ARCHIVES OF ACOUSTCS
17, 1, 17–30 (1992)

TIMBRE, TONE COLOR, AND SOUND QUALITY : CONCEPTS AND DEFINITIONS

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Timbre is a magic word used by composers, musicians, sound engineers, and other audio and hearing professionals to describe all auditory sensations other than pitch, loudness, and perceived duration. The concept of timbre is widely used and has a long tradition. However, the meaning of timbre is fuzzy and encompasses an enormous variety of phenomena. The formal definition of timbre, as accepted by the American Standards Association, is very limited and impractical and there is little consistency in its interpretation. There also is general confusion regarding relations among timbre, tone color, and sound quality, which are frequently treated as synonymous terms. In addition, a multidimensional character of timbre is not supported by a practical system of well-defined and clearly linked dimensions. To develop such a system one needs to clarify the meaning of timbre and to reexamine its current definition.

1. Introduction

Music and speech, together with visual information, are two of the most important elements of human communication and artistic expression. Changes in loudness, pitch, timbre, tempo, and rhythmic pattern of mutually related sounds efficiently convey various moods, impressions, desires and intellectual arousal. Through the centuries humanity has developed large numbers of spoken languages and very sophisticated musical systems. It also has enlarged substantially musical instrumentarium. The technical means to produce, transmit, and reproduce sound-based information has been also improved significantly, especially during the last thirty years. In this context it is alarming that our ability to communicate with words about sound is still very limited and does not match our abilities to manipulate the sound.

The area that especially lacks uniform and clear terminology is the area of sound quality (Pol. jakość dźwięku), tone color (Pol. brzmienie), and timbre (Pol, barwa dźwięku). Despite some standardized definitions and many attempts to discover underlying elements of these terms, the meaning and range of them are still unclear. There is

also a multitude of other terms that appear to have identical or very similar meaning with terms listed above. A selected list of such terms is presented in Table 1.

Table 1. The most common terms with meanings synonymous with or very similar to timbre which have appeared in selected publications on speech and music perception, psychoacoustics, and audiology

GENERAL:	sound quality
	tone quality
	sound color
	tone color
	spectral timbre
	spectral color
	timbral color
	timbral quality
MUSIC:	musical quality
	musical color
	musical timbre
	instrumental color
	instrumental timbre
SPEECH:	voice quality
	vocal quality
	vowel quality
	vowel color
	vocal color

The lack of precision and stability of terminology has led to enormous richness of terms used by both professionals and general public in describing changes in sound. The large number of terms used in sound description is a blessing for artistic freedom of expression, but it is a source of problems when it comes to communication among people. Effective communication requires a formalized system of terms where all denotations are clearly defined and linked together in both the vertical and the horizontal structures.

Despite the richness of vocabulary used by professionals in describing the sound, or maybe rather due to it, the average person has little or no vocabulary for explaining his perceptual and emotional reactions to sound. There are several reasons why public illiteracy in sound description has developed at a time when so much effort has been given to enrich our musical perception and to develop "true-to-nature" sound reproduction. Among them are (1) overemphasis of visual communication in public education, (2) "loud is good" philosophy in audio entertainment, (3) traditional, counterproductive competition between "engineering" and "musical" description of sound, (4) myth of the "golden ears" created by some professional reviewers of sound- and audio-related pro-

ducts, and (5) problems with effective translation of sound-related terminology from one language into another. In addition, the meaning of some words changes as a function of profession (musician, sound engineer, audiologist, acoustic consultant, speech therapist), region, age, and cultural background. Some words also become suddenly more fashionable, and this temporarily broadens their meanings beyond the more-or-less established ones. Some researchers in the field also contributed to the present state of the art in public sound education by overemphasizing the need for experimental testing of specific hypothesis concerning the mechanisms underlying sound perception while neglecting the need for clear definitions of terms being tested. As a result there have appeared many publications on sound quality and timbre in which the conclusions contradict rather than complement each other. They help neither to understand the phenomena underlying timbral perception nor to improve our communication about sound.

