A study of timing in an Estonian runic song[a)]

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All note durations were measured in an Estonian runic song where one and the same melodic pattern is repeated 32 times in succession. It was found that the durations acoustically tend to form two categories that could be called the short and the long note. This result was confirmed by the multidimensional scaling of the measured durations. Other dimensions that seem to influence the relative duration of a particular note in the performance are related to the metrical position of the note and to whether a vowel or a diphthong corresponds to the note in the sung text. The results of this study suggest also that the opposition of the short and long notes may determine the rhythmic structure of the runic song rather than the properties of the verbal text.

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INTRODUCTION

Several investigations have shown that there exists only an approximate correspondence between the written record of a musical rhythm and the timing in real performance where the relations between the note durations systematically deviate from their nominal values. Garbuzov (1950) has found that the duration of longer notes tends to vary more than does that of shorter ones, the possible variation range being 500 ms for a quarter note, 200 ms for an eighth note, and 150 ms for a sixteenth note in the performance of the theme of the g-minor fugue from "Das Wohltemperierte Klavier I" by J. S. Bach. Povel (1977) has investigated the temporal structure of isochronous note sequences in the C-major prelude from the same collection and found considerable differences in the average temporal patterns as realized by three performers. Sundberg and Frydén (1985) have concluded that a sharpening of durational contrasts, which in their study was achieved by the shortening of short notes (but not by the lengthening of long ones), makes the musical performance more acceptable to the listener as compared to a mechanical reproduction with strict mathematical proportions between note durations. Bengtsson and Gabrielsson (1983) indicate that, in the performance of a Viennese waltz, the relative durations of every beat in a single bar can be 25%, 42%, and 33% of the duration of the bar, respectively, rather than 33% each. Sundberg and Verrillo (1980) have investigated the performance of the very last notes (the final retard) in musical pieces, where tempo slowdown is very common. Their study of the performance of the "motor" keyboard music by J. S. Bach, Scarlatti, and Haydn has shown that the timing of the last notes depends on such characteristics of the score as the length of the last musically conceptual unit, the length of the final cadence, and the preretard mean tempo. Clarke (1982) concluded from his study of the performance of the "Vexations" by Satie that rhythm and tempo are not independent parameters in music.

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All the above investigations are related to the classical tradition of European music, where the composition as a written musical text is transformed during performance into a succession of real sound events. In oral cultures, however, music exists mostly in a non-notated form; i.e., it is never written down except by scholars. Edlund (1985) has noted that it is generally possible to tell from the rhythmic properties of the performance whether a piece of music is notated or not, and that prescriptive notation causes a peculiar rhythmic style of performance which is different from that observed in non-notated music. This peculiar style is characterized at least in the classical European tradition by a highly organized rhythmic structure, contrasting with the more liberal timing in non-notated music.

The purpose of this investigation is to describe the timing in archaic Estonian folk music, the so-called runic (or Kalevala-type) tunes. This kind of music can be classified as non-notated music but with a fairly regular rhythmic, as well as metric, structure, which, with certain liberty, can be marked down by means of conventional notation. Ethnomusicologists generally believe that runic songs represent a sort of symbiosis between music and speech where the constructive role of upholding the whole is, to some extent, divided between the musical rhythm and the properties of the verbal text (see, for example, Tampere, 1934). This would mean that the proportions of the durations should not be fixed too strictly as they are thought to depend on the phonetical peculiarities of the text. As to the written notation of runic tunes, it is widely used in the process of their collection and preservation by scholars. However, it is generally recognized that the correspondence between the performance of a tune and its notation is to a great extent conventional with respect to the rhythm as well as to the pitch.

In connection with the present study, a question can be posed as to which level of the musical structure is appropriate for the analysis of timing in such kind of music. Shaffer (1981) has examined the performance of music by Chopin, J. S. Bach, and Bartók mainly within the framework of a theory of motor programming. Among other things, he has studied the last Bulgarian dance from Bartók's "Mikrokosmos," Book 6, a composition that is based on folk music and characterized by quite an extraordinary rhythm, with the eight quavers in the bar divided among three beats according to the scheme $3 + 3 + 2$. Shaffer has found some evidence that the timing there was accomplished on the individual note level rather than on the beat level, which suggests that note level must be chosen for the analysis.

