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Human Nature after Neo-Darwinism

Abstract:
In the course of the 20th century the so-called Modern Synthesis of Neo-Darwinism has become the dominant paradigm in modern biology. First, it is explained how and why Darwin's broad definition of evolution, in which the environment plays an important role, was narrowed down by Neo-Darwinism to a radical gene-centric view. Next, the paradigm shift taking place today in 'postgenomic' evolutionary biology and genetics is discussed. It is argued that this shift opens the way to a more humane conception of evolution, more in line with Darwin's view. Finally, I will discuss some of the implications of this paradigm shift for human self-reflection, taking *The Music of Life. Biology Beyond Genes* of systems biologist Denis Noble as a starting point.

Keywords:
Neo-Darwinism, Dennis Noble, gene-centrism, postgenomics, agency, human self-reflection

The quest for human nature is not an easy task, and for more than one reason. One such reason is that both the subject and the quest are not fixed, but have a long history. Concerning the subject, human nature is part of, and, therefore, cannot be isolated from, the evolution of life on earth, which started about four billion years ago and will probably continue long after and beyond the extinction of the human being. Although almost negligible compared to the 'deep time' of the earth's life, humanity itself (the biological species *Homo sapiens*, whose ancestors entered the evolution of life about 2.3 million years ago), is marked by a, in this case, both natural and cultural history as well.

Moreover, the raise of historical consciousness in the humanities, as well as the natural and social sciences throughout the last two centuries has changed the very question concerning human nature. Until, and throughout, the 18th century human nature was still predominantly understood as a fixed essence. Even a skeptical mind like David Hume did not doubt this static conception. In his 1748 *Inquiry Concerning Human Understanding* we read: "Mankind is so much the same, in all times and places, that history informs us of nothing new or strange in this particular. Its chief use is only to discover the constant and universal principles of human nature."[1] For our current era, the issue no longer seems to be the discovery of the unchangeable essence of humanity, but rather to explain its very changeability, as it is expressed in the overwhelming variety of human cultures throughout the course of human history. Of course, we can define this changeability itself as an essence, but in doing so we can arrive at some rather abstract definitions, like the one Helmuth Plessner provides in his 1928 *Die Stufen des Organischen und der Mensch*, where he characterizes man as "artificial by nature." Being ex-centric, man is pressed, "towards ever different realizations" of himself, and for that reason "leaves a history behind himself."[2] According to Plessner, one consequence is that the quest for human nature cannot refrain from the empirical study of those different realizations in time and space.

However, there is an additional reason why questioning human nature is such a difficult endeavor. Even when we restrict our inquiry into human nature to a description of one particular realization (be it a particular culture, or even a single person), we find ourselves overwhelmed by the complexity of the human life-form. Human life consists of many, often interrelated, dimensions, ranging from its biological, psychological, sociological and political characteristics to various artistic, religious, moral, and scientific activities, as well numerous cultural and technical artifacts and institutions. As a result, human nature must be studied from the point of view of a variety of natural and social sciences (such as biological anthropology, neuroscience, psychology, sociology, political science, and cultural anthropology), as well from those of humanities (history, archeology, literature, law, cultural studies, theology, philosophy, etc.), in order to account for its rich complexity. Moreover, the quest for human nature is not restricted to sciences and humanities. Many of the activities that are part of human nature, such as artistic expression and religious contemplation, consist of reflections on human nature as well. Self-reflection is an inherent aspect of the ex-centric character of the human life-form. In addition, self-reflection is generally considered to be a *sine qua* for the 'good life,' as expressed in the familiar words of Socrates: "an unexamined life is not worth living."[3]

The many interrelated dimensions of human life are indicative of the complex texture that we call human nature. Yet, in the history of human self-reflection one particular dimension has often been emphasized; one may consider attempts to define man as a *zoon politikon*, an *animal rationale*, or *symbolicum*, or as a *Homo sapiens, faber,* or *ludens*. In reality, we cannot reduce the complexity of human nature to any one of these constitutive dimensions.