An additional important source of difficulties in communicating about auditory sensations is misinterpretation or lack of understanding of the conceptual model underlying the adopted system of terms. In many cases one terminological system is as good as another, yet they cannot be mixed together without the risk of increasing the confusion. A typical logical error is assuming that (a) loudness, pitch and timbre are independent dimensions of perception and (b) different pure tones produce different timbre sensations. The nature of this error becomes more obvious later.

The purpose of this article is to discuss and clarify the meaning of the three basic terms used in the global description of sound: timbre, tone color, and sound quality. The article presents some of the author's concepts and offers suggestions on possible links between main psychoacoustical terms in an effort to make our communication easier and less ambiguous. The specific goal of this article is to advocate more general interpretation of timbre than has been found in the majority of the textbooks on musical acoustics and psychoacoustics and to differentiate between the connotations of timbre, tone color, and sound quality. The author also hopes that this article will invigorate discussion on timbre terminology that will ultimately become clear and logically structured.

2. The concept of timbre

Physical sounds stimulating our ears result in various auditory images that evolve in our perceptual space [22]. McAdams [23] defined auditory image as a "psychological representation of a sound exhibiting an internal coherence in its acoustical behavior". The stress on coherence is important, since different acoustical components are combined in the auditory space into a single percept representing a physically meaningful entity. Such a percept is a weighted sum of various underlying sensations and can be described in terms of their values. A single auditory image can be perceptually analyzed by the listener by focusing his attention on individual sensations or details of the image, and/or by making changes to his actual frame-of-reference [12]. Several coexisting images can also be merged together to create a more generalized picture of the acoustical environment surrounding the listener. This picture is the sound that we hear.

An auditory image is commonly described in terms of loudness, pitch, (perceived) duration, spaciousness, and timbre. While loudness, pitch, and perceived duration can be considered as one-dimensional magnitudes, both spaciousness and timbre clearly have a complex (multidimensional) character.

Loudness is that attribute of an auditory image that reflects the listener's impression of the amount of sound energy which reaches the ear. A loudness scale orders sounds from soft to loud.

Pitch is that attribute of an auditory image that reflects the listener's impression of the location of the dominant spectral component along the frequency scale. A scale of pitch orders sounds from low to high.

Perceived duration is that attribute of an auditory image that reflects the listener's impression of the physical duration of a stimulus. A scale of perceived (apparent) duration orders sounds from short to long.

All three above-defined parameters are widely recognized as the universal attributes of auditory images. This means that, in general, they are neither source nor process specific. This cannot be said about the other two attributes, especially timbre, which first and foremost carries information about a source of sound and/or characteristics of sound transmission.

Timbre has been defined by the American Standard Association (ASA) [1] as "that attribute of ausitory sensation in terms of which a listener can judge that two sounds similarly presented and having the same loudness and pitch are dissimilar". This definition is supplemented by a note stating that "timbre depends primarily upon the spectrum of the stimulus, but it also depends upon the waveform, the sound pressure, the frequency location of the spectrum, and the temporal characteristics of the stimulus."

The ASA definition follows in its concept the original definition of timbre (Klangfarbe) formulated by HELMHOLTZ [11]. The phrase "similarly presented" refers foremost to sound duration and spatial presentation. In a similar definition offered by PLOMP [28], loudness and pitch are supplemented by apparent duration.

Timbre, understood in the above way, encompasses a vast variety of phenomena, yet its formal definition is very limited and does not permit one to compare timbres of two arbitrary sounds. In an important attempt to clarify the meaning of timbre, PRATT and DOAK [30] revised ASA and Plomp's definitions to the form given below.

Timbre is that attribute of auditory sensation whereby a listener can judge that two [similarly presented] sounds are dissimilar using any criteria other than pitch, loudness or duration.

Pratt and Doak's intention was to free the timbre definition from the impression that judgement of timbre must take place under conditions of equal loudness, pitch, and duration. Their timbre definition is also more suitable for atonal (undefined-pitch) sounds.

In its narrow interpretation timbre depends on the spectrum of the stimulus and can be interpreted as the perceived spectrum, i.e. the listener's reaction to the distribution of sound energy along the frequency scale. Such reaction involves both the spectral envelope and the spectral distribution of sound components. This narrow interpretation of

timbre, however, is only applicable to steady state sounds (static timbre). Timbre of sounds varying in time (dynamic timbre) depends additionally upon the waveform envelope and the temporal characteristics of the stimulus. These two aspects of timbre have been called "musical quality" and "sound quality", respectively, by HELMHOLTZ [11].

