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From the Editor

Volume Seven of the Journal of Music Theory Pedagogy has a somewhat different format. We have prepared the issue from electronic manuscripts submitted by the authors and have changed several design aspects. Most important for the readers, endnotes in each article are now footnotes on each page, a change we hope will simplify following the references in the text. We are much indebted to the work of Sarah Schaffer, the new production editor, and to the technical advice provided by John Schaffer. We appreciate very much their contributions of time and expertise.

This issue contains several articles on music cognition research as applied to aural skills pedagogy—articles that in an earlier form were part of a special session of the Society for Music Theory conference in the fall of 1992. Complementing these articles is a review of David Butler's guide to perception and cognition. We hope this group of papers will provide both practical suggestions and challenging ideas on a topic of great current interest.

Our reviews editor has also chosen Michael Friedmann's book on twentieth-century ear training to be discussed. We encourage readers to respond, both pro and con, with their experiences in teaching this difficult repertoire. In Volume Eight we expect to have articles about this subject from different points of view, including Professor Friedmann's comments about his own pedagogy.

Other articles in this issue consider a variety of subjects: ways of incorporating different types of analysis and prose writing into the theory curriculum, new uses for technology, and an examination of the learning process itself. Winold and Lord both discuss the differences between objectivist and constructivist paradiagms and what effects such differences can have on how we teach.

The end of this volume includes revised guidelines for contributors. We have prepared more detailed guidelines for electronic manuscripts and a style sheet, which are available upon request. We look forward to receiving your submissions and comments.

Mary Wennerstrom
Indiana University

A Systematic Approach to Invariance in Twelve-Tone Music

Timothy R. McKinney

Integrating theories of twentieth-century music into the traditional four-semester undergraduate theory core presents several challenges to the instructor; at many institutions, however, the basic theory sequence provides the only vehicle for exploring the structure of more recent music. The problems include accelerating the pace of traditional harmony study and grappling with the immensity and diversity of the twentieth-century repertoire. While both problems are perplexing, the latter presents a more serious stumbling block for both instructors and students.

In a recent article David Mancini defines one danger encountered when incorporating twentieth-century theory in the basic sequence: after rigorous study of tonal harmony, a short survey of newer music seems superficial because of a "lack of precise theoretical and analytical tools traditionally available to students at this level."[1] Mancini focuses his discussion on the identification and comparison of pitch collections. Noting that labels such as *polychord* or *mixed-interval chord* have limited analytical application, he proposes a distillation of set theory in order to provide students with "a systematic method of presenting analytical conclusions."[2]

Mancini addresses two fundamental pedagogical issues: (1) What do we want students to learn about this music? and (2) What tools will

[1]David Mancini, "Teaching Set Theory in the Undergraduate Core Curriculum," *Journal of Music Theory Pedagogy* 5/1 (Spring 1991): 95.

[2]Ibid. In a related vein Joel Phillips suggests in his review of Stefan Kostka's *Materials and Techniques of Twentieth-Century Music* ["Review of Three Twentieth-Century Texts," *Journal of Music Theory Pedagogy* 5/2 (Fall 1991): 201-213] that Kostka spends an inordinate amount of time placing descriptive labels (mystic chord, quartal chord, etc.) on sonorities that can be described more precisely through set theory. Kostka does introduce set theory in his text; Phillips chides him for clinging to ambiguous descriptive labels as well. The conflict arises from the interaction of the traditional survey-oriented, descriptive approach to teaching twentieth-century music with the current trend toward utilizing more precise and meaningful analytical tools. Kostka attempts to cover both bases.

contribute most effectively to the learning process? Do we want the class to acquire a set of descriptive labels, or would we rather they have a systematic analytical method capable of elucidating musical relationships and structure? The answer seems clear, yet the time-constraint obstacle looms large. We cannot expect sophomores to deal with professional theoretical and analytical systems without risking general insurrection; but, as Mancini argues, we can with effort distill these theories into more accessible form.

My purpose in the present paper is to examine these two basic issues, the goals and the tools of learning, in light of the pedagogy of twelve-tone theory. Much of this pedagogy falls into the "descriptive labeling" category. Students learn what a row is, learn its basic transformations (transposition, inversion, retrograde, and retrograde inversion), learn how to construct a matrix of the forty-eight common row transformations, and learn to "chase" the row through a given composition. When they have completed their analysis, what have they learned about the music? They have learned about as much as they would by labeling every vertical sonority in the second movement of William Schuman's *Three-Score Set* as a polychord. Or, to make the point more dramatically, they have learned what they would by labeling tertian chords according to their scale-degree roots, yet not considering voice leading or functional relationships among the scale steps.

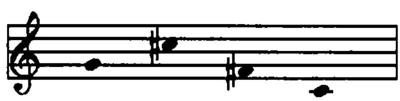
Little wonder that students often respond by branding twelve-tone music as meaningless mathematical machination. They have not been provided with tools that allow them to appreciate the musical side of serial music, but rather have been taught to do elementary math. Due often to time pressures, the student likely learns little of factors governing the composer's construction and utilization of the row, and of concepts such as combinatoriality, invariance, and derived rows. Assuming that twelve-tone theory is approached from the grounding in elementary set theory that Mancini proposes, combinatoriality and the derived row may be presented without excessive strain on student mental fortitude. Current twentieth-century textbooks by Joel Lester, Stefan Kostka, and Joseph Straus follow this approach to a greater or lesser extent.[3]

[3]Joel Lester, *Analytic Approaches to Twentieth-Century Music* (New York: W. W. Norton, 1989); Stefan Kostka, *Materials and Techniques of Twentieth-Century Music* (Englewood Cliffs, NJ: Prentice Hall, 1990); Joseph Straus, *Introduction to Post-Tonal Theory* (Englewood Cliffs, NJ: Prentice Hall, 1990).

Invariance proves more slippery; yet it is perhaps most significant from a musical standpoint. Precise tools accessible to the undergraduate student for understanding this concept are lacking. Although the principle of invariance has been examined extensively in the professional literature, many studies brim with algebraic formulae and complex calculations unsuitable for the average undergraduate classroom and are not for the mathematically faint-at-heart.[4] What I propose is a distillation of invariance theory using extensions of existing methods into a form comprehensible to undergraduate students within a limited time, a distillation that propels the student further into the musical intricacies of the twelve-tone universe. I will first examine the basic aspects of set and twelve-tone theory prerequisite to the study of invariance and survey the treatment of invariance in recent textbooks. My proposed method will then be introduced and applied in a brief analysis suitable for classroom presentation.

FIGURE 1. Calculating best normal·order

a.



b. G C C# F# (G)

c.	C	C#	F#	G	F#	G	C	C#
	0	1	6	7	0	1	6	7
d.	C	C#	F#	G	F#	G	C	C#
	7	6	1	0	7	6	1	0

[4]The classic studies of invariance include Milton Babbitt, "Twelve-Tone Invariants as Compositional Determinants," *The Musical Quarterly* 46 (1960): 246-259; Donald Martino, "The Source Set and its Aggregate Formations," *Journal of Music Theory* 5 (1961): 224-273; Allen Forte, *The Structure of Atonal Music* (New Haven: Yale University Press, 1973); David Lewin, "A Theory of Segmental Association in Twelve-Tone Music," *Perspectives of New Music* 1 (1962): 89-116; David Beach, "Segmental Invariance and the Twelve-Tone System," *Journal of Music Theory* 20/2 (1976): 157-184; and John Rahn, *Basic Atonal Theory* (New York: Schirmer Books, 1980).

The concepts from set theory that provide a useful foundation for the exploration of twelve-tone theory include pitch class (employing modulo 12 integer notation), interval class, best normal order and set class, and set symmetry. Recognition of symmetrical sets, the most difficult of these concepts to grasp, can be facilitated if approached as a by-product of placing a set in best normal order. Confronted with a set such as that shown in Figure 1a, the student first writes the set in scalar order, beginning on any pitch and repeating the first pitch at the end in parentheses (Fig. 1b). The student next looks for the largest interval between adjacent notes and marks it with a bracket. The instructor should explain the rationale behind this process, that normal order is a referential order that requires that the set be placed in the smallest possible range; we look for the largest interval because it will provide the boundaries of the smallest overall range when inverted. In the example the largest interval appears twice; thus there are two brackets, indicating that the set may be transpositionally symmetrical.

Next the student writes out the set beginning on the pitch(es) on the right end of the bracket(s), thus obtaining the normal order(s) of the set (Fig. 1c). At this point I have the student convert the set into integer notation in order to select best normal order and to identify the set class from a list of prime forms. This conversion is accomplished simply by setting the first pitch to zero and counting ascending half-steps from it. The best normal order likely will be the normal order containing the first smallest interval after the zero. If the normal orders prove to be identical, as in Figure 1, the set is transpositionally symmetrical, meaning that it may be held totally invariant under transposition.

The student is not yet through, however, because of the ticklish possibility that the set is inverted. I find that identifying inverted sets causes more consternation among undergraduate students than any other aspect of set theory. To alleviate this problem I stress that every set has a minimum of two normal orders: one read from left to right and one read from right to left, both spanning the smallest possible range of the set, but doing so from opposite directions.[5] Rather than

[5]The term *normal order* is used here to denote any ordering of a set that encompasses the smallest possible range. *Best normal order* denotes the ordering of the set within the smallest possible range that has the first smallest interval adjacency. This usage follows Forte (1973), 3-5, and differs from *normal form* as used by (among others) Rahn (1980), 31-38. Rahn's normal form is equivalent to Forte's best normal order. In later writings Forte often uses

introducing the complexities of inversion formulae, I merely have them "invert" the process by which they obtained the first set of numerals (Fig. 1d). The last pitch is now set to zero, and the student counts descending half-steps.[6] Now, out of all of the normal orders found through this process (four in the example), the best normal order is the one containing the first smallest numeral after the zero. If the same sequence of numerals appears reading both left to right and right to left, the set exhibits inversional symmetry and will be held totally invariant under inversion followed by transposition.

There are numerous methods and shortcuts for finding best normal order. The method I present here is not entirely original, nor is it my intent in presenting it to endorse it over other methods. I explain it in detail because it is the method the students with whom I have worked have understood and employed most readily, and because the explanation demonstrates that recognizing transpositionally and inversionally symmetrical sets can become an integral component of finding a referential order for a pitch collection. Symmetrical sets are important players in the realm of aspects of twelve-tone theory such as combinatoriality and invariance.

With these fundamentals of set theory in hand, twelve-tone theory may be grasped comfortably. Any of the numerous methods of constructing and labeling a twelve-tone matrix or list of row transformations may be used for an elementary introduction to the system without affecting later study of invariance. Whether the matrix is constructed using integers or pitch names, or whether a list of row transformations in staff notation is used, is irrelevant because, as will be shown below, we will be concerned initially with the intervals between pitches rather than the pitches themselves. In the present discussion, and in my classroom, I use a pitch-name matrix with a "movable zero" designation of row transformations (i.e., the original prime form is labeled "P0" regardless of its starting pitch). Since some students confuse order numbers with transposition numbers if both sets of numbers begin with zero, I thus use 1-12 for order numbers.

After finding the row and constructing some sort of table of row forms, the student can find the row throughout the remainder of the

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normal order to mean *best normal order,* for example in *The Harmonic Organization of 'The Rite of Spring'* (New Haven: Yale University Press, 1978), 3.

[6]Mancini's comments on the musical importance of inversional axes are well taken; the method for recognizing inversion given above is but a first step toward understanding the significance of inversional equivalence. See Mancini, 99-100.

work, labeling row transformations and order numbers. Kostka describes the traditional means of accomplishing this feat:

> Always work from a matrix. If you get lost, try to find several notes that you suspect occur in the same order in some row form, and scan the matrix for those notes, remembering to read it in all four directions.[7]

This method is time-honored, yet also time-consuming. Larry Austin and Thomas Clark offer a more precise method for analyzing serial music in their text *Learning to Compose*.[8] Their "serial-interval" method involves measuring each successive interval in a row according to the number of half-steps it contains when the second note is placed in a higher register than the first note, regardless of the actual relative register of the tones as they appear in the row. To illustrate, we take the row stated at the beginning of Webern's *Quartet*, Op. 22 (Fig. 2a) and write it out in letter names (Fig. 2b; normally the student would do this across the top of a matrix).[9] Next we count the number of half-steps from each pitch up to the following pitch; the specificity created by always counting up gives the system its value.[10] Accordingly, D-flat up to B-flat is nine half-steps, B-flat up to A is eleven, A to C is three, and so forth, continuing as in Figure 2b.

The serial intervals for the inversion of the row obviously represent the inversions of the intervals given in Figure 2b, and may be determined simply by taking mod. 12 complements (Fig. 2c). Because intervals are always reckoned upward, reversing the order of the pitches in retrograde forms also results in interval inversion: starting at the end of the row, G up to D becomes 7 rather than 5. Sharper students quickly notice that the retrograde pattern reverses the inversion pattern (compare 2c and 2d). In like fashion, the serial-interval

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[7]Kostka, 222.

[8]Larry Austin and Thomas Clark, *Learning to Compose: Modes, Materials and Models of Musical Invention* (Dubuque, IA: Wm. C. Brown, 1989). A similar system appears in Straus, 120-125.

[9]That the row stated at the beginning is actually P7 in Webern's original scheme is not of critical importance in the undergraduate classroom. Matrices built on Webern's original "P0" for each of his published works appear in Kathryn Bailey, *The Twelve-Note Music of Anton Webern: Old Forms in a New Language* (Cambridge: Cambridge University Press, 1991), 337-343.

[10]All of the intervals could be measured downward as well, but most students find reckoning upward more intuitive.

FIGURE 2.
Webern, *Quartet*, Op. 22, opening row and serial-interval patterns

a.

b. P0: Db Bb A C B Eb E F F# G# D G
9 11 3 11 4 1 1 1 2 6 5

c. I0: Db E F D Eb B Bb A G# F# C G
3 1 9 1 8 11 11 11 10 6 7

d. R(P0): G D G# F# F E Eb B C A Bb Db
7 6 10 11 11 11 8 1 9 1 3

e. R(I0): G C F# G# A Bb B Eb D F E Db
5 6 2 1 1 1 4 11 3 11 9

pattern for retrograde inversion reverses that of the prime form (Fig. 2e), and is the inverse of the retrograde pattern.

The serial-interval method proves most useful when the row proves hardest to follow. For example, a pair of intersections in m. 22 of the first movement of Op. 22 often throws students off the track initially. If they look in the next measure, however, they find the pitches B, B-flat, and D stated in succession in the same voice. Analyzing the serial-interval pattern of this fragment yields 11-4. Comparison of this fragment with the catalogue of serial-interval patterns in Figure 2 reveals that the fragment represents the fourth through sixth notes of a prime form (the only appearance of an 11-4 segment). The specific prime form can be deduced by counting half-steps up from C of P0 to the B that occupies the same position in the fragmented row: C to B is eleven half-steps, therefore the fragment comes from P11. The row can be identified much more quickly through this method than by scanning the matrix for the pitches B, B-flat, and D. As I will demonstrate below, the serial-interval pattern also provides a powerful tool for analyzing ordered invariance within a given row.

Each of the three recent textbooks devoted to twentieth-century theory cited above contains a general discussion of invariance, yet none provides a systematic method for predicting and locating it. Lester devotes an entire chapter to "common elements" in the twelve-tone system, and includes a useful summary of the nature and function of invariance:

> Common elements add focus to a passage, bringing a small number of pitch-classes or intervals to the fore, and highlighting them against the background pitches. These highlighted pitch-classes and intervals then form networks with one another, connecting phrases and larger sections to one another.[11]

Although he notes that an interval that occurs more than once in a row will be held invariant in some other transformation of the row, Lester's suggestions for finding common elements, while laudable in their emphasis on musically sensitive listening, fall short of a systematic method:

> In your study of a new piece, begin by listening for prominent pitches and repeated pitch-classes, intervals, and pitch-class sets. As you discover a common element in the piece, try to figure out how it works by finding that common element in a very simple series such as a chromatic scale. This will help increase your understanding of the piece, of the composer's choices among the many precompositional possibilities, of the composer's style, and, finally, of the twelve-tone system itself.[12]

This last sentence provides a worthy answer for the question "What do we want students to learn about this music?" In Lester's approach, however, the burden for discovery rests heavily on student intuition.

Kostka also stresses the importance of invariance for the compositional process: "One of the more difficult tasks of the analyst is attempting to determine why a particular row form and transposition have been chosen. . . .Invariance is frequently a factor."[13] Kostka comes closer to a systematic method, suggesting that the student analyze the interval class between adjacent members of a row and noting that sym-

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[11]Lester, 190.
[12]Lester, 203.
[13]Kostka, 218.

metrical patterns within the interval-class succession "may indicate that a segment of the row is its own retrograde or retrograde inversion."[14] The advantage of the serial-interval method over using interval classes resides in the greater accuracy and specificity it provides. A repeating set of adjacent numerals within the serial interval-pattern predicts invariant ordered segments created by a specific operation (transposition or inversion), whereas a repeating set within an interval-class array could indicate invariance by either transposition or inversion.

Straus advocates using the serial-interval pattern to analyze twelve-tone music in general, but he does not apply it in his discussion of invariance. His text, the most technical of the three, uses pitch class to demonstrate how dyads may remain invariant under inversion, with this demonstration coming from almost a compositional point of view:

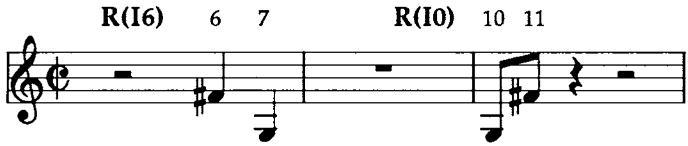
> Let's say we have within a series a dyad of which we are particularly fond. We are so fond of this dyad that we want to be sure to keep it as a unit even while we transform the series. It's not hard to do, as long as there is an equivalent dyad elsewhere in the series. We simply choose a T_nI that will map those two dyads onto one another. . . . Let's try to map [(0,11)] onto (6,5). . .We are looking for the index number of [11,0] and [5,6]. The index number is 5 (0 + 5 = 6 + 11). T_5I will thus map 0 and 11 onto 6 and 5 (and vice versa).[15]

Straus notes that the same principles apply to holding larger collections invariant, although he does not provide a complete exposition of these principles nor a systematic means of finding both ordered and unordered invariance.

Analysis of the row in Webern's *Das Augenlicht,* Op. 26 will prove the usefulness of the serial-interval method for predicting ordered invariance. Invariance in and of itself, of course, is not always a significant phenomenon. For example, two-note invariant segments are inevitable; at least one of each of the eleven dyad adjacencies within the row will be held invariant in at least one inverted row transformation. Furthermore, any repeated interval class within the adjacent pitch classes of a row creates an invariant dyad segment under both transposition and inversion. Since there are only six possible interval

[14]Kostka, 214.
[15]Straus, 147-148.

EXAMPLE 1. Webern, *Das Augenlicht*, Op. 26, Violin, mm. 4-6



classes, and eleven adjacencies within a row, repeated interval classes always exist. These facts deny invariant dyads any intrinsic significance. They attain importance only if represented several times within the row or if manipulated so that they are especially prominent musically.[16]

Webern frequently emphasizes invariant dyads through registral or timbral isolation.[17] *Das Augenlicht* opens with a seven-bar instrumental introduction that presents interlocking statements of R(I0), R(I6), and R(P5). The violin part for these measures contains only four notes (see Ex. 1): the F-sharp and G in m. 4 are the sixth and seventh notes of R(I6), and the G and F-sharp in m. 6 are the tenth and eleventh notes of R(I0). Webern thus highlights the invariant dyad through both register and timbre.

Invariant segments larger than the dyad are not inevitable, and thus possess greater intrinsic significance. Larger segments can be located by comparing all forty-eight row transformations or, as Lester suggests, by careful listening. The serial-interval method allows the presence of invariant segments to be deduced directly from the original row before even constructing a matrix simply by locating repeating patterns among the numerals of the serial-interval pattern. Figure 3a contains the prime form of the *Das Augenlicht* row, the transposition levels that would be written across the top of the matrix, and the row's serial-interval pattern. Reading from left to right, the 4-1

[16]Invariant dyads are discussed at length in Babbitt, "Twelve-Tone Invariants as Compositional Determinants."

[17] See especially his *Variations*, Op. 27.

pattern found as the fifth and sixth numerals repeats as the tenth and eleventh numerals. This repeated pattern will create an invariant trichord segment under transposition. The interval-class difference of the pitch classes beginning each appearance of the segment provides the transposition operators that will realize the invariant trichords: interval class 3 separates B (3) and D (6), and therefore any two row transformations related to one another as P0 relates to P3 or as P0 relates to P9 will share an invariant ordered trichord (Fig. 3, b and c).[18]

As shown in Figure 4a, a second invariant trichord occurs toward the end of the row: the 9-4 pattern found as the seventh and eighth numerals repeats as the ninth and tenth numerals. The interval-class difference of the E (8) and F (9) that begin these patterns is 1; there-

FIGURE 3. *Das Augenlicht*, row and invariant trichords

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
	2	11	3	11	4	1	9	4	9	4	1	
b. P3:	B	C#	C	Eb	D	F#	G	E	G#	F	A	Bb
c. P9:	F	G	F#	A	G#	C	C#	Bb	D	B	Eb	E

FIGURE 4. Invariant trichords under transposition

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
	2	11	3	11	4	1	9	4	9	4	1	
b. P1:	A	B	Bb	C#	C	E	F	D	F#	Eb	G	G#
c. P11:	G	A	G#	B	Bb	D	Eb	C	E	C#	F	F#

[18]The P0-P3 and P0-P9 relationships are abstractly identical, but it is helpful (especially to undergraduates) to list every row transformation that shares invariant segments with P0.

fore any two row transformations related to one another as P0 relates to P1 or as P0 relates to P11 will share an invariant ordered trichord (Fig. 4, b and c).

Invariant ordered segments that appear under retrograde inversion may also be deduced directly from the original serial-interval pattern. Because the process for determining the transposition level is a bit more complicated for these segments, however, I prefer to introduce invariant segments first under simple retrograde. These are found by comparing the original serial-interval pattern read left to right with the inverted serial-interval pattern read right to left (Fig. 5). The 3-11 segment occurring as the third and fourth numerals of the original pattern appears in reverse order as the sixth and seventh numerals of the inverted pattern. Notice that the corresponding 1-9 and 9-1 patterns also match; this numeric exchange will always occur. Determining the transposition level of the retrograde containing the invariant trichord again can be accomplished by consulting the pitch classes of P0, but this time we must compare the pitch classes on opposite ends of the respective trichords. Interval class 4 separates A (the first pitch of the first trichord) and C-sharp (the last pitch of the second trichord); therefore any row transformation related as P0 to R(P4) or P0 to R(P8) will share an invariant ordered trichord (Fig. 5, b and c).

FIGURE 5. Invariant trichords under retrograde

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
		2	11	3	11	4	1	9	4	9	4	1
Inv:		10	1	9	1	8	11	3	8	3	8	11
b. R(P4):	B	Bb	F#	A	F	G#	G	Eb	E	C#	D	C
c. R(P8):	Eb	D	Bb	C#	A	C	B	G	G#	F	F#	E

Any segment of the inverted serial-interval pattern that duplicates a segment of the original pattern when both segments are read from left to right indicates an invariant ordered set under inversion. In Figure 6a, the 11-3 segment between the second and third numerals of the original pattern repeats as the sixth and seventh numerals of the inversion, creating yet another invariant trichord. Notice again that the segments in the corresponding positions also match.

Deducing the transposition level of the inversion that contains the invariant segment requires a different calculation from that used for transposition and retrograde. For this calculation the pitch-class numerals written above the row become especially handy. Find the pitch-class numeral above the first note of the first appearance of the segment and add this value to the pitch-class numeral appearing over the first note of the second appearance of the pattern; this process yields the transposition level of the inversion that shares the invariant segment. In the example, the first note of the first segment is B-flat, pitch class 2, and the first note of the second segment is E-flat, pitch class 7; 7 plus 2 equals 9, and therefore any row transformations related as P0 to I9 will share two invariant trichord segments (Fig. 6b). A special property of inversion is that the first segment will always map onto the position of the second segment and vice versa.

FIGURE 6. Invariant trichords under inversion

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
		2	11	3	11	4	1	9	4	9	4	1
Inv:		10	1	9	1	8	11	3	8	3	8	11
b. I9:	F	Eb	E	C#	D	Bb	A	C	G#	B	G	F#

As mentioned before, the presence of invariant segments under retrograde inversion can be deduced directly from the original serial-interval pattern: any symmetrical pattern of numerals (reading the same from left to right or right to left) will generate invariant segments under retrograde inversion. Three such segments exist in the *Das Augenlicht* row (see Fig. 7a): 11-3-11, 9-4-9, and 4-9-4. The process for finding the specific retrograde inversion resembles that for finding shared segments under inversion alone: add the pitch-class values of the first and last notes of the symmetrical pattern. For the 11-3-11 segment, 2 (B-flat) plus 3 (B) makes 5;therefore any row transformations related as P0 to R(I5) will share an invariant ordered tetrachord (Fig. 7b). For the 9-4-9 segment, 8 (E) plus 6 (D) makes 14. Since we are using mod. 12 addition, 12 is subtracted from any number greater than 11. Therefore, any transformations related as P0 to R(I2) will share an invariant ordered tetrachord (Fig. 7c). For the 4-9-4 segment, 5 (C-sharp) plus 10 (F-sharp) makes 15, 15 equals 3 mod. 12, and the invariant tetrachord will be realized in R(I3) (Fig. 7d).

FIGURE 7. Invariant tetrachords under retrograde inversion

a. P0:
0 2 1 4 3 7 8 5 9 6 10 11
G# Bb A C B Eb E C# F D F# G
2 11 3 11 4 1 9 4 9 4 1

b. R(I5):
D Eb G E G# F F# Bb A C B C#

c. R(I2):
B C E C# F D Eb G F# A G# Bb

d. R(I3):
C C# F D F# Eb E G# G Bb A B

FIGURE 8. Invariant segments under retrograde inversion

0 2 3 4 5 6 7 1 8 9 11 10
A B C C# D Eb E Bb F F# G# G
2 1 1 1 1 1 6 7 1 2 11

In the *Das Augenlicht* row the elements of each symmetrical pattern are contiguous; this is not always the case. In the serial-interval pattern in Figure 8 the 2-1 . . . 1-2 grouping forms a symmetrical pattern across the intervening numerals. Any segment of the serial-interval pattern that repeats in reverse will create ordered invariance under retrograde inversion. Successions of repeated numerals also form symmetrical patterns, such as the 1-1-1-1-1 pattern in Figure 8 that predicts an invariant ordered hexachord under retrograde inversion. The process for finding the transposition level of the retrograde inversion sharing the invariant segments remains the same in either case.

The serial-interval method provides a systematic means of finding invariant ordered segments that does not burden undergraduate students with complex concepts or formulae, requiring only that they be able to calculate interval sizes in half-steps and be able to employ mod. 12 addition. The students now possess a tool that can be applied easily in analysis or composition. The search for unordered invariance requires a different tool, since it cannot be deduced solely from the ordered serial-interval pattern. Unordered invariant sets are unearthed through the process of imbrication, or taking each possible three-,four-, five-, and six-note segment of adjacent pitches and placing them in best normal order. Although a "brute force" method that lacks the elegance of the serial-interval pattern, imbrication nonetheless produces results without demanding new skills.

The two situations indicating unordered invariance are (1) the repetition of a set class within the row and (2) the presence of a symmetrical set. Any set class that appears more than once will be held invariant under transposition as long as both appearances of the set are in prime, or both in inverted, form; if only one appearance of the set is inverted, the set will be held invariant under inversion. Figure 9 lists the five-note sets contained in the *Das Augenlicht* row; in order to keep track of inverted sets, I have students mark them with a lower-case "i" (placed at the end). Set class 5-1 appears twice in the row; because 5-1 is inversionally symmetrical, these two appearances may represent two prime forms or two inversions, or a prime form and an inversion. We will take the first possibility first, and save the other one for the discussion of symmetrical sets.

FIGURE 9. Pentachords in the row of *Das Augenlicht*

Pentachords	Prime Form	Set Class
G#, A, Bb, B, C	0,1,2,3,4	5-1
A, Bb, B, C, Eb	0,1,2,3,6	5-4
A, B, C, Eb, E	0,1,4,5,7 i	5-Z18 i
B, C, C#, Eb, E	0,1,2,4,5	5-3
B, C#, Eb, E, F	0,1,2,4,6 i	5-9 i
C#, D, Eb, E, F	0,1,2,3,4	5-1
C#, D, E, F, F#	0,1,2,4,5 i	5-3 i
C#, D, F, F#, G	0,1,2,5,6 i	5-6 i

The process for finding the transposition level that realizes the invariant unordered pentachord resembles that used for ordered subsets, differing only in that the first notes of the best normal orders are compared rather than the first notes of the segments in actual row order. The difference of the pitch-class numbers for these pitches as they appear in the row still provides the transposition level. As shown in Figure 10a, G-sharp (0) and C-sharp (5) differ by interval class 5; therefore any transformations related as P0 to P5 or P0 to P7 will share an invariant unordered pentachord (Fig. 10, b and c).

Set class 5-3 also appears twice in Figure 9, once in prime and once in inverted form, thus being held.invariant under inversion. Inverted sets can cause difficulties for students because they must be read in descending order; in other words, the pitch representing "0" in the best normal order for the inverted 5-3 (C-sharp,D, E, F, F-sharp) is F-sharp, not C-sharp. The process for predicting which inverted row transformation holds an unordered set invariant resembles the method used for invariant ordered segments under inversion, although again using the first notes of the best normal order rather than actual row order. The pitch-class value of the first note of the best normal order of the first appearance of the set class is added to the pitch-class value of the first note of the best normal order of the second appearance of the set class. In Figure 9, 5-3 begins with B (3) and 5-3i with F-sharp (10); 3 plus 10 makes 1 (mod. 12). Therefore, any row transformations related as P0 to I1 will share two unordered pentachords (Fig. 11). In this particular instance the two pentachords interlock to form an invariant eight-note set.

FIGURE 10. Invariant unordered pentachords under transposition

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
b. P5:	C#	Eb	D	F	E	G#	A	F#	Bb	G	B	C
c. P7:	Eb	F	E	G	F#	Bb	B	G#	C	A	C#	D

FIGURE 11. Invariant unordered pentachords under inversion

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
b. I1:	A	G	G#	F	F#	D	C#	E	C	Eb	B	Bb

The presence of symmetrical sets also creates unordered invariance, with transpositionally symmetrical sets being held invariant under transposition and inversionally symmetrical sets being held invariant under inversion. Transpositionally symmetrical sets divide into two groups: those with equidistant elements and those without. The equidistant sets ([0,6], [0,4,8], [0,3,6,9], and [0,2,4,6,8,10]) hold invariant when transposed by any interval class they contain: [0,6], holds invariant in P6, [0,4,8] holds invariant in P4 and P8, [0,3,6,9] holds invariant in P3, P6, and P9, and [0,2,4,6,8,10] holds invariant in P2, P4, P6, P8, and P10. Transpositionally symmetrical sets whose elements are not equidistant hold invariant under tritone transposition (P6) except for [0,1,4,5,8,9] (set class 6-20), which holds invariant in P4 and P8.[19] The *Das Augenlicht* row contains no transpositionally symmetrical subsets larger than the two-element tritone, which cannot be unordered in the context of a twelve-tone row.

The transposition levels of the inverted row transformation that will hold an inversionally symmetrical set invariant is determined by taking the first and last pitches of the best normal order and adding their pitch-class values in the original row. The inversionally symmetrical pentachord 5-1 appears twice in the *Das Augenlicht* row. The first and last pitches of the best normal order for the first appearance are G-sharp and C (Fig. 9), the sum of their pitch-class values in the original row (0 and 4) is 4, and therefore any row transformations related as P0 to I4 share an invariant unordered pentachord (Fig. 12, a and b). The best normal order for the second appearance of 5-1 begins on C-sharp (5) and ends on F (9), which sum to 2 (mod. 12); any row transformations related as P0 to I2 share an invariant unordered pentachord (Fig. 12c).

The 5-1 pentachord engenders still more invariant relationships in addition to the transpositional invariance demonstrated in Figure 10 and the inversional invariance generated by its symmetry demonstrated in Figure 12. Because it exhibits inversional symmetry, and because it appears twice in the row, one appearance may act as a prime form and the other as an inversion, thus creating additional invariance under inversion. Taking the first appearance as the prime form

---

[19]This refers only to hexachords and smaller sets. The complements of these transpositionally symmetrical sets are themselves transpositionally symmetrical and hold invariant under the same transposition levels. For a complete listing and examination of transpositionally symmetrical sets, see Richard Cohn, "Properties and Generabilities of Transpositionally Invariant Sets," *Journal of Music Theory* 35 (Spring/Fall 1991): 1-32.

