

SOUND COLOR

by Wayne Slawson

Berkeley and Los Angeles,

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Reviewed by

Steven Block

Wayne Slawson spent ten years formulating an initial theory of timbre. The fruits of that labor, *Sound Color*, received the 1987 Society for Music Theory "Outstanding Publication Award" and this monograph should help initiate a long overdue revolution in the consideration of timbre as a structurally controllable musical resource.

The complexity of the nature of time immediately asserts itself when an opening definition of "sound color" is sought. While Slawson quotes the American Standards Association's simple definition of timbre as "the way two sounds of the same loudness, pitch, and duration differ," his explanation of sound color as a distinct aspect of timbre is abstract, since it demands a lengthy explanation of sound color production in order to narrow the range of the term's inclusion. One instinctively understands Slawson's illustration of "graininess" or "attack characteristic" as aspects of timbre which are *not* properties of

sound color. However, while the source-filter model¹ is used to provide a clear illustration for the rules of sound color and the scope of the sound color universe, a concise definition is never offered.²

The first rule of Slawson's theory is as follows: "To keep the color of a sound constant, keep the resonance frequencies (F_1, F_2, F_3 , etc.) and bandwidths (B_1, B_2, B_3 , etc.) constant."³ This definition is arrived at after the theory is limited to sound produced solely by electronic means. (Instrumental color is the result of a complicated source-filter interplay since the filter (the instrument itself) changes as pitch changes. Sound color, therefore, may not be held invariant with respect to pitch when produced by instrumental means.) The above rule is restricted further to filter systems which do not produce anti-resonances, and constrained to use in systems with "adequate sources," sources which excite at least two or three resonances in a filter.

¹ A knowledge of resonance curves and spectrum envelope is assumed in the following discussion. A brief explanation of the source filter model can be found in Slawson's earlier article, "The Color of Sound: A Theoretical Study in Timbre" (*Music Theory Spectrum* 3 (1981), p. 133-134), while a more thorough investigation of all the ramifications of the model which lead to the first rule is the subject of Chapter 2 in *Sound Color*.

² It is clear that Slawson's method is to introduce the reader without an acoustics background to various terms via illustration. Nevertheless, the inquiry into sound color is more vague at the outset for lack of a definition. I offer the following definition based on a discussion with Robert Morris:
Sound Color is the subjective correlate of a two-peaked transfer function imposed on the spectrum of a sound.

³ *Sound Color*, p. 42.

The dimensions of sound color are addressed in the second rule: "Sound Color has the dimensions of **openness**, **acuteness**, **laxness**, and **smallness**. These dimensions are defined by the equal-value contours shown in Ex. 1. To hold sound color constant with respect to one dimension, change the values of F_1 and F_2 in such a way as to remain on one of that dimension's equal-value contours."⁴ Here Slawson borrows from linguistic theory in positing that the distinguishing features of vowels are ultimately the means of the discovery of sound-color dimensions. One hears, then, that the dimension of **openness** corresponds to the vocal mechanism of producing vowels so that moving along the x-axis produces vowels which have an increasingly open sound ("boot," "boat," "bought"), while vowels along the vertical plane have equal-openness. Similarly, the term **acuteness** refers to the "bright" quality of the vowels whose dimension increases in the converse manner to **openness**--so that a sequence along a vertical plane such as "bought," "balm," "bad," increases in **acuteness** but is equal in **openness**. (Incidentally, the word "bad" is high in both **openness** and **acuteness**.) **Laxness** corresponds generally to the shortness of the vowel sound so that the center of a contour graph is its most lax point; the edges of the graph, of course, are least lax.

The dimension of **smallness** was not described in Slawson's earlier article (see footnote 1) and is one which he himself later suggests

⁴ *Ibid.*, p. 57.

might not be as perceivable as the other sound color qualities he postulates. This dimension is more easily understood graphically, as the diagonal lines along the F_1 - F_2 planes, but the sequence "nuke," "neck," "knack," one of increasing **smallness**, is not easy to differentiate aurally from a sequence of increasing **acuteness** and **openness**. Slawson's rationale for this dimension is supported only by the third part of his theory, which deals with the organization of the dimensions of sound color.