It is generally accepted that the same sound reaching our ear with different sound intensities causes different timbre sensations. There is no consensus, however, whether the same musical note played on the same musical instrument with two different dynamic levels invokes identical or different timbre sensations. And if we can recognize that two sounds were played on the same musical instrument, does it mean that they have produced identical timbre sensations? Answers to such questions cannot be given on the basis of the existing definition of timbre.

The authors of the ASA definition of timbre seem to accept the existence of a certain, three-dimensional auditory space with two of the dimensions labeled as loudness and pitch. What they have not specified clearly enough is whether the sensation of timbre is or is not independent of sensations of loudness and pitch. In other words, they did not specify if pitch and loudness were dimensions of timbre, or if all three of them were orthogonal dimensions of something else. A good analogy to such ambiguity is the description of an elongated cube (perpendicular parallelepiped) either with the help of its three basic dimensions (a, b, c) or by its volume (V) and two of its basic dimensions. Since $V = abc$, both descriptions are correct and satisfactory, yet as long as all the components of the equation are not identified, we do not know whether we talk about three linear variables or two linear plus one global variable.

3. Hearing-vision analogy

In many instances drawing an analogy between two similar systems helps to understand the inner workings of one of them. In the case of the auditory system such a reference is usually the visual system. A visual image has two main attributes: color and form. Perception of color is called color vision, and perception of form is called spatial vision. Color vision refers to the perception of light, while spatial vision refers to the perception of patterns and details in the visual world. These two types of vision closely resemble two types of hearing: spectral hearing and spatial hearing.

Color, like beauty, is in the eye of beholder [4]. The sensation of color derives from intensity, dominant wavelength, and composition (purity) of light. These three elements have their perceptual counterparts in brightness (sometimes calles lightness), hue, and saturation.

Brightness (lightness) is the aspect of color sensation that comes from the amount of energy of light waves. However, the phenomenal brightness of light depends not only on energy but also on frequencies involved. This dependency is a close analog to the mechanisms underlying the sensation of loudness.

Hue (chroma) is the sensation reported by an observer with normal color vision exposed to monochromatic light, i.e. to a single electromagnetic wavelength falling be-

tween approximately 420 (violet) and 740 (red) nanometers. Hues are numbered from 1 to 24 and traditionally represented on a color circle, called the Oswald circle. Distances between two successive hues along the circle correspond to just noticeable differences and therefore differ in the size of intervals along the frequency scale. Such a scale resembles the Bark (critical band) scale of pitch sensation [34, 46].

Saturation (strength of hue) refers to the purity (dominance) of a particular wavelength contributing to color sensation. The narrower the band of wavelengths, the more highly saturated is the resulting color sensation. Two different hues combined together produce another hue but with lower saturation than would be produced by the monochromatic light of corresponding frequency. If the number of hues added to the sensation becomes large enough the resulting sensation approaches gray. Several scales of saturation have been developed to describe the change in sensation resulting from an increase in the number of hues. The most widely known scale has been developed by INDOW and STEVENS [13] and is based on a unit called "chrome".

The above description of color vision indicates a strong analogy between loudness of sound and brightness of color and between pitch of sound and hue of color. According to CHRISTMAN [4] and KIMBLE and GARMEZY [15], there is also an analogy between saturation of color and timbre of sound. Such sets of analogies would speak of the close relationship between the organization of visual and auditory spaces. However, the last analogy seems to be superficial since saturation of color is a unidimensional phenomenon while timbre of sound has a multidimensional character. To this author the auditory analog of the saturation of color is the strength of pitch (timbral tonality, tonal clarity, or width of sound [18]) rather than the complex timbre sensation.