FIGURE 12. Invariant unordered pentachords under inversion (inversionally-symmetrical set)

	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
b. I4:	C	Bb	B	G#	A	F	E	G	Eb	F#	D	C#
c. I2:	Bb	G#	A	F#	G	Eb	D	F	C#	E	C	B

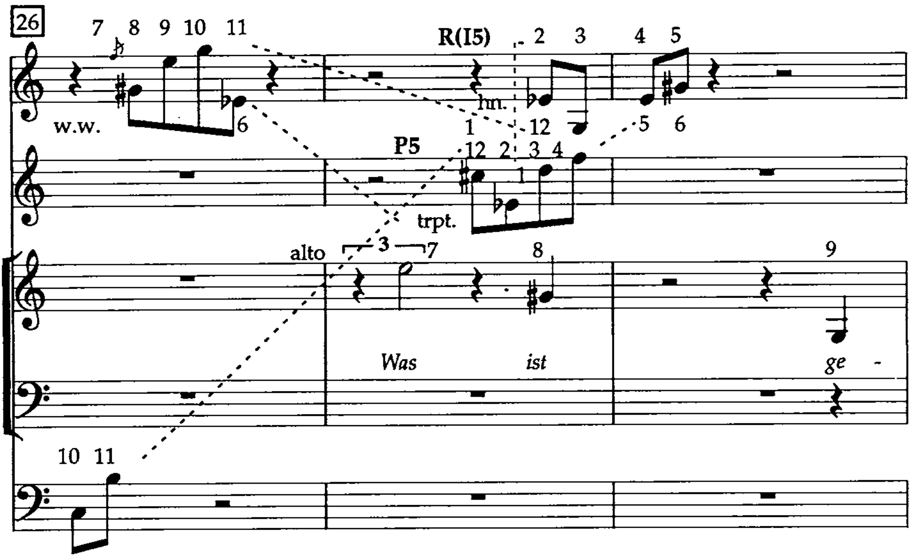
FIGURE 13. Invariant unordered pentachords under inversion (inversionally-symmetrical set)

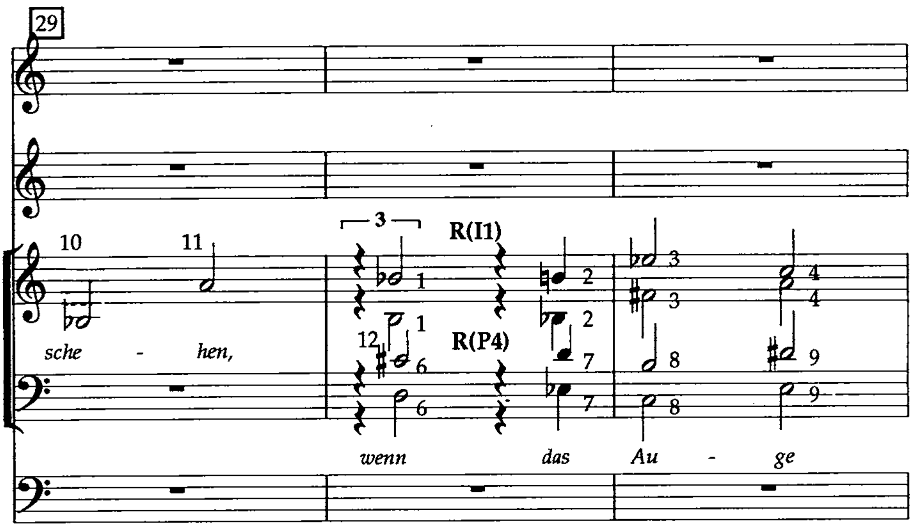
	0	2	1	4	3	7	8	5	9	6	10	11
a. P0:	G#	Bb	A	C	B	Eb	E	C#	F	D	F#	G
b. I9:	F	Eb	E	C#	D	Bb	A	C	G#	B	G	F#

and the second as the inversion (see Fig. 9), we add the pitch-class values of G-sharp (0) and F (9) to obtain the specific inversion that contains the invariant sets (Fig. 13). Any row transformations related as P0 to I9 will share two invariant unordered pentachords, again due to the reciprocal mapping that takes place under inversion.

The row to *Das Augenlicht* possesses a significant amount of both ordered and unordered invariance, and examination of a passage from the work will demonstrate that this invariance heavily influenced Webern's choice and use of specific row transformations. Example 2 contains the excerpt in short score, with all pitches sounding as written. The four choral voices share the same rhythm at the beginning of the excerpt, causing a strict note-against-note arrangement of four row transformations. The types of row transformations used and their transposition levels suggest soprano-alto and tenor-bass pairings. The continuation of the passage supports these pairings, since the soprano and alto lines conclude independently while the tenor-bass pair continues only when new row transformations enter in the upper voices in m. 30. The R(I2)-R(I3) pairing in the soprano and alto, being equiva-

EXAMPLE 2. Webern, *Das Augenlicht*, Op. 26, mm. 20-37


26
7 8 9 10 11
R(I5)
2 3
4 5
w.w.
6
hn.
1
12
5 6
P5
12 2 3 4
1
trpt.
alto
3
7
8
9
Was
ist
ge -
10 11


29
10
11
3
R(I1)
1
2
3
4
3
4
sche - hen,
12
1
R(P4)
6
2
7
8
9
6
7
8
9
wenn
das
Au - ge

EXAMPLE 2. (continued)

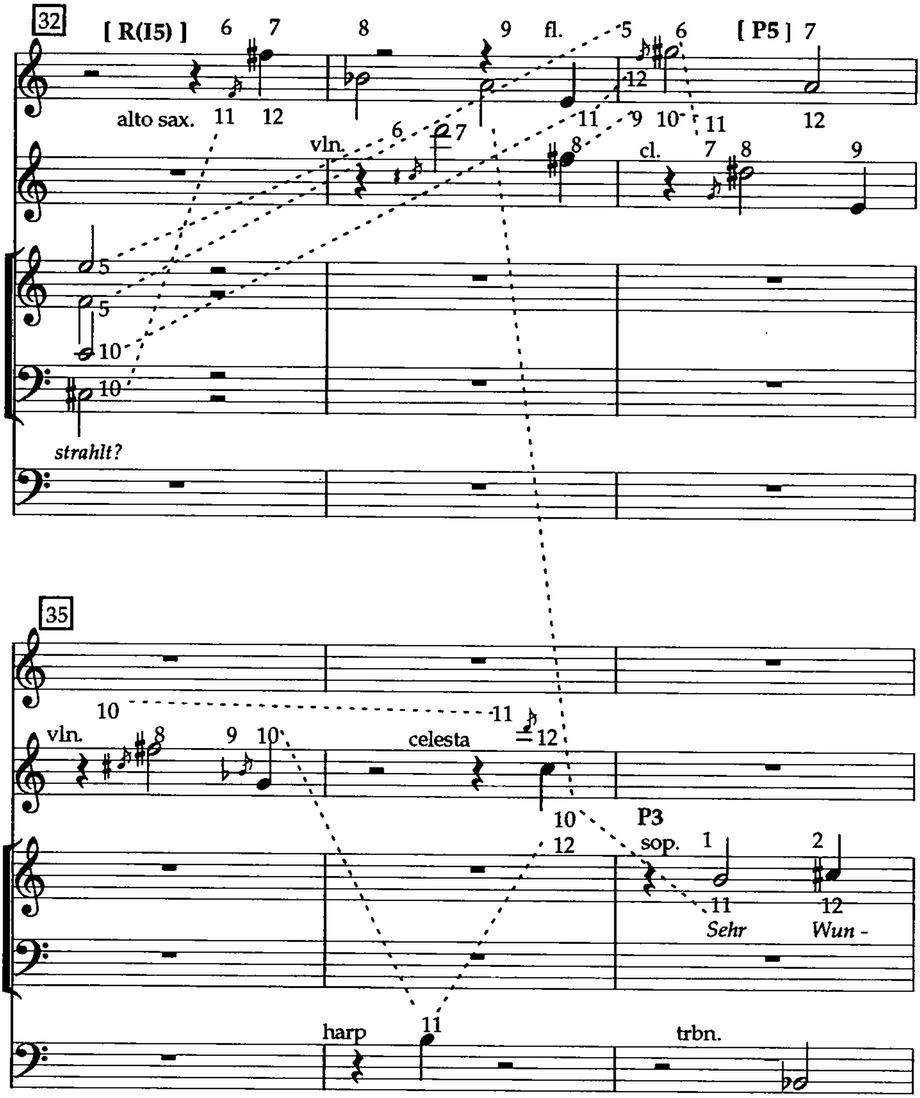


FIGURE 14. Assymetrical combinatoriality

R(I2):	B C E C# F D Eb	G F# A G# Bb
P10:	F# G# G Bb A	C# D B Eb C E F

lent to the P0-P1 pairing demonstrated in Figure 4, contains an invariant ordered trichord that is realized in mm. 21-24. The C-sharp-F-D in the alto in mm. 21-23 is echoed in the soprano in mm. 22-24. Even though rests intervene in mm. 23-24, Webern emphasizes the invariant trichord by maintaining the same contour. The tenor-bass pair P10-P11 also bears the P0-P1 relationship; the invariant trichord generated by this pairing will be discussed in connection with mm. 30-32.

Invariance also governs the other row pairings at the beginning of the passage. Unordered invariance plays a role in the R(I2)-P10 pairing between the soprano and tenor (equivalent to the P0-I4 pairing in Fig. 12) and the identical R(I3)-P11 pairing in the alto and bass. Each pairing contains an invariant pentachord and an invariant septachord that appear at opposite ends of the respective row transformations, resulting in a type of asymmetrical combinatoriality that prevents octave duplications (see Fig. 14; the row is non-combinatorial in the traditional sense). The R(I3)-P10 pairing between the alto and tenor, being equivalent to P0-R(I5) (Fig. 7b), shares an invariant ordered tetrachord. The G-sharp-G-B-flat-A in the tenor in mm. 21-23 reappears with a different contour in the alto in mm. 27-29. The final pairing, grouping R(I2) in the soprano with P11 in the bass, is equivalent to the P0-R(I3) pairing of Figure 7d and thus also shares an invariant ordered tetrachord. The C-E-C-sharp-F in the soprano in mm. 21-23 reappears in the bass and alto sax in mm. 31-32.[20]

The orchestra enters with the retrograde-related pair I5-R(I5) at the cessation of the block chords in m. 23. Webern presents the first five notes of each instrumental row form as a discrete motive, reflecting the five-note segmentation of the preceding chordal passage. While the retrograde relationship obviously controls the pairing of I5 and

[20]This is the only pairing that creates octave duplication. The potential octave occurs in the sixth position of the row transformations, precisely after the point at which Webern breaks off the strict note-against-note writing in m. 23.

R(I5), the principle of invariance led Webern to link this pair to the continuation of R(I2) in the soprano line in m. 24: R(I2) and R(I5) share an invariant ordered trichord by virtue of transposition by interval class 3 (as demonstrated in Figure 3). The invariant trichord stands out clearly: the D-E-flat-G beginning the woodwind motive in m. 23 reappears at the same pitch level at the resumption of R(I2) in the soprano in m. 24.

The alto's R(I3) also interacts with the I5-R(I5) pair. The last two pitches of the first statement of the invariant trichord in m. 23 (E-flat and G) join with the following two woodwind pitches (E and G-sharp) to form an invariant tetrachord that permeates mm. 26-28. Using retrograde-related row transformations obviously provides ample opportunity for invariance, such as the five-note cello motive in mm. 23-24 that returns in retrograde in mm. 25-27; Webern goes beyond the obvious, however, by linking the continuation of R(I3) in the alto with the I5-R(I5) pair through the unordered tetrachord. The tetrachord appears in the woodwinds in m. 26 in the order G-sharp-E-G-E-flat, and again in mm. 27-28 in retrograde: E-flat-G-E-G-sharp. The trumpet introduces P5 in m. 27, and the fifth and sixth notes of this row intersect with the E and G-sharp ending the retrograde statement of the invariant tetrachord in m. 28. Another intersection occurs in m. 26, where the E-flat in the woodwinds serves as the sixth pitch of the alto's R(I3) and introduces the invariant tetrachord in the order E-flat-E-G-sharp-G. Finally, the B-flat-A dyad in the alto in m. 29 duplicates the dyad which ends the five-note motive in m. 24 and which begins its retrograde in m. 25.

A second chordal passage begins in m. 30, retaining the five-note length of the first passage and maintaining the same contour in the soprano line. The tenor and bass resume P10 and P11 after six bars of rest, and the invariant trichord they share is partially represented: the E-flat-C-E in the bass in mm. 30-31 is begun in the tenor in mm. 31-32. The chordal passage ends before the trichord concludes; its last tone appears in the flute in m. 33. Webern presents a new pairing between the soprano and alto: their R(I1)-R(P4) pairing is equivalent to the P0-I9 pairing illustrated in Figures 6 and 13, and thus shares two invariant ordered trichords as components of two invariant unordered pentachords. The first invariant trichord (E-C-sharp-D) is not well delineated in the music; the second (F-G-sharp-G) appears as a literal intersection in the orchestra in m. 34. Invariance between R(I1) and R(P4) that occurs entirely within the chordal passage is limited to the opening dyad: the soprano and alto merely exchange notes in m. 30.

The intersection of invariant segments becomes quite prevalent when R(I1) in the soprano interacts with P10 and P11 in the tenor and bass. R(I1) and P10 share an ordered tetrachord; the second through fifth notes of the soprano in mm. 30-32 appear in stretto imitation one note later in the tenor (the last note appears in the flute in m. 33). At the same time, R(I1) and P11 share an ordered tetrachord that intersects with the one shared by R(I1) and P10. The E-flat-C-E-C-sharp in the bass line of mm. 30-32 appear in stretto imitation one note later in the soprano, with the final C-sharp appearing in the violin. Figure 15 illustrates the intersection of the various invariant segments operative in mm. 30-32. The trichord E-flat-C-E appears three times, first in P11, then R(I1), and finally P10, with each overlapping entrance retaining the same contour. The six row transformations active at the end of the second chordal passage complete their courses with numerous intersections in mm. 32-36.

Invariance, both ordered and unordered, clearly governed Webern's choice and use of row forms in the cited passage.[21] Every row pairing used simultaneously exhibits one or more invariant seg-

FIGURE 15. Intersection of invariant segments, *Das Augenlicht* mm. 30-32

R(I1):	Bb 1	B 2	Eb 3	C 4	E 5	(C#) 6
R(P4):	B 1	Bb 2	F# 3	A 4	F 5	(G#) 6
P10:	C# 6	D 7	B 8	Eb 9	C 10	(E) 11
P11:	D 6	Eb 7	C 8	E 9	C# 10	(F) 11

[21]In light of the analysis presented above, Kathryn Bailey's comments on page 23 concerning *Das Augenlicht* seem curious: "Although the Op. 26 row offers considerable invariant combinations, Webern does not take advantage of this property; therefore it is not significant."

ments, and successive row transformations often intersect on invariant beginning and ending pitches. An analysis that merely traces the row through the work misses the emphasis Webern places on certain pitches and pitch collections through invariance, and therefore misses the musical (not mathematical) intricacy of the passage.

The methods outlined in this paper not only provide systematic tools for predicting and locating invariance, but also provide at least an elementary appreciation of how invariance works and how it might influence the musical structure of a twelve-tone work. Just as the construction of the row precedes composition of a twelve-tone work, analysis of the properties of the row should precede analysis of the work. By first analyzing the row itself, the analyst can better understand the precompositional and compositional processes of the composer. The degree of ordered invariance the student might encounter ranges from totally invariant symmetrical rows, such as those in Webern's *Symphony*, Op. 21 (Fig. 16a) and Dallapiccola's *Cinque Canti* (Fig. 16b), to rows that contain no invariant ordered segment larger than the dyad, such as that in Dallapiccola's *Quaderno Musicale di Annalibera* (Fig. 16c). Most rows fall between these extremes of ordered invariance. Unordered invariant sets larger than the dyad are more

FIGURE 16. Selected rows

a. Webern, *Symphony*, Op. 21.

P0:	F	Ab	G	F#	Bb	A	Eb	E	C	C#	D	B
		3	11	11	4	11	6	1	8	1	1	9
R(P):		3	11	11	4	11	6	1	8	1	1	9

b. Dallapiccola, *Cinque Canti.*

Gb	F	B	D	C	Ab	C#	A	G	Bb	E	D#
	11	6	3	10	8	5	8	10	3	6	11

c. Dallapiccola, *Quaderno Musicale di Annalibera.*

	Bb	B	Eb	Gb	Ab	D	Db	F	G	C	A	E
		1	4	3	2	6	11	4	2	5	9	7
Inv:		11	8	9	10	6	1	8	10	7	3	5

ubiquitous, and will usually be utilized at some point in the work.

A word of warning: students should not be disappointed if they find a row rich in invariance that was not exploited by the composer, or that was used only in part. They have discovered that the composer must be up to something else, a discovery that should prompt them to search for other reasons behind a composer's choice of row transformations. For example, the serial-interval pattern of the row to Webern's *Quartet*, Op. 22 (given in Fig. 2) contains two symmetrical patterns that yield ordered tetrachords by retrograde inversion, both of which appear in the pairing P0-R(I7). Throughout the cited movement, however, Webern pairs primes and inversions whose transposition levels sum to 10 (P0-I10, P6-I4, P9-I1, etc.) in order to retain the same set of dyad pairs between row transformations.[22] Although the P0-R(I7) pairing (or its equivalent) with its invariant ordered tetrachords does not appear, other unordered invariant groupings resound throughout.

After a grounding in basic set and twelve-tone theory as set forth above, the concept of invariance and the systematic method for finding it can be presented in one or two class sessions. Another one or two sessions should be spent leading the class through several analytical applications of the method before requiring them to apply it on their own. As a final assignment before concluding the unit on twelve-tone music, I suggest having the students write their own twelve-tone works employing the concepts studied in the unit. I ask my students to construct a row, being aware of its properties as they do so, and then manipulate these properties in a sixteen- to thirty-two bar composition. An effective variant of this assignment involves giving all of the students the same row and instructing them to write a brief composition utilizing its properties. Take a class period or two and have the students report on their compositions (what worked well, what did not), or select a few representative compositions and lead the class in a discussion of their most interesting features. Although the result will seldom be great art, students can become engrossed in the project and discover facets of the twelve-tone system far beyond those normally presented in the undergraduate classroom. Through the methods proposed in this paper students can begin to see the music beyond the math.

[22]See George Perle, "Webern's Twelve-Tone Sketches," *The Musical Quarterly* 57/1 (January, 1971): 1-25.

Music Analysis: Purposes, Paradigms, and Problems

Allen Winold

Music analysis is at the core of everything we do as music theorists. When we speculate about the nature of musical elements such as melody, harmony, texture, or form, we formulate hypotheses based on formal or informal analysis of works, and then test these hypotheses by analyzing other works. When we elucidate the structure and meaning of a single work or explore the commonalities of a given musical style, we gather our data through analysis. When we teach sight singing or ear training, we base our pedagogical principles on insights gained from analysis.

Music analysis is a process that involves seeking answers to four fundamental types of questions.

Segmentation questions: What principles should guide us in dividing a musical structure into smaller units and sub-units? What makes a beginning? What makes an ending?

Similarity questions: How do smaller units and sub-units relate to each other in terms of their characteristic features? How does one work relate to other compositions by the same composer, by different composers, or to works from other cultures?

Structural questions: How do the units of a work relate to each other in terms of syntactic function? How do they combine to form larger units, up to and including the entire work?

Semantic questions: What does a work of music, as a whole or in terms of its constituent units, mean? Is this meaning fixed or does it change from time to time, culture to culture, or person to person? How does a work relate to extra-musical aspects, such as emotions, physical motion, other arts, or other disciplines?

Though there is general agreement on the importance of music analysis and on the basic nature of its central issues, there is less agreement on the specific methods to be used. In this paper I consider analytical methods by focusing upon the purposes that lead us to analyze, the paradigms that guide us, and the problems that beset us.

Pragmatic concepts of purposes

A brief review of the contributions of two of the most important American thinkers—Charles Sanders Peirce (1839-1914) and William James (1842-1910)—will provide a philosophical frame for our discussion. Peirce lived in relative obscurity without a permanent teaching position to use as a platform for the presentation of his ideas, and he was known to only a small group of intellectuals. He never completed a full-length book that would record the complete working out of his ideas, possibly because they were constantly developing and changing. Still, he is regarded by many as the most original, versatile, and influential of all American philosophers. In 1878, in an article entitled "How To Make Our Ideas Clear," he set forth what has come to be known as the pragmatic maxim. "Consider what effects, that might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of these effects is the whole of our conception of the object."[1] For a pragmatist the meaning of concepts like "soft" or "hard" would be that when a soft object is scratched it would show scratches but a hard object would not. The pragmatic definition of consonance and dissonance would be that when we hear a consonant or a dissonant chord there is some measurable difference in the physiological or psychological response each evokes. If there is no difference, then the concept may be essentially meaningless.

This approach is based upon the idea of *abduction*, which Peirce argued should be included with induction and deduction as the three co-equal, co-operative modes of inference. Induction involves deriving general principles from specific cases; deduction involves deriving specific cases from general propositions; and abduction involves formulating, testing, and accepting or rejecting hypotheses. Abduction is roughly synonymous with the scientific or experimental method, but Peirce urged that it could be applied not just to physical experiments but also to ideas.

William James was trained as a medical doctor and is regarded as one of the founders of experimental psychology. A dedicated humanist and moralist, his approach to pragmatism was adopted to a

[1]Charles Sanders Peirce, *Collected Papers of Charles Sanders Peirce*, ed. Charles Hartshorne and Paul Weiss (Cambridge, MA: Harvard University Press, 1934), vol. 5, 258.

large extent as a defense against the attacks upon religion presented by Darwinism and other scientific developments at the end of the nineteenth century. Though he was a student, friend, and benefactor of Peirce, James carried the notion of pragmatism into nominalist, positivist, and radical empiricist directions never anticipated nor intended by Peirce. In his essay, "What Pragmatism Means," he defined pragmatism as "the attitude of looking away from first things, principles, 'categories,' supposed necessities; and of looking towards last things, fruits, consequences, facts."[2] He further said that a pragmatist "turns away from abstraction and insufficiency, from verbal solutions, from bad a priori reasons, from fixed principles, closed systems, and pretended absolutes and origins."[3]

James spoke of truth in a way that led many Europeans to regard pragmatism as nothing more than a pseudo-philosophical rationale for the American business ethos.

> Grant an idea or belief to be true, what concrete difference will its being true make in any one's actual life? How will the truth be realized? What experiences will be different from those which would obtain if the belief were false? What, in short, is the truth's cash value in experiential terms?. . .The truth of an idea is not a stagnant property inherent in it. Truth happens to an idea. It becomes true, is made true by events.[4]

His view of the role of theory is especially pertinent for our profession. "Theories thus become instruments, not answers to enigmas, in which we can rest."[5]

Peirce was strongly opposed to James's reinterpretations of pragmatism, so much so that he proposed changing "pragmatism" to "pragmaticism," a name Peirce believed to be so ugly no one would ever steal it. Peirce was a brilliant thinker, who had limited influence on his own generation, but lasting influence upon later generations. James was an effective popularizer of ideas, who had enormous influence upon his own time, but less direct influence upon succeeding generations.

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[2]William James, *Pragmatism: A New Name for Some Old Ways of Thinking* (New York: Longmans, Green and Co., 1907), 54-55.

[3]Ibid., 51.

[4]Ibid., 200-201.

[5]Ibid., 53.

Purposes of music analysis

With this philosophical background, we may describe the purposes of music analysis in terms of at least four areas.

> ***Composition***: We analyze in order to discover compositional processes in a work or group of works, which may be helpful in writing other compositions.
>
> ***Style***: We analyze in order to enumerate and describe the stylistic characteristics of a group of works, a single composer, or a period.
>
> ***Performance***: We analyze in order to make performance and teaching more appropriate, insightful, effective, and meaningful, and to assist memorization.
>
> ***Musicianship***: We analyze in order to make skills such as sight reading, keyboard realization, improvisation, and ear training more accurate, efficient, and artistic.

In light of pragmatic principles, we could say that the significance of any analytical observation ultimately rests on the practical effect that it has in fulfilling the purposes listed above. Analytical significance thus lies in applications: a variation technique discovered in one composition can generate another work; a textural type described in one work of a composer can help identify other works by the composer; a harmonic analysis can make a performance more effective; and the recognition of a common rhythmic pattern can make sight reading more accurate.

Many of our students and our colleagues in performance study, composition, conducting, and musicology might applaud increased emphasis on "last things, fruits, and consequences." A pragmatic approach to music analysis should lead to greater instructional effectiveness and efficiency, since studies in educational psychology and experience in the classroom clearly demonstrate that students learn best when they apply their knowledge to solving meaningful problems.

Should we, however, reject any analytical endeavor that does not have immediate, practical consequences? I do not believe so. Some of the most brilliant and influential analytical work has been done with little obvious concern for practical applicability, and our field is the richer for it. Music analysis is often undertaken for other appropriate purposes:

- to discover the essence, the true nature, or the organic unity of a work;
- to arrive at an appreciation or evaluation of a work;

- to understand the relation of the work to its socio-cultural context;
- to enhance our listening enjoyment and understanding;
- to convey our experiences and ideas of a work to others.

Are these purposes totally devoid of pragmatic significance? Probably not. Any of them could be redefined in pragmatic terms: listening enjoyment, for example, might be measured in terms of observable psychological or even physiological response. Even if analysis entails no direct pragmatic significance, however, it can contribute indirectly to the pragmatically-oriented purposes discussed earlier. An analysis of the organic unity of a work could lead to a correct performance of the work. Schenker said,

> A performance, in serving background, middleground, and foreground, can employ the greatest variety of color. Even the richest and most varied resources of performance can be taught—and learned—with great exactness. On the other hand, commitment to background, middleground, and foreground *excludes all arbitrary personal interpretation.*[6] (emphasis added)

As a Schenkerian agnostic, I would argue that no analysis of a work, not even the most effective, does more than provide possibilities. I would stress the "greatest variety of color" portion of this quote, but true Schenkerians would probably stress the rest of the quote. They would insist, as did my Schenker mentor, Franz Eibner, that the performance must be guided by the analysis.

We analyze music to internalize it, to achieve a more effective and meaningful relationship with it, to make it our own. Even if it could be proven conclusively that a particular analysis of a work was wrong, whatever that might mean, we could still argue that the analysis helped to internalize the work for the analyst. A creative analysis is a "co-creation," in the same sense that a creative performance is a "re-creation."

Paradigms

Analytical methods can be considered in terms of two paradigms that are currently quite influential in educational research and instructional technology, the *objectivist* paradigm and the *constructivist* para-

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[6]Heinrich Schenker, *Free Composition: Volume III of New Musical Theories and Fantasies,* trans. and ed. Ernst Oster (New York: Longmans, 1979), xxiii.

digm. After presenting these two approaches, I will briefly consider their implications for analyzing music and for the teaching of music analysis. The following chart suggests the main differences in these two paradigms.

objectivist	*constructivist*
positivistic experimentation	naturalistic inquiry
nomothetic	ethnographic
quantitative	qualitative
derived from psychology	derived from anthropology
meaning exists in the world	meaning is imposed on the world
single, correct meaning	multiple meaning, indexed in experience

Scientific research guided by the objectivist paradigm relies on laboratory experimentation, with strict control of variables and concern for issues of reliability. This research is nomothetic, in that it seeks to establish laws with general validity going beyond individual cases. It is generally quantitative, and its assumptions and methodology are derived to a large extent from experimental psychology.

Research guided by the constructivist paradigm substitutes naturalistic inquiry or field study for controlled laboratory experimentation. Though reliability is important, it is not sought in strict control of experimental variables but rather in thick description or detailed ethnographic reports of observations, in triangulation or correlation of three or more independent observers, and in other methods. It does not seek to establish universally valid laws but rather to give complete details of the products and processes of the given situation under investigation. Extrapolation to other situations is subject to the judgment of individuals. These methods of research tend to be qualitative rather than quantitative, as they are in at least some branches of the parent disciplines of anthropology and sociology.

Epistemological considerations sharply differentiate the two paradigms. For the objectivist, meaning exists in the world; for the constructivist, meaning is imposed upon the world. For the objectivist there is a reality "out there" that consists of entities and actions, each of which has a single, correct meaning, label or description. Different persons may perceive or label things differently, but the objectivist would claim that this difference comes from developmental factors, such as a child calling every animal a "doggy," or that it is simply the result of perceptual error.

For the constructivist there is also a reality, but it is not "out there"; rather, each person is an active participant in constructing reality. Differences in perception are not ascribed cavalierly to developmental delay or error. Multiple meanings are indexed to experience, a concept perhaps best understood in a linguistic context. Special words like "now" and "my" have meaning indexed to, or dependent on, a particular instant in time or a particular person. For the constructivist every word, and indeed everything we can perceive or conceive, is indexed to experience. Mark Johnson[7] has carried this idea one step further by asserting that all meaning is indexed to our individual experiences with our own bodies.

It is tempting to assign current methodologies of music analysis to one of these two paradigms, but it is more reasonable to find influences of both paradigms in each methodology. If we are engaged in labeling chords, constructing bass-line reductions, identifying pitch-class sets, or performing other similar analytical operations, we operate in the implicit framework of the objectivist paradigm. The constructivist might begin by questioning the very existence of such musical entities as chords, scales, or even notes. Mary Louise Serafine[8] has shown convincingly that these are not pre-existing entities in the music, nor even in a posited musical universe that surrounds the given composition, but are instead the products of individual analysts.

In the analysis of musical form, both objectivists and constructivists would probably begin by insisting that musical forms are not fixed molds into which composers pour their material. Following this obligatory disclaimer, however, the objectivist would probably provide students with the clearest possible guidelines for determining the degree of fidelity that a given work shows to an assumed formal norm. The constructivist would start with a much smaller set of assumptions and leave the door open to novel analyses that might differ radically from existing analytical models.

These two paradigms represent opposing tendencies and directions rather than a sharp dichotomy. Neither paradigm is clearly superior, especially when we turn to the teaching of music analysis. Objectivist approaches to analysis may be more effective with beginning students and constructivist approaches with more advanced students, though this is not an iron-clad rule. Acquainting students with commonly accepted formal norms and textural stereotypes is an important part of their education; learning to challenge these when ap-

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[7]Mark Johnson, *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason* (Chicago: University of Chicago Press, 1987).

[8]Mary Louise Serafine, *Music as Cognition: the Development of Thought in Sound* (New York: Columbia University Press, 1988).

propriate is equally important.

Most of us are probably more familiar and comfortable with objectivist methods. I would urge consideration of the rich possibilities for motivating students afforded by the constructivist methods, but this approach involves rethinking certain basic assumptions about teaching. The objectivist paradigm regards knowledge as something "out there," which is somehow to be gotten "in here," that is, into the mind of the student. Therefore teachers often adopt a "systems approach" to instruction: breaking the subject into small units, discovering behavioral objectives for each unit, and carefully structuring these units into a logically organized curriculum. Instruction in the objectivist paradigm involves carefully monitored drill and practice, and testing relies on clearly spelled out, right-or-wrong criteria.

Substituting the constructivist paradigm leads to a totally different set of implications for instruction in a field like music analysis. If learners are active participants in the construction of reality and meaning, then there is no attempt to get material from "out there" to "in here." Instead the constructivist looks for ways to help students construct plans in response to given specific situations, and to carry out these plans. The dominant model of instruction is thus not the systems approach, but rather "cognitive apprenticeship"; learners are put into situations that provide effective "real-world" problems, and teachers present possible tools for solving them. Instead of drill and practice, the dominant method of achieving solutions is exploration and emulation. Often, the roles of problem-giving teachers and solution-providing students are reversed and the students present novel problems to the teachers. The teachers then demonstrate how they go about solving, or in some cases just *trying* to solve, the problem presented by the students.

I recently took this problem-solving approach in a graduate seminar, when a student brought in the little-known *Adagio and Rondo Concertante* for Piano Quartet by Franz Schubert (1816). I began with the glib assertion that the rondo portion of the work should present no problem; the composer had clearly labelled its form and the only task for the analyst was to seek the location of the A B A C A, etc. sections. I was wrong. The movement bears little or no resemblance to classical rondo design. The students had the opportunity of watching a perplexed professor struggling at first to make the movement "fit" into rondo form, and then coming to the realization that the movement was really in a free sectional form. They and I learned something from this experience that we could not have learned in a more structured situation. They had the opportunity to observe the order of questions

I posed to myself and the way I went about answering them. I learned that I should take to heart my own constructivist advice about starting with a small set of assumptions and leaving the door open to a novel analysis, even when it might fly in the face of the composer's own form label.

Problems

Having considered some of the purposes and paradigms of music analysis, I turn to some of its problems. I shall discuss three general types of problems, those of analytical terminology, those of ambiguity and multiple interpretations, and those of matching analytical purposes and paradigms.

