THE BODY AS A MELODY: IS DNA MUSICAL?

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Music is a strange thing. I would almost say it is a miracle. For it stands halfway between thought and phenomenon, between spirit and matter, a sort of nebulous mediator, like and unlike each of the things it mediates -- spirit that requires manifestation in time and matter that can do without space... we do not know what music is. -- Heinrich Heine (quoted in Critchley. 1977a, p. 217)

Why are we moved by music? One reason may be that the body itself is intrinsically musical, right down to the DNA that makes up our genes.

The idea that DNA and music might be connected comes from the work of Dr. Susumu Ohno, a geneticist at the Beckman Research Institute of the City of Hope in Duarte, California. (Ohno and Ohno. 1986; Ohno and Jabara. 1986) The genes of every organism are composed of strands of DNA, which in turn are made up of four nucleotides containing the bases adenine, guanine, cytosine, and thymine, arranged in sequences that are unique for each species. In an imaginative leap, Dr. Ohno assigned musical notes to these substances -- *do* to cytosine, *re* and *mi* to adenine, *fa* and *so* to guanine, and *la* and *ti* to thymine. Then. having assigned musical notes to each base, Dr. Ohno chose a particular key and timing, as well as the duration of each note. The result was a melodic composition that was finally fleshed out with harmonies by his wife, Midori, a musician. When completely transcribed, the scores were then performed by professional musicians on instruments such as the piano or organ, violin, and viola.

Dr. Ohno has notated over fifteen songs of the DNA of a variety of living organisms during the past two years. He finds that the more evolved an organism is, the more complicated is the music. The DNA of a single-cell protozoan, for example. translates into a simple four-note repetition. But the music transcribed from human DNA -- e.g. the body's receptor site for insulin -- is much more complex. Listeners knowledgeable about music have taken these DNA-based compositions for the music of Bach, Brahms, Chopin. and other great composers. These melodies are majestic and inspiring. Many persons hearing them for the first time are moved to tears: they cannot believe their bodies, which they believed to be mere collections of chemicals, contain such uplifting. inspiring harmonies -- that they are musical.

Not only is it possible to make music starting with DNA, but one can also do the reverse -- start with great pieces of music, assign nucleotides to the notes. and end up with a particular type of DNA. When Dr. Ohno transcribed a Chopin piece into a chemical notation, sections of the resulting formula were the DNA of a human cancer gene. It seems that even cancers have their own music! [Professor Ohno's process is. of course, an arbitrary one. There are many musical systems world-wide, each of which would yield different results if its tones were transposed onto the genetic code, and if the resulting tones were harmonized and divided into the discrete notations and beats characteristic of that particular form of music. The point is that DNA and music can be related to each other, not that the music that results from this process conforms invariably to that of a particular cultural tradition.]

Many great artists, writers, and musicians have heard messages in nature, some of them musical. When Mozart heard a complex, lengthy piece of music fully formed, where was it coming from? When Hesse said in the prologue to *Demian* that he had learned to listen to the messages his blood whispers to him, what was he actually hearing? How do we explain synesthetes, those individuals whose senses operate together in such a way that they can smell sounds and see musical tones? Where is this information coming from? Are they in touch with some music encoded in their bodies?

Concert pianist Lorin Hollander has described the rich visual imagery he has experienced all his life on playing the works of the great composers. These images, he states, often take the form of highly complex geometric designs. His experience affirms Pythagoras' assertion in the sixth century B.C.: "There is geometry in the humming of the strings. There is music in the spacings of the spheres." Hollander was astonished when he later discovered that these forms, which he had visualized since childhood, were practically identical to many of the beautiful tile designs of Islamic mosques scattered throughout the Middle Last and India. The pentagonal and hexagonal shapes that are repeated in these designs show striking similarity to the way DNA is represented in two-dimensional chemical notation. In the body the nucleotides that make up DNA are not, of course, two-dimensional figures; that is only the way we draw them "on paper." But that may be the way they display themselves to the imagination -- whether to Hollander, whose music calls them forth, to molecular biologists, or to the great artists who embellished the mosques of Islam.

If connecting DNA and music seems fanciful, we should recall that there is no reason in principle, why DNA has to be described in the familiar alphabetical symbols of organic chemistry -- C for carbon, N for nitrogen, O for oxygen, H for hydrogen, and so forth. It could be described using many symbols, even musical notes. If we were imaginative enough to think musically as well as alphabetically, this just might permit us to hear the music of the body. This experience could provide us with nobler visions of the body, and might allow us at long last to escape the tyranny of machine thinking.

Recognizing the music latent in DNA suggests a new way of looking at evolution. Rather than a method of passing *genes* from one generation to another, the evolutionary process could be a way of passing the *music* along, each generation "making music" for the next. Mutations would be ways of tinkering with the melody, of creating new, more complex tunes. "Survival of the fittest" might mean "staying in key," "playing with the orchestra," or "maintaining the harmony." The natural world would not be "nature red in tooth and claw," it would be a gigantic symphony instead, composed of innumerable instruments. Since some structures in humans are the same as in distant species like protozoa and mice -- the chemical receptors for insulin and endorphins are examples -- we might conceive of' ourselves as "in the same section of the ordtestra" as these species, or as "playing the same instruments." Instead of sitting imperiously atop the evolutionary chain, we might see ourselves as simply occupying the "first chair," dependent on our "colleagues" to flesh out the score and enrich the performance. We might even begin to think of the Absolute not as a blind watchmaker who fashioned a mindless machine, but as the Maestro who wrote the melody and interwove all the harmonies.

But the material world is more than just the DNA of living creatures; it is nonliving things such as rocks, stars, and galaxies as well. One could conceivably notate *any* of these things musically. When Pythagoras spoke in the sixth century B.C. of "the music of the spheres," was he comprehending this sort of notation in the heavens? Could the music in our genes reflect the music of the universe? After all, the stuff of which our bodies are made was spawned in remote galaxies, and the atomic components of' our DNA have been processed through the lifetimes of several stars. Is the vast universe, then, the source of the primordial melodies that eventually precipitated in our protoplasm? Is the cosmos an immense music bank from which the music of our DNA is on loan? Was Plotinus correct when he said, "All music, based upon melody and rhythm, is the earthly representative of heavenly music"?

Many of the scientists who have pondered the nature of the universe have responded deeply to music. Pythagoras measured harmonies on a lyre string; Nobel physicist Richard Feynman beat salsa rhythms on his bongos; and Nobelist in physical chemistry Ilya Prigogine is a gifted pianist. Lawrence LeShan has noted that at the famous Copenhagen Conference of 1932, which was attended by the greatest physicists of the day, there was enough musical talent and training for a first-rate orchestra.(LeShan. 1990, p. 19) The thoughts of Einstein, who was famous for his affection for the violin, come tantalizingly close to uniting the scientific and musical visions. He said, "[Music and scientific research] are nourished by the same source of longing, and they complement one another in the release they offer." (Wilczek and Devine, 1989)

Plotinus' suggestion of a music-permeated cosmos echoes through many traditions. The legendary Zen patriarch Lao-tzu spoke of the Great Tone that is "the tone that goes beyond all usual imagination." In the Hindu tradition the Great Tone is *Nada Brahma*, the tone from which God made the world, which continues to sound at the bottom of creation, and which sounds through everything. (Berendt 1987, p. 171)

The image is one of music embedded in everything, perhaps in human tissue itself. Could different body parts "have their own music -- music that is more differentiated than the DNA music shared by all cells as suggested by Professor Ohno? Could they *respond* to certain music?

Without doubt, body parts can respond to the "wrong" music. The British neurologist Macdonald Critchley cites examples from long ago: in 1605. LeLoirier's *Treatise of Specters* told of an individual who experienced urinary incontinence on hearing the music of the lyre, and Shakespeare in *The Merchant of Venice* spoke of "some that are mad if they behold a cat, and others when the bagpipe sing with noise cannot contain their urine," Critchley relates a famous case dating to 1913 in St. Petersburg of a rare disease known as musicogenic epilepsy -- epilepsy brought on by music. It involved, ironically, the well-known music critic Nikonov. His first attack came when he was at the Imperial Opera" House watching a performance of Meyerbeer's *The Prophet*. During the third act he became tremulous and sweaty and his left eye began to twitch uncontrollably. He developed a severe headache and lost consciousness. Nikonov thereafter became a prey to these attacks, each brought on by music and nothing else. Even at a distance, music would trigger epilepsy. As a result, he was tormented by a veritable phobia of hearing music. "If out of doors the sound of an approaching military band reached him, he would stop his ears, and seek refuge in a back street or

any handy doorway or shop." Eventually the attacks became more or less controlled with medication. (Critchley, 1977b, p.6)

In contrast, could certain tissues become healthier if "their music" were played? Perhaps. Many healers throughout history have realized the body's capacity to respond to certain music. In 1529, Caelius Aurelianus wrote of a musician who could literally make specific parts of the body dance: "A certain piper would play his instrument over the affected parts and these would begin to throb and palpitate, banishing the pain and bringing relief."(Quoted in Henson, 1977, p. 6) And Aulus Gellius, writing circa A.D. 160, said:

> I ran across the statement very recently in the book of Theophrastus *On Inspiration* that many men have believed and put their belief on record, that when gouty pains in the hips are most severe they are relieved if a fluteplayere plays soothing measures. That snake-bites are cured by the music of the flute, when played skillfully and melodiously, is also stated in a book of Democritus, entitled *On Deadlv Infections,* in which he shows that the music of the flute is medicine for many ills that flesh is heir to. So very close is the connection between the bodies and the minds of men, and therefore, between physical and mental ailments and their remedies.

It is not just in the stories of antiquity that we see the healing power of music. A child psychologist recently reported his experience with an eleven-year-old boy who was diagnosed as a catatonic schizophrenic. The child had not uttered a word in seven years. In one session with him, the therapist played Bach's *Jesu Joy of Man's Desiring*. The boy began to weep. When the music ended he announced through his tears, "That is the most powerful music I have ever heard; now I can speak!" (personal communication, 1990)

If the body can respond so decisively to music, it must in some sense be music. As Goethe put it, if the eye were not in some measure the sun, it could not know the sun.

In addition to the physical body, other manifestations of the physical world are being transcribed into music. Computer scientist Robert C. Morrison of East Carolina University in North Carolina has developed computer programs that will translate patterns of numerical data into musical tones. He points out that the ear is a much more sensitive instrument than the eye for recognizing patterns. Thus through the medium of music a person could distinguish recurrent themes in chemical analyses, economic indicators, and other patterns of data too complex to allow ready analysis either visually or mathematically. In quality control systems an investigator could listen for disharmonies in the music instead of looking for mathematical irregularities. (Toot-Bernstein, 1990, pp 12-14)

The physical world also can be experienced by bringing the sense of touch into play. Scientists David W. Abraham, Ralph L. Hollis, and Septimiu E. Salcudean at the IBM Thomas J. Watson Research Center in Yorktown Heights, New York, have developed a "magic wrist" that converts complex images from a scanning electron microscope, an instrument that can display the surface atoms of a material, into three-dimensional movements. This permits the person wearing the wrist device actually to feel the atomic surface structures of metals and alloys. The IBM group plans also to attach their magic wrist to an atomic-force microscope, which measures the attractive forces

binding metals together, to enable people to experience firsthand the affinities between the constituent chemicals. (Toot-Bernstein, 1990, p. 14) This will allow the investigator to feel what is going on at the atomic level -- literally to "have a feeling" for the substance with which he or she is working.

