CONCEPTUAL MODELS AND CROSS-DOMAIN MAPPING: NEW PERSPECTIVES ON THEORIES OF MUSIC AND HIERARCHY

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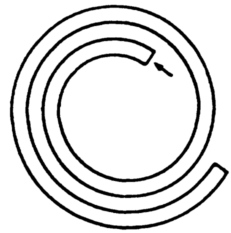
As part of an exploration of people's knowledge about elementary physics, Michael McCloskey and his associates designed a set of experiments that presented subjects with simple non-quantitative problems involving the behavior of moving objects. Here are the instructions for one such problem:

> The diagram [Example 1] shows a thin curved metal tube. In the diagram you are looking down on the tube. In other words, the tube is lying flat. A metal ball is put into the end of the tube indicated by the arrow and is shot out of the other end of the tube at high speed. (McCloskey 1983, 300)

After reading the instructions subjects were asked to draw the path the ball would follow after it emerged from the tube, ignoring air resistance and any spin the ball might have. Slightly over half of their subjects, who were college undergraduates whose background ranged from never having taken a course in physics in either high school or college to having completed at least one college physics course, gave the solution shown in Example 2a. According to Newton's first law, in the absence of a net applied force, an object in motion will travel in a straight line. Thus, from the view of classical physics the correct answer is that after the ball



Example 1. McCloskey, Diagram of spiral tube

Examples 2a and 2b. McCloskey, Solutions to the spiral tube problem

leaves the tube it will travel in a straight line in the direction of its instantaneous velocity at the moment it exits the tube, as shown in Example 2b.

In order to explain the remarkable consistency exhibited by his subjects' incorrect responses to this and similar problems, McCloskey proposed that these responses were based on what he called a *naive impetus theory*. This theory rests on two fundamental assertions about motion. The first assertion is that the act of setting an object in motion imparts to the object an internal force or "impetus" that serves to maintain the motion (ibid., 306). Thus the curvilinear impetus imparted to the metal ball as it travels through the spiral tube shapes its path once it exits the tube. The second assertion is that a moving object's impetus gradually dissipates (either spontaneously or as a result of external influences), and as a consequence the object gradually slows down and comes to a stop. As a reflection of this assertion, subjects tended to show the path of the ball straightening out the farther it got from the end of the tube. McCloskey noted that this theory was highly similar to pre-Newtonian physical theories popular in the fourteenth through sixteenth centuries, vestiges of which can be seen in the work of such pioneers as Galileo Galilei (ibid., 317).

McCloskey's work vividly demonstrates that theories—or what I shall later formalize as **conceptual models**[1]—are central to how we structure our understanding of the world. An extensive body of recent work by cognitive scientists has suggested that cognitive structures of this sort provide essential guides to inference and reason, and are in general basic to thought. In this essay, I want to explore the role conceptual models play in theories of music. Basic to my approach is the assumption that theorizing about music is an activity specialized only in its domain, not in the cognitive processes it involves. Conceptual models are accordingly an integral part of theories of music. Our analyses of music are conditioned and constrained by the conceptual models we employ, just as our accounts of the behavior of physical objects are shaped by our theories of motion.

The effect different conceptual models have on accounts of music can be seen in three analyses of the opening eight measures of the rhythm theorist's hobby horse, the theme from the first movement of Mozart's A major piano sonata, K. 331 (Example 3).

Edward Cone gave his analysis of this theme in his *Musical Form and Musical Performance* of 1968. The analysis comes just after the introduction of a striking metaphor for the melodic and harmonic shape of a musical phrase: Cone likens the shape of a phrase to a game of catch.

> If I throw a ball and you catch it, the completed action must consist of three parts: the throw, the transit, and the catch. There are, so to speak, two fixed points: the initiation of the energy and the goal toward which it is directed; the time and distance between them are spanned by the moving ball. In the same way, the typical musical phrase consists of an initial downbeat (/), a period of motion (‿), and a point of arrival marked by a cadential downbeat (\). (Cone 1968, 26–27)

Cone uses this notion of the shape of a musical phrase in his treatment of the rhythm of Mozart's theme; his analysis of the opening period is given in Example 4. He rejects a simple alternation of strong and weak measures, an alternation typical of many rhythmic analyses, on the basis of harmony: the first and fifth measures of the period should be strong because of the firm statement of tonic; the fourth and eighth measures should also be strong because of the emphasis provided by the cadences. A consideration of the motivic structure of the period refines this analysis. The first phrase consists of two individual sequential measures followed by a two-measure unit. The shape of the two-measure unit duplicates the shape of the phrase in miniature: it consists of two half-measure units followed by a full measure. As shown in Example 4, the internal dynamic of the two-measure unit is the same as that of the complete phrase. The second phrase begins with the same sequential measures as the first, but in m. 7 the compression that prepares the closing cadence brings the rise from A to C♯ into prominence. Cone's hearing of this rise as a third member of the sequence prompts him to assign it the same

Example 3. Mozart K. 331/I/theme, mm. 1–8

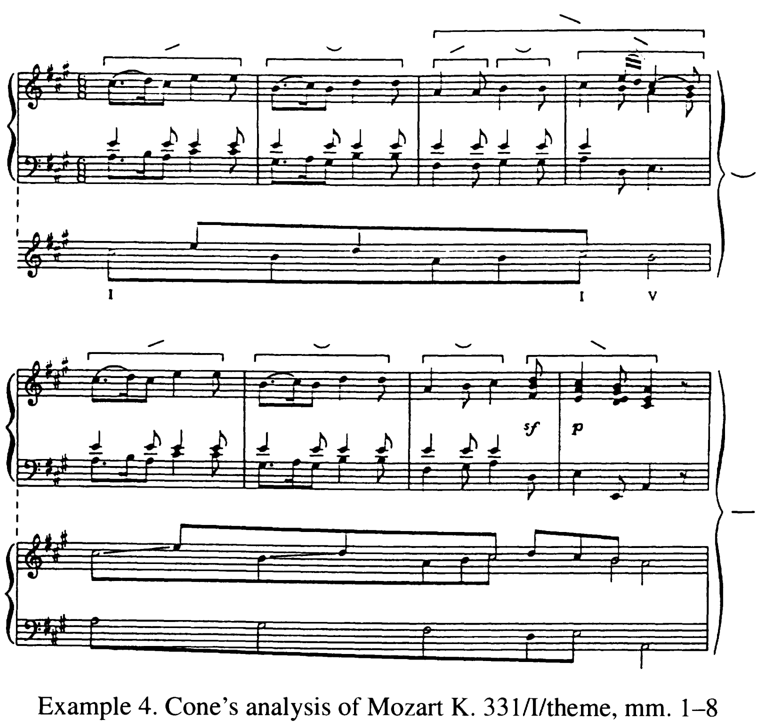
rhythmic symbol as the second member of the sequence, heard in m. 6. Voice-leading concerns and the forward energy of the *sforzando* cause Cone to group the final eighth of m. 7 with the cadential material of m. 8; this constitutes the closing downbeat.

Although Leonard Meyer's analysis of Mozart's theme appeared after Cone's (first in a Bloch lecture of 1971, then in his *Explaining Music* of 1973), his methodology is essentially the same as that which he had developed with Grosvenor Cooper over a decade earlier. Cooper and Meyer understood rhythmic structure to be perceived as "an organic process in which smaller rhythmic motives, while possessing a shape and structure of their own, also function as integral parts of a larger rhythmic organization" (Cooper and Meyer 1960, 2). Rhythmic relationships are analyzed as patterns of beats, in which a stable accent and one or more weak beats are grouped together in different ways; these low-level, foreground patterns combine with one another in various ways to form more extended rhythmic groupings. In this way the musical surface gives rise to a hierarchy of rhythmic groupings (Meyer 1973, 27–28).