Analytical terminology

One problem that concerns me, perhaps more than other theorists, is confusing the description of musical features with the description of syntactical functions or affective characteristics, thus mixing the purposes listed at the beginning of the paper. Sometimes one term tries to describe aspects of similarity, structure, and semantics. An infamous historical instance illustrates a confusion of structure and semantics. Until recently we designated a cadence ending on a strong beat as a *masculine* cadence and a cadence ending on a weak beat as a *feminine* cadence. We no longer use these terms, because we realize the lack of sense and sensitivity they imply.

There are other instances where description and significance are confused. I became aware of one example when I taught for a year at the Hochschule für Musik in Vienna and had to use Riemann symbols instead of Roman numerals for harmonic analysis. I am reasonably comfortable with most of the concepts of Riemann theory, but I cannot accept all of them. For example, I find it problematic to label the iii chord as a parallel or substitute chord for the V chord. Sometimes the iii chord does function like a V chord, but sometimes it does not. In the Riemann system, however, the iii chord is always labelled "Dp," even when it is not functioning as a dominant.[9]

[9]Dp stands for Dominant-parallel. The word "parallel" in German has the meaning of "relative" in English. G major and E minor are called parallel keys. The G major chord and the E minor chord in the key of C major are called parallel chords in the Riemann system.

Another problem occurs when we attempt to make a single analytical term or symbol express both similarity and structural relations. For example, in a sonata form we may designate the first theme of the second key area as "S" (second theme), even though it is similar in melodic characteristics to "P" (the opening theme of the movement). Though there are ways of getting around this problem in most analytical labelling systems, I find it most helpful to provide two concurrent analyses, one devoted to similarity relations and the other devoted to structural relations.

As a final example of a terminological problem, let me cite the analysis of texture as an area in which music analysts do not have a sufficiently rich set of terms to capture the significant features of a composition. Interesting attempts, such as the graphic system recommended by Monte Tubb[10] in the pages of this journal, suggest possible solutions, but there is no widely adopted set of terms beyond the highly inadequate "monophonic, homophonic, polyphonic" descriptions that appear in most textbooks.

Ambiguity and Multiple Interpretation

As teachers, I believe we should encourage students to make the intellectual odyssey from doxology to dogma to doctrine to doubt to delight in diversity. I understand the forces that lead in the opposite direction, toward assertions of the inevitable rightness of a particular analysis. Most of us have gone through years of private study of an instrument or voice with teachers who insisted that their methods of performance and their interpretations of music were the only right ones. It is natural that these experiences, and similarly rigid views found in core works in our own field, should lead us to adopt an authoritarian stance ourselves. I believe, however, that in our own analysis and teaching we should resist this tendency and learn to cherish the possibility, indeed the necessity, of alternate ways of looking and listening to musical works.

I am advocating a *legitimization of ambiguity*, the realization that a musical entity can be heard in two or more different ways simultaneously. For example, a passage of Mozart can be both thematic and transitional at the same time. I am advocating an *acceptance of multiple interpretations*, the realization that a musical entity may be heard in

[10]Monte Tubb, "Textural Constructions in Music," *Journal of Music Theory Pedagogy* 1/2 (1987): 201-224.

one way at one time and in another way at another time, depending on the assumptions or conditions we posit. For example, the location of the return of the opening section of a movement may be heard as being at one point if we attend primarily to factors of texture and tonality, and at another point if we attend primarily to melodic factors. I would even go so far as to say, as have others, that the possibility of evoking ambiguity and multiple interpretation is one of the valid criteria for establishing the worth of a musical work. I would temper this by reference to the intellectual or the musical worth of a work, recognizing the possibility that a simpler, less ambiguous work might still have enormous cultural, sociological, or personal value.

Matching purpose and paradigm

For my final problem I shall paraphrase a song from *The Mikado* and recommend, not to "let the punishment fit the crime," for I hope our analyses are neither punishments nor crimes, but rather to let the paradigms of our analysis fit the purpose. Determining the percentage of time a given composer uses augmented sixth chords may be helpful for the analysis of style, but contributes little to the effectiveness of performance. Completing a sophisticated, mathematically-based analysis of pitch structure in a composition may be fascinating for a composer, but be of no practical interest or value for a sight reader.

Not everyone agrees with this notion. Ian Bent claims that "the distinction often drawn between formal analysis and stylistic analysis is a pragmatic one, but is unnecessary in theoretical terms."[11] Some theorists believe that analysis should be primarily an intellectual exercise, unsullied by pragmatic considerations of application. I would argue that considerations of the purpose of analysis can guide and inspire us, making our analyses more effective. I would urge us to give greater consideration to possible audiences for our analyses, and greater primacy to our purposes and goals in making the analysis. I would encourage us to broaden our conception of the appropriate ways for reporting analytical results to include not just our written reports, graphs, and charts, but also our compositions, improvisations, and performances.

If we do not constantly re-examine analytical premises and methods, we run the danger of meriting the harsh criticism leveled at analy-

[11]Ian Bent, "Analysis," *The New Grove Dictionary of Music and Musicians* , ed. Stanley Sadie (London: MacMillan, 1980), vol. 1, 340.

sis by Pierre Boulez, a criticism that would probably have delighted the pragmatists, whose words I quoted at the beginning of this paper.

> Analysis is only of real interest when it is active, and it can only be fruitful in terms of its deductions and consequences for the future. . . .We are swamped with vast tables of ridiculous symbols, reflections of a void, time-tables of trains which will never leave. [12]

Boulez has said that he regards his compositions as "works in progress." We should regard our analytical efforts as "analyses in progress," subject to revision or re-interpretation as our experiences and perspectives change. We should regard our meta-theoretical speculations, such as those I have shared in this paper, as "essays in progress," subject to correction and improvement as we exchange ideas with our students and colleagues. This is the great joy of our profession.

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[12] Pierre Boulez, *Boulez on Music Today*, trans. Susan Bradshaw and Richard Rodney Bennett (London: Faber and Faber, 1971), 16-17.

Difficulty Factors in Melodic Perception

Jeffrey L. Gillespie

As an instructor of twentieth-century aural skills for the past six semesters, I have become increasingly interested in the perception of melodies that do not fall clearly into the category of "tonal." I would like to guide students toward effective listening strategies, but I have difficulty determining which strategies are best for the students. Where and, more importantly, how should one begin with these tonally-comfortable students? At a special session of the 1987 Society for Music Theory conference, Elizabeth West Marvin posed similar questions:

> To what extent, then, does our perception of non-tonal materials rely upon 'default' techniques for tonal perception? Should aural skills curricula for non-tonal music build upon groundwork laid in tonal training (on 'altered' scales, scale-degrees, harmonies) or should they assume a completely separate atonal sound world?[1]

These questions are difficult to answer, and opinions vary considerably. Consider the published texts devoted to contemporary aural skills: Herder's *Tonal/Atonal*, which promotes a "tonally-referenced" approach, Adler's *Sight Singing*, with an interval-based format, and most recently, Friedmann's *Ear Training for Twentieth-Century Music*, featuring a set-class approach. Each text is designed for classroom use, and each is strikingly different. How can we choose? And *should* we choose one approach over another?

The few published studies that deal with "non-tonal" pitch perception have yet to provide many practical suggestions for the skills pedagogue. Several studies reflect biases on the part of the experimenter regarding what constitutes an atonal pattern. Example 1 presents two such patterns from earlier studies (Taylor, 1976; Dowling

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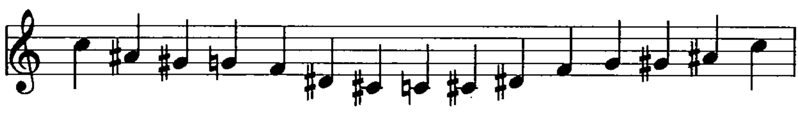
[1]Complete citations for all sources mentioned are given at the end of the article.

EXAMPLE 1. Two melodies considered "atonal" in previous studies

Taylor (1976)



Dowling and Fugitani (1971)

and Fugitani, 1971). The Taylor melody may be heard as a C-Phrygian scale or an Ab-major scale with C as the top and bottom boundary, and the other pattern as centered around A or C. The studies often assign melodies to one of only two categories: tonal or atonal, with nothing in between. Since real twentieth-century music is not so cut-and-dried, these categories are of limited practical use. What one listener hears as atonal may indeed sound tonal to another.

Answers to these problems may be found from the students themselves, and the present pilot study represents a first attempt to do just that. The long-range objectives are to gain a better understanding of what makes a pattern difficult to hear and of how a listener most naturally perceives a pattern (intervallically, tonally, or in some other way). With this information, an instructor will be better equipped to consider more effective teaching strategies.

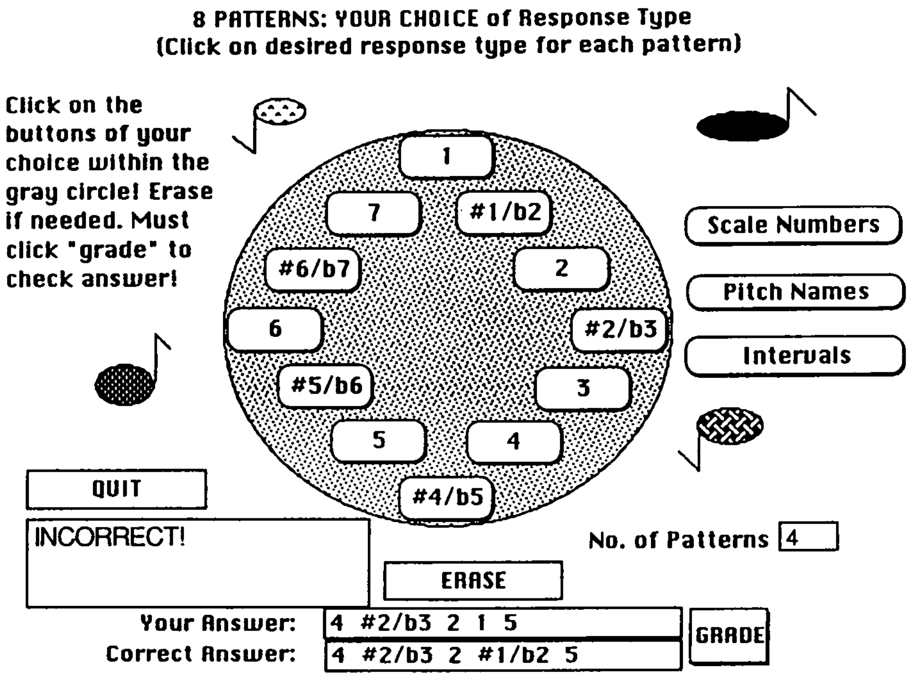
Several considerations served to guide the methodology. Since I was interested in obtaining a large body of data from subjects, and since I could make no prior predictions of what that data would reveal, I was drawn to ideas championed by Lincoln and Guba's *Naturalistic Inquiry*. According to these authors, a naturalistic study is "emergent" in design, with incoming data serving to guide subsequent stages of the project. Although I made certain decisions regarding the test format, I wanted subjects to respond based upon their "natural" tendencies when perceiving a pattern. To avoid biases in the construction and categorization of pitch patterns, I decided that all patterns for this study would be randomly generated from the chromatic scale.

Following the test, subjects were interviewed informally to glean additional feedback not revealed by the experimental data.

Six participants were chosen for their status as experienced listeners. Four subjects were Ph.D. theory students, three of whom had experience teaching aural skills. One subject was a theory faculty member, and the sixth was an undergraduate music major who had just completed the twentieth-century aural skills course with an A average. Additional information regarding these six participants is provided in Figure 6, which concludes this article.

The test itself consisted of 31 five-note patterns, generated randomly within a two-octave range around middle C, with no repeated pitches and a maximum range of a major seventh. A Macintosh computer served as the sound source. These 31 patterns were presented to the listener for transcription via a circular HyperCard grid, such as that presented in Figure 1. The continuous grid prevented the listener from having to displace octaves, as would have been necessary if the grid were horizontal.

FIGURE 1. Sample HyperCard screen taken from pilot study



Following the first hearing of a pattern, the subject was required to respond with a transcription. If the response was incorrect, a second hearing was given; the process was continued for a maximum of four tries. After the pattern was correctly transcribed or after four incorrect attempts, a new pattern was presented. Three possible response modes were available to the listener: scale degree numbers (or solfège, depending on the listener's preference), consecutive intervals, and pitch names. The test sequencing was designed to require some "forced" responses and some "choice": three practice patterns (one forced scale response, one forced interval response, and one forced pitch name response); eight with the listener's choice of response mode; four forced scale, four forced interval, and four forced pitch name; and eight more choice responses.

All incoming data was recorded as shown in Figure 2. In the top line of data, the first number (1) represents the pattern number. The following five numbers represent the actual pitches of the pattern presented, with middle C as 60. The next set of digits represents the listener's response in scale degree numbers, followed by the seconds taken for the response to be completed (18 seconds), concluding with "N" for an incorrect response.