One aim of this study was to find such material for the measurements that would be statistically representative enough, i.e., where one and the same melody pattern would be repeated many times in succession and therefore every position would be characterized by several samples. As a matter of fact, a number of performance studies avoid statistical interpretation of the results, which is reasonable from a musical point of view, since even a simple repetition in music is never exactly the same either in the musical or in the acoustical sense. The absence of statistical generalization, however, can leave an investigation on the level of a verbal paraphrase of the acoustic properties of the musical performance.

In runic song, the multiple repetition of a melody (although with a different text) is very common. However, we believe that, in a song like that, such parameters as note durations and metrorhythmic accents are by and large insensitive to variations in the verbal text and therefore every repetition can be considered an independent sample of the melody.

I. MATERIAL

In this paper, the timing in an Estonian swing song "Kiik tahab kindaid" is investigated. Generally, swing songs in Estonian folk music are characterized by a strong manifestation of the rhythm that resembles the back and forth movement of a swing, differing from the main body (73.4%) of the runic songs, where rhythm can be described as an isochronous succession of notes of the same durations, usually notated as eighths (Lippus, 1984). The investigated song was recorded in 1936 as sung by two elderly women in North Estonia (Jõelähtme parish). During the song, every line of the text is performed alternately by the first and the second singer, except for the last two syllables of every line, which are performed together. Thus every line of the text is repeated twice. As the number of text lines is 16, we have a total of 32 repetitions of the melodic pattern, 2 repetitions (Nos. 15 and 21) among them being modified and containing one note less than the others.

Despite the slight differences occurring also between the rest of individual repetitions of the melody, nevertheless, it seems possible to write down the invariant melodic pattern. Figure 1 represents this pattern as heard by (a) a musicologist (UL) and (b) a phonetician (IL). The first difference between these patterns is that (a) uses three different rhythmic units, the quarter note, the eighth, and the appoggiatura, whereas (b) uses only two of them, the sixteenth and the quarter note. The second difference is that melody (a) fits a regular meter 6/8, while melody (b) does not fit any, the first bar of it containing 6 units with the length of an eighth note, but the second bar only $5\frac{1}{2}$. The third difference is that IL hears the melodic position 2 as consisting of two different

FIG. 1. The notation of the Estonian folk song "Kiik tahab kindaid" as heard by (a) a musicologist UL and (b) a phonetician IL.

notes instead of one. This way, the overall number of the notes in her record is 11, i.e., one more than in the notation by UL.

Essens and Povel (1985) have investigated the human capacity of metrical representation of temporal patterns, i.e., of mapping the pattern on a frame formed of equal time intervals. In this sense, the notation by UL is metrical and the one by IL is not. Essens and Povel found that metrically interpreted patterns are generally much better reproduced than nonmetrically interpreted ones, except those having 2:1 interval ratios. This finding can be associated with the general impression derived from the comparison of the above two notations that the notation (a) depends more on a musical qualities, whereas (b) perhaps gives priority to the exact acoustical relationships between the melody notes. Later in the text, we shall refer predominantly to the notation (a) by UL, which consists of ten different notes.

However, Lippus (1984) has pointed out that the metric structure in this song [which on the basis of her notation (a) can be fixed as 6/8] is, in fact, rather vague. The metrically weak position is extended in time during the performance: A fermata could be put upon every quarter note in the melody, and, as a result, the duration of these notes may become quite indefinite.

II. PROCEDURE

The recording of the tune was fed to the computer from the tape via a low-pass filter with a cutoff frequency of 5 kHz and a 12-bit A/D converter with a sampling frequency of 10 kHz. The pitch and the SPL curves were determined by means of the routine described by Allik *et al.* (1984). In these curves, the time difference between two successive frequency and SPL values was 10 ms. The boundaries between successive notes were determined manually using the frequency and the SPL rises and decays as cues. The main presumption here was that the sung notes would correspond to the voiced segments of the sound signal. The duration of every note was measured as the time from onset to onset, i.e., from the beginning of the measured note to the beginning of the next one. The segmentation procedure was guided by the notation of UL [Fig. 1(a)]; i.e., the melody position 2 was not divided into two separate units.

