THE ANALYSIS AND COGNITION OF MELODIC COMPLEXITY

THE IMPLICATION-REALIZATION MODEL

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Preface

This book and its predecessor explore a surprising idea: that a cognitive "genetic code" enables both naive and experienced listeners to comprehend the entire world of melody (see Narmour 1989). This code governs (1) complete prospective realizations of melodic implication, which cognitively generate three simple archetypal structures; (2) partial realizations of these, which produce five archetypal derivatives; (3) retrospective realizations and denials of implication, which double the number of archetypal and derivative structures; and (4) the contextual sharing of intervals between all these various types, which geometrically increases both the number and the complexity of the available structures.

An earlier book, *The Analysis and Cognition of Basic Melodic Structures* (Narmour 1990), explicated and encoded the archetypes of process [P], duplication [D], and reversal [R] as well as their partial realizations—the derivatives of intervallic process [IP], registral process [VP], intervallic duplication [ID], intervallic reversal [IR], and registral reversal [VR]. Retrospective analogues to these also exist. A discussion of exact and near registral returns [aba, aba^1], dyadic structures [1, 2, 3, etc., symbolized according to the size of the interval], and monads [M] completed the survey of basic structures in that work.

Building on the theory of the first book, parts 1 and 2 of *The Analysis and Cognition of Melodic Complexity* first show how unclosed harmonic-metric contexts allow these discrete structures to combine in a finite number of complex patterns (some 200 in number). Given this possibility, part 3 then demonstrates how the basic archetypes can chain together in a theoretically infinite number of ways. Parts 1–3 also attempt to explain how listeners cognitively assimilate all these complex melodic structures; how parameters such as harmony, duration, and meter interact to produce transformational melodic closure; how intra- and extraopus style, tessitura, and level feedback obtrude in our perception of prospective and retrospective implication; and how different kinds of structures overlap and cause complex networks of realizations, enriching the inherent aesthetic syntax of melody.

Part 4 examines the role of articulative, formational, and transformational dissonance in the structuring of melody; the hierarchical tangling produced by simultaneous kinds of different structuring; the embodiment of registral direc-

tion in the structural implication of higher levels; and the phenomenon of "missing" melodic structural tones in higher-level structural voice leading.

The last three chapters explore time-tagged, discontiguous realization, informally explicate some general principles governing grouping, examine the top-down influence of modeled repetition on melodic structure, discuss the necessary methodology for discovering structural melodic strings, and speculate about how listeners cognitively encode melody from the bottom up.

On numerous occasions, I also discuss the emergence of structural hierarchies, including how higher-level transforms influence lower-level structures (feedback), and vice versa (feedforward). But, like the first book, the present volume concerns itself mostly with note-to-note relations. The full treatment of melodic hierarchies and the analysis of higher-level combining and chaining await a third book.

It should be emphasized that learned style structures do not theoretically bind the constants espoused here to govern melodic implication and realization. That is, the implication-realization model does not depend solely on the conditioned learning of musical isomorphs for its theoretical foundations. Indeed, the claim herein is that the bottom-up constants of the theory per se make possible the differentiated perception of all melodies ever written, regardless of stylistic provenance. The reader will thus find in this book not only analyses of tonal melodies written between the seventeenth and the nineteenth centuries but also analyses of "nontonal" melodies written in the last hundred years (e.g., melodies of Schoenberg, Webern, Berg, Varèse, Bartók, Penderecki, Boulez, Crumb, Subotnick, and Wernick). In addition, two appendixes illustrate how the implication-realization model might apply to medieval and Renaissance melodies (app. 3) and to melodies from other cultures (app. 4).

I say "might apply" because, although the constants of the theory are indeed independent of style and thus enable one to analyze any sequence of melodic pitch, one can never adequately explain melodic perception without a firm knowledge of the top-down structures and the bottom-up materials of a melody's style. For this reason, the implication-realization model requires that analysts defend their invocation of style with reference to the rules governing the ascription of the analytical symbols. Such required stylistic representations should ultimately produce a deeper understanding of style's effect on the cognition and perception of melody.

Although I base the 435 analyses here on the psychological principles discussed in the first volume, readers will find the present work more analytical (and thus less theoretical) than its predecessor. Indeed, in order adequately to survey the number of structures that exist, parts 1 and 2 are necessarily somewhat taxonomic and thus partly descriptive—although chapters 2–7 also explore the methodology and the implicit conclusions of the theory and also offer

some critical analyses of melodic idiostructures. Only the discussions of chaining (chaps. 8–10) and structural dissonance (chap. 11) hypothesize theories not found in the first book.