Detailing operations on sound color forms the mainspring of the theory, as Slawson attempts to derive a universe of sound color space which is analogous to the types of pitch systems developed by Forte, Lewin, Starr, and Morris. Slawson's last rule defines transposition and inversion in sound color space with respect to each of the above dimensions. Thus, *transposition* effects a particular sequence of colors within any of the four dimensions and a defined sound color universe by the addition of a constant value which preserves the direction and size of the distances of the original sequence. *Inversion* involves a negation of a value within the dimension (Ex. 2 illustrates **acuteness** transposition and **smallness** inversion). Slawson considers the wrap-around of the sound color dimension to be akin to the modulo octave in pitch-class space, the space itself as being varied as 24, 9, or 12 elements.

Chapters 3-6 are among the most valuable of the book and contain acoustic, scientific, and musical evidence in support of

Slawson's theory which was not cited in his earlier article. Though, as Slawson himself points out, the musical evidence is hard to verify since it depends in large part on the reader's agreement with the analysis of the music provided. The provision of such evidence is seminal to the intentions of the author both to provide an explanation of an aspect of timbre and to generate future compositions which utilize sound color organization. The musical evidence is also important to the theory since it verifies that such concepts as invariance, transposition, inversion, and differentiation of the four sound color dimensions can be heard.

The final chapter of *Sound Color*, one which has revolutionary implications for its practical usage in composition, defines both the various ranges of sound color space and the operations which can be utilized with respect to sound color--operations analogous to those in pitch-class space of differing cardinality. Just as **closure** is an important property for the aggregate of a pitch-class universe in which one defines transformations occurring **within** the aggregate, so it becomes a central property around which sound-color collections must also be derived. In defining sound-color collections, however, closure becomes problematic with respect to the property of **laxness** because in reasonably-sized collections which approach closure with respect to **smallness**, **openness**, and **actueness**, the **laxness** property may be relevant only with respect to one operation. The 9-element collection which Slawson utilizes (Ex.1), for instance, is a collection in

which eight of the elements are equally non-lax with respect to the lax element "ne." Utilizing the transposition operation, any of the eight elements would be transformed to "ne," and further transposition would generate short-vowel colors that are not part of the collection. Slawson defines the term **normal**, then, as applying to collections which are closed for transposition inversion with respect to the other three dimensions of sound color. In this way, the transformation possibilities are a bit more manageable. The transformation of the above 9-element set, then, with respect to transposition and **acuteness**, can be defined as the following operation using cyclic notation: (uu oe ii) (oo ne ee) (aw aa ae). The **smallness** dimension yields cycles of differing length along the diagonal contours, and thus, with respect to transposition, yields one 3-element cycle and two 2-element and 1-element cycles ((uu ne ae) (oo aa) (oe ee) (aw) (ii)). For inversion, however, the 3-element cycle is reduced, since "closure" means that the outer elements invert into each other around the axis of "ne," which naturally inverts into itself: (uu ae) (ooaa) (oe ee) (aw) (ii) (ne).

The above has ramifications for any size sound-color space, and perhaps more so for a 12-element sound color space (Ex. 3)--which is defined by Slawson, and which becomes more meaningful when viewed in terms of combinatoriality. Transposition in this space, with respect to **openness**, for instance, yields the following cycles: (uu oo aw) (uh ah) (oe aa) (ih eh) (ii ee ae). Multiple operations in sound-color

space can then be defined for each dimension within any sound color space, with only the modulo number needing to be changed in accordance with the cardinality of the specific series for any of the operations.

Slawson demonstrates multiple operations and combinatoriality through the example of his own composition with the 9-element series. In the matrix below (Ex. 4), combinatoriality is defined for a 9-element universe and with respect to openness. An initial ordering of the sound-color universe is then transposed or inverted with respect to a particular dimension and combined with other orderings of the same collection to produce secondary sets. The 12-element sound color universe certainly suggests some interesting mappings between sound-color and pitch-class universes.

Aside from a few typos, *Sound Color* is relatively free of technical errors. One strong suggestion for a second edition of this book would be either an appendix or an inclusion in the text of a chart detailing the vowel sounds represented by the symbols used. There is no primary source given to look up these vowels, and at the very outset, where explanations of the sound color dimensions are first given, and where knowledge of the vowel sounds is essential, no definition is produced. While readers with a background in linguistics will recognize the sound of the vowel symbols, some music theorists

or composers may not be able to intuit easily the meaning of the particular symbols.⁵

Some of the difficulties with Slawson's theory are alluded to above--or pointed out by Slawson himself--but it would be appropriate to reiterate that the central limitation of sound color is its application solely to electronic sound. This limitation alone might seriously damage Slawson's hope for pursuance of his theory via compositional experimentation, particularly since the organizational aspects of the theory, as espoused by Slawson, are not common concerns of many contemporary composers of electronic music.

On a very simple perceptual level, Slawson himself addresses the limitations of the listener. How much education may be necessary to hear individual sound color dimensions, and what cardinality of sound-color space is perceptually discernible, will need to be explored. The more complex problem of whether **smallness** is perceptually recognizable creates further difficulties when considering its importance in defining the closure of the various sound color spaces that Slawson proposes for use in compositional organization.

Since Slawson's basic logic in developing an initial study of sound color has been to apply laws used with respect to pitch, thus paving the way for further extensions of the theory (e.g. similarity, other set-operations), it is not surprising that combinatoriality is

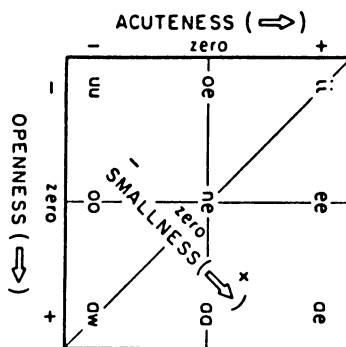
⁵ The sound of [oo], for instance, is that of the long vowel "o," but that of [ii] is not, respectively, that of the long vowel "i," but rather of long vowel "e."

introduced. However, the very essence of combinatoriality, its usefulness for pitch organization, and its perceptibility, may rest upon the 12-element pitch-class space to which it primarily has been limited. It takes an ardent leap of faith to assume that a knowledgeable listener could be taught to hear a 9-element aggregate sound color collection passing by in relation to other related ordered arrangements of the 9-element sound color universe. Considering the wide variety of cardinalities possible for sound color space at the present time (since no norm has been established through usage), it is unlikely that combinatoriality could be adequately discerned. It is more likely that the best scenario created by such organization would be one in which a listener would have a general idea of saturation of sound color, an idea which may be antithetical to the education of listeners with respect to that parameter of timbre.

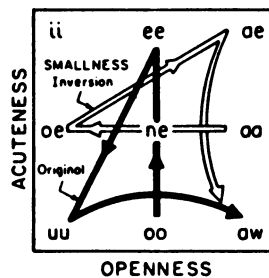
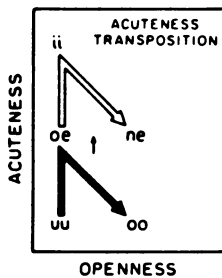
The above reservations are quite minor when considering the elegance of the general theory and its fine presentation. It is the deft organization of this book that makes it possible to reach a rather wide audience, ranging from those concerned with music perception research to composers interested in sound color manipulation. Slawson builds his theory in a logical and hierarchical manner, letting very little data, even if it detracts from the theory, slip by. At the same time, the generalizations which result from the concern with reaching a wide audience are sometimes a weakness, since the book leaves all of us concerned with the necessity for further experimentation in many

musical areas. The bibliography is a gem which will enable the uninitiated to plunge into primary source material on the subject in great depth. It alone may help to bring about the greater awareness of the nature of timbre that Slawson seeks. One can only hope that sound color and timbre in general will become more thoroughly researched in the future and that theories such as Slawson's will provide a means to elucidate existing compositions and to encourage further development of timbral organization.

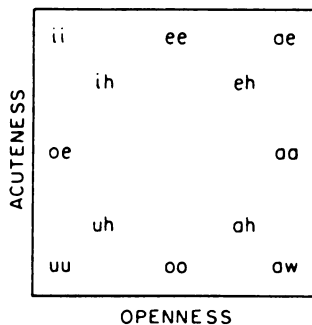
Example 1



Example 2



Example 3



Example 4

		AGGREGATE 1	AGGREGATE 2
(a)	Prime	[oo ee uu aw	ii ae oe aa ne]
	Retro. (IO)	[ne oe aa ii ae	uu aw ee oo]
(b)	Prime	[oo ee	uu aw ii ae oe aa ne]
	Retro. (IO)	[ne oe aa ii ae uu aw	ee oo]