dissertations

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Tonal orientation in Skriabin's preludes: an analysis on the basis of information theory

1965 unpublished master's thesis, University of Texas.

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An important class of musicological problems is summarized in the scheme: given a musicological statement true of certain musical compositions (or pairs of compositions, etc.), to find a music-theoretical statement true of exactly the same compositions.

Let us suppose, for example, that we know which one of any two Skriabin piano preludes is chronologically earlier. Almost certainly this knowledge is based not on music-theoretical considerations exclusively, that is, it is not knowledge computed just from the notes, rests, clefs, and other primitive symbols of current common musical notation that in some particular order constitute one Skriabin prelude and in a different order constitute another prelude. It is knowledge based, seemingly to a large extent, on such "external" evidence as dates written on the original manuscripts, publishers' plate numbers, watermarks, and correspondence by or to the composer. The problem according with the above-mentioned scheme is to discover whether Skriabin's "style" as reflected in his preludes changed progressively as he aged and if so, to determine music-theoretical properties that preserve this progressive change. (A fuller description of the problem would make explicit the disallowance of "trivial" solutions, possible because of the finitude of the corpus, that require no internal analysis of the preludes and therefore cannot be extended to a case where "external" evidence is insufficient to determine a prelude's chronological place.)

It seems fair to say that music-theoretical investigations have not occupied musicologists to an extent proportionate to the importance of music theory in musicology. Perhaps to compensate this gap, several (mostly nonhistorical) musicologists have looked to the eminently successful mathematical theory of communication for concepts or techniques useful to

[1]See, for example, Joel E. Cohen, "Information Theory and Music," *Behavioral Science* 7:137–163 (1962), and Lejaren A. Hiller, Jr., "Informationstheorie und Computermusik," *Darmstädter Beiträge zur Neuen Musik* 8(1964).

musical theory.[1] Mr. Hughes, who (I quote from his *vita* sheet) earned the degree Bachelor of Music in Piano Pedagogy from the University of Texas and stayed to do graduate work, writes that "The Information Theory, as defined by Claude Shannon and Warren Weaver . . . , is, for practical purposes, divided into two general areas acceptable in musicology as well as in other fields: Conception and Perception" (p. 2). However, as will be evident, Hughes's characterization of his treatment of the Skriabin preludes as information-theoretic in the Shannon tradition is mistaken. (Indeed, Hughes miscopies Shannon's well-known formula as $\Sigma_i\ p_i\ 1\ d\ p\ _i$ (p. 10). Although the contents of p. 10 are attributed to Fritz Winckel, Hughes's unannotated presentation, twice, of "l d" instead of "log," encourages a suspicion that Hughes does not know what he is writing about here.) Nevertheless, I will examine Hughes's contribution. Though his procedures are almost purely music-theoretical, I am unable to regard them as a substantial contribution to the stylistic problem which (I believe—he does not say) Hughes endeavours to solve.

Most of the thesis (pages 31 through 186) belongs to Chapter IV, entitled "Results of the analysis of the preludes." Nearly all of this chapter consists of graphs and other tabulations of numerical data that Hughes calculated from 80 Skriabin piano preludes by procedures he presents in eight steps. These steps are outlined below. Because some of Hughes's verbal constructions are idiolectal and unkeyed to standard English, I am unsure that I have reproduced always the meaning he would convey.

Step 1. The "note-duration" of each note in a prelude can be expressed as a fraction of the beat (which usually is specified by the time-signature denominator). Hughes calls this fraction the "bit value" of the note. The sum of all the bit values belonging to a prelude—one bit value for each note—is called the "bit" of that prelude, e.g., for Opus 11, No. 1, Hughes computes "Bit = 105.45."[2] Consider two notes of the same *note-type*[3] if they represent the same pitch and do not differ enharmonically; consider two notes of the same *note-type-type* if they represent the same pitch-class and do not differ enharmonically, though they may be octaves apart. Following Hughes, extend the notion of "bit value": the bit value of a note-type for some prelude is the sum of the bit values of every note in the prelude that is in the note-type; the bit value of a note-type-type is the sum of the bit values of every note in the prelude that is in the note-type-type. Hughes presents two graphs for a prelude. Arranging the note-types along the x-axis in ascend-

[2] I have made no attempt to check Hughes's numerical calculations in general, though in the course of preparing this review I did find some errors. Occasionally, decisions were required by the calculator that are not included in the calculation procedures Hughes presents. For example, in the left-hand part of the antepenultimate measure of Opus 11, No. 1, Hughes apparently assigned to each note the bit value $\frac{1}{3}$, whereas the bit value $\frac{2}{5}$ seems to me correct. The cited situation is complicated because the rhythm is not noted in current common musical notation, but the bar placement seems to disallow Hughes's "five-against-three" interpretation. Naturally, questions such as this must be resolved before one can recognize the utility of the bit of a composition as an objective measure.