In a book so seemingly given over to analysis and symbolic generalization, the question arises as to what the implication-realization model accomplishes. Since the theory distinguishes bottom-up perception (which rationalistically operates on parametric primitives) from top-down cognition (whose empirical invocation relies on stylistic conformance), it treats musical parameters as separate entities. The need for rules of correspondence leads to a formalized analytical method not only for parsing melodic structures on low levels but for determining how structural tones emerge on higher levels as well, which will be of considerable interest to systematic music theorists. The separate-parameter approach also entails structural concepts of formation and deformation, which make the theory diachronically operational, with all that promises for historical musicology.

Although the theory keeps perceptual structures separate from compositional structures, it has the power vis-à-vis perception to illuminate compositional strategies in all melodic styles.[1] This is possible because, even though the analytical symbology is conceptually simple, the bottom-up/top-down outlook allied with the separate-parameter approach makes possible fine-grained analytical criticism. At the same time, since the theory models experienced listeners' performance (as opposed to their competence), it offers a rigorous way to study style's effect on musical comprehension. Indeed, for those interested in style studies, the theory's symbology provides an economical way to keep tabs on large numbers of melodies.

Although the book is highly analytical, numerous issues in psychology crop up throughout, particularly in the last two parts (chaps. 11–14). Chapter 12, for instance, raises questions concerning how long melodic implications last and what kinds of contexts prevent listeners from construing discontiguous realizations. The same chapter also explains the continuing compositional popularity of the appoggiatura and the turn (∾) as a melodic consequence of increasing both perceptual "conflict" and cognitive "load." Chapter 13 on grouping treats the "forgetting" of implication and discusses how "startover" functions determine syntactic connections. Finally, chapter 14 gives a detailed picture of how the theory accounts for bottom-up cognitive encoding. Thus, despite the ostensible emphasis on analysis in parts 1–3, much of the book still addresses the immediate concerns of researchers in the cognition and perception of music. Indeed, as in *The Analysis and Cognition of Basic Melodic Structures*, implicit

1. The theory informs compositional planning only to the extent that such structuring is congruent with perception and cognition.

in the discussion are many hypotheses for psychological experiment. It may be noted in this connection that some preliminary psychological evidence supporting the implication-realization model is already in.[2]

For the uninitiated, the first chapter summarizes the theory of the earlier volume while introducing the basic discrete structures. As in the first book, an appendix (app. 1) formally enumerates the theoretical-analytical rules (theorists who have not read the first book may wish to peruse this synopsis before proceeding with the text proper). In addition, the back matter displays a complete glossary of the analytical symbols (app. 2), which should help the reader absorb the theory. Another appendix (app. 5) catalogs the primary and derivative archetypes and illustrates all the various possible combinational structures. For those wishing more background, numerous footnotes refer to relevant discussions in the first book. To assist the reader further, I have been liberal throughout with subheadings and chapter summaries. Finally, to aid those unfamiliar with *The Analysis and Cognition of Basic Melodic Structures*, a dictionary-style key at the bottom of each page from chapter 2 onward keeps the nomenclature of the main symbols in focus.

I wish to thank the graduate students enrolled in my seminars at the University of Pennsylvania for their help. Over many semesters, various classes suffered through numerous versions of this book. Through it all, these future scholars maintained their patience and offered useful criticisms and helpful suggestions for improving the presentation of the theory. They also collected many of the examples in this and the previous book. For these and the illuminating classroom discussions, I am permanently in their debt.

I also wish to express gratitude and affection to my wife, Kathy, to whom the dedication properly belongs. Simply put, without her I could never have finished either this or the previous volume.

2. See Krumhansl (1991), Krumhansl and Schellenberg (1990), and Schellenberg and Krumhansl (1991). The trials for these experiments used tonal music, atonal music, and Chinese music, provisionally raising the possibility that the universal claims of the theory are correct.

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1

The Basic Theory of Melodic Implication and Realization

The Three Hypotheses

For those unfamiliar with *The Analysis and Cognition of Basic Melodic Structures*, I herewith introduce the theory of melodic implication and realization.[1]

Three basic theoretical constants constitute the implication-realization model: that A + A implies A (i.e., that sameness or similarity causes the subconscious expectation of more sameness or similarity, all other things being equal); that A + B implies C (i.e., that differentiation causes the expectation of further differentiation); and that the definition and evaluation of these two hypotheses in both cognition and musical analysis depend on syntactic parametric scales (i.e., on gradated, innate cognitive input systems).