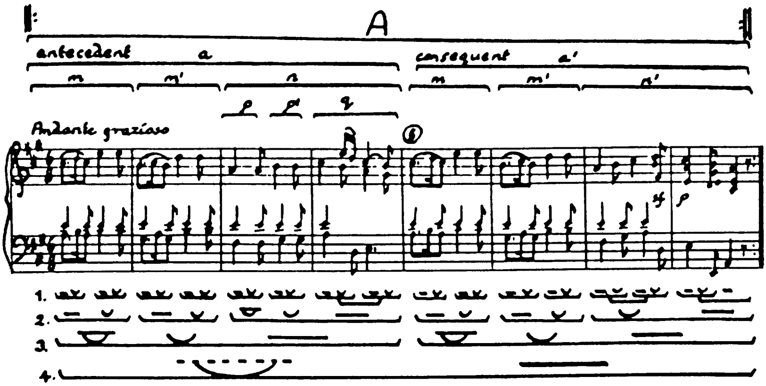
Meyer's analysis of the opening period of Mozart's theme is given in Example 5. The first level of the analysis starts at the half-measure level of the music, important for Meyer because the dotted-eighth/sixteenth/eighth patterns of the first two measures of each phrase do much to determine the grouping and accentual pattern of the complete bar. In mm. 3 and 4 Meyer's analysis on level 2 corresponds closely with Cone's reading: although the symbols are slightly different (Meyer's indication for a retrospectively weak accent replacing Cone's symbol for an initial downbeat), on this level as well as the third and fourth the analyses for the most part agree. The main difference between the two is that Cone *starts* his analysis at what for Meyer is the third level of a rhythmic hierarchy.

In his 1978 article "The Theory and Analysis of Tonal Rhythm" Robert Morgan noted that, although both Cone's and Meyer's work reflected the influence of Heinrich Schenker's theory of tonal music, their analyses of Mozart's theme were still beholden to certain aspects of metrical dogma. For his part, Morgan proposed considering the theme from a more consistent Schenkerian viewpoint. Morgan noted that Schenker's theory supplied a method for locating points at which structural motions originate and terminate; his idea was to correlate these points of structural origin and termination with the points of principal accent through which the larger rhythm of a passage is regulated. In Morgan's analysis the first phrase of the theme is governed by the overall motion from C♯5 and A3, in m. 1, to B4 and E3 in m. 4 (see Example 6, level 3). This overall motion is articulated on the next level (level 2 of Example 6) by a motion down to A4 and F♯3 in m. 3. Although the A4 could be seen as the completion of a third span from C♯5, the bass F♯3 and the acceleration away from A4 to B4 on the second beat of m. 3 prevent closure.

Up to this point Morgan's analysis agrees, in most respects, with the analyses by Cone and Meyer. However, Morgan does not believe the first beat of m. 4 should be heard as accented relative to the second beat. The



Example 4. Cone's analysis of Mozart K. 331/I/theme, mm. 1–8



Example 5. Meyer's analysis of Mozart K. 331/I/theme, mm. 1–8

acceleration of m. 3 continues into m. 4, carrying the music forward to the arrival of the bass on the dominant on the second beat, an arrival that is the rhythmic goal and closing accent of the phrase. From Morgan's perspective the rhythm of this phrase is not a matter of strong and weak beats or strong and weak measures; the rhythm is created by an articulated tonal process that moves between the two points defined by the outer-voice frame (Morgan 1978, 446).

The acceleration in the first phrase is answered by an even greater acceleration in the second, for the consequent phrase must go through the dominant to arrive on the tonic. The arrival on tonic gives a different character to the closing accent of the second phrase; for Morgan, it is the difference in character between the two closing accents, and not some analogy to two large beats, that is responsible for the upbeat-downbeat effect created by the pairing of antecedent and consequent. The notion that accent refers to a *point* of emphasis, a notion implicit in this analysis, also leads Morgan to reject Cone's and Meyer's reading of the rhythm of mm. 3 and 4 as a diminution of the overall rhythm of mm. 1 through 4. If mm. 3 and 4 supply the downbeat for mm. 1 and 2 they must represent an arrival, but in fact the point of arrival occurs only at the end of the unit. Morgan does not believe m. 3 can be both an arrival and a departure at the same time.

Although these three analyses converge on a number of points, it is in their divergences that they are instructive. These bear witness to different conceptual models, much as the different solutions to McCloskey's spiral tube problem reflect different theories of the behavior of physical objects. More specifically, these analyses use two different models of hierarchy to characterize the structure of music. One model views musical

Example 6. Morgan's analysis of Mozart K. 331/I/theme, mm. 1–8

hierarchy as the consequence of a single overarching principle that, through elaboration, gives rise to the musical surface. The other model views musical hierarchy as the result of small patterns that combine to form larger patterns, which in turn combine to form still larger patterns.

These models of hierarchy are not unique to accounts of musical organization, but are borrowed from other domains and applied to music. Such applications do not occur willy-nilly but are in fact highly structured by a cognitive process called **cross-domain mapping**, which recent research has shown to be pervasive in human understanding. An explanation of why it is possible to apply certain models to certain domains, as well as how a given conceptual model constrains our reasoning—why a particular model of hierarchy allows us to say some things about music but not others—requires a consideration of basic aspects of the process of cross-domain mapping.

In the following three sections I shall give a fuller account of conceptual models, the process of cross-domain mapping, and the role both play in theories of music, using ideas about the hierarchical organization of music as a point of focus. In the first section I shall take up the basic features of conceptual models, as well as the process of cross-domain mapping through which these models come to be applied to music. In the second section I shall offer an account of the historical sources and structural attributes of two conceptual models of hierarchy. In the third section I shall offer an analysis of the way these models of hierarchy are used in the accounts of Mozart's theme by Cone, Meyer, and Morgan, and consider in more detail how conceptual models condition and constrain theories of music.

Conceptual Models and Cross-domain Mapping

The basic notion of a conceptual model I shall use here is of a relatively stable cognitive structure that is used to guide inference and reason.[2] In its simplest form, a conceptual model consists of concepts in specified relationships, pertaining to a specific domain of knowledge. The conceptual model is stored in memory as a unit, and recovered in its entirety in response to environmental cues or stereotyped reasoning situations. I shall reserve the term **theory** for integrated clusters of conceptual models that share a common domain.

As a simple example of a conceptual model, consider our model for HEIGHT. This model involves concepts about objects in physical space, which are in specified relationships that rely on the concepts of linear measure and verticality; the most typical domain is *height relative to me*, although extensions of this domain (*height relative to me in an airplane aloft*; *height relative to an airplane aloft*) are readily available.

It is often the case that aspects of a conceptual model such as HEIGHT will be mapped onto another domain lacking some of the specific features of the source domain. For example, the relative positions *up* and *down*, which are part of HEIGHT, may be mapped onto the domain of emotions:

> I'm feeling *up*. My spirits *rose*. I'm feeling *down*. I *fell* into a *depression*. My spirits *sank*.

onto the domain of consciousness:

> Get *up*. I'm *up* already. He *rises* early in the morning. He *fell* asleep.

and onto the domain of health:

> He's at the *peak* of health. Lazarus *rose* from the dead. She's in *top* shape. He came *down* with the flu.

Each of these domains lacks the explicit spatial aspect of HEIGHT, and in each the concept of linear measure is relatively weak—that is, we do not normally keep in mind a detailed representation of gradations of emotions, consciousness, or health.