4. The timbre confusion

On the basis of the information provided it is logical to assume, as PRATT and DOAK [30] seem to have assumed, that the American Standard Association intended to define timbre as a dimension orthogonal to loudness and pitch. Such a definition of timbre, disguised sometimes as quality or tone color, can be found in several dictionaries, lexicons, and research papers (e.g. [16, 31, 44]). However, since the definition of timbre itself is not unequivocal, global interpretation of timbre also is possible. Interestingly, such an interpretation is directly expressed, or can be inferred from positions taken toward timbre, by BLADON and LINDBLOM [2], CLARK and MILNER [5], NAKATANI and MERMELSTEIN [26], PORGES [29], SCHÖNBERG [35], TIFFANY and CARRELL [42], WINCKEL [45], and others.

Arnold SCHÖNBERG [35, pp. 503–504], as cited by WINCKEL [45, p. 118)), says, "I cannot accept the distinction between tone color and pitch as it generally is stated. I find that tone makes itself noticed through color, one dimension of which is pitch. Tone color is therefore the large area, of which pitch is one division." The concept of pitch as an attribute of timbre agrees also in essence with the concept of frequency-based timbre solfege [20], where timbre recognition is based on perceptual monitoring

of loudness density distribution along the pitch scale. Contemporary speech research also seems to accept the notion that timbre (quality) of vowel depends primarily on the combination of pitches given by prominent spectral peaks of physical sound.

A strong argument for loudness and pitch as dimensions of timbre comes from research on brightness (density) and volume sensations produced by pure and complex tones [3, 10, 17, 39, 41]. Results of these studies indicate that brightness and volume (a) are independent (orthogonal) of each other, and (b) can be unequivocally described in terms of loudness and pitch. In other words, they constitute a pair of new (rotated) coordinates in the loudness-pitch plane. Therefore, all those who accept Stevens' concept of volume and brightness and also assume that these dimensions are dimensions of timbre (as many people do) should also accept both pitch and loudness as timbre dimensions.

EISLER [7], GABRIELSSON and SJÖGREN [9], MCDERMOTT [25], SONE, KIDO, and NEMURA [38], and several other researchers who investigated timbre (quality, tone color) by means of factorial analysis of semantic differential also have found that loudness and/or pitch are dimensions of timbre. Such a result is hardly surprising since (a) loudness and pitch were included into a set of initial scales, (b) loudness and pitch are dominating perceptual attributes of sound, and (c) listeners probably had much more experience in judging loudness than most of the other attributes. Inclusion of loudness and/or pitch as initial scales of judgement in the above studies also means that the authors of those studies might consider loudness and/or pitch as attributes of timbre.

The above described ambiguity in the definition of timbre also contributes to the confusion about whether all pure tones produce different or identical timbre sensations (or have any timbre at all). If the meaning of timbre encompasses pitch and loudness, the answer should be affirmative, but if its meaning is independent of them, the answer should be negative. The psychoacoustical literature is divided on this subject and one can find statements supporting the former [40, 45] as well as the latter [28, 33, 43] view.

The facts and discussion presented above have led this author to the conclusion that timbre, as defined by ASA and understood as a sensation independent of pitch and loudness, is not the same "general timbre" to which we usually refer when talking about music and auditory sensations. Such "general timbre" clearly embraces both loudness and pitch. Therefore, one may conclude that we need two different terms to describe these two separate connotations. But then, which of these two connotations should still be labeled "timbre"? And how should the other term be labeled to clarify the issue rather than to deepen existing confusion? Finally, one has to realize that any attempt to redefine the "fuzzy" meaning of timbre may likely result in a massive opposition by one or another group of the society. SLAWSON [37] warns that since timbre "is already used widely in many different senses by scientists, music theorists, and composers, it would be hopeless to try to reach agreement on a single meaning." This is certainly true when the "new" meaning of timbre is a relatively narrow one. However, the present author believes that a single but at the same time clear and sufficiently broad meaning of timbre, which embraces many various "denominations of timbre", will help us to

communicate and will earn a general acceptance.

In this content it should be noted that the idea to supplement "timbre" by another auxiliary term is not a new one. In a frustrating attempt to answer the question whether two different sounds played on the same musical instrument produce or do not produce the same timbre sensation, KITAMURA [16] suggested replacing timbre by two separate timbre-related terms: (a) sound impression produced by characteristic properties of the sound source (sound color), and (b) "sound impression expressed by descriptive adjectives of sound color" (quality of sound color). Similar frustration seems to have led SLAWSON [37, p. 20] to introduce the term "sound color" to denote an abstract, i.e. having no reference to a specific mode of sound production, representation of the timbre. One may wonder, however, whether the proposed distinctions are practical and if they do not clutter even more the differentiation between the phenomena of sensation and perception.

