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VERBAL TIMBRE DESCRIPTORS OF ISOLATED CLARINET TONES

Hal Abeles

Recent work in the perception of tone quality has indicated that longstanding theories suggesting that the timbre of a given tone is determined solely by its harmonics may not be valid. Other factors, such as the attack or legato transient of a tone, may also influence the perception of timbre. Musicians have generally not concerned themselves with these physical characteristics of tone quality, but instead have relied on verbal descriptions such as dark, round, thin, etc., to communicate the quality of a particular tone. It has been suggested that these verbal descriptors are vague terms, meaning different things to different people and meaningless to the uninitiated. The current series of studies attempts to investigate the use of timbre descriptors by musicians and nonmusicians, specifically examining the following questions:

1. What terms are used most frequently to describe clarinet timbre?
2. Is there consistency in the manner in which the terms are applied?
3. Do musicians and nonmusicians differ in the application of the descriptors?
4. Can the terms be grouped (factor analyzed) to identify dimensions of clarinet timbre?

This paper focuses on two of a series of continuing studies.

RELATED RESEARCH

Physical Parameters

The first investigation of the physical parameters of timbre was conducted by Helmholtz (1862). His work suggested that the quality of a musical tone was directly related to the number and strength of the partials comprising the tone. This position was left unchallenged for the greater part of a century. Recently, researchers (Craig & Jeffries, 1962; Pratt, 1974) have suggested that the phase relationships of the partials present may be an additional important factor in determining timbre. Work by Berger (1964), George (1957), Richardson (1957), Saldanha and Corso (1964), and Thayer (1972) has indicated that the initial transient, or attack of a musical tone may play a critical role in musical instrument identification. As a result of this more recent work, Pratt (1974) has proposed that the Helmholtz original model for timbre, which included only the steady-state portion of a tone, be extended to include specifications for the complete amplitude versus time history of all harmonics for that note.

Multidimensional Scaling

Studies by Plomp (1970), Wessel (1974), Wedin and Goude (1972), and Grey (1975) employed the technique of multidimensional scaling (MDS) to investigate timbre. The results of their studies suggest that certain physical characteristics (e.g., the interactivity of harmonic amplitude levels) may be correlated with the perceived psychological distance of timbre stimuli.

Verbal Descriptors

Early attempts by psychologists (Stumpf, 1890; Lichte, 1941; Stevens, 1965) to identify verbal descriptors of timbre tended to include subjective pre-selected descriptors and yielded a variety of results. These investigations do suggest though that timbre is a mul-

tifaceted dimension and that some of the facets can be reliably measured.

More recent investigations of verbal descriptors of timbre have been undertaken by Pratt and Doak (1976), Von Bismark (1974), Plomp and Steeneken (1969), Helmholtz (1954), Jost (1967), and Abeles and Sherman (1975). These studies employed semantic scales and in some cases factor analysis to assess the timbre of various synthetically produced tones. Three of the studies (von Bismark, Pratt and Doak, and Abeles and Sherman) closely parallel the current investigation.

Using the semantic differential and factor analysis, von Bismark attempted to identify independent features of timbre which can be described in terms of verbal attributes. The tones employed in the investigation consisted of voiced and unvoiced speech sounds (German) as well as musical sounds. The thirty-five tones were rated on 30 semantic differential scales (e.g., heavy-light, simple-complex) selected from 69 scales which had been used in previous investigations. Both musicians and non-musicians served as subjects for the study. A factor analysis of the results indicated that 91 percent of the total response variance could be accounted for with a four factor solution. The independent factors were labeled: Dull-Sharp, Compact-Scattered, Full-Empty, and Colorful-Colorless. The first factor (Dull-Sharp) accounted for 44 percent of the response variance. The factor analysis of both the musician's and non-musician's results produced similar, although not identical solutions. Bismark concludes that "language does indeed provide groups of subjects with some verbal attributes other than loudness and pitch, which are used consistently in the same manner to describe a considerable portion of timbre" (p. 157).

Pratt and Doak (1976) developed a rating scale for describing synthesized clarinet timbres based on questionnaire responses from college music students and faculty. The respondents were presented with a list of nineteen words commonly used to describe timbre and were asked to select six words with which they thought timbre could be most accurately described. On the basis of these responses, the researchers constructed three semantic differential scales, which were employed to describe the clarinet-like tones. The results of the study suggest that under certain conditions the semantic scales could distinguish between the tones. The consistency of the subjects varied with the harmonic content of the tones employed with the dull-brilliant scale producing the most consistent results. These results tend to agree with the von Bismark study reported above.