Symbological letters can refer to single parametric elements (a + a, a + b; e.g., to individual pitches or itemized durations); they can refer to isolated parametric shapes (A + A, A + B; e.g., to registral directions, melodic intervals, or durational patterns); or they can refer to musical forms (*A* + *A* or *A* + *B*; e.g., to repeated or differentiated units). Since the move from element (a) to shape (A) to form (*A*) progresses hierarchically, implication and realization on any one level have the potential to conflict with implication and realization on any other level. This is what makes music cognitively and analytically interesting—and the theoretical explanation of it extremely difficult.

The Five Primary Archetypes

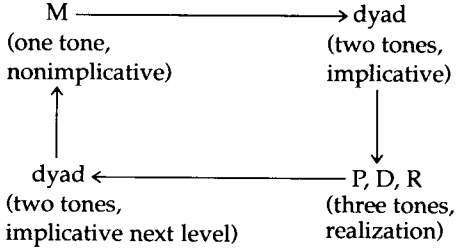
From the fundamental hypotheses A + A → A and A + B → C (→ = implies) and the syntactic parametric scales, I derive five and only five melodic archetypes:

1. process or iteration, whose intervallic and registral relations are A + A; symbolized P or D (P = process, D = duplication, i.e., iteration);
2. reversal, whose intervallic and registral relations are A + B; symbolized R;

1. The *Analysis and Cognition of Basic Melodic Structures* (Narmour 1990) is referred to in the notes as *ACBMS*. Narmour (1989a) contains a brief summary of the theory.

3. exact or near registral return (discontiguous pitch relations); symbolized aba or aba[1];
4. dyad (two-element groupings denying implication); symbolized with numbers representing the relative size of the denied interval (e.g., 2 = major or minor second; 5 = perfect fifth, diminished fifth, or augmented fifth; etc.); and
5. monad (one-element groupings generating no implications); symbolized M.[2]

Both the initial tone and the terminal tone of a closed process [P], a closed duplication [D], or a closed reversal [R] function as structural tones, potentially making a dyad on level 2. Since either the initial note or the terminal note of any dyad is the structural tone, potentially making a monad [M] on level 3, hierarchical production in the implication-realization model thus typically advances from P, D, or R to dyad and then from dyad to monad [M].[3] More formally, rules of production proceed recursively from one-note to two-note to three- or more-note groupings and then back again:



The fundamental importance of this recursive production scheme will become clearer once we encounter the analyses.

Process [P] and Duplication [D]

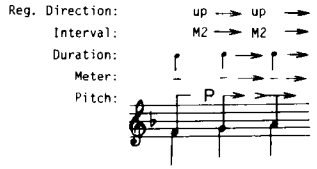
The registral direction and intervallic motion of *process* (and *duplication*) sit under the control of the bottom-up Gestalt laws—laws governing common direction (= common fate), similarity, and proximity or some combination of these.[4] The ascending F-G-A pattern in example 1.1, for instance, creates a pro-

2. *ACBMS* discusses every structure in this introduction, devoting a separate chapter to each.

3. For the psychological evidence for treating the initial and terminal notes of syntactic structures as transformations creating a new level, see chap. 5 of *ACBMS*.

4. The Gestalt term *common fate* signifies a retrospective visual analysis, where one understands the direction of a line after one perceives it. Throughout this book, I translate the term *common fate* into *common direction* since in the implication-realization model I argue that listeners prospectively project melodic lines before actually perceiving them. For a fuller discussion of how the model treats Gestalt laws of pattern perception, see chap. 4 of *ACBMS*.

cess [P] exemplifying the bottom-up Gestalt laws (1) because registral direction continues (up/up = A + A), (2) because the intervals constituting the pattern are similar (M2 + M2 = A + A), and (3) because the pitches lie relatively close together (with reference to the diatonic collection of tones). As the arrows illustrate, G-A is open and ongoing and thus also functions to continue the process [P]. That is, the pitch A "catches the arrow" of F-G's implication (note the tail), but, in turn, the realization of F-G-A further implies a continuation to, say, B♭ in the diatonic system, B in the whole-tone system, or C in the pentatonic system (note the arrow after the tail, symbolizing nonclosure). One would say essentially the same of a duplicative pattern [D] like C-C-C whose repeated intervals, lateral registral direction, and repeated pitches imply continuing replication (all other things being equal).