Figure 2 gives an example of how the segmentation was accomplished. It represents a beginning of the melody repetition 27, the upper curve indicating the SPL and the lower one the F_0 variations in time. The rounded numbers above the time axis correspond to melody units [see Fig. 1(a)]. Accidentally, the F_0 curve happens to be relatively poor with

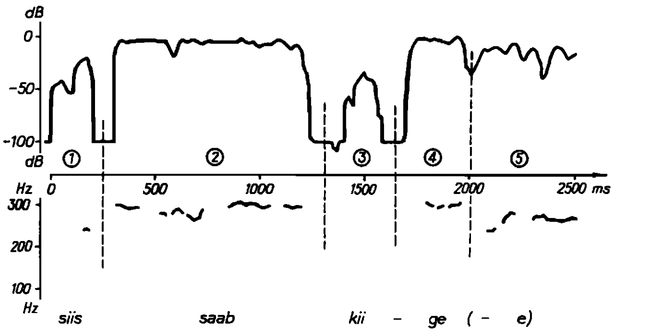

FIG. 2. An example (the beginning of the melody repetition 27) of the determination of the boundaries between the successive notes on the computer printout. The upper part shows the SPL (in negative dB) and the lower part the F_0 (in Hz) variations in time (ms). Generally, sharp SPL decays and rises enable us to determine the durational boundaries with the time resolution of no more than 50 ms on the assumption that sung notes correspond to the voiced segments of the sound signal. However, sometimes it is necessary also to look for F_0 changes, for example, when trying to detect the boundary between the melody positions 4 and 5 (melody positions are indicated by the rounded numbers in the middle). The sung text is given in the bottom part of the figure.

this repetition. As one can see, sharp SPL decays are usually suggestive of boundaries between successive notes. However, sometimes it is necessary to watch the F_0 changes e.g., when looking for the boundary between the melody units 4 and 5 in this example. The time resolution apparently has to be estimated as a bit longer than the 10-ms difference between the two successive SPL and F_0 values in the output of the computational procedure, yet we do not think it should exceed 50 ms.

Multidimensional scaling of the measurement results was performed using the nonmetric multidimensional unfolding approach by Kamensky (1977). In this approach, a number of experts have to rank a set of objects according to the quality under investigation. These rankings serve as input to a scaling routine. The routine searches for a multidimensional space where the objects, as well as experts, would be placed in such a way that the rank order of the distance from every expert to every object would correspond to the input ranking of the objects by every expert. In our study, the ten notes in the melody were considered as objects and the ranking of the notes according to their duration in every repetition from the 30 identical ones as the ranking of the objects by a particular expert. Modified repetitions Nos. 15 and 21 were excluded.

III. RESULTS AND DISCUSSION

A. Measurement of note durations

The measured durations of all notes in the analyzed song are given in Table I. Figure 3 represents the same data as a histogram. The durations are distributed around two central values. The first distribution has its mode at about 350 ms and a relatively narrow distribution range. The second set is centered at a point close to 950 ms but its variation range is approximately twice as large as that of the first set with no salient mode. The variation range of the second set is expected to be wide because, as has been pointed out above, all the quarter notes' durations are extended during the performance. However, it is interesting that the notes shorter than quarter notes form only one distribution. Although notes Nos. 1, 3, 6, and 9 are marked down by UL as eighths in Fig. 1(a) and notes Nos. 4 and 7 as appoggiaturas, these two categories cannot be distinguished in Fig. 3. This is in good agreement with the notation of IL in Fig. 1(b), which uses only two rhythmic units, the sixteenth and the quarter note.

TABLE I. Note durations as measured from onset to onset in an Estonian runic song "Kiik tahab kindaid." The rows correspond to the melody repetitions, the columns to the melody positions [see Fig. 1(a)]. In repetitions 15 and 21 (marked with an asterisk), the rhythm is different from that of the rest of the song.