FIGURE 2. Sample data listing, including exact pitches presented (middle C = 60), listener's response for each trial (indicating response mode as well), seconds taken to respond, and whether response was correct or incorrect (Y or N)

```
1, 64 68 70 63 67 , 1  3  #4/b5 #1/b2 3   ,  18, N
1, 64 68 70 63 67 , 1  3  #4/b5 #1/b2 4   ,  32, N
1, 64 68 70 63 67 , 1  3  #4/b5 7  #2/b3  ,  46, Y
2, 60 61 67 62 69 , m2 P4  M3  P5 ,  16,  N
2, 60 61 67 62 69 , m2 M3  P4  P5 ,  24,  N
2, 60 61 67 62 69 , m2 P4  M3  P5 ,  25,  N
2, 60 61 67 62 69 , m2 TT  P4  P5 ,  29,  Y
3, 65 66 62 64 71 , d#/eb E  C  F  A  ,  20, N
3, 65 66 62 64 71 , d#/eb E  C  D  A  ,  13, Y
4, 59 56 58 64 60 , 2  7  #1/b2 5  3  ,  35, N
4, 59 56 58 64 60 , 2  7  #1/b2 4 #2/b3  ,  21, N
4, 59 56 58 64 60 , 2  7  #1/b2 5 #2/b3  ,  39, Y
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FIGURE 3. Interval difficulty ratings, derived from confusion matrices of Blombach and Parrish (1988). The first figure represents "percentage correct" in their study, and figures in parentheses represent reciprocal values used in the present study to indicate interval difficulty level

	Ascending	Descending
P1	100 (0)	100 (0)
m2	85 (15)	82 (18)
M2	90 (10)	69 (31)
m3	78 (22)	60 (40)
M3	69 (31)	67 (33)
P4	86 (14)	69 (31)
TT	63 (37)	58 (42)
P5	80 (20)	75 (25)
m6	43 (57)	42 (58)
M6	56 (44)	57 (43)
m7	63 (37)	44 (56)
M7	62 (38)	36 (64)
P8	91 (9)	70 (30)

To determine what makes a pattern difficult to hear, rating systems can be designated to analyze the various features of the pattern. Items to consider are the number of direction changes, the range, the total consecutive interval content, and more complex judgments about interval difficulty level and the degree of "tonal fit." Interval difficulty ratings may be determined from previous interval studies, such as Blombach and Parrish (1988). Figure 3 presents figures from that particular study. The numbers without parentheses represent "percentages correct" taken from confusion matrices. For the current test, I used the reciprocal figures (in parentheses): the higher the number, the greater the expected difficulty in correctly identifying the interval.

Ratings for "tonal fit" may be determined from probe tone results of Krumhansl and Kessler (1982), presented in Figure 4A. Krumhansl's probe tone tests involve initially establishing a tonal context, in this case C major or C minor, through the playing of a scale fragment or a simple harmonic progression. Then a single pitch is presented from the chromatic scale; the listener is asked to rate how well that particular pitch "continues" or "fits within" the established tonal context. According to the figures in Figure 4A, C was selected as the pitch most closely related to the context, followed by the other pitches of the tonic triad.

While these probe tone ratings are presented in the key of C, they can easily be applied to any pattern placed within a scale system. Once a tonic is chosen for a five-note pattern, the Krumhansl values may be assigned to each of the pitches. A total of the five values provides quantified information on the tonal stability of the entire pattern within the chosen tonal placement. Since the original figures increase with tonal strength, I again chose to use reciprocal values, so that higher numbers indicate an increase in non-tonal strength. The higher the total of all scale degree values in the pattern, the more difficult that pattern may be to perceive according to a particular tonal placement. For any given pattern, there are twelve different tonic placements from which a listener may choose, including tonics that are not present in the pattern itself. Since a listener is expected to focus on one particular tonal center if responding by the scale system, it is the lowest figure (or "most tonal" placement) that is most significant. For illustration, Figure 4B presents a sample pattern, with calculated values for "non-tonalness" for each of the twelve possible tonic placements, based upon the "C Major Context" figures of Krumhansl and Kessler.

Example 2 presents a sampling of patterns selected from the original test. The patterns include a variety of difficulty factors for comparison. For instance, for the third pattern listed (C#-F-G-F#-A), the first rating of 11 represents the total range of the pattern—eleven semitones from G up to F#. The second number indicates three changes of direction within the pattern, following the initial ascent from C# to F. The total interval content, or the semitone sum of all the consecutive intervals, is 34. The interval difficulty rating, based on the figures of Blombach and Parrish (Fig. 3), is 168. And finally, 15.27 represents the "most tonal" placement, according to the Krumhansl figures from Figure 4: if C# is chosen as tonic, then the sum of the corresponding values of the scale degrees in the pattern is 15.27. This high value indicates that the pattern is quite non-tonal in comparison with other patterns presented in the test.

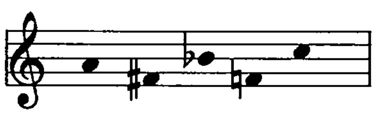
With definitive values for these difficulty factors, correlation studies can be run against subjects' response success to determine which factors most influence perceptual accuracy. Though a larger group of subjects is needed to attempt such correlations, several observations may be made with the six participants of the current study (Fig. 5).

FIGURE 4.

4A) Probe tone ratings from Krumhansl and Kessler (1982), taken from Table 2.1 of Krumhansl (1990). Since these figures increase with greater tonal stability, the present study used reciprocal values (in parentheses) to correlate increase in value with increase in tonal instability

Tone	C Major Context		C Minor Context	
C	6.35	(.65)	6.33	(.67)
C#/Db	2.23	(4.77)	2.68	(4.32)
D	3.48	(3.52)	3.52	(3.48)
D#/Eb	2.33	(4.67)	5.38	(1.62)
E	4.38	(2.62)	2.60	(4.40)
F	4.09	(2.91)	3.53	(3.47)
F#/Gb	2.52	(4.48)	2.54	(4.46)
G	5.19	(1.81)	4.75	(2.25)
G#/Ab	2.39	(4.61)	3.98	(3.02)
A	3.66	(3.34)	2.69	(4.31)
A#/Bb	2.29	(4.71)	3.34	(3.66)
B	2.88	(4.12)	3.17	(3.83)

4B) Sample pattern with non-tonal strength values calculated for all twelve possible tonic placements, based upon the original figures of Krumhansl and Kessler (1982). According to the values, the most non-tonal placement would be with E as tonic, and the most tonal placement would be with F as tonic.



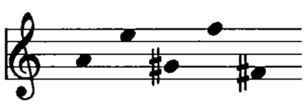
Tonic

C = 16.09 (3.34 + 4.48 + 4.71 + 2.91 + .65 = 16.09)
C# = 17.6

D =	18.42	G =	19.93
D# =	17.82	G# =	18.96
E =	20.29	A =	18.04
F =	12.76	A# =	14.71
F# =	16.54	B =	19.89

Item B indicates the percentage of errors for each of the four consecutive intervals of all response patterns; participants were definitely most accurate at the beginnings of responses and least accurate at the ends. Additional observations may be made for those patterns labeled by scale degree numbers. Figure 5C indicates that in 43.66% of the scale responses the first note was chosen as tonic. This percentage is interesting when compared with the percentage of first pitches that represent Krumhansl's "most tonal" tonics: 19.72%. When placing patterns within a tonal system, listeners chose the strongest "Krumhansl tonal fit" in only 38.03% of the responses. This disappointing percentage does little to support Krumhansl's original figures (see Fig. 4). If, however, the "top four" strongest tonal placements are considered for each pattern, based on Krumhansl's values, the percentage is much higher: in 83.1% of the responses, listeners chose one of these four tonics.

EXAMPLE 2. Sample patterns taken from pilot test, with "difficulty factor" ratings (Range / Direction Changes / Interval Total / Interval Difficulty / Non-Tonalness) and generalized categories for comparison (H - High, M - Medium, L - Low)

Highest Overall Ratings	Ran/Dir/ITot/IDif/Non-Tonal
	11 / 3 / 35 / 186 / 14.47 (1=E) (H H H H M)
	10 / 3 / 26 / 165 / 15.88 (1=B) (H H H H H)
	11 / 3 / 34 / 168 / 15.27 (1=C#) (H H H H H)
Lowest Overall Ratings	
	7 / 1 / 12 / 77 / 13.66 (1=Eb) (L L L L M)
	8 / 2 / 14 / 100 / 12.9 (1=Eb) (M M L L L)

EXAMPLE 2. (cont.)

"Featured" Factors — Ran/Dir/ITot/IDif/Non-Tonal

11 / 1 / 12 / 61 / 12.47 (1=A)
(H L L L L)

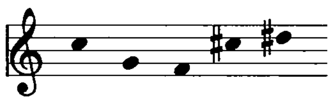
4 / 1 / 6 / 77 / 16.23 (1=F)
(L L L L H)

7 / 3 / 14 / 84 / 13.27 (1=F)
(L H L L L)

9 / 1 / 17 / 161 / 13.09 (1=A)
(M L M H L)

10 / 3 / 28 / 157 / 12.9 (1=A)
(H H H H L)

More "Non-Tonal" Values



10 / 1 / 17 / 129 / 14.8 (1=Ab)
(H L M M M)

(Most "tonal" tonics = Ab [14.8], C [14.81], Eb [14.84], F [15.3]; least tonal tonic = E [21.51])

7 / 3 / 19 / 122 / 12.76 (1=F)
(L H M M L)

(Most tonal tonics = F [12.76], Bb [14.71], C [16.09], F# [16.54]; least tonal tonic = E [20.29])

Finally, a few personal observations about the participants. All but one listener averaged between 26 and 33 seconds for each response, with one averaging 58 seconds. Most interesting is the response preferences when participants were given a choice. One respondent answered by interval every time. Another consistently chose scale degree numbers and verbally expressed annoyance at being forced to re-

FIGURE 5. Statistical information

A)

Participant	# Correct 1st Try	Ave. Incorrect Tries per Pattern	Ave. Time per Pattern
#1	0	2.25	33.06"
#2	10	1.25	28.98"
#3	5	1.86	33.00"
#4	11	1.46	28.08"
#5	6	1.57	26.33"
#6	3	2.25	57.70"

B) % OF ERRORS (by interval placement):

1	2	3	4
10.6%	22.5%	32.8%	34.1%

C) % OF RESPONSES WITH 1ST NOTE CHOSEN AS TONIC: 43.66%
(% OF PATTERNS WITH 1ST NOTE AS "MOST TONAL" TONIC, ACCORDING TO KRUMHANSL: 19.72%)

D) % OF RESPONSES WITH "MOST TONAL" TONIC CHOSEN: 38.03%
% OF RESPONSES WITH ONE OF THE "TOP FOUR" TONICS CHOSEN: 83.10%

spond by interval during certain portions of the test. The other four listeners exhibited a distinct preference for responding by scale degree, with occasional interval response. Since background and training are likely to play a part in such response choices, brief profiles of each participant are included in Figure 6.

For the next stage in this study, I plan to expand data collection by testing a greater number of listeners, at least 30, using the same method of randomly generated patterns. With a larger amount of data, linear regression analysis may be used to evaluate each individual difficulty factor regarding its degree of influence on listeners' perceptual accuracy. Subsequently, I hope to test listeners with actual melodies from the literature. With information gathered from studies such as this, aural skills instructors will be better equipped to organize melodic examples for dictation purposes and to achieve a clear progression from one difficulty level to the next during the course of a semester. With more subjects tested, a better understanding would be gained regarding the natural tendencies of listeners: Is there a general preference for the scale system approach no matter what the tonal fit of patterns may be? Is each listener different in preference, perhaps based on prior experience? Which listeners achieve the highest accuracy levels, those who favor a scale system approach, an interval approach, or a flexible approach to listening? With more information on listeners' natural tendencies and corresponding accuracy levels, we as teachers can better guide students to reach their potential as listeners, in ways that are most comfortable to the students.

FIGURE 6. Profiles of the six participants

Participant #1
Major Instrument: Voice   Level: Senior
Aural Skills Training: Scale degree numbers; completed undergraduate sequence (including non-tonal aural)
Teaching: None
Music for Pleasure Listening: Primarily Baroque
Test response preference: Intervals (consistently)

Participant #2
Major Instrument: Piano   Level: Ph.D. theory student
Aural Skills Training: Solfège; private aural skills training, no non-tonal aural training
Teaching: Sophomore level aural skills, twentieth-century aural skills, graduate aural review
Music for Pleasure Listening: Contemporary "classical"
Test response preference: Solfège, occasional interval

Participant #3
Major Instrument: Viola   Level: Theory faculty
Aural Skills Training: not available
Teaching: Twentieth-century analysis ca. fifteen times, twentieth-century aural skills three-four times
Music for Pleasure Listening: Jazz, chamber music
Test response preference: Scale numbers, occasional interval

Participant #4
Major Instrument: Saxophone   Level: Ph.D. theory student
Aural Skills Training: Solfège and scale numbers; no non-tonal aural skills
Teaching: Freshman and sophomore ear training for four+ years
Music for Pleasure Listening: Gospel
Test response preference: Scale numbers (consistently)

(continued)

FIGURE 6. (cont.)

Participant #5
Major Instrument: Piano/Organ Level: Ph.D. theory student
Aural Skills Training: Scale numbers; no non-tonal aural skills
Teaching: Twentieth-century analysis twice, twentieth-century aural skills six times
Music for Pleasure Listening: Classical, jazz, pop/rock, country, gospel, show tunes
Test response preference: Scale numbers, occasional interval

Participant #6
Major Instrument: Piano Level: Ph.D. theory student
Aural Skills Training: Two-three semesters of basics, no non-tonal
Teaching: Twentieth-century analysis, freshman and sophomore written theory
Music for Pleasure Listening: Twentieth-century Russian and English, Bartók, classical, rock, Celtic-folk
Test response preference: Pitch name, some scale numbers

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Interval and Scale-Degree Strategies in Melodic Perception

William E. Lake

The ability to produce and identify intervals and scale-degree pat terns contributes greatly to the perception, understanding, and performance of melodies. These musical building blocks form the basis of two contrasting perception strategies, which have emerged from recent music cognition research. This article reviews a small portion of that research, examines diagnostic tools for determining students' approaches, and discusses teaching techniques for promoting the flexible use of these two strategies.

W. Jay Dowling[1] investigated scale-degree versus interval representations in the perception of tonal melodies. Subjects had to recognize melodies in exact transpositions even when they were obscured by being shifted against the established key, thereby systematically altering the scale degrees. The task was thus stacked against those relying solely on a scale-degree strategy. Figure 1 shows sample stimuli. Letter D is the exact transposition of A with altered scale degrees.

The results showed variations in performance according to the subjects' musical experience (see Fig. 2; cross-hatched bars are for stimuli shifted against the key). Inexperienced subjects recognized exact transpositions moderately well regardless of whether scale degrees changed or not. Moderately experienced subjects performed very well with scale degrees held constant but at chance when they were changed. Professionals did very well regardless of conditions. Surprisingly, those with little musical experience performed significantly better than those with moderate experience when asked to recognize exact transpositions with changed scale degrees.

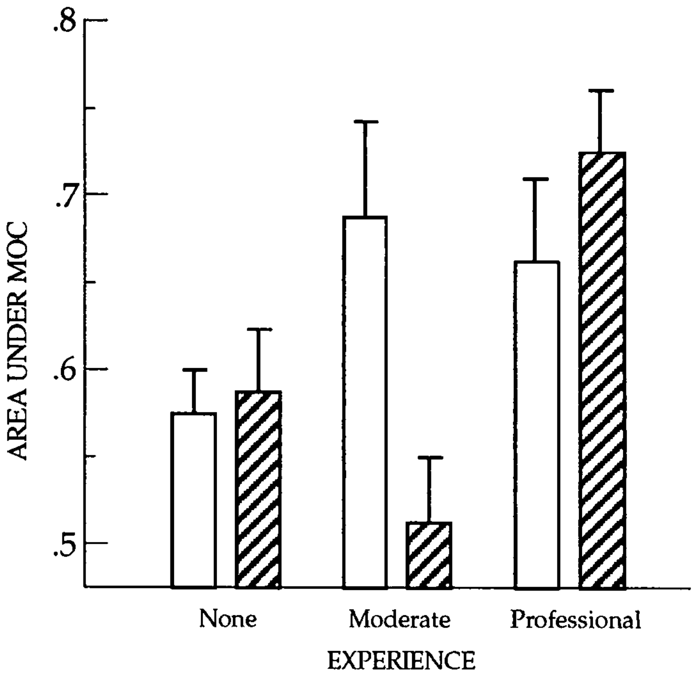
My dissertation investigated expectancy in tonal melody. Freshman and sophomore music majors heard a key-establishing context followed by a pair of tones and were then asked to sing their expectancies for continuation. Clearly some subjects were concentrating pri-

[1]Complete citations for all sources mentioned are given at the end of the article.

FIGURE 1. Dowling's stimuli (*Music Perception* 3/3 (1986): 284)

Fig.1 Examples of stimuli in Experiment 1: (A) A novel melody introduced with chordal context ending with the tonic (I) chord; (B) a same-context transposition of A; (C) a same-context imitation of A; (D) a different-context transposition of A; (E) a different-context imitation of A. The Roman numerals under the staves indicate the chord labels in the context; the small numbers above the melodies indicate the interval pattern in semitones; and the small numbers below the melodies indicate the scale-step values of the pitches. Note that transpositions preserve interval pattern exactly, and that the chordal context determines the initial scale-step values.

FIGURE 2. Dowling's chart of results versus experience (*Music Perception* 3/3 (1986): 289)



marily on the interval between the two stimulus tones, since they gave the same continuation for a particular interval even though its scale-degree interpretation changed.at each presentation. Other students related the two tones not to each other but to the established key. Their continuations converged on the nearest highly stable tone, producing different continuations for the same interval depending on context.

These perceptual differences can strongly affect student performance on aural skills tasks. Neither approach is ideal for all situations. A scale-degree strategy is most suitable for tonal melodies. A typical problem for an interval thinker is to misjudge a leap and then remain off by a step; thinking scale degrees, however, allows quick reorientation after such a mistake. On the other hand, an interval strategy works best for atonal melodies and passages in tonal melodies that are modulatory or tonally vague. A typical mistake for a scale-degree thinker, who is not careful about specific intervals, is to alter notes to fit into some key (either imagined or no longer in force). Although some teachers concentrate solely on one or the other approach, the ideal strategy is a flexible one, utilizing intervals and scale degrees depending on the demands of the melody.

The degree to which a student favors one strategy over the other is useful information for an aural skills instructor. Those students strongly adhering to a single strategy need to be guided toward a more flexible approach. Dowling's results suggest that a teacher could predict a student's preferred strategy based on musical experience. He conjectures that: (1) inexperienced listeners code melodies as sequences of pitch intervals, (2) moderately experienced listeners (mean of five years training) code melodies as scale-degree sequences, and (3) professionals (fifteen or more years experience) use a flexible system incorporating both (Dowling, 289).

In contrast, I found different strategies within a homogeneous experience group, and my practical classroom experience corroborates that finding. College aural-skills students usually fall in the high end of Dowling's moderately experienced category. Typically, all three strategies are represented in every class; thus some relatively experienced musicians rely only on interval representations. Dowling's conclusions suggest an odd, although not impossible, developmental sequence. It seems unlikely that students would forget how to listen intervallically while they are learning scale-degree representations, only to recover that ability as professionals.

An alternative hypothesis portrays reliance solely on either intervals or scale-degree representations as a strategy associated with inexperience. With training, music coding strategies become more flexible. The initial preference for intervals or scale degrees then depends on factors such as personality or cognitive style. Support for this notion can be drawn from Charles Schmidt, who found correlations between certain tests of cognitive style and aural skills performance in general. However, even if such a relationship were proven, its practical use would be limited. A teacher may better test directly for listening strategies.

What diagnostic tools can best determine students' strategies? Instead of time-consuming individual singing tests, a short listening test is usually more practical because it can be done quickly en masse. Isolated recognition of either intervals or scale degrees, however, reveals surprisingly little, since many students do not apply these skills in melodic contexts.

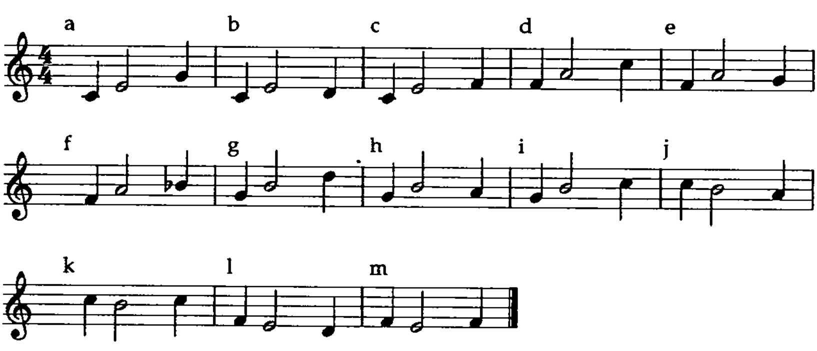
Dictation of specially designed tonal and atonal melodies tells a bit more. A tonal melody containing large leaps among members of the tonic triad should be more difficult for interval thinkers. Conversely, a melody with conflicting semitones lacking proper resolutions should be more difficult for scale-degree thinkers. Both, however, can be too difficult for beginning music majors, a number of whom will not be able to produce any response. My experience shows that this sort of diagnostic test is inconclusive in one-third to one-half of the cases.

Dowling's experiment was not intended as a diagnostic excercise, but replicating it produces useful results. It best identifies scale-degree thinkers, because the task is stacked against them. It does not distinguish well between the interval and the flexible strategies. The task is easy enough that a proficient interval thinker can score highly and appear to belong in the flexible-strategy category. Conversely, poor overall performance might be equated with an interval strategy instead of a poorly executed scale-degree strategy. This diagnostic approach tends to be inconclusive in about a quarter of the cases.

A paper-and-pencil variant of my earlier experiment often produces good results. Students rate different continuations of the three ascending major thirds and two descending minor seconds found in a major key, played in random order (see Ex. 1). Those who rate stable tones highly are scale-degree thinkers. Those whose high ratings follow consistent interval patterns (a-d-g, b-e-h, c-f-i, j-l, and k-m—the first and last patterns are most popular) are interval thinkers. This

EXAMPLE 1. Expectancy-type diagnostic test

Instructions: Rate on a scale of 1 to 7 how good a continuation the third note is of the other two



diagnostic procedure is inconclusive about as often as Dowling's, but it places relatively few cases in the flexible-strategy category. Thus it gives a better indication of which strategy is favored, even for students who employ a moderate degree of flexibility in their perceptual strategy.

After obtaining this information about approaches, a teacher can assign exercises to help students develop the opposite strategy and to use both flexibly. This pedagogy works best when instruction is individualized, but it can also succeed in the traditional monolithic classroom. For example, students of different mindsets can be paired off to work together—to coach each other—on exercises given to the entire class.

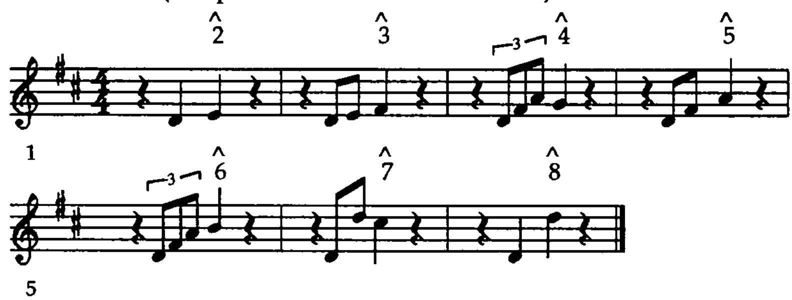
A number of activities can promote this flexibility. Most of them work for both ear training and sight singing and are discussed here after a few prefatory observations. These suggestions are emphatically not arranged in a pedagogical sequence. Although one conventional aural-skills pedagogy begins atomistically and builds up to a full context, my practical experience suggests that some context is necessary from the outset. Probably a spiral approach is best, cycling continually from context to isolation and back. Determining the exact pedagogical sequence to suit a particular situation must be left to the reader.

Prefatory Notes

Lyrics. Solmization or other labels act as catalysts to help students bond together musical concepts and sounds. (Bodily motions may also be added for extra reinforcement.) While each of the many solmization systems for scale degrees have pros and cons, some system is probably better than none. For intervals, there are labels—diatonic (e.g., minor second) or chromatic (number of semitones)—and note names. If interval drill is to transfer to melodic tasks, however, it needs to be attached to specific notes and not just to abstract labels. While students may initially find it easier to sing and think without lyrics, in the long run they probably learn more with a system than without.

Finders. Have students memorize "finders." Short exercises containing an instance of every scale degree or interval can be memorized and employed as references. Upon encountering difficulty hearing or singing some scale degree or interval, students can recall (singing if necessary) the corresponding fragment of a finder and check the accuracy of their best guess. Robert Hurwitz's scale-degree finder (Ex. 2) proceeds from *do* to each diatonic degree, either by step or via the tonic triad.

EXAMPLE 2. Scale-degree finder (sing also in harmonic minor) (adapted from Robert Hurwitz)



Examples 3 and 4 illustrate two interval finders. Example 3 employs an axis, thereby avoiding tonal associations, and Example 4 places intervals in the context of a major scale. For additional benefit, all of these finders can be performed with the units in scrambled order.

EXAMPLE 3. Axial interval finder (adapted from David Cope)

EXAMPLE 4. Major-scale interval finder

A note of caution should be sounded here. Knowing a single instance of each concept is merely one step towards a complete understanding. Students must outgrow whatever crutches they use initially, including the ever-popular associations with familiar tunes, since singing and identification of both intervals and scale degrees must be practically instantaneous to be useful in musical contexts.

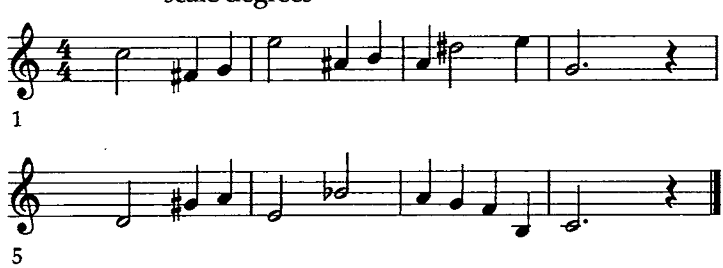
Isolated Drill. Scale degrees and intervals can be sung or identified one at a time without reference to any particular musical context. The goal is to eliminate distractions, allowing concentration on individual items. Presumably repetition with appropriate feedback will result in eventual mastery. Isolation drills are best done on few hearings at steadily increasing tempos, in preparation for their application to real-time singing and dictation.

Partial Isolation

Target practice. Recognition in context helps connect skills learned in isolation to actual music. Students can be given a particular scale degree or interval (the target) on which to concentrate. They must then indicate its occurrence in some manner while singing or hearing a melody. The goal is to match memory of the target to its sound in real time. In sight singing, one could hum a melody, and solmize only

EXAMPLE 5. Leap to a target scale degree by many different intervals

EXAMPLE 6. Use a target interval to leap to many different scale degrees



specified scale degrees (especially tonic triad tones) or sing the name of a target interval (for example, perfect fourth). In dictation, students can write out as many numbers as there are tones and then either circle the numbers on which the target scale degree occurs or put a check between numbers whose tones form a target interval. As proficiency develops, students may search for several targets at once (for instance, all tonic triad tones).

To intensify such drill, melodies can be specially constructed to employ heavily a particular scale degree or interval. Example 5 leaps to the target, *sol*, by many different intervals. Example 6 uses a target interval, the tritone, to leap to many different scale degrees. This sort of exercise can be very difficult because, unlike a scale-degree target, the actual pitches of the target interval change. For this exercise it is better not to use sequence, since sequences suggest patterns larger than a single interval.

Fetch. Students need to be able to focus on any scale degree or interval while singing or listening. To train this ability, one might stop a melody at selected points, recall (singing, if necessary) a particular interval or scale degree, and compare the last tone or interval to it. As proficiency develops, these comparisons can be done without stopping, first on longer tones and later on every tone. The hierarchical nature of tonality may be employed for maximum efficiency: all scale degrees are either tonic triad tones or neighbors to them. Thus only the tonic triad need be held in memory; other degrees can be figured from it. Initially, a tonic/dominant drone can help cement the triad in memory. No comparable hierarchy exists among intervals.

Context

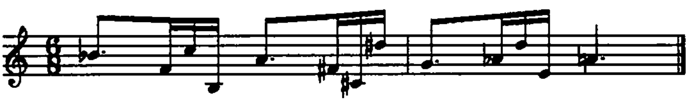
Highlights. Find prominent features of a melodic contour (beginning and ending; cadences; high, low, and turning points; distinctive leaps) and identify the scale degrees or intervals involved. Meter and rhythm can also be considered, by identifying accented degrees or intervals. This exercise promotes application of both scale-degree and interval concepts, letting the context determine which ones are needed.

Set-ups. Rather than give the starting pitch when setting up an exercise, have students find it given only the tonic note. This approach encourages position-finding relative to the tonal context.

Broaden horizons. A context is more than just the adjacent pitches or intervals. Students should be encouraged to sing or identify scale degrees of, or intervals between, nonadjacent tones (e.g., from down-

EXAMPLE 7. Recovery exercise—use scale degrees (Chopin, *Mazurka* Op. 59 No. 2)

EXAMPLE 8. Recovery excercise—use nonadjacent intervals (adapted from Schoenberg, *Klavierstück*, op. 33a)



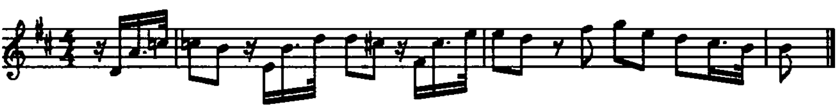
beat to downbeat). A truly effective strategy cannot proceed solely note-by-note.

Recovery. Broadened horizons should help students recover in the middle of an exercise. The goal is to get back on track after mistakes by using scale degrees or nonadjacent intervals. Students can be forced out of the note-to-note rut by interspersing extreme difficulties and easy passages. In Example 7, the beginning moves too fast to follow easily; recognizing $\hat{5}$ or $\hat{3}$ in the middle, however, allows one to finish singing or writing down the melody. In Example 8, the large and difficult intervals are framed by tones that form seconds.

Distraction. At all levels, working against a distracting context sharpens one's concentration. A scale-degree strategy depends on establishing and remembering a tonal context. Beginners can practice holding in memory at first the tonic alone and later the tonic triad, while listening to distracting speech or music. An interval strategy depends on forgetting or ignoring tonal contexts. Many students fall prey to the tonal implications that interval patterns suggest. One curative is to sing intervals in same-type chains (that is, the last note of one becomes the first note of the next). Such chains may initially suggest a key but always violate it before long. For example, in a chain of four ascending major seconds, there is a tendency to sing a minor second for the fourth note to stay within a diatonic tetrachord. Advanced students can be challenged by bitonal exercises, approached first in terms of maintaining one key against the other but ultimately of conceiving the two keys at once.

EXAMPLE 9. Abrupt modulation (adapted from Schubert)

EXAMPLE 10. Real and tonal sequence (Handel, *Concerto Grosso* Op. 6 No. 12 in B minor, Largo)



EXAMPLE 11. Tonal references in atonal music (adapted from Berg, *Violin Concerto*)

g: E:

Flexibility

New Keys. To navigate from one key to another involves putting aside one tonal context and taking up a new one. Especially with distant keys, it helps to think intervallically across the juncture. Even beginning students can practice this skill by finding the tonic for each new exercise intervallically from the previous one, and then placing the new tonal context around it. This drill is good preparation for melodies that modulate abruptly (see Ex. 9), since it requires switching quickly between intervallic and scale-degree strategies.

Combinations. Once students become somewhat proficient with scale degrees and intervals, one may combine one of each (for example, *ti* and major sixths) in a single drill. Activities described above as target practice, fetch, and highlights are all amenable to this approach.

Sequence. Alternating real and tonal sequence also promotes flexibility. Tonal sequence depends on scale degrees, while real sequence typically violates the scale. In Example 10 intervallic thinking is helpful for navigating the chromaticism of the first two legs, but the last interval of the third leg is changed—a good place to return to a scale-degree strategy.

Tonal/Atonal. As noted before, tonality usually works best with a scale-degree strategy and atonality with an intervallic one. One could alternate them either from exercise to exercise or within exercises. Ronald Herder's book explores this idea. Some atonal melodies contain tonal references, which can aid in their perception. To sing or take down the tone row in Example 11, it helps to think triadically, or even tonally (beginning in g and ending in E). Other melodies use pitch centricity or axes, while maintaining a fundamentally intervallic character. In Example 12, G and C# serve as anchors for the sinuous chromaticism.

EXAMPLE 12. Pitch axis within fundamentally intervallic music (Bartók, *Mikrokosmos*, no. 115)

Recent research suggests that the best melodic perception strategy is a flexible one, incorporating both scale degrees and intervals. Yet quite a few aural skills curricula focus exclusively on one or the other. Many teachers put off purely intervallic (i.e, atonal) music until the last few weeks of study or even omit it entirely. If one intends to teach a flexible perceptual strategy, music literature favoring the two different approaches should be interspersed from the outset. Consequently, atonal music might be taught much earlier than is customary. Concentrating exclusively on diatonic tonal music for a year or more gives little incentive to develop flexible strategies. Ideally students will combine in singing and listening their understanding of both intervals and scale degrees.

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Scale-Degree Function: A Theory of Expressive Meaning and Its Application to Aural-Skills Pedagogy

Steve Larson

This paper describes aspects of a theory of expressive meaning in common-practice tonal music and its implications for the teaching of aural skills. The theory is inspired by Rudolf Arnheim's applications of laws of perceptual organization (derived from principles of Gestalt psychology) to the perception of visual art.[1] The theory is also supported by the results of empirical studies in music perception and corroborated by computer models of music cognition.

According to this theory, we tend to experience music as action within a field of musical forces. It is the often purposeful quality of this action that led Schenker to speak of the "will of the tones," but such a feeling of purpose does not require that these actions be attached to a specific agent.[2] Drives that we experience in listening—especially a tendency toward simplicity—lead us to feel the "will of the tones" operating in a field of musical forces that I call *gravity, magnetism,* and *inertia.* We tend to be unaware of these forces (just as we tend to be unaware of forces that we experience in the physical world), but they shape our perceptions so that musical sounds seem to embody directed tensions or goals.

One goal of aural training is to encourage a listener to experience and identify these directed tensions, both because they help us recognize the functions of musical notes or patterns and because conveying their expressive meanings is central to good musicianship. Current work in music theory, cognitive science, and music perception allows

[1]Rudolf Arnheim, *Art and Visual Perception: A Psychology of the Creative Eye,* new version, expanded and rev. ed. (Berkeley and Los Angeles: University of California Press, 1974). For more on the implications of Arnheim's work for research and teaching in music, see Steve Larson, "On Rudolf Arnheim's Contributions to Music Theory," *Journal of Aesthetic Education* (Special Issue devoted to the work of Rudolf Arnheim) 27/4 (1993): 1-7.

[2]Fred Maus, "Music as Drama," *Music Theory Spectrum* 10 (1988): 56-73.

us to explain directed tensions in terms of musical forces; recognizing these forces can help us to improve aural-skills pedagogy.

Internal Representations of Musical Relationships

The terms *audiate, hear as,* and *trace* are important for understanding the internal representation of musical relationships. *Audiate* means to hear internally sounds that are not physically present.[3] *Hear as* means to give meaning to a sound by (subconsciously) assigning it to a category, and *trace* means the internal representation of a note that is still melodically active. These and other terms used in this paper are summarized in Figure 1.

FIGURE 1. List of definitions

Internal Representation

audiate. To hear internally sounds that are not physically present.
hear as. To give meaning to a sound by (subconsciously) assigning it to a category.
trace. The internal representation of a note that is still melodically active.
unstable. To hear a note as unstable means to audiate a more stable note to which it tends to move and a path that would take it there, displacing its trace.

Steps and Leaps

step. Half-steps and whole-steps. The second note in a melodic step tends to displace the trace of the first.
leap. Thirds and larger intervals. The second note in a melodic leap does not tend to displace the trace of the first.

Musical Forces

gravity. The tendency of an unstable note to *descend* to a more stable note.
magnetism. The tendency of an unstable note to move (up or down) to the *nearest* stable pitch. (Magnetism is affected by distance—the closer we get to a goal, the more it attracts us.)
inertia. The tendency of a pattern of musical motion to continue in the *same* direction. (What is meant by "same" depends on how that musical pattern is represented in our internal hearing.)

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[3]Edwin E. Gordon, *Learning Sequences in Music: Skill, Content, and Patterns* (Chicago: GIA Publications, 1993), 3. "Audiation takes place when one hears *and comprehends* music for which the sound is no longer or may never have been physically present."

These terms allow us to distinguish between stable and unstable notes. To hear a note as unstable means to audiate a more stable note to which it tends to move and a path (usually involving step-wise motion) that would take it there, displacing its trace.

The distinctions consonant/dissonant and stable/unstable should not be confused. Consonant and dissonant depend on notation and interval names, while stable and unstable refer to the perceived tendencies of individual notes (or of harmonies) in context. Consonant and dissonant create mutually exclusive categories, while stable and unstable can be used only comparatively. Roger Graybill has commented on the importance for theory instruction of making the differences between these pairs of terms clear. David Butler makes a similar distinction between "sensory consonance and dissonance" and "musical consonance and dissonance."[4]

Steps and Leaps

This definition of unstable suggests that intervals may be divided into two classes: steps and leaps. Augmented unisons, minor seconds, and major seconds are called steps. (A diminished third is a step whose name suggests that it is heard as a leap.) Minor thirds and larger intervals are called leaps. (An augmented second is a leap whose name suggests that it is heard as a step.)

In a melodic step, the second note tends to replace the trace of the first, leaving one trace in musical memory. In a melodic leap, the second note tends to support the trace of the first, leaving two traces in musical memory. Experiments in music perception and published discussions in music cognition often support this distinction between steps and leaps, or they seem to depend implicitly on such a separation.[5] What Hindemith calls a "step-progression" seems analogous to what, in visual perception, the Gestalt psychologists call the "phi phenomenon." Several recent theoretical discussions also build explicitly upon this distinction of steps and leaps.[6]

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[4]Roger Graybill, "Pedagogically Speaking: Consonance and Dissonance in the Freshman Theory Class," *In Theory Only* 9/5-6 (1987): 51-56. David Butler, *The Musician's Guide to Perception and Cognition* (New York: Schirmer Books, 1992). Butler's book is reviewed later in this volume.

[5]A comprehensive summary of these experiments and discussions can be found in Albert S. Bregman, *Auditory Scene Analysis: The Perceptual Organization of Sound* (Cambridge, MA: The M.I.T. Press, 1990).

[6]Peter Westergaard, *An Introduction to Tonal Theory* (New York: W.W. Norton, 1975); Steve Larson, "Questions about the Ursatz: A Response to

Musical Forces and Scale-Degree Function

When we listen to tonal music, we experience certain musical forces, including gravity, magnetism, and inertia. They are responsible for some of the dynamic tendencies we experience in listening to music. Each may be explained in terms of the principles of perceptual organization articulated by Gestalt psychologists. Together, they afford necessary and sufficient conditions for the emergence of "scale-degree function."

Musical gravity is the tendency of an unstable note to descend to a *lower*, more stable pitch. For example, in a context where C is heard as stable and the D above it is heard as unstable, listeners experience gravity as a tendency of the D to descend to C. Whether it is learned or innate, our perception of musical gravity is immediate, and it is central to expression in tonal music. Gravity arises in part because we hear musical motion taking place in musical space. This metaphor is a natural one. Several spatial models have been proposed in the music cognition literature,[7] but the metaphor is clear in earlier writing, too (as just one example, consider Schenker's idea of *Tonraum*). Musical space is clearly asymmetrical—it has an "up and down." Arnheim discusses this "anisotropy of musical space" and argues that we experience dynamic tendencies in both visual art and music that parallel the tendencies of gravity in physical space.[8]

