Introduction

All of us link music to memory, to motivation and to human social contact. Only a handful of individuals may play music, but all can at least sing some, and do so. Music is like breathing—all-pervasive.

Creative expression, such as music, arises from core capabilities within increasing ecological/cultural opportunities.[1] With expanding environments there is a greater diversity of expression. Music is a core human experience and generative processes reflect cognitive capabilities.

Underlying the behavior of what we might call a basic proclivity to sing and to express music are appetitive urges, consummatory expression, drive, and satisfaction.[2] The expression is not as simple as food ingestion, but then that is not so simple either in our species,[3] since the lures encouraging us to eat are boundless.

Music, like food ingestion, is rooted in biology. Appetitive expression is the buildup of a need, and consummatory experiences are its release and reward. Musical appetitive and consummatory experiences are embedded in culturally rich symbols of meaning.

Music is linked to learning, and learning is what we do best; the pedagogical predilection is vast. And, like the consideration of emotions, as Darwin understood, music is a human core capability. Moreover, Darwin did not separate emotions and cognition. I have not either. Emotional systems are forms of adaptation; consider, for instance, the importance for survival of the immediate detection of facial expression. The diverse forms of its bodily expression are emboldened with cognitive capability, rich in information transfer and processing.

Darwin, and certainly John Dewey, understood that emotions are rich in cognitive functions and appraisal processes. There are diverse forms of appraisals and some of these, like music and faces, are affectively opulent. Moreover, the issue is about function. Music is rich in information processing and tied to an appreciation of nature.

Cognitive resources are rich in the generative processes within the expectations that surround music; this puts music within both the sciences and the arts. The cognitive architecture, the generative processes, the diverse variation, and embodiment of human meaning within almost all spheres of human expression are rich fields of discovery for the arts and the sciences.[4] Human meaning is tied to social contact,[5] and music is a fundamental part of human meaning: making it, participating in it, remembering it, and sharing diverse forms of experience in vectors of meaning.

Art, like science, is embedded in discovery, test, experiment, and expansion through technique. There is no divide between the scientific and the artistic. They run into each other quite readily and naturally as they expand the human experience. A romantic sensibility about song, appreciating it as an instrument of music, is a continuous function within the broad array of our investigations. Song either culturally evolves or does not depending upon the resources available and the strokes of genius punctuated within often stable cultures.

Moreover, music is richly filled with emotions. What makes song a good example of emotion is that emotions are bound to the functions of music. Now this might seem a long way from birdsong, and it is, but so are we. For us, music evolved from communicative functions into a highly cognitive action, a piece of aesthetics that happens to occur—and we of course are all the better for it.

Cognitive and Neuroscience Revolutions

I was fortunate to have begun my career within the "cognitive revolution," and now there has emerged a discipline called "social neuroscience." This book is a reflection of both.

By the middle of the 1970s, behaviorism was on the wane and the rigorous methods that emerged as virtues would be dissociated from its ontological claims. All references in behaviorism to the mind are, in some narrow sense, references to behavior without mention of cognition or experience. Behaviorism dominated the field of psychology, like its counterpart psychoanalysis in psychiatry, for much too long. Both had something to contribute, but not to the extent to which they overshadowed their respective fields.

The cognitive revolution is deeply rooted as a reaction to behaviorism, especially via Noam Chomsky's critique of B.F. Skinner in 1957, and in *The Structure of Behavior* by Miller, Pribram, and Galanter.[6] The downfall of behaviorism was that it was utterly inadequate to account for our cephalic capacity. Further, the learning theories that predominated were just too narrow. In this case, Occam's razor cut too close and left a barren landscape. The foundations of sensory data dominated disproportionately. From where we now stand, and in spite of much dissension and a lack of integration among groups, the cognitive revolution is capable of producing an understanding of music.

The cognitive revolution looks somewhat like a resurrection of modern rationalism, but it is broader than that. Concepts are tied to diverse forms of cognitive capacity that inhere in function and adaption, including innate concepts; but that is only part of the story that emerges from the cognitive revolution. Cognitive systems are not antithetical to sensory/motor regions of the brain, along with other regions of the brain vital for perception or action.[7] It is not whether we have concepts that are deeply part of the cognitive architecture versus the sensory pangs of experience; it is just the issue of the adaptation, speed, and coherence of human action and performance.

After all, cognitive systems are embedded in rooted problem solving, something my colleague Mike Power has called "cognitive physiology," and others now call "cognitive biology." To me it is plain old Biology 101: cognitive systems are inherent in biological adaptation. We come prepared with a toolbox of capabilities that allow us to readily recognize animate objects, to sense time and space, to use language, and to discern agency in others.

J. J. Gibson suggested that there is direct cephalic access to environmental sources of information and practices in the organization of action.[8] Thus, some questions are: what are the conditions for adaptation and what are the factors in the environment that allow readily available resources? This view of cognitive resources is linked to the ecological/social milieu, to what is available, what is dependable, what is utilizable, as well as the ability to use and unload information into environments that expand, enable, and bolster memory functions as core cognitive events.[9]

Context helps to facilitate performance, musical, and otherwise. Our ways of hearing and responding to music are steeped in the direct ecological exposure to and expectations about sound and meaning, music and context, pervading our musical sensibilities.[10] A vivid sense of being within a context grounded in forms of ecological validity renders musical experience as palpable a human experience as there is, woven within tapestries of history, invention, and capabilities. It is this sense of grounding that makes features stand out so easily in music and enables the mutualism among the perception, action, and external events that are quite palpable in music.[11] The events are always relative to a framework of understanding—a social context rich in practice, style, and history.

Cognitive expectations are linked to Gibsonian anchoring to events. Core features that enable easy adaptation to the environment are represented in the brain and the social milieu of ritual and performance. Anchoring is one of the features of shared musical experiences, of the rites, rituals, and symbols of our lives pregnant with musical expression,[12] to affordances that are richly endowed with structures that facilitate memory.[13]

The expansion of memory facilitates the wide array of what we do, including music. The emphasis is on action and perception knotted together and coupled to events—in this case musical events - listening to and participating in them.

Table I.1 from Merlin Donald is about memory and action in perception, which crosses virtually the entire realm of musical expression. It is easily adapted to musical sensibilities and capabilities tied to memory coded internally and externally. Internally, it is rather limited, and, externally, it resembles what is sometimes

TABLE I.1

Properties of Internal and External Memory Compared

Internal Memory Record (endgram)	External Memory Record (exogram)
Fixed physiological media	Virtually unlimited physical media
Constrained format, depending on type of record, and cannot be re-formatted	Unconstrained format, and may be re-formatted
Impermanent and easily distorted	May be made much more permanent
Large but limited capacity	Overall capacity unlimited
Limited size of single entries (e.g., names, words, images, narratives)	Single entries may be very large (e.g., novels, encyclopedic reports; legal systems)
Retrieval paths constrained; main cues for recall are proximity, similarity, meaning	Retrieval paths unconstrained; any feature or attribute of the items can be used for recall
Limited perceptual access in audition, virtually none in vision	Unlimited perceptual access, especially in vision
Organization is determined by the modality and manner of initial experience	Spatial structure, temporal juxtaposition may be used as an organizational device
The "working" area of memory is restricted to a few innate systems, like speaking or subvocalizing to oneself, or visual imagination	The "working" area of memory is an external display that can be organized in a rich 3-D spatial environment
Literal retrieval from internal memory achieved with weak activation of perceptual brain areas; precise and literal recall is very rare, often misleading	Retrieval from external memory produces full activation of perceptual brain areas; external activation of memory can actually appear to be clearer and more intense than reality

Source: Adapted from Donald 1991.

called "extended mind."[14] The scope of musical memory is expanded to what Donald calls an "exogram." An exogram is an external record of memory.[15]

All of this contributes to the cognitive neuroscience of different features of musical sensibility.[16] A study of music emphasizes its independence from language while tying it, like all of our cognitive functions, to a diverse set of cognitive capabilities. Moreover, common forms of mental representations underlie action and perception in musical performance and musical sensibility.[17]

Diverse forms of cognitive systems reflect brain evolution,[18] with musical sensibility distributed across a wide array of neural sites, something that Leonard Meyer, an early exponent of a cognitive/biological perspective, appreciated.

Music, Meyer, and Pragmatism

Musicologists like Leonard Meyer understand that uncertainty is a basic fact of our existence, and that cognitive architecture is rooted in determining relevant information, as well as seeing that the search for meaning is adapted to what Meyer in 1967 called "embodied meaning."[19] Embodied meaning or action, a sense of all body kinesthetics, is a popular concept now, very much in vogue. It was commonly understood by such early pragmatists as John Dewey and George Herbert Mead, and also by those they influenced, namely, Leonard Meyer, who studied at both Columbia University and the University of Chicago.

Meyer had a theory of music that was intimate to this sense of action and perception. His is a view of cognitive resources embedded in emotion,[20] in which emotions are tied to action, and embedded in biological problem solving, not perfect problem solving.

What Meyer incorporated into his sense of music was a pragmatism based in Peirce and Dewey's notion of inquiry. Peirce understood that "thinking is a species of the brain and cerebration is a species of the nervous action;"[21] Peirce and Dewey always noted that there are no precognitive events. For both, degrees of cognitive systems underlie perception, attention, and action.

The theory of inquiry, of hypothesis testing, is entrenched in this cognitive perspective; what Peirce called the "fixation of belief" rooted in the organization of action. The orientation is not simply reactive, but anticipatory and also responsive to discrepancy with expectations.

Of course, Meyer and his approach to understanding music was a precursor to the cognitive revolution. He had embraced John Dewey and other early pragmatists with the idea that cognitive systems are inherent in action with anticipatory cognitive systems. Musicologists like Meyer also embraced psychobiology with the idea of something like cognitive physiology. Meyer's collaborations with psychologists (e.g., Burton Rosner, who moved to Oxford from the University of Pennsylvania) were about categorical perception in music.[22]

But these are categories in action. Perception for Meyer, as it was for Dewey, is tied to although not bound by, action. However, movement is not a trivial feature; indeed, now we know that imagining action is adaptive and tied to problem solving. Imagining events is an important feature of adaptive systems. Both Dewey and Meyer were anchored in an evolutionary perspective in which they understood that the animated machinery that permeates musical expression is based in diverse biological adaptations (e.g., anatomy, functions).

In explaining music, at least in part, Meyer noted, "Understanding music is simply a matter of attending to and comprehending tonal-temporal relationships."[23] Underlying the reciprocity of play, regularity, and style is in part the patterns of repetition;[24] and, of course, rhythm is endemic to music.[25]

The cognitive revolution was very much focused on understanding the structure of cognition and the relationships between expectations and subsequent actions. These include musical constraints, like linguistic constraints, for the production of diverse languages.[26] Living within constraints, and also breaking them, are features of the cognitive nature of music; the gaps in our experience underlie the curiosity and the emotions of some of the aesthetic and intellectual exploratory cognitive drives (see chapters 4 and 5).[27]

Music is often functional because it is something that can promote human well-being by facilitating human contact, human meaning, and human imagination of possibilities. We came quite easily, one might surmise, to the cephalic state of enjoying music for itself, its expanding melodic and harmonic features, its endless diverse expression of sound, moving through space, and within our power to self-generate it.

Music, under many conditions, also breaks barriers; Ray Charles, blind since his childhood, was as capable as anyone of singing "Georgia" or "God Bless America." Music has the power to bridge many divides. Perhaps, as Oliver Sacks noted in his book on music, "The image of the blind musician or the blind poet has an almost mythic resonance, as if the gods have given the gifts of music or poetry in compensation for what they have taken away," and thereby provides some "sight" or insight into human bonds that matter.[28]

"Music to my ears" is an old idiom in the English language. It was first attested in James Fenimore Cooper's *Home as Found* (1838),[29] but was probably in popular use well before that. After all, it succinctly expresses in a single phrase a fundamental auditory perception of the way rhythm and music convey pleasure, familiarity, and welcome. As a phrase, "music to my ears" connects the notion of ease with that of aesthetics, a natural property and an event replete with sweetness. While musical meaning is much broader than this, what surely makes music so culturally robust, so much a part of all of us, is the ease with which it manifests itself in our experiences.

Another phrase regarding music that everyone identifies with is "I've got rhythm, who could ask for anything more?" from the George and Ira Gershwin musical *Girl Crazy*.[30] It concisely conveys the way music is linked to movement: tapping, swirling, and dancing. This well-known song can be played, like virtually all music, many different ways and in many different styles. Beginning in 1934, when the Gershwins first played the song publicly, through Benny Goodman in 1943, to Charlie Parker in 1946, and up to the present day, many artists have celebrated the different forms of music in this song. As Lawrence Zbikowski, a musician and musicologist, has well noted in *Conceptualizing Music*,[31] the music of Goodman or Parker maintains coherence, as it is steeped in a set of categories that share a family of characteristics and common themes.

Cognition and Action

Cognition is endemic to musical events and tied to biology, adaptation, and prediction. Indeed, we know that human organization is replete with anticipatory cognitive systems, most of which encompass the vast cognitive unconscious.[32] Action sequences are well orchestrated and embedded in successful survival for both short- and longer-term expression.[33]

One early limitation of the cognitive revolution was its tendency to leave out discussions of emotions: that "other stuff." Too often emotions were thought to render one less rational, less prone to act. After all, the term "passions" traditionally means to be passive, unable to act, and they were thought to render one ineffective. This traditional view dominated the perspective of the cognitivists, and so left out an important part of biology: our emotions and their adaptive nature. Such a view of emotion is now considered extreme and not tied to biological perspective.[34] After all, one can get lost in thought and not be able to act just as easily as one can get lost in emotions and not be able to be effective. Emotions are no less adaptive than abstract thought.

Cognitive expectations knotted to goals generally underpin the organization of human and animal action, as well as music. Cognition is no spectator, and musical expectations are but one example among others. Important biologically derived cognitive systems are not divorced from action or perception, but are endemic to them.[35]

Lakoff and Johnson (1999) depict relationships between perception and action, which underlie all of music, with thinking, perceiving, communicating, imagining, and the like (see table I.2).[36] Music is the kind of thing that is an action but which can also permeate our imagination by imprinting on our neural systems.

Music plays inside our heads, and as we shall see, common neural circuits underlie the action of playing and hearing music, as well as imagining the music in reverberation.[37]

Music is fundamental to humans as a species. Most of the expectations we have may not be explicit, since the vast array of the cognitive systems are not conscious; imagine playing an instrument while being explicitly conscious of all that we have to do. Impossible![38] Cognitive systems are vastly unconscious and underlie action as well as music. The inferences, expectations, and prediction of auditory events are not particularly part of our awareness, and certainly the mechanisms are not.[39]

Table I.2

Relationships that Underlie All Aspects of Musical Experience

Thinking (music) as perceiving
Imagining (music) as moving
Knowing (music) as seeing and responding
Attempting insight (through music) as searching
Representing (music) as doing
Becoming aware (of music) as noticing
Communicating (music) as showing
Knowing (music) from a "perspective"
Listening as detecting, knowing

Source: Adapted from Lakoff and Johnson 1999.

Hermann Helmholtz, a German scientist of the nineteenth century, worked on the physiology of harmony and the acoustical representation of sound. He suggested, with regard to music, that "Aesthetics endeavor to find the principle of artistic beauty in its unconscious conformity to law."[40] The vast cognitive unconscious, essential for adaptation to changing landscape, was part of his aesthetic sensibility. Helmholtz merged romantic and Enlightenment neuroscientific interests to understand that perception is mediated by mechanisms of measurement, expectations, and hypotheses.[41]

Imagined Action, or Music and the Brain

Positron Emission Tomography (PET) measures blood flow. It is used as a marker of brain activation. For instance, when subjects were asked to imagine grasping objects,[42] significant activation of regions of the brain concerned with movement occurred. In further studies that used neuromagnetic methods to measure cortical activity, the primary motor cortex is active both when subjects observed simple movements and when the subjects performed them.[43]

Of course, the motor cortex is activated in a wide array of human cognitive/motor activities. Importantly, motor imagery is replete with cognitive structure and is reflected in the activation of neural circuitry.[44] So too is auditory imagery reflected in different regions of the brain, including anticipatory musical imagery.[45]

In another study focusing specifically on sensory events in a functional magnetic resonance imaging scanner (fMRI), subjects were presented with spoken words via headphones. Then, in a second part of the experiment, the same individuals were asked to identify the words with silent lip-reading.[46] Not surprisingly, many of the same cortical regions were activated.

In other words, hearing sounds is like imagining them. Both tasks recruit many of the same brain regions.[47] Across a number of perceptual experiences, imagining employs the neural systems involved in seeing them, hearing them, or touching them. Imagine a visual rotation, for example, versus actually looking at a rotating object; it takes a similar amount of time.[48] Moreover, very similar neural circuits are also activated when the object is imagined or viewed.[49] Imagining is the process of creating brain stimulation internally that is similar to what would be created by external stimulation. In other words, the neural structures that are active in imagining objects appear similar to those structures that are active when looking at the objects.[50]

Not surprisingly, hearing music activates many of the regions linked to auditory perception. However, regions of the auditory cortex are also activated when subjects are asked to imagine music or other auditory stimuli (figure I.1).[51]

Thus, despite the difficulty in the end of not knowing what people are actually imagining, one can dissociate hearing something from seeing it through diverse regions of the brain. Of course, the inverted spectrum problem (whether you and I really see or hear the same thing) is always humbling and reminds us that it is difficult to discern what others see and hear, as well as the corresponding relationships to what we report and observe behaviorally.

Perhaps one is now in a better position to understand the genius of Beethoven; deaf for years, he must have heard music imaginatively to compose the way he did. Think of the cognitive

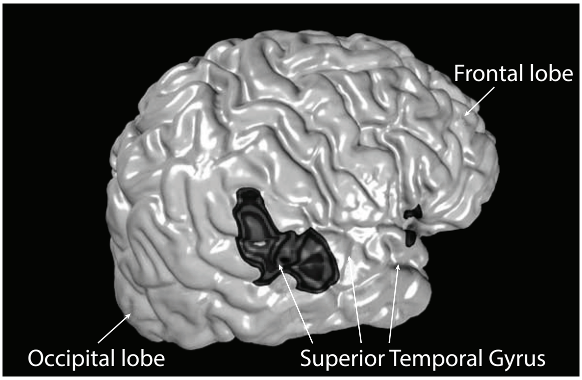

Figure I.1 A neuroimaging scan revealing that even in silence the auditory cortex, pictured here in the posterior portion of the right superior temporal gyrus, is activated.

Source: Reprinted from *Neuron*, vol. 47, Zatorre and Halpern, "Mental Concerts," 2005, with permission from Elsevier.

complexity, the richness of the later parts of Beethoven's life. In fact, we now know that musical hallucinations are often a feature of acquired deafness such as Beethoven's.[52]

Beethoven also reveals a spiritual preoccupation as he probes the depth of human expression;[53] the Ninth Symphony represented an age of romantic possibilities with such freedom of expression by one whom some have considered the most creative genius of his historical period—those last quartets are simply mind-boggling to musical sensibility.[54]

Of course, it also becomes somewhat easier to understand that the same "music to one's ears" may not be heard by one's neighbor. Beethoven is one thing, the rest of us quite another. Yet, the recruitment of cortical regions is generic.

Embodied Cognition

We are now in a better position to understand the neurobiology of musical sensibilities. The neuroscientific revolution of the 1970s and 1980s provided a better understanding of anatomical connectivity. Through anatomical study we now know that the cortical structures are in direct contact with the viscera;[55] the contact is one synapse or connection away from the peripheral guts, the brain stem, and the cortex. Music warms and cools the brain quite directly and rapidly.

The emergence of the cognitive sciences has allowed us to understand the dominance of information systems in the brain, and as such we can now appreciate the diverse information processing systems and appraisal systems that are ingrained in the brain. The cognitive systems are larger than the class of syntax narrowly defined in terms of language, but semantic systems underlie diverse semiotics of song, language, movement, and the organization of action.

Another recent revolution in science is in understanding the diverse information molecules that inform the brain, relating peripheral gut reactions to central orchestration of behavior. The list is quite long and some items are very familiar: steroids, peptides (e.g., oxytocin, vasopressin), and neurotransmitters such as dopamine. Dopamine is an adrenal hormone synthesized in a part of the medullar region. Dopamine is also produced in the brain. Catecholamines like dopamine are tied to action, prediction of events, reward, syntax, and musical sensibility (see chapters 3 and 4, and figure I.2).

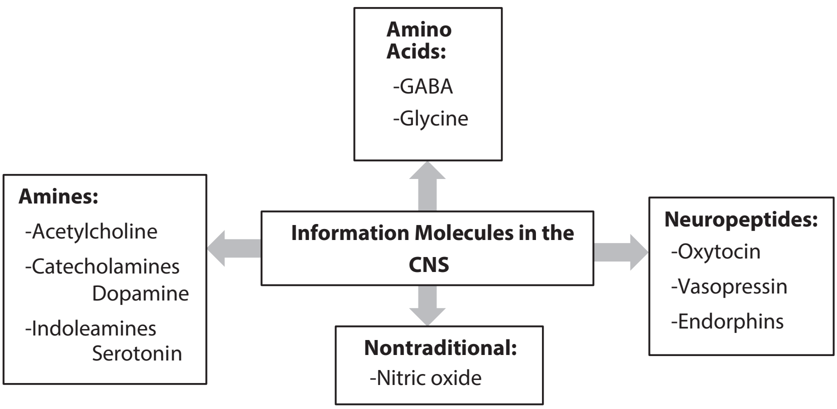

Figure I.2 Examples of important information molecules found in the central nervous system.

Neurotransmitters tend to be broad in terms of regulation.[56] We typically associate dopamine with the diminished regulation and expression of Parkinson's disease, but dopamine also underlies all aspects of the organization of action.[57] Hormonal messengers are a fundamental information class of molecules, of which there are many besides dopamine and norepinephrine. Central norepinephrine is tied to attention.[58] They are the same molecules involved in the organization of behavior as physiological signaling systems.[59]

Information molecules have a phylogenetic history of evolutionary recruitment into diverse functions. The techniques of molecular biology, regulatory physiology, and behavioral neuroscience anchor them to function. Function and adaptation are what underpin biology. Song has long been viewed in the context of function, as it still is in birds. However, song also expands with cultural legacies and expression. Most people's enjoyment of Ray Charles or Beethoven serves no specific function. Biology is one thing; overzealous adaptationism is another. My hope is that this book reflects the former and not the latter.

Music and Culture

Music is a binding factor in our social milieu; it is a feature with and about us, a universal still shrouded in endless mysteries. How music came into being is, like most other features in our evolution, hard to pinpoint. Evolutionary evidence over a wide range of cultural groups reveals diversity of song and instrument, yet gaps and speculative considerations remain: some cultures sing a lot, some sing less, but most do sing.[60] Music is typically something shared, something social; we may sing in the shower or on a solitary walk, but music is most of the time social, communicative, something expressive and oriented toward others.[61]

Music cuts across diverse cognitive capabilities and resources, including numeracy, language, and space perception. In the same way, music intersects with cultural boundaries, facilitating our "social self" by linking our shared experiences and intentions. Perhaps one primordial influence is the social interaction of parental attachments, which are fundamental to gaining a foothold in the social milieu, learning, and even surviving; music and song are conduits for forging links across barriers, for making contact with others, and for being indoctrinated within the social milieu.

Ian Cross and Iain Morley[62] have pointed out the floating, fluid expression of music. There is little doubt that the fundamental link that music provides for us is about emotion and communicative expression, in which the prediction of events is tied to diverse appraisal systems expressed in music.[63]

Music is fundamental to our social roots.[64] Coordinated rituals allow us to resonate with others in chorus,[65] for which shared intentional movements and actions are bound to one another. Perhaps not surprisingly, a philosopher of the Enlightenment would glorify music as a state of nature, putting it squarely within a civilizing factor in some fantasized natural inclination of well-being. Jean-Jacques Rousseau, in fact, had considerable musical talent, writing and winning awards for his music early in his career. Operatic songs were a feature of his aesthetics, with song and sensual experience permeating his early life, a life that was also filled with strife.

Rousseau was fortunate enough to be steeped in song, in music—a glorification of the state of nature. Indeed, the French Enlightenment was rich with theories regarding the origins of music and language (e.g., D'Alembert, Condillac, Diderot, Rousseau),[66] which would come to dominate the landscape as "the language of music," featuring a musical vocabulary connected to diverse emotions.[67]

For Rousseau, Homeric tone and expression suggested an important link between verse and song. In poetry and music, melodic tones for which "the beauty of sounds is natural"[68] are pervasive, while suggestions and responsiveness to the muses appear in what Nietzsche later identified in *The Birth of Tragedy* as music with the Dionysiac urge of self-expression and freedom.[69] Music is a primordial wellspring of utter human creativity and expression, in which music and the muses are at the forefront, breaking boundaries that divide us as a feature of the human will,[70] tied to cephalic capabilities, and reflecting social context and human meaning.[71]

Social meaning in music is particularly clear during the subsequent Romantic period. It pervaded nineteenth-century Europe;

Hector Berlioz is a good example, with his symphonic fantasies that breed human possibilities of hope and transformation.[72]

Culture-bound music is a shared resource that is tied to diverse actions, including sexual function. Yet, sexual function[73] remains but a small piece of where our species has taken music.

Music permeates the way in which we coordinate with one another in rhythmic patterns, reflecting self-generative cephalic expression[74] attached to a rich sense of diverse musical semiotics and rhythms.[75] Music is embedded in the rhythmic patterns[76] of all traditional societies. Our repertoire of expression has incurred a crucial advantage: the ability to reach others and to communicate affectively laden messages.

The social communicative bonding of the wolf chorus is one example that comes to mind,[77] a great chorus of rhythmic sounds in a social setting. A common theme noted by many inquirers is the social synchrony of musical sensibility.[78] The motor sense is tied directly to the sounds, synchrony, and movement. Sometimes the actual motor side of singing is underappreciated.[79] Neurotransmitters, which are vital for movement, are tethered to syntax and perhaps to sound production (see chapter 3). The communicative social affective bonding is just that: affective. This draws us together and, insofar as we are a social species, remains essential to us; a chorus of expression in being with others, that fundamental feature of our life and of our evolutionary ascent. Music is indeed, as Timothy Blanning noted, a grand "triumph" of the human condition, spanning across cultures to reach the greatest of heights in the pantheon of human expression, communication, and well-being. It is in everything.[80]

A natural inclination to observe wondrous nature, to paraphrase Immanuel Kant,[81] is to capture something aesthetic and awe-inspiring. Music is a piece of nature, our nature. Nature allows us to be close to a sublime essence: to be as serene as a fresh dawn and dusk, or as fearful as a threatening bolt of lightning near one's head. Dewey similarly emphasized that art as experience is pervasive.[82] This is a book rooted in social and behavioral neuroscience. Its contents make contact with diverse disciplines. They range from evolution and comparative biology, to musicological considerations about the origins of music. The book is centered in behavioral neuroscience with observations that are both specific to music and more general to basic brain function. Music serves many functions in our lives. From the first sounds to some of the last, human well-being and music are extant across the life cycle of human experience.

In what follows, I give a sense of the origins of music, from the appearance of the relevant anatomical features, to the development of diverse forms of biological systems that figure in musical expression (chapters 1–3). Music reflects our social nature and is tied to other instrumental expression in the adaptation to changing circumstances. Indeed, expectancy and violations of those expectations in music linked to memory and human development (chapters 4–6) are critical features in the aesthetics of musical sensibility (like other avenues of human experience). Music is also connected to movement and dance (chapter 7). The same cognitive factors that underlie what we expect, and variation on the expected, inhere in musical experiences. Moreover, diverse information molecules (e.g., dopamine, and peptides such as vasopressin/vascotocin or oxytocin) that may be involved in the organization of musical expression are imbedded in core neural circuits of the brain that underlie a wide array of human experience. Without music, our world is endlessly impoverished.

The book does not present a grand synthesis or one theory about music; what it does is bring together diverse fields of inquiry that matter in understanding music and human experience. What is special about music? Music contributes to the vast array of human social solidarity and individual expression amidst creative intensification of human experience, within an endless auditory expansion of human sensibility and general well-being.