Abeles and Sherman (1975) employed a checklist approach to examine the verbal descriptors of "french" and "german" clarinet timbres. Six excerpts approximately ten seconds in length were employed, representing a variety of clarinet performance styles (i.e., articulation, dynamics, range). Non-musicians, non-clarinetist musicians and clarinetists were instructed to describe the examples by checking up to five of the twenty descriptors presented (randomly selected from a list of 118). The results of the pooled data produced a five factor structure which accounted for 65 percent of the total item variance. An additional analysis was undertaken of the frequency with which the descriptors in the five factors were selected to describe either the french or german timbre examples. Significant differences were found in the descriptor's frequency profiles of the different timbre categories. The authors conclude that the results tend to reinforce the multi-dimensional characteristic of timbre, but suggest that the contextual nature of the stimuli employed may have allowed confounding variables (e.g., interpretative differences) to account for the differences observed.

The current investigation focuses on the verbal descriptions of timbre which are commonly used by musicians. Although Plomp (1970) and Grey (1975) suggest that verbal descriptions have limitations (e.g., words may not exist to describe certain perceived differences), the frequency with which such words are used by musicians for pedagogical purposes suggests that they do likely differentiate among musically relevant timbre

differences. This investigation was designed to gather information on the parameters of their use to describe acoustically produced clarinet tones.

SELECTION OF DESCRIPTORS

An initial list of descriptors was generated by a content analysis of articles dealing with clarinet tone quality published in *The Clarinetists Magazine* (1952-1964) and *The Instrumentalist* (1950-1974). Additional descriptive terms were obtained from sampling 22 student and faculty clarinetists at the School of Music, University of North Carolina at Greensboro. A total of 118 terms were produced by these methods.

To reduce the 118 descriptors to a number more suitable for investigation, the terms were placed in a survey format. Respondents were instructed to rate (on a five option scale) each of the descriptors on their appropriateness for describing clarinet timbre. Fifteen clarinetists, fifteen nonclarinetist music majors, and twenty-six nonmusic majors at Indiana University participated in the rating. The mean ratings from each group were pooled to provide a single ranking for each of the 118 adjectives. These rankings were used to select the descriptors employed in studies reported below.

Study 1. An audio tape was prepared of 24 different isolated clarinet tones in random order. Three graduate student clarinetists at Indiana University each produced eight of the tones, two to represent each of the four registers of the clarinet. Loudness equalization and pitch accuracy were subjectively controlled. Each tone was presented for a period of two seconds with a seven second interval between tones provided for the subject to respond.

Thirteen nonmusic majors, ten nonclarinetist music majors and twelve clarinetist music majors at Indiana University were asked to describe the 24 clarinet tones using a checklist technique. For each tone a subject was presented with five descriptors randomly ordered and selected from the forty descriptors with the highest mean ranking resulting from the descriptor survey described above. The subjects were asked to designate up to five descriptors for each tone. Subjects responded to a total of 72 tones (three replications) which were heard on a Sony Model TC 252 tape recorder employing Koss Model Pro 4A headphones.

The results of the administration were first transformed and then factor analyzed. Three through eight factor solutions were examined for each sample of subjects as well as the pooled sample. A three-factor varimax solution of the pooled sample data seemed most appropriate when a subjective criterion for limiting the number of factors was employed. The three-factor structure, Shape, Density, and Depth, accounted for 50 percent of the total item variance. Items selected to define the factors appear in Table 1.

Table 1. Three Factor Solution of Clarinet Timbre Descriptors

Shape		Density		Depth	
Round	.64	Intense	.60	Rich	.67
Centered	.80	Brilliant	.62	Projecting	.64
Pinched	-.82	Clear	.69	Focused	.60
Thin	-.81	Penetrating	.68	Resonant	.82
		Airy	-.55	Pure	.52
		Fuzzy	-.77		

An additional analysis was undertaken to examine the relationships between the frequency of descriptors used by the three groups of respondents and the original ranking of the descriptors resulting from the descriptor survey. The Spearman-Rank Order cor-

relation coefficients based on this data indicate moderate agreement (.40, .54) among the subjects responding to the 24 clarinet tones while negative relationships (–.37, –.39) occur between the descriptors actually used by the musically trained respondents and the words subjects had indicated were appropriate for use to describe clarinet sounds.

A comparison of the factor structures presented in Table 1 above and by Abeles and Sherman (1975) do not yield many similarities, although a few of the same descriptors appear in both tables. This result suggests that contextual perceptions of timbre may differ from perceptions of isolated timbres, although caution must be used when interpreting these results as a larger pool of descriptors was employed by Abeles and Sherman. The negative relationships between the descriptors employed by respondents and the survey results seem to support this interpretation.

Study 2. An audio tape consisting of 66 pairs of the 24 different clarinet tones employed in Study 1 was prepared. The 66 pairs represented all possible combinations of the cells in the three performers by four clarinet ranges matrix of stimuli. Each pair consisted of a tone presented for a period of two seconds followed by a two-second interval of silence, followed by a second two-second tone, followed by a seven-second between-trial period during which the subject was to respond.

