length. This variable originates in the prosody of Estonian speech. All non-compound Estonian words are broken down into successive disyllabic sequences, starting with the word-initial syllable (which is always stressed). There are three types of disyllabic sequences called the short, the long and the overlong (Lehiste 1997). For the sake of simplicity we overlooked differences between the long and overlong disyllables. Consequently there may occur only two types of disyllabic sequences, the short and the long. In the first case, such a disyllabic sequence consists of a short and a long syllable. In the second case, such a sequence consists of a long and a short syllable. In the case of words containing an odd number of syllables, single syllables remaining at the end of a word were (somewhat arbitrarily) classified as long. For example, syllables in a non-compound Estonian word [mi-ne-mat-ta-gi] are classified as short-long-long-short-long.

This variable has no equivalent rule in Friberg's (1991) set because it is language-specific, and because the rule set deals with the instrumental music only.

2. Metrical position. This variable goes back to the nature of trochaic metre employed in old folksongs. The eight sound events per verse line are distributed between four trochaic feet, each one consisting of a strong (ictus) and a weak (off-ictus) position.

The equivalent for this variable is the rule InegallesInegales.

3. Melodic charge. As applied by Friberg (1991), see preceding section.

4. Final. It is generally recognised that one of the functions of musical expression is to make the structure of the music more explicit to the listener (Sundberg 1999b). The phenomenon of final lengthening is well known in speech as well as in music. Alternatively, the location of the structural boundary may be signalled to the listener by making the sound event(s) near the boundary shorter. Under the present variable, sound event no. 8 in each verse (melody) line is encoded as final, in order to oppose it to sound events no. 1 through 7 in the line.

The equivalent for this variable is the rule Phrase.

5. Melodic peak. It seems reasonable to believe that the highest notes in folksong melody are somewhat more important than others. This is supported by a visual inspection of *post factum* notations of the songs (Laugaste 1989), indicating that the singer has apparently often intended to underline these notes using also other means, such as articulation and duration. The highest note has been picked out (encoded) as the melodic peak under this variable. Some melodies do not have a clearly pronounced single peak; in such cases, if the highest note occurred more than three times during one and the same line, it was concluded that the variable was not applicable for that particular verse line.

The above variable is related to the rule Faster Uphill.

6. Number of phonemes per syllable Expected syllable duration in speech. It seems logical that even in singing (not to mention in speech), the duration of a syllable must depend on the amount of articulatory activity needed in order to produce it. A straightforward way to estimate this activity would be to calculate the number of different phonemes per each syllable. On the other hand, there is evidence regarding the hierarchical relationship between partsstructure of an utterances in speech SIIN EI OSANUD SEDA JÄRGNEVAT TÄPSUSTUST PAIGUTADA: as sequences of syllables. The disyllabic sequences of Estonian discussed above provide one example of such a hierarchy. Those sequences are roughly isochronous, which means that if the first syllable is longer, the second syllable will be shorter, and vice versa. This makes it complicatedimpossible to postulate a direct dependence of syllable duration on the number of its constituent phonemes.

Two methods were compared to each other for the purposes of the present study. First, tFor the purpose of our study, the issue was settled using the text-to-speech synthesizer of spoken Estonian (Mihkla, Eek and Meister 1999). The subroutine which determines individual phoneme durations for Estonian text-to-speech synthesis, was deleted from the softwarethe corresponding software (Mihkla, Eek and Meister 1999). This subroutine requires the input of an orthographically correct Estonian text, complemented with information about palatalisation and overlong quantity degrees (which are not reflected in the orthography). The resulting individual phoneme durations were summed to the limits of the syllable. Second, the number of phonemes was counted for each syllable. No distinction was made between short and long vowels or consonants because the first variable in our set, the syllable length, seems to count for this opposition. Geminate were divided between the two successive syllables so that each syllable received a half.

In order to compare the two methods to each other, the correlation was computed between the measured syllable durations in singing and the estimated syllable durations for the synthesis resp. the number of phonemes per syllable. The correlation was slightly higher for the second variable

($r=.36$) than for the first ($r=.35$), so we decided to use the number of syllables as a suitable variable in the following statistics.