	1	2	3	4	5	6	7	8	9	10
1	230	620	300	320	720	340	440	850	390	1020
2	320	1130	260	400	870	390	350	960	490	800
3	300	980	300	370	780	440	190	830	380	1060
4	350	1040	320	350	840	400	310	780	420	830
5	200	1000	340	310	760	310	280	860	420	1040
6	260	1080	340	370	910	300	380	760	390	1150
7	330	660	300	330	920	320	270	810	460	1350
8	340	720	370	330	870	330	390	930	440	1030
9	330	990	320	230	610	540	180	720	390	1080
10	350	1050	330	370	750	320	320	1100	430	1060
11	330	1030	440	510	730	380	430	360	620	970
12	410	1100	360	210	920	360	290	930	430	960
13	190	1170	370	290	850	370	200	1070	400	1260
14	320	1220	330	320	960	340	430	950	330	1110
15*	330	880	370		1110	360	470	890	390	1190
16	350	920	400	430	920	290	310	730	390	1210
17	410	960	340	440	480	390	550	540	250	1180
18	310	1120	460	370	830	430	300	830	450	860
19	330	1050	300	780	490	290	410	680	450	1110
20	300	980	340	350	940	460	310	850	360	880
21*	280	810	520		1200	310	420	710	550	1020
22	340	970	330	390	1000	310	380	1060	480	920
23	330	670	350	260	770	340	410	760	420	1040
24	270	1220	310	340	880	340	290	980	390	830
25	390	1060	370	390	710	320	420	810	440	1090
26	390	1190	450	450	840	330	360	830	380	870
27	250	1060	350	350	820	310	330	730	380	1080
28	260	1250	350	370	820	340	270	1050	320	1170
29	300	610	410	260	890	240	220	650	350	1080
30	160	890	350	370	810	290	280	780	410	970
31	320	940	350	310	1000	240	200	720	450	1030
32	340	1120	360	270	800	400	370	880	440	810
$\bar{x}$	310	993	350	361	816	349	329	826	412	1028

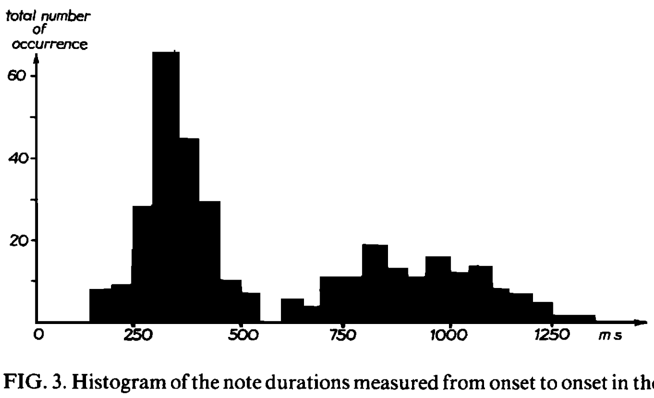

FIG. 3. Histogram of the note durations measured from onset to onset in the investigated song.

The mean durations of the notes designated as eighths and appoggiaturas by UL are also very similar to each other (310, 350, 349, and 412 ms for notes Nos. 1, 3, 6, and 9, 361 and 329 ms for notes Nos. 4 and 7; see Table I), which suggests that appoggiaturas do not belong to the leftmost part of the first distribution, but are distributed over the whole of it instead. It is interesting that the mean duration of appoggiatura No. 4 is even longer than the mean duration of its preceding eighth note No. 3, thus sharply contrasting with the melody notation by UL in Fig. 1(a). It can be concluded that the notation (b) by IL is in better agreement with the actual note durations in the song.

Fraisse (1982) has studied the distribution of note durations in European classical music (Chopin, Beethoven, Debussy *et al.*) and has found that notes with only two different rhythmic values represent more than 90% of the total number of notes there. Usually the ratio of these rhythmic values is 1:2 or 1:3. As to the absolute durations of the notes (which in Fraisse's study instead of being measured directly from the performance were determined on the basis of the metronome instructions in the score), the duration of the longer note usually varies between 300 and 900 ms, while the duration of the shorter note is about 200–300 ms. Fraisse points out that the above absolute duration values seem to possess some kind of universal character because nearly the same values have been observed in nonmusic periodic human activities (the speed of tapping, for example).

