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Leonard Meyer's Theory of Musical Style, from Pragmatism to Information Theory

ABSTRACT Despite its ubiquity in both academic and popular discourses on music, the concept of musical style last received in-depth scholarly treatment three decades ago, in music theorist Leonard Meyer's final book, *Style and Music* of 1989. Meyer's text remains widely cited today, but its date obscures the even earlier origins of its central concerns in Meyer's work of the 1950s and '60s. Indeed, Meyer developed his most enduring ideas amidst an array of momentous intellectual changes, not least of which were the rise (and fall) of information theory and cybernetics, and the transition from behaviorist to cognitive psychology, both of which impacted his work and legacy in lasting ways.

While Meyer's general understanding of musical style remained largely consistent across his career, this essay examines a series of subtle shifts in the details of his conception as his intellectual focus shifted from pragmatist philosophy to a wholesale engagement with information theory to, eventually, cognitive psychology. Meyer's most important early influences were American pragmatists like John Dewey and Morris R. Cohen, but already by 1957 he argued for a continuity between the mathematical structure of Markov chains and the pragmatist theories of meaning and emotional response on which his famous *Emotion and Meaning in Music* (1956) was based. While explicit mention of information theory soon dropped out of his writings, I show how information and computation continue to resonate throughout his later works and, thus, how they live on in current music-theoretical notions of style. KEYWORDS information theory, cybernetics, style, pragmatism, Leonard B. Meyer

One of the most influential music scholars of the postwar period, Leonard Meyer resists easy intellectual categorization. While perhaps best known for his first book, *Emotion and Meaning in Music* (henceforth EMM), he is also largely responsible for the now-thriving music-theoretical subfield concerned with the study of partimenti and, more generally, the musical "schema," the Gestalt-like figure that is at once an object of cognition and of musical material.[1] But his career began in an intellectual climate that did not confine these topics to the label of "music cognition," with which they are most widely associated today, in part because that discipline did not yet exist. Meyer's PhD was in the "History of Culture," and even as he came to identify more explicitly with the emerging field of cognitive psychology, his citations always ranged widely across the humanities and sciences. This breadth of thought presents a challenge for engaging closely with Meyer's work, and his ideas have arguably been most influential when they have inspired scholars to pursue related questions in narrower disciplinary terms that cast aside many of Meyer's more eclectic commitments. And while Meyer's penchant for synthesizing disparate intellectual strains was surely impressive, this is not to suggest that his thought escaped the challenges of what would now be called "interdisciplinarity"; as Naomi Cumming

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notes in her landmark study of Meyer's early work, "his appropriation of [his sources] is . . . unsystematic. The texts used are not related to the wider context of their authors' thought," and "as psychological theories they are outdated" by the time of Meyer's writing.[2]

This article takes up Cumming's observation as something of a theme, not with the aim either of tearing down Meyer's work or of building a cohesive system out of its sometimes incompatible parts, but as a means of demonstrating lines of influence that continue to shape musical thought today precisely because of their unsystematic and at times unrecognized presence. I focus in particular on Meyer's engagement with information theory and cybernetics, which begins in earnest with the 1957 essay, "Meaning in Music and Information Theory."[3] On the one hand, it seems natural to consider information theory as part of Meyer's legacy given his importance for the broader field of music psychology, and especially for computational corpus studies, both of which involve the use of statistical analysis.[4] But on the other hand, work in these areas rarely, if ever, makes more than passing reference to Meyer's writings engaging with information and cybernetics, despite the fact that those writings are more or less contemporaneous with his still widely cited first book. His actual engagement with information theory and related trends is, rather, buried under his later, more disciplinarily coherent image as a cognitive psychologist of music. I suggest that there is much to be gained from taking a new look at Meyer's early intellectual trajectory, not only as a point of interest in the recent history of music theory but also as the starting point for a critical account of more recent computational practices.

Understanding Meyer's engagement with information theory and cybernetics, however, requires one step further back into his intellectual formation, because his turn to these technical discourses followed closely from his earlier commitments to the American pragmatist philosophical tradition.[5] Meyer's adoption of information theory is, at its core, based on a specific analogy between a pragmatist conception of "meaning" and the information-theoretic concept of entropy; but that analogy's origins and its trajectory in his later thought are only fully intelligible with reference to an earlier series of disciplinary encounters (and misreadings) between music and pragmatism. Meyer's case is thus instructive as an episode in midcentury intellectual history because it shows information theory and cybernetics tipping an unstable disciplinary balance (and nascent conceptions of musical meaning and signification) that could well have gone in a different direction.[6]

I thus begin by outlining Meyer's early positions on emotion and meaning, the titular terms from EMM, which was his last major publication prior to his direct engagement with information theory. The discussion throughout is further focused by way of careful attention to the implications of Meyer's intellectual development for his understanding of the concept of style. Style is a key term here for several interconnected reasons. First, it is a topic of continuous, intense interest across his career, even as other terms change around it.[7] Indeed, to give in to a temptation to think somewhat teleologically, Meyer's final book, 1989's *Style and Music*, represents something of a culmination of various strands in his thought. The definition that opens the first chapter of that book is deceptively simple:

"Style is a replication of patterning, whether in human behavior or in the artifacts produced by human behavior, that results from a series of choices made within some set of constraints."[8] But, as I will argue, it is shot through with information theory, all the more significantly for its evasion of specific references to it. *Style and Music* also warrants consideration because it, like the concept of style itself, is notably under-studied in music scholarship of the past three decades, despite being cited relatively frequently.[9] A fuller consideration would require examining Meyer's interdisciplinary citations more broadly, with particular attention to his adaptation of previous humanistic approaches to style, but this article aims only to present one component of this larger project. I will return to *Style and Music* after examining Meyer's early intellectual influences in EMM and his turn to information theory in *Music, the Arts, and Ideas* (henceforth MAI).[10]

PRAGMATIST ROOTS

Adapted from Meyer's doctoral dissertation at the University of Chicago, EMM develops an account of musical meaning in terms of the fulfillment or denial of listeners' expectations. Though the ensuing years brought a number of terminological and conceptual shifts, many of Meyer's core views on music would remain unchanged from this early date. His original expectational account is rooted most deeply in the thought of American pragmatist philosophers and psychologists, most notably John Dewey and the lesser known Morris R. Cohen. Moreover, Meyer was already formulating ideas about style in pragmatic terms, so a full account of his approach to style requires close consideration of his early work on musical meaning.

Dewey and Emotion

Meyer's theory of musical meaning is closely tied to his understanding of emotion, which he summarizes with a simple definition: "Emotion or affect is aroused when a tendency to respond is arrested or inhibited."[11] The main source for this definition is John Dewey's conflict theory of emotion, which treats emotion as the result of a conflict between tendencies or habits that requires some kind of response or resolution.[12] As Dewey scholar Thomas Alexander puts it, for Dewey, "emotion naturally arises in experience because experience is in a rhythmic alternation from stable to precarious and back. As a stable situation (like walking) is suddenly transformed into a precarious one (like running across a snake), the emotional seizure marks the inhibition of habits, and announces the phase of readjustment; it is the tension of object and response."[13] In its original context, Dewey's approach represents one important effort at dealing with what were at the time well-known controversies: Does emotion originate as an internal mental state that is subsequently exteriorized? Or does emotion arise only at the final stage of action, after a physiological response to a stimulus has been recognized or reflected upon? Dewey's aim is to avoid the dualism of the former question (associated with Darwin) but also to avoid the overcompensation of the latter (associated with William James), which still holds mind at a remove from body despite reversing their priority.[14] Without examining Dewey's position in great detail, it suffices to note that he instead considers

emotion or affect to be one aspect of an experience that is more properly understood holistically, as a function of the organism's various responses to a stimulus—and further, in terms of the way the response and the stimulus are mutually determining.[15] Psychologist Roswell P. Angier, whose work Meyer draws on in EMM, glosses Dewey's position as follows: "Movement and stimulus are interlocking, altering their nature *pari passu* as the total mode of behavior proceeds, each serving to modify the other in the sense of clarifying or defining (for action or consciousness) just what the other *is*."[16] That is, for Dewey, both physiological and affective components shape the response to a stimulus as it occurs. There can be no purely physiological phase that eventually ends and gives way to emotion, since there is no determinate "end" to a given stimulus-response situation.

Even more central to Meyer's approach to emotion is the notion of habit, or tendency. The idea of a stimulus or inhibition is only sensible, in Dewey's terms, as an interruption of an ongoing course of events, a familiar set of repeated actions or behaviors that for living creatures are either instinctive or (primarily, for Meyer and Dewey) learned. Meyer describes two ways in which habits or tendencies can be inhibited: "In one case a tendency is inhibited not by another opposed tendency but simply by the fact that for some reason, whether physical or mental, it cannot reach completion. . . . In the other case two tendencies which cannot both reach fruition at the same time are brought into play almost simultaneously. If they are about equal in strength, each tendency will block the completion of the other. The result is not only affect, as a product of inhibition, but doubt, confusion, and uncertainty as well."[17] Furthermore, such inhibited tendencies will often themselves produce new tendencies directed toward clarification of the confusion established by the initial inhibition.

Meyer's argument for understanding music in terms of emotional response follows directly from these basic ideas: music, as a more or less systematic set of sonic tendencies, produces an equally systematic set of affective confusions as these tendencies intersect and conflict. Meyer sees music as a particularly rich site for understanding affect in these terms because of the medium's apparent homogeneity. That is, because musical tendencies, inhibitions, and resolutions all occur within the same medium and are controlled by stimuli of the same type—namely, sounding musical materials—then musical affect can be studied relatively objectively. While there is no musical emotion without a human listener, "the structure of the affective response to a piece of music can be studied by examining the music itself."[18] This lucky state of affairs is opposed to everyday life, in which "the factors which keep a tendency from reaching completion may be different in kind from those which activated the tendency in the first place. The stimulus activating a tendency may, for example, be a physical or psychic need of the organism, while the inhibiting factors may simply be a series of external circumstances which keep the organism from satisfying the need."[19] Meyer's argument for studying musical scores directly—engaging with "the music itself"—is thus a consequence of his specific claims about the psychological experience of music.