[3] All technical terms italicized in this review are my invention; they seem more appropriate to a brief statement of Hughes's work than his own expressions.

ing scalar order (C-double-sharp in some octave would precede D-flat in that octave), but excluding from a place in the graph all note-types whose bit value for the prelude is zero, Hughes plots the positive bit values as *y*-coordinates and draws a straight line connecting adjacent points, resulting in a *one-graph*. Similarly, a *two-graph* is a graph of occurring note-type-type (in ascending order) against positive bit value. Hughes then computes what he calls "arithmetic mean one" for the prelude: the sum of the bit values of all note-types that are relative maxima in the one-graph, divided by the number of such relative maxima. He calls a note-type "important" (to the prelude) if its bit value is greater than arithmetic mean one and arranges the important note-types in order of decreasing bit value (in this arrangement all but the most important one of "octave-equivalent" note-types are discounted).

Step 2. All sequences of three or more successive points in the two-graph of a prelude, such that the first and last but no intermediate points of the sequence are relative maxima or relative minima in the two-graph, are assigned a measure of "complexity" that is obtained as follows: compute the arithmetic mean of the bit values of the note-type-types constituting the end points of the sequence; subtract this number from the bit value of each intermediate point in the sequence; display the resultant sequence of one or more signed numbers. (For this computation the two-graph is presumed to continue endlessly from the last occurring note-type-type to the first occurring note-type-type.) Then "arithmetic mean two" is got: the bit values of all note-type-types in the two-graph, divided by the number of such note-type-types.

Step 3. The "important" note-type-types (that is, the note-type-types that are relative maxima in the two-graph, even if their bit value is not greater than arithmetic mean two) are arranged in order of decreasing bit value. "If possible," writes Hughes, "an attempt to perceive a tonal orientation is made at this point" (p. 23). This may be done by comparing the set of important note-type-types with major or minor scales.

Step 4. The set of important note-type-types is compared with possible "Skriabin chords," that is, chords possessing the directed semitonal-interval structure 6 - 4 - 6 - 5 - 5. Identities or near-identities are noted.

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[4]Professor Hans-Heinz Draeger, who served as supervising professor for Hughes's thesis, presented a paper entitled "An attempt towards a semantics of chordal progressions" at what Hughes calls "the International Congress of the Musicological Society at Salzburg on September 4, 1964." I am extremely indebted to Professor Draeger for making available to me an outline of his presentation. Draeger's outline begins:

> The basic idea:
> each step in the circle of fifths upwards results in a tendency towards an open, a non-final effect;
> each step down in the circle of fifths results in a tendency towards a closed, a final effect.

Proceeding from this basic idea, Draeger introduces the concept I call Draeger numbering and extends this to chords (the Draeger number of a chord is the sum of the Draeger numbers of the note-type-types instanced by chord elements) and to chordal progressions.

Step 5. Each important note-type-type, together with every other note-type-type whose bit value is greater than arithmetic mean two, is assigned a *Draeger Number* from the following table:[4]

Note-type-type:	D♭♭	A♭♭	E♭♭	B♭♭	F♭	C♭	G♭	D♭	A♭	E♭	B♭	F	C	G
Draeger number:	1	2	3	4	5	6	7	8	9	10	11	12	13	14

Note-type-type:	D	A	E	B	F♯	C♯	G♯	D♯	A♯	E♯	B♯	
Draeger number:	15	16	17	18	19	20	21	22	23	24	25	etc.