Fraisse's conclusions seem to be valid with respect to our study, too. Figure 3 indicates that the note durations in the analyzed song were centered at 350 and 950 ms, the approximate ratio of which is 1:3.

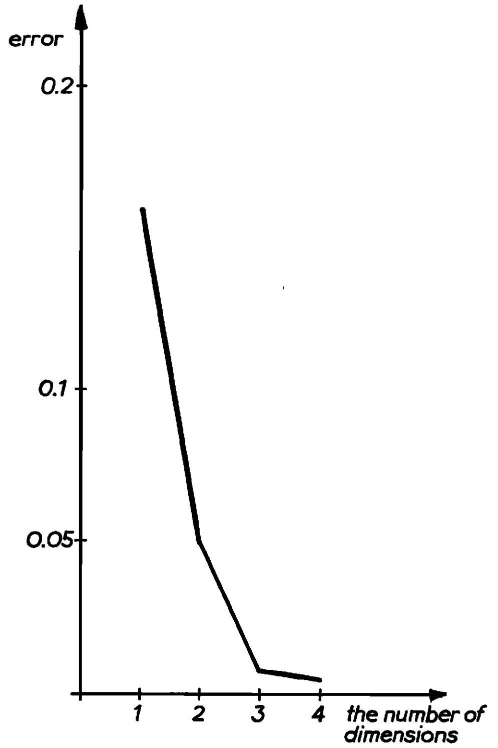

FIG. 4. The error (stress) magnitude (ordinate) plotted as a function of the dimensionality of the multidimensional scaling result (abscissa).

B. Multidimensional scaling

In multidimensional scaling, it is necessary to find a compromise between the dimensionality of the resulting configuration and the magnitude of the error (or the stress) that characterizes the correspondence between the scaling input and output (usually a low number of dimensions entails a larger error). Figure 4 depicts the error rate as a function of the dimensionality of the space in our study. As one can see, there is no significant decrease of the error if the number of dimensions is three or more, which indicates that three-dimensional space should be chosen for the analysis.

True, Davison (1983) has pointed out that it is seldom necessary to add dimensions in order to diminish the stress below 0.05. We have obtained this value with already two dimensions, which seems to argue for a two-dimensional solution. However, we have found three dimensions being more useful for the analysis of melody positions, while two dimensions are better for the analysis of melody repetitions.

A representation of dimensions 1 (the abscissa) and 2 (the ordinate) from the three-dimensional configuration of the melody notes is presented in Fig. 5 (the axes were not rotated). All the "long" (i.e., quarter) notes are grouped together in the picture (Nos. 2, 5, 8, and 10), which suggests that, as melody constituents, all "long" notes seem to function in a very similar manner despite the large variation in their absolute durations (see Fig. 3). As it was impossible to distinguish between the eighths (Nos. 1, 3, 6, and 9) and the appoggiaturas (Nos. 4 and 7) on the basis of their absolute durations, it would be interesting to ask whether this can be done in Fig. 5. In fact, all the "short" notes [i.e., the eighths and the appoggiaturas according to the notation (a)] can be connected by a semicircle in Fig. 5, where the appoggiaturas stand next to one another. However, the basic opposition in Fig. 5 is again between the "long" (the center) and the "short" (the surrounding semicircle) notes, as was the case in Fig. 3.

In Table II, we find the text of the song. As every text line is repeated twice, the number of separate text lines is half of the number of melody lines. In positions 4 and 5 (except in repetitions 1 and 2) and 7 and 8, one and the same syllable is divided between the two notes. When this kind of division happens elsewhere, the vowel repetition is marked in parentheses. Note that sometimes (position 2 in repetitions 7 and 8 and in repetitions 21 and 22) the note contains two different syllables.