Cohen, Peirce, and Meaning

When, in the introduction to *Emotion and Meaning in Music*, he turns to his title's second key word, Meyer moves away from Dewey, but only as far as an adjacent line of

pragmatist thought. His pursuit of the concept of meaning is driven by an impatience with the kinds of questions often posed about musical meaning in particular: Does music refer to anything outside of itself? Is musical meaning of an entirely different kind than "meaning in general"?[20] In an attempt to sidestep these questions, Meyer posits a general definition of meaning from pragmatist philosopher Morris R. Cohen: "Anything acquires meaning if it is connected with, or indicates, or refers to, something beyond itself, so that its full nature points to and is revealed in that connection."[21] Cohen's next sentence, not quoted by Meyer, helps clarify this definition's stakes: "Preoccupation with introspective psychologic considerations leads us so to emphasize intuition as to consider it the essential element of all meaning. But such a view is not necessary."[22] Meaning is thus not a property of a mind or of an object, but of a relation. For Meyer, then, "it is pointless to ask what the intrinsic meaning of a single tone or series of tones is. Purely as physical existences they are meaningless. They become meaningful only insofar as they point to, indicate, or imply something beyond themselves."[23]

Going further, Meyer elaborates that meaning arises out of a "'triadic' relationship between (1) an object or stimulus; (2) that to which the stimulus points—that which is its consequent; and (3) the conscious observer."[24] Beyond introducing the observer explicitly into the equation, this passage cements the importance of pragmatism throughout EMM, being a near-direct quotation from Cohen's *Preface to Logic* (though a rather vague citation also attributes the idea to George Herbert Mead, obscuring the definition's near word-for-word resemblance).[25] *Preface to Logic* is certainly not a well-known text in the reception of pragmatism, nor was Cohen widely influential after his death in 1947. Writing ten years later, the philosopher of science Ernest Nagel lamented that "it must be admitted that few professional philosophers continue to read Cohen or to be influenced by his ideas."[26] But Cohen was a devotee of the much more famous Charles Sanders Peirce, having edited and published the first major collection of the latter's writings in 1923, along with an early bibliography in 1916.[27] More specifically, the three-part account of meaning that Meyer adapted from Cohen must be understood to be directly inherited from Peirce, whose obsession with triads is well documented. To understand Meyer's (mis)reading of Cohen and its implications for his information-theoretic turn thus requires a brief examination of the triad at the heart of Peirce's semiotic theory, consisting of what would come to be called the sign, object, and interpretant.[28]

In the earliest formulation of his semiotic theory, Peirce suggests that "the conception of a third is that of an object which is so related to two others, that one of these must be related to the other in the same way in which the third is related to that other. Now this coincides with the conception of an interpretant. An other is plainly equivalent to a correlate."[29] This dense formulation, typical of Peirce's prose style, requires unpacking, particularly in his use of unmarked terms like "other" and "correlate" in highly specific ways, along with the first introduction of the "interpretant," which comes to have major significance for Peirce's system. In this case his use of "object" does not refer to what would later be called a semiotic object, instead referring generically to the different components in a signifying relation. Another passage from the same essay clarifies, somewhat: " . . . and thus we resort again to a mediating representation which represents

the relate as standing for a correlate with which the mediating representation is itself in relation."[30] The "mediating representation" is something that comes between the "relate" and the "correlate"—but the relate also *stands for* the correlate, a formulation that finally allows for a translation into less muddled terms more familiar in Peirce's reception: A sign (relate) stands for an object (correlate) by way of a mediating third, or interpretant, which itself is brought into relation with the object ("in the same way" as the sign). That is, the relation between sign and object regiments and organizes the relation of interpretant and object.[31]

This glimpse into the terminological tangle at the heart of Peircean semiotics sheds some light on the original passage from Cohen that Meyer adapted in his triadic definition of meaning:

> But a more adequate view of meaning regards it as a triadic relation between (1) an object; (2) that to which it points; and (3) a conscious observer.[32]

The Peircean reading of this passage would have it that (1) is a sign or "relate," (2) is an object or "correlate," and (3) is an interpretant (this reading of the observer as interpretant is addressed further below). Cohen uses "object" for (1) in the generic sense of Peirce's 1868 statement, where "object" merely refers to any component of the meaningful triad. But Meyer's rewriting of the passage obscures its Peircean origins:

> (1) an object or stimulus; (2) that to which the stimulus points—that which is its consequent; and (3) the conscious observer.[33]

By adding "stimulus" to (1), Meyer perhaps clarifies its nature as a sign somewhat—but by adding "its consequent" to (2), he mixes two semiotic functions, allowing the sign (relate) to point to an object (correlate) that is also its consequent (interpretant). Thus, Meyer's modifications to (1) and (2), far from clarifying Cohen's definition, actually confuse two different stages in the Peircean semiotic process. Annotating Meyer's definition foregrounds the conflicting sense contained in each component:

> (1) object [in the later, technical sense] or stimulus [as sign] leads to (2) that to which the stimulus points [as object]—that which is its consequent [as interpretant].

Both progressions—object to interpretant, sign to object—are well formed but describe different stages of the same process. While Meyer probably did not realize it, the confusion builds on the ambiguity in Cohen's use of the word "object," which is licensed by Peirce's 1868 essay but contradicted by his later usage. The entire situation also leaves high and dry the "conscious observer." Indeed, even Cohen's phrasing obscures the radical nature of Peirce's notion of meaning by suggesting that an observer exists outside of the semiotic process, simply observing the relation between sign and object. Focusing instead on the processual nature of the interpretant—its status as an action or response regimented by the relation itself—would make it clearer that the conscious observer is more properly constituted by the very movement of interpretants. Cohen himself moves in this direction later in the same passage, noting that "if we distinguish between the organic human being and the mind as the subject of knowledge, we can see that the latter as

percipient is not a term in the perceived relation even when the same object has different effects on different organisms."[34] That is, no static mind can simply decide, purely subjectively, what the relation between a sign and an object (in the standard Peircean sense) means, because this kind of meaning is part of a holistic process contingent on more or less objective constraints of body, environment, language, etc. On the other hand, in Meyer's doubled formulation the conscious observer is rendered even more static, dissociated not just from the sign–object relation but also from the interpretant.

The Early Account of Style: From Expectation to Information

Meyer's early focus on general problems of emotion and meaning was directly motivated by his interest in the concept of musical style. Already in the preface to EMM, he writes, "an understanding of the cultural and stylistic presupposition of a piece of music is absolutely essential to the analysis of its meaning. It should, however, be noted that the converse of this proposition is also true: namely, that an understanding of the general nature of musical meaning and its communication is essential to an adequate analysis of style and hence to the study of music history and the investigations of comparative musicology as well."[35] But these formulations are not as evenly matched as Meyer's chiastic phrasing suggests. Meaning and style are hierarchical: A general structure of meaning underlies all musical style, which itself facilitates the experience of meaning in specific works. EMM's titular terms thus point to the concept of style from the beginning, and Meyer discusses style there in ways that are largely consistent with the later account in *Style and Music*.

It is worth quoting his definition from EMM at length:

> Musical styles are more or less complex systems of sound relationships understood and used in common by a group of individuals. The relationships obtaining within such a style system are such that (a) only some sounds or "unitary sound combinations" are possible; (b) those sounds possible within the system may be plurisituational within defined limits; (c) the sounds possible within the system can be combined only in certain ways to form compound terms; (d) the conditions stated in (a), (b), and (c) are subject to the probability relationships obtaining within the system; (e) the probability relationships prevailing within the system are a function of context within a particular work as well as within the style system generally.[36]

Though he does not explicitly invoke "choice," a key term in his later definition, there is already a clear sense in which style is understood as a system of probabilistic constraints. For Meyer, most music theory already implicitly describes systems of probabilities, as borne out by "a glance at almost any book on the theory of music (whether Zarlino's or Rameau's) or the examination of any discussion or description of style."[37] Perhaps most notably, he cites Walter Piston's famous table of root progressions, consisting of statements of likelihood: "I is followed by IV or V, sometimes by VI, less often II or III / II is followed by V, sometimes VI, less often I, III, or IV," and so on.[38] Even more directly, "statistical style studies, such as those made by Frances Densmore [explicitly listing numbers of ascending and descending intervals] also indicate that probability is one of

the central facts of style."[39] But Meyer is quick to recognize a gap between the abstract invocation of probability and the task of actually measuring musical tendencies statistically. In his words,

> The difficulty with statistical style studies is threefold. First, there are . . . certain natural probabilities, such as the fact that a process once established tends to continue in the same manner, which need not become musically actualized in a majority of cases in order to become probable within a style system. Although this might be overcome by positing certain "natural" probabilities, it is always possible that what is natural, even in this psychological sense, may become culturally overlaid and hence inoperative. Statistics cannot tell us whether or not this is the case.[40]

What Meyer means here is that different musical tendencies may have different origins; some aspects of a style may simply be the result of basic psychological biases, while others may be consciously constructed, and may even contravene those biases.[41] A naïve statistical analysis will place these different kinds of tendencies on the same level. Meyer also notes that styles are constantly changing, even within the course of a single piece, a fact that a statistical snapshot will struggle to capture. And finally, he notes that some styles rely on norms that are not enacted directly, as in late Romantic music that avoids straightforward cadences and tonal stability but seemingly only achieves its fullest meaning for listeners who understand that these features are nonetheless "present" in their contravention. Statistics calculated only on the basis of what actually appears in the score will not be able to capture these hidden categories.