There is no equivalent rule for this variable as Friberg's (1991) set deals with instrumental music only.

7. The *post factum* notations, otherwise rhythmically uniform, occasionally contain instances where two successive eighth-notes have been replaced by a dotted eighth followed by a sixteenth. Those instances were singled out despite the possibility of their eventually derivative or artefactual character. We doubt, firstly, that the performer has in those cases intentionally used a dotted pattern instead of the normal pair of eighth-notes. We would rather suggest that pairs of a dotted eighth and a sixteenth are in principle not different from most of the pairs of double eighths. Secondly, pilot calculations of average durations for sixteenths, normal eighths and dotted eighths reveal that the ratios between averages diverge from those expected from notation, i.e. the sixteenths, for example, not coming out nearly twice shorter than the eighths.

6. MODEL RESULTS AND THEIR DISCUSSION

Covariance analysis of the material was performed in order to estimate the influence of selected variables on sound event durations. A summary of the results appears in Table 1 below.

Table 1. Covariance analysis of sound event durations in seven old Estonian folksongs by a single female performer. N is the total number of syllables (notes) in each song. r^2 is the coefficient of determination which measures the amount of sound event duration variability in each song that can be determined by the total effect of seven individual variables. Columns 4 to 10 present the statistical significance level of the effect of each variable to the sound event duration in each song. In some of the songs the effect may be non-significant (n/s), or the variable not applicable (n/a).

	N	r^2	Significance level						
			phonol syll	metric pos	mel peak	# of phonemes exp syll durat	dotted	final	mel charge
1	2	3	4	5	6	7	8	9	10
leskim	204	.128	.0021	n/s	n/s	n/s	n/a	n/s	n/s
läksinm	367	.400	n/s	.0001	n/s	.0001	.0001	.0405	n/s
minulk	284	.396	.0073	.0014	n/s	.0001	n/a	n/s	.0295
vendas	493	.168	.0267	.0001	n/s	.0001	n/a	n/s	n/s
kallism	76	.332	n/s	.0323	.0178	.0008	n/s	.0006	n/s
minav	95	.274	.0099	n/s	n/s	.0228	n/a	n/s	n/s
peren	318	.515	.0507	.0001	n/s	.0001	.0001	n/s	n/s
Overall	1837	.298	.0008	.0001	n/s	.0001	.0001	n/s	n/s

Covariance analysis of the material was performed in order to estimate the influence of selected variables on sound event durations. A summary of the results appears in the Table.

The effects of four out of seven variables on sound event durations were highly significant. The variables concerned include those of metrical position (strong or weak), the number of phonemes per event (in ms), deviations in the score from isochronous sequence ($p < .0001$ in all three cases) and the phonological length of the event (short or long, $p = .0008$). The effects of three variables, the melodic peak, the final note of the line, and melodic charge, were not significant.

The covariance analysis model is capable of accounting for an average total of 30 per cent of sound event duration variance in the seven songs studied. The percentage varies across songs. It reaches the highest value of 52 per cent in the song 'Peren' and the lowest value of 17 per cent in the song 'Vendas'.

An earlier finding (Ross and Lehiste 1998), according to which metrically strong, or ictus, positions of the line are performed longer than the metrically weak, or off-ictus, positions, was confirmed by the covariance analysis. There seem to exist at least two possibilities for interpreting this result. When projected against the background of the Kalevala metre theory (Lippus 1995), it suggests that the partly quantitative nature of the trochaic metre, as described on the 'phonological' level, is indeed acoustically realized in runic songs. Application of the swing rule (Inegales) should in this case be specific to the runic song tradition. If, however, the swing rule also operates in Friberg's (1991) set of rules intended to simulate the performance of a musical idiom different from the runic songs, it would suggest that making stressed positions longer and unstressed positions shorter is a more universal cognitive principle in the musical performance, specific neither to the old Baltic-Finnic folksongs nor to the

Western tonal music idiom.

The effects of four out of seven variables on sound event durations were highly significant. The variables concerned include those of metrical position (strong or weak), estimated acoustical duration of event (in ms), deviations in the score from isochronous sequence ($p < .0001$ in all three cases) and the phonological length of the event (short or long, $p = .0008$). The effects of three variables, the melodic peak, the final note of the line, and melodic charge, were not significant.