Twenty-two nonmusic majors, 22 clarinetist music majors and 22 nonclarinetist music majors at Indiana University were asked to indicate in each pair the tone which best represented the descriptor which appeared at the top of the response sheet. The terms selected for investigation in this study were: Mellow, Controlled, Clear, Penetrating, and Airy (the five descriptors indicated to be the most appropriate for describing clarinet timbre based on the results of the survey described above), and Complex, Pleasing, and Interesting (chosen because they had functioned successfully as discriminators in semantic differential studies involving melodic uncertainty, e.g., Crozier, 1973, but not generally associated by musicians with timbre). Each subject responded to only one descriptor per session.

The data were analyzed focusing on three aspects: 1) the consistency with which an individual subject responded was examined with the Coefficient of Consistence (Edwards, 1957); 2) the agreement between respondents within a subgroup (e.g., clarinetists) was described with the Coefficient of Agreement (Edwards, 1957); and 3) the agreement between respondents across subgroups was examined by ranking the clarinet tones by the results of each descriptor, and comparing the ranks across subgroups using the Spearman-Rank Order correlation procedure.

The results of the examination of respondent consistency appears in Table 2.

Table 2. Average Coefficients of Consistence for Clarinet Timbre Descriptors

	Clarinetists	Other Music Majors	Nonmusic Majors
Mellow	.82	.52	.60
Controlled	.41	.54	.43
Clear	.43	.47	.11*
Penetrating	.52	.39	.18*
Airy	.54	.56	.40
Complex	.12*	.41	.25
Interesting	.33	.46	.07*
Pleasing	.51	.42	.33

*not significant at the .05 level

An examination of Table 2 indicates that in all but four instances the subject's responses demonstrate greater consistency than would be expected by chance. The musically trained subjects generally had higher levels of consistency than did the nonmusicians. Lower levels of consistency were obtained for the terms not generally associated by musicians with timbre.

Table 3 presents the Coefficients of Agreement (COA) for each subgroup by descriptor.

Table 3. Coefficients of Agreement for Clarinet Timbre Descriptors

	Clarinetists	Other Music Majors	Nonmusic Majors
Mellow	.78	.33	.85
Controlled	.11	.36	.13
Clear	.31	.37	-.09
Penetrating	.28	.35	.11
Airy	.42	.30	.07
Complex	-.12	.01	-.09
Interesting	.01	.05	-.04
Pleasing	.20	.15	.13
Mean COA	.25	.24	.13

The COA can range from 1.00 to a negative integer, which increases as the number of respondents increases. A positive COA indicates some agreement among respondents. The results displayed in Table 3 parallel those reported in Table 2 with the musically trained subjects generally agreeing more with each other than the nonmusicians, and the terms not generally associated by musicians with timbre producing lower COAs.

The Spearman-Rank Order correlation coefficients between the subgroup rankings of the tones for each descriptor appear in Table 4.

Table 4. Relationship Between Groups of Clarinet Tone Rankings by Descriptors

	Clarinetists - Other Music Majors	Clarinetists - Nonmusic Majors	Other Music Majors - Nonmusic Majors
Mellow	.75	.41	.45
Controlled	.90	-.06	.26
Clear	.61	.15	.04
Penetrating	.55	-.16	.41
Airy	.27	.17	.68
Pleasing	.30	.30	.70

The coefficients reported in Table 4 generally indicate more agreement is present between the clarinetists and other musicians than with either of these two groups and the nonmusicians. The descriptors Complex and Interesting are not reported because the lack of agreement within groups seemed to preclude any across group analysis.

A comparison of the results of the common and uncommon timbre descriptors suggest that clarinetists and other music majors are more consistent and agree more when they are asked to employ descriptors more commonly used to describe timbre than when asked to use uncommon timbre descriptors, while nonmusic majors seem to be relatively less consistent and less in agreement than trained musicians on the use of any verbal descriptors of timbre.

CONCLUSIONS

The results of the investigations reported above do suggest some answers to the questions stated at the onset of the investigation. The results of Study 1, the Abeles and Sherman study and the descriptor survey give some indication of what terms may be used consistently when describing clarinet timbre, but the dissimilarity of these results and the lack of agreement when certain of these terms are applied (Study 2) tend to constrain the determination of a clear answer to the first question addressed in these studies. At this stage it seems that it may be possible to indicate what terms may *not* be appropriate to use when describing clarinet timbre, but not to identify a narrow group of terms capable of defining the different facets of clarinet timbre.

The results of the studies seem to suggest more definitive answers to Question 2 and 3 addressed in these studies. There does seem to be consistency with which certain descriptors are applied by those with some musical training, while nonmusicians tend not to produce consistent results. In addition, the application of *appropriate* descriptors is quite similar between different subgroups of musically trained respondents.

The final question posed at the beginning of these investigations seems still unanswered. The difference apparent in the factor solutions produced by Abeles and Sherman (1975) does not provide the stability desired with such analyses. One possible reason for the differences evidenced, the use of both contextual and noncontextual stimuli, requires that additional investigations be undertaken to examine possible interactions of timbre descriptions and other aspects of a performance.

These studies have provided some information on the perception and description of clarinet timbre, but have only begun to answer the complex questions which investigations in the area of timbre present.

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