It would be interesting to ask whether one can find some relationship between the properties of the text of the song and the results of the multidimensional scaling. As to the verbal aspect, it is generally recognized that word stress and quantity relations between syllables are the main determinants of the Estonian runic verse. According to Lippus (1984), "a verse in the runic song consists of eight syllables which can be either short or long. Prosodically Baltic-Finnic languages belong to the quantitative type where syllable length is directly connected with the meaning of the words. It is necessary to note that the first syllable need not always be long yet, however short, it always carries the stress. Consequently, in many verse lines a kind of discrepancy arises

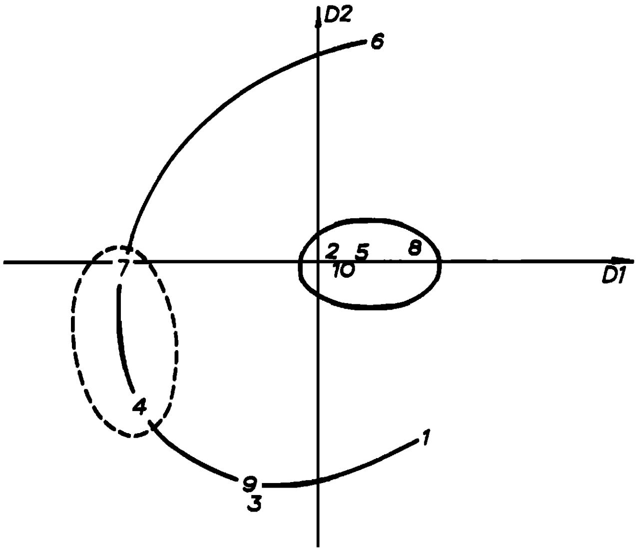

FIG. 5. The configuration of the melody notes in the analyzed song as a result of multidimensional scaling: dimensions 1 (abscissa) and 2 (ordinate) from the three-dimensional solution. The numbers correspond to the notes in the melody [see Fig. 1(a)]. The long notes (Nos. 2, 5, 8, and 10) are grouped together at the center, whereas the short notes (Nos. 1, 3, 4, 6, 7, and 9) form a surrounding semicircle, the appoggiaturas in Fig. 1(a) being neighbors. The notes with a frequent occurrence of the diphthong in the text stand at one end of dimension 2 (Nos. 1, 3, and 9) and the remaining notes with mainly a vowel content are distributed along the rest of the ordinate.

between syllable length and stress, long syllables not coinciding with the stressed ones, or vice versa."

Table III presents the proportions of some text properties in the total number of melody repetitions: the number of syllables with diphthongs, syllables both with a diphthong and a long vowel, syllables of long quantitatively, and, finally, stressed syllables, in every position of the melody.

There is some evidence that the occurrence of either

TABLE III. Total number of diphthongs, diphthongs and long vowels together, long syllables, and stressed syllables, in the melody positions of the analyzed song. In positions 4 and 5 and 7 and 8, one and the same syllable is divided between the two positions (see Table II).

Total number of	Melody positions 1	2	3	4 and 5	6	7 and 8	9	10
diphthongs	12	4	10	2	4	0	22	0
diphthongs + long vowels	18	8	22	4	12	4	24	0
long syllables	28	22	30	12	26	14	24	4
stressed syllables	32	12	32	8	28	4	14	0

vowel or diphthong in the text may be related to the configuration of notes in Fig. 5. The notes with a frequent occurrence of diphthongs (Nos. 1, 3, and 9) are grouped together at one end of the ordinate, whereas all the other notes, i.e., with a rare occurrence of a diphthong, are distributed along the rest of the axis. One should remember that the particular multidimensional scaling approach used in this study is nonmetric, which means that it is not the absolute distances between the notes that count, but only their rank order. Consequently, the fact that, in Fig. 5 for example, the distance between the notes 4 and 7 is longer than that between the notes 9 and 4 along the ordinate does not indicate a greater durational contrast between the members of the respective pairs of notes.

As appears from Table III, melody positions Nos. 1, 3, 6, and 9 quite regularly feature a dynamically stressed syllable, and these positions may probably be considered the arsis of the verse foot. As to the quantity relations, the positions with a frequent occurrence of the long syllable are the same as those just mentioned (i.e., Nos. 1, 3, 6, and 9). Figure 6 represents dimensions 1 (the abscissa) and 3 (the ordinate)

TABLE II. Sixteen different text lines in the analyzed song where every text line is repeated twice, segmented according to the melody positions. In positions 4 and 5 (except repetitions 1 and 2) and 7 and 8, a syllable is divided between the two notes. When this happens elsewhere, the repeated vowels are presented in parentheses.

Nos. of repetitions	Melody Positions 1	2	3	4 and 5	6	7 and 8	9	10
1 and 2	läh-	me	kii-	ge-le	kii-	ku-	mai-	e
3 and 4	kas	sie	kii-	ge	kan-	nab	mei-	da
5 and 6	kui	ei	kan-	na	ne	ka-	du-	gu
7 and 8	mis	sina	kriuk-	sud	kii-	ge-	ke-	ne
9 and 10	au-	gud	a-	lus-	lau-	a-	ke-	ne
11 and 12	pau-	gud	pea-	lis-	puu-	(uu-)	ke-	ne
13 and 14	kii-	ge	kriu-	nub	kin-	da-	(a)i-	da
15 and 16	a-	lus-	lau-	da	an-	de-	(e)i-	da
17 and 18	pea-	lis-	puu	pu-	na-	si	pae-	lu
19 and 20	oot	oot	kii-	ge	noo	noo	kii-	ge
21 and 22	las	minu	ven-	da	võ-	tab	nai-	se
23 and 24	tei-	ne	vend	tuob	tei-	se	nai-	se
25 and 26	kol-	mas	vend	saab	kos-	jas	käi-	nud
27 and 28	siis	saab	kii-	ge	kin-	da-	(a)i-	da
29 and 30	a-	lus-	lau-	da	an-	de-	(e)i-	da
31 and 32	pea-	lis-	puu	pu-	na-	sed	pae-	lad

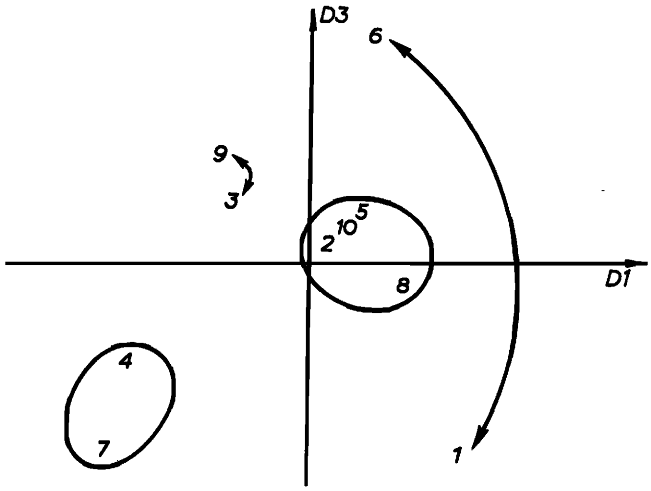

FIG. 6. The configuration of the melody notes in the analyzed song as a result of multidimensional scaling: dimensions 1 (abscissa) and 3 (ordinate) from the three-dimensional solution. The notes with the main metric accent (Nos. 1 and 6) or the long ones (Nos. 2, 5, 8, and 10) stand at one end of the abscissa, and the eighths with the secondary stress (Nos. 3 and 9) or the appoggiaturas (Nos. 4 and 7) are placed at the other end.

from the three-dimensional scaling configuration (with no rotation). As both Figs. 5 and 6 indicate, it is hardly possible to find any relationship between either the dynamic stress or the syllable length in the text and the actual note durations. Positions Nos. 1, 3, 6, and 9 do not form a coherent whole in Fig. 5 or in Fig. 6.

However, Fig. 6 indicates that the metric accent and the note durations as measured in the analyzed song may be in a somewhat similar relation to each other as the word stress and the syllable duration in the runic verse. In Fig. 6 as well as in Fig. 5, either the notes with the main metric stress (Nos. 1 and 6) or the long ones (Nos. 2, 5, 8, and 10) stand at one end of the abscissa, and the eighths with secondary stress (Nos. 3 and 9) or—according to notation (a)—the appoggiaturas (Nos. 4 and 7) are placed at the other. A runic song then may represent an alteration of "strong" and "weak" notes where a note may be strong either due to its stressedness or to its long duration; similarly, as in the verbal text, both the dynamic stress and the quantity relations contribute to actual verse properties. It must be noticed also that it is only in Fig. 6 that the appoggiaturas (Nos. 4 and 7) can be distinguished from the other short notes.