INFORMATION THEORY, CYBERNETICS, AND ARTIFICIAL INTELLIGENCE

Given Meyer's statement of caution in EMM, it may seem surprising that only a year later he published his first essay invoking information theory as a complementary means of understanding musical affect and meaning. Information theory, introduced in its canonic form by Claude Shannon in Bell Labs' *Bell System Technical Journal* in 1948 and brought to wider notice in a reprint published alongside a more accessible explanatory essay by Warren Weaver as *The Mathematical Theory of Communication*, provided the epistemological foundation for many of the major technological developments of the 20th century.[42] But while its origins are in the study of communication, information theory quickly made a mark on the wider intellectual world. John R. Pierce's *An Introduction to Information Theory*, aimed at a general audience and first published in 1961, attests to this widespread influence, with chapters on applications in "language and meaning," physics, cybernetics, psychology, and art.[43] Meyer's foray into information theory is thus very much of its time.[44] But there is also a specificity to Meyer's engagement with information theory, particularly because of his role as one of the most important figures in the study of music cognition in the period that saw the rise not just of information theory but also of cognitive psychology, which has its own entanglements with computation. Thus, it is worth outlining not only the basic technical details of information theory but also the history of its complex relationships with the related fields of

cybernetics and artificial intelligence, all areas that deeply influenced Meyer's conceptions of the human mind and human expression.

A Brief Introduction to Information Theory

Information theory models communication as the transmission of a message over a channel from a source to a receiver, as exemplified in Figure 1, Shannon's classic "noisy channel model." At the theory's core is entropy, the unit in which information is measured, understood as the degree of "uncertainty of the recipient as to what message [a] source may produce and transmit."[45] The mathematical details of information theory deal with the statistical properties of message sources and channels, particularly regarding the maximum achievable rate of transmission and the most efficient encoding of a given message or group of messages. Entropy is typically calculated in bits (short for "binary digits"), a feature that originates in part with the practice of transmitting telegraph messages in the form of alternating on/off voltages but that is particularly useful for digital computers.

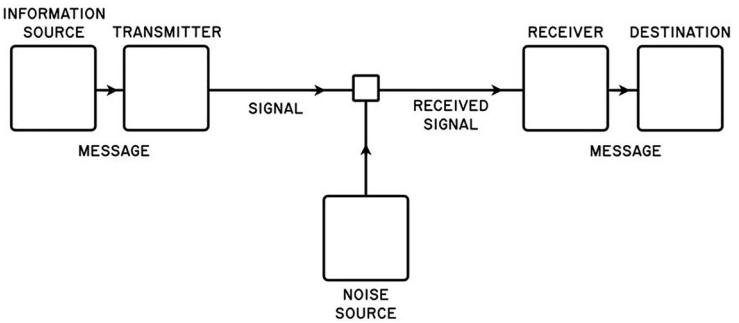

FIGURE 1. The noisy channel model of communication. Adapted from Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana: University of Illinois Press, 1949), 5.

The matter of encoding is particularly important for applications of information theory to language and music. In both cases, the focus is less on transmission than on the properties of the signal itself that permit various kinds of compression. For example, to transmit a message in English, one could encode the 26 letters and the space with 5 bits ($2^5 = 32$), but five encodable locations would be wasted. By attending to the frequencies at which letters appear in actual English text—for example, that *e* is the most common letter, or that *q* is almost always followed by *u*—it is possible to devise encoding schemes that take advantage of redundancies in order to reduce the number of bits required for transmission.[46] The details of a particular encoding scheme are less important than the recognition that many of them are possible: One can code for multi-letter or multi-word blocks, or take into account specific grammatical features. The concept of redundancy can thus be separated from the actual implementation of a technical communication system and instead serve as a model for language (or music) itself. In Meyer's early writings on information theory, musical style, as a system of probabilities learned by exposure and

experience, is understood to consist of redundancies that manifest themselves in the fulfillment or denial of expectations of precisely the kind captured by the information-theoretic idea of entropy.[47] Thus, the common harmonic progression from dominant to tonic might demonstrate the kind of redundancy observed in the *q-u* succession in English, or individual chords and pitches might be described in terms of frequency profiles like those of individual letters. Meyer's invocation of redundancy will be an important point of focus later in this essay.

Disentangling Trends in Cybernetics and Information Theory

Information theory, and its adoption across a range of disciplines in the 1950s and '60s, was intimately tied up with the development of cybernetics. Presented most notably in Norbert Wiener's *Cybernetics* of 1948 (Meyer's main source on the topic), the field is difficult to characterize in brief because of its broad—even universal—interdisciplinary aspirations; in Wiener's terms it constitutes "the entire field of control and communication theory, whether in the machine or in the animal."[48] As historian of science Andrew Pickering puts it, "Wiener tried to tie together all sorts of more or less independent lines of scientific development: digital electronic computing (then still novel), information theory, early work on neural networks, the theory of servomechanisms and feedback systems, and work in psychology, psychiatry, decision theory, and the social sciences."[49] Emerging out of the technological developments spurred by military research in the Second World War, early cyberneticians were hardly unified in their conceptions of the nascent discipline, or of the prospects for specific constituent theories and approaches.[50] Shannon himself famously expressed skepticism over the true breadth of information theory's applicability.[51] But generally speaking, the early years of cybernetics were characterized by great enthusiasm at the possibility of describing a variety of natural and social processes as complex feedback systems of communication and control, a goal to which the mathematical precision of information theory seemed well suited. As I discuss below, Meyer's citations in MAI show that he understood his foray into information theory explicitly as an engagement with this wider cybernetic discourse.

The complexity of the history of cybernetics, however, makes it insufficient simply to point out that Meyer was aware of its general trends. For example, many of the early cyberneticians were concerned with modeling the human brain as an embodied system, seeking to understand how complexity could arise out of systems made of simple parts.[52] However, the next generation of scholars shifted their focus to models of the mind as a processor of symbols rather than an embodied agent interacting with its environment. By the mid-1950s, as the programmable computer became more central to cyberneticians' thought, an analogy between machine and physical brain or body was displaced by a model that treated the computer as a disembodied, symbol-processing mind, particularly in work by Allen Newell and Herbert Simon.[53] Importantly, the embodied and disembodied perspectives never underwent a clean break, and often shared the same conceptual tools (including information theory). But the disembodied form has taken on a number of highly specific institutional forms, particularly the study of artificial intelligence, a field that initially boomed in the 1960s as what is now known as GOFAI, or Good

Old-Fashioned Artificial Intelligence.[54] For the purposes of the story I am telling about Meyer's intellectual development, the most important concomitant of early AI research is the emergence of cognitive psychology.[55] In opposition to behaviorist approaches that treated the organism as a black box that could only be understood in terms of its responses to external stimuli, cognitive psychology took up cybernetic and information-theoretic ideas about communication and control processes to propose, and investigate, what could now be understood as the internal structure of the mind—thoughts as control signals. Through the end of his career, Meyer would continue to draw on the work of important transitional figures like Herbert Simon and George Miller.[56]

With this historical sketch in mind, the next section traces Meyer's adoption of information theory and various related discourses, beginning with the publication of his first essay dealing with information theory in 1957. The discussion is organized around several key information-theoretic terms, with a focus on their role in the 1957 essay: the noisy channel model, redundancy, noise, and feedback. Then, the following section turns more specifically to Meyer's growing discontentment with information theory, as the focus extends into the later chapters of MAI and to his later writings. I show that even as he rejected more explicit applications of information theory and cybernetics, he maintained many of their assumptions. Thus, I will argue that in examining the impact of information theory on Meyer's thought more broadly, it is important to attend to instances where information-theoretic principles are ostensibly disavowed but continue to operate on another level.

STYLE AND INFORMATION

It requires no archaeological effort to lay out the intellectual connections that drove Meyer's initial interest in information theory. One year after the publication of EMM, he stated clearly:

> I have dealt elsewhere at some length [in *Emotion and Meaning in Music*] with the central importance of the arousal and subsequent inhibition of expectant tendencies in the shaping of musical experience. In that analysis of musical experience many concepts were developed and suggestions made for which I subsequently found striking parallels—indeed equivalents—in information theory. . . . In particular, it would seem that the psycho-stylistic conditions which give rise to musical meaning, whether affective or intellectual, are the same as those which communicate information.[57]

In a display of optimism typical for the time, Meyer adds that, if the connection proves fruitful, "the seemingly disparate and discrete worlds of physical phenomena, bio-social behavior, and humanistic creation can, at least from this point of view, he brought together and subsumed under" the law of entropy.[58] As if to demonstrate this point, the ensuing pages repeat, almost word for word, passages from EMM elaborating Meyer's account of musical meaning (including the passage describing its "triadic" nature), glossed to draw out connections with information theory. Put as plainly as possible, Meyer's

analogy is as follows: Entropy, as a measure of "surprise" in a signal, seems to give quantitative measure to the qualitative experience produced by the inhibition or conflict of tendencies in music. In particular, the manner in which this affective experience is conditioned by the musical sounds that preceded the moment of inhibition or conflict seems to be equivalent to the way that, in a Markov model, the probability of a given symbol depends on the symbols that preceded it.

The Noisy Channel, Encoding and Decoding

Because information theory models the transmission of signals, any cooptation of information-theoretic ideas in other domains involves implicitly or explicitly interpreting that domain in terms of Shannon's noisy channel model. In his initial 1957 account Meyer would presumably have understood the composer (or possibly the score) as the information source in Shannon's diagram, with the performer functioning as the transmitter and the listener as the receiver and/or destination.[59] The precise mapping Meyer had in mind is less important than what it licenses: The noisy channel model formalizes and reifies the observer in his triadic definition of meaning. In other words, the looser sense of "pointing" among stimuli and objects is replaced by a Markov model describing the transition probabilities among different symbols, and the "conscious observer" is replaced with a receiver programmed to decode the symbols being transmitted. This interpretation widens the gap between Meyer's reading of Cohen's definition of meaning and that definition's Peircean roots. Where Meyer had already turned Cohen's version of Peirce's interpretant—which is not separable from but instead intimately tied up with and constituted by the stimulus and the object to which it points—into an external, conscious observer, the information-theoretic reading further solidifies the observer as a separate entity.

There is also the question of what, exactly, is being encoded and decoded. In information theory, an encoding scheme is not related to the meaning of the message transmitted; Shannon and Weaver famously distinguished between the technical and semantic problems in transmission, arguing that the same message could be transmitted by way of different encoding schemes without a change in meaning, which is the province of the human interpreter rather than the transmission system.[60] But for Meyer, musical meaning inheres in something like the phenomenological experience of the encoding scheme itself, of the fluctuations of entropy as an incoming signal is processed (he calls this "embodied," as opposed to "referential" meaning).[61] This point would seem to lend further support to Meyer's reliance on the musical score as a convenient substitute for the listener's musical experience: While the interpretation of English text, for example, requires both transmission (encoding and decoding of the raw text across a channel) and interpretation (a further semantic decoding), musical meaning exists primarily in the realm of the former process, which, by analogy, can be carried out more or less mechanically given only the notational inscription.

Noise

While Shannon's account of information theory begins with the description of an ideal, noise-free channel between transmitter and receiver, it is the ever-present possibility of

failure in transmission that motivated the theory in the first place, and noise likewise plays a central role in Meyer's account. Meyer contrasts the relatively straightforward "acoustic noise"—"poor building acoustics . . . poor transmission systems . . . or just plain extra-musical sounds"—with what he calls "cultural noise," or "disparities which may exist between the habit responses required by the musical style and those which a given individual actually possesses."[62] One of Meyer's richer coinages, cultural noise stands in a strange relationship to information theory. As a feature of the receiver or transmitter rather than the channel, it (apparently unintentionally) reaches into the cryptographic aspect of Shannon's work. A receiver subject to cultural noise is more like the enemy cryptanalyst in Figure 2, Shannon's depiction of a system for transmitting secret messages, from his 1949 article, "Communication Theory of Secrecy Systems."[63] Unlike the decipherer, the enemy does not possess the key that would allow him or her to decode the message; subject to cultural noise, such an agent is not actually the message's target audience.

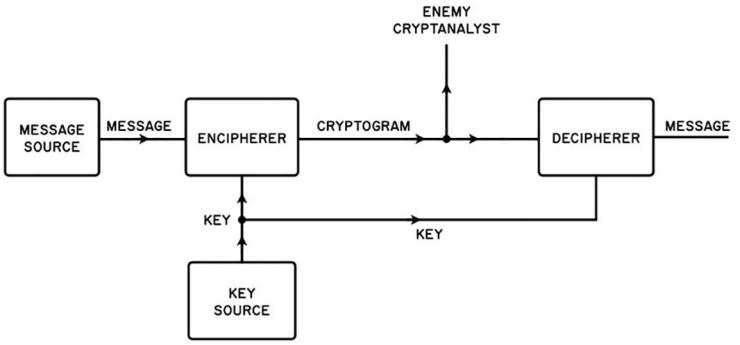

FIGURE 2. Shannon's schematic of a general secrecy system, where the key is transmitted separately so that only the decipherer can read the message. Adapted from Claude E. Shannon, "Communication Theory of Secrecy Systems," *The Bell System Technical Journal* 28, no. 4 (October 1949): 661.

Indeed, for Meyer, the main source of cultural noise is "cultural distance, whether historical or anthropological."[64] Something like Boasian cultural relativism is thus transformed into a problem of signal processing.[65] But cultural noise is also a concern in the more proximate setting of contemporary music, where "'noise' is the result of a time-lag between the habit responses which the audience actually possesses and those which the more adventurous composer envisages for it."[66] In other words, the modern composer, like a cryptographer, devises a new musical language that functions as an encoding scheme unknown to the audience (though Meyer believes, at least initially, that the audience may yet crack the code given enough time).

Feedback

Though Meyer's initial engagement with information theory was mostly limited to Shannon and Weaver's foundational work, there are also signs of an interest in the

broader realm of cybernetics and control theory that would grow in Meyer's work in the following years. Indeed, despite its limited scope, the 1957 paper also introduces one of the most important concepts from cybernetics by suggesting that the "process of revaluation [i.e., the musical meanings "attributed to the antecedent stimulus in retrospect," after hearing the consequent] is the mental counterpart to the 'feedback' process in automatic control and information theory. For both feedback and revaluation are processes whereby future behavior, whether of automatic systems, motor reflexes, or expectations, is conditioned and controlled by the results of past events."[67] This is not, perhaps, the most perspicuous definition of feedback—after all, what future events are not conditioned by the results of past ones? But the attempt to retrofit his existing theory of musical meaning with cybernetic qualities does partly reconfigure Meyer's earlier adaptation of Dewey's account of emotion. Building a taxonomy of varieties of meaning in EMM, Meyer defines "evident meaning" as meaning attributed to an earlier event in light of later events. He represents this process as follows, where *S* stands for stimulus and *C* stands for consequent:

S1. . . . C1 = S2. . . . C2 = S3. . . . , etc.[68]

Meyer's focus here is on the way each consequent event is in turn treated as a stimulus, a process that seems to be derived from Dewey's account of the holistic, interlocking relationship between emotion and response as they unfold in time. But the diagram, and Meyer's description of it, never quite makes good on the full implications of his definition of "evident meaning," which would seem to require a loop back in the diagram so that, for example, after experiencing S3, C1 would be reinterpreted as C3, with the consequences of that reinterpretation cascading down the chain. The turn to the notion of feedback in the 1957 information theory essay, where it appears in Meyer's updated discussion of "evident meaning," thus seems to go some way toward correcting this confusion, reinstating a more radical form of revaluation than the linear process implied in EMM, and perhaps one even more in line with Dewey's theory. Such revaluation seems to be closely analogous to what in music theory is more generally called "structural listening," which implores the listener to attend simultaneously to both the immediate musical detail and the totality of musical form, so that the implications of the first measure of music are only understood upon completion of the last.[69] But in Meyer's hands structural listening is reimagined not as a tortured, dialectical struggle to reconcile part and whole but rather as a control diagram for a computational process.

Redundancy

If, as I have argued, the encoding and decoding associated with the noisy channel model only appear implicitly in his writings, and while feedback remains undertheorized, redundancy would become a key term for Meyer throughout the rest of his career. The term first appears in Meyer's writing in the 1957 information theory essay, in the context of a quote from Weaver's explication of Shannon: "Redundancy is that portion of a message which 'is determined not by the free choice of the sender, but rather by the accepted statistical rules governing the use of the symbols in question.'"[70] From this moment,

redundancy never leaves Meyer's thinking on music, even long after information theory ceases being an explicit point of reference. The word appears more than 30 times in the newly added postlude to the 1994 reprint of MAI and also features in the 2008 essay, "A Universe of Universals," where redundancy is presented as one of five major categories of "bio-psychological universals."[71] Its role in *Style and Music*, while less prominent, is no less significant; I will consider this point in more detail later.

Returning first to the 1957 account, Meyer argues that "redundancy is of particular significance because it is one of the factors which allows for those important places in the experiencing of music where the listener's habit responses are able to 'take over'—where the listener can pause, albeit briefly, to evaluate what has taken place in the past and to organize this experience with reference to the future."[72] The more efficiently musical information is transmitted, the lower the required channel capacity, allowing the mind to attend to other tasks. Alternatively, redundancy is what makes music comprehensible in the case of, for example, "solo sonatas for a string or woodwind instrument where chords are only partially stated and melodic 'lines' are mentally constructed on a minimum of material."[73] Acoustic noise can produce similar conditions, so that a musical texture that is partially masked by nonmusical sound may nonetheless be intelligible thanks to the listener's ability to "fill in" missing sounds.

Furthermore, redundancy is central to Meyer's critique of new music. The crux of his position is that "in their zeal to 'pack' music full of meaning some contemporary composers have perhaps so overloaded the channel capacity of the audience that one meaning obscures another in the ensuing overflow."[74] In 1963's "The End of the Renaissance," Meyer takes a charitable attitude toward this development, suggesting that music that does not meet the information-theoretic demands of human perceptual abilities at least follows a "consistent and tenable" philosophical position, a sort of proto-posthumanism:[75] "Man is no longer to be the measure of all things, the center of the universe. He has been measured and found to be an undistinguished bit of matter different in no essential way from bacteria, stones, and trees."[76] But already in the final chapters of *Music, the Arts, and Ideas*, written only a few years later, he had settled on the position that he would stand by for the rest of his career, namely that musical value is tied to syntactic comprehensibility.[77] Thus, music that fails to activate listeners' expectations in a kind of Goldilocks zone—whether by overwhelming their channel capacities by way of serialist or aleatoric processes, or by being "insistently, almost aggressively" redundant, as in minimalism—is, at best, deserving of suspicion.[78]

MISGIVINGS AND NEW DIRECTIONS

With its chapters spanning the decade between 1957 and 1967, *Music, the Arts, and Ideas* represents the period of information theory and cybernetics' greatest interdisciplinary influence and the beginning of their decline. Meyer's thought, and his citations, track that shift relatively clearly, but with some peculiarities. The five chapters in the book's first part, the latest of which was originally published in 1963, all include discussions of information theory and progressively include more citations of scholars working on

cybernetics and related topics. The later chapters, all first published on the book's release in 1967, soften Meyer's claims about the usefulness of information theory for modeling music directly. But at the same time he increasingly relies on thinkers with significant commitments to cybernetic ideas, now refracted more often through the increasingly influential cognitive approach to psychology, wherein the mind is treated as a computational system. Thus, as the dream of cybernetics and information as the foundation for a universal science faded, Meyer found himself increasingly drawn to a field with a narrower but far more enduring commitment to many of the same basic ideas. While these changes are important for the history of music psychology in general, I argue that they are also formative for Meyer's later theory of style, and for that reason are worth considering in more detail.

The Insufficiency of Statistics

Having already critiqued the straightforward application of statistics to music analysis in EMM, Meyer extends these arguments in some of his discussions of information theory. Where his earlier critiques, offered casually and without specific citations, center around the difficulty of distinguishing between probabilities arising from "natural" and "cultural" sources (e.g., universal Gestalt principles as opposed to learned stylistic norms), in the 1957 essay he draws on ideas from probability theory as well as from information theory and cybernetics to characterize the complexity of the problem of making reliable statistical claims about music. From Ernest Nagel's *Principles of the Theory of Probability* (and also citing Norbert Wiener's *Cybernetics*), he draws the argument that observed statistics are potentially misleading unless their interpretation is motivated by hypotheses about the mechanism underlying the situation being measured.[79] In music, one specific problem includes "the tendency of systemic uncertainty to diminish and of designed uncertainty to be introduced as the music unfolds."[80] In other words, according to Meyer, the total information in a piece decreases as its ending becomes increasingly certain (e.g., approaching a cadence), for which the composer will compensate by introducing additional uncertainty. Related problems involve the different statistical norms of different sections of a piece (as in the presumably heightened uncertainty in the development section of a sonata) and the way hierarchical levels differ in their employment of uncertainty. For example, "it seems more likely that a phrase or melody will begin with a skip than that a progression of phrases will initially involve a large skip."[81] The lone numerical figure of entropy would struggle to capture the nuances of these basic musical features.

Later chapters in MAI also reverse course from Meyer's earlier view of experimental music as appropriate to the historical situation. Babbitt, Boulez, and Stockhausen come under fire for promoting compositional methods not compatible with human perceptual faculties, however self-consistent the underlying mathematics.[82] He argues, citing Wiener's *Cybernetics*, that composers who justify aleatoric music with reference to quantum physics are misguided because the statistical nature of observations at the quantum level does not negate the determinism of physical laws at the macro level.[83] And, going beyond his earlier arguments, he broadens the scope of his citations in two important directions.

First, in stating bluntly that "the statistical and mathematical aspects of information theory [cannot] be applied to music directly and without qualification,"[84] he cites Joel E. Cohen's important 1962 article, "Information Theory and Music."[85] Cohen's essay summarizes and critiques the existing work—already quite extensive—on music and information theory, including Meyer's 1957 essay, showing signs already of the broader dissatisfaction with information theory that would become more widespread by the end of the decade:

> In some extensions, the use of the calculus of information theory was carefully justified or the calculus was modified according to the requirements of the field of study. In other extensions, however, "experiments" were performed without regard to their validity or significance. This was usually done by appealing to the reader's intuition with amorphous generalities, then leap-frogging to the H-formula for information content and inserting some numbers. Of this trick, extensions into musical theory have been particularly guilty.[86]

It is not clear exactly when Meyer encountered Cohen's essay, or what effect it had on Meyer's thinking on information theory, since he had already developed his own versions of related arguments in his earlier work. While he probably discovered a number of new approaches to music and information theory in Cohen's extensive bibliography, he had already cited several of Cohen's major sources in his 1961 essay, "On Rehearing Music."[87]

However, and second, Meyer also raises an argument from a thinker he had previously avoided (and would thereafter continue to avoid): Noam Chomsky, the chief purveyor of a rationalist approach to the study of human linguistic abilities more or less directly opposed to Meyer's empiricism.[88] One of Chomsky's most important early contributions was a critique of the Markov-based approach to language popularized by Shannon; Chomsky showed that Markov models cannot, in principle, generate certain kinds of long-range structures, like the self-embedded forms that are ubiquitous in language (such as nested clauses), and as a result such models can only capture linear, instant-to-instant progressions of symbols.[89] Cohen, in 1962, extended this argument to music, and Meyer followed suit soon after.[90] It is possible that Meyer came to Chomsky's arguments by other means than Cohen's article (they do cite different Chomsky texts), but Meyer's total avoidance of Chomsky elsewhere and his citation of both Cohen and Chomsky on the same page of MAI, in support of the same argument about information theory, suggests that Cohen was his most direct source.

Pragmatism and Information in *Style and Music*

Perhaps as a result of his engagement with Chomsky, or for other reasons stemming from the critiques of statistical approaches to music outlined above, Meyer's approach to information theory undergoes a shift beginning with the newly written chapters for MAI. References to the theory itself—including citations of Shannon or Weaver—that had been ubiquitous for a period of five or six years suddenly become scarce. Instead, information theory and cybernetic discourse become embedded in a different stratum of Meyer's thought, with key concepts from those domains continuing to inform his

conception of music cognition without explicit acknowledgment of their origins. Perhaps the most important of these is redundancy, which, as outlined above, makes prominent appearances in his writings all the way to the end of his career. There is only one explicit discussion of redundancy in *Style and Music*, but the relevant passage warrants close consideration:

> Patterns must have sufficient *redundancy*—internal relational reinforcement—to combat the errors that tend to occur in the transmission of information. . . . The syntax of tonality, for instance, involves enough redundancy that, if for some reason one or two pitches in a triadic melody or a cadential chord progression are masked and inaudible, a competent listener has a very good chance of being able to guess what the missing tones would have been. And it seems reasonable to suppose that innovations that can withstand errors in transmission—cultural, as well as acoustical, noise—have a better chance of being replicated than patterns that do not. Such redundancy—the redundancy of melody or harmony or rhythm—occurs *within* a single parameter and is primarily psychological. But there is another kind of reinforcement, a kind of systemic redundancy in which different parameters within some realm support or complement one another by fulfilling necessary but different functions. That is, the constraints of a style complement one another, producing what might be called *strategy sets*. . . . Systemic redundancy is clearly an aspect of style.[91]

These words could almost have come directly from the 1957 information theory essay. It is even clearer here than in the other late examples cited above that redundancy in Meyer's thought is linked to information—a word that itself only appears in its technical sense once in the book outside of this passage (in an instance that is discussed below). Redundancy in the transmission of information, subject to acoustic and cultural noise—what links this language from the 1960s to the later definition of style is the description, at the end of the passage, of a new kind of "systemic redundancy" operative among stylistic constraints.[92] Meyer is referring to the ways that different parameters, or different musical aspects, can reinforce what he sees as the overarching goals of a style: In Wagner's later music, according to one extended example in *Style and Music*, the need for a large number of characteristic leitmotifs led to the shortening of such motifs compared with the *idées fixes* associated with Berlioz, or even Wagner's own earlier music; the need to maintain musical variety without distorting the characteristic qualities of the leitmotifs makes the use of sequences attractive; sequences lend themselves to modulation and/or chromaticism; chromaticism supports the deferral of closure, also associated with deceptive cadences, which allow for the suturing together of long passages of continuous music, and so on.[93]

In this account, musical choices in one domain can support those in another, so that the overall effect of the music for the listener is reinforced or overdetermined—made redundant. Thus, stylistic constraints—an important feature of Meyer's later thought—turn out to be built on the information-theoretic principles of earlier decades. And though the matter is not discussed explicitly in *Style and Music*, it is difficult not to read this claim in terms of Meyer's earlier arguments about value: If music that is syntactically rich in one parameter, like pitch, is better than music that is syntactically simple, then

music that is rich in inter-parametric redundancy would be better than music in which parameters work against one another.[94]

The only other explicit reference to information theory in *Style and Music* comes, of all places, alongside the only reference to Morris R. Cohen, Meyer's early guide to pragmatism. Discussing, appropriately, the nature of meaning (this time in historiographical rather than in psychological or perceptual terms), Meyer quotes from Cohen's late work, *The Meaning of Human History*: "We can understand the significance of what did happen only if we contrast it with what might have happened. . . . Indeed we could not grasp the full significance of what has happened, even though the facts of history were completely revealed to us, unless we had some idea of what the situation would have been otherwise."[95] This quotation, beyond providing a rare explicit link to his earliest intellectual commitments, describes a form of meaning that Meyer had defined in EMM: "Since these probability relationships [of a musical style] always involve the possibility of alternative consequences, a given stimulus invariably gives rise to several alternative hypothetical meanings."[96] Combined with Cohen's earlier, triadic definition, and cast in Peircean terms, meaning can be understood not just as an interpretant but also as a set of possible interpretants contingent on variations in the relations among sign and object. Then, alongside the citation of Cohen in *Style and Music*, Meyer links these ideas to information theory, quoting from a review of a book by Wendell R. Garner: "The lesson of information theory is that the information is carried not by what the stimulus is but by what it could have been. . . . The informational properties of the stimulus can be determined only in relation to its total set."[97] Of course, none of these arguments are new for Meyer. What makes them meaningful here is the way they stick out of the texture of his late work, amidst a panoply of citations from art history, analytic philosophy, history, literary criticism, and more, demarcating an important throughline otherwise lost in the noise: the centrality of pragmatist thought, refracted through information theory.

Meyer in the Emerging Cognitive Psychology

While references to redundancy, noise, and meaning show Meyer looking back in his late work to his earliest influences, some of his most enduring commitments emerged in the course of disciplinary changes that took place around the time the essays in MAI were being written. Chief among these was the rise of cognitive psychology. As Meyer turned away from the explicit use of information theory to model music, he increasingly cited authors using information theory to describe the human brain, including Colin Cherry, whose *On Human Communication* draws on information theory to address questions about auditory attention, and D. E. Broadbent, recognized as one of the first scholars to describe the human nervous system in computational terms.[98]

Even more influential regarding Meyer's long-term views on human cognition was Herbert Simon. In the later chapters of MAI, Meyer repeatedly cites Simon's "The Architecture of Complexity" (1962), which draws on broader information-theoretic and cybernetic ideas along with Simon's own work on artificial intelligence to deduce general features of the operation and evolution of all kinds of "systems"—cognitive, biological,

social, symbolic, and more. Meyer's own views on history and style change would continue to be influenced by Simon's ideas in *Style and Music*, where he cites the same essay in arguing that "complex forms can arise from simple ones by purely random processes" (and thus one should not, for example, think of earlier musical styles in terms of features that they lack relative to more recent ones).[99] And Simon's *Models of Thought*, a 1979 collection of writings on human cognition in terms of information processing, likewise plays a prominent role in *Style and Music*. Specifically, Meyer draws on Simon's idea that, in searching for a solution to a problem, mental resources are limited and thus various priorities must be balanced heuristically, without perfect knowledge of the situation—the passage Meyer quotes states that "search ends when a good enough alternative is found."[100] A similar conception of cognitive "search" was central to Simon's earlier work, with Allen Newell, on the "General Problem Solver," an important (if famously unsuccessful) early artificial intelligence project that aimed to formalize the use of heuristics to solve logical problems.[101] "Search" refers to the process of determining the set of steps required to achieve a desired goal, often understood in terms of navigating a decision tree; a common problem with early efforts to implement such processes computationally was the exponential rate of growth of such decision trees as the difficulty of a problem increases. Meyer's invocation of Simon thus implies that the composer's process of winnowing and reconciling the many possible stylistic constraints impinging on a given decision is driven by a cognitive process structured along the same lines, heuristically calculating the optimal solution to a musical problem given the information available.[102]

CONCLUSION: THE PRESENT AND FUTURE OF COMPUTATIONAL MUSIC THEORY

Meyer's shift from an information-theoretic model of music to a more broadly computational model of the mind has not prevented recent scholars from applying information theory directly to problems of music theory and analysis. While computational music theory has existed more or less continuously since the earliest days of computers, developments in computer hardware and software in recent decades have made these methods—and the corpora on which they rely—much more accessible, and they have facilitated a new wave of computational music scholarship. Notable examples include David Temperley's 2019 article, "Uniform Information Density in Music," or Jacoby, Tishby, and Tymoczko's 2015 study, "An Information Theoretic Approach to Chord Categorization and Functional Harmony," both of which seem as if they could have emerged directly from Meyer's 1957 work.[103] While scholars today are likely to treat information theory as one tool among others rather than as a fundamental link between musical meaning and all other realms of science and art, these recent studies nevertheless continue implicitly to evince a version of that earlier universalizing ambition. Jacoby, Tishby, and Tymoczko apply their machine-learning approach to 16 corpora ranging from the Renaissance to the 18th century to recent popular music; and the conclusion of Temperley's article is dedicated to staving off potential arguments against the generality of his method.

Information theory also sits uneasily within the broader discipline of music theory. In a continuation of Meyer's turn to cognitive psychology, most applications of

computational methods have appeared in venues associated with music perception and cognition. There have been some exceptions in recent years, with information-theoretically informed articles appearing in flagship publications like the *Journal of Music Theory* and *Music Theory Online*, but computational techniques still are rarely incorporated into music-theoretical training.[104] While some major figures in music psychology argue that mainstream music theory should reform its methodological commitments in the scientific direction of cognitive science, such a shift seems unlikely.[105] And it is perhaps ironic that a more promising path to a greater acceptance of information-theoretic or other computational methods—in the form of an alliance with the broader digital humanities (DH)—seems to have been precluded precisely by Meyer's success in linking information theory with music psychology at such an early date. Computationally inclined music scholars have long been trained to approach their work in terms of perception and cognition in a way that DH scholars in literary studies, for example, have not.

My suggestion, in closing, is that music scholars interested in information theory and computation more generally would do well to situate themselves more explicitly within the digital humanities today. Just like the original wave of information theory, DH has at times positioned itself (or been positioned by funders and institutions drawn in by its technical allure) as a panacea, this time amidst 21st-century worries about the state of higher education and the decline of the humanities rather than the postwar cybernetics moment. My suggestion thus arises not out of optimism regarding this prognosis but rather from the recognition that the conversation around DH resituates familiar challenges in a broader intellectual and political context. It is beyond the scope of this essay to delve into this conversation in any detail, but at its best it allows for mutual interrogation between, for example, computational models of detective fiction and Derrida's theory of genre or Bakhtin's approach to literary form, as in literary scholar Lauren M. E. Goodlad's recent work.[106] One analogous route in music might be to view computational methods through the lens of a Peircean theory of meaning, considering the ways algorithms recognize, manipulate, and produce musical signs in ways variously in tune and at odds with human capabilities and intentions.[107] A turn to Peirce taps into existing music-theoretical interest in semiotics and also recaptures some of Meyer's original interest in pragmatism; but many other directions are possible that might put computational music theory in conversation with work in media theory, philosophy, intellectual history, and other fields. A more DH-aligned computational music theory would certainly raise more questions than it answers—and as such, would perhaps recapture some of the intellectual ambition of Meyer's own career-long attempt to think through style with both information-theoretic precision and humanistic breadth. ■

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NOTES

1. Leonard B. Meyer, *Emotion and Meaning in Music* (Chicago: University of Chicago Press, 1956). On schemata, see, for example, Robert O. Gjerdingen, *A Classic Turn of Phrase: Music and the Psychology of Convention* (Philadelphia: University of Pennsylvania Press, 1988); and Vasili Byros, "Meyer's Anvil: Revisiting the Schema Concept," *Music Analysis* 31, no. 3 (2012): 273–346.
2. Naomi Cumming, "Analytical and Aesthetic Concepts in the Work of Leonard B. Meyer" (PhD diss., University of Melbourne, 1987), 15.
3. Leonard B. Meyer, "Meaning in Music and Information Theory," *Journal of Aesthetics and Art Criticism* 15, no. 4 (1957): 412–24.
4. For reflections on Meyer's role in the adoption of cognitive science in music studies, see the commemorative tributes in *Music Perception* 25, no. 5 (June 2008).
5. Pragmatism and cybernetics have rarely been discussed in the same breath, though notable exceptions include John Durham Peters and Benjamin Peters, "Norbert Wiener as Pragmatist," *Empedocles: European Journal for the Philosophy of Communication* 7, no. 2 (June 2016): 157–72; and Laura Moorhead, "Down the Rabbit Hole: Tracking the Humanizing Effect of John Dewey's Pragmatism on Norbert Wiener," *IEEE Technology and Society Magazine* 34, no. 3 (September 2015): 64–71.
6. As such, this essay complements and takes inspiration from recent work exploring information theory's tendency to take hold unexpectedly (at least at first glance) in humanistic disciplines. See, in particular, Bernard Dionysius Geoghegan, "From Information Theory to French Theory: Jakobson, Lévi-Strauss, and the Cybernetic Apparatus," *Critical Inquiry* 38, no. 1 (2011): 96–126. See also Poornima Paidipaty, "'Tortoises All the Way Down': Geertz, Cybernetics and 'Culture' at the End of the Cold War," *Anthropological Theory* (February 2020).
7. For more on these shifts, see Byros, "Meyer's Anvil."
8. Leonard B. Meyer, *Style and Music: Theory, History, and Ideology* (Philadelphia: University of Pennsylvania Press, 1989), 3.
9. Recent computational or cognitive studies that draw directly on Meyer's theory of style include, among many others: Daniel Shanahan and Joshua Albrecht, "Examining the Effect of Oral Transmission on Folksongs," *Music Perception* 36, no. 3 (February 2019): 273–88; Mitchell Ohriner, *Flow: The Rhythmic Voice in Rap Music* (New York: Oxford University Press, 2019); Janet Bourne, "Perceiving Irony in Music: The Problem in Beethoven's String Quartets," *Music Theory Online* 22, no. 3 (September 2016); Christopher Wm. White, "Changing Styles, Changing Corpora, Changing Tonal Models," *Music Perception* 31, no. 3 (2014): 244–53. Meyer himself made only a single attempt at a statistical style analysis of his own in Leonard B. Meyer, "Nature, Nurture, and Convention: The Cadential Six-Four Progression," in *The Spheres of Music: A Gathering of Essays* (Chicago: University of Chicago Press, 2000), 226–51.
10. Leonard B. Meyer, *Music, the Arts, and Ideas: Patterns and Predictions in Twentieth-Century Culture* (Chicago: University of Chicago Press, 1994).
11. Meyer, *Emotion and Meaning in Music*, 14.
12. John Dewey, "The Theory of Emotion. (I) Emotional Attitudes," *Psychological Review* 1 (1894): 553–69; John Dewey, "The Theory of Emotion. (II) The Significance of Emotions," *Psychological Review* 2 (1895): 13–32. Dewey's earlier work on emotion also plays a role in his much broader philosophical approach to the concept of experience, and in his aesthetics. See Thomas M. Alexander, *John Dewey's Theory of Art, Experience and Nature: The Horizons of Feeling* (Albany: State University of New York Press, 1987).
13. Alexander, 139.

14. For example, Dewey notes that "the very phrase 'expression of emotion,' as well as Darwin's method of stating the matter, begs the question of the relation of emotion to organic peripheral action, in that it assumes the former as prior and the latter as secondary." Dewey, "The Theory of Emotion. (I)," 553. See also Alexander, *John Dewey's Theory of Art, Experience and Nature*, 137.
15. The closest Dewey comes to stating this position in a straightforward way might be his still-gnomic suggestion that "all 'emotional expression' is a phase of movements teleologically determined." Dewey, "The Theory of Emotion. (II)."
16. Roswell P. Angier, "The Conflict Theory of Emotion," *American Journal of Psychology* 39, no. 1/4 (1927): 393. Meyer cites Angier's essay approvingly, as evidence of the widespread diffusion of Dewey's ideas, though it is worth noting that the essay was already nearly 30 years old at the time of Meyer's citation.
17. Meyer, *Emotion and Meaning in Music*, 15.
18. Meyer, *Emotion and Meaning in Music*, 32. This point is also related to Meyer's shift in terminology from "expectation" to "implication" over the course of his career, as he felt that "expectation" connoted too strongly a conscious recognition on the part of the listener. Vasili Byros, "Unearthing the Past: Theory and Archaeology in Robert Gjerdingen's *Music in the Galant Style*," *Music Analysis* 31, no. 1 (March 2012): 327n, suggests that the shift was partly due to the influence of his student Eugene Narmour, whose implication-realization theory developed the term at great length, though a footnote added to the 1957 information theory essay in *Music, the Arts, and Ideas* (8) shows that Meyer had already settled on the "more objective" term by 1967, the year Narmour arrived at the University of Chicago as a graduate student.
19. Meyer, *Emotion and Meaning in Music*, 23.
20. Meyer, *Emotion and Meaning in Music*, 32–33.
21. Morris R. Cohen, *A Preface to Logic* (New York: Meridian Books, 1958), 60. Cited in Meyer, *Emotion and Meaning in Music*, 34.
22. Cohen, *A Preface to Logic*, 60.
23. Meyer, *Emotion and Meaning in Music*, 34.
24. Meyer, *Emotion and Meaning in Music*, 34.
25. Cohen, *A Preface to Logic*, 42. Though his wording is slightly different, Mead, a pragmatist social psychologist, does argue that meaning is constituted in a "threefold relationship" among "a gesture by one organism, the resultant of the social act in which the gesture is an early phase, and the response of another organism to the gesture." George Herbert Mead, *Mind, Self, and Society: From the Standpoint of a Social Behaviorist* (Chicago: University of Chicago Press, 1934), 76.
26. Ernest Nagel, "Morris R. Cohen in Retrospect," *Journal of the History of Ideas* 18, no. 4 (1957): 548.
27. Charles S. Peirce, *Chance, Love, and Logic: Philosophical Essays*, ed. Morris R. Cohen (New York: Harcourt, Brace & Company, 1923); Morris R. Cohen, "Charles S. Peirce and a Tentative Bibliography of His Published Writings," *Journal of Philosophy, Psychology and Scientific Methods* 13, no. 26 (1916): 726–37.
28. A detailed examination of the links between Peirce and Meyer also extends the work of the late Naomi Cumming, who notes the influence in a number of publications on Meyer. See Naomi Cumming, "Analytical and Aesthetic Concepts in the Work of Leonard B. Meyer" (PhD diss., University of Melbourne (Australia), 1987); F. E. Sparshott and Naomi Cumming, "Meyer, Leonard B.," *Grove Music Online*, 2001; Naomi Cumming, "Style and Music: Theory, History and Ideology," *Musicology Australia* 13, no. 1 (January 1990): 46–49. That said, in Cumming's argument Peirce acts simply as a representative for pragmatism; she does not draw out specific genealogical connections via Morris or any of Meyer's other direct

sources. This is less a critique of Cumming than an acknowledgment of her method, which differs significantly from mine in that she aims to "avoid an undue preoccupation with [Meyer's] sources" ("Analytical and Aesthetic Concepts," 15).

29. Charles S. Peirce, "On a New List of Categories," *Proceedings of the American Academy of Arts and Sciences* 7 (1865): sec. 12.
30. Peirce, sec. 9.
31. For an accessible overview of Peirce's semiotic theory, see Paul Kockelman, "The Semiotic Stance," *Semiotica* 2005, no. 157 (January 2005): 233–304.
32. Cohen, *A Preface to Logic*, 42.
33. Meyer, *Emotion and Meaning in Music*, 42.
34. Cohen, *A Preface to Logic*, 42.
35. Meyer, *Emotion and Meaning in Music*, ix.
36. Meyer, *Emotion and Meaning in Music*, 45.
37. Meyer, *Emotion and Meaning in Music*, 54.
38. Meyer, *Emotion and Meaning in Music*, 54; Walter Piston, *Harmony*, 3rd ed. (New York: W. W. Norton, 1962).
39. Meyer, *Emotion and Meaning in Music*, 55. Densmore's work, and Meyer's references to comparative musicology, raise important questions about style's relevance for (and music theory's epistemological presumption toward) music outside the European tradition. These questions are beyond the scope of the present article, but see Charles Keil and Steven Feld, *Music Grooves* (Chicago: University of Chicago Press, 1994) for a serious engagement with, and the beginnings of a critique of, Meyer's approach from an ethnomusicological standpoint.
40. Meyer, *Emotion and Meaning in Music*, 55–56.
41. See David Huron, *Sweet Anticipation: Music and the Psychology of Expectation* (Cambridge, MA: MIT Press, 2006), 80–85, for an example involving the commonplace notion in the pedagogy of counterpoint that large melodic leaps tend to be followed by stepwise motion in the opposite direction.
42. Claude E. Shannon and Warren Weaver, *The Mathematical Theory of Communication* (Urbana: University of Illinois Press, 1949).
43. John R. Pierce, *An Introduction to Information Theory: Symbols, Signals & Noise*, 2nd, rev. ed. (New York: Dover, 1980). See also Abraham A. Moles, *Information Theory and Esthetic Perception*, trans. Joel E. Cohen (Urbana: University of Illinois Press, 1966).
44. Indeed, computation and information theory had caught the attention of music scholars from a very early stage, a history that Eamonn Bell examines in "The Computational Attitude in Music Theory" (PhD diss., Columbia University, 2019). Meyer's own trajectory is important less for his being the first than for the way his forays in this area grew into an influential branch of musical thought more generally.
45. Pierce, *An Introduction to Information Theory*, 80.
46. My account here is drawn more or less directly from Shannon's discussion of different encodings for English text in *The Mathematical Theory of Communication*, 13–15, and Weaver's discussion of encoding in his supplementary essay (107–8).
47. Meyer, *Music, the Arts, and Ideas*, 11.
48. Norbert Wiener, *Cybernetics: Or, Control and Communication in the Animal and the Machine* (Cambridge, MA: MIT Press, 1948), 11.
49. Andrew Pickering, *The Cybernetic Brain: Sketches of Another Future* (Chicago: University of Chicago Press, 2010), 3.
50. Claus Pias, ed., *Cybernetics: The Macy Conferences 1946–1953. The Complete Transactions* (Zurich: Diaphanes, 2016). Steve J. Heims, *The Cybernetics Group* (Cambridge, MA: MIT Press, 1991) focuses on the role of social scientists in the group. For the military history, see

Paul N. Edwards, *The Closed World: Computers and the Politics of Discourse in Cold War America* (Cambridge, MA: MIT Press, 1996).

51. Claude E. Shannon, "The Bandwagon," *IRE Transactions on Information Theory* 2, no. 1 (1956): 3.
52. Pickering, *The Cybernetic Brain* focuses on these kinds of projects.
53. Allen Newell, J. C. Shaw, and Herbert A. Simon, "Report on a General Problem-Solving Program," *Proceedings of the International Conference on Information Processing*, 1959; and Herbert A. Simon, "The Architecture of Complexity," *Proceedings of the American Philosophical Society* 106, no. 6 (1962): 467–82, discussed further below. See discussion in Edwards, *The Closed World*, 240, 252.
54. The term was coined by John Haugeland, *Artificial Intelligence: The Very Idea* (Cambridge, MA: MIT Press, 1985). GOFAI's assumptions and pretensions were critiqued most witheringly by Hubert L. Dreyfus, *What Computers Still Can't Do: A Critique of Artificial Reason* (Cambridge, MA: MIT Press, 1992). By contrast, many of today's major AI projects actually look back (at times knowingly, at times not) to the earlier stage of cybernetics, as modern deep learning systems rely on neural networks trained on massive datasets rather than preprogrammed facts and logical operations. See Editorial, "Return of Cybernetics," *Nature Machine Intelligence* 1 (2019): 385.
55. See Edwards, *The Closed World*, 253, on the close temporal and personal proximity of the birth of the two disciplines.
56. George A. Miller is best known for his article "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," *Psychological Review* 63, no. 2 (1956): 81–97, which Meyer cites approvingly in *Style and Music*; he is also coauthor, with Eugene Galanter and Karl H. Pribram, of *Plans and the Structure of Behavior* (New York: Henry Holt and Company, 1960), a text that would become, in Paul Edwards's words, "a manifesto for cognitivism" (*The Closed World*, 233).
57. Meyer, *Music, the Arts, and Ideas*, 5. Originally published as Leonard B. Meyer, "Meaning in Music and Information Theory," *Journal of Aesthetics and Art Criticism* 15, no. 4 (1957): 412. Meyer in fact alludes briefly in EMM to the idea that his theory of musical meaning may have parallels in information theory, specifically regarding the concept of entropy (255). This seems to have been a late addition, as the text otherwise bears no recognizable influence from information theory.
58. Meyer, *Music, the Arts, and Ideas*, 5–6.
59. While the 1957 essay includes no explicit suggestion that "the composer is like an information source" or "the listener is like a receiver," in a later chapter of MAI Meyer endorses the idea as expressed in a quotation from Milton Babbitt that describes the performer and audience in these terms. See Meyer, MAI, 290, quoting Milton Babbitt, "Who Cares If You Listen?" *High Fidelity* 8, no. 2 (February 1958): 39.
60. Shannon and Weaver, *The Mathematical Theory of Communication*, 3, 95–96.
61. Meyer, *Music, the Arts, and Ideas*, 6. See also Lejaren A. Hiller and Leonard Maxwell Isaacson, *Experimental Music: Composition with an Electronic Computer* (New York: McGraw-Hill, 1959), 2: " . . . computer-produced music which is 'meaningful' is conceivable to the extent to which the laws of musical organization are codifiable."
62. Meyer, *Music, the Arts, and Ideas*, 16.
63. Claude E. Shannon, "Communication Theory of Secrecy Systems," *Bell System Technical Journal* 28, no. 4 (October 1949): 656–715. See also an extended reading of this diagram in terms of a broader theory of networks of communication in Paul Kockelman, *The Art of Interpretation in the Age of Computation* (New York: Oxford University Press, 2017), 57.
64. Meyer, *Music, the Arts, and Ideas*, 16.

65. Relativism was a topic of active debate early in Meyer's career, and the turn to information theory provided a technical explanation for the position Meyer had already begun to develop in EMM—that relativism describes real practical difficulties in cultural interpretation but is not philosophically tenable when held to what he considered a "monistic" extreme. See, in particular, Leonard B. Meyer, "Universalism and Relativism in the Study of Ethnic Music," *Ethnomusicology* 4, no. 2 (1960): 49–54.
66. Meyer, *Music, the Arts, and Ideas*, 16–17.
67. Meyer, *Music, the Arts, and Ideas*, 13. On feedback, Meyer cites Arnold Tustin, "Feedback," *Scientific American* 187, no. 3 (1952): 48–55.
68. Meyer, *Emotion and Meaning in Music*, 37.
69. See Theodor W. Adorno, "On the Problem of Musical Analysis," in *Essays on Music*, ed. Susan H. Gillespie, trans. Richard D. Leppert (Berkeley: University of California Press, 2002); and an elucidation in Peter Szendy, *All Ears*, trans. Roland Végső (New York: Fordham University Press, 2017), 105–12.
70. Meyer, *Emotion and Meaning in Music*, 16; quoting Warren Weaver, "Recent Contributions to the Mathematical Theory of Communication," *ETC: A Review of General Semantics* 10, no. 4 (1953): 269.
71. Meyer, *Music, the Arts, and Ideas*, 317 ff.; Leonard B. Meyer, "A Universe of Universals," *Journal of Musicology* 16, no. 1 (1998): 6.
72. Meyer, *Music, the Arts, and Ideas*, 16.
73. Meyer, *Music, the Arts, and Ideas*, 16.
74. Meyer, *Music, the Arts, and Ideas*, 17.
75. Meyer, *Music, the Arts, and Ideas*, 82.
76. Meyer, *Music, the Arts, and Ideas*, 83.
77. Meyer had developed this argument in the context of tonal music in the earlier essay, "Some Remarks on Value and Greatness in Music," in *Music, the Arts, and Ideas,* Ch. 2.
78. Meyer, *Music, the Arts, and Ideas*, 325. Meyer recognizes a contradiction whereby, in his account, uncertainty leads to increased information and thus to increased musical value—so should noise not be considered aesthetically valuable? His solution is to establish a distinction between desirable and undesirable uncertainty. The former "is that which arises within and as a result of the structured probabilities of a style system in which a finite number of antecedents and consequents become mutually relevant through the habits, beliefs, and attitudes of a group of listeners," whereas the latter "arises when the probabilities are not known, either because the listeners' habit responses are not relevant to the style (cultural noise), or because external interference (acoustical noise) obscures the structure of the situation being considered" (Meyer, *Music, the Arts, and Ideas*, 17). See also Weaver's related discussion in Shannon and Weaver, *The Mathematical Theory of Communication*, 109.
79. Meyer, *Music, the Arts, and Ideas*, 18; Ernest Nagel, *Principles of the Theory of Probability*, ed. Otto Neurath, vol. 6, *The International Encyclopedia of Unified Science* 1 (Chicago: University of Chicago Press, 1939), 59; Wiener, *Cybernetics*, 35.
80. Meyer, *Music, the Arts, and Ideas*, 19.
81. Meyer, *Music, the Arts, and Ideas*, 19. Intriguingly, Meyer proposes a simulation-based approach to these difficulties that is in some ways analogous to modern machine-learning techniques: Rather than analyze works on the basis of statistical assumptions, what about "introducing hypothetical mental constants with arbitrarily assigned numerical weightings, taking into account the various difficulties discussed above—then studying the resulting melodies" (20)?
82. "Arguments for Experimental Music," in Meyer, *Music, the Arts, and Ideas*, 245–65.
83. Meyer, *Music, the Arts, and Ideas*, 256.
84. Meyer, *Music, the Arts, and Ideas*, 262.

85. Joel E. Cohen, "Information Theory and Music," *Behavioral Science* 7, no. 2 (1962): 137–63.
86. Cohen, "Information Theory and Music," 137.
87. Meyer, *Music, the Arts, and Ideas*, Ch. 3. Most notably, Meyer cites Edgar Coons and David Kraehenbuehl, "Information as a Measure of Structure in Music," *Journal of Music Theory* 2, no. 2 (1958): 127–61; Fred Attneave, "Stochastic Composition Processes," *Journal of Aesthetics and Art Criticism* 17, no. 4 (1959): 503–10; Hiller and Isaacson, *Experimental Music*; Abraham Moles, "Informationstheorie Der Musik," *Nachrichten Technische Fachberichte* 3 (1956): 47–55; and Joseph E. Youngblood, "Style as Information," *Journal of Music Theory* 2, no. 1 (1958): 24–35.
88. In music, Chomskyan ideas have been most famously taken up in the generative approach of Fred Lerdahl and Ray Jackendoff, *A Generative Theory of Tonal Music* (Cambridge, MA: MIT Press, 1983). Meyer's avoidance of Chomsky is salient in later essays dealing explicitly with the idea of musical grammar, like Leonard B. Meyer, "Grammatical Simplicity and Relational Richness: The Trio of Mozart's G Minor Symphony," *Critical Inquiry* 2, no. 4 (1976): 693–761, and it is particularly notable that, in the later essay, "A Universe of Universals," Meyer would choose not to engage with one of the great proponents of human cognitive universals.
89. Meyer cites Noam Chomsky, *Syntactic Structures* (The Hague: Mouton & Co., 1963), originally published in 1957; while Cohen cites Chomsky, "Three Models for the Description of Language," *IRE Transactions on Information Theory* 2, no. 3 (1956): 113–24.
90. Cohen, "Information Theory and Music," 154–55; Meyer, *Music, the Arts, and Ideas*, 262.
91. Meyer, *Style and Music*, 141–42. Emphasis in original.
92. Cultural noise also appears once more in *Style and Music*, in a footnote within the same section from which this passage is quoted (144).
93. Meyer, *Style and Music*, 45–47.
94. See Meyer, "Value and Greatness in Music," in *Music, the Arts, and Ideas*; and Meyer, "Grammatical Simplicity and Relational Richness."
95. Morris R. Cohen, *The Meaning of Human History* (La Salle, IL.: Open Court Publishing, 1947), 80–81. Quoted in Meyer, *Style and Music*, 74.
96. Meyer, *Emotion and Meaning in Music*, 37.
97. Ray Hyman, "Review of *The Processing of Information and Structure*," *Science* 186, no. 4165 (1974): 730–31.
98. Colin Cherry, *On Human Communication* (Cambridge, MA: MIT Press, 1957); D. E. Broadbent, *Perception and Communication* (Elmsford, NY: Pergamon Press, 1958).
99. Simon, "The Architecture of Complexity," 471; cited in Meyer, *Style and Music*, 43n13. Here, Meyer mixes cybernetics and information theory with architectural historian James S. Ackerman's account of style from "A Theory of Style," *Journal of Aesthetics and Art Criticism* 20, no. 3 (1962): 227–37.
100. Herbert A. Simon, *Models of Thought* (New Haven, CT: Yale University Press, 1979), 3; quoted in Meyer, *Style and Music*, 136. Though Meyer doesn't use the term, this is what Simon referred to as "bounded rationality," a concept that draws on information-theoretic ideas about uncertainty to explain the cognitive limits on human decision making.
101. Newell, Shaw, and Simon, "Report on a General Problem-Solving Program." The history of the GPS is covered thoroughly in Edwards, *The Closed World*; and critiqued in Dreyfus, *What Computers Still Can't Do*.
102. Meyer is critical of the idea that a piece of music could be understood to solve a single underlying problem, but he is amenable to the notion of a stylistic "goal" that accounts for something like the problem-solving approach; Meyer, *Style and Music*, 146–47. The idea that style is bound up with particular artistic problems and their solutions is discussed extensively in art-historical terms in Ackerman, "A Theory of Style."

103. David Temperley, "Uniform Information Density in Music," *Music Theory Online* 25, no. 2 (July 2019); Nori Jacoby, Naftali Tishby, and Dmitri Tymoczko, "An Information Theoretic Approach to Chord Categorization and Functional Harmony." Note that Temperley explicitly places his work in Meyer's lineage, while Jacoby, Tishby, and Tymoczko do not.
104. See, for example, Ben Duane, "Agency and Information Content in Eighteenth- and Early Nineteenth-Century String-Quartet Expositions," *Journal of Music Theory* 56, no. 1 (2012): 87–120. For the purposes of this discussion, I leave aside the field of music information retrieval (MIR). MIR focuses primarily on engineering problems and is even further removed from mainstream music theory than music psychology, despite some overlap at the margins. That's not to suggest that the field would not warrant its own consideration in terms of the history outlined here, though it should be noted that the sense of "information" in the field's name is much broader than that captured by information theory.
105. See David Huron, "Methodology: On Finding Field-Appropriate Methodologies at the Intersection of the Humanities and the Social Sciences," in *Ernest Bloch Lectures, University of California at Berkeley*, 1999; David Huron, "On the Virtuous and the Vexatious in an Age of Big Data," *Music Perception* 31, no. 1 (2013): 5; and Justin London, "Music Theory as Junk Science, and How and Why We Need to Fix It," (online presentation, Future Directions of Music Cognition, March 22, 2021): https://osf.io/y5w2z/.
106. Lauren M. E. Goodlad, "A Study in Distant Reading: Genre and the Longue Durée in the Age of AI," *Modern Language Quarterly* 81, no. 4 (December 1, 2020): 491–525.
107. Brian A. Miller, "Digital Scores, Algorithmic Agents, Encoded Ontologies: On the Objects of Musical Computation," in *Material Cultures of Music Notation: New Perspectives on Musical Inscription*, eds. Floris Schuiling and Emily Payne (New York: Routledge, forthcoming).