Nevertheless, in this essay I will focus on one particular biological determination of man: the Neo-Darwinist account of human nature. After my introduction, it will be clear that this choice does not imply that I endorse this Neo-Darwinist account of human nature. On the contrary, I will criticize Neo-Darwinism because it reduces human nature to its molecular basis, and, more particularly, to genes, which are considered to be the final determinants of human life. The reason for focusing on Neo-Darwinism is that this reductionist and consequently impoverished image of human nature has continued to grow in popularity, not only in evolutionary biology and the connected life sciences, in which it is the dominant paradigm, but also in the social sciences

1) David Hume, *Enquiries Concerning Human Understanding and Concerning the Principles of Morals* (Oxford: Clarendon Press, 1975), 83.

2) Helmut Plessner, *Die Stufen des Organischen und der Mensch: Einleitung in die philosophische Anthropologie* (Frankfurt am Main: Suhrkamp, 1981), 382, 416.

3) Plato, "Apology," in *Plato: Complete Works*, ed. J. M. Cooper, and D. S. Hutchinson (Indianapolis, IN: Hackett Pub., 1997), 38a.

and humanities, ranging from evolutionary psychology and economics, to evolutionary ethics and aesthetics. Moreover, due to bestsellers like Richard Dawkins' *The Selfish Gene*[4], which sold over one million copies since its publication in 1976, the Neo-Darwinist image of man has become part of popular reflection on human nature far beyond the walls of academia.

The rise of Neo-Darwinism did not come out of the blue. It is part of the naturalization and mechanization of a worldview that has characterized western modernity since the 16th century. This tradition has not only led to a disenchantment of living nature surrounding human beings, but has also profoundly affected our view on human nature, and the human place in the cosmos. Neo-Darwinism, which culminated in the 20th centuries 'Modern Synthesis' of evolutionary theory and molecular genetics, not only questioned the alleged gulf between human beings and other animals (as Darwin already did), but even the gulf between animate and inanimate nature. The result is a reductionist, deterministic, and even nihilistic image of man, leaving little room for meaning, morality, art, and other dimensions of human life that have long been considered to be important, if not crucial, aspects of understanding humanity.

In the western world, the 'greedy reductionism' of Neo-Darwinism has met severe criticism, especially from representatives of Christian and humanistic traditions. However, as these criticisms are often motivated by a no less 'greedy transcendentism', they fail to convince those who adopt a modern scientific worldview.[5] However, in the last decades there is also a growing body of biologists critical of Neo-Darwinism. In their view, recent developments in epigenetics and systems biology necessitate a fundamental reconsideration of some of Neo-Darwinism's basic presuppositions. Although at first glance these discussions are rather technical and specific in scope, they have far-reaching implications for human self-reflection.

In what follows I will first situate the so-called Modern Synthesis of Neo-Darwinism in the history of modern biology. Whereas Darwin developed a broad definition of evolution, in which the environment plays an important role, the dominant Neo-Darwinist paradigm was narrowed down to a radical gene-centric view. I will then discuss the paradigm shift that is currently taking place in 'postgenomic' evolutionary biology and genetics. This shift opens the way to a more humane conception of evolution, more in line with Darwin's own view. Finally, I will discuss some of the implications of this paradigm shift for human self-reflection, taking system biologist Denis Noble's *The Music of Life. Biology Beyond Genes* as a starting place.[6]

1. The Modern Synthesis of Neo-Darwinism

The static image of man, as expressed by David Hume in 1749, gradually changed throughout the second half of the 18th century. Discoveries in the natural sciences and the development of archeological and historical research evoked the awareness that both nature and culture have a much longer history than the four thousand years previously estimated from interpretations of the Bible – especially the discovery of the so-called 'deep time' in geology, which motivated a fundamental historicizing of our worldview.

This historicizing also affected the study of living nature. Whereas Hume's contemporary Linnaeus (1707–1778) – who prepared the way for modern biology – still presented a rather static classification of nature in his *Systema Naturae* (1735), one generation later Jean-Baptiste Lamarck (1744–1829) developed the first consistent evolutionary theory in his *Philosophie Zoologique* (1809), stating that all species develop from previous

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4) See Richard Dawkins, *The Selfish Gene* (Oxford: Oxford University Press, 1976).