Generally, the results discussed above indicate that the properties of the verbal text in the runic song can scarcely be deduced from data on actual note durations. This tempts one to question the common point of view (expressed, for example, by Tampere 1934), according to which the melody in the runic song is strongly influenced by the qualities of verbal text. It may be suspected that the musical structure of the song analyzed is rather determined by some factors specific to one-voiced music. Lippus (1988) hypothesizes that the most important factor in the rhythmic structure of one-voiced music may be the opposition between the long and the short durations regardless of their absolute values. This hypothesis seems to be in good agreement with the results of our investigation, which demonstrate, first, the importance of the short–long durational opposition in the rhythmic structure of the song and, second, the relative immunity of the measured note durations to the properties of the verbal text.

As has been mentioned above, the multidimensional scaling approach used in this study yields also a configuration of the "experts," i.e., of the 30 identical repetitions of the melody. This two-dimensional configuration (with unrotated axes) is presented in Fig. 7. A deeper inspection of this configuration shows that most of the repetitions form a homogeneous group with no significant deviations. It has to be mentioned that no difference between the two performers (remember that every text line was performed by either singer in turn) can be detected on the basis of this configuration (the possible differentiation would show up as a difference between the even- and the odd-numbered melody lines). The major deviations from the main group are repetitions Nos. 11, 17, and 19, which all contain a pair of an eighth and a quarter note where the absolute duration of the quarter note is less than that of the eighth (see Table I). These absolute durations are 430 and 360 ms in repetition 11, 550 and 540 ms in repetition 17, and 780 and 490 ms in repetition 19. This opposition between the written notation and the real durations of the notes seems a bit striking, but, on the other hand, it may well be that these repetitions have to be written down as differing from the remainder.

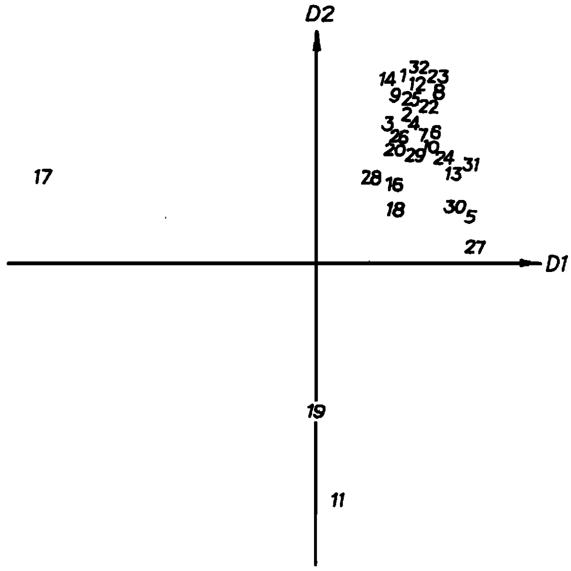

FIG. 7. The two-dimensional configuration of the melody repetitions in the analyzed song as a result of multidimensional scaling. Repetitions Nos. 15 and 21 are absent due to their rhythmic difference from the rest.

IV. CONCLUSIONS

Measurement of the note durations in an Estonian runic song shows that: (1) The rhythmic units acoustically tend to constitute two durational categories, which might be called short and long notes; (2) the duration of the long notes can vary within limits twice as wide as those for the duration of the short notes; and (3) the ratio of the mean durations of the short and the long notes is about 1:3. Multidimensional scaling of the measured durations shows that the notes tend to group according to: (1) the same short–long opposition as with the absolute duration values and (2) the vowel versus the diphthong content of the sung words.

The results of this investigation demonstrate also the relative immunity of the rhythmic structure of the melody to the properties of the verbal text qualities. Rather, they confirm the hypothesis that in one-voiced music the opposition between short and long values may be regarded as a sort of guiding principle in the rhythmic organization.

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