The covariance analysis model is capable of accounting for a total of 30 per cent of sound event duration variance TAAS SAMA LUGU?-KUHU/MILLEGA TÄPSELT SEOSTUBas the average in studied performances. The percentage varies across songs. It reaches the highest value of 52 per cent in the song 'Peren' and the lowest value of 17 per cent in the song 'Vendas'.

There seem to exist at least two possibilities for interpreting the significant influence of the metrical position on sound even durations in folksong. OneKUI SEE ON ESIMENE, KAS SIIS ON KA TEINE? confirms an earlier finding (Ross and Lehiste 1998), according to which metrically strong, or ictus, positions of the line are performed longer than the metrically weak, or off-ictus, positions. When projected against the background of the Kalevala metre theory (Lippus 1995), it suggests that the partly quantitative nature of the trochaic metre can be acoustically followed in runic songs. Providing, however, that the so-called swing rule (Inegalles) is also working in Friberg's (1991) set, intended to simulate the performance of a different musical idiom, this may suggest that making stressed positions longer and unstressed positions shorter is a more universal principle specific neither to the old Baltic-Finnic folksongs nor to the European tonal music idiom.

The influence of the number of different phonemes expected syllable duration in speech on the real acoustic duration of sound events in singing should be readily accessible to common sense. It is evident that the duration of syllables consisting of, for example, two a single phonemes (such as both the first and the second the first in the Estonian word [as-tei-sa]) must be shorter than the duration of syllables consisting of six phonemes (like the first one in the word [vintsk-le-ma]). Since both vowels and consonants may have different lengths in Estonian, the phonological length of a syllable is another of the characteristics of speech prosody independent of the number of phonemes in the syllable. (It is, however, reflected in the predicted duration of a syllable.) As the covariance analysis demonstrates, both variables, the number of phonemes in a syllable estimated syllable duration as well as its phonological length exert a significant influence on the acoustic durations of sound events. This points to the fact that some features essential from the point of view of speech communication tend to remain undamaged in singing.

The note pairs, which in the *post factum* notation are rendered as the dotted eighth followed by a sixteenth, were found significantly different in their acoustical duration from the rest of the notes rendered as isochronous strings of eighths. This suggests that it is justified to separate these from other notes in the notation, even where their real proportions only remotely resemble the nominal values, a sixteenth expected to be twice less in duration than an eighth.

As the melodic charge rule failed to significantly influence sound event durations in folksongs, the acoustical form of folksong performance appears not to reflect the underlying tonal structure of the songs. This seems to point to the essentially linear nature of the runic songs (Lippus 1995), with the tonal component either weak or not present at all.

7. CONCLUSIONS

Seven generative rules affecting sound event duration in musical performance (Friberg 1991) were examined in order to determine their suitability for modelling the performance of old Estonian folksongs. Three rules out of seven were rejected because of their irrelevance for the musical tradition investigated. The remaining four rules were complemented by three additional ones derived from the nature of articulatory production in singing, the prosodic description of the Estonian language, and the specifics of the old folksong performance tradition. The influence of seven variables on the acoustical duration of sound events in folksong performance was investigated by means of covariance analysis. Of the four original rules adopted from Friberg's (1991) set, the Inegalles rule, which makes metrically strong positions in isochronous melodies longer and weak positions shorter, was found to apply in runic songs. We did not find evidence of the effect of three rules: Melodic Charge, Faster Uphill and Phrase. The Melodic Charge rule is expected not to work because of weak tonal structure in the runic songs. The Faster Uphill rule is expected not to work because of the relatively narrow ambitus of melody in those songs. The two additional variables, which were formulated ad hoc and were not present in Friberg's set, relate to the prosodic characteristics of Estonian speech. Their significant influence on sound event durations in runic songs, together with the negligible effect of some of Friberg's rules, suggests a pronouncedly speech-like character of the analysed folksongs. The latter retain a number of characteristics stemming from speech prosody, while failing to evidence other characteristics thought to be specifically musical.

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