Musical magnetism is the tendency of an unstable note to move (up or down) to the *nearest* stable pitch. Furthermore, magnetism is affected by distance—the closer we get to a goal, the more it attracts us. For example, in a context where D and G are heard as stable and the F between them is heard as unstable, listeners experience musical magnetism as a tendency of the F to ascend to G (because F is closer to G than it is to D). If that F should then move to F#, the magnetic

Neumeyer," *In Theory Only* 10/4 (1987): 11-31; and Stephen Dembski, "Steps and Skips from Order and Content: Aspects of a Generalized Step-Class System," paper presented at the meeting of the Society for Music Theory, Baltimore, Maryland, November 1988.

[7]Roger N. Shepard, "Structural Representations of Musical Pitch," in *The Psychology of Music*, ed. Diana Deutsch (Orlando, FL: Academic Press, 1982), 343-390, summarizes earlier spatial models. See also Carol L. Krumhansl, *Cognitive Foundations of Musical Pitch* (New York: Oxford University Press, 1990) and Fred Lerdahl, "Tonal Pitch Space," *Music Perception* 5/3 (1988): 315-349.

[8]Rudolf Arnheim, "Perceptual Dynamics in Musical Expressions," in *New Essays on the Psychology of Art* (Berkeley and Los Angeles: University of California Press, 1986), 214-227.

force drawing us to G will intensify (because F# is now closer to G than F was). Magnetism appears to influence intonation and intonation judgments.[9] Arnheim discusses analogous forces operating in visual art.

Musical inertia is the tendency of a pattern of musical motion to continue in the *same* fashion. What is meant by "same" depends upon how that musical pattern is represented in our internal hearing. For example, if a pattern of musical motion begins "C-D-E, D-E-F," listeners may experience musical inertia as a tendency to continue the pattern "E-F-G," etc. Gestalt psychology calls this tendency "the law of good continuation."[10] Meyer's work on emotion in music and Narmour's implication-realization theory grant an important role to what I call inertia.[11]

Each of the musical forces acts on notes at all times. The less stable a note, the more that note will convey to the listener the effects of these forces.[12] The combination of these effects in a given context contributes to the expressive quality of a note, and is sometimes called "scale-degree function." However, even though scale-degree function plays a central role both in music and in discussions of music, the term is often not explicitly defined. When used to describe an aspect of melody, it seems to refer to the characteristic qualities that distinguish one tone of a scale from the others. These melodic tendencies are often represented with diagrams such as that in Example 1.[13]

[9]Robert Frances, *The Perception of Music*, trans. W. Jay Dowling (Hillsdale, NJ: Lawrence Erlbaum Associates, 1988).

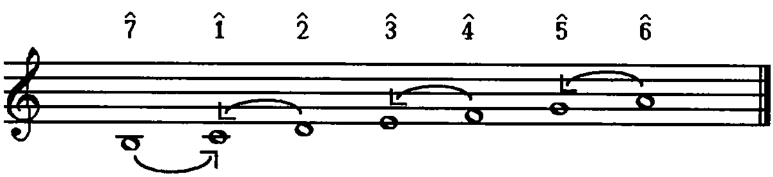
[10]Wolfgang Koehler, *Gestalt Psychology: An Introduction to New Concepts in Modern Psychology* (New York: Liveright Pub., 1947).

[11]Leonard Meyer, *Emotion and Meaning in Music* (Chicago: University of Chicago Press, 1956); Eugene Narmour, *The Analysis and Cognition of Basic Melodic Structures* (Chicago: The University of Chicago Press, 1990); Eugene Narmour, *The Analysis and Cognition of Melodic Complexity* (Chicago: The University of Chicago Press, 1992).

[12]A computer program based on the operation of these forces predicts melodic continuations that resemble those of trained listeners. See Steve Larson, "Modeling Melodic Expectation: Using Three 'Musical Forces' to Predict Melodic Continuations," *Proceedings of the Fifteenth Annual Conference of the Cognitive Science Society* (Hillsdale, NJ: Lawrence Erlbaum Associates, 1993), 629-634. This report is available from the Center for Research on Concepts and Cognition; Indiana University; 510 North Fess Street; Bloomington, IN 47408 as CRCC Technical Report #70.

[13]Example 1 is similar to Example 1-7 in Edward Aldwell and Carl Schachter, *Harmony and Voice Leading*, 2nd ed. (San Diego: Harcourt Brace Jovanovich, 1989), 9.

EXAMPLE 1. Some tendencies of individual scale degrees in the context of major tonic harmony



Example 1 captures some important aspects of the perceptual dynamics of musical expression. Heightening students' attention to these tendencies improves their ability to identify correctly which scale degree they are hearing and can help focus listening skills in general. Furthermore, Example 1 can help to explain certain aspects of common-practice harmony (such as rules for doubling and voice leading) and summarizes the magnetic and gravitational pulls exerted on the diatonic major scale degrees in the context of tonic harmony. However, such a diagram does not depict the influence of inertia. Nor can it show the differing contexts established by tonic triads in different positions—let alone the different contexts created by other harmonic environments.

Three- and Four-Note Patterns

While Example 1 provides students with useful information, teaching students about the operation of the musical forces within the context of prototypical patterns is also valuable. These forces generate a set of three- and four-note patterns, shown in Tables 1 and 2. These patterns meet the following conditions (where "stable note" means a member of a tonic-triad frame): (1) each pattern begins on a stable note, (2) each pattern moves by step, and (3) each pattern ends on a stable note.[14]

[14]These patterns also meet an additional condition—that none contains both $\hat{3}$ and b$\hat{3}$. That this condition seems less "necessary" in terms of the assumptions outlined above may explain why it seems one of the first conditions to be relaxed in music of the late nineteenth and early twentieth centuries, music which makes use of patterns that not only meet the three numbered conditions but that also mix $\hat{3}$ and b$\hat{3}$.

TABLE 1. The three-note patterns

scale degrees	*letter names in C*	*forces which predict the third note*		
$\hat{5}$-$\hat{6}$-$\hat{5}$	GAG	gravity	magnetism	
$\hat{5}$-b$\hat{6}$-$\hat{5}$	GAbG	gravity	magnetism!	
$\hat{5}$-#$\hat{4}$-$\hat{5}$	GF#G		magnetism!	
$\hat{5}$-#$\hat{4}$-$\hat{3}$	GF#E	gravity		inertia
$\hat{5}$-$\hat{4}$-$\hat{5}$	GFG			
$\hat{5}$-$\hat{4}$-$\hat{3}$	GFE	gravity	magnetism!	inertia
$\hat{5}$-$\hat{4}$-b$\hat{3}$	GFEb	gravity	magnetism	inertia
$\hat{3}$-#$\hat{4}$-$\hat{5}$	EF#G		magnetism	inertia
$\hat{3}$-#$\hat{4}$-$\hat{3}$	EF#E	gravity		
$\hat{3}$-$\hat{4}$-$\hat{5}$	EFG			inertia
$\hat{3}$-$\hat{4}$-$\hat{3}$	EFE	gravity	magnetism!	
$\hat{3}$-#$\hat{2}$-$\hat{3}$	ED#E		magnetism!	
$\hat{3}$-$\hat{2}$-$\hat{3}$	EDE		magnetism?	
$\hat{3}$-$\hat{2}$-$\hat{1}$	EDC	gravity	magnetism?	inertia
b$\hat{3}$-$\hat{4}$-$\hat{5}$	EbFG		magnetism?	inertia
b$\hat{3}$-$\hat{4}$-b$\hat{3}$	EbFEb	gravity	magnetism?	
b$\hat{3}$-$\hat{2}$-b$\hat{3}$	EbDEb		magnetism!	
b$\hat{3}$-$\hat{2}$-$\hat{1}$	EbDC	gravity		inertia
b$\hat{3}$-b$\hat{2}$-b$\hat{3}$	EbDbEb			
b$\hat{3}$-b$\hat{2}$-$\hat{1}$	EbDbC	gravity	magnetism!	inertia
$\hat{1}$-$\hat{2}$-$\hat{3}$	CDE		magnetism?	inertia
$\hat{1}$-$\hat{2}$-b$\hat{3}$	CDEb		magnetism!	inertia
$\hat{1}$-$\hat{2}$-$\hat{1}$	CDC	gravity	magnetism?	
$\hat{1}$-b$\hat{2}$-b$\hat{3}$	CDbEb			inertia
$\hat{1}$-b$\hat{2}$-$\hat{1}$	CDbC	gravity	magnetism!	
$\hat{8}$-$\hat{7}$-$\hat{8}$	CBC		magnetism!	
$\hat{8}$-b$\hat{7}$-$\hat{8}$	CBbC		magnetism	

TABLE 2. The four-note patterns

scale degrees	*letter names in C*	*forces which predict the fourth note*		
$\hat{5}$-$\hat{6}$-$\hat{7}$-$\hat{8}$	GABC		magnetism!	inertia
$\hat{5}$-$\hat{6}$-b$\hat{7}$-$\hat{8}$	GABbC		magnetism	inertia
$\hat{5}$-b$\hat{6}$-b$\hat{7}$-$\hat{8}$	GAbBbC		magnetism	inertia
$\hat{8}$-$\hat{7}$-$\hat{6}$-$\hat{5}$	CBAG	gravity	magnetism	inertia
$\hat{8}$-b$\hat{7}$-$\hat{6}$-$\hat{5}$	CBbAG	gravity	magnetism	inertia
$\hat{8}$-b$\hat{7}$-b$\hat{6}$-$\hat{5}$	CBbAbG	gravity	magnetism!	inertia

Table 1 catalogues the three-note patterns. The first column describes the pattern as it would be understood in the context of its tonic-triad frame. The second column gives letter-name equivalents in the key of C. The third column indicates which forces predict the actual third note. An example may make this clearer. In the pattern $\hat{5}$-#$\hat{4}$-$\hat{3}$, gravity pulls the unstable #$\hat{4}$ down, to $\hat{3}$; thus, gravity does predict the third note of the pattern $\hat{5}$-#$\hat{4}$-$\hat{3}$. In the same pattern, magnetism pulls the unstable #$\hat{4}$ to the nearest stable note, $\hat{5}$; thus, magnetism does *not* predict the third note. And in the same pattern, the inertia developed by the first two notes tends to continue the line in the same direction, to $\hat{3}$; thus, inertia does predict the third note. Where the final motion is a half-step, the magnetic pull is strongest; this strength is indicated by an exclamation point after the word magnetism. When stable notes can be found both a whole-step above and a whole-step below a pattern, we may experience motion to either note as a giving in to a magnetic pull; this ambivalence is indicated by a question mark after magnetism. For two of the patterns, no force appears to predict the third note. Table 2 catalogues the four-note patterns. The patterns that end with the half-step (the upper tetrachords of the ascending and descending melodic minor scale, marked with an exclamation point after magnetism) are most strongly directed toward their goal. Table 3 classifies the three-note patterns by shape (in columns) and by starting note (in rows).

Since goal direction is an important aspect of tonal music, the patterns in which the final note is most strongly predicted by the musical forces are those that are most fundamental to the structure of tonal music. In these patterns the unstable notes have their most characteristic tendencies and their clearest scale-degree function emerges. A ranking of the patterns can thus be suggested. Table 4 first groups each three-note pattern under the unstable scale degree that it includes (in two somewhat artificial columns—one for major and one for minor). Within each such group, the patterns are listed in the order of their strength—the degree to which the final note is predicted by a combination of gravity, magnetism, and inertia.

By focusing on the forces themselves (which operate in all musical contexts) instead of just memorizing the tendencies of selected notes in one context (such as in Ex. 1), students may learn to generalize their knowledge to other contexts. Such instruction in the operation of musical forces further improves students' listening skills. Understanding how the musical forces operate within these patterns also makes harmony and counterpoint easier to explain, since students understand the principles instead of memorizing rules and their apparent exceptions.

TABLE 3. The three-note patterns, classified by shape (columns) and starting note (rows) (U = Up; D = Down)

UU (*asc passing tone*)	*UD* (*upper neighbor*)	*DU* (*lower neighbor*)	*DD* (*desc passing tone*)
	$\hat{5}$-$\hat{6}$-$\hat{5}$ $\hat{5}$-b$\hat{6}$-$\hat{5}$	$\hat{5}$-#$\hat{4}$-$\hat{5}$ $\hat{5}$-$\hat{4}$-$\hat{5}$	$\hat{5}$-#$\hat{4}$-$\hat{3}$ $\hat{5}$-$\hat{4}$-$\hat{3}$ $\hat{5}$-$\hat{4}$-b$\hat{3}$
$\hat{3}$-#$\hat{4}$-$\hat{5}$ $\hat{3}$-$\hat{4}$-$\hat{5}$	$\hat{3}$-#$\hat{4}$-$\hat{3}$ $\hat{3}$-$\hat{4}$-$\hat{3}$	$\hat{3}$-#$\hat{2}$-$\hat{3}$ $\hat{3}$-$\hat{2}$-$\hat{3}$	$\hat{3}$-$\hat{2}$-$\hat{1}$
b$\hat{3}$-$\hat{4}$-$\hat{5}$	b$\hat{3}$-$\hat{4}$-b$\hat{3}$	b$\hat{3}$-$\hat{2}$-b$\hat{3}$ b$\hat{3}$-b$\hat{2}$-b$\hat{3}$	b$\hat{3}$-$\hat{2}$-$\hat{1}$ b$\hat{3}$-b$\hat{2}$-$\hat{1}$
$\hat{1}$-$\hat{2}$-$\hat{3}$ $\hat{1}$-$\hat{2}$-b$\hat{3}$	$\hat{1}$-$\hat{2}$-$\hat{1}$ $\hat{1}$-b$\hat{2}$-$\hat{1}$	$\hat{8}$-$\hat{7}$-$\hat{8}$ $\hat{8}$-b$\hat{7}$-$\hat{8}$	

Combining and embellishing the patterns

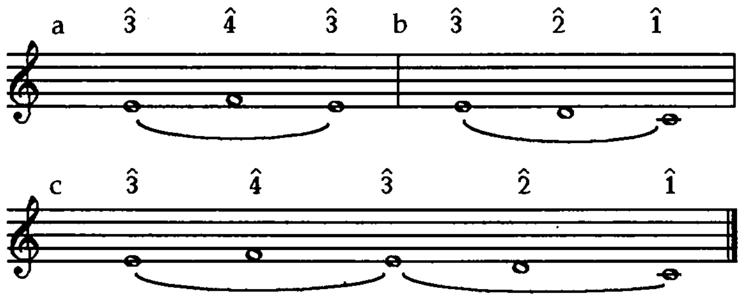
These three- and four-note patterns may be combined successively or simultaneously. Successive combination is an important basis of tonal melody. If the last note of a pattern is the same as the first note of a following pattern, their combination elides that note (for example, joining two three-note patterns to form a five-note pattern). Example 2 illustrates this successive combination of patterns. Example 2c is a five-note combination ($\hat{3}$-$\hat{4}$-$\hat{3}$-$\hat{2}$-$\hat{1}$) of two three-note patterns (Ex. 2a and 2b).

Such elided patterns create smoothly directed melodic motion. If the inertia of the second to third note (the last two notes of the first pattern) predicts the direction of the third to fourth notes (the first two notes of the second pattern), the result is even smoother. Example 3 shows a string of elided patterns, each introduced by the inertia of the preceding pattern. The string in Example 3 is canonical in two senses: (1) the melodic patterns that occur most frequently at all levels of melodic structure are embellishments of portions of this string, and (2) the string may be sung as a canon so that adjacent patterns are sung simultaneously.

TABLE 4. A ranking of three-note patterns

unstable note	major	forces which predict the third note			minor
$\hat{6}$	$\hat{5}$-$\hat{6}$-$\hat{5}$	gravity	magnetism		
$\flat\hat{6}$		gravity	magnetism!		$\hat{5}$-$\flat\hat{6}$-$\hat{5}$
$\sharp\hat{4}$	$\hat{3}$-$\sharp\hat{4}$-$\hat{5}$		magnetism!	inertia	
	$\hat{5}$-$\sharp\hat{4}$-$\hat{5}$		magnetism!		$\hat{5}$-$\sharp\hat{4}$-$\hat{5}$
	$\hat{5}$-$\sharp\hat{4}$-$\hat{3}$	gravity		inertia	
	$\hat{3}$-$\sharp\hat{4}$-$\hat{3}$	gravity			
$\hat{4}$	$\hat{5}$-$\hat{4}$-$\hat{3}$	gravity	magnetism!	inertia	
		gravity	magnetism?	inertia	$\hat{5}$-$\hat{4}$-$\flat\hat{3}$
	$\hat{3}$-$\hat{4}$-$\hat{3}$	gravity	magnetism!		
		gravity	magnetism?		$\flat\hat{3}$-$\hat{4}$-$\flat\hat{3}$
	$\hat{3}$-$\hat{4}$-$\hat{5}$			inertia	
			magnetism?	inertia	$\flat\hat{3}$-$\hat{4}$-$\hat{5}$
	$\hat{5}$-$\hat{4}$-$\hat{5}$				
			magnetism?		$\hat{5}$-$\hat{4}$-$\hat{5}$
$\sharp\hat{2}$	$\hat{3}$-$\sharp\hat{2}$-$\hat{3}$		magnetism!		
$\hat{2}$	$\hat{3}$-$\hat{2}$-$\hat{1}$	gravity	magnetism?	inertia	
		gravity		inertia	$\flat\hat{3}$-$\hat{2}$-$\hat{1}$
			magnetism!	inertia	$\hat{1}$-$\hat{2}$-$\flat\hat{3}$
	$\hat{1}$-$\hat{2}$-$\hat{3}$		magnetism?	inertia	
	$\hat{1}$-$\hat{2}$-$\hat{1}$	gravity	magnetism?	inertia	
		gravity			$\hat{1}$-$\hat{2}$-$\hat{1}$
			magnetism!		$\flat\hat{3}$-$\hat{2}$-$\flat\hat{3}$
	$\hat{3}$-$\hat{2}$-$\hat{3}$		magnetism?		
$\flat\hat{2}$		gravity	magnetism!	inertia	$\flat\hat{3}$-$\flat\hat{2}$-$\hat{1}$
		gravity	magnetism!		$\hat{1}$-$\flat\hat{2}$-$\hat{1}$
				inertia	$\hat{1}$-$\flat\hat{2}$-$\flat\hat{3}$
					$\flat\hat{3}$-$\flat\hat{2}$-$\flat\hat{3}$
$\hat{7}$	$\hat{8}$-$\hat{7}$-$\hat{8}$		magnetism!		$\hat{8}$-$\hat{7}$-$\hat{8}$
$\flat\hat{7}$			magnetism		$\hat{8}$-$\flat\hat{7}$-$\hat{8}$

EXAMPLE 2. The successive combinations of patterns



The simultaneous combination of patterns forms an important basis of tonic prolongation. Consider three-element tonic prolongations in which the three elements are: (1) a tonic in root position or first inversion, (2) an inversion of V7 or vii, and (3) another tonic in root position or first inversion. The most common outer-voice frameworks for such prolongations may be described as pairs of patterns (usually step-step, but sometimes leap-step) that give in to one or more of the musical forces (these patterns include the stronger ones in Table 1 and the incomplete-neighbor patterns $\hat{1}$-$\hat{4}$-$\hat{3}$ and $\hat{3}$-$\hat{7}$-$\hat{8}$).[15] Prolongations of other harmonies rely on similar principles of resolution (giving in to the forces) and combination.

Several fruitful combinations of simultaneous patterns, which I call solfège drills, are given in Example 4. Each of these combinations meets the following criteria: (1) each unstable note in the combination appears in one and only one of the patterns, and (2) the patterns (together with an appropriate bass line) imply a prototypical harmonic progression (the Roman numerals beneath each drill both describe the implied progression and suggest the appropriate bass line). Singing one of these upper voices while playing the suggested bass line on the piano is an effective way to internalize the sound and meaning of active tones in the scale. These combinations (with minimal adjustments for proper doubling and voice leading) also help students with part-writing skills.

[15]The most common of these combinations are listed in Aldwell and Schachter, *Harmony and Voice Leading*, 2nd ed., 116-117.

EXAMPLE 3. Elided patterns, each introduced by the inertia of the preceding pattern

These patterns provide shapes that are simple and directed. This directed quality is a source of what we call scale-degree function. The organizing power of these simple shapes also makes them ideal sources for improvisation. They are easy to embellish because they provide a secure path that is easy to hear and return to. And they teach embellishment by example because they themselves are simple embellishments. These specific three- and four-note patterns enjoy a privileged status in the structure of tonal music. Tonal melody relies heavily on the combination and embellishment of these patterns.

The progressions created by the solfège drills in Example 4 not only provide ideal backgrounds for learning to improvise, but also provide the best environments for studying the operation of musical forces in harmonic contexts other than simple tonic prolongations.

Recommendations for teaching aural skills

This theory of expressive meaning in music suggests that the construction, identification, combination, and embellishment of basic tonal patterns should be a central part of the training of musicians. Many of the following recommendations for teaching aural skills are followed by brief commentary suggesting how or why these suggestions might be implemented.

1. *Play a perfect fifth on the piano with your left hand. Above this* $\hat{5}$ / $\hat{1}$ *frame, improvise a brief piece with a clear beginning, middle, and end. Be sure to do this exercise in various keys. (No additional explicit constraints.)* The piano is a central tool for developing musicianship skills. To improvise, the student must audiate something and then produce it. The natural desire to improve one's own creations is pressure enough to encourage students to audiate more clearly and to translate more precisely that audiated sound into decisions about which keys to strike.

EXAMPLE 4. Simultaneous combinations of three- and four-note patterns—solfège drills

three-note patterns in major

$\hat{5}$	$\hat{4}$	$\hat{3}$
$\hat{3}$	$\hat{2}$	$\hat{1}$
$\hat{8}$	$\hat{7}$	$\hat{8}$
I	V^7	I

three-note patterns in minor

$\hat{5}$	$\hat{4}$	$\flat\hat{3}$
$\flat\hat{3}$	$\hat{2}$	$\hat{1}$
$\hat{8}$	$\hat{7}$	$\hat{8}$
i	V^7	i

four-note patterns in major

$\hat{5}$	$\hat{6}$	$\hat{7}$	$\hat{8}$
$\hat{5}$	$\hat{6}$	$\hat{5}$	$\hat{8}$
$\hat{5}$	$\hat{4}$	$\hat{4}$	$\hat{3}$
$\hat{3}$	$\hat{2}$	$\hat{2}$	$\hat{1}$
$\hat{8}$	$\hat{8}$	$\hat{7}$	$\hat{8}$
I	ii^6_5	V^7	I

four-note patterns in minor

$\hat{5}$	$\flat\hat{6}$	$\hat{5}$	$\hat{1}$
$\hat{5}$	$\hat{4}$	$\hat{4}$	$\flat\hat{3}$
$\flat\hat{3}$	$\hat{2}$	$\hat{2}$	$\hat{1}$
$\hat{8}$	$\hat{8}$	$\hat{7}$	$\hat{8}$
i	$ii\text{ø}^6_5$	V^7	i

2. *Play another improvisation above a $\hat{5}/\hat{1}$ frame, but with one or more of the following constraints: (a) sing each note as you play it, (b) sing each gesture after you play it, (c) sing each gesture before you play it, (d) sing each gesture with solfège after you play it, (e) sing each gesture with solfège before you play it, (f) sing each gesture with solfège as you play it, (g) use one or more three- or four-note patterns as the basis of all or part of your improvisation.* These graded constraints provide both an extremely efficient method of assessing a student's musicianship skills and a well-tested method for improving aural skills.

3. *Given the first two notes of a pattern and a musical force, sing and then write the notes predicted by that force.* Example 5 provides the beginning of an exercise blank to facilitate this assignment and to record comments for further discussion. Students could complete a three- or four-note pattern, following the guidelines of Tables 1 and 2.

4. *Play a perfect fifth on the piano with your left hand. Above this $\hat{5}/\hat{1}$ frame, sing each of the three- and four-note patterns given in Tables 1 and 2. Looking only at the first column, determine which musical forces predict the final note. Check your answer against the columns on the right. As you sing each pattern, feel the effects of the combined forces—perform the pat-*

tern in a way that reflects the changing tension in it. Repeat, omitting the first note of each pattern. When students integrate their felt kinesthetic and emotional responses with the directed tensions of musical motions, they most quickly learn the identification of scale degrees that solfège is intended to teach. This approach also helps students to see the relevance of their theory courses for their performing, composing, and listening activities.

5. *Have a friend establish a tonal center (possibly by playing a $\hat{5}/\hat{1}$ frame) and then perform one or more patterns. Sing back the pattern(s). Sing them back with solfège. Echo the pattern(s) on the piano or on your instrument. Identify them by pointing to Tables 1, 2 or 3.* Skill at this exercise may appear to be a prerequisite to beginning work on Exercise 9, but I've encountered students for which the "unnatural" order of Exercise 9 and then Exercise 5 works better.

6. *Make up a game involving the elision of patterns. (One of the rules might concern how the direction of the last two notes of one pattern influences the direction of the first two notes of the following pattern.) Play your invented game.* An inventive sense of play is a central musical skill that should be cultivated and nurtured whenever possible.

7. *While playing the bass line indicated by the Roman numerals in Example 4, sing one of the upper voices with solfège syllables. Let your performance of these patterns reflect the dynamic tendencies created by the musical forces that shape it.* Frequent practice of this exercise is a cornerstone of my aural-skills teaching.

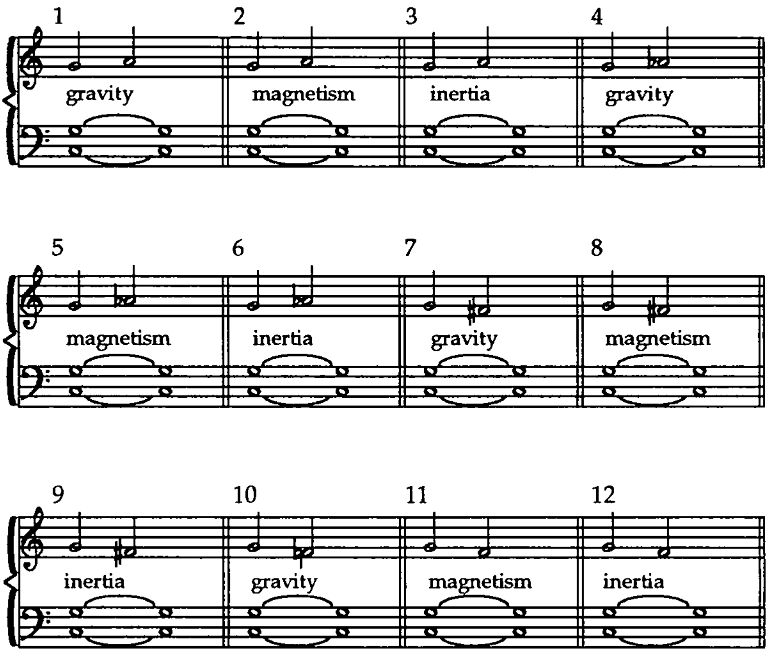
8. *Sing one of the patterns from a solfège drill given in Example 4 while playing another.* Playing one voice while singing another is easier to learn that it may seem (especially if one begins to learn this skill with simple combinations like those in Exercises 7 and 8), and is an essential part of making the study of counterpoint a part of aural-skills development.

9. *Practice singing and playing a combination of two patterns from Table 1 that create the outer framework of a tonic prolongation (for example, $\hat{8}$-$\hat{7}$-$\hat{8}$ and $\hat{1}$-$\hat{2}$-$\hat{3}$).* Let your performance of these patterns reflect the dynamic tendencies created by the musical forces that shape it. Write out several of these combinations and use them as the basis of Exercises 10-11.

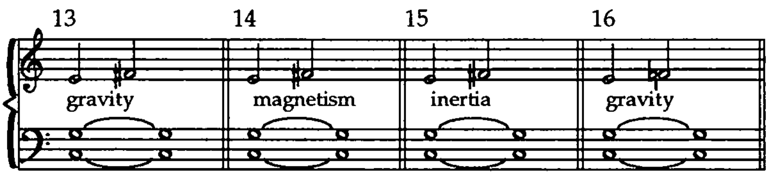
10. *Have a friend perform one of the pattern combinations in Exercise 9.* Sing back the separate voices of the pattern combination. Sing back the separate voices with solfège. Echo the pattern combination on the

EXAMPLE 5. Exercises in pattern completion

Patterns starting on $\hat{5}$



Patterns starting on $\hat{3}$



piano or on your instrument. Identify the two patterns by pointing to the appropriate patterns in Table 1.

11. *Have a friend perform one of the patterns from Exercise 9 twice (either a soprano or bass part).* On the second performance, add an appropriate second part (bass or soprano). Point to the patterns you have used in Table 1.

12. *Make up a game that is a variation on Exercises 8, 9, 10, or 11.* Exercises 8-11 are relatively new for me, and I would enjoy hearing about others' experience with them.

13. *Before and/or after sightsinging or practicing a passage of music, find three- and four-note patterns and/or their embellishments in the passage. Suggest ways in which a performance could reflect the dynamic tendencies created by the musical forces that shape it.* Making this a central task of courses in sight singing will improve both students' accuracy and the expressive quality of their performance.

14. *With a group, sing each of the patterns in one of the combinations given in Example 4 in turn. Begin at different times to create a round*

15. *Alternate performances of patterns as in Exercise 14 with improvised embellishments of the same patterns (preserving the underlying harmonic rhythm).*

16. *Have each member of a group sing a different pattern contained in one of the combinations given in Example 4. Repeat the pattern rhythmically. Each group member may embellish some or all of the repetitions of his or her pattern. Or do the pattern sequentially, beginning at different times to create an embellished round.* Some students will be slow to "get into" Exercises 15 and 16, but patience and support here will lead to great improvements in their musicianship skills.

The Power of Prose: Writing in the Undergraduate Music Theory Curriculum

Deron L. McGee

Introduction

We often regard writing as a tool for evaluating our students' knowledge of a subject and their ability to produce information in one of several prescribed forms. This communication-based use of writing permeates the history of education and is still useful in this capacity today. Recent studies, however, reveal clear links between writing, thinking, and learning and suggest several ways that writing projects can enhance students' acquisition and comprehension of course materials. These projects provide an active way to manipulate and synthesize new information and frequently require a deep level of thought and understanding. Since writing is closely linked with cognitive development, it can help our students develop critical thinking skills and can improve the depth and breadth of their musical knowledge. When writing becomes a part of the learning process, students gain needed practice in written communication while they assimilate course content.

> Busy professors don't have time to be writing instructors, and no one should expect them to be. Often they do spend time 'correcting' papers, however. That time could be better used in planning assignments and devising strategies for students to improve their work in progress, rather than dealing with writing disasters after they have occurred.[1]

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[1]Lois Berry, *The Busy Professors's Guide to Writing Across the Curriculum* , quoted in Brad Hughes, *Suggestions for Designing Effective Formal Writing Assignments* (Madison, WI: Program for Writing Across the Curriculum, College of Letters and Science, University of Wisconsin, 1992), 1.

Initial Interest

Twenty such writing disasters initiated my interest in creating additional opportunities for students to improve their skills. My sophomore theory students are required to write a significant analytical paper each semester in lieu of a final exam. Subject to my approval, the students select a movement from a work they are currently preparing to perform. After creating a formal and harmonic analysis of the work, the students write a paper about the movement, drawing on their analyses for support and examples. The original final project assignment is shown in Figure 1.

FIGURE 1. Original Final Project Assignment

Select a movement from a piece you are currently preparing to perform or a series of shorter pieces such that the total number of measures is at least 250. The piece should be from the Classical period if possible, and must be approved by your instructor. Create a complete harmonic and formal analysis of the music. You may include charts or diagrams as necessary. After completing the analysis, write an analytical paper of at least 1000 words about the movement. Use your analysis to support your assertions and to illustrate your points. The paper should be well written and documented if sources are used. It is due at noon on the Wednesday of finals week, no exceptions.

The project requires students to demonstrate proficiency with the technical language of music by labelling various formal divisions and by describing the harmonic structure through Roman numeral analysis. The assignment enhances student interest since at the same time they are intimately involved with performing the music, a connection that makes the project more relevant and personal. The project encourages students to observe patterns, identify abstract relationships, and think actively about the organization and coherence of the music and why such properties exist. It also encourages speculation—why are certain constructions present and others excluded? The project is also designed to move the students from working with the "laboratory rats" of textbook examples toward investigating what Michael Rogers calls "the rich messiness of music."[2]

[2]Michael Rogers, "The Rich Messiness of Music: Teaching Theory in Music with Contradiction and Paradox," *College Music Symposium* 30/1 (1990): 131-141.

The results of the initial project were mixed in terms of paper quality and student outcomes. The students were quite adept at labelling formal divisions and describing the harmonic structure of the music, abilities that were expected since these aspects closely paralleled exercises previously prepared by the students on a smaller scale. Unfortunately, after completing the analyses, nearly all of the students complained that they had nothing to say about the music because their analytical charts said it all. The students were unable to use their findings to observe trends or tendencies, to identify recurring patterns, or to relate their harmonic descriptions to other musical parameters such as melody or rhythm. In addition, they had tremendous difficulty generating assertions about the music based on their analyses. If the students expressed opinions about "how the music works," they had trouble logically supporting their positions and even more difficulty using their analyses and musical examples to illustrate their points.

The writing in these papers was generally acceptable in terms of mechanics; it was comprised primarily of grammatically correct complete sentences with proper spelling and punctuation. How the class organized, developed, and presented ideas, however, was often not acceptable; the writing frequently was muddled, confused, and in some cases impenetrable. This project represented the first analytical paper encountered by the students and many found it challenging to develop their own interpretations of the music. Instead of absolute right or wrong answers, the students had to rely on their own creativity and ingenuity. Many employed strategies for which they had been rewarded in the past, approaches such as making broad generalizations, restating their analytical process "step-by-step," and focusing on the history of the work or composer. These strategies led to papers that made general claims not supported by the analyses, papers that repeated information in the analytical charts without additional insights, and papers that read like poorly written "assembly instructions."

The incoherent organization presented in the theory students' final projects can be attributed to "an underlying thinking crisis."[3] John Bean contends that the problem with most undergraduate writing is not that the students lack the requisite mechanical skills, but rather that they have not reached a sufficient level of cognitive development to perform complicated writing tasks. Bean's students had consider-

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[3]John C. Bean, "Involving Non-English Faculty in the Teaching of Writing and Thinking Skills," *International Journal of Instructional Media* 9/1 (1982): 51.

able difficulty finding something to say; they had trouble organizing their thoughts, as evidenced by their incoherent papers; they had trouble analyzing and synthesizing data; and they had difficulty creating and supporting logical arguments.[4]

Even though the organization of ideas and the style of their presentation were not successful in many cases, the analysis project proved to be the most valuable experience of the semester for the majority of the class because it provided a creative approach to applying the theoretical concepts presented throughout the semester. Students grasped more abstract relationships and gained greater insight into musical processes. The project required the students to become actively involved in the learning process and gave them the freedom that accompanies interpretation, making theory relevant to a particular piece of music. The assignment also demonstrated that traditional harmonic theory could not adequately explain many aspects of their pieces, such as rhythmic or melodic processes. The realization that a theory informs some aspects of music at the exclusion of others represented a giant step toward breaking down their fixation with right and wrong answers. The project even motivated many students to begin asking about alternative perspectives of musical analysis.

Theories of Writing, Thinking, and Learning

Theories that explain the relationships between writing, thinking, and learning provide insights into the success of the final project, in terms of the students' learning. Janet Emig states that writing is a successful tool for learning precisely because writing as a process parallels many powerful learning strategies.[5] It provides a means for immediate feedback and self-analysis, while leaving a product that is available for long-term scrutiny and criticism from oneself and others. In addition, writing supplies a framework for connecting new information with previously learned material, often requiring a synthesis of such information into a new whole. Finally, writing is an active and personal activity that encourages one to become engaged with the subject material.

Another theory concerning the relationship of writing to thinking and learning is the "theory of reflection." Martin Nystrand ex-

[4]Bean, 52-3.

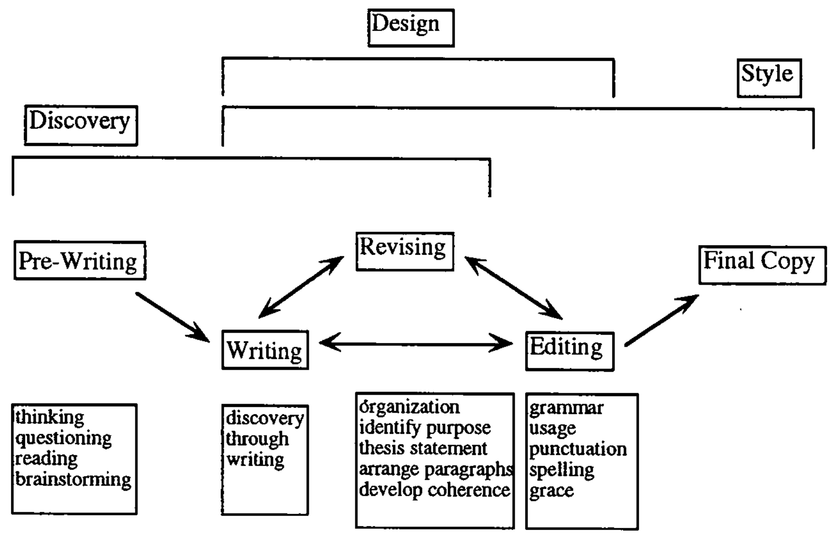
[5]Janet Emig, "Writing as a Mode of Learning," *College Composition and Communication* 28 (1977): 128.

plains that writing is a deliberate process of concentration followed by moments of reflection.[6] Writing slows down our thoughts, fostering a more deliberate thinking process than say, speech. Often when we write, we make statements that beg for a response or that force us to continue writing in an effort to explain our position. Through this effort, we reflect on what we have written and in turn clarify our convictions to ourselves.

The Writing Process

John Bean proposes attacking writing problems by designing assignments that challenge the students to develop reasoning skills and offer them opportunities to practice the process of writing. Figure 2 shows a diagram of the writing process that I currently use with my students.[7] The writing process is divided into four separate stages:

FIGURE 2. The Writing Process



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[6]Martin Nystrand, *Using Informal Writing to Teach Thinking* (Madison, WI: Program for Writing Across the Curriculum, College of Letters and Science, University of Wisconsin, 1992).

[7]This diagram is adapted from Bean, 53 and includes ideas from Hughes, *Suggestions*.

pre-writing, which includes finding a usable topic, defining an audience, discovering ideas, and developing a rough plan for the paper; drafting or writing, characterized by developing and organizing ideas into sentences and paragraphs; revising, which includes adding, deleting, rearranging, and substituting materials; and editing, characterized by smoothing out sentences, improving word choices, and cleaning up mechanics. The chart also shows three overlapping operations that occur during the process of writing. The discovery phase occurs early in the process when students are grappling with new material, relating new ideas to previously mastered concepts, and thinking about what to write. The design phase emerges during the "writing-revising-editing" cycle, and reflects the improved understanding of the material under consideration. Elements of style and design improve throughout the process, although much of the final polish emerges during the last stages of editing.

Proponents of Writing Across the Curriculum programs frequently classify writing projects as either *formal* or *informal*. A formal writing assignment requires students to submit polished pieces of writing to be evaluated in some manner, usually in the form of a grade. Informal writing is generally ungraded (although not unrewarded) and encourages exploratory engagement with course materials. Formal writing assignments, such as research and term papers, traditionally have been associated with the final product as a means of evaluating students. By contrast, informal writing, such as keeping journals, summarizing articles and lectures, and writing micro-themes (one- or two-page papers on a specific topic), generally emphasize the process of writing illustrated in Figure 2. I prefer to think of formal and informal assignments as representing opposite poles on a continuum. The goals of both types of writing exercises can emphasize the process over the final product.

Writing as a Way of Learning and Knowing

Several available studies provide information about how specific kinds of writing affect learning.[8] These studies show that writing im-

[8]These studies include Judith Langer and Arthur N. Applebee, *How Writing Shapes Thinking: A Study of Teaching and Learning* (Urbana, IL: National Council of Teachers of English, 1987); J. A. Glover et al., "Distinctiveness of encoding: The effects of paraphrasing and drawing inferences on memory from prose," *Journal of Educational Psychology* 73/5 (1981): 736-744; and Francis J. diVesta and G. Susan Gray, "Listening and notetaking," *Journal of Educational Psychology* 63 (1972): 8-14.

proves both short- and long-term recall, overall comprehension, and retention of specific details when compared to reading or listening alone. Different types of writing assignments have specific effects on learning, as each emphasizes a particular kind of understanding. Five styles may be relevant to the music theory curriculum; arranged from the most informal to the most formal type of assignment, they are free-writing, note-taking, short answers, summaries, and analytical essays.

Free-writing is a general term that encompasses several kinds of informal writing assignments. A typical one asks students to write continuously for five minutes on a prescribed subject—writing everything they know until the time expires. Langer and Applebee found that this type of writing allows students to actively engage the subject material, to generate questions and discussions, and to highlight gaps in their knowledge. It also focuses on the exploration and discovery aspects of the writing process. Free-writing provides an opportunity for the student to make connections with previous knowledge in a risk-free environment, since these assignments are not collected or graded. These connections often result in superior recall when compared with only note-taking activities (see Glover et al.).

Di Vesta and Gray demonstrate that note-taking when listening to a lecture or while reading is more effective than reading or listening alone in terms of content recall and comprehension. Note-taking provides a broad assimilation of information, although specific details and relationships among more circumscribed concepts within the subject are not emphasized. Langer and Applebee mention that this type of writing requires little thought, leading to a lack of depth in understanding.

Writing tasks requiring short answer responses produce greater gains in recall and comprehension than note-taking. Preparing written answers to study questions helps students to focus on specific knowledge, since they often answer such questions with considerable detail. This type of writing, however, produces little connection among the specific questions or between the questions and larger-scale concepts.

On the other hand, summaries of articles, chapters, or units provide an opportunity for students to review material they have encountered by emphasizing broad topics and relationships without addressing specific detail. Although the level of thought is often superficial, summaries and paraphrases are superior to mere copying and quoting. Finally, analytical essays require students to synthesize concepts, to relate details to larger issues, and to think on a level different from the other writing tasks described. This level of thought is often deeper, more focused, and more involved than the superficial thought employed to take notes or answer study questions.

These studies clearly show the positive effects of writing on the student's understanding and recall of new information. Even more important, they demonstrate the pedagogical importance of writing tasks that allow writers to manipulate new material in terms of their existing understanding. The specific effects on learning and thinking of each type of writing are summarized in Figure 3. By understanding these principles, we can design writing assignments that effectively achieve specific goals in the music theory curriculum.

FIGURE 3. Writing Assignments and Benefits

Writing Type	Learning Benefit
Free-writing	Focuses students on previous knowledge, allowing old and new material to be synthesized, enhancing learning.