5. The expanded concept of timbre

The concept of timbre presented in this paper is built directly upon the ambiguity of the ASA definition that permits interpretation of timbre as a global dimension embracing both pitch and loudness. According to this concept, timbre is a global sensation embracing all other sensations reflecting the spectral, but not the spatial, character of sound. Such sensations include but are not limited to loudness, pitch, perceived duration, brightness, roughness, annoyance, etc. Thus, timbre is, first and foremost, an N-dimensional spectral sensation. It can be viewed in different frames-of-reference, analyzed along various scales of attributes, or judged as a whole according to one of the designated criteria of timbre (pleasantness, naturalness, or fidelity) [19]. Therefore, two sounds which produce the same sensation of loudness but sound different, produce different timbre sensations observed in $(N - 1)$ – dimensional space. When both loudness and pitch are identical the timbre difference is confined to $N - 2$ dimensions. Every comparative judgment involving the perceived spectra of two or more sounds can therefore be viewed as a timbre judgment in a limited timbral subspace.

The above generalized concept of timbre is practical and seems to be intuitively adopted in many studies in music, psychoacoustics, and quality assessment of audio transmission. Its main advantages are:

(1) it captures well the popular meaning of timbre and permits elimination of the "ambiguity and awkwardness" [42] of the current definition of timbre;

(2) it applies to both the comparative and the absolute assessment of sound; comparison of timbre of a particular sound to our preconceptions does not seem to involve a conscious adjustment in pitch and/or loudness;

(3) it can be successfully applied in perceptual comparison among sounds having only either equal loudness or pitch;

(4) it embraces both tonal and atonal sounds; and

(5) it permits treatment of correlated scales of annoyance and loudness as two di-

mensions of timbral space (the classical interpretation of timbre separates loudness from timbre).

According to the above concept of timbre both the ASA definition and the PRATT and DOAK'S definition [30] of timbre are acceptable and valid as long as loudness, pitch, and perceived duration of all compared sounds are kept constant. These definitions, however, do not reflect an assumed generality of timbre connotation. Such a general definition should be formulated as, or in a manner similar to, the definition given below.

Timbre is that multidimensional attribute of an auditory image in terms of which the listener judges the spectral character of sound. Timbral differences observed among a group of sounds are meaningful only as long as they refer to the same conditions of comparison.

A complementary definition of spaciousness can be formulated as follows.

Spaciousness is that multidimensional attribute of an auditory image in terms of which the listener identifies the size and locations of various sound sources and the size of acoustical space. Spatial differences observed among a group of sounds are meaningful only as long as they refer to the same conditions of comparison.

If differences along one dimension of timbre, such as loudness, dominate overall perception of sound and are not a desired object of assessment, such differences can be equalized; i.e., the said dimension can be excluded from assessment. After such a dimension is excluded from consideration, the auditory images are projected to $(N - 1)$ – dimensional space, and the differences among the images along the remaining dimensions of perceptual space become more pronounced. This operation can be extended on more than one dimension. The resulting $(N - k)$ – dimensional space, where k is the number of dimensions removed from consideration, may be called a "residual space" or "residual dimension". Many such spaces can be created with different dimensions removed (equalized). They need, however, to be clearly labeled for future identification. For example, one needs to know whether data obtained in two different studies on timbre refer to the same timbral space.

The above concept of "residual dimension" is not new and for many decades we have subscribed to the concept of timbre as a "residual dimension" representing the remaining differences in sensation when differences in loudness and pitch had been equalized. This particular residual dimension is very convenient in a variety of application. For example, normalized loudness and pitch are basic requirements for comparative assessment of musical instruments and sound reproduction systems. In some other cases, however, normalized loudness is all that is needed (e.g. selection of radio announcers, evaluation of pathological voices). Surprisingly, although timbre has been assigned as a residuum for both loudness and pitch together, we have not established similar residual dimensions for either loudness or pitch alone. Therefore, it seemms justified, and even beneficial, to accept a more general connotation of timbre and talk, when we need to, about loudness-equalized timbre (L – timbre), pitch-equalized timbre (P – timbre), loudness/pitch-equalized timbre (LP – timbre), and so on. Such a system of timbral sub-

spaces may be called the X – timbre system. A basic descriptive model of an auditory image that utilizes the X – timbre system of labels is shown in Fig. 1.

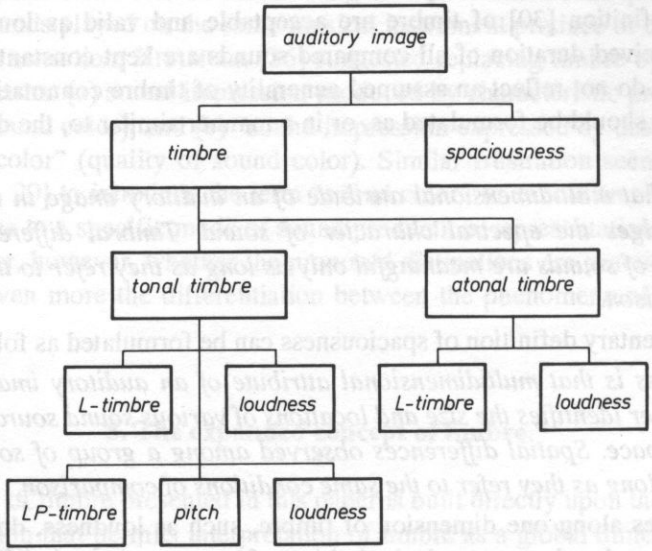

FIG. 1. Basic elements of a hierarchical model of the auditory image based on the concept of "residual dimensions" (X – timbre).

The X – timbre method of labeling the timbral subspaces is very flexible and cannot be outgrown. It constitutes a solid frame of reference needed for the future development of more specific attributes of auditory image which are necessary for parametric sound assessment [21]. Those among the readers who feel appalled by the "technical" character of X – timbre terms may always assign and define one or more "operational" labels and use them instead of X – timbre terminology. Such operational labels may be especially useful when particular timbral subspaces are widely and frequently used; e.g. LP – timbre subspace. In the case of LP – timbre, such a term might be "spectral timbre" or the "spectral color", which has already appeared in that context in the literature [24, 42]. In fact, as long as the concept of timbre presented in this study is used, the actual labels of timbral subspaces are of secondary importance providing they are clearly defined and generally acceptable. The readers are invited to help in developing such operational labels for frequently used subspaces.

6. Timbre vs. tone color

Most dictionaries and professional publications on music and acoustics are in agreement that timbre and tone color are two synonymous terms. Usually a third term, sound quality, also is added to this list. The term tone by itself, however, refers to a sound

which has a particular and usually well-defined pitch [31, 44]. Tone color, therefore, implies the tonal property of sound and should be used within such limits. Thus, it should only denote the timbre of a sound that has a defined pitch (tonal timbre).

According to the above interpretation, the sound having tone color always possesses timbre but the reverse statement is not always true. Therefore, tone color should be regarded as a timbral subspace rather than as a synonym of timbre.

Tone color is that attribute of an auditory image that reflects the listener's impression of the spectral character of a defined-pitch (tonal) sound and its changes under defined listening conditions.

Such a meaning of tone color is broader than the connotations given to "musical timbre" and "instrumental timbre" in music (e.g., [11, 36]) since it embraces defined-pitch noises and impulse sounds. The presented concept of tone color is also different from that of PLOMP [28], who suggested the possibility of using tone color to refer to the perceptual differences between steady-state complex tones.

7. Timbre vs. sound quality

As noted before, timbre, sound quality, and tone color, are traditionally regarded as synonymous terms [6, 11, 14, 32, 33]. The Random House Dictionary [31] refers to acoustic quality as "the texture of a tone, dependent on its overtone content, that distinguishes it from others of the same pitch and loudness", and to phonetic quality as "the tonal color, or timbre, that characterizes a particular vowel sound." Not everybody, however, follows such a concept. OLSON [27], for example, described timbre as "an instantaneous cross-section of the tone quality." FISHBURN [8] defined timbre as "tone quality plus tone color," and ŁĘTOWSKI [19, 21] described sound quality as the emotional aspect of timbre.

In general, quality may be broadly defined as a set of properties (features, characteristics) of a given object that determine the object's capacity to fulfill a particular need. The term quality refers, therefore, to both the designated character of an object and to the merit of its superiority. In the domain of psychoacoustics, the first of these meanings is parallel to the connotation of timbre while the second meaning is a unique one. Sound quality, therefore, can either imply timbre or a rating or emotional assessment and, in such cases, cannot be viewed as an equivalent to timbre which is emotionally neutral and simply represents differences among auditory images. One timbre is no better than another unless we set up a target (reference point) and judge the excellence of fit or superiority of one fit over another. Therefore, it seems logical to differentiate between timbre (perceptual attribute) and quality (emotional attribute) of sound. This permits timbre to reflect sound categories while sound quality reflects superiority, fit, and the listener's level of appreciation. Such a differentiation reflects well in the types of scales used for multidimensional (parametric) assessment. Timbre constituents are those which are assessed on the dominance or similarity scales, while quality components are assessed on the preference scales [19].

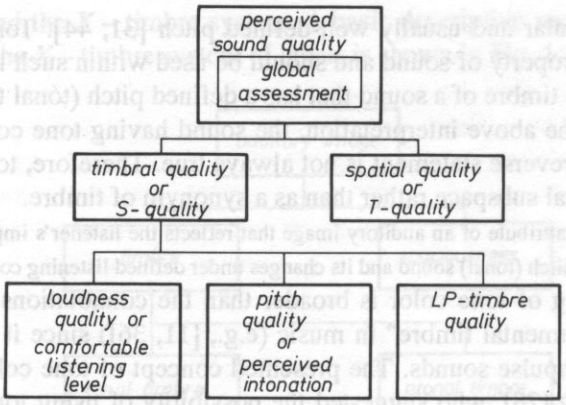

FIG. 2. General outline of a hierarchical model of sound quality assessment.

There is one more practical reason to differentiate between timbre and sound quality. Sound quality frequently extends beyond timbre and incorporates an impression of spaciousness. In such cases one may talk about timbral as well as spatial quality of sound. These two qualities merge together in the overall quality of sound. Sound quality, therefore, should be defined generally enough to embrace all of these meanings. Such a definition is proposed below.

Sound quality is that attribute of an auditory image in terms of which the listener can express his/her satisfaction or dissatisfaction with that image. Sound quality can be judged by comparing images produced by several external stimuli or by referencing a perceived image to the concept residing in the listener's memory.

Similarly as for timbre, we can differentiate between various "residual" subspaces of sound quality and label them correspondingly. For example, we can single out the spatial quality (timbre-equalized quality, or T – quality), loudness-equalized quality (L – quality), or loudness/pitch-equalized quality (LP – quality). The basic elements constituting the general frame of the timbral quality assessment are shown in Fig. 2. The terms displayed in Fig. 2. are designed to be used when the precise information about conditions of quality judgments is essential. In everyday human communication, when such information is not sought, the general term "sound quality" may be sufficiently descriptive.

8. Conclusions

The discussion presented above outlined certain implications resulting from various interpretations and/or understandings of timbre, tone color, and sound quality. The author's definitions of timbre, tone color and sound quality clearly differentiate between the denotations of these three terms. The author advocates a more general interpretation of timbre, than it is found in majority of textbooks on musical acoustics and psychoacoustics. His definition of timbre embraces both loudness and pitch as timbral dimensions. His concept of X-timbre extends the meaning of timbre also to smaller,

$(N - k)$ – dimensional, perceptual spaces ($k = 0, 1, 2, ..., N$). According to the author's belief, such a generalized concept of timbre and separation of timbre from tone color and sound quality, clear the way toward effective parametric description of auditory images.

Ideas presented in this paper are intended to make psychoacoustical terminology less ambiguous and more practical. The author hopes that his suggestions clarify rather than just modify existing terminology. Nevertheless, the concepts and suggestions presented in this article are only propositions and an invitation to join the efforts in making sound description and assessment clearer and more meaningful.

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Received on October 30, 1990