5) Jos de Mul. *Philosophical Anthropology* 2.0. In: Jos de Mul. (ed.), Plessner's Philosophical Anthropology. Perspectives and Prospects (Amsterdam/Chicago: Amsterdam University Press / US distribution: Chicago University Press, 2014), 457–475.

6) Denis Noble, *The Music of Life. Biology Beyond the Genome* (Oxford, New York: Oxford University Press, 2006).

ones.[7] Lamarck distinguished two forces he saw as comprising evolution; a life force (*Le pouvoir de la vie*) driving animals from simple to complex forms, and a force adapting animals to their local environments and differentiating them from each other (*L'influence des circonstances*). With regard to the impact of the environment, Lamarck distinguished two related laws. The first one states that a more frequent and continuous use of any organ gradually strengthens, develops, and enlarges that organ, while the permanent disuse of any organ imperceptibly weakens and deteriorates it until it finally disappears. The second law states that such acquired characteristics are reproduced in the offspring.

This law of the inheritance of acquired characteristics gained a certain degree of popularity throughout the course of the 19th century – the often quoted example being the long neck of the giraffe, which, according to Lamarck, evolved because generations of giraffes reached for ever higher leaves. We even find it in Charles Darwin's *The Origin of Species* (1859), in which he repeatedly and approvingly refers to Lamarck's laws, including the giraffe example.[8] However, Darwin also developed a complementary explanation in his theory of natural selection. This theory – which Daniel Dennett refers to as the best and most 'dangerous idea' ever[9] – states that a simple mechanistic algorithm of reproduction, variation, and selection is responsible for the entire evolution of life on earth. Unlike Lamarckian evolution, which is the result of a fast, discontinuous, and purposive adaptation, Darwinian evolution is a slow, gradual, and random process that takes many thousands of generations.

Lamarck's popularity ended quite abruptly after a publication of experiments by the German biologist August Weismann, who tested Lamarck's theory of the inheritance of acquired characteristics with a rather cruel experiment. After cutting off the tails of 68 white mice repeatedly over 5 generations, and observing that no mice were born without a tail, or even one that was consequently shorter, he concluded that hereditary information moves only from germline cells to somatic cells, and never in reverse. This thesis, known as the Weismann barrier, effectively banished Lamarckism from mainstream biology, including the Lamarckian elements in Darwin's evolutionary theory, shifting the focus exclusively on natural selection.

Although Darwin successfully described the process of natural selection, he was not able to explain it. He was not aware of the publications of his contemporary Georg Mendel, in which he reported his experiments with the genetic traits of peas. Mendel discovered that genetic traits consist of discrete units (for which the Danish botanist Wilhelm Johannsen introduced the word "genes" in 1909), the inheritance of which follows specific mathematical laws. Mendel's discovery inspired the development of modern genetics, and the so-called population genetics of the 1920's and 30's played an important role in this development by synthesizing Darwinian evolutionary theory and Mendelian genetics, and giving it a robust mathematical foundation. Julian Huxley's book *Evolution, the Modern Synthesis* gave this Neo-Darwinian project its name.[10]

However, the real breakthrough of the Modern Synthesis came after the discovery of the material substrate of the gene: the DNA molecule in the cell nucleus, by Francis Crick and James Watson in 1953. This large double helix molecule, which consists of about three billion nucleotides in four different variants, was supposed to code for all of the genetic traits of the organism. DNA plays a crucial 'vertical' role in that the encoded genetic traits in the reproduction are transferred to the offspring. However, it also plays a no less crucial role in the

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7) Jean-Baptiste Lamarck, Philosophie zoologique (Union générale d'éditions: Paris, 1968).
Carl von Linné, *Systema naturae* (Ann Arbor, MI: Published for the Ohio Herpetological Society by Cushing-Malloy, 1963).

8) Charles Darwin, *The Origin of Species by Means of Natural Selection, or, The Preservation of Favored Races in the Struggle for Life* (New York: Mentor, 1958), 201.

9) See Daniel Dennett, *Darwin's Dangerous Idea: Evolution and the Meanings of Life* (London: The Penguin Press, 1995), 21.

10) See Julian Huxley, *Evolution. The Modern Synthesis* (London: G. Allen & Unwin ltd., 1942).

construction and regulation of the organism, because the code is used to produce – via an transcription into messenger RNA and a subsequent translation into a protein – more than 100,000 different kinds of proteins. These proteins function as the building blocks of the organism, enzymes in the digestion of food and damaged tissues, means of transport of chemical substances through the body, hormones in the regulation of bodily processes, and anti-bodies in the immune system.

The discovery of DNA, and the subsequent research of its functioning, made it possible to explain the variations in offspring discussed by Darwin in his theory of natural selection. These differences are not only the result of the recombination of genetic traits of the parents through sexual reproduction, but account for traits which are also subject to small changes because of mutations due to copy errors during the reproduction of the genes – e.g. from radiation. The resulting differences may be disadvantageous for the offspring if they lead to something as detrimental as the malfunctioning of specific organs, but they can also lead to a greater reproductive success and biological fitness. Within this Neo-Darwinian perspective, the longer neck of the giraffe is not the result of its intensive use of its neck, but the outcome of a long series of small mutations.

Neo-Darwinism also reinforced the 'Weismann Barrier' and the ban on Lamarckism, by the formulation of a so-called 'central dogma.' This dogma, formulated by James Crick in 1956, states that genetic information flows exclusively from DNA, via RNA, to proteins, which can then form protein networks up through the biological levels to that of the whole organism, but can never flow the other way.[11] Although it is true that proteins cannot code for DNA, the 'central dogma' soon was interpreted in a much broader way. Following Weismann, it was taken to mean that the organism and its environment could not have any influence on the expression of the genes. This strict separation of the germline cells and soma cells – the implication of the Neo-Darwinian identification of genetic traits with specific sequences of nucleotides in the nucleus – lead to a gene-centered, strongly reductionist and determinist notion of genetics and evolution. After having been developed by George Williams in his book *Adaptation and Natural Selection*[12], this gene-centered view was especially popularized by Richard Dawkins in his aforementioned, *The Selfish Gene*. According to Dawkins' account, the organism is nothing more than a temporary vehicle for the reproduction of immortal selfish genes. Although Dawkins does not talk much about humans, he ends *The Selfish Gene* with the clam that, "we are built as gene machines and cultured as meme machines, [but we] have the power to turn against our creators," and that "we, alone on earth, can rebel against the tyranny of the selfish replicators,"[13] but the extreme reductionist and determinist exposition which makes up the preceding 200 pages does not offer even the beginning of a clue about how this could be possible. The impression we are left with is that of a rather pessimistic nihilism.

Surprisingly, this did not temper the enthusiasm for the Neo-Darwinian project. As expressed by Sarah Richardson and Hallam Stevens (with a strong sense of irony), from whom I quote at length:

> The discovery of the double-helical structure of DNA in 1953 lit the flame. The breathtaking rapidity with which this discovery lead to the entrenchment of the central dogma (DNA→ RNA→ protein), the cracking of the genetic code, the emergence of genetic engineering technology, and the early understanding of Mendelian diseases created an expectation of exponential increases in our ability

11) Francis Harry Compton Crick, "Ideas On Protein Synthesis," http://profiles.nlm.nih.gov/ps/retrieve/ResourceMetadata/SCBBFT, accessed Apr. 30, 2017

Francis Harry Compton Crick, "On Protein Synthesis," Symposia of the Society for Experimenta; Biology 12 (1958): 138–163

Francis Harry Compton Crick, "The central dogma of Molecular biology," Nature 227 (1970): 561–563.

12) See George Christopher Williams, *Adaptation and Natural Selection*, (Princeton: Princeton University Press, 1966).

13) Dawkins, *The Selfish Gene*, 30th anniversary ed. (Oxford, New York: Oxford University Press, 2006), 201.

to measure and interpret DNA information. DNA satisfies the compulsions of many scientists: measurable, discrete, molecular (yet apparently integrative), deterministic, and evolvable. If a little DNA sequence was good, then a lot – the genome – would be great. With the prospect of greatness, reasonable people are prone to hyperbole: save money, develop cures, predict disease, learn about our ancestors, and bring justice to all. It can be hard to judge harshly someone in love.[14]

2. Biology Beyond Genes

Inspired by these hyperbolic expectations, quite a lot of money and energy has been invested in the *Humane Genome Project* (1990–2003). Due to the joint effort of thousands of researchers all over the world, the sequencing of the entire human genome was realized in an impressively short period of time. However, in the light of the high expectations, the result was relatively disappointing for several reasons.

First, the number of genes in the human genome turned out to be much smaller than expected. Instead of 100,000 genes (like that of different proteins), the number turned out to be about 20,000. Apart from the fact that this modest number offended human narcissism (the tiny, unicellular *Protozoa*, for example, already has three times more genes than *Homo sapiens*), it also made clear that the "one gene, one function" credo of Neo-Darwinism was incorrect. Most human genes do not code alone, but function in large genetic networks, and depending on the network, they can execute multiple functions. The number of possible combinations of 20,000 genes is hyper-astronomical. Mathematicians call it a combinatorial explosion, and the number of combinations is not only far beyond our imagination, but also beyond the number of particles in the universe.

Second, not all genes express themselves in proteins; they can be 'switched' on, or off. The non-coding part of the DNA – about 98.5%, initially termed junk-DNA and believed to have no function, – turned out to have all kinds of regulative functions regarding the gene expression. It was expected that the *Humane Genome Project* would crown the Neo-Darwinian project, but it became clear that, although determining the sequence of four DNA bases turned out to be relatively easy, understanding its role in biological systems is incredibly challenging.[15] Although impressive in many respects, the *Human Genome Project* marked a new beginning, rather than the end, of genetics.

Moreover, some recent developments in so-called 'postgenomic' research not so much urge the extension of Neo-Darwinist theory, but, conversely, undermine some of its basic presuppositions.[16]

First of all, it turned out that mutations are not random. The speed, amount, and the location of genome change can be influenced functionally.[17] The immune system, for example, is able to react to many different antigens. This kind of natural genetic engineering is not restricted to the immune system, but also plays a role in the development of organic functions and explains the non-random number of limbs, digits, segments, and vertebrae across a variety of taxa. The development of life is a constructive process, as the organism shapes its own developmental trajectory by constantly responding to, and altering, internal and external states.[18]

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14) Sarah S. Richardson, and Halam Stevens, *Postgenomics: Perspectives on Biology after the Genome* (Durham; London: Duke University Press, 2015), vii.

15) Ibid, ix.

16) Denis Noble, "Physiology is Rocking the Foundations of Evolutionary Biology," *Experimenta; Physiology* 98, no. 8 (2013): 1235–1243.

17) James A. Shapiro, *Evolution: a View from the 21st century* (Upper Saddle River, N.J.: FT Press, 2011).

18) Kevin N. Laland, Tobias Uller, Marcus W. Feldman, Kim Sterelny, Gerd B. Müller, Armin Moczek, Eva Jablonka, John Odling-Smee, "The Extended Evolutionary Synthesis: Its Structure, Assumptions and Predictions", *Proc. R. Soc.* B, 282 (2015): 1–14.

Secondly, genetic change is not gradual. Often whole sequences of DNA, containing multiple genes, are transposed to another part of the genome. These mobile genetic elements, sometimes called 'jumping genes' – already discovered by Barbara McClintock in 1951, but long neglected – are not rare, as recent research demonstrates. Over two-thirds of the human genome is derived from mobile elements.[19] Moreover, such genetic cut and paste work in most cases is not a one-time occurrence. For a large part, the genome consists of semi-stable genetic elements that may be rearranged in the genome, thus modifying the information content of DNA.[20] These rearrangements are the result of active manipulation by the cell's enzymes, and this constant interaction between the germline (the genes) and somatic elements fundamentally undermines the central dogma of the Modern Synthesis.[21]

Moreover, the 'jumping' of the genes is not restricted to transpositions within the genome, but also takes place between species. In the case of prokaryotes (unicellular organisms without a nucleus) this kind of horizontal transfer of genetic material takes place quite frequently, but it also happens quite often in the case of eukaryotes (cells with a nucleus). Many elements of the eukaryotic cell, such as the mitochondria, were initially bacteria that invaded the cell, but became part of it, and contributed their DNA to the cell. For that reason the 'tree of life' is actually a 'network of life.'[22]

Thirdly, given the fundamental Neo-Darwinist rejection of Lamarckism, the most remarkable development in the postgenomic era is the rehabilitation of the 'inheritance of acquired characteristics' in epigenetics, a generic term for all kinds of inheritance that does not involve a change in the sequence of DNA.

> These include components of the egg and post-fertilization resources (e.g. hormones), behavioral interactions between parents and offspring (e.g. maternal care), parental modification of other components of the biotic and abiotic environment (e.g. host choice) and inheritance of symbionts directly through the mother's germ cells or by infection.[23]

Under this broader notion of heredity, inheritance can occur from germ cell to germ cell, from soma to germ cell, from soma to soma, and from soma to soma, via the external environment.[24]

A spectacular example of genetic research is an experiment performed by Sun Yong-Hua in Wuhan, China, who used the nucleus of a carp, inserted into the fertilized, enucleated egg cell of a goldfish. Where, within the paradigm of the central dogma, one would expect a carp, the offspring was actually a hybrid that was closer to a goldfish than to a carp in several respects.[25] These kinds of epigenetic effects are also demonstrable in humans. A study done in Scandinavia clearly shows the transgeneration of food availability to human

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19) A. P. Jason de Koning, Wanjun Gu, Todd A. Castoe, Mark A. Batzer & David D. Pollock, "Repetitive Elements May Comprise Over Two-Thirds of the Human Genome", *PLoS Genet*, 7 (2011): e1002384.

20) Peter J. Beurton, Raphael Falk, & Hans-Jörg Rheinberger, T*he Concept of the Gene in Development and Evolution: Historical and Epistemological Perspectives* (Cambridge: Cambridge University Press, 2008).

21) John S. Mattick, "Rocking the Foundations of Molecular Genetics", *Proc Natl Acad Sci* USA, 109 (2012): 16400–16401.

22) Carl Woese, & Nagel Goldenfeld, "How the Microbial World Saved Evolution from the Scylla of Molecular Biology and the Charybdis of the Modern Synthesis," *Microbiol Mol Biol Rev* 73 (2009): 14–21.

23) Kevin Laland, "The Extended Evolutionary Synthesis: Its Structure, Assumptions and Predictions."

24) Alexander V. Badyaev and Tobias Uller, "Parental Effects in Ecology and Evolution: Mechanisms, Processes and Implications" *Phil. Trans. R. Soc. B* 364 (2009): 1169–1177.

25) Yong-Hua Sun, Shang-Ping Chen, Ya-Ping Wang, Wei Hu, and Zuo-Yan Zhu,"Cytoplasmic Impact on Cross-Genus Cloned Fish Derived from Transgenic Common Carp (Cyprinus carpio) Nuclei and Goldfish (*Carassius auratus*) Enucleated Eggs," *Biology of Reproduction* 72 (2005): 510–515.

grandparents influencing the longevity of grandchildren.[26] A no less striking example of a study of epigenetic inheritance independent of the germline showed that the stroking and licking behavior by adult rats towards their young results in epigenetic behavior epigenetic marking of the relevant genes in the hippocampus that predispose the young showing the same behavior when they become adults.[27]

For a last example of epigenetic inheritance, I want to mention a remarkable experiