THE POWER OF MUSIC

THE POWER OF *Music*

Pioneering Discoveries in the New Science of Song

ELENA MANNES

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TO MY PARENTS

Leopold Damrosch Mannes

and

Evelyn Sabin Mannes

With love and gratitude

CONTENTS

FOREWORD

The power of music to engage human minds and stir the emotions has fascinated thinkers for thousands of years. Well over 2,000 years ago Plato remarked that "rhythm and harmony find their way into the inward places of the soul." Despite this ancient interest, it is only in the past decade that an organized community has emerged dedicated to research on music and the brain. The youth of this field partly reflects the new technologies which have spurred its growth, brain imaging techniques which allow scientists to observe human brains as they perceive or makes music. These remarkable tools have quickly revealed that there is no single "music center" in the brain. In fact, it seems that each subcomponent of music (e.g., harmony, rhythm, etc.) engages a broad network of brain regions, so that music as a whole has access to vast portions of our brain.

With this sea change in the scientific study of music many old questions about music and the mind are being renewed. Why does music have such strong effects on our emotions? Is music a universal language? Why does music often make us want to move and dance? How does music get so deeply in our memories? Does learning music improve other cognitive abilities? Can musical activities help restore some of the abilities of neurological patients? These are just a few of the questions

that the cognitive neuroscience of music is beginning to address.

One question that has driven much of my own research is: What is the relationship between music and language? In exploring this question, I have found many hidden connections between these two domains. For example, musical and linguistic grammar have many obvious differences, yet research grounded in neuroscience points to significant overlap in the way the brain processes the abstract structure of these two domains. This has opened new ways of studying (and perhaps one day, treating) certain language disorders, and illustrates how long-standing debates about music and the mind are being invigorated by new experimental and empirical research.

In her documentary "The Music Instinct", and now in this book, Elena Mannes has captured a young field at an interesting point in its development. Her film and book give us a portrait of a young research community. Going behind the scenes and beyond the texts of scientific papers, she lets us hear the voices of scientists who are passionate about their research. Adding much more information than was available in the film, this book ranges across many interesting questions about music and the mind, and provides a colorful introduction to a number of current debates in this field.

To those students who may be considering a career in the scientific study of music and the mind, allow me to encourage you. This is a new field and many big questions remain unanswered or only partly addressed. It is a field which allows one to bridge the study of culture and biology, and to develop significant new theories and rapidly connect these theories to experimental studies. Furthermore, there are increasing opportunities to connect basic research with real-world applications of music in education or medical rehabilitation. If

you find yourself attracted to this field, please visit the Society for Music Perception and Cognition (www.musicperception.org) to get information on conferences, student opportunities, journals, videos, and other resources for researchers.

The capacity and proclivity for music is one the most fascinating aspects of being human. As the study of music and the brain expands in this new millennium, prevailing ideas will change and new theories will evolve, but one thing is certain: this is a scientific journey that is now well underway.

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President, Society for Music Perception and Cognition

INTRODUCTION

Music Matters

I would teach children music, physics, and philosophy; but most importantly music, for in the patterns of music and all the arts are the keys of learning

PLATO

A summer night, an old barn and music in the air, the melodies and harmonies of amateurs and professionals playing chamber music, mingling with the night sounds of crickets through the barn's open doors. This is how I first knew music: not as a formal production with remote musicians far up on a stage, but as an intimate, personal creation joining musicians, like my father the pianist, and listeners in the experience.

Music is in my genes. The child of a family of professional musicians, I've always known the power of music. It was all around me when I was growing up—alive in the house at night, in concerts and in recordings. From my earliest childhood, I was aware of my parents' and their friends' passion for this art

form. Music informed our life and the moments that live in my memory. When I now listen to certain pieces, I can still hear the music of that chamber group from my childhood or be transported to my teenage years, driving down a country road with folk music blasting from the radio.

I am not a professional musician, but I've always felt that music is an inextricable, inborn part of me. I've wondered if that's true for everyone, and as a documentary producer/director, I wanted to explore that central question. Within the last decade, there has been an explosion of interest in the science of music, and a new generation of scientists has developed the tools to discover the intimate connections between music and human life. The resulting discoveries reveal hard evidence that music truly is a fundamental aspect of life, something that defines us and binds us together as humans. We are now creating a future in which music will clearly be recognized as far more than background entertainment. Some scientists call the potential use of music for healing, changing behavior, and understanding our origins and our universe the stuff of science fiction; imagine prescribing music for neurological disorders and as treatment for the aging brain? Yet our new knowledge offers significant and often startling conclusions about music and the natural world and has major implications for the future of education and medicine.

My fascination with the human relationship to music first led me to develop and produce *The Music Instinct: Science & Song,* a two-hour PBS special, co-produced by New York PBS station WNET/Thirteen that aired in June 2009. The research and production took me on a remarkable journey. I found that passionate scientists all over the world are chasing clues to music's power: imagine a scientist jiving to the beat of a rock star

who's singing inside an fMRI scanner, an archeologist trekking through a German forest to a remote cave containing the world's oldest instrument, a researcher analyzing the cries of infants lined up in a nursery and finding distinct musical intervals.

The science of music is an adventure happening all around us right now. Neuroscience is delving deeper into the brain to understand the interaction with music. There's new work in genetics and relatively young fields such as psychoneuroimmunology and chronobiology, exploring the complex interplay between music and our being. Every day we are gaining a deeper understanding of this art that so profoundly affects our imagination, spirit, and physiology. For centuries, philosophers and musicians themselves have speculated about music, seeking to explain its magic. Yet, it is only recently that science has sought in earnest to join the exploration.

We humans know instinctively that music has a primal power. Historians and anthropologists have yet to discover a music-less culture, and music predates agriculture, and perhaps even language. The foundations of music have even been traced as far back as known musical instruments, crane bone flutes from the Jiahu site in China where humans lived from 7000 to 5700 B.C., produce a tonal scale. Archaeologists in Slovenia recently unearthed a flute that had been fashioned from the femur of a bear by our Neanderthal cousins. These archaic flutes from 36,000 years ago are more than twice as old as the cave paintings in Lascaux, France. The primitive instruments still create a remarkably pure and beautiful tone.

Singing, along with simpler instruments such as rattles and drums, likely preceded these flutes. In fact, the act of human singing may have begun as long as 250,000 years ago. Even the

way young children call their mothers—Ma-ah, or Mom-my—is musical, as children use a simple, two-syllable falling musical phrase that appears to be universal across cultures. Children tease one another in a specific, similar, singsong way no matter where in the world they live.

The elements of music—time, pitch, and volume—echo our pulse, our breath, our movement, and our vocal range. At our emotional core, we experience these elements as joy, sadness, exhilaration, and a hundred other feelings. Anyone who has been transported by Bach or Mozart, moved to weep by a national anthem or hymn, stirred to dance by a rock rhythm, or taken back in time by the notes of a pop tune from the past knows the power of music. And we continually look to music to accompany the most significant moments in our lives, from weddings to wakes. Not only can music can be found in every known human society, but there are also surprising common threads among all the world's music. A researcher who traveled to a remote corner of Cameroon in Africa where tribe members have never heard Western music found that these tribe members could identify the emotional quality of western music in the same way western listeners do. [1] This leads us to ask whether there something about music itself, in the physics of sound and in musical structure, that is universal, bridging time and culture. Language development, human emotion, and intelligence are intimately connected to music. New research on animals and music informs the theory of evolution. Cosmology has contributed fascinating evidence regarding the relationship between musical sound and the birth of the universe.

As I gathered research for the television production, I spoke with visionary scientists and world-famous musicians it often

seemed that I was peeling layers of an onion. Each new study, each new piece of evidence leads to more questions.

- How much of our musicality is learned and how much is innate?
- Can examining the biological foundations of music help scientists unravel the intricate and entangled web of human cognition and brain function?
- Is music, like language, a uniquely human trait?
- Why is music virtually universal across cultures and time—does it provide some evolutionary advantage?
- Could music's role in the natural world reveal a basic bond among all animals?
- Might music contain organizing principles of harmonic vibration that underlie the cosmos itself?

That last question holds the key to the true importance of the new science of music. Sometimes people ask: "don't we already know that music is powerful, that it moves us, that it makes us feel better; why do we need all these scientific studies? Can't we just enjoy music and accept its mystery just as humans have for centuries?"

The question is understandable. But we're at a moment of breakthrough. This is a profoundly exciting time in music research. It's not just that we're learning more about what music is purely for the sake of the knowledge, as wondrous as that may be. What's really significant is that we're learning how music can be more powerful than ever before in human history. And we're learning how to *harness* its power.

Take education. There's been much debate about whether

listening to music can make us smarter. But now there's hard evidence that musical *training* can help us learn other skills. And science has led us to the edge of what promises to be a revolution in the use of music for healing. Certainly, music as medicine has been a fixture in indigenous cultures around the world. But in the West, that linkage has been the stuff of myth and fringe science at best. Not so any longer. Many of the scientists I've met came to their work because they had musical training and a love for the art. For example, neuroscientist Jamshed Bharucha trained as a classical violinist. Neurologist and Neuroscientist Gottfried is trained as an organist. Neuroscientist Daniel Levitin is an amateur saxophone player and former music producer. Each became a scientist in order to answer questions sparked by their musical training. Their passion for music – and for its potential – is driving their work. They, too, know that music may always remain in some ways a mystery. But these passionate scientists clearly see the opportunities unfolding with each new piece of knowledge.

Vocalist/pianist/conductor Bobby McFerrin, pianist and conductor Daniel Barenboim, percussionist Evelyn Glennie, cross-genre violinist Daniel Bernard Roumain (DBR), and British rockers Jarvis Cocker and Richard Hawley are some of the musicians who share a deep curiosity about music with today's leading scientists. Their experiences with music and sound connect hard science to real human experience – interweaving the scientific and the sensory.

Following the story of music has led me from the laboratory to the concert hall, into the world of nature, out to the cosmos, back into the story of our ancestors and their earliest song, and forward to a future of exciting potential. This journey reveals

how we understand and experience music, and heals the human body and mind. I write not as a scientist, but as a journalist eager to tell a great – and accurate – story, rendering musical and scientific principles and fascinating new research accessible to an interested but not expert reader.

My emphasis is on the hard scientific work that underpins the hypothesis that music is inextricably linked to our existence and--if we know how to use it--changes our existence. Sometimes, however, I touch upon so-called "fringe science" still in the realm of speculation. But when I do so, it is clearly labeled as such. After all, some "alternative" thinking just might be paving the way for thorough scientific investigation. Just as alternative medicine is receiving some acknowledgement from the world of western science. One approach does not always negate the other. That said, my passion for this subject is driven by the incontrovertible evidence documented by rigorous science. And I agree with the researchers around the world who believe it's time to take music out of that realm of speculation and wishful thinking into a new era. One scientist told me: *We have to admit we're still in the embryonic stage of music research.*[2] But already the strides have been tremendous.

On a personal level, this journey has led me to a fuller appreciation of my family's musical legacy -- and to the conviction that we have only begun to tap music's potential to change our lives.

PART I

The Musical Body and Brain

CHAPTER ONE

Feeling the Sound

Do any of us really know what music is? Is it merely physics?
Mathematics? The stuff of romance, or of commerce?
Why is it so important to us? What is its essence?

STING

Music is the hidden mathematical endeavor
of a soul unconscious it is calculating.

GOTTFRIED WILHELM VON LEIBNIZ, INVENTOR OF CALCULUS

Often as a child, I lay in bed at night listening to the sound of chamber music wafting up the stairs. I also remember lying under the grand piano, sometimes for a long time, listening and feeling the vibrations of the huge instrument as my father played. It was a physical sensation but it was somehow emotional, too. I loved it and I felt safe there, connected to something outside myself, and connected to myself.

Years later, I was amazed to find that several musicians and scientists had memories remarkably similar to mine. Daniel

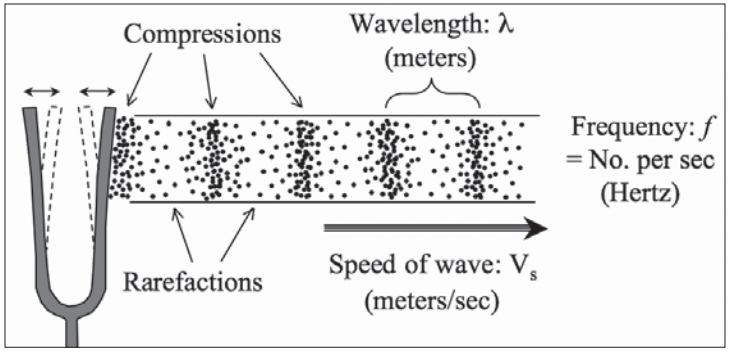

FIGURE 1 Cellist Michael Fitzpatrick recalls that in the third grade he sang a solo from Carousel; when he stepped up to the microphone and started to sing March Went Out Like a Lion he had the sense of

Levitin, cognitive psychologist and neuroscientist, also remembers lying underneath the piano while his mother played. He says he felt enveloped by the sound--mesmerized.[3]

Cellist Michael Fitzpatrick recalls that in the third grade he sang a solo from *Carousel***;** when he stepped up to the microphone and started to sing *March Went Out Like a Lion* he had the sense of putting his fingers into a light socket. [4]And from the multi-talented singer/pianist/conductor, echoed a similar childhood experience. He heard his mother playing the piano and he remembers crying. He didn't know why, but he was crying. And he says he's always wondered why it is that music can make us cry so spontaneously.[5]

"It's striking that these childhood experiences of sound are so intense," says McFerrin. It really does make you wonder if we humans have some special physical relationship with musical sound. I can feel that vibration underneath the piano to this day. Did it somehow affect the very cells of my body, cementing the experience into my being?" [6]

My musician/scientist father believed that we have a special relationship with music. He addressed the subject in a speech more than a half century ago, long before the current scientific fascination with music. He said:

What I am going to talk about is far from a demonstrable series of scientific facts. In strict parlance, it cannot even be dignified by calling it a theory. In truth, it is at best a series of speculations about music, which has taken place in my mind over a long period of time and which, as a whole, can be called no more than a hypothesis. Since it concerns itself with trying to understand why music is the thing that it is and why it has such a direct and strong impact on the listener. . . . I believe that answers to these questions concern themselves basically with the human body.

Leopold Mannes, my father, said that music is fundamentally composed of there elements: time, pitch and volume. Yet pitch, too, is determined by vibration frequency so it's really a directly a function of time as well. "Time", my father wrote, "forms a sort of space-time continuum, in which music lives, and so …time is a very fundamental and compelling factor. I have come to believe", he continued," that the time or pulse values in music would never have the impact on us which they have, were it not for certain so-called 'built-in clocks,' which we all possess." He identified these "clocks" as heart beat, the respiratory rate, and the rhythmic movements with which we walk, run and dance. He then went on to compare these organic rhythms of our bodies to the rhythms of music. For example, marches correspond to the normal human walking rate of 120 steps to the minute – or really a basic 60 rhythm accounting for both legs. And music that is relaxing, my father

said, corresponds to the normal resting human pulse of around 84 beats per minute.

Fascinated by music's influence on the human body, I set out to talk to scientists and musicians and discover what they know about the power of music. What is the connection between musical sound and the body? How does it affect the body and maybe even change it?

It turns out that science today is showing that music is in fact encoded into our bodies and brains. The fact that music seems to trigger our emotions in a way that nothing else does suggests to many scientists that it has an important place in the natural world and that it has something to do with the evolution of our species. Yet the story of the human connection to music begins with our everyday physical reactions to sound.

What is music? In essence, it is vibration. When I speak, sound waves come out of my mouth, compressing air molecules as they travel outward. If you could see a sound wave moving as I speak, you'd observe the molecules come together and then push apart. Think of ripples in a pond. When the body of water is disturbed by a stone being dropped into it or a rowboat pushing through it, waves are created and then the water molecules push back. The back and forth movement is the vibration.

This vibration, this sound has incredible physical power. A singer's voice, for example, can shatter glass. And sound waves produce patterns in matter. The study of this wave phenomenon is called "cymatics," a term that is based on the Greek word for "wave" and coined by Swiss scientist Hans Jenny. Jenny expanded on the work of an 18th century natural scientist Ernst Chiadni who spread sand over thin glass plates and set the particles in motion with the vibration of a violin bow. Jenny used

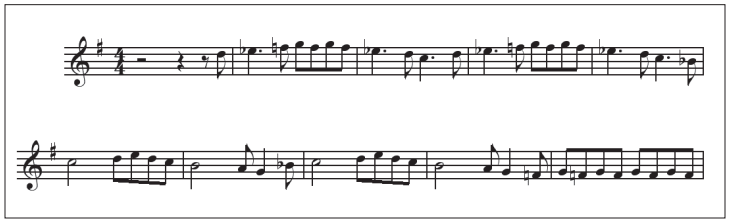

FIGURE 2 Cellist Michael Fitzpatrick recalls that in the third grade he sang a solo from Carousel; when he stepped up to the microphone and started to sing March Went Out Like a Lion he had the sense of. (IMAGE CREDIT GOES HERE.)

different techniques to create patterns in sand and in liquids with vibration. The higher the frequency of the sounds, the more complex the shapes became. Sand was pushed from areas where the vibration was stronger and collected in areas where it was weaker. Jenny showed how different pieces of music create certain patterns. For example, here is Bach's Toccata and Fugue in D minor, 1st movement Bar 30.

There's no more telling illustration of the nature of sound—in particular, musical sound—than a very personal one: the story of world-famous percussionist Evelyn Glennie. Glennie grew up on a farm in Scotland, the daughter of an accordionist in a country dance band. Her first instruments were the mouth organ and the clarinet. She has become the first full-time solo professional percussionist in 21st century western society, and she's done this under very unusual circumstances. Glennie wants to be known simply as a musician, a description she has surely earned. But she knows that what makes her story fascinating is the fact that she has been profoundly deaf since the age of 12.

Glennie says that the hearing loss was gradual, and now she can usually hear someone speaking but can't distinguish the

words without the aid of lip-reading. Glennie trained herself to feel the pitches of high frequencies. Of course, she was already an accomplished musician. As a child, she had perfect pitch: she was able to identify a note without hearing any related notes next to it. But by the time she was 12, doctors determined that her degenerative hearing was caused by severe nerve damage and she was now "profoundly deaf," with only a little residual hearing left. She has learned to lip read very proficiently. And her perfect pitch, something that she retains although she cannot "hear" a note in the way that a non-deaf person can, helps her to speak.

As a child, Glennie was told she'd never play music again. But she refused to accept that prognosis. When she was 12, she saw a school mate playing percussion and started taking lessons. It "felt right," she says. Her music instructor helped her learn how to feel the music. She would touch the sides of the large timpani (kettle) drums. Then the teacher would adjust them to various tones and Glennie noticed she could sense the different vibrations in different parts of her body. She'd also stand with her hands against the classroom wall to feel the vibrations. Years later, she applied to London's prestigious Royal Academy of Music and graduated with honors. [7]

But how can she possibly be a performing musician? How can she hear rhythm and pitch? She showed me how when I went to her home in England. She performed first on marimba and then on an array of percussion instruments. There was no sign of anything out of the ordinary—except that she was playing barefoot. It was like watching a ballerina. Her feet arched and bent and stretched with the music. For Glennie, the fact that music starts with the physical fact of vibration is the essence of her

art. "Music is energy," she explains. It's possible to feel vibrations through the whole body. And for me, this is a very crucial part of what I do." Glennie feels the sound—different rhythms, even different pitches—through her feet and through different parts of her body. She feels the low sounds--like that of a bass drum – in the lower part of her body. And then a high sound, like a cowbell, she can sense in the upper part.

Glennie notes that most people tend to make a distinction between hearing a sound and feeling a vibration. But the distinction we make in expressing this difference in English doesn't even exist in the Italian language. The verb "sentire" means to hear and same verb in the reflexive form, "sentirse" means to feel. Glennie is convinced that all of us have more ability than we imagine to feel sound with our whole bodies. She points out that we all know what it is to feel vibration when a large truck passes by, and we all can feel the vibration of a bass drum.[8] When I was lying under the piano as my father played,

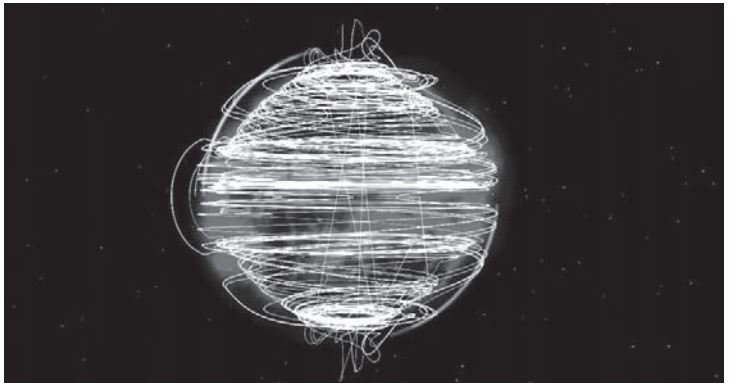

FIGURE 3 Cellist Michael Fitzpatrick recalls that in the third grade he sang a solo from Carousel; when he stepped up to the microphone and started to sing March Went Out Like a Lion he had the sense of.

I don't remember making the distinction between hearing and feeling either. So perhaps it's a difference in perception that those of us with "normal" hearing adopt as adults.

Many musicians have an instinctive understanding of how musical sound interacts with our bodies. They know – they feel – that sound impacts our bodies in a way no other art does. Opera singer Irene Gubrud says: "As a very young child, I experienced who I was through sound. I felt whole."[9]

Daniel Bernard Roumain, a young cross-genre violinist, thinks one reason music is so powerful is that sound actually penetrates our bodies: "You know when someone says that a piece of music 'touched me' or 'moved me', it's very literal. The sound of my voice enters your ear canal and it's moving your eardrum. That's a very intimate act. I am very literally touching you and when you speak to me, you are literally touching me. And then we extend that principle to the sound of a violin."[10]

The conductor and pianist Daniel Barenboim believes that our early connection to sound is another reason for its power—one that in today's world we sometimes forget. He thinks that because we live in a very visual society we're more aware of what we see than what we hear. But he reminds us that the latest scientific evidence reveals that the ear, which we now know is active in the womb, has an advantage over the eye that doesn't see until we are born.

He also says:

"The ear has a head start over the eye, which doesn't see anything until it comes out. The eye is also something that one can control more fully. If you don't like the way I look, and you don't want to see me, you close your eyes and I disappear. But if you don't like my voice and you're in the same room, then you

cannot shut your ears in a natural way. Sound literally penetrates the human body."[11]

This human relationship to sound starts early. The fetus begins to develop an auditory system between 17 and 19 weeks. Already, we are in a world of sound, of breath and heartbeat, of rhythm and vibration. But how do we know what the fetus actually hears? Until recently, there were different theories. Some doctors thought that the fetus could only hear some frequencies, probably high ones. It certainly wasn't known whether we could hear and respond to music before birth until the groundbreaking research of Sheila Woodward, a South African, who wanted to know more about musical sound in the womb. She was a young scientist in the early 1990's—and pregnant; she wondered what music her own child was being exposed to before birth. In her studies at the University of Capetown, she worked with the Institute of Maritime Technology to adapt an underwater microphone so it could be placed in the uterus.

Her team came up with a tiny waterproof hydrophone, about two inches long, that doctors found safe enough to put inside the womb. As part of Woodward's research, this miniature microphone was inserted through the cervix into the uterus of a mother in early labor and placed alongside the neck of the unborn child. The mic recorded exactly what was audible inside the uterus as Woodward played music, sang herself, and had the mother sing. "The big question," she says, "was, 'Does music really exist in the womb and is it very different from the way we hear it in the outside world?'

As we listen to the recordings that Woodward conducted with several mothers in early stages of labor, we first hear the rhythmic sound of blood coursing through the uterine artery.

Theme, Finale played at 112 as suggesting a comfortable walking rate. And most marches are set to that tempo. Keep in mind that if the tempo is set to 120, the basic pulse is actually given by the first and third beats. So 120 becomes 60. And the normal resting human heart rate is 60 to 80 beats per minute. *Andante* is a fast walk of 76 to 108 bpm. A fast march might be set at 124 beats per minute. A musical tempo of *Lento* or *Largo* ("Slow") is 40-60 bpm.

Cellist Michael Fitzpatrick also thinks the great composers were tapped into the natural pulse rates of the way our blood flows, the way our heart beats. When you listen to their music, he says, "it has a very specific effect on the body and can calm the mind, relax the body, and free the emotions."[19] And at the frontiers of today's science, researchers have discovered evidence for what many musicians have instinctively felt for centuries.

CHAPTER TWO

Music Plays the Body

The ear is the way.

THE UPANISHADS

Can you hear the rushing of the river? That is the way.

ZEN BUDDHIST SAYING

In a lab, a subject sits before a computer monitor. There's a band aid-like object wrapped around her finger and another device behind her ear, measuring her pulse rate and galvanic skin response —that is, how much she's sweating. First we hear a rather slow, melodic piece played over the speakers—Albinoni's Adagio in G. The monitor shows the read-out from the subject. The waves are fairly long and shallow. Then comes the theme from Hitchcock's thriller *Psycho.* The waves quickly become shallower, with sharper spikes. The measuring devices clearly show that the subject has a physiological reaction to the change in music.[20]

A hallmark study on the human physiological response to

CHAPTER THREE

The Brain Plays Music

"I think I should have no other mortal wants, if I could always have plenty of music. It seems to infuse strength into my limbs and ideas into my brain. Life seems to go on without effort, when I am filled with music."

GEORGE ELIOT

When we listen to music well, we allow music to happen to us. We don't think consciously about what's going on inside our heads. But to actually see the human brain in action as it responds to music is to marvel – both at the phenomenon and at the technology that's allowing us to see it

Neuroscientist Lawrence Parsons and his technicians ran a fascinating brain/music experiment. Two British rock stars, Jarvis Cocker and Richard Hawley, and a hip, shaven-headed scientist were in an fMRI scanning room. One rocker was singing in the scanner while his partner strummed the guitar next to the machine, the music accompanied by the buzz of the

scanner. The control room monitor showed blue-tinted scanner images of the singer's brain; the images constantly morphed and changed with a liquidity that was hypnotizing. As I watched this scene I actually burst out laughing with the wonder and strangeness of what I saw. To Parsons, it was business as usual. But actually even ten years ago, this event would have been unthinkable.

Only within the last decade has the technology of brain research made it possible to actually take pictures of the brain in action. fMRI (Functional Magnetic Resonance Imaging) and PET (Positron Emission Tomography) measure changes in the blood flow and blood oxygenation in the brain which indicate neural activity. These new scanning techniques have driven an explosion of research studying the interaction of the brain and music. The results are truly revolutionizing our understanding of the human connection to music.

In the 1990s, when music science was beginning to take off, the headlines and the literature often focused on one particular question: are we somehow wired for music? The new brain studies were beginning to offer real proof that we are indeed. Our physical responses to music are rooted in the brain and the way it processes information. There's evidence that we are born with brain structures that allow us to experience music emotionally and physically. And today many scientists are convinced that there is a biology of music, a hard-wired capacity for musical appreciation and expression.

As we learned in Chapter One, the inner ear and the auditory cortex of the brain are actually built to respond to pitch: the ear converts sound waves to electrical signals sent to the brain: and the auditory cortex is laid out in actual pitch order. Thus, the brain

active in areas for phrasing and coordinating music as well as in the areas associated with cognitive and emotional interaction. What Parsons saw was the brain doing "complicated social work with a lot of millisecond decision planning "as the musicians performed. He was also looking at the brain at its peak demand, when two musicians or singers are working together to create music. What this pioneering study shows is that "Music is intrinsically social," as Parsons says.[52]

Other researchers are very intrigued by the idea that music can actually synchronize people's brain states. When we go to a concert – be it rock or classical – part of what makes it enjoyable and special is that it's a *shared* experience. And it's not just that our physical bodies are present in the same space. We're all entraining to the beat. So do our brains synchronize in other ways, too? Can music put a community – a society – of brains into the same state? Logic says yes. And some researchers believe that the field of music neuroscience is now moving from the study of individual brains toward the study of a society of brain stats.

CHAPTER FOUR

Is Music Our Genetic Birthright?

Without music life would be a mistake.