From the set of all Draeger numbers so assigned, presuming it has more than one element, one can compute the integer that is the smallest positive difference between any two Draeger numbers in the set (e.g., the integer 1 if there are consecutive numbers in the set); also, one can compute the largest positive difference. Call the sum of all natural numbers between and including the smallest positive difference and the largest positive difference the *complexity numerator.* Hughes's "degree of tonal complexity," which is computed for each prelude, is obtained by dividing the complexity numerator by $\frac{1}{2}(r + r^2)$, where $r + 1$ is the number of elements in the set of Draeger numbers so assigned. The "degree of tonal complexity" is 1 if the note-type-types to which Draeger numbers are assigned are all "circle-of-fifths connected"; otherwise, the "degree of tonal complexity" will be greater than 1. Hughes reports that "there is conjecture that this tool could successfully be used to indicate more clearly the differences between Classical and Romantic music. There is indication that the most complex tonally orientated composition of the Classical period would still have unbroken consecutive arrangement (i.e., the assigned Draeger numbers would form an arithmetic progression with 1 as common difference), and that there would be a clear departure from this phenomenon in Romantic music" (p. 28).

Step 6. The sum of all the Draeger numbers so assigned, divided by the number of such numbers, is referred back to the given table, and "pinpoints the location of the Prelude as shown by the Circle [of Fifths]" (p. 28). The interpretation of non-integral quotients is not made clear.

Step 7. Exactly the same as *Step 5*, except that important note-type-types alone are considered.

Step 8. The signed difference of the "degree of tonal complexity" obtained in *Step 5* from the corresponding "degree of complexity" obtained in *Step 7* is computed.

Clearly, Hughes has made an unusual and, for the most part, an original choice of measurements. Since Hughes explicitly distinguishes (p. 15 and elsewhere) "tonal orientation," which is his concern, from "tonal organization," which has been a central concern of musical theorists for several centuries, the necessity for unusual measurements should cause no surprise, whatever one takes "tonal orientation" to mean. Hughes writes that tonal orientation "is meant to be the occurrence of each note and its durational value" (p. 15). But this is not of much help. The unfortunate ambiguity of the word "tonal"—it may mean "pertaining to tone" and it may mean "pertaining to (some formulation of) tonality"—often remains unresolved by the context in which the word is used in this thesis. I propose that, in future writing, "tonal" be reserved for "pertaining to tone," and would introduce "tonalistic" for "pertaining to tonality."

The crucial questions that an evaluator of Hughes's work must ask are: What are Hughes's hypotheses? What measurements does he extract to test these hypotheses? Do these measurements, or data computed from them, confirm or infirm the hypotheses? Was Hughes's laborious data-collection effort necessary, or are there simpler ways of obtaining the same results?

We find that Hughes neither articulates any specific hypotheses about Skriabin's preludes nor puts the data he has collected to any significant use. Indeed, all that Hughes provides, besides the data he obtained by following the eight steps and an introduction to and explanation of these steps, is: a list of the 80 Skriabin preludes arranged by most important scale-degree (e.g., tonic, dominant, flatted supertonic) in the *Step-3* sense (pp. 23–24); a list of these preludes, classified by circle-of-fifths location in the *Step-6* sense, and sub-classified by key (pp. 190–195); and a list and graph of the *Step-8* figures arranged by increasing opus number (pp. 196–198). Hughes's comments on this graph, the culmination of his thesis, are:

> Since the 0 line is a result of a subtraction of Step 5 from Step 7, 0 indicates the axis of tonal orientation, above or below which every tonal composition has to be placed. This chart shows the development of Skriabin's style in this regard. It is important to notice that Op. 11, No. 15, an entirely diatonic composition, is one of the three Preludes placed on the 0 axis, and that the deviations are very slight through Op. 37. The first major departure from tonality . . . occurs in Op. 33 where orientation begins to be conceived in terms of the Skriabin Chord. Then in Op. 35 and Op. 37, this consistent development of tonal orientation regresses. But this regression is momentary as a striking attempt toward atonality is described in Op. 39 through Op. 74. A comparison of other composers, by this procedure, is a task for future research (p. 198).

Surely the fact that Skriabin's later preludes are more "chromatic" than his earlier preludes was well-known before Hughes; equally surely, Hughes's methods have achieved no noteworthy quantification of the situation, and a graph such as Hughes's last graph, which looks comparatively placid on the left end and comparatively inquiet on the right, could have been produced by sampling methods that would not have required Hughes to spend so much of his time as a computer. And surely Hughes deserves criticism for having become engaged in a data-collection procedure of this magnitude without clear hypotheses, without justification of the unconventional measurement criteria, and with hardly any comment on the results other than "they are here."

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