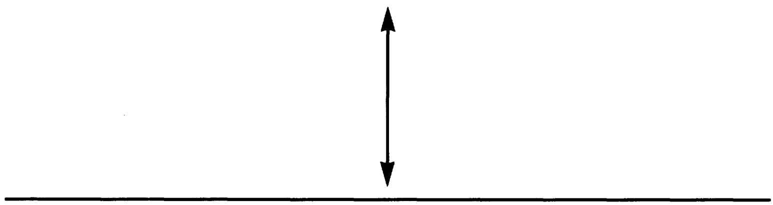
Wholesale mappings from a source domain (such as *height relative to me*) onto a number of different target domains (such as *emotions*, *consciousness*, and *health*) were first noticed not in a study of conceptual models but in George Lakoff and Mark Johnson's 1980 *Metaphors We Live By*. Lakoff and Johnson accumulated a substantial body of evidence (of which the examples given above are but a small sample) demonstrating that metaphor was not simply a manifestation of literary creativity, but was in fact pervasive in everyday discourse. Based on this evidence, they argued that metaphor was a basic structure of understanding through which we conceptualize one domain (typically unfamiliar or abstract—the target domain) in terms of another (most often familiar and concrete—the source domain). Since Lakoff and Johnson's initial study a number of other studies—including Fauconnier 1997, Gibbs 1994, Johnson 1987, Kövecses 1990, Lakoff 1987, Lakoff and Turner 1989, Sweetser 1990, Turner 1987, 1991, and 1996—have bolstered this argument. In these studies it has become conventional to use "metaphor" to refer to cross-domain mappings that are a basic part of our thought processes; the "metaphorical expressions" of language are surface realizations of such mappings.[3]

One challenge metaphor theorists have faced is the ultimate grounding of the process of cross-domain mapping. Even if we grant that we understand a target domain in terms of a source domain, how is it that we understand the source domain in the first place? Mark Johnson endeavored to answer this question by proposing that meaning was grounded in repeated patterns of bodily experience (Johnson 1987). These patterns give rise to what Johnson called **image schemata**, which provide the basis for the concepts and relationships essential to metaphor and, by extension, conceptual models. An image schema is a dynamic cognitive construct that functions somewhat like the abstract structure of an image, and thereby connects up a vast range of different experiences that manifest this same recurring structure (ibid., 2). Image schemata are by no means visual—the idea of an image is simply a way of capturing the organization inferred from patterns in behavior and concept formation. By definition, image schemata are preconceptual: they are not concepts, but they provide the fundamental structure upon which concepts are based.[4] In turn, cognitive structures concerned with concepts, such as conceptual models, are ultimately grounded in image schemata.

As one example of an image schema, consider the VERTICALITY schema, which might be summarized by a diagram of the sort given in Example 7.[5] We grasp this structure repeatedly in thousands of perceptions and activities that we experience every day. Typical of these are the experiences of perceiving a tree, our felt sense of standing upright, the activity of climbing stairs, forming a mental image of a flagpole, and watching the level of water rise in the bathtub. The VERTICALITY schema is the abstract structure of the VERTICALITY experiences, images, and perceptions. Our concept of verticality is based on this schema, and this concept is in turn the basis for the spatial orientation of up and down so crucial to conceptual models such as HEIGHT.

The theory of image schemata is also fundamental to current explanations of what makes cross-domain mapping possible. As George Lakoff and Mark Turner have suggested in their writings on the Invariance Principle, mappings are not about the *imposition* of the structure of the source domain on the target domain, but are instead about the establishment of correspondences between the two domains (Lakoff 1990, 1993; Turner 1990, 1993). These correspondences are not haphazard, but instead preserve the image-schematic structure latent in each domain. For instance, mapping the simple spatial relationship *up-down* onto the domain of emotions relies on our repeated experiences with what we ourselves feel and what we observe in others: buoyancy ("up") when exhilarated ("she walked with a spring in her step;" "I was floating on air"); deflation ("down") when depressed ("he walked as though he carried the weight of the world on his shoulders"). Mapping *up-down* onto the domain of emotions preserves the image-schematic structure of the physical states we associate with emotions, and imports the spatial orientation of the underlying VERTICALITY schema in order to provide a coherent account of these states.

We also map *up-down* onto the domain of musical pitch: we typically speak of "high" notes and "low" notes. We needn't look far to find a correspondence of *up-down* in our experience of musical pitch: when we make "low" sounds, our chest resonates; when we make "high" sounds,



Example 7. Diagram of the VERTICALITY scheme

our chest no longer resonates in the same way, and the source of the sound seems located nearer our head. The "up" and "down" of musical pitch thus correlate with the spatial "up" and "down"—the vertical orientation—of our bodies. Mapping *up-down* onto the domain of musical pitch preserves the image-schematic structure of our embodied experience of musical pitch, and imports the spatial orientation of the underlying VERTICALITY schema in order to provide a coherent account of this experience.

The VERTICALITY schema thus offers a straightforward way to explain why we characterize musical pitch in terms of *high* and *low* even when the actual spatial orientation of the means through which we produce pitches—for instance, the keyboard of a piano or the fretboard and strings of a guitar—either does not reinforce the characterization or runs directly counter to it. Of course, there is no necessity to this characterization—we can also understand pitch in terms of size, given that small things typically vibrate more rapidly than large things. This is in fact how pitch is characterized in Bali and Java: pitches are not *low* and *high* but *large* and *small*.[6]

When the mapping of *up-down* onto pitch is combined with the interpretation of pitches as objects and the division of the frequency continuum into discrete slots, almost the entirety of the conceptual model for HEIGHT can be applied to music. A visual manifestation of this model is provided in our notation of pitch: pitches are rendered as individual notes (or objects); notes that are the result of more rapid vibrations of the sounding medium are placed higher on the page than notes which result from less rapid vibrations (with the exception of sharps and flats); and the linear measure of pitch is divided into a sequence of slots, with each slot representing one element of a diatonic scale.

HEIGHT, of course, is a relatively simple conceptual model: it assigns no priority to pitches within its metaphorical space, provides no account of how one moves through or experiences this space, and in general renders pitches inert. Musicians have often used more complex conceptual models to vivify their characterizations of music and make their accounts of musical organization more comprehensive. Among these are two models of hierarchical organization that were first applied to music in a thoroughgoing way during the early nineteenth century, at about roughly the same time that theorizing about music came to be associated with official institutions dedicated to the study of music. These models also inform Cone, Meyer, and Morgan's analyses of Mozart's little theme. The first model, which I call a chain-of-being hierarchy, was used to characterize pitch organization. The second model, which I call an atomistic hierarchy, was used to characterize metrical organization. Although these two models are distantly related, they were originally developed at different points in the history of Western thought to cover non-intersecting domains of human experience. In the following, I shall trace the origins and basic features of these two models of hierarchical organization, and then turn to their application to music.

Two Models of Musical Hierarchy

Historical models of hierarchical organization

The principal mark of chain-of-being hierarchies is a conception of the universe as a precisely arranged system of interdependent levels or degrees of existence extending from a Supreme Being down to the lowliest organism. Although an incredibly rich collection of ideas—one writer has noted that the history of chain-of-being hierarchies is a history of Occidental thought (Patrides 1973, 434)—only a few central aspects need concern us here.