FRIEDRICH NIETZSCHE

Music—figuratively speaking—is in *my* genes. I grew up with it all around me. I was exposed constantly to the melodies, harmonies and form of Western classical music. But what about other genres? Do I have the same natural affinity for other kinds of music, for the music of other cultures? Or am I able to appreciate only the music I grew up with, and unable to experience pleasure listening to music that is quite different from what I'm used to?

The answer is that at least some of the time, enjoying unfamiliar music is difficult for people. Take me to a Chinese opera and I'm but because I don't "get it". I don't understand what the composer is doing and I'm not moved emotionally. It's

PART II

The Musical Self

CHAPTER FIVE

Agony and Ecstasy

How We Listen

When I hear music, I fear no danger, I am invulnerable, I see no foe. I am related to the earliest times and to the latest.

HENRY DAVID THOREAU

If we listen—really listen—to music, we recognize moments that give us a little start, a shiver down the spine, a "frisson" of surprise. It could be a chord change or a harmony or a turn in the melody. And then a song or a phrase may elicit a memory and a particular emotion. For example, when I hear a Joni Mitchell song, or Joan Baez or of course the Beatles, I actually am taken back to my room as a teenager or my first car or a person I was with when I heard these pieces of music. So when music makes us feel something, how much is due to our associations with it and how much is due to something in the music itself? Are there certain elements built into the musical structure of songs

to believe that it can be healing and transforming in a variety of ways. In the last couple of decades, science has made amazing advances in defining some of those ways. No doubt in years to come, it will define others. It's right to be cautious in making claims for treatment or cure by using therapies that may not have been examined with scientific rigor. But there are also those who believe we've lost something by drawing too rigid a boundary between music and the wider role it can play in our lives.

CHAPTER THIRTEEN

Conclusion

Beyond the Concert Hall

Music is a higher revelation than all wisdom and philosophy. Music is the electrical soil in which the spirit lives, thinks, and invents.

LUDWIG VON BEETHOVEN

Science has given us a new perspective on our connection to music. It's reminding us that music offers so much more than entertainment. I was lucky because from earliest childhood, I was surrounded by music, immersed in it. It was an integral part of my life, even though I had no aspirations to become a professional musician. I heard live music as a part of daily life. I listened as my father improvised on the piano, playing with music. And I had an inkling that music is some kind of magic sound, another kind of language.

Over the time I've spent learning about the new science of music, I've been struck by how scientists and musicians alike

together. Its potential seems boundless. I also believe that the mystery and magic of music will always remain. It is awesome. And we will always be awestruck when music is at its best and when we deeply listen.

NOTES

Chapter One: Feel the Sound

1. Tom Fritz, of the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany, conducted this study in the Cameroon in 2006. Fritz collaborated with his colleague, Stefan Koelsch. The results were published in the March 29th, 2009 issue of Current Biology. Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, A., Friederici, Music, Current Biology, Volume 19, Issue 7, 573-576, 19 March 2009.
2. Dr. Barry Bittman, Director, Mind-Body Wellness Center, phone conversation with Elena Mannes 11/17/2009.
3. Interview with Daniel Levitin for *The Music Instinct:Science & Song*, PBS (aired June 2009).
4. Interview with Michael Fitzpatrick for *The Music Instinct: Science & Song"*, PBS (aired June 2009).
5. Interview with Bobby McFerrin for *The Music Instinct: Science & Song*, PBS (aired June 2009).
6. Interview with Bobby McFerrin for *The Music Instinct: Science &*
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8. Interview with Dame Evelyn Glennie for *The Music Instinct: Science & Song"*, PBS (June 2009).
9. Irene Gubrud interview with Elena Mannes. Irene Gubrud interview with Elena Mannes.
10. Interview with Daniel Bernard Roumain (DBR) for *The Music Instinct: Science & Song*, PBS (June 2009).

11. Interview with Maestro Daniel Barenboim for *The Music Instinct: Science & Song*, PBS (June 2009).
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Chapter Two: Music Plays the Body

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A NOTE ON THE AUTHOR

Elena Mannes has won six Emmys and many other national awards for her documentaries. She is a member of one of the first families of American music. Her grandparents founded the Mannes College of Music in New York City; her great uncle, Walter Damrosch, conducted the Metropolitan Opera and was the instigator for the building of Carnegie Hall.

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