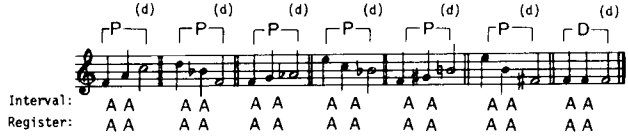


Ex. 1.1.

Observe that, although I symbolize the pattern of example 1.1 with the symbolic token P (for process), a complex set of relations symbolized by the various arrows of each parameter lies behind the symbol—relations we must always remember in interpreting such a simplified symbological analysis of melody.

For example, in addition to registral direction, intervallic motion, and pitch, the process [P] of example 1.1 also specifies both length of realization and metric location: a quarter note plus a quarter note implies another note at least as long as a quarter note, and the two events on metric beats imply that a third one occur at least on the level of the tactus. That music listeners expect not only "what" in terms of pitch, intervallic motion, and registral direction but also "where" in terms of durational length and metric location determines, as we shall see, whether, and the extent to which, a subsequent event fulfills the numerous implied conditions of realization.[5] Since pitch cannot occur without duration, it is the length/location property of melodic implication that makes possible the hierarchical embedding of structures. For structures occurring before the implied temporal location and encapsulated within an initially implied duration create lower levels of realization.

5. As Jones (1981a) points out, listeners' expectations of events involve temporal properties without which one would never experience earliness or lateness of events (see also Jones 1981b).



Ex. 1.2.

To make the Gestalt laws operational in the bottom-up sense, I define intervallic similarity (A + A) when continuation of registral direction occurs as any two adjacent intervals differing by a minor third or less.[6] Common direction (or common fate) in registral motion obviously defines itself: up followed by up (C-D-E), down by down (E-D-C), and lateral by lateral (C-C-C). Example 1.2 illustrates a few patterns satisfying the intervallic and registral definitions of process [P] and duplication [D] (the small letter d in parentheses over the bracket interfaces refers to durational cumulation, i.e., to a short note moving closurally to a long note; observe that, in both registral direction and intervallic motion, A + A relations of similarity obtain).

Registral Return [aba]

Another independent structure, *registral return*, also functions in accordance with the bottom-up Gestalt laws. Registral return is a discontiguous relation. In an up/down pitch pattern like C-E-B, for example, the discontiguous terminal pitch B lies proximate to the initial C, creating a pattern of *near* registral return (symbolized aba^1), discontiguous nearness of pitch defined as being no greater than a major second away from the initial, modeling pitch.[7] Unlike the ongoing, nonclosural quality of P and D, aba^1 portends closure (whether articulative, and thus remaining wholly on the level of its occurrence; or formational, and thus striving for, but not reaching, a new hierarchical level; or transformational, and thus belonging to a new structural level).

Common instances of *exact* registral return (symbolized aba) are neighboring tones (e.g., C-D-C) and melodic patterns involving larger intervals, like up/down or down/up configurations of C-G-C (P5, P4). The difference between the initial tone and the discontiguous terminal tone in exact registral return [aba] is a unison. We shall examine musical cases of near and exact registral return shortly.

6. The invocation of bottom-up Gestalt laws, which can be formalized, circumvents the top-down problem of defining "good" and "best" continuation that has plagued Gestalt theory since its inception.

7. Because near registral return can extend over many notes (e.g., aba^{1}b^{1}a^{2}b^{2}a^{3}b^3 . . .), I use Arabic superscripts to denote near registral return instead of primes since numbers take up less space on the analysis and are easier to draw.

Reversal [R]

In contrast to process [P], duplication [D], and near or exact registral return [aba^1, aba], which are governed by bottom-up Gestalt laws, the theory also hypothesizes realizations of *reversal* [R] of implication. Theoretically, reversal [R] is a symmetric construct, having intervallic and registral properties that are the opposite of process [P] and duplication [D]. The up/down chimes of G-E-C (the NBC logo, originally signifying the General Electric Corp.) illustrate a typical melodic reversal structure [R]. In realization of reversal, differentiation of both intervallic motion and registral direction occurs (in the NBC chimes, intervallic relations are M6 + M3 = A + B, while registral direction is up/down = A + B). Note that, in reversal [R], interval moves from large to small.

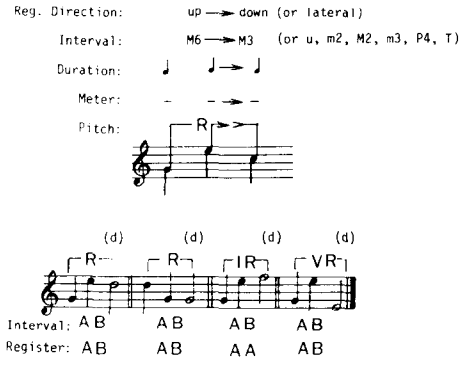
I define intervallic differentiation (A + B) when register changes direction as a minor third or more.[8] Registral differentiation (A + B), of course, defines itself since registral direction either changes or continues.

Reversal [R] is the functional opposite of process [P] and duplication [D] in that, like exact and near registral return [aba, aba^1], it creates some degree of melodic closure (whether articulative, formational, or transformational). The NBC logo works well as an aural trademark precisely because, as a large ascending interval moving to a small descending one, the reversal structure it produces functions as a closed, and thus highly memorable, unit.

As with ongoing implications of continuation [P, D], reversal implications [R] specify registral direction and intervallic motion: descent or lateral motion should follow ascending leaps, and ascent or lateral motion should follow descending leaps. In addition, differentiation (A + B) must characterize the smaller interval following the large leap. Example 1.3 shows three reversal structures with differing degrees of intervallic differentiation (in G-E-C the difference is a perfect fourth, whereas in G-E-D and D-G-G it is a perfect fifth).

The arrows in the synthetic case at the top of the example again remind us that what lies behind the analytical ascription of any R symbol is a complex set of implied registral, intervallic, durational, and metric specifications. Note that C "catches" the implication of the leap of G-E, but, owing to the function of closure, no arrow appears after the tail. Observe also about the D-G-G (down/lateral) that a melodic unison qualifies as an intervallic and registral realization of a reversal implication (the symbols IR and VR remain to be discussed). Fi-

8. As the reader shall see, a slight variation exists in definition between intervallic differentiation when registral direction continues (M3 or more = A + B) and when it changes direction (m3 or more = A + B). The reason for this is that registral change itself adds a modicum of differentiation. Hence, the amount of intervallic differentiation needed when register changes direction is slightly less. *ACBMS* discusses this in detail.



Ex. 1.3.

nally, note that differentiation (A + B) characterizes both the intervallic motion and the registral direction of reversal [R].

Although not currently recognized as a perceptual constant in cognitive psychology, it is my belief that psychologists will eventually discover the general concept of syntactic reversal to be a fundamental cognitive principle of all temporal pattern perception—equal to the bottom-up Gestalt laws of similarity, proximity, and common direction (= common fate).[9]

The Application of the Gestalt Laws

The invocation of bottom-up Gestalt laws as incarnations of process [P], duplication [D], and registral return [aba] in the implication-realization model needs a little explanation. Historically, psychologists once conceived of Gestalt laws as organizing stimuli from the top down, from predetermined, presumably innate wholes. As is now well known, this approach, relying on notions of "good" continuation, "good" completion, and the like, carries with it a host of epistemological and methodological problems.[10] To avoid these, I here invoke the Gestalt laws of common direction, similarity, and proximity as hypotheses from the bottom up—operating on pitch elements, registral directions (up, down, lateral), and intervallic motions. In other words, I eschew outright all top-down notions of learned "goodness" as constants, adopting only bottom-up Gestalt principles that are formalizable.

To explain: with reference to process [P] and duplication [D], I conceive of

9. When psychologists employ the word *reversal* in the understanding of the arts, it is usually in the metamotivational or synergistic sense of hypothesizing the existence of opposite pairs of cognitive states (see Apter 1984).

10. Chapter 4 of *ACBMS* reviews these problems. See also Narmour (1977). The designation of common direction (= common fate), proximity, and similarity as bottom-up aspects of Gestalt theory is not new (see Pomerantz 1981).

bottom-up Gestalt laws parametrically and implicatively, which is to say, nonclosurally with reference to intervallic and registral motion (instead of closurally in terms of some preexistent whole). C-D-E could imply F♯, and a realization of C-D-E-F♯ could imply G♯—and so on, with no predefined ending (a whole-tone scale generated from such an initial pattern could, after all, continue replicating beyond the range of human hearing). Likewise, the same C-D-E could imply F (diatonic system) or G (pentatonic). Thus, in the implication-realization model, the Gestalt laws constitute a set of *bottom-up* rules determining nonclosure. Hence, the application of these rules does not depend on any prior outcome, on any preordained learned, *top-down* form, which is to say, on any prior Gestalt.

As we shall see, the application of bottom-up Gestalt laws to the separate variables of pitch, intervallic motion, and registral direction leads to the perceptual possibility of partial realizations within the parameter of melodic implication. For instance, an ascending pattern of C-D-B (M2 + M6) realizes the implied registral direction of C-D (up is followed by up) but not the implied intervallic motion: large differentiatedly follows small (M2 − M6 = A + B, a difference of a P5), which extends beyond the model's rule for intervallic similarity (where A + A is defined as a plus/minus minor third or less). The leap of the major sixth in this relation also violates the continuation of specific pitch (i.e., E♭, E♮, F, F♯, or G could have followed C-D as a similar intervallic realization, whereas A♭, A♮, B♭, or B♮ could not have).

Likewise, the up/down pattern of C-D-C realizes intervallic implication (M2 followed by M2 = A + A) but not the implied registral direction (down/up = A + B). Moreover, instead of the implied ascending registral continuation to E♭, E♮, F, F♯, or G, exact registral return [aba] to C follows the initial C-D.

The Problem of Style

The three hypothetical constants of the implication-realization model—A + A implying A, A + B implying C, and the syntactic parametric scales—are context free. Consequently, the theory will analyze (and thus partly explain) all melodies ever written or to be written, regardless of stylistic origin.[11] What this surprising assertion means is that the hypotheses of the theory operate independently of any specific style structures, of any learned, replicated complexes of syntactic relations. Instead, the hypotheses of the model deal with style materials—with the syntactic primitives of learned simplex elements (pitches, durations, chords) and with the stylistic shapes (intervals, patterns, abstract progressions) characterizing and instantiating the individual parameters of the music in question.

11. I say "partly" because any full explanation always involves a discussion of style.

Contrary to current opinion in musicology and music theory, style structures are an extremely problematic source from which to divine the constants of a cognitive theory of melodic implication (though perhaps less problematic as a source from which to formulate nonperceptual theories of music). For the definition of style's domain is too variable to enable the discovery of consistent cognitive rules of analysis. Moreover, since structural representations of style in the mind of the listener constantly undergo change (formation, deformation, transformation), their inherently variable instability prevents in principle the use of top-down learning as an analytical constant from which to construct a convincing cognitive theory of melodic implication. For each listener possesses a different style knowledge, a unique set of cognitive style structures. Although all experienced listeners share style knowledge to some extent, it is not tenable to posit that any one cultural segment of that shared knowledge represents a perceptual whole. Just as there is no such philosophical thing as *a* language, so there is no such cognitive thing as *a* style.[12] In short, the notion of an "ideal" listener with an "ideal" structural knowledge of any given style is hopelessly rationalistic in terms of determining the real-time operational constants governing perceptual implication and realization in melody.

From a theoretical point of view, since within any given style one can find almost any sort of melodic continuation to follow any sort of specific initial pattern, the realization of the pattern being analyzed usually ends up being the evidence for the analysis of the implication itself.[13] Analysts with scores in hand typically look ahead to make sure such and such take place and then retrodictively argue that such and such was implied all along. De jure and de facto become incestuous. A priori and a posteriori cohabit.

In sum, because music theorists all too often invoke implication from prior stylistic knowledge of realization, analytical encoding of implication and realization runs the risk of circularly reinforcing the very conclusions that it sought to critique. This is why, in constructing a perceptual theory of implication and realization, music theorists must rely on psychology rather than on an a priori knowledge of style structures to formulate the theoretical constants of melodic perception.[14]

The Two Aspects of Style: Simultaneous Top Down and Bottom Up

Problematic though style may be as a source for formulating constants in a perceptual theory of melody, it nevertheless exists indisputably as an empirical and phenomenological fact. Every theoretical model of music must come to

12. See Davidson (1986), quoted and discussed in Rorty (1989, 15).

13. For the full arguments, consult chaps. 2–4 of *ACBMS*.

14. For detailed arguments on why using style as a constant in a theory of perceptual implication is problematic, perhaps even futile, see chaps. 2–3 of *ACBMS*.