Collection of Verbal Descriptions of Musical Sound Timbre in Czech Language

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Abstract
The words used for description of musical sound timbre were acquired. The research was carried out among people with active relation to the music (instrument players, conductors, composers, sound engineers etc.). Each respondent have filled out the questionary composed of two parts. In the first part personal background of the respondent (respondent profile) was collected, in the second part respondent wrote down particular expressions he uses for timbre description, synonymic and antonymic relations among them. Common frequency vocabulary and frequency vocabularies over the selected respondent classes were created from the data and compared. Dissimilarities between expressions were defined (using synonymic and antonymic relations) and used for the construction of space of expressions.

Introduction

The timbre of musical sound represents a subjective phenomenon which reflects the acoustic properties of musical signals in our consciousness in a complex manner, and which together with pitch and loudness represents a fundamental psychoacoustic quantity. The majority of contemporary researchers regard timbre as multidimensional subjective quantity. In many timbre studies main features (categories, dimensions, factors) of some specific class of musical sounds are searched from the results of listening tests.

Method used for the interpretation of results is dependent on the method of listening test. Listened sound can be identified as like to a specific musical instrument [1]. When dissimilarities are judged in pairs of sounds, external interpretation of results may use either acoustic characteristics of listened signals [2] or spontaneous verbal descriptions collected in different listening of the same sound context [3]. It is also possible to select verbal attributes in advance [4]. The main problem in this case is the representativeness and method of selection: is it possible to use approved set of attributes or is it necessary to start new selection for every new context of sounds?

Our research group proposed a project leading to the selection of verbal attributes used for the description of timbre in Czech language. The basic aims of this project are:

- search for dimensions of perceptual timbre space and for their verbal descriptions,
- finding when all musicians share common perceptual space or certain groups (professional, age, etc.) use specific dimensions described by specific words.

The methods used in this study are based on sound-context free collection of verbal attributes and their evaluation used in pilot experiment with a group of violin players [5]. The results of the first stage of the project are summarised in this contribution.

Method

The research was carried out using questionary composed of two parts. In the first part respondents have described their personal profile – their age, instrument(s) they play, etc. The second part of the questionary was divided into three subsections. In the first subsection respondents wrote down in free order the words and expressions which they use for the description of musical sound timbre, in the second one they wrote down groups of synonyms and in the third one they wrote down groups of antonyms.

The research was carried out among students and professors of Faculty of Music of Academy of Performing Arts in Prague, members of several symphonic and chamber orchestra from different regions of the Czech Republic, teachers from musical schools and people from recording studios. These groups overlap in some cases, e. g. professors of the musical faculty are often also members of chamber orchestra or solo players.

The first part of the questionary was used for the description of population sample and for the discrimination of respondents into classes according to selected criteria. The second part as a whole was used for building of individual respondent vocabulary. Common vocabulary or partial vocabularies for respondent groups were then created from individual vocabularies. The second and the third subsections of the second part of the questionary were used for the determination of word links. Every pair of related expressions was scored +1 for synonymic and –1 for antonymic link. Scores for each pair of expressions *i,j* summed over all respondents or respondent group were arranged into square matrix of link scores $l_{i,j}$. This matrix had many undefined elements (missing values), so reduced matrices with expressions having at least link score $\pm L$ were calculated. This procedure led to substantial reduction of missing values. Then dissimilarity $d_{i,j}$ of the pair of expressions was defined:

$d_{i,j} = l_{max} - l_{i,j}$ for pair *i,j* with link score $l_{i,j}$, where l_{max} is maximum link score over all pairs;

$d_{i,j} = l_{max}$ for pair *i,j* with no link.

Reduced matrices of dissimilarities were evaluated using metric multidimensional scaling method (MDS) [6]. This method was used for computing of space of expressions describing timbre and for selection of optimal number of its dimensions.

Results and discussion

Finally 120 respondents have sent back filled questionaries. Distribution of respondents according to the instruments they play is rather disproportionate but it approximately corresponds with some exceptions to the distribution of instrument players in symphonic orchestra. More detailed description of the distribution is in [7]. In the following analysis the division to only main instrument groups (bow, wind, keyboard) is used in order to reach sufficient amount of respondents in individual classes.

Respondents wrote down 1 964 different words and expressions in total. Each respondent wrote at least one its own "new" word, only 230 words (i. e. 12 %) from common vocabulary have relative frequency greater then 5 % (word used at least by 6 respondents). Table 1 shows number of respondents in selected classes and corresponding number of words with relative frequencies greater then indicated value. In Table 2 thirty the most frequent words from common vocabulary are presented. Table 3 shows differences between partial vocabularies of selected instrument classes. Even if professional musicians have very complex experience with all kinds of musical sounds, results from Table 3 suggest that respondents of individual classes prefer some expressions.

Table 4 describes properties of reduced matrices of links. In reduced matrices with

Class		Resp.	Relative frequency >=			
			5 %	25 %	30 %	50 %
All		120	230	30	25	5
nstrument	Bow	48	206	28	22	5
	Wind	24	173	36	21	10
	Keyb.	34	279	25	19	5
Sex	Male	87	214	36	23	6
	Female	33	237	35	25	6
Age	< 30	37	274	27	20	5
	30 - 50	40	369	41	30	8
	> 50	43	186	31	26	8

Table 1: Number of respondents in selected classes and number of words in partial vocabularies with relative frequency greater than indicated level.

increasing reduction criterion (minimum link score) decreased number of expressions and also decreased the percentage of missing values which improved the robustness of MDS results. An example of the resulted perceptual space is in Figure 1. The dimensions can be represented by the expressions in English:

D1: bright, clear – gloomy, dark
D2: hard, sharp – delicate, soft
D3: wide – narrow
D4: hot, hearty – unpointed

Conclusions

The set of words selected in the questionary shows its richness and multiformity and also strong view of musical professionals. The majority of the most frequently used words is known from spontaneous verbal description of timbre. Even if simple translation into English (or any other language) cannot be precisely correct, their closest English equivalents are known from many published studies of musical sound timbre and thus

Expression	All		Rank in class			
	f_{abs}	f_{rel}	All	Bow	Wind	Keyb.
ostrý – sharp	94	78.3	1	1	1	1
temný – gloomy	79	65.8	2	5	2	2
měkký – soft	78	65.0	3	2	3	4
jasný – clear	75	62.5	4	3	4.5	4
sametový – velvety	61	50.8	5	7	6	4
kulatý – round	58	48.3	6.5	14.5	4.5	8
jemný – delicate	58	48.3	6.5	9.5	11.5	6.5
tupý – unpointed	55	45.8	8	11	8	10
tvrdý – hard	54	45.0	10	9.5	8	15.5
světlý – bright	54	45.0	10	16.5	11.5	10
drsný – harsh	54	45.0	10	12.5	19.5	6.5
sladký – sweet	53	44.2	12	4	15	22
plný – full	51	42.5	13	12.5	8	15.5
tmavý – dark	46	38.3	14.5	21.5	15	15.5
hrubý – rough	46	38.3	14.5	7	15	37
teplý – warm-hot	43	35.8	16	21.5	23.5	15.5
zářivý – radiant	42	35.0	17	16.5	45	22
vřelý – warm-hearty	40	33.3	18.5	7	31	78
čistý – clear	40	33.3	18.5	26	15	19
barevný – colored	38	31.7	20.5	19	45	12
zvonivý – ringing	38	31.7	20.5	39.5	19.5	10
průzračný – lucid	36	30.0	23.5	24	65.5	15.5
úzký – narrow	36	30.0	23.5	39.5	8	37
široký – wide	36	30.0	23.5	32	15	37
chladný – cool	36	30.0	23.5	14.5	31	61.5
kovový – metallic	34	28.3	26.5	32	31	22
studený – cold	34	28.3	26.5	27.5	31	37
svítivý – shining	32	26.7	28	48	19.5	37
zastřený – blurred	31	25.8	29	19	23.5	28.5
hladký – smooth	30	25.0	30	39.5	45	28.5

Table 2: Thirty the most frequently used words (with English equivalents) from common vocabulary with their relative frequency and rank (including ties) in common and partial vocabularies of selected respondent classes.

Δf_{rel}	Bow - Wind	Bow - Keyb.	Wind - Keyb.
1. > 2.	warm-hearty sweet	warm-hearty sweet rough cool honeyed	narrow hard full warming
1. < 2.	narrow round	dry ringing	- - -

Table 3: Words from partial vocabularies with differences in relative frequencies greater then 20 %.

they confirm internationality of the perception of musical sound and its verbal description.

Further stage of the project will be focused on the reduction of the number of representative expressions, definition of links among them and on more detailed description of differences among classes of musical professionals.

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Reduction criterion	Number of words	Percentage of missing values	Optimal number of dimensions
- - -	1347	99,3	- - -
5	77	71,2	8
8	43	57,4	6
11	33	48,7	5
14	**23**	**42,3**	**4**
23	10	24,4	2

Table 4: Number of words, percentage of missing values in matrix of pair links and optimal number of dimensions of space model in dependency on reduction criterion (minimum value of link score).

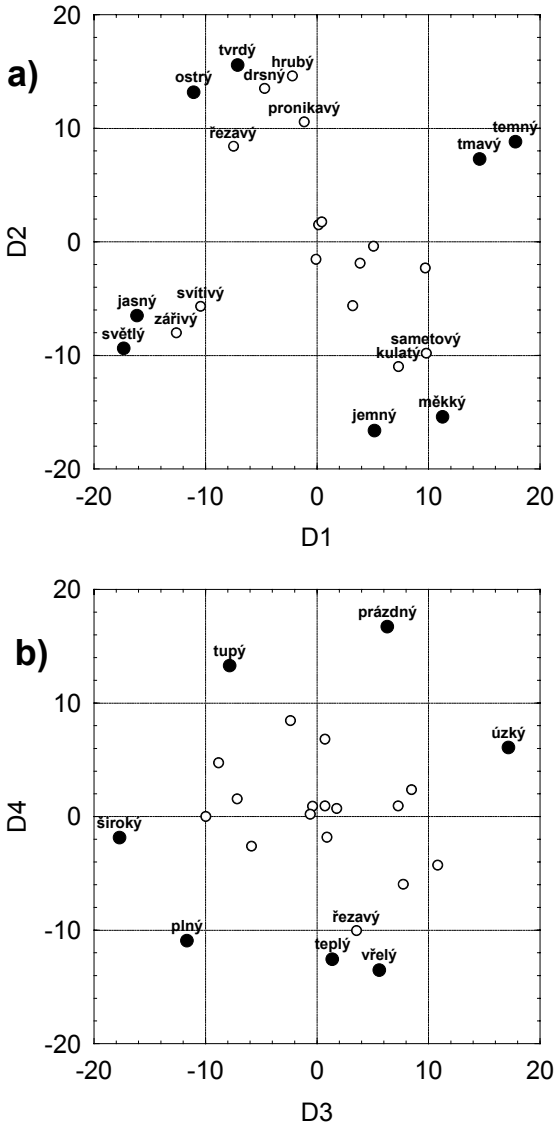

Figure 1: The four dimensional perceptual space of words for all respondents, reduction criterion L = 14; a) dimensions 1, 2; b) dimensions 3, 4.