Note-taking	Improves recall and comprehension compared with reading or listening alone.
Study Questions	Improves recall of information required to answer specific questions.
Summaries	Requires students to reformulate information into a clear concise form. This often involves more mental manipulation than note-taking or answering study questions, thereby improving learning.
Essays	Requires more extensive manipulation of information than other types of writing. This type of assignment generally involves more work than the others and demands the most complex thinking and reasoning skills.

Incorporating Writing in the Theory Curriculum

Learning from previous mistakes in terms of designing the final project and preparing the students for it, I developed a series of smaller-scale writing assignments that fostered discussion, helped students think critically about music and/or theory, improved their ability to logically support assertions, helped them examine alternative perspectives and theories, and improved the style of their presentations. These short assignments helped the students grow cognitively and musically, and improved their writing skills by providing additional opportunities for practice. The focus of the short assignments and the longer final project was on the *process* of writing, including revising and editing, rather than on the final *product*.

Over the past three years, I have implemented writing assignments that correspond roughly to free-writing, summaries, and analytical essays. Figure 4 shows a transcript of a typical free-writing exercise that I use early in the course.

I have asked a variety of questions, such as: How is theory related to performance? What fields outside of music influence music theoretical thought? Can music theory influence fields outside of music? and, Is music analysis interpretation? Although many of us may be hard pressed to answer such questions definitively, in the context of a brainstorming session and subsequent discussion undergraduate students can begin to address these issues. There are no right or wrong answers and they are not graded on their prose. The goal of this exercise is to prompt thinking about music theory and to bring out past

FIGURE 4. Transcript of Free-Writing Assignment

Please take out a piece of paper. I would like you to write continuously for five minutes answering the question: What is music theory? Please write everything that comes into your head even if it doesn't pertain to music or theory. When you begin, write continuously without lifting the pencil from the paper (except to start a new page). This will not be turned in or graded, so please feel free to write whatever enters your mind. I would like you to write everything you know about music theory. You may also ask questions about what music theory is, suggest what music theory could be or perhaps should be, even tell me what music theory isn't. Whatever enters your mind. Any questions? OK...you may begin.

experiences and knowledge of the subject. The material generated in five minutes often leads to a lively discussion concerning what constitutes music theory—its scope, purposes, associated fields, and its relationship to the other sub-disciplines of music, such as conducting, musicology, performance, and education. This assignment generates a variety of responses, but most importantly it focuses the students' thinking on music theory and requires them to become actively engaged in the learning process.

Short papers, one or two pages, require students to be concise in terms of their thoughts as well as their writing. It is difficult to make clear, well structured points in a small amount of space. By using short assignments, the teacher can gradually increase the difficulty level throughout the year. It is relatively easy to create specific assignments to correspond with new material. John Bean goes even farther when he states that "except for advanced students, the traditional term paper should be abandoned in favor of a sequence of shorter writing assignments specifically designed to develop creative, independent thought."[9] While I agree with Bean's ideas concerning the use of short assignments, I also believe that working with complete pieces of music or at least entire movements is important for music students at all levels of theory instruction, and projects of this magnitude cannot be adequately addressed in two-page assignments. Short assignments, however, can set the stage for the larger, more involved projects.

Figure 5 shows a short assignment requiring students to create a brief abstract of a textbook chapter. Anyone who has attempted to write such an abstract knows that this is a challenging task. It forces

FIGURE 5. Summary Assignment

Summarize the important points from chapter I (16th century polyphony) of your textbook. Write a short paper that accurately and fairly represents the information found in that chapter. The paper should be well written and clearly organized. Summarize the information in <u>Your Own Words</u>. Do not copy from the book. Your intended audience is a high school music class. You are limited to a maximum of two typed pages, excluding examples. A draft is due one week from today with the final version due two weeks from today.

[9]Bean, "Involving Non-English Faculty," 52.

students to consolidate their understanding of the material in order to present it in a concise and coherent manner. It also forces students to represent the material they encounter fairly and accurately.

Andrea Lunsford demonstrates that basic writers have difficulty presenting the views and opinions of others fairly, especially if they disagree with the premises or arguments.[10] She finds that students tend to relate personal experience and beliefs rather than ideas of others that they find objectionable. By having students accurately summarize the opinions of others, the teacher forces them to see things from an alternative perspective and thus grow cognitively. The assignment in Figure 5 works well early in the semester because it starts students thinking and writing while not forcing them to deal with some of the more problematic aspects of writing about music, such as writing about musical examples. This assignment provides a good means for introducing students to the writing process and it represents a relatively well-defined project requiring no speculation.

A typical sequence of assignments might begin with a summary similar to Figure 5 and continue with a more difficult assignment such as the "compare and contrast" example in Figure 6. This assignment requires the students to examine critically the musical excerpts and to deduce similarities and differences. It also requires them to use the examples to clarify and support their assertions. This assignment is still quite well defined since it does not demand speculation on the part of the student and the excerpts are short enough for the students to analyze them thoroughly.

The "compare and contrast" assignment could be followed by a more speculative or philosophical assignment such the "analytical symbols" assignment shown in Figure 7. This assignment requires students to think critically about the theory they are applying to generate their analyses and the limitations of such a theory. It also encourages them to think about the types of relationships and patterns that emerge as a result of the analytical process. This assignment is considerably more difficult for the students, since they are asked to examine the assumptions of the theory they have been taught. The approach is uncomfortable for many students who like the security of clear solutions to problems. If the writing assignments are sequenced and prepared carefully, however, this type of assignment is a natural culmination of a process that unfolds throughout a semester or year.

[10]Andrea A. Lunsford, "Cognitive Development and the Basic Writer," *College English* 41 (1979): 38-46.

FIGURE 6. Compare and Contrast Assignment

Prepare a complete harmonic analysis of the opening eight measures of Mozart's Sonata in A Major and Schumann's Soldiers March (the music has been provided). Once the analysis is complete, write a brief paper comparing these two excerpts. You may discuss similarities or differences in harmony, form, melody, rhythm, texture, timbre, etc. When discussing the music, use examples from your analysis to support your assertions. The paper should be well written using clear and concise prose with a maximum length of two typed pages, excluding examples. The theory faculty is your intended audience. A draft is due one week from today with the final version due two weeks from today.

FIGURE 7. Analytical Symbols Assignment

What do the analytical symbols tell us about the music? What don't they tell us? Write a short paper using your analysis of Mendelssohn's *Song Without Words* as an example. What do the analytical symbols tell us about harmony, melody, rhythm, etc.? Write this in a formal style using clear, concise prose. The theory, history, and composition faculty represent your intended audience. The paper is not to exceed two pages excluding examples. A draft is due one week from today and the final version is due two weeks from today.

When I assign a longer paper, I now divide it into smaller parts that students can work on over a larger portion of the semester. Students submit a prospectus for comments relatively early in the semester and prepare several drafts of the project for review. The paper can then be revised based on the questions and advice offered by the instructor. This schedule encourages students to make revisions and work on the process of writing, reinforcing musical concepts and enhancing learning. Figure 8 shows a revised version of the final project illustrating the concept of subdividing large projects. The students begin this project at least six weeks prior to its due date and I give credit for completing each task on time, although not necessarily with traditional grades. Developing the prospectus allows the students to explore ideas generated from their analyses, while helping them mold the basic shape of their papers. Generally, the students' interest level

FIGURE 8. Revised Final Project Assignment

For the final project, select a movement from a piece you are currently preparing to perform. Bring it to your instructor for approval by April 1. A complete formal and harmonic analysis of the movement is due on April 15. Next write a brief (one page) prospectus outlining the issue(s) you will discuss in the paper. Then write an analytical paper based on your analysis. A draft is due at the first conference and a revision is due at the second conference.

You should make a statement about "how the piece works" and support your assertions with examples from your analysis. You do not need to address the movement as a whole in the written portion of the paper. Rather you may decide to address a specific aspect of the movement's organization, tonal relationships, the use of a specific type of harmony, rhythmic motives, melodic construction, etc.; the possibilities are limitless.

The paper is to be well written using clear, concise prose and is not to exceed ten typed pages. You will submit the paper, all of the analysis, and any additional charts, graphs, etc. that you believe are necessary to clarify and support your assertions. I am your intended audience.

Everyone is required to sign up for two individual conferences; times are available on my office door. The following schedule will be adhered to:

4/1	All music for the final project must be approved
4/15	Analysis complete—draft turned in
4/22	Brief prospectus due
4/29-30	Individual conferences—Draft due
5/6-7	Individual conferences—Revision due
5/13	Final project due—Noon! (No Exceptions)

I will be available for additional assistance during my normal office hours or by appointment. I strongly encourage you to begin early and stay on schedule.

grows as they become more actively involved with the project, resulting in both a better final product and, more importantly, a positive learning experience.

In addition to improving the understanding of concepts, fostering cognitive development, and enhancing the students' writing skills, these assignments frequently generate valuable discussion opportunities and raise important theoretical issues that may otherwise be omitted. By the fourth semester of the theory sequence, the students have been introduced to the traditional musical forms. When discussing organization in music, I introduce an alternative concept of form as a process that evolves and develops over time as opposed to a rigid system into which we attempt to "pigeon-hole" musical works. The perfect textbook example of sonata form, if it exists at all, happens so rarely that we spend more time discussing how individual pieces vary from the traditional definition than we do discussing the textbook model. I challenged the students to create a new theory of musical organization that happens "in-time," during the initial hearing of the piece. Their assignment appears here as Figure 9.

FIGURE 9. "In-Time" Theory Assignment

We have discussed several "fixed" musical forms such as binary and ternary song forms, sonata-allegro form, rondos, variations, and contrapuntal forms. We have also discussed form as a musical process. Your task is to construct a new, "in-time" theory of musical organization. You must speculate, use your imagination, and be creative. Describe and discuss your idea or ideas and demonstrate the principle with a brief analytical example. The paper should be written for your peers and should be no more than two pages, excluding examples. A draft is due one week from today and the final version is due two weeks from today.

The results of the "in-time" theory paper were exciting. I did not help the students by pointing them to any other research or writings on the subject. They could use any principle they desired to describe how they "understood" the music while it was being experienced. Most found the exercise challenging and liberating; it was a chance to be completely creative. The vast majority of the students presented ideas that they believed were quite strange and outside the mainstream of theoretical thought, while a few students still adhered to the security of fixed forms. Most of the students related musical organization to emotional states, while some discussed music as narrative. Others believed music was organized through expectation or according to sound color.

Each of these ideas has received considerable attention in the theoretical community during the past twenty or thirty years.[11] I in-

[11]Leonard Meyer, *Emotion and Meaning in Music* (Chicago: University of Chicago Press, 1956) and *Explaining Music* (Chicago: University of Chicago Press, 1973); Fred Maus, "Music as Drama," *Music Theory Spectrum* 10 (1988):

troduced the writings of Leonard Meyer to address emotions and the affective qualities of music and to discuss the concept of expectation in the implication-realization theory of melodies. The writings of Fred Maus address the issues of music as narrative and drama, and Wayne Slawson has studied sound color. Several prominent theoretical systems, of course, were not suggested by this class, such as the transformational theories of Schenker and Lerdahl and Jackendoff and theories based on literary criticism and semiotics.

Each concept presented by the students was considered in turn and through the discussion generated we were able to address issues that are not often raised in undergraduate theory courses. The students were particularly interested in the topics because they developed the theories, in a sense, on their own. Many of the students pursued readings in these areas after the discussions and all of these concepts reappeared in the final projects!

Designing Writing Assignments

When designing a series of assignments, try to establish a logical sequence, beginning with easier kinds of thinking about course materials and then progressing toward more difficult assignments. I like to begin with summaries of readings or lectures and then move gradually to projects that involve presenting and supporting arguments, speculation, evaluation, and the application of concepts in new settings. Another way to think about this progression is starting with narrowly focused questions and moving toward more ill-defined questions or problems, those without absolute answers.[12] A series of short assignments given throughout a semester continuously develops the cognitive skills of the students.

To clarify expectations in terms of the scope, depth, format, length, and resources to be used, provide students with a written model for a formal assignment. I also try to present questions that will guide the students' thinking and offer advice about shaping and presenting ideas. Since some people consider assignments to be only possibilities to get students thinking, I often tell the class how closely to fol-

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56-73 and "Music as Narrative," *Indiana Theory Review* 12 (1991): 1-34; Wayne Slawson, *Sound Color* (Berkeley and Los Angeles: University of California Press, 1985).

[12]Several of the ideas in this section are discussed in Nystrand, *Using Informal Writing* and Hughes, *Suggestions*.

low the instructions. In addition, I identify the evaluation criteria for the assignment, especially those linked to the important musical or theoretical concepts. By explaining to students that I emphasize organization, logic, and clarity of expression as the primary criteria for evaluation (of course, embodied in clear expression is coherent sentence-level structure and proper mechanics such as correct spelling, grammar, and punctuation), students feel less intimidated by the interpretive aspects of their writing. I also give students credit for creativity, ingenuity, and grace in their presentations.

If an assignment involves the use of sources, tell students which documentation system to use. These guidelines provide an opportunity to introduce students to a particular style of writing, including the documentation conventions employed, and can lead to a discussion of plagiarism. While most of the assignments described here leave few opportunities for integrating outside sources, plagiarism is a common problem.[13] It is actually quite interesting to make musical connections to plagiarism by asking students to consider musical practices such as quotation, parody, and arranging. This discussion can be used as a springboard into the exploration of several musical concepts, while driving home the point that certain academic standards must be observed when using material from outside sources.

Any type of writing is easier to focus if the intended audience is known. If the audience changes, students must adjust their writing to readers with different levels of music experience. I specify an audience for each assignment and change that audience throughout the semester. Sometimes students write for their classmates—people who have read many of the same materials but have not thought specifically about the author's topic. On other occasions, I select a particular group of musicians, such as historians or composers, as the audience. Finally, I have students explain musical concepts to an audience of non-musicians. When writing for them, the students must thoroughly understand the concept since they cannot use technical terminology to describe it and must translate the idea into non-technical terms.

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[13]Bean reports that in an informal survey of randomly selected term papers from across all departments at the College of Great Falls (Montana), researchers recorded a 70% plagiarism rate (Bean, 63-64). The majority of these incidents appeared to be unintentional (the result of "cutting and pasting" information from sources). Most students, however, must believe that these practices are an academically acceptable method of "research."

Responding to Assignments

Perhaps the most important aspect of writing assignments, besides assigning them in the first place, is the type of feedback the students receive during the process. I set high standards for writing assignments and let them be known in advance. In my experience, students generally live up to my expectations if the evaluation criteria are explicitly defined and examples of quality projects are made available to the class. When sharing these examples, I try to present ones that are quite different in their approaches so that students don't automatically mimic one successful format. Sharing examples of student work publicly rewards the selected students even if the examples are displayed anonymously.

Responding to writing assignments not as a judge but as a reader genuinely interested in what the writer has to say may help break a cycle that has been established throughout the students' educational careers, where they write papers that they don't want to write for teachers who don't want to read them.[14] Incorporating individual interests into the project design increases the relevance to the students. By not grading drafts, but giving credit for their completion and returning them with comments, I try to make the students realize that I am interested in what they have to say.

I never take a position in which a student's presentation is criticized severely because it doesn't fit with currently accepted theoretical thought. Rather, I frequently present counterarguments, alternative perspectives, and additional source materials if necessary when responding to student assertions. In my experience, when students take a dogmatic position on a specific topic, they do not realize that alternative perspectives exist. By providing another view, I encourage students to confront these alternatives and account for them in their revisions. Eventually the students learn to integrate other ideas with their own.

When responding to student papers, read for different purposes at different stages in the process, suggesting only one or two goals for students in the revision or in the next paper. I concentrate on specific questions such as: Is the writer addressing all parts of the assignment? Are the ideas presented in the paper interesting, thoughtful, and thought-provoking? Does the writer demonstrate adequate understanding of theoretical terms and concepts?[15] By directing comments

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[14]Bean, 63.

[15]Several of the suggestions in this section are discussed in Hughes, *Suggestions*.

at specific problems that the student can address, I reduce the amount of time necessary for writing comments.

Try to be as specific as possible with responses, since students often misinterpret vague comments of praise and criticism because they don't know what specifically was strong or weak in their work. Instead of marking a paper with a generic comment such as "good," I often explain what is specifically good about it: organization, logic, support, and use of examples. The same principle applies to criticism; instead of saying the paragraph or sentence is awkward, I tell the student why the flow of the paragraph is awkward or how transitions from one idea to the next can be improved. If a paper has many problems related to editing tasks, such as grammar, word choice, and punctuation, concentrate on one section and identify those problems that interfere with meaning. After marking these problems, perhaps rewriting a few sentences as examples, I ask the student to revise the remainder of the paper and resubmit it. I am careful not to create a polished paper, since the student will often mimic the format instead of developing individual writing skills. If there are persistent problems, I encourage the student to get help from the campus writing center or to come for editing advice. This kind of session will be more beneficial in the long run than simply correcting the paper.

I like to provide opportunities for students to talk about their writing while it is in progress. These opportunities take many forms such as individual conferences, student presentations, or brief amounts of class time set aside for students to discuss their topics in pairs or small groups. In addition, I have students read and comment on their peers' writing, thereby receiving feedback on their own. Students learn by doing; allowing students to comment on each other's writing benefits both the author and the student performing the criticism. I provide guidelines for constructive criticism to assist students in this task. As they begin editing and criticizing the work of their peers, they actually become more critical of their own writing, often correcting many problems before they turn in their original draft.

Time Commitment

The most common reservation expressed when teachers discuss the implementation of writing in an established course is that it will take an inordinate amount of time to grade all of these papers. While it is true that some additional time is required to prepare good, thought-provoking assignments, evaluating the assignments doesn't have to add any appreciable time commitments to the course. There are several ways to reduce the amount of time spent grading or responding to written assignments.

First, use short assignments of no more than two pages. The time required to grade and/or respond to a two-page written assignment is no longer than it takes to grade a typical analysis or part-writing exercise. Second, don't attempt to mark all errors; instead mark only specific types of errors and suggest revisions. Third, incorporate peer review into the writing process and allow students to generate their own criticism. Fourth, by breaking longer assignments into smaller parts, I observe the project in progress. This familiarity with the work greatly reduces the time required to grade and respond to large-scale papers such as the final analytical project detailed earlier. Fifth, when scheduling conferences, make time during normal office hours; for final projects, schedule appointments during lecture and discussion times during the last two weeks of class. These are times already committed to the course and the students are scheduled to be there. Finally, we don't need a vast quantity of these assignments to observe positive results. I have typically given three to six in-class free-writing assignments (that are not collected or graded), three short assignments, and the final project each semester.

Closing Remarks

The principles discussed here are equally applicable to history classes, performance studios, education, conducting, and composition classes. I have given only theory examples because of the focus of my teaching. The concepts presented, however, are sufficiently general to be applied in any of the sub-disciplines of music while being specific enough to generate good, thought-provoking assignments. I believe the benefits of writing assignments are such that they should be implemented in all undergraduate courses.

> The purpose of integrating writing tasks into pedagogy is not merely to teach proper forms of expression, such as how to write, but rather to increase the effectiveness of what instructors already do. For writing assignments to have a positive effect on learning and reasoning, they must be initiated and sustained as a regular activity and they must be meaningfully integrated into the existing syllabi.[16]

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[16]Nystrand, *Using Informal Writing to Teach Thinking*, 4.

If writing assignments can be implemented across the music curriculum, we will greatly enhance the breadth and depth of our students' understanding of course content, the relationships among the various sub-disciplines of music, and the relationships of music to other disciplines. In addition, we can help our students grow intellectually by improving critical thinking and writing skills, while enhancing their assimilation of course content.

Harnessing Technology to Open the Mind: Beyond Drill and Practice for Aural Skills

Charles Lord

Instructional software for aural training has been alive and well for quite some time. Development has moved from mainframe programs on the PLATO system to microcomputers of the Apple II family and its competitors, and more recently to the Macintosh and MS-DOS machines with their greater power and speed. Software design has also developed considerably. After beginning with simple drill and practice, the approach is now much more flexible; teachers who are computer novices can modify a packaged program to their liking through built-in flexibility. Response mechanisms are now increasingly sophisticated, as ambitious programmers have constructed expert systems which interact with learners in meaningful and intelligent ways.

Objectivist Theory

A common foundation of instructional theory underlies nearly all of this work. Although little is written specifically about this objectivist model, it undergirds much current pedagogy. There is, however, a contrasting view of knowledge acquisition; in the light of this alternate theory, the rationale supporting the instructional design of computer-based aural-training software can be reexamined. One model currently in use at the University of Kentucky attempts to utilize paradigms arising from this alternate view of knowledge.

The traditional view of knowledge and instruction can be called the *objectivist* model. Knowledge, according to objectivism, is a set of facts and/or specific skills to be learned. Since these items are objective, they can be transmitted from teacher to learner accurately and cleanly; if learned well, they will be represented in memory in such a way as to be readily accessible. The purpose of instruction therefore becomes the direct transmission of this body of knowledge from the teacher to the learner. Knowledge, as represented in the brain, exists in a hierarchy or network, each schema linked to other schemata with which it is conceptually connected. If instruction can transmit the specific components of a knowledge base, the entire framework of the hierarchy or network will eventually develop. It is assumed that, once the knowledge base is in place, its application to new learning situations of varying context and complexity will be possible. In this view, the failure of a learner to apply knowledge accurately to a new situation is a sign that the components of the knowledge base are not yet in place, and that further work needs to be done on them.[1]

Problems with Objectivist Theory

What's wrong with this model for aural training? Several things, actually. The most important is that at best it works only partially. We as theory pedagogues drill and train intervals and sonorities for four semesters, and students still have difficulty identifying them accurately, much less applying their knowledge in musical contexts. Let us examine some reasons *why* this method seems to have such limited success.

1. Objectivist theory assumes the *transfer* of knowledge from one context to another. In practice, this transfer may not occur with sufficient predictability.[2] While students can memorize the sound of an isolated major sixth well enough to succeed on a theory test, they may have difficulty transferring that identification ability to actual melodies or to complete musical textures.

2. Training by drill develops cognitive schemata that tend to be rigid rather than flexible.[3] For example, learning the major sixth as $\hat{1}$-$\hat{6}$

[1]For an exposition of what is by this date traditional schema theory, see David E. Rumelhart, "Schemata: The building blocks of cognition," in *Theoretical Issues in Reading Comprehension* , ed. Rand J. Spiro, Bertram C. Bruce, and William F. Brewer (Hillsdale, NJ: Lawrence Erlbaum Associates, 1980), 33-58.

[2]Rand J. Spiro et al., "Knowledge acquisition for application: Cognitive flexibility and transfer in complex content domains," in *Executive Control Processes in Reading*, ed. Bruce K. Britton and Shawn M. Glynn (Hillsdale, NJ: Lawrence Erlbaum Associates, 1987), 177-199. See page 179 and following.

[3]See, for example, both Richard L. Coulson, Paul J. Feltovich, and Rand J. Spiro, "Foundations of a misunderstanding of the ultrastructural basis of myocardial failure: A reciprocation network of oversimplifications," *The Journal of Medicine and Philosophy* 14 (1989): 109-146; and Paul J. Feltovich, Rand J. Spiro, and Richard L. Coulson, "The nature of conceptual understanding in biomedicine: The deep structure of complex ideas and the development of misconceptions," in *Cognitive Science in Medicine: Biomedical Modeling* , ed. David A. Evans and Vimla L. Patel (Cambridge, MA: MIT [Bradford] Press, 1989), 113-172.

of a major scale or as the opening of the NBC pattern imposes limits on the context in which the interval will be readily recognized. The learner will have to think differently to recognize the interval as $\hat{2}$-$\hat{7}$ of a major scale (which of course also has a different harmonic implication).

3. Isolating elements from their natural context emphasizes the separateness of the elements rather than their integration. If learning activates prior knowledge, teaching sonorities out of context may link them cognitively more to other isolated sonorities rather than to the role each sonority might play in a phrase. In fact, research in other domains has shown that such training can actually develop barriers between schema types instead of fostering interconnectedness.[4]

Ill-Structured vs. Well-Structured Content Domains

If, then, problems such as these exist with objectivist theory, where can answers be found? Encouraging efforts to solve similar problems in other content domains have been under way since about the middle 1980s. They span areas from reading comprehension to medical diagnosis; all these domains are what researcher Rand Spiro calls *ill-structured*.[5] Ill-structured domains share certain features. Two of those have clear applications to aural training.

1. "The same features assume different patterns of significance when placed in different contexts."[6] For example, the major sixth cited earlier carries different connotations in different tonal settings. As NBC, it may imply a tonic outline or perhaps a resolving dominant 13th chord, while as $\hat{3}$-$\hat{8}$ of a minor scale it will most likely be heard as a I^6. (Of course, if the minor key context suggests VI or a decorated III, the cognitive associations will differ still further from that which was learned.)

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[4]See, for example, both Mark H. Burstein and Beth Adelson, "Issues for a theory of analogical learning," in *Artificial Intelligence and the Future of Testing*, ed. Roy Freedle (Hillsdale, NJ: Lawrence Erlbaum Associates, 1990), 137-172; and Carl B. Bereiter and Marlene Scardamalia, "Cognitive coping strategies and the problem of 'inert knowledge'," in *Thinking and Learning Skills: Current Research and Open Questions*, ed. Susan F. Chipman, Judith W. Segal, and Robert Glaser (Hillsdale, NJ: Lawrence Erlbaum Associates, 1985), vol 2, 65-80.

[5]Rand J. Spiro, et al., "Knowledge acquisition," 184.

[6]Ibid.

2. "An explosion of higher order interactions among many relevant features introduces aspects of case novelty,"[7] making each new case a challenge in itself. Not only can the harmonic background suggest different interpretations of an interval: so can aspects such as metric placement, rhythmic duration, articulation, accent, dynamics, and register. So many factors come into play in one's interpretation of an interval in context that its identification becomes a highly complex cognitive task.

Constructivist Theory

To deal with such complexity, educational theorists and instructional designers in other domains are turning to an alternate view of knowledge and its acquisition, commonly referred to as *constructivist*.[8] This view emphasizes a different dimension of learning from that of the objectivists. To a constructivist, the act of learning is not simply the taking in and storing of objective information for later retrieval. Learning also involves an attempt to interpret the information and to test these interpretations. Moreover, since each person's prior knowledge and experience are unique, the representation of that knowledge will differ from learner to learner. It is important, therefore, not to view knowledge as simply *received*; instead, it is the *construction* of that knowledge by the learner, the active *process* of learning, which is crucial.

That construction takes place in two ways. First, as is generally agreed by cognition experts, information learned is integrated into one's prior knowledge as it is learned, i.e., constructed into the existing schematic network. Secondly, and just as importantly, as new contexts arise in which this knowledge is to be applied, the prior knowledge itself must be reassembled or *reconstructed* to fit the new situation. Therefore, when cognitive skills need to be applied in widely differing contexts, the type of knowledge required is not so much the *retrieval* of information as its *reassembly* for flexible *application*—knowledge for *use*, not for *reproduction*.[9]

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[7]Ibid.

[8]For a representative sampling of constructivist thought as it relates to instructional design, see *Educational Technology* 31/5 and 31/9 (May and Sept. 1991). I owe a debt of gratitude to Allen Winold for guiding me to these articles.

[9]Rand J. Spiro et al., "Cognitive flexibility, constructivism, and hypertext: Random access instruction for advanced knowledge acquisition in ill-structured domains," *Educational Technology* 31/5 (1991): 28.

As a result, the purpose of instruction shifts from the acquisition of a static retrieval scheme to the construction of knowledge for varying contexts. One means of accomplishing this purpose is to explore multiple contexts from multiple perspectives. John Bransford refers to "anchored instruction," or sustained activity within a single context.[10] One may well focus on a specific aspect within a given context for a time; the full context, however, is always present for the learner so that the interconnectedness of various aspects is apparent.

An advantage of this approach is that the most essential problem of the traditional approach—that of transfer of knowledge within varying contexts—is addressed directly. The very activities one performs in learning this way consist of working exercises within a single context, only to confirm one's success by performing similar activities in a different but similar context. If the contexts and activities are chosen wisely, a natural progression will emerge of maturing knowledge together with its application.

Implications for Instructional Design

What are the implications of these alternate paradigms for the use of technology in music instruction and the design of instructional software? To date we have seen primarily two modes of software design and hardware use: drill and practice and intelligent tutoring systems.[11] The former mode functions well for transmitting basic facts and skills, but there are limits to its applicability.

First, drill and practice designs normally do not use full contexts. In fact, rarely is any context at all provided for basic interval and sonority training. Secondly, they rely heavily on identification, i.e., the retrieval of knowledge, rather than on its construction for application. Without applying one's knowledge in varying contexts, one never learns whether or not that knowledge is confined to the specific context in which it was learned. Finally, transfer of this type of knowledge is required only within the subdomain of the program at hand, e.g., to different pitch representations of the same sonority, not to real musical contexts. The teacher never learns if the student has acquired

[10]John D. Bransford et al., "Anchored instruction: Why we need it and how technology can help," in *Cognition, Education, and Multimedia: exploring ideas in high technology*, ed. D. Nix and R. Spiro (Hillsdale, NJ: Lawrence Erlbaum Associates, 1990), 123.

[11]Multiple examples of both of these designs exist in the music software literature. As the focus of this paper is general and philosophical, I prefer not to cite specific examples here.

the type of knowledge that is *useful* in the larger musical world rather than merely *retrievable* in isolation. Drill-and-practice designs differ little from those of a traditional objectivist aural classroom; technology has provided an expansion of the *means* of instruction but not necessarily of its *approach.*

Intelligent tutoring designs represent a significant improvement, as they can act as guides to more accurate and fluent learning. The notion of learning through a "cognitive apprentice" is particularly attractive to constructivists.[12] Difficulties are that the approach to the subject itself is usually still objectivist, and that the production of software requires the development of an elaborate expert system to serve as cognitive apprentice from within the computer. Such systems, which are fascinating to study and create, have to be highly sophisticated to mimic human behavior, and thus often produce important insights into the underlying structure of a domain. Instructional designer David Jonassen, after building expert systems in many different domains, has concluded that the primary benefit of such systems actually comes from uncovering these insights rather than from the elusive attempt to create a fully functional system successful enough to satisfy even the unappreciative computer user.[13]

Rethinking the Function of Music Technology in Aural Training