Similar attempts have been made in medicine and surgery. One eye surgeon is seeking to apply the magic wrist in doing retinal surgery. Presumably anything that would magnify one's sense of touch would create an advantage in performing delicate surgical procedures, which now are done by relying primarily on vision. This would be like having one's fingertips in the cutting edge of the scalpel. (Toot-Bernstein, 1990, p.14).

One can imagine a multisensory device that not only would transcribe the body's DNA into music as Ohno has done, but translate it into kinesthetic stimuli as well -- a kind of "magic ear" and "magic wrist" combined. This would allow us to hear and feel what is going on inside our DNA and other body parts, allowing grander visions of the body than anything contained in the machine view.

One can also imagine diagnostic devices that make use of these capabilities. Today the various X-ray and scanning devices give the physician primarily visual images of the function of certain organs -- thyroid, lung, liver, kidney, and others. Based on the appearance of those images, the physician judges whether or not the organ "looks" normal. But rather than diagnosticians saying only that there appears to be a spot on the lung or a mass in the liver, the new devices might enable them to detect bodily disharmonies using nonvisual senses -- to say, for example, that the lung tissue sounds out of key, that there are sour notes coming from the thyroid, or that the kidney is off beat -- or, while wearing the magic wrist, to say that these organs literally do not feel right.

Today the practice of medicine is regarded largely as an intellectual affair. These diagnostic methods would go far beyond the intellect, however, and engage the senses and sensitivities of the physician in a much broader way. Although they would make the practice of medicine more demanding, they almost certainly would bring new meaning and greater fulfillment to being a doctor because they would call forth more of his or her innate human potential. And these breakthroughs just might make the practice of medicine easier. Just as the introduction of the stethoscope expanded what physicians could hear, these new tools would expand the reach of the senses and thus provide the physician with more information on which to base his or her judgments.

Physiologist Robert S. Root-Bernstein of Michigan State University has written of the need for a sensual science. Tools such as those above could revolutionize the way physicians and young scientists in general perceive the physical world. They would speed discovery, he suggests. because they would enhance the creative process by allowing a firsthand, immediate knowledge of the natural world. Root-Bernstein points out that many of the greatest scientists had the ability to relate sensually to their object of investigation. A typical recent example is Nobel Prize-winning geneticist Barbara McClintock, who attributed her astonishing insights to a highly developed "feeling for the organism." Another Nobelist, the great neuroanatomist and histologist Santiago Ramón y Cajal. also possessed this ability. Sir Charles Sherrington, the legendary English

neurologist who studied with Ramón y Cajal, reported: "He treated the microscopic scene as though it were alive and were inhabited by beings which felt and did and hoped and tried even as we do... He would envisage the sperm cells as activated by a sort of passionate urge in their rivalry for penetration into the ovum-cell." (Toot-Bernstein, 1990. p. 13)

Sherrington, one of the greatest neurologists in the history of medicine, was himself able to see the body in highly novel ways. He coined one of the most endearing terms to describe the human brain -- the "enchanted loom -- which, in the context of the body as music, translates easily into a musical instrument: a magic harp, lyre, piano.

In his admirable book *Nada Brahma: The World is Sound,* musicologist and writer Joachim-Ernst Berendt observes that in Latin the term meaning "to sound through something" is *personare*. "Thus," he states.

> at the basis of the concept of the person... stands a concept of sound: "through the tone." If nothing sounds through from the bottom of the being, a human being is human biologically, at best, but is not a *per-son*, because he does not live the sound which is the world. (Berendt, 1987, p. 171)

The trick is to hear the music that is the body. If we can do so, the meaning of the body can be transformed. It becomes not a blind, silent, doomed machine but a glorious composition, a part of God's oeuvre: the Great Tone.

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