The ingredients for this complex of ideas came from Plato and Aristotle; Aristotle's connection of "powers of the soul" with levels of being in *De Anima* proved particularly influential. However, it was in Neoplatonism that these ideas first appeared fully organized into a coherent general scheme.[7] Crucial to this organization was Plotinus's notion that the perfection of the One included a superabundance which, overflowing, was the source of the Many, and that this generation of the Many from the One could not come to an end so long as any possible variety of being in the descending series was left unrealized. One of the principal ways the Neoplatonic cosmology was transmitted to the Middle Ages was through Macrobius's *Commentary on the Dream of Scipio* (late fourth, early fifth centuries of the Christian Era). In a passage expanding on the revelation presented to Scipio that minds are given to man out of the eternal and divine fire of the stars, Macrobius writes,

> Accordingly, since Mind emanates from the Supreme God and Soul from Mind, and Mind, indeed, forms and suffuses all below with life, and since this is the one splendor lighting up everything and visible in all, like a countenance reflected in many mirrors arranged in a row, and since all follow on in continuous succession, degenerating step by step in their down-

ward course, the close observer will find that from the Supreme God even to the bottommost dregs of the universe there is one tie, binding at every link and never broken. This is the golden chain of Homer which, he tells us, God ordered to hang down from the sky to the earth. (Macrobius 1990, 145)[8]

The notion of a Great Chain of Being proved a concise and powerful model through which humans could give order to their universe. It also provided a model through which the distribution of power could be accomplished and justified. The model is quite evident in ecclesiastical hierarchies: power flows from the top down, in the same way that being and soul flow from the Godhead down through the various levels of being, from highest to lowest.

Inherent in the Neoplatonic scheme is a tension between the self-sufficiency of the One and the multitudinous abundance of creation it gives rise to: it is a paradox that the One needs nothing else, and yet produces everything else. Giordano Bruno, writing in the sixteenth century, reveled in this paradox (Lovejoy 1936, 120). Yet it was also Bruno who, by combining the concept of atomism with the comprehensive organization provided by the Neoplatonic scheme, inspired a way of thinking about hierarchical organization that would eventually compete with the Great Chain of Being.

For Bruno, atomism was a metaphysical principle that provided the basis for a demonstration of the underlying unity of all nature (Kargon 1973, 133). This view was especially influential in England, where Bruno lived from 1583 to 1585, and where two factors combined to transform his vague, metaphysical scheme into a compelling account of order. The first was a challenge to the model for the distribution of power provided by the application of a chain-of-being hierarchy to the social sphere. In a social chain-of-being hierarchy, the power of any individual is linked, as an essential property, to the level occupied by that individual within the system: the higher the level, the greater the power over others. A refutation of this model can be seen in Thomas Hobbes's *Leviathan* of 1651. Hobbes argued that all humans were basically equal in the faculties of body and mind: all had approximately equal power over others. Because of this equality, the natural state of individual humans was one of competition. Only by imposing a social order on humans from without, in the form of a common power "to keep them all in awe," was it possible to overcome the natural state of virtual or actual war (Hobbes 1651, chapter 13). Thus the properties ascribed to each member of a society (which result in equal measures of power for all members) are different from those according to which societal order should be established (which result in unequal measures of power): the properties of the individual are independent of the properties of the system.

The second factor important in the development of an alternative view of hierarchical organization was the increased presence of mechanical devices in people's lives (Kargon 1973, 132). These machines provided thinkers of the time with practical models of the organization of nature. Among the most important of these was the mechanical clock. As Gideon Freudenthal has observed,

> In the construction of the mechanical clock it was possible to produce complicated movements by an appropriate disposition of gears and a driving force. The task of science [in the seventeenth and eighteenth centuries] can be interpreted as the attempt to discover in a limited area and to a limited extent the principles of construction of the divine clock. (Freudenthal 1986, 63)

The model of a clock is one that appears consistently in the dispute between Isaac Newton and Gottfried Wilhelm Leibniz on the ultimate nature of matter. Although the details of this dispute need not concern us here (they are discussed in detail in Freudenthal 1986, chapter 3), the different methodological approaches used by Newton and Leibniz are of interest. Leibniz held to what had become, by the early eighteenth century, a traditional Baconian methodology: scientific inquiry should seek to disassemble the divine clock, piece by piece, never speculating beyond what could be observed. Although Newton was in sympathy with this methodology, it was inadequate for a purely mechanical account of physics since the ultimate workings of the clock—its atomic structure—could not be observed. Newton's solution, given in the final "Query" appended to the fourth edition of his *Opticks*, was a practical one, which divided scientific theorizing into two halves (Hughes 1990, 177). The first half is *analysis*:

> This Analysis consists in making Experiments and Observations, and in drawing general Conclusions from them by Induction, and admitting of no Objections against Conclusions, but such as are taken from Experiments, or other certain Truths. (Newton [1730] 1952, 404)

The second half is *synthesis* or *composition*, in which the various inductive generalizations produced by analysis are organized into a logical system based on a limited number of essential principles. In the case of the divine clock, synthesis of necessity played a larger role than analysis (which led Leibniz to accuse Newton of arguing from hypothesis rather than from observation). However, Newton believed this exception to his overall methodology was justified by the potential results:

> to derive two or three general Principles of Motion from Phænomena, and afterwards to tell us how the Properties and Actions of all corporeal Things follow from those manifest Principles, would be a very great step in Philosophy, though the Causes of those Principles were not yet discov-

> er'd: And therefore I scruple not to propose the Principles of Motion above-mention'd, they being of very general Extent, and leave their Causes to be found out. (Newton [1730] 1952, 401-402)

In other words, the scientist simply had to assume that the general principles produced by synthesis held even on levels that could not be directly observed: the mechanical workings of the divine clock were assumed to be consistent throughout.

When combined with the independence of elemental and systemic properties proposed in the social sphere, this approach developed into a new conception of hierarchical order, which I call an atomistic hierarchy. In contrast to a chain-of-being hierarchy, an atomistic hierarchy can be built from the bottom up, its organization governed by a set of general principles that obtain no matter what the specific attributes of a given level. It is a concise and concrete account of organization, and one that, through applications in physics, chemistry, and biology, has had an enormous influence on how humans view their world.

Structural features of chain-of-being and atomistic hierarchies

Each of the two sorts of hierarchy I have discussed offers a different view of how the world is organized. The fundamental conceit of chain-of-being hierarchies is to regard a domain as a huge organism pervaded by a force, the origins of which are mysterious. "Being" and "political power" are both examples of such forces. This force manifests itself as properties instantiated in varying degrees by the elements of the domain. In a traditional Great Chain of Being, for instance, a rock has the property of *substance*, a tree has the properties of *substance* and *life*, and an insect has the properties of *substance*, *life*, and *mobility*. The domain can be organized into a hierarchy in which any given level is distinguished by a specific set of properties that embody aspects of Being. These properties include all of the properties that distinguished lower levels, plus properties unique to the given level: trees include *substance* and add *life*; insects include *substance* and *life* and add *mobility*. Inclusion within the hierarchy is thus of properties, but not elements.

The fundamental conceit of atomistic hierarchies is to regard a domain as an extended mechanism operating according to a limited set of general principles. The laws of classical physics are an example of one such set of principles. All of the actions and properties of elements within the domain, from the smallest to the largest, and from the most simple to the most complex, follow these general principles. Thus sub-atomic particles and planets both conform to the same principles. Classes of elements may be distinguished according to common conformance with the general principles of the system. The actions and properties of electrons, protons, and neutrons on the atomic level are by no means identical, but they can be distinguished from the actions and properties of atoms on the molecular level. In addition, all of the elements within a given class have the shared property of combining into units: electrons, protons, and neutrons combine to form atoms, and atoms combine to form molecules. The domain can be organized into a hierarchy in which each level is a conformance class whose elements combine into units which constitute the elements of the next higher level in the hierarchy. This process continues recursively until the limits of the system are reached. Inclusion within the hierarchy is thus of elements, but not properties.

The basic structure of each of these models of hierarchy can be described in terms of relationships that are established between the general, abstract property of "energy" and the CONTAINER schema.[9] "Energy" takes form as the mysterious force of a chain-of-being hierarchy, or the power that drives the mechanism of an atomistic hierarchy. For both models, the CONTAINER schema provides the basic internal structure of the levels that make up the hierarchical system.