We can look beyond these two modes of design toward a wider-ranging view of the nature and function of music technology itself, and toward the potential uses of a music workstation (by which I mean a computer, appropriate software, a MIDI keyboard, and preferably a CD-ROM drive). David Perkins of Harvard's Project Zero has identified five key facets of the various environments in which humans learn, whether these be traditional classrooms, computer labs, or other situations.[14] These facets include:

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[12]See for discussion and examples John S. Brown, Allan Collins, and Susan E. Newman, "Cognitive apprenticeship: Teaching the craft of reading, writing and mathematics," in *Knowing, Learning, and Instruction: Essays in honor of Robert Glaser*, ed. Lauren B. Resnick (Hillsdale, NJ: Lawrence Erlbaum Associates, 1988), 453-494.

[13]David Jonassen and Sherwood Wang, "Cognitive outcomes of building expert systems," paper presented at the conference of the Association for the Development of Computer-based Instructional Systems, St. Louis, Missouri, November 1991.

[14]David N. Perkins, "Technology meets constructivism: do they make a marriage?," *Educational Technology* 31/5 (1991): 18-19.

1. *Information banks*, or resources for learning. They include examples such as teachers in front of classes, textbooks, libraries, and computerized databases.

2. *Symbol pads*, or places where symbols are recorded and manipulated. Examples are student notebooks, blank manuscript paper, or word processors.

3. *Construction kits*. These are sets of prefabricated parts and processes which beg for creative assembly. One example is children's Lego sets, but one could also include computer-based environments in which, for example, alterations to mathematical equations produce changes in a computer-generated design.

4. *Phenomenaria*. This term, coined by Perkins, denotes spaces in which the phenomena of a domain are available for examination and manipulation. While these are more difficult to identify in educational circles, the science laboratory could qualify in one sense, while simulation games—computer-based or not—would represent another type. Also beginning to appear are computer-based learning environments, or "microworlds," such as those for the observation and manipulation of Newtonian physics.[15]

5. *Task managers*. These comprise the executive control aspects of the learning environment—managing what is to be done, providing evaluation of student progress, and perhaps offering guidance. The teacher is of course the classic task manager, but textbook exercises and most computer-based training have some of the same functions.

In light of Perkins's study of learning environments, we can examine the roles that instructional technology currently plays in music. For software designed in the drill and practice mode, the music workstation acts primarily as information bank, symbol pad, and task manager. It provides the information to be learned, serves as the interface through which the learner responds to the information, and functions as executive by managing the tasks, offering feedback, and evaluating the results. Over the last decade, the task management function has expanded to include not only programmer-determined task selection and ordering but also user-determined tasks. The soft-

[15]B. Y. White and P. Horwitz, *Thinker Tools: Enabling Children to Understand Physical Laws* (Cambridge, MA: BBN Laboratories, 1987).

ware user may determine certain aspects of the tasks chosen, their presentation modes, and the evaluation process, although this transfer of control is normally reserved for the teacher rather than the student. These programs thus allow many aspects of task management to be transferred from the instructional designer to the end user of the software, in effect providing a sort of construction kit to the teacher.

In the intelligent tutoring mode, the workstation also acts primarily as information bank, symbol pad, and task manager. What differs is largely the approach to task management. When intelligent feedback guides the learner and/or the sequence of instruction, a much more sophisticated manager plan is in operation. Moreover, the tasks themselves often require a well-developed expert system to perform the evaluation. Nonetheless, both of these design modes—drill and practice and intelligent tutoring systems—function within the same instructional paradigms. The workstation is used as an environment for designer-controlled learning, with the multiplicity of task management features actually occupying the vast majority of programming effort. Indeed, for many projects, designing the learner feedback and evaluation aspects is the most labor intensive part of the project. Unfortunately the result remains a learning experience for the student that differs little from that of the objectivist framework, with little learner control, little use of context, and little attempt to transfer learning beyond the limited context provided by the software at hand.

A Paradigm Shift?

It may be time for a paradigm shift.[16] We have at our disposal a technology that has enormous potential as a learning resource. To date we have tapped only one small fraction of that potential—the portion that derives directly from our own collective past experience. Might we not also explore the new possibilities provided by today's music workstation?

What if we thought of a music workstation less as a task manager and more as a phenomenarium—a learning environment in which all aspects of the musical world are available to study, to manipulate, and to use creatively, at least in simulated form? In this microworld one could find potentially not only pitches and rhythms but also timbres, dynamics, articulations, textures, layers, formal designs, arrangements, and notated scores. What if we allowed the learner to control

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[16]Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 2nd ed. (Chicago: University of Chicago Press, 1970).

much of this experience? With appropriate guidance either before or during the process we might encourage students to *explore* this world, guiding them through specific projects that focused their efforts in productive ways.

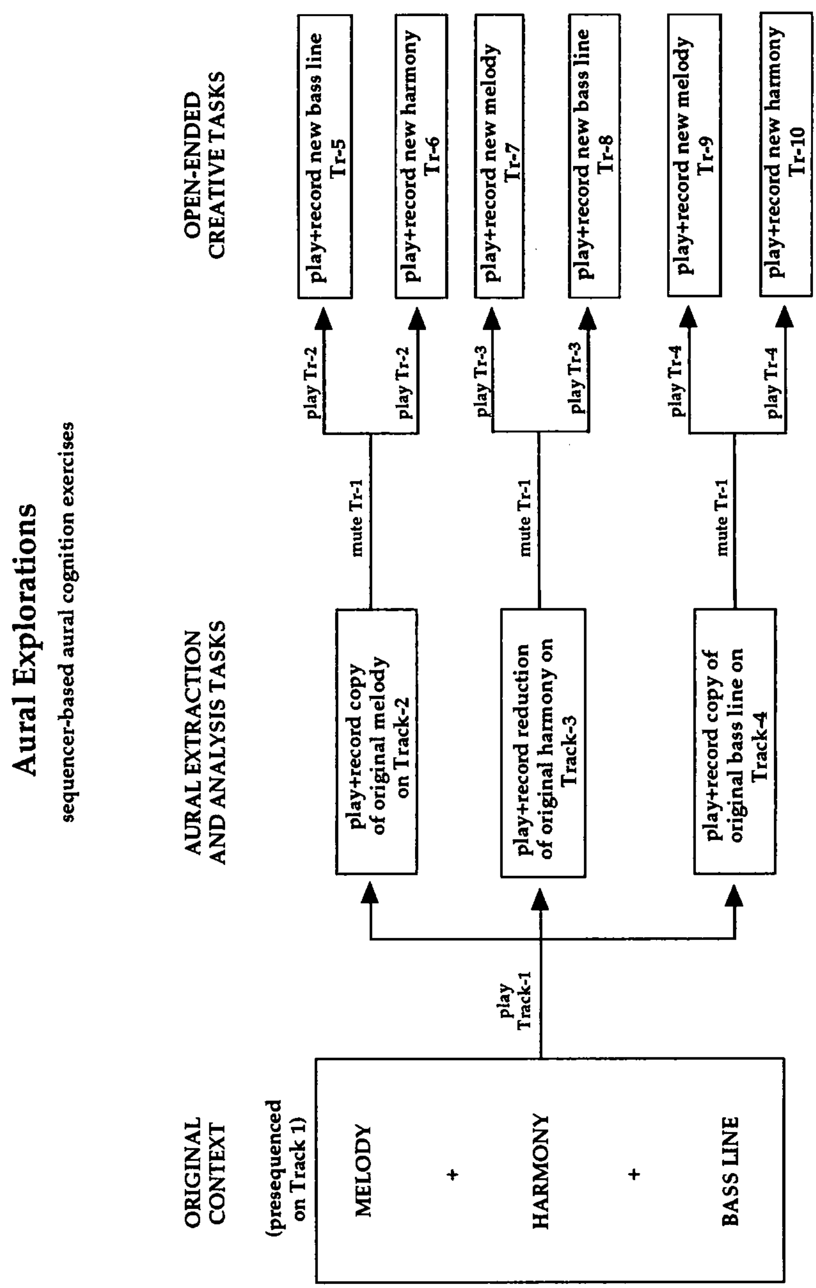
Might we not ask more open-ended musical questions, allowing students to respond in ways they themselves perceive as musical? Indeed, in a world as complex as that of music, there is usually more than one correct answer to a musical question. Why need we wait to begin such attempts until expert systems are developed to handle evaluation of such questions? Is it not possible that the technology, instead of handling evaluation for us, can be harnessed to reveal more of the cognitive processes and learning strategies that students undertake in solving musical problems? Would not these insights in fact prove even more beneficial for the development of future instructional designs?

If we did allow a shift to this approach, the result would be a vastly different learning environment for students. It would incorporate the principles of constructivist thought with the use of a music workstation as phenomenarium. It would ask questions in music and expect responses in musical sounds rather than symbols. It would allow for creativity—a feature that most students of music would relish. And it would leave evaluation mostly to the teacher, who would thereby gain greater insight into students' aural developmental processes.

An Example of the Paradigm Shift in Practice

At Kentucky, we have begun to implement such an approach. We hold at least half of our aural training sessions in our technology lab, which has eight Macintosh computers and twelve MIDI keyboards. While our efforts to date have been informal and developmental, one type of anchored instruction in a fully contextual environment has proven fruitful. We use a rudimentary MIDI sequencer, one which reads and stores MIDI input but does not provide editing capabilities. Our rationale is that we can be assured that what students have recorded is what they *played* in real time, not what they later calculated, analyzed, and edited. Into this sequencer we input a parallel period or other formal subunit from the standard musical literature, complete with its full context. We then ask students to perform various tasks with the sequence to focus on the interrelated elements of the music (see Fig. 1, left side).

Figure 1. Schematic diagram of Aural Explorations model for contextual aural training.



For example, one goal we have is to ensure students' ability to focus aurally on the structural framework of the passage, i.e., the outer voices and the underlying harmony. One means of training this ability is to ask the student to focus on each aspect until it has been cognitively extracted from its context. The procedure we use requires students to play back and record on the sequencer first the melody, then the essential bass line, and finally the harmony—both harmonic rhythm and sonorities—as they perceive them. Each aspect is recorded on a separate track for teacher evaluation and/or for further creative work. The results of these tasks are stored on diskette and submitted to us for evaluation.

There are many rewarding features of this process.

1. The musical context is always present for the student, thus reinforcing the interconnectedness of the various elements of music.

2. These exercises train both memory and comparison skills; comparison requires that both long-term memory and immediate perception be available simultaneously. This process simulates what students will experience later when they coach lessons or lead rehearsals.

3. By asking students to focus on each aspect separately, we ensure that the skills needed for success in other types of exercises (e.g., being able to isolate the bass line for dictation) are being trained.

4. Dual perceptual modalities are required, joining the kinesthetic with the aural. Research has shown that multidimensional or multimodal perception—what cognitive psychologists call *dual encoding*—leads to more flexible and readily applicable learning.[17] Thus training with both aural perception and the associated muscular motion produces a more cognitively flexible learning.

5. Analytical processing is required for reproducing the harmony of a passage. Reductive decisions about the number of distinct chords (harmonic rhythm), sonority identification, and, to a gradually increasing extent, voicing are all incorporated into student responses. The result is that the aurally generated analytic processes in which students engage become evident to the evaluator. Indeed, we are finding it fascinating to *hear* how students *think*.

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[17] Cynthia Leshin, "Cognitive maps for the development of higher level thinking skills," paper presented at the conference of the Association for the Development of Computer-based Instructional Systems, St. Louis, Missouri, November 1991.

6. Much of the control of the exercise is left to the students. Clear tasks are provided, but factors such as limits of time spent, number of hearings, and number of attempts at playing back are not controlled. Students are expected to respond to this assignment as to any other in any class, or as they would in practicing for a private lesson.

7. By employing a progressive sequence of these exercises, we ensure that the ability to transfer learned skills to different contexts is being developed. This type of transfer is especially valuable since it is being performed between full musical contexts rather than between instances of isolated elements.

8. Finally, the musical experience for the students is much more like that of the rest of their musical life, situated as it is in full musical contexts and requiring a performed response rather than factual retrieval and identification.

As a complement to this extractive/reductive work, we proceed gradually toward encouraging student creativity. We may ask for any one of the extracted tracks to serve as the basis for original work (see Fig. 1, right side). For example, we may ask that the student listen only to the extracted melody, then create a new bass line to complement it. Alternatively, we might ask for a different harmonization. Similar exercises can be created for an extracted bass line or harmonic progression.

These examples constitute but a first step toward a new approach. Though we at Kentucky have only begun to explore the possibilities, several informal observations are worth noting. As teachers, we are learning more about how students hear from this type of exercise than from notated examples and are thus able to guide students more effectively. Although there is less emphasis on accurate labeling of components, students are demonstrating their ability to transfer their knowledge from context to context; the interconnectedness of the various elements becomes an inherent feature of these students' understanding of music. Finally, it is a joy for us as musicians to ask questions in music and receive responses in musical sound rather than on paper. Both students and faculty sense immediately the clearer, more direct relationship between aural training and the rest of the musical world.[18]

[18]We do not require all of the possibilities represented in Figure 1 for all sequences; rather we vary and expand them in a manner designed to derive maximum cognitive flexibility from assignments of reasonable length.

Summary

This paper has examined both the objectivist and constructivist views of knowledge acquisition and consequently of instruction. It has outlined several reasons why constructivist views deserve application to the development of computer-based aural-training software, as well as to instruction in the classroom. It also provides one example in which a constructivist approach is producing rewarding results in practice.

A constructivist vision of the aural-training software of the future might include at least these features:

- it would ask questions with musical sound and receive answers in musical sound;
- it would allow open-ended responses, i.e., multiple right answers, for complex questions;
- it would employ anchored multidimensional and multiperceptual instruction, with sustained activity in a single complex context;
- it would leave most evaluation off-line, at least for open-ended responses; and
- it would simulate the real musical world as closely as possible.

If we as instructional designers—computer-based or classroom-based—explore this approach, the music workstation will be a phenomenarium, encouraging students to learn by exploring music in new and creative ways.

Reviews

David Butler, *The Musician's Guide to Perception and Cognition.* New York: Schirmer Books, 1992. xv, 265 pp.

Reviewed by Elizabeth West Marvin

The Musician's Guide to Perception and Cognition belongs on every music theorist's bookshelf. For those with a specialized research interest in music cognition, it provides extensive bibliographic references, an overview of research areas that may lie outside one's specialization, excellent compact disc examples of stimuli like those used in a number of classic studies, and a very readable ("no more jargon than is absolutely necessary," p. ix) introductory text for teaching music cognition classes. But this book is not intended solely for the specialist, but also for a more general reader—"the musician," as its title indicates. Indeed, there is something of interest for musicians from many musical disciplines, and for theorists teaching a variety of courses (harmony, acoustics, history of theory, analysis and performance, and pedagogy of theory, for example).

What does it mean for the structure and content of this book that its intended primary audience is musicians? First, its language assumes basic musical knowledge, but assumes no specialized scientific, psychological, acoustic, physiological, or statistical knowledge. So, for example, basic principles of controlled experimentation (such as dependent and independent variables, or psychophysical testing's just-noticeable differences, method-of adjustment, and magnitude estimation) are all defined; acoustical principles, from divisions of the string and the harmonic series to tuning and temperament, are presented at an introductory level and aurally demonstrated; the parts of the ear are carefully diagrammed and labelled, with their various functions explained; and experimental findings are summarized without detailed statistical data on probability or numerical significance.

Second, the author understands that musicians often learn best by ear; hence he has included an invaluable teaching tool: the CD of musical examples. Butler notes that "hearing a stimulus pattern often reveals more to a music student than repeated readings of the description of an experimental procedure, and the listening experience often provokes students into valuable critical evaluation and 'what if' conjecture" (pp. ix-x). Indeed, these first two points (the book's accessible language and its musical examples) work together to place Butler in the role of "translator" for the musician interested in reading the experimental literature. It is not easy to read an article that describes its stimuli in terms of hertz, decibels, and milliseconds and then to imagine how those stimuli must sound. Butler's realizations enable the reader/listener to focus quickly on the perceptual issues raised by the study without puzzling over the design of the stimuli.

Third, Butler voices many musicians' criticisms of psychophysical and cognitive experimentation in music, but he does so in an even-handed way that actually addresses musicians' incomplete understanding of just why these experiments are designed as they are. He explains that scientists' objectives in designing "music" experiments are often quite different from those that musicians would read into them, and he notes that scientific experiments are designed to yield results that can be generalized to large populations of listeners who are not necessarily as musically literate as our students and colleagues. While some are quick to blame psychologists for results that seem to us to be unmusical, Butler notes that the problem may actually lie with those who seek to draw musical conclusions from what are essentially non-musical stimuli. His even-handed treatment of both the musicians' and the psychologists' possible areas of weakness is demonstrated in passages such as this one, drawn from the book's Preface (p. x):

> There are a number of ways to become ensnared by problems in this research area. The most obvious way is methodological: to be careless or unknowing about experimental design or procedure, to misapply statistical procedures or misinterpret statistical reductions, to become a bit zealous in drawing inferences from test results. Another way to encounter problems is to be musically innocent: to miss hidden variables in musical stimuli and in response tasks or, conversely, to mistake unmusical stimuli or responses for valid musical ones; to ask inexpert listeners to make sophisticated musical judgments, or the reverse.

The Musician's Guide to Perception and Cognition is divided into two parts; the book's title reflects this organization, which from the outset clearly separates perception from cognition. The author defines "perception" as "the awareness and judgment of a sensation, mediated by prior knowledge" (Glossary, p. 232) and "cognition" as a "perception based on, or affected by, knowledge" (p. 223). This distinction is wisely maintained throughout the book, as is the distinction between the sensory attributes of sound treated in the first part of the book ("Psychophysics of Musical Sound") and the cognitive aspects of sound in music treated in the second ("Mental Representations of Musical Relationships").[1] Even the chapter titles, which have an organization that is parallel from Part One to Part Two, reflect this distinction: "The Sensory Attributes of Pitch" parallels "Cognitive Aspects of Pitch in Music"; "The Sensory Attributes of Timbre" parallels "Cognitive Aspects of Musical Timbre"; and "The Sensory Attributes of Time and Space" parallels "Cognition and Time in Music."[2] The text concludes with a chapter on the development of cognitive awareness in music from prenatal responses onward, followed by two appendixes ("Frequency Equivalents for Twelfth-Octave Equal Temperament [A=440Hz]" and "The Humane Treatment of Human Subjects"), notes for each chapter, a glossary of terms, references, and an index.

The book's two main parts are preceded by two introductory chapters that give an overview of the field of music psychology and present basic acoustic principles. Chapter 1 presents a topical outline of music psychology, drawn from the subject indexes of a dozen texts that survey the field. The breadth of the field is demonstrated by this six-part outline:

I. Psychoacoustics and Musical Sound
II. Musical Systems and Cognition
III. Affective Responses to Music
IV. Ability (e.g., Performance, Creativity, Intelligence, Heredity)
V. Applications (Clinical, Industrial, Educational, Social)
VI. Testing, Experimental Methodology[3]

Butler's book is limited to just the first two of these; he wisely does not attempt to cover all six within the confines of this introduc-

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[1]To Butler's credit, he is careful throughout the book to use appropriate language to distinguish between the sensory and cognitive aspects of pitch, timbre, and so on—clearly defining terms that musicians might confuse or attempt to use interchangeably. Intensity, for example, is a physical attribute of sound energy, measured in decibels, while amplitude is "the peak value attained by a sound wave during a single vibratory cycle" (p. 221). Together, intensity and amplitude contribute to what we perceive as loudness. Similarly, frequency is "the rate at which a vibration completes a full cycle, measured in hertz (Hz)" (p. 227), which we perceive as pitch.

[2]The author notes that the chapters are designed so that they need not be read consecutively; some readers may wish to reorder the chapters so that the sensory and cognitive aspects of pitch, of timbre, and of time are paired.

[3]Butler's outline is presented in Table 1-1, pp. 2-4.

tory text. Even within these two subject areas, the author has chosen to treat some subjects in less depth, and notes that the "limited scope of this book" precludes more detailed coverage (see, for example, pp. 193 and 159). In the chapter on cognition of time in music, for instance, Butler devotes only one page each to the issues of tempo, rhythm and meter, and proportionality. Indeed, the book is just too short to cover every topic with the level of detail it deserves. If the book finds a sufficient market to justify a second edition, Butler should consider expanding his discussions of the experimental literature, especially in the latter portions of Part Two.

Further, there are at least two missing topics that really belong in this book—even given its self-imposed limitation to topics of sensory perception and musical cognition. The first of these is an introduction to the neurology of music perception. The physiology of the ear, presented in Chapter 3, ought to be complemented by physiological diagrams of the brain and discussion of brain function, especially given the wealth of research that exists on brain lateralization and hemispheric dominance among musicians and non-musicians.[4] The second of these topics, psycholinguistics and its parallelisms to music cognition, could easily have become a part of Butler's discussion (pp. 161-163) of the perception of hierarchical levels in musical structure. In this connection, he discusses Schenker's and Lerdahl and Jackendoff's music-analytical theories; yet not even in the discussion of the latter authors, who are heavily influenced by linguistic theory, does he con-

[4]For an overview of this literature, see *Music and the Brain: Studies in the Neurology of Music* , ed. M. Critchley and R.A. Henson (London: William Heinemann Medical Books, Ltd., 1977) and Oscar Marin's contribution (Chapter 15) to Diana Deutsch's *The Psychology of Music* (New York: Academic Press, 1982). Researchers frequently cited in connection with hemispheric asymmetry are Thomas Bever, Doreen Kimura, and Isabelle Peretz. See, for example, Bever's "Broca and Lashley Were Right: Cerebral Dominance is an Accident of Growth," in *Biological Studies of Mental Processes* , ed. David Caplan (Cambridge, MA: MIT Press, 1980); Bever and Robert J. Chiarello's "Cerebral Dominance in Musicians and Nonnusicians," *Science* 185 (1974): 536-539; Kimura's "Left-Right Differences in the Perception of Melodies," *Quarterly Journal of Experimental Psychology* 16 (1964): 355-358 and "Functional Asymmetry of the Brain in Dichotic Listening," *Cortex* 3 (1967): 163-178; Peretz and José Morais's "Modes of Processing Melodies and Ear Asymmetry in Non-Musicians," *Neuropsychologia* 18 (1980): 477-489 and Morais, Peretz, Marc Gudanski, and Yves Guiard's "Ear Asymmetry for Chord Recognition in Musicians and Non-Musicians," *Neuropsychologia* 20 (1982): 351-354. None of these articles is cited in the list of references that concludes Butler's book.

nect the analytical theories with psycholinguistic research.[5] Butler does effectively demonstrate connections between music and psycholinguistic research in discussing two of his listening examples, however (Examples 5.4 and 5.5, pp. 84-85). Here listeners are asked to write down four sentences in which the initial consonants of key words are interrupted by noise; predictably, listeners are influenced by the context of the sentence in identifying the obscured words. The "musical" analog is a gliding sine tone that is interrupted periodically by white noise; when the white noise is removed, listeners discover brief gaps in the tone. Yet the glide sounds uninterrupted and continuous in the white-noise condition because of the context provided by the rising or falling glide.

Butler's *Musician's Guide* would be my first choice as a required text for student purchase in a music cognition course. However, because of the brevity with which some subjects are treated (and because of the few omissions cited above), I would supplement with readings drawn from other books and collections (most notably Deutsch, Sloboda, Dowling and Harwood, and Howell, Cross, and West)[6] and from articles in *Music Perception* and other scientific journals reporting on experimental research. If the course were to attempt to cover developmental issues, Butler's too-brief final chapter would be supplemented with readings from Hargreaves's book-length treatment of the

[5]Butler's discussion cites Heinrich Schenker, *Free Composition*, trans. Ernst Oster (New York: Schirmer Books, 1979) and Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, MA.: MIT Press, 1983). In contrast to Butler, John A. Sloboda's *The Musical Mind: The Cognitive Psychology of Music* (Oxford: Clarendon Press, 1985) contains an extended section comparing Schenker with Chomsky (pp. 11-23). More to the point, however, are experimental studies that merge issues of musical and linguistic interest, such as the study of rhythm and contour in speech. See, for examples in the rhythmic domain, *Rhythm in Psychological, Linguistic and Musical Processes*, ed. James R. Evans and Manfred Clynes (Springfield, IL: Charles C. Thomas Publisher, 1986); speech contour studies often examine "motherese," as in D.N. Stern, S. Spieder, and K. MacKain, "Intonation Contours as Signals in Maternal Speech to Prelinguistic Infants," *Developmental Psychology* 18 (1982): 727-735. Issues of hierarchical versus serial processing of sentences as heard or read would seem to have direct analogies to the cognition of music. Replication of experimental models drawn from this line of psycholinguistic research and adapted to musical stimuli appear to be a ripe area for study.

[6]W. Jay Dowling and Dane Harwood's *Music Cognition* (Orlando, FL: Academic Press, 1986), like Butler's text, comes with recorded musical examples (on cassette). Deutsch and Sloboda are cited in footnotes 4 and 5. Peter Howell, Ian Cross, and Robert West are editors of a collection of essays by

subject.[7] Finally, if the course were designed to conclude with a research project that might take the form of an experimental study, then a good psychology methods book would also be required.[8]

Why does the Butler stand above the others cited here? Because it is written from a musician's point of view, with a musician's vocabulary; because it is organized and written as a textbook (not solely as a research publication); and because its CD can be put to use in a variety of ways. Here is a book that does not define "interval" or "dominant seventh," but instead defines "amplitude," "dichotic listening," "Fourier analysis," and "mel scale." Every technical acoustical, psychological, physiological, or statistical term of importance is given in boldface on its first appearance; the boldface signals its inclusion in the book's glossary. The glossary does not merely repeat information given in the body of the text, but expands upon it and refers the reader to related glossary entries.

The book's textbook orientation is reflected not only in the author's decision to compile a glossary, but also in his inclusion of chapter summaries and sets of problems, which vary from requests for definitions to class discussion questions, from library research tasks to mathematical calculations.[9] Some questions might be assigned and

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some thirteen English contributors, entitled *Musical Structure and Cognition* (Orlando, FL: Academic Press, 1985). Another new volume that might also be included on a library reserve list is *Psychology and Music: The Understanding of Melody and Rhythm,* ed. Thomas J. Tighe and W. Jay Dowling (Hillsdale, NJ: Lawrence Erlbaum Associates, 1993).

[7]D. Hargreaves, *The Developmental Psychology of Music* (Cambridge: Cambridge University Press, 1986).

[8]I suggest William J. Ray and Richard Ravizza's *Methods Toward a Science of Behavior and Experience,* 3rd ed. (Belmont, CA: Wadsworth Publishing Company, 1988) because it presents not only a good introduction to scientific method and experimental design, but also some elementary statistics and detailed information on writing and reading scientific articles in APA (American Psychological Association) style.

[9]An *Instructor's Manual,* available on disk from the book's author, provides answers for each chapter's problems; these answers are particularly helpful for Chapters 2 and 3, where mathematical calculations are required. The manual also contains ideas for class demonstrations and discussions, as well as additional references. Readers interested in obtaining a copy of the manual (available only in Macintosh format) should send a blank 800K diskette and two 29-cent stamps to: Prof. David Butler, School of Music, 1866 North College Road, The Ohio State University, Columbus, OH 43210. Two references which may be of interest to readers of this journal are additional CDs of acoustical examples available for purchase. Philips CD No. 1126-061, which includes the decibel scale and stretched and compressed scales, among other demon-

collected by the instructor, and later form the core of a class discussion. In the introductory chapter, for example, he asks: "Suppose that you are interested in finding whether listeners can distinguish the timbres of two different violins with better than chance levels of accuracy. What is the dependent variable of the study? List at least six independent variables, and explain how you would control them" (pp. 13-14). Some questions force students to use technical information covered in the chapter to solve musical problems; for example: "Assuming that sound travels at about 1,150 feet per second, how long would it take for the sound of a trumpet at an outdoor concert to reach a flautist sitting 60 feet away? Expressed as a note value, what would be the duration of this time lag, given that the music was currently proceeding at MM. quarter note = 132?" (p. 33). Most of the chapter problems are good opportunities for students to put psychological or acoustical information into musical context, and are worth assigning and discussing in class.

Butler's text and CD are also full of "self-tests," which make for enjoyable reading and involve the reader directly with the perceptual issues under discussion. For example, in the second chapter's introduction to acoustics, Listening Example 2.5 presents "four complex tones in which all partials other than the fundamental have been removed by filtering" (p. 22). The tones are produced by a French horn, violin, sine wave, and piano, but not necessarily in that order; readers are invited to determine by sound the order in which the four tones are presented, and then check their responses with the list given in one of the problems that concludes the chapter. The problem then asks students to consider further the listening strategies used to make their determinations. Visual self-tests are also given, such as an occluded figure that is seen only partially as a slit moves from left to right (Figure 9-1). Readers try to identify the visual pattern from these partial images as the "narrow 'window' passes from left to right in each succeeding frame" (p. 144); they are given the complete image in one of

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strations, is available from the Acoustical Society of America for approximately $20 (500 Sunnyside Blvd., Woodbury, NY 11797); *The Space-Sound-CD Dummy Head Recording* was available for about $45 in 1990 from Audio Electronics, P.O. Box 1401, D-4000, Düsseldorf 1, Germany. Among the class demonstrations that Butler suggests in the manual is a very effective graphic demonstration of the difference between arithmetic, exponential, and logarithmic scales that is carried out physically by having the class line up in a single column and then vary the patterns with which individuals step away from the straight-line starting point.

the notes to this chapter. This visual exercise is an effective demonstration of the perceptual "now."

As stated above, the CD that accompanies this text is one of the reasons this book is such a strong teaching tool. This valuable resource will be underutilized if it is put it to work only the music cognition classroom. Many listening examples would be appropriate for an acoustics course, especially those in Chapters 2-4.[10] Filters are applied to acoustic instrumental sounds to allow only certain partials to be heard together or successively; tones with partials that are integral multiples of their fundamental are compared to tones comprised of equal-tempered partials; combination tones are demonstrated; sustained tones of orchestral instruments are presented with their attack transients removed; and chord progressions in C major and F# major are compared in equal temperament, Pythagorean tuning, quarter-comma meantone temperament, and just intonation. In fact, these tuning examples and the text's discussion of their derivation (not to mention the earlier chapter on acoustics) would be appropriate reading and listening for classes in history of theory: to clarify early treatises' treatments of musical proportions, divisions of the string, and tunings, for instance, or to demonstrate the *Affect* associated with specific keys.

As students in history of theory classes read Mattheson's *Der vollkommene Capellmeister* (1739), they can hear a musical realization (Listening Example 7.2) drawn from this treatise to illustrate the concept of compound or polyphonic melody. This same example would be perfectly appropriate in any undergraduate harmony class, as would Listening Example 7.9 (examples of changing-note and gap-fill melodies) in a unit on melodic analysis. Listening Examples 7.10 and 7.11 (examples of "consonant" and "dissonant" intervals, and several interval pairs that imply different tonal centers) could be included in a class discussion that attempts to define "tonality." Butler's text stimulates such a discussion: for example, he asks "do these classifications [consonant and dissonant] adequately describe the pleasantness or unpleasantness of the combinations? Do all 'consonant' chords sound intrinsically stable? Do all 'dissonant' chords sound unstable?" (p. 119).

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[10]This is not to imply that only the listening examples are appropriate to an acoustics course. Chapter Two ("Essentials of Acoustics") is good introductory reading. In fact, the entire first part of the book ("The Psychophysics of Musical Sound") could prove useful in such a course—particularly the chapters dealing with the sensory attributes of loudness, time, and space. Some discussion of stereo mixing and room acoustics is included in the sections entitled "Auditory Localization" and "Spatial Cues" (pp. 91-99).

Indeed, a wealth of examples in this book could be used in undergraduate theory and aural skills courses, depending on the creativity and resourcefulness of the teacher.[11] Listening examples can form the point of departure for class discussion in the rhythmic domain. For instance, Listening Example 9.4 presents an ear-training question to students who hear an adaptation of Beethoven, Symphony No. 5 (III): "the example may be in 3/2, 3/4, 3/8, 6/4, 6/8, or 12/8 meter. If you decide which meter the example is 'really' in, what would prevent someone else from arguing just as successfully for another choice? What effect(s) would a change of tempo have on your choice?" (p. 160). Teachers of set-theoretical analysis classes can demonstrate the distinction between pitch and pitch class by means of the "Shepard's Tones" illusion (Listening Example 3.8) and the octave-displaced pitches of the melody presented in Listening Example 7.5.[12] Even studio teachers or theorists who teach classes relating analysis to performance can use Butler's discussion of expressive timing (pp. 156-159) and Listening Example 9.3, which compares renditions of a performance of Beethoven's Sonata No. 30, Op. 109 (III) using a computer-controlled Bösendorfer piano. The first rendition is unaltered, the second is "the same performance, but with all notated simultaneities adjusted [by computer] so that their onsets are actually synchronous," and the third is "the same performance, but with all key velocities equalized" (p. 157).[13]

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[11]It is clear from numerous references in the text that Butler has taught his share of aural skills courses, and has learned about music cognition from the experience. He notes, for example, that "it can evidently be disconcerting for someone with absolute pitch. . .to complete a melodic dictation exercise in, say, the key of G while a diabolical aural training instructor plays the melody in some other key" (p. 50). In reference to some psychological studies of rhythm, he notes "this is not likely to interest musicians who observe much more complex perception and production activity in the aural training classroom and in the performance studio" (p. 159). In the chapter on the development of cognitive awareness in music, he notes with some humor: "Anyone who has ever taught a 'homogeneous' group of students in a college-level aural training class will appreciate how widely the levels of cognitive skill within, say, a kindergarten classroom might vary" (p. 218).

[12]These examples are drawn from the work of Roger Shepard and Diana Deutsch. See, for example, R. N. Shepard, "Circularity in judgments of relative pitch," *Journal of the Acoustical Society of America* 36 (1964): 2345-2353, and his "Structural Representations of Musical Pitch," in Deutsch's *The Psychology of Music* (see footnote 4). See also D. Deutsch, "Octave Generalization and Tune Recognition," *Perception & Psychophysics* 11 (1972): 411-412.

[13]This example is based on experimental research by Caroline Palmer; see, for example, her "Timing in Skilled Music Performance" (Ph.D. diss.,

Clearly, the inclusion of the CD and the text's discussions surrounding these listening examples are among the book's strongest suits; these alone justify the opening statement of this review.[14] But this text has far more to offer than entertaining aural sleights of hand (or "sleights of ear"). The *Musician's Guide* is an excellent overview of the field of music cognition; it represents the breadth of research in this area while managing to balance (mostly with success) the presentation of basic terminology and concepts at an introductory level with more advanced discussions and critiques of classic and recent experimental studies. Moreover, it is well written and well organized.[15] Musicians will enjoy reading this text and will probably find classroom materials here that they can draw on for many years.

Cornell University, 1988) and "Mapping Musical Thought to Musical Performance," *Journal of Experimental Psychology: Human Perception and Performance* 15 (1989): 331-346.

[14]One advantage of the CD format (over the cassette that accompanies Dowling and Harwood's music cognition book, for example) is the availability of CD-ROM technology. Teachers with some HyperCard experience could write audio stacks for use in classroom demonstrations or for a computer listening lab where students might explore topics in music cognition at their own pace, of course with proper documentation and citations to the publisher of the text and CD! Users of the CD should be forewarned (as Butler does repeatedly, pp. 39 and 78, for example) not to turn the volume too high; even with the warnings, I found myself pulling off the earphones mid-example at least once.

[15]In addition, the book is remarkably free of errors. I found no typographical errors, except that Listening Example 7.11 cites Figure 7-10 when it probably should cite Figure 7-14. Listening Example 8.3 is played three times, not twice as the text states; and Listening Example 7.2 is longer than the notation presented in Figure 7-3. These are small errors, easily fixed if there is another edition. The CD that accompanied my book was not error free, however, since there was some distortion on the final two tracks. I have not yet attempted to compare this disc with other discs or to have it replaced; even so, this CD will get many repeat listenings and much classroom use.

Reviews

Michael Friedmann, *Ear Training for Twentieth-Century Music.* New Haven: Yale University Press, 1990. xxvi, 211 pp.

Reviewed by William Thomson

Imagine a familiar scene: Two well-schooled musicians sit eye-to-eye at a table in an urban restaurant. They are discussing the premier performance, just heard, of the.great Keplered Høering's latest work.

"What a piece! Notice the way he permuted his all-combinatorial prime set in the second movement? And how'd you like the clever way he brought in Schoenberg's favorite hexachord toward the end?"

"Incredible ingenuity!" his colleague replies. "The way he manipulates those three invariant pitch classes from trichord 3-4, as constants through the first movement, really holds it all together for me."

"You're right. But I guess harmony impressed me most. The best was the steady organic growth of the third movement—you know, where every third aggregate's interval content is inversionally derived from the one before. That's deep-down structural integrity!"

Regretfully, let us close this efflorescence of pitch-structural hearing. Our two conversationalists would unquestionably have more insights to share from hearing Maestro Høering's music, but a pause for reflection seems timely.

Is the language of our hypothetical exchange exaggerated? Not really. The ideal user of Michael Friedmann's *Ear Training for Twentieth-Century Music* might be expected to speak in much this way, if the book's implicit premises have merit and if its goals are met and absorbed. Most readers have probably examined Professor Friedmann's book at length since its release three years ago. A probing review of it by Elizabeth West Marvin appeared in the Spring 1992 issue of *Music Theory Spectrum.* The volume has been awarded a publications commendation from the Society of Music Theory. For these reasons my remarks need not dwell on what is already known or is readily available from other sources. I'll focus instead on the theoretical and pedagogical tenets that motivated the book, as well as estimates of predictable success for achieving its goals.

The book is a rigorous study that applies the concepts and vocabulary of set theory to hearing music. Its goal is to develop a "confidently aware musician" (p. xxvi), one with a good ear that "goes beyond the mechanics of accurate dictation or precisely pitched singing: it enables the listener to perform acts of at least rudimentary analysis without consulting the score" (p. xxiii). In the author's opinion these goals demand a different kind of book. And from this thin volume's introductory pages it is evident that comprehension, for him, is indissolubly tied to the verbalization of identities: First one learns a category; this in due time enables the listener to enact a tripartite event, a bundled co-presence of Identification-Perception-Understanding.

Such an emphasis demands a work that is "theoretical." As Friedmann tells us, "much of the book is therefore devoted to defining and elaborating theoretical concepts as well as exercising them by means of abstract examples and musical illustrations from the literature" (p. xxiii). It leads to a book long on words, short on doing. At stake here as well is the author's conviction of what makes twentieth-century music tick in its own special way. This basis is "the precise articulation of structural relations," and thus it follows that "perceiving them is a precondition for understanding affective content and gesture" (p. xxiii). Admirable convictions. But let us note early on that there is room for the suspicion that twentieth-century music as class is not so peculiar in its experiential demands, that one author's articulation of structural relations may be another's play on extraneous fictions.

Inherited Abstractions of Set Theory

A more careful and thorough presentation of the basic language and concepts of set theory would be hard to find. Friedmann knows the talk well. He capably sets it down here with conviction and a flair for detail. Any musician interested only in reviewing these concepts would find this book a reliable source. In this respect it's an admirable text. Yet I predict that conversations of the kind idealized in our opening paragraphs will not occur, neither soon nor in the remote future. My reasons are several. They are blessedly simple and fundamental.

The most compelling should be mentioned first. It is that we communicate with each other only when what we say is capable of projecting images of perceivable things. If I tell you that "X and Y are within twenty miles of each other," my utterance is not gibberish. It corresponds eminently with the statement "Pitch-class X is inversionally related with pitch class Y." Both claims are syntactically precise. But your understanding—your *conceptualization* of either message—is severely limited by its reliance on inherently intangible things.

We cannot *see* the objectifications represented by X's and Y's nor can we *hear* pitch classes; both achieve perceptual meaning only when linked with sensate things. For this reason any system of aural classification of pitch derived solely from the semitonal pitch collection, as groups of twelve permutable and neutral elements, harbors an inherent danger. Both set numbers and interval vectors are unreliable indicators of relative sonance, a condition confirmed by some of the most modest sonorities of history. Major and minor triads possess the same Forte number (3-11) and interval vector <0,0,1,1,1,0>, and yet the history of music has been preoccupied with how they are the veritable Light and Dark of music. In the same way, major-minor seventh chords and half-diminished seventh chords are interval class inversions of each other, as Friedmann dutifully reports on page 97. But *Tristan* would not have been the same if Wagner had mistaken the sound of one for the other, thinking of both merely as tetrachord 4-27, interval vector <0,1,2,1,1,1>.

This leads us to a crucial observation. The necessity for concreteness renders problematic, if not irrelevant, many recent discussions of music insofar as they are intended to refer to an aural experience. They lack verifiable relevance because they engage in language that cannot hook into concrete images. That they may speak of things which exert control in music, as heard, is an even more dubious axiom. These limitations are central to the problem of musical description as it has developed in serialist analytics over the past four decades. They are but magnified when one attempts to construct pedagogical processes of audition around these rarefied tenets, tenets eminently suited for describing things discoverable in notes. So when Friedmann repeatedly refers in his study to interval vectors, or to any other index rooted in pitch class or interval class content, we must be aware of the tenuous ways they bear, when at all, on the musical experience.

Recognizing, perhaps, that the raw pitch classes of modulus 12 are frail underpinnings for aural description, the concept of *Superset* is introduced in the discussion of trichords (Chapter 4). But even the definition of this mega-grouping, which includes such homely pre-post-tonal collections as the diatonic, pentatonic, whole-tone, and octatonic, is abstract to the core.

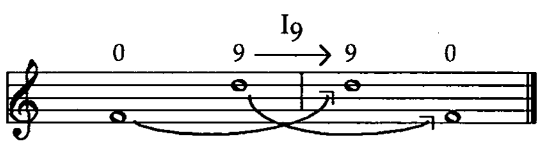
> A superset of a given set class is a set class containing a larger number of pitch classes than the original set class does. Pitch classes forming the original set class can be found amid the pitch classes forming the superset. (p.41)

Note the casual indifference posed by this definition for what is hearable: (1) a *set class* (which as a term occurs four times in the definition) is composed of *pitch classes* and is therefore a second generation abstraction; and (2) the conditions that render a set as an *original set* are undefined. Even this inclination toward the impressionistic is more defensible than the classificatory tedium students are told they "should" endure every time a trichord is heard. The directions for Exercise 4.6 are not inconsistent, so I quote them in full.

> EXERCISE 4.6
> Preliminary exercise continued: Interval content of trichords
>
> To define set class types by means of the second route described above [conversion of a heard sound into a Forte number by recognition of interval content], the preliminary exercise on interval content of trichords used earlier in the chapter should be extended to two steps: (a) the three unordered interval types should be put into interval vector form—if we hear a three-note chord the lowest pitch of which we call 0, and that can then be described as <0,+9,+13> with ip (9), (13), and (4) (=i(3), (1), (4)), the interval vector is <1,0,1,1,0,0>; and (b) we should learn to identify the interval content with the set type name of 3-3 (and normal order name [0,1,4]). (p. 47)

Another demonstration of dubious conformity between canon and perceptual probabilities has to do with the invariance property. Example 1 illustrates dyadic invariance under I9. Assuredly, invariance is there *in the notes*. But when *heard*, dyadic invariance is perhaps the last thing that comes to mind. What one *hears*, plain and simple, is the repetition of one pitch (d) and the return to another (f). To impose the convoluted notion of pitch invariance on such straightforward aural happenings misrepresents the decoding process that is percep-

EXAMPLE 1. Dyadic invariance under I9 (Friedmann p. 31, Ex. 3.8a)

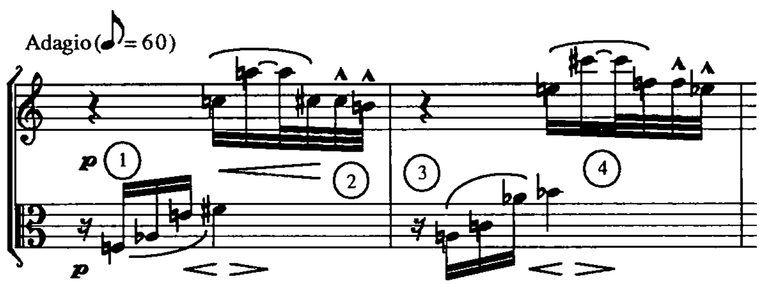


tion. Even more damaging for a textbook, it makes conceptual mountains from aural molehills. The very relevance to audition of pitch class invariance, under permutational operations, is at best tenuous. As Milton Babbitt made clear in his definitive exposition of that property three decades ago, its projection depends on the co-option of other musical properties.[1]

Additional examples of excessive conceptual complexity, without redeeming aural payoff, are sprinkled through the book's exercises. Is aural cogency gained by observing in Example 2 that sets 1 and 3 and 2 and 4 are related by T or that 1 is transformed into 2 by intervallic inversion (I7)? (See Friedmann's questions on p. 101.) These are means used by the composer to derive pitch content; aurally, rhythm, contour, and imitative texture project structure here. The *particular* pitches engaged are of negligible consequence, except that they don't project pitch focus.

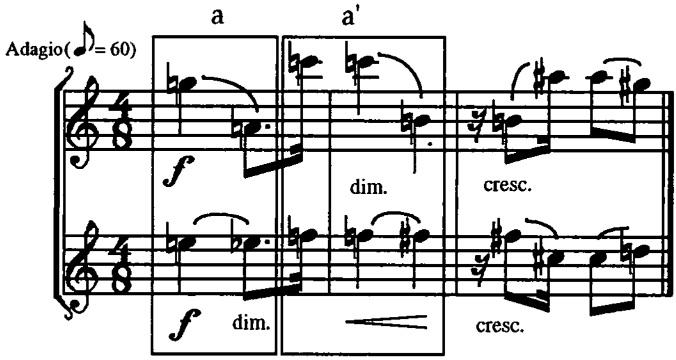
Exercise 4.8 (p. 50) deals with the identification of trichordal combinations of the type [0,1,4]-3-3 within a range of two octaves. One must realize that just fixing in mind the six potential transpositionally related series derivable from this model is no small task. Once accomplished, then the charge is to identify each melodic or chordal sounding of such sets as per its respective *rip*<()> index. Let us presume that these terminological and configurational hoops are, in time, negotiable. One must then ask "Why should a musician learn to categorize triads by such a cumbersome system? If I hear the figure repre-

EXAMPLE 2.
Schoenberg, *String Quartet* No. 3, second movement, mm. 92-3, first violin and viola (Friedmann p. 161, Ex. 134)

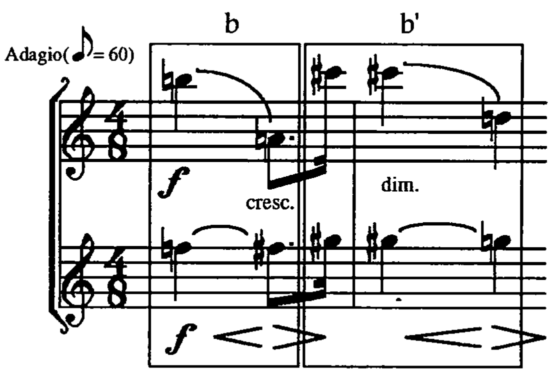


[1]Milton Babbitt, "Twelve-Tone Invariants as Compositional Determinants," *The Musical Quarterly* 46 (1960): 254.

EXAMPLE 3.
Schoenberg, *String Quartet* No. 3, second movement, mm. 1-3, first and second violins (Friedmann p. 163, Ex. 138)



EXAMPLE 4.
Schoenberg, *String Quartet* No. 3, second movement, mm. 6-9, first and second violins (Friedmann p. 163, Ex. 139)



sented by *rip*<1,8)> I don't wish to be burdened with its clumsy numerical icon. Should I need a conceptual underpinning, I possess simpler means absorbed from the age of five years." Students in an age-range for this text will come similarly equipped.

Exercise 3.15 (p. 33) has students examine Examples 138 and 139 (shown here as Examples 3 and 4) to discover how the latter is derived by transformation from the former. The notation makes the transformation apparent: *b* and *b′* are inversionally transposed versions of *a* and *a′*. So much for note reading. Is this relevant to successful listening? Upon coming to this realization, have I satisfied the "precondition" mentioned in the *Introduction* "for understanding affective content and gesture?" Must one really believe it makes a difference—that it *should* make a difference—to the listener, to know that these exacting pitch transformations are therein incorporated?

I wager that any *structural* and/or *affective* punches thrown by this flyweight passage will be derived from far more accessible properties than from attention to—much less realization of—IT relationships. Even if these two excerpts were temporally adjacent, the phenomenal message would still be a product of the contrasting melodic contours (disjunct vs. conjunct), of the direct and easily assimilated rhythms, of the dynamics, and perhaps even of the cadential sonances (4ths and 5ths). They are explicit. Why depend on a deeply embedded abstract relationship, such as exact pc inversion, when eminently accessible cues are there for the hearing? I have heard this Schoenberg Quartet at least three times in live performance, as many as five times in recordings. I must confess that I had never missed knowing these esoterica were lurking there in that second movement. I earnestly doubt that my future receptions will be enhanced by knowing it. (Granted, I may be simply a comparatively poor listener.)

Other exercises suffer inconsistencies by swinging from monumental busywork to the pedestrian. Exercise 4.15 (p. 54) incorporates inversionally symmetrical trichord types. After a melodic form is played, students are to sing back an improvised transformation (an inversion or transposition) demonstrating pitch class invariance. Readers who try this procedure will find it an agonizingly slow process, an agony unaccompanied by great advances in learning. The virtue tested is patience, not confident audition. But no wonder. The problem posed is not actually aural; the problem is matching an improvised response to a conceptual model. It's a problem in filling a prescription rather than in diagnosing an illness.

Yet, immediately following, Exercise 4.16 is so transparently soluble that its heuristic utility is hard to defend. Students are to identify invariant transformations incorporated into a pair of melodic fragments. They know from the assignment's directions that invariance is present, and whether the second fragment contains *same* or *different* pitches will be apparent as soon as it sounds. If they are not the same, T is automatically the only possible answer. What is *heard* is not the property of invariance but the presence or absence of transposition.

Most troubling of all, procedures such as those of Exercise 4.20 (p. 58) can lead to contradictions for the listening process. Students listen to a trichord, say *c′ g′ b-flat,* then determine and sing the whole-tone scale into which at least two of the trichord's pitches fit. Thus the whole-tone scale containing *B-flat* and C would be sung, pitting its *G-sharp* against the trichord's *G-natural.* My point? This conjunction runs cross-grained to the goal. The only scale that fits the prescription is jarringly non-conformable with the sounded trichord.

Language and Order of Learning

By the time students get to this book they will have been occupied with music on a formal basis for a decade or more. They will have absorbed a good bit of the nomenclature and conceptualized metabolism of some kind of music. For them, language is most effective when it conforms to the norms of their accrued conventional wisdom. When it does not, cautious provisos and adjustments must be injected by an author or teacher to justify the discrepancy. When variances with absorbed understanding go unjustified, the new and untested will either be discarded automatically or, even worse, added to the unsuspecting student's mounting tangles of confusion.

The book introduces a number of terms (with their accompanying conceptual apologia) for which I predict less than promising futures. Some are obsolete before their time, others of questionable utility for the listening musician. Among these are *contour class, contour interval, modal order, modal interval, modal inversion, modal sequencing* and *modal transposition.* A few may at first seem to be extensions from the traditional lexicon. They are not.

Since the author has written extensively about contour, and especially of its nature and utility in the music of Schoenberg, his expertise is especially welcome in an aural skills text. The study here is exacting and exhausting. Indeed, *Contour* provides Friedmann with a field day. He coaxes from it the additional properties of *Contour Class, Contour Adjacency Series, and Contour Interval.* It is possible to be excessively creative in cultivating rubrics of classification.

Contour adjacency has to do with whether a pitch rises or falls relative to its predecessor. From it grows a *Contour Adjacency Series* (represented as series of pluses and minuses denoting those relative higher/lower relations). Then a *Contour Class* attaches a specific high/low number value to each pitch, still fastidiously avoiding recognition of particular pitches or of tonal hierarchy within the collection. And finally, a *Contour Interval,* to distinguish it from just a plain old everyday *interval,* is best known within a *Contour Interval Series (CIS).* It is "a *relative* description of the space between elements of a Contour Class" (p. 35). So if a Contour Class (CC) consists of the series <1,4,5,3,0,2,7,6>, then the Contour Interval Series (CIS) consists of <+3,+1,-2,-3,+2,+5,-1>.

The post-baccalaureate value of such elaborate mappings and symbolisms for contoural abstractions, which, after all, are pretty simple things, is not immediately evident. Furthermore, they are defined in a way that will inevitably lead to frictions with previously held ideas and definitions. On page 35 we read that "a small contour interval does not necessarily designate a small pitch interval." All of this is meaningful (and understandable) in the light of the author's recent definition of a *contour interval,* but it will arouse an unresolved dissonance with what a student tucked away some years earlier as "large" and "small" intervals. And there is an even more disruptive element hidden here. As pedagogy, this elaborate focus on contour occurs out of sync with a rational learning sequence. Without doubt, its recognition is desirable in developing receptivity for pitch collections as trajectories in time, but that comes before grappling with the benumbing specificities of actual pitch successions. In this study it is introduced at a time when most students will have more trouble ignoring discrete pitch content than in recognizing a generalized melodic sweep.

Equally rich in classificatory prose is the book's treatment, toward the end of Chapter 6, of *Modal order.* The thrust of this discussion can be gathered from the following two statements pertaining to intervals within a mode. They may at first not ring clear.

> 1.The modal treatment of a pitch collection "is always characterized by a *'flattened' treatment of the intervals: in modal motion and processes, the intervals between the scale steps of the mode are treated as if they were equivalent*" (p. 117). Stravinsky's Russian Dance from *Petrouchka,* for instance, "treats the diatonic set modally by 'equalizing' the set classes 3-10 [0,3,6] and 3-11 [0,3,7], by moving among the scale degrees of the mode without differentiating between half-steps and whole-steps" (p. 117).
>
> 2. Modal steps, regardless of their comparative size, "act as though they span equal intervals" (p. 117).

Take the collection {0,1,3,5,8,9} and treat it modally. Because of this equal-interval behavior of modal pitches, when pitch class simultaneity {0,3} (which is enacting the modal roles of degrees 0-2) moves to {1,5} (enacting 1-3), then to {3,8} (enacting 2,4), and finally to{5,9} (=3,5), paranormal things are said to happen (see Ex. 5). Because these pitches have been used in a way that keeps "the modal interval M.I. (n) constant," the passage enacts what is known as *parallel thirds* (p. 117).

EXAMPLE 5. Modal flattening: parallel thirds in the collection {0,1,3,5,8,9}

(0-3 1-5 3-8 5-9)

Quite a trick. But there is more to come. On page 118 we read of the "flattening of pitch and pitch class space." This happens only to "modal intervals," but what Friedmann has in mind is not what his readers have understood by *flattening* since their first lessons on the fiddle or clarinet a decade ago. The revised conception grows even more disreputable when it is applied to *pitch class space*, in that a pitch class is by definition incapable of being described as "higher/lower" or "larger/smaller." A better term for *flattening*—assuming that the term is at all worth rescue—may be *neutralized*. But *flattened* it is. And to make bad matters worse, the parent concept of *Modal interval* is expanded into unique operations called *Modal inversion, Modal sequencing, and Modal transposition*. Readers intrigued by these additions to the budding grove of twentieth-century music theory can find them within pages 118-119.

Polymodality is defined as "the superimposition of two different modes with the same tonal center" (p. 116). This doesn't fully conform with what I think is widespread use, in which bimodal or polymodal relations need not be confined to pitch collections with the same tonic. Expanding this narrower sense of the concept, Friedmann goes on to hold that even the melodic form of the minor scale, as distinct from the "natural" form, is best conceived of as a polymodal combination, as "superimpositions of M.O. [modal order] <0,2,3,5,7,8,10> and M.O. <0,2,3,5,7,9,11>" (p. 116). This complicating new twist, two scales for one, ignores the conception of those scales' contents as *alter-*

natives within a single hierarchical system, one that finds some pitches fixed (such as tonic, mediant, dominant), others movable. This latter conception is far simpler, yet richer in its explanatory potential. It ties tonal music of modern times together with ancient Greek theory (the *hestotes* and *kenoumenoi* of the Greek Greater Perfect System) and ancient Chinese theory's *lü* system (the *wu sheng* and *pien* tones). The more confining option is of less long-term utility to the student.

The Perils of Systemic Inconsistency

Friedmann's examples from the twentieth-century repertoire may seem unnecessarily selective for some musicians. Confined to the music of Schoenberg, Stravinsky, Debussy, and Bartók, they nonetheless fit admirably his perspective of what makes music worthwhile. They lend themselves to the sort of analytical fragmentation of pitch organization his pedagogy celebrates. As I commented earlier, his sense of appropriate repertoire is colored by the conviction that twentieth-century music is fundamentally and unequivocally different from the music of preceding centuries. Held hostage by this popular fiction, he nonetheless doesn't consistently honor it, thereby weakening the theoretical integrity of his pedagogy.

"Set class," he tells us, "is the fundamental harmonic structure of post-tonal music. . . . No sound is consigned a priori to dissonant status" (p. 39). These are words well-calculated to enunciate the stark contrast of New from Old. The Old way had us grading sonance "according to linguistic rules established between the fifteenth century and the eighteenth century," rules that were "threatened only by modest ambiguities in the nineteenth century" (p.69). These rules are only "tenuously applicable" in the twentieth-century repertoire. Friedmann's emphasis, furthermore, is "on the aspects of twentieth-century musical languages that radically depart from the structuring tools of tonal music" (p. 9).

These manifestos of revolution make all the more curious the use of several old bottles for newly vinted wines, such as a reference (p. 97) to the dominant seventh and half-diminished seventh chords as potential sonic paradigms (for example, the 4-27 tetrachord). After all, if what is said in the final paragraph of the *Introduction* is meant, there can be no *dominant (V)* seventh chord in a post-tonal context. This pesky paradox hardens in musical examples where obviously tonal implications are hard to ignore, yet go unmentioned. For instance, melodies 4-26 and 4-27 twine through a B V7 in E and a Bb V7 of Eb respectively. An experienced listener would readily grasp these tainted pre-post-tonal gestalts, so why not comment on them, as mnemonic guides, when they have been endorsed as such earlier?

Since twentieth-century interval classes cannot be consigned a priori sonance status, they must be *contextualized* before they have meaning (as consonant or dissonant). There are twelve trichord types, each separately neutral in structural potential. They are among the emancipated aggregates of our Schoenbergian heritage.

Credibility for this position of neutrality is severely tested internally on several occasions. Three families of sonance are introduced (p. 40) in an attempt to simplify the roster of trichords one's ears might confront. These three-element collections are to be identified roughly in the hearing experience "according to *conspicuous* [my italics] interval characteristics." The families consist of (1) trichords with a minor second; (2) trichords with a major second but no minor second; and (3) trichords with neither a minor second nor a major second. These indexed generalizations provide reasonable and helpful means for sonance identification and differentiation, so it's a pity they don't resonate well with the author's sworn neutrality in such matters. Indeed, they raise the specter of—of all things—an a priori classification of sonance, one derived from non-linguistic sources. If sonance classifications from the fifteenth through the eighteenth centuries were mere linguistic rules, as per the discussion on p. 69, then how can the minor second and the major second play such pivotal roles in the aural detection of non-contextual sonority types? Indeed, it does seem strange that the octave, that most axiomatic of all axioms in the world of modulus 12, could be described as a mere remnant of an archaic linguistic convention.[2]

Similar inconsistencies hide just below the skin of discussions and exercises, where things we've been assured don't mix well are mixed. They color the introduction of the four supersets: the *diatonic*, subsuming what Friedmann calls "the major and natural minor scales and the common medieval modes" (p. 41); the *pentatonic*; the *whole-tone*; and

[2]This idea that designations of dissonance in earlier centuries were a priori absolutes and not context-bound is a specious interpretation of what was meant by the elaborate tables in theoretical tracts. Any theorist who belabors, as many pre-Baroque theorists did, such fussy categories as "perfect consonance," "imperfect consonance," "pluperfect," "imperfect dissonance," and "perfect dissonance" clearly has something less than absolutes in mind. I have no doubt that, if consulted, Tinctoris of the fifteenth and Rameau of the eighteenth century would both heartily agree with this book's *comparative* system for identifying trichords out of context—by whether they do or don't contain major or minor seconds.

the *octatonic*. Since the first two of these supersets have been hopelessly tainted by several centuries of fraternization with *centrist* music, their inclusion as crutches for learning the sounds of post-tonal configurations is at best questionable. But this is just one of the several gaps in the jerry-built fence erected here between the twentieth century and its past. In fact, the author seems unsure about just where the centrist and the non-centrist twains may (or may not) meet. His text is sprinkled with reminders that the pitches of twentieth-century music are the neutral monads of modulus 12. Q.E.D. But then he confides on page 116 that the languages of modes, centricity, and sets are really not all that irreconcilable.

Pedagogical Anamolies

A book marketed for its didactic value should meet a few requirements beyond those demanded of books for other functions. Learning is difficult. As any experienced teacher knows, it is not an automatic response to indifferent presentation. Textbooks are used principally by persons who are just forming their individual perspective of the world, not merely adding to it. This sensitive developmental facet imposes a special consideration: Narrow conceptualizations make weak supports for later development.

This is a difficult book to understand. Its problem is not format; that is derived from an effortless progression from dyads (Chapter 2) through "Sets of More Than Four Elements" (Chapter 6). Even its subdivisions, into a succession of *Definitions* and *Exercises*, make the process as obvious and user-friendly as the operatic pairings of *recitativo-aria*. The difficulty lies in the book's language, not just in its prolixity but also in its reliance on the hard-core vocabulary and syntax of set theory. The writing has a distinctly Euclidean ring to it, a special irony in view of the author's expression of concern, in his *Introduction,* for the analytical and linguistic trenches that separate musicians today. But an additional barrier is the recurring sense that definitions may be less cogent to actual listening than imagined, that many exercises are better suited for gaining conceptual fluency in a private language than in flexing auditory muscles.

In this vein, Exercise 3.1 is a tedious exercise in keeping track of numbers rather than in recalling and imaging pitches; the exercises dealing with contour class and its derivatives swerve off into the slow lane of abstract rubrics. There is arguable relevancy for a listener in knowing that the fourth pitch of a melody is 3 in a <1-4-5-3-0-2-7-6> contour class relationship, as one learns to learn on page 34. These are clusters of knowing that, although reeking of precision and irrefutable "truths," soar way beyond the decoding of sensory cues.

Exercise 3.19 is challenging fun for two skilled old pros in improvisation, but it pits *hearer* against *heard* in a disturbing way because it deals only with *contour* classes. In fact, the barrier to be vaulted in this exercise is that of avoiding actual pitch matches between heard line and improvised response. Other exercises demand operations that are redundant or beside the point, in view of presumed previous understandings and skills.

Exercise 4.1 asks students who have heard a trichord to first name pitch class numbers; then identify the three pitch intervals contained in the collection; and finally to "assess the unordered pitch class intervals represented by these three pitch intervals [heard in the trichord]" (p. 40). The charge of excessive emphasis on conceptual doctrine seems all the more warranted when we observe something of the processes entailed. If a listener can do steps #1 and #2, then the need for delving into unordered pc intervals seems specious. If I hear collection *c' a' c#''* and I can identify its components by names (or notational symbols), and interval names, all else bears shaky relevance to my hearing comprehension.

Some exercises conceal snags that probably weren't anticipated. For instance, a particular trichord is to be identified by the superset to which it belongs. But this misleads novice readers into believing that every trichord will therefore belong to only one of the defined supersets, which is not true. Still, the text makes clear that "a trichord that is a subset of the octatonic mode will be referred to as an 'octatonic trichord,' a trichord that is a subset of the diatonic mode as a 'diatonic trichord,' and so on" (p. 42). So students may be distressed to find that some trichords belong to more than one superset. Trichord *Eb D F* [0,1,3], for instance, belongs to both diatonic and octatonic supersets. This presents some discomfort for the student, who, upon hearing such combinations, must go through the additional process of choosing between one or the other for a "correct" answer.

Even keyboard exercises project an aura of dull musical irrelevance. In its barebones simplicity, Exercise 4.17 is reminiscent of what we used to endure at the keyboard in our grapplings with the manifold permutations of I-IV-V-I. But the harmonic templates provided are, alas, even less conducive to realizations of musical sentiments. One is shown in Example 6. Even strict behavioral rules are imposed, making the déjà vu all the more piquant. For this set of exercises, one must 1) not move any voice more than ip (2) in any succession, 2) avoid crossed voices, 3) observing rules 1 and 2, keep one common pitch,

EXAMPLE 6. Keyboard improvisation on trichords (Friedmann p. 55, Ex. 4.13d)

and 4) observing the three previous rules, retain when possible two common pitches between voice movements.

The book's pedagogical inconsistencies, contradictions, and nonsequiturs arise in part, I believe, from the inherent tensions imposed by its title—its acknowledged subject matter—and what the book is in fact really about. The musical repertoire, the heuristic content and processes, and the thorny language of the six chapters and their ancillary pages provide clues that ear training is perhaps more vehicle than destination, that the book's core issue is the development of fluency in the language of *Setspeak.*

Exercises such as 5.11b support this conclusion. Students are asked to listen to a four-measure excerpt;[3] then to write down the series of pitch intervals within the first two measures; and then to identify the transformational operations that relate the two pairs of segments. But if students can identify the intervals present, why aren't they merely required to write down the pitches themselves? The transformational derivation of the pairs of segments was of more concern for the composer than it will be for his listener, reminding us of Schoenberg's injunction to his brother-in-law Rudolf Kolisch that, given a musical statement, one should be concerned with "What it is," rather than with "How it was made."[4]

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[3]Schoenberg, *String Quartet No. 3*, II, mm. 92-95. Measures 92-93 are given in Example 2.

[4]Arnold Schoenberg, *Letters*, ed. Erwin Stein and trans. Eithne Wilkins and Ernst Kaiser (London: Faber and Faber, 1964), 164. Letter to Rudolf Kolisch, 27 July 1932: "You have rightly worked out the series in my string quartet [Third String Quartet]. . . . But do you think one's any better off for knowing it? . . . I can't utter too many warnings against overrating these analyses, since after all they only lead to what I have always been dead against: seeing how it is *done*; whereas I have always helped people to see: what it *is*!"

Other exercises reinforce, in their own ways, the same conclusion. Even the catch-all approach to tetrachordal identifications implies that system and nomenclature are the tails wagging this pedagogical dog. Each new tetrachord is to be compared with no fewer than seven potential rubrics: tetrachordal number (Forte number), unordered pc content, interval vector, trichord subset content, sonance family (i.e., presence or absence of ic 1 or ic 2), whole-tone group, and, finally, any other appropriate subsets such as "diatonic" or "octatonic" (see the discussion above about diatonic and octatonic trichords). Then later, in Chapter 6, with an introductory discussion of the "important and relatively easy to recognize" (p. 104) seven-pc sets, sixteen set paradigms are exposed, including the eleven "important ones" introduced earlier. Some of these are given names that test one's sense of ontological propriety, such as "nearly octatonic' septad, "almost whole-tone" septad, and the "diminished seventh plus one" pentad (pp. 107-108). But names seem trivial when we realize that this is a smothering by riches, teaching in which categorizing the bouquet replaces smelling the roses.

In closing this regrettably negative review, let us observe that our little opening dialogue reveals as much by what *is not* said about Maestro Høering's music as by what *is*. The super-listeners of our make-believe conversation report nothing about the timbral, loudness, rhythmic, nor textural properties of what they have just heard, implicitly pointing a finger at one of the limitations of descriptive analytics conventionally derived from set theory. *Ear Training for Twentieth-Century Music* perpetuates this sin of omission. It is inconceivable that a course focused on the aural interception of twentieth-century music could ignore the peculiarities and pitfalls of rhythm that inhabit the repertoire. At one point we read that "music segments are structures delineated by contour, register, rhythm, and set class characteristics" (p. 69). The last one is very important to Friedmann. But one of them—the one without which the other three cannot exist—plays not even a supporting role in this unfolding drama.

The book comes by its flaws naturally. Its problems are but tributaries of a fissure that has deepened in academic considerations of music over the past forty years. Music is approached as a conglomerate of profoundly intricate parts, parts not readily apprehended nor explained yet which are held to be crucial to adequate comprehension. In this perspective, ties that bind are sought mainly in sources that can be demonstrated as operational causes: The listener somehow must retrace each step of the composer's creative process. The analyst's searches are guided by an established doctrine, whether one based on *pre-* or *post-* or *whatever-* tonal strictures. And thus what Friedmann thinks of as "precise articulation[s] of structural relations" becomes the bottom line "precondition for understanding affective content and gesture."

This academic infatuation for arcane interpretation, for complexity in the face of yawning simplicities, is not new. Bernard Shaw satirized another outcropping of the same quaint foible in his *Caesar and Cleopatra*. At the beginning of Act IV, Cleopatra approaches the local musical pundit, "the old musician," to ask if he can teach her to play the harp. Assured by him that he's uniquely suited to the task, that indeed "all the other teachers are quacks," she asks: "How long will it take?"

> *Musician*: . . .only four years. Your Majesty must first become proficient in the philosophy of Pythagoras.
>
> *Cleopatra*: Has she [indicating the slave who as they speak plays the harp] become proficient in the philosophy of Pythagoras?
>
> *Musician*: Oh, but she is but a slave. She learns as a dog learns.

Hearing this, the Empress lets the old musician know that, since the slave girl plays better than he does, she prefers a mongrel pedagogy. She adds emphatically that he will teach her, and that furthermore,

> whenever I strike a false note you shall be flogged; and if I strike so many that there is not time to flog you, you shall be thrown into the Nile to feed the crocodiles.

Their dialogue ends with the old musician, shocked by this impudent demand for educational accountability, saying:"But true art will not be thus forced."[5]

[5]Bernard Shaw, *Caesar and Cleopatra* (New York: Brentano's, 1906), 77-78.

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With instructor's manual. An anthology of 117 complete short pieces or movements by 60 composers (Sweelinck to Duke Ellington, emphasizing Bach, Beethoven, hymns, and nineteenth-century American popular songs). To be used for basic harmony courses. Some commentary in the text; the instructor's manual provides more background, discussion questions, and indexes.

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An introduction to Schenkerian concepts, combining harmonization exercises, singing and keyboard work, and musical passages for analysis. Part One: 3-chord groupings; Part Two: 4-chord groupings (including chromaticism); Part Three: Harmonizing Melodies; Part Four: Pedagogical Applications.

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Designed more for music literature and history classes (upper-level undergraduate and graduate) but also presents a descriptive analytical format based on nine elements (such as texture, sound color, and time). Part I traces precedents and influences up to 1945; Part II focuses on works from 1945 to around 1970 (including new aesthetic and technological approaches); and Part III discusses more recent developments (such as new views of performance, minimalism, and computer and digital systems). Pieces for study are discussed at the ends of chapters. Additional sections include notational information, an extensive bibliography, and a discography.

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A small anthology of 102 short musical excerpts by nineteen composers, representing women from the seventeenth through the

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