In a chain-of-being hierarchy, the energy in terms of which the system is defined (*e.g.*, "Being," or "political power") is distributed unequally throughout the system. Systemic organization is consequently based on the amount of energy (interpreted as "properties of Being" or "extent of political power") each element of the system has. The containers (or hierarchical levels) that articulate this organization group elements according to their amount of energy (or systemic properties). Although chain-of-being hierarchies oftentimes offer vivid and dynamic accounts of organization, hierarchical structure (based on the contents of the containers that make up the hierarchy) is in fact relatively abstract.

In an atomistic hierarchy, energy is distributed throughout the system according to a fixed set of general principles. Systemic organization is consequently based on the way different elements of the system manifest these principles. The containers (or hierarchical levels) that articulate this organization group elements according to common conformance with the general principles. The generality of the organizing principles of atomistic hierarchies means that the principles can seem somewhat removed from actual experience, although hierarchical structure (based on the contents of the containers that make up the hierarchy) is in fact relatively concrete.

Given these structural attributes, each model has a slightly different potential as a source domain. A chain-of-being hierarchy will map these predicates onto a target domain:

= the target domain is pervaded by a mysterious force
= this force manifests itself as properties instantiated to varying degrees by the elements of the domain

= the domain can be organized into a hierarchy in which each level is distinguished by a unique set of properties
= each level of the hierarchy includes all of the properties of the next lower level, and adds new properties unique to that level
= the higher levels of the hierarchy more completely manifest the mysterious force (and are thus more perfect) than the lower levels of the hierarchy

Because chain-of-being hierarchies have often been used to structure natural and human domains, applying the model to other domains may suggest that elements of that domain have natural or anthropomorphic aspects, even though these are not necessary entailments of the mapping.

An atomistic hierarchy will map these predicates onto a target domain:

= the target domain is analogous to an extended mechanism
= this mechanism operates according to a limited set of general principles
= all of the actions and properties of elements within the domain follow these general principles
= classes of elements may be distinguished according to common conformance with the general principles, and the shared property of combining into units
= the domain can be organized into a hierarchy in which each level represents a conformance class
= the elements on each level of the hierarchy combine to form units; these units constitute the elements of the next higher level in the hierarchy
= the recursive combination of elements into units continues until the limits of the system are reached.

Because atomistic hierarchies have often been used in scientific explanations, applying the model to other domains may suggest that a "scientific" approach is being used, even though this is not a necessary entailment of the mapping.

Given the different structural attributes each model of hierarchy will map onto a target domain, it follows that each provides a different model for reasoning about the target domain. Nowhere is this clearer than in the first thoroughgoing applications of these models to the domain of music during the early nineteenth century.

Mapping models of hierarchy onto music

Early in his *Cours complét d'harmonie et de composition* of 1806 Jérôme-Joseph de Momigny presents a C major scale arranged as two symmetrical tetrachords, as shown here:

G a b C
C d e F

Of the three main notes, G, C, and F, which, Momigny muses, is the most important? His response is accompanied by a telling image:

> it is [tonic] who plays the premiere role in *le Ton*. She is the center of gravity, the purpose of all purposes, the end of all ends; in a word, it is to her that the scepter of the musical empire is entrusted.[10]

At the beginning of the chapter in which this passage occurs Momigny linked his concept of *le Ton* with that of hierarchy;[11] with his image of tonic holding the scepter he leaves no doubt as to what sort of hierarchy he has in mind. A similar, if less colorful, image is near the center of his explanation of order in music, which appears twelve years later in the second volume of the *Encyclopédie méthodique*. This order, which Momigny claims is purely metaphysical, consists in a natural hierarchy of seven notes that are arranged according to the authority of the one called tonic (Momigny 1818, 2:179). As Renate Groth has noted, this is essentially the same definition of order given over two decades later by François-Joseph Fétis; the most important difference is that Fétis assigned this order the name *tonalité* (Groth 1983, 58).

By mapping a chain-of-being hierarchy onto the domain of music Momigny creates a very specific notion of *le Ton*. The origin of *le Ton* is mysterious—Momigny never gets more specific than claiming that it is "metaphysical." The notes organized by *le Ton* occupy different levels, according to their directive force; these levels Momigny establishes through various musical propositions (Momigny 1806, 1:49ff.). Perhaps most important, notes are regarded as agents with powers proportional to their status within the hierarchy: the properties characteristic of *le Ton* increase as one ascends towards tonic. Thus, even though Momigny identifies dominant as the generator of the scale (based on the presence of a minor seventh in the overtone series) he argues that it must be regarded as subservient to tonic, for the authority of tonic cannot be challenged (ibid., 1:47–48).

The conception of tonal organization produced by mapping a chain-of-being hierarchy onto music was a powerful one. We see it not only in Momigny's early formulation of the concept of *le Ton*, but also in the persuasive account of tonal organization presented in the first and third volumes of Heinrich Schenker's *Neue musikalische Theorien und Phantasien*. As presented in *Harmonielehre*, the mysterious force that pervades the domain of music is that of Nature, manifested through the overtone series. In Schenker's conception, every tone within the musical domain is possessed of the urge to produce endless overtones, much as living beings have procreative urges.[12] Beginning with a single tone, Schenker creates a community of tones arranged in hierarchical order, with the notes closest to the source-pitch having priority over those more remote (Schenker 1906, §§17-18, pp. 54-55). The tonal system that results is a manifestation of the desire of the source tone to rule over others, and to extend this rule as far as possible.[13] In his *Der freie Satz* of almost thirty years later Schenker retained this conception of tonal organization and, by emphasizing the organicism latent in this conception, built from it an account of the coherence of entire works of music. He did this by proposing that the transformation of the musical source (now the *Naturklang*, or chord of nature) proceeded through discrete levels from background to foreground. The background represented an abstract, initial working-out of the tendencies of the chord of nature through the *Ursatz*, or fundamental structure; the foreground represented the musical work as we conventionally think of it.[14] Schenker makes clear that this foreground *emanates* from and is controlled by the background.[15] Thus the hierarchical organization of music is no longer restricted to the ordering of single tones into a scalar system, but manifests itself as a series of transformations that steadily enrich musical content. In Schenker's vision of the relationship between structural levels a version of the Neoplatonic cosmogony central to the original Great Chain of Being continues to echo:

> Between fundamental structure and foreground there is manifested a rapport much like that ever-present, interactional rapport which connects God to creation and creation to God. Fundamental structure and foreground represent, in terms of this rapport, the celestial and the terrestrial in music. (Schenker 1979, 160)[16]

A rather different view of musical order is presented by Gottfried Weber in his *Versuch einer geordneten Theorie der Tonkunst*, which appeared in a number of editions in the early nineteenth century. When this view is introduced Weber's topic is not the organization of pitches, but the organization of musical rhythm. For Weber, rhythm depends on regularity, and the mechanical nature of this regularity is revealed in his breathless definition:

> If . . . a symmetrical measured division of the times is found in a piece of music, i.e., the time is distributed into exactly equal general divisions, and these are again divided into equal parts, and the latter are farther separated into equal smaller quotas or proportional parts, &c. and the duration of the tones in relation to one another is exactly measured according to such divisions of time, so that a general division always appears as a symmetrically arranged group of several smaller portions of time, and these taken together as a smaller subordinate group of yet smaller parts, and the accent is also symmetrically apportioned amongst all these divisions of time—then the music is measured and rhythmical. . . (Weber 1851, 1:62 [§47])

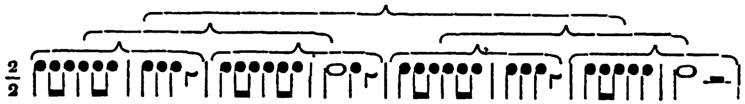
This mechanical notion of rhythm is accompanied by a mechanical notion of time-keeping: Weber emphasizes the importance of inventions like the metronome and devotes a lengthy footnote to instructions for constructing a pendulum that will accomplish the same thing (ibid., 1:68–71).

Weber follows his digression into the mechanics of time-keeping with a detailed account of the rules by which musical measures are constructed, first dividing the measure into its constituent parts and then building measures according to symmetrical patterns of accent. He then proceeds to further levels of rhythmic organization.

> But there is still a *higher* symmetry than this. That is to say, as parts of times taken together form small groups, so also can several groups taken together be presented as parts of a larger group, of *a greater* or *a higher rhythm*, of *a rhythm of a higher order.*
>
> We may go still farther, and to such a greater rhythm we may annex moreover a second and a third, so that these two or three together constitute again a still higher rhythm. Thus, e.g. in the following passage [Example 8], two measures taken together constitute a small rhythm, two of these taken together constitute again a rhythm of a higher species, and again two of the latter taken together constitute a capital or principal rhythm. (ibid., 1:85 [§68])
>
> The construction of the members of the larger rhythms is a symmetry proceeding more by the gross; it is perfectly similar to that involved in the structure of measures, except simply that it is all on a larger scale. As a measure consists of two or three parts, so two or three measures form the parts of a greater rhythm, and several such rhythms are again parts of a still higher group.
>
> Hence the measures are distinguished from one another in such higher rhythms, in respect to their greater or less internal weight or accentuation, in the same way the parts of the measure are distinguished among themselves; i.e., the heavy or accented *measures* assume a prominence above the lighter, as do the heavier *parts* of the measure above the lighter. (ibid., 1:87 [§69])

What Weber has described, of course, is an atomistic hierarchy of metrical groups: beats combine into measures, measures combine into groups of measures, and so on up through a series of hierarchical levels.

Mapping an atomistic hierarchy onto the domain of musical rhythm emphasizes the regularity of accentual pattern often associated with the concept of meter. By turning rhythm into a machine, Weber can describe its organization with three basic principles: (1) all units of rhythm are either accented or unaccented; (2) these units are grouped into cyclic pat-



Example 8. Weber's example of hierarchical levels of rhythm

terns of accent which form symmetrical groups; (3) the groups of one level constitute the units of the next higher level. All of the objects within this domain must conform to these principles, but not necessarily in exactly the same way: although accent or non-accent applies to both beats and groups of measures, with beats the property lasts for but an instant, whereas with groups of measures the property lasts for the duration of the group. No limit is specified for the hierarchy that results, although Weber does not develop levels beyond those shown in his example.

The approach to musical rhythm proposed by Weber became standard during the nineteenth century, although subsequent theorists often added interesting complications. Moritz Hauptmann, for instance, imposed a Hegelian interpretation on metrical groupings, which permitted him to frame the basics of meter and harmony in the same terms (Hauptmann 1893, 189ff.). By the time of Hugo Riemann's 1903 *System der musikalischen Rhythmik und Metrik*, the hierarchical structure represented by Weber's "capital or principal rhythm" was presented as the normative framework (*normatives Grundschema*) of rhythmic organization: beats formed measures, which in turn formed duple groups, which combined into two half-phrases of four measures each, which joined to create the eight-measure phrase (Riemann 1903, 196–98).

Reasoning about music through chain-of-being and atomistic hierarchies

Chain-of-being and atomistic hierarchies developed at different points in the history of Western thought to cover non-intersecting domains of human experience. These differences are reflected in the basic structure of each type of hierarchy, and result in two distinct models for reasoning about the world. When these models are mapped onto music they yield different inferences about how musical materials are organized, which lead to different ways to analyze music. If our reasoning is guided by a chain-of-being hierarchy, we infer that each musical work constitutes a domain pervaded by a mysterious force. Musical analysis consists in explicating the way different musical elements embody this mysterious force. By this means the proper place of these elements in the musical hierarchy can be determined, and an account of musical structure produced. If our reasoning is guided by an atomistic hierarchy, we infer that each musical work operates like an extended mechanism. Musical analysis consists in identifying the basic components of this mechanism and explicating the principles according to which it works. The view of musical structure that results is of a hierarchy of distinct yet interrelated substructures that, combined, constitute the musical work.

With these two models for reasoning in mind, let us now return to the three analyses of the rhythmic organization of Mozart's little theme discussed above and consider in more detail how conceptual models condition and constrain musical analysis.

Conceptual Models and Music Theory

According to the Schenkerian paradigm Robert Morgan adopts, tonality is characterized by the property of control: within a tonal composition, every pitch controls or is controlled by other pitches. Pitches located at the foreground have only the property of being controlled. Pitches located at middleground levels control pitches at lower levels and are themselves controlled by pitches at higher levels. Pitches located at the background level are governed only by restrictions placed on the *Ursatz* by the chord of nature.

Morgan's correlation of rhythmic organization with this account of tonal organization has two important entailments for the conception of musical rhythm. First, rhythm becomes a matter of motion between structurally significant events: the initiation and completion of each rhythmic motion is marked by the appearance of the pitches that control a given span; the character of the rhythmic motion will reflect relationships between these controlling pitches. Thus the first rhythmic motion of Mozart's theme begins with the *Kopfton* in m. 1, and ends with the appearance of $\hat{2}$ in m. 4; the motion has the character of an antecedent because a complete motion from $\hat{3}$ to $\hat{1}$ has not yet been achieved (see Example 6). Second, the type of accent assigned a given musical moment will tend to be unequivocal. Emphasis, as an articulation of rhythmic motion, follows from hierarchical structure: emphasized pitches will be those located at higher levels of the tonal hierarchy. Because the location of a given pitch within the hierarchy is not equivocal, the emphasis it receives will not be equivocal. Thus m. 3 cannot have both an upbeat accent and a downbeat accent at the same time, but must be given a rhythmic reading that matches the overall tonal structure.

Although Leonard Meyer's treatment of Mozart's theme certainly takes account of tonal structure, his rhythmic analysis begins, as noted above, at the musical surface. The accentual groups of the first (surface) level of the hierarchy become the elements of the second level of the hierarchy; the accentual groups of the second level become the elements of the third level; and so on up through four levels of hierarchical organization (see Example 5).[17]

From Meyer's perspective, rhythmic organization, insofar as it is metrical, is independent of tonal organization, since the elemental patterns of metrical accent can be specified in the absence of pitch. The overall rhythmic character of a passage results from an interaction between tonal organization and patterns of metrical accent occurring on a number of hierarchical levels. The emphasis accorded a given musical event can only be reckoned in context: on level 2 of Meyer's hierarchy m. 3 is (as a whole) accentually weak; on level 3 it is one component of a strong accent; and on level 4 it is a subcomponent of a weak accent. The property of accent is, in consequence, different on each hierarchical level, since the accent proper to each level pertains to different spans of musical events.

The differences between these two accounts of the rhythmic structure of Mozart's theme follow in part from the way each model of hierarchy constrains reasoning about music.[18] From the perspective of a chain-of-being hierarchy, the musical surface is the least important of all levels; given the way musical events are assigned to hierarchical levels, any polysemous reading of such events is little more than analytical dithering. From the perspective of an atomistic hierarchy, there can be no grand plan of musical organization that does not originate with the simplest and most readily apprehended of musical materials. However, there is a bit more to the story: the constraint these models impose on our reasoning goes beyond the inferential possibilities provided by their relational structure and penetrates to the very core of what counts as relevant phenomena for theorizing and analysis. Indirect evidence for this constraint is supplied by the way each model of hierarchy is mapped onto music: chain-of-being hierarchies have been mapped almost exclusively onto the domain of musical pitch—they have generally not been mapped onto the domain of musical meter; atomistic hierarchies have been most often mapped onto the domain of musical meter—mapping them onto the domain of pitch has not met with wide acceptance.[19] This evidence suggests that the relationship between source domain and target domain is in fact not arbitrary, but is itself constrained by basic predicates of the process of cross-domain mapping.

This particular aspect of the constraint imposed by conceptual models returns us to the Invariance Principle of Lakoff and Turner. According to this principle, for those portions of the source and target domains involved in a cross-domain mapping, the mapping preserves the image-schematic structure of the target domain and imports as much of the image-schematic structure from the source domain as is consistent with this preservation.[20] Mapping a model of hierarchy onto music will preserve aspects of our musical experience, and structure these by importing the relationships between "energy" and the CONTAINER schema embodied by this model. When we take a chain-of-being hierarchy as the source domain we preserve our sense that some aspects of music are more important than others, and import a model of systemic organization in which energy is distributed unequally and hierarchical levels group elements according to their amount of energy. This mapping works well for the asymmetrical pitch relations typical of tonal music, but less well for the measured domain of metrical rhythm. When we take an atomistic hierarchy as the source domain we preserve our sense that some aspects of music are regular and recurring, and import a model of systemic organization in which energy is distributed equally and hierarchical levels group elements according to common conformance with general principles. This mapping works well for the measured domain of metrical rhythm, but less well for the asymmetrical pitch relations typical of tonal music. Thus the image schemata that ground our conceptual models also facilitate mapping these models onto novel domains, subject to the limitations of the image-schematic structure of both domains.

Additional evidence for the role played by image schemata in conceptual models and cross-domain mapping is suggested by Edward Cone's analysis of Mozart's theme, which makes use of a blend of the approaches to musical organization used by Morgan and Meyer. For Cone, as for Morgan, musical rhythm involves motion between points of tonal stability. The first and fifth measures of the theme should be strong because of the firm statement of tonic; the fourth and eighth measures should also be strong because of the emphasis provided by arrivals on important harmonies. However, Cone, like Meyer, is also interested in the contribution of the musical surface to our understanding of musical rhythm as a whole. Cone's overall interpretation of the rhythmic structure of the opening eight measures is thus shaped by meter, motivic structure, and surface accents. What guides Cone's analysis is his concept of musical energy—it was this that prompted his comparison of a musical phrase to a game of catch. The path of energy that marks the transit of the ball in the game of catch is the analog for the path of musical energy constituted by a given passage in a work of music. Starting with the concept of energy rather than with a model of hierarchy allows Cone to tap into both models of hierarchy and draw from each what he needs. By this means he can forge a single account of musical rhythm that recognizes both models of hierarchy but which is restricted to neither.

That Cone is able to do this is no accident, for in doing so he demonstrates what Mark Turner and Gilles Fauconnier have called **conceptual blending** (Fauconnier 1997; Fauconnier and Turner 1996; Turner 1996, chapter 5; Turner and Fauconnier 1995). The details of blending need not concern us here; what is most important is that Cone's account draws on two conceptual models to create a characterization of musical rhythm that blends aspects of both, and that he is able to do this through a general, abstract property central to the image-schematic structure of both models.

According to the approach I have developed here, the discrepancies between these three analyses of Mozart's theme reflect the role played by conceptual models in theories of music. At work are two different models of hierarchical organization. One maps a chain-of-being hierarchy onto music, and highlights one set of aspects of the musical domain. The other maps an atomistic hierarchy onto music, and highlights a different set of musical aspects. Two of the analyses—those by Robert Morgan and Leonard Meyer—rely on relatively straightforward mappings, one from each model of hierarchy. Where the structure of the models of hierarchy diverge, there also will the musical analyses based on these models diverge. The third analysis, by Edward Cone, blends the two mappings by focusing on commonalities between their image-schematic structures. By focusing on these commonalities, Cone puts some distance between his interpretation and notions about hierarchical organization and produces yet a third analysis of Mozart's theme. The discrepancies between the three analyses are thus not the result of different opinions about what constitutes the theme of the first movement of Mozart's sonata, nor are they a consequence of analytical inconsistencies; they instead follow from the structure of these two conceptual models and the way they are employed in accounts of music.

Conclusion

In this essay I have proposed that our reasoning about the world is guided by conceptual models, which are relatively stable cognitive structures that consist of concepts in specified relationships, and that pertain to specific domains of knowledge. The ultimate grounding of conceptual models is provided by image schemata, which function as cognitive summaries of repeated patterns of bodily experience. Theories consist of integrated clusters of conceptual models that share a common domain.

The conceptual models fundamental to theories of music are most typically borrowed from concrete domains and brought to bear on the domain of music through the process of cross-domain mapping. This process relies on establishing correspondences between the image-schematic structure of the source domain and the image-schematic structure of the target domain. Each such mapping will preserve only a portion of the structure of the target domain, and import only as much of the structure of the source domain as is appropriate. The description afforded by applying any given conceptual model to the domain of music is consequently constrained by those aspects of the structure of the target domain that are preserved in the mapping, and those aspects of the structure of the source domain that are imported. Our accounts of music may vary widely, but they will not vary absolutely inasmuch as they are limited by the process of cross-domain mapping.

It follows that conceptual models do not give us access to deep, timeless, and immutable truths about musical structure. They instead offer us an image of how we construct our understanding of music. This image reveals not only those aspects of musical experience that are important to a culture or subculture at a given historical moment, it also gives an indication of what counts as a particularly clear or compelling model for a given writer. Thus the asymmetrical pitch relations typical of tonal music have been described in terms of logic (Riemann 1874), centripetal forces (Louis and Thuille 1920), psychological energetics (Kurth 1913), and gravity (Schoenberg 1978), as well as in terms of chain-of-being hierarchies.[21]

My account of the role played by conceptual models in theories of music must be regarded as preliminary: although we know much more about the human mind than we did twenty years ago, we still know surprisingly little. What we do know suggests that "the mind" is staggeringly complex and admits of no simple explanations of what it is or how it operates. Nonetheless, by integrating theories of music within the broader perspective provided by cognitive science, it is my hope that advancements in the latter can be more easily applied to the former. Approaching our theories of music as specialized forms of the multifarious theories we have about the world can change our regard of music, and can also provide insights for studies in cognitive science: in its immediacy and complexity, the domain of music is surely one of the most fascinating that human minds have created. Our fascination with this domain can be seen in the endurance and constant reinvention of music. I believe we can also see it in our theories of music, which seek to draw the outlines of the Muse that, by showing us a reflection of our inmost beings, still holds us all in thrall.

NOTES

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1. As a typographical convention, when technical terms are first introduced they will be given in **boldface** type.
2. This sort of model has occupied researchers in cognitive science and artificial intelligence for over twenty years. However, there is great diversity in just what is meant by a conceptual model and what such cognitive structures are called. On *mental models* see P. N. Johnson-Laird 1983; Barsalou 1992, chapter 7; and the various essays collected in Gentner and Stevens 1983. On *idealized cognitive models* see Lakoff 1987 and McCauley 1987. On *cultural models* see Quinn and Holland 1987; D'Andrade and Strauss 1992; D'Andrade 1995; Shore 1996. On *frames* or *frameworks* see Minsky 1975, 1985. On *cognitive domains* see Langacker 1987, 1992. On *mental spaces* see Fauconnier 1985. On *knowledge structures* see Abelson and Black 1986.
3. Another way to characterize this distinction is between conceptual metaphors and linguistic metaphors. A conceptual metaphor is a mapping between two different domains; a linguistic metaphor is the manifestation of such a mapping in language. See in particular Gibbs 1994 for a discussion.
4. For an application of the theory of image schemata in a music-theoretical context see Saslaw 1997. With regard to the preconceptual status of image schemata, see Edelman 1989, chapter 8; and 1992, 238–41. Lawrence Barsalou and his associates have recently posited a similar preconceptual structure, called a *perceptual symbol*, as the basis of concepts; see Barsalou, Yeh, Luka, Olseth, Mix, and Wu 1993. For a discussion of empirical research that supports the theory of image schemata, see Gibbs and Colston 1995.
5. The diagrams used to illustrate image schemata are often a source of confusion, for the very reason that they offer a concrete visual representation of an elusive theoretical construct. For his part, Johnson takes pains to emphasize that such diagrams, whose main function is to represent the key structural features and internal relations of image schemata, can be misleading, in that they tend to make us identify schemata with rich images or mental pictures (see Johnson 1987, 23–28). In the simplest terms, whatever actually occupies our thoughts is not, by definition, an image schema. We can conceive of image schemata, just as we can conceive of any of a number of non-conceptual or preconceptual cognitive processes, but that is another matter.
6. In the case of the Balinese characterization of musical pitch, what would be preserved by the mapping would not be directly embodied experience as much as repeated experience with resonating objects in the physical world. My thanks to Benjamin Brinner for confirmation of the way pitch is characterized in Bali and Java.

   Yet another way to characterize musical pitch has been noted by Andrew Barker. Barker observes that the metaphors of "up" and "down" are not built into ordinary Greek in the way that those of tension and relaxation are; thus Greek theorists of antiquity spoke more literally of "sharpness" (height) and "heaviness" (depth) (Barker 1989, 134 n. 43).

7. Concerning the complex of ideas associated with the great chain of being and Neoplatonism, see Lovejoy 1936, 61; concerning *De Anima*, see ibid., 58.
8. It is also in Macrobius that we find a detailed discussion of the harmony of the spheres, as well as the legend of Pythagoras and the blacksmith's shop (Macrobius 1990, 185–200). The connection between harmony and order found in Macrobius was an important one, and may have contributed to the application of a metaphorical chain-of-being hierarchy to music. However, it is also striking that the image of a ladder is used in both domains: in the Middle Ages the hierarchical organization summoned by the Chain of Being was more commonly represented by Jacob's Ladder (Kuntz 1987, 6); and some early mnemonic diagrams show the gamut as notes on a ladder (Berger 1987, Figure 1; and the associated discussion, 9–10).
9. My account of the basic relationship between the general, abstract property of "energy" and the CONTAINER schema follows Johnson's account of force gestalts; see Johnson 1987, 42–48.
10. The complete passage runs as follows: "J'ai déja dit que ce sont là les trois Notes principales du Ton. La TONIQUE l'emporte sur toutes les Notes. C'est elle qui joue le premier rôle dans le Ton. Elle est le centre de gravité, le but de tous le buts, la fin de toutes les fins; en un mot, c'est à elle que le sceptre de l'empire musical est confié." (Momigny 1806, 1:47) The image is used again on p. 81 of the same volume.
11. "*Le Ton* is hierarchy, the order established between the notes of a genre or a mode." ["Le Ton est la hiérarchie, l'ordre établi entre les Notes d'un genre et d'un mode." (Momigny 1806, 1:47)]
12. "Es ist selbstverständlich, daß den Trieb, Generationen von Obertönen ins Unendliche zu zeugen, jeder Ton in gleichem Maße besitzt. Man darf, wenn man will, auch diesen Trieb einem animalischen vergleichen, denn er scheint in der Tat dem Fortpflanzungstrieb eines Lebewesens durchaus nicht nachzustehen." (Schenker 1906, §14, p. 42) ["It is self-evident that the urge to produce unending generations of overtones belongs to every tone in equal measure. One might also compare this urge to that of animals, for it appears in fact to be in no way inferior to the procreative urge of a living being."]
13. "Nun aber, was soll denn Beziehung heißen im Leben des Tons und was soll hier wohl Intensität des Sichauslebens bedeuten? Beziehungen des Tones sind seine Systeme. Äußert sich der Egoismus des Tones darin, daß er, hierin einem Menschen ähnlich, lieber über seine Mittöne herrscht, als daß er von ihnen beherrscht wird, so sind ihm zur Befriedigung dieser egoistischen Herrschsucht eben in den Systemen die Mittel zur Herrschaft geboten. Ein Ton herrscht über die andern, wenn er sich dieselben nach den in den Systemen geschilderten Verhältnisse unterwirft." (Schenker 1906, §38, pp. 106–107) ["But now, what does 'relationship' mean in the life of the tone and what in this context would be implied by the intensity of living life to the fullest? The relationships of a tone are its system. Once the egoism of the tone manifests itself in such a way that the tone (rather like a human) might rule over its fellow-tones rather than be ruled by them, then these very systems provide the means for satisfaction of this egoistic love of power. A tone rules over others when it subjugates them to the relationships outlined in the systems above."]

14. Robert Snarrenberg has recently pointed out what I would characterize as competing conceptual models in the usual translations of Schenker's terms (e.g., "fundamental structure" for "*Ursatz*"); see Snarrenberg 1994, 45–52.
15. ". . . all the foreground diminutions, including the apparent "keys" arising out of the voice-leading transformations, ultimately emanate from the diatony in the background." (Schenker 1979, §4, p. 11) [". . . ist doch alle Vordergrund-Diminution, einschließlich der scheinbaren Tonarten aus den Stimmführungsvervandlungen, zuletzt eben aus der Diatonie im Hintergrund erflossen." (Schenker 1956, §4, p. 40)]
16. "Ähnlich wie von Gott zum Geschöpf zu Gott eine Fühlungnahme waltet, stets ineinanderlaufend, stets gegenwärtig, wirkt sich eine Fühlungnahme auch zwischen Ursatz und Vordergrund aus als gleichsam einem Jenseits und Diesseits in der Musik." (Schenker 1956, 29).
17. In the complete analysis Meyer actually adds two additional levels of hierarchy, although the sixth and final level is somewhat speculative. (Meyer 1973, 39)
18. For more on constraint, including an empirical study of how conceptual models constrain people's accounts of electricity, see Gentner and Gentner 1983, the discussion of Gentner and Gentner's work in Johnson 1987, chapter 5; and Gibbs 1994, chapter 4.
19. Eugene Narmour's recent attempts to map an atomistic hierarchy onto pitch have met with only limited success, and the application has not been widely adopted; see Narmour 1983-84. In some recent analyses Narmour reads musical structure as only quasi-hierarchical, and thus better dealt with in terms of networks; see Narmour 1990.
20 My characterization of the Invariance Principle follows Turner's formulation, which runs as follows: "*In metaphoric mapping, for those components of the source and target domains determined to be involved in the mapping, preserve the image-schematic structure of the target, and import as much image-schematic structure from the source as is consistent with that preservation*" (Turner 1990, 254; emphasis as in original); see also Lakoff 1990, 1993; Turner 1993). For another discussion of the Invariance Principle, see Saslaw and Walsh 1996. In early formulations, the Invariance Principle was called the Invariance Hypothesis; its earliest form is as the conceptual metaphor GENERIC IS SPECIFIC, which is presented in Lakoff and Turner 1989, chapter 4.
21. What has been said for theories of tonal organization is also true of theories of hierarchical organization—that is, there are ways to characterize hierarchical organization other than the two historical models I have discussed here. For example, Cohn and Dempster 1992 treat hierarchies in terms of axiomatic logical models; Lawrence Barsalou, in his overview of recent work in cognitive psychology, presents a less rigorous formalization of hierarchy, and distinguishes between taxonomies and partonomies (Barsalou 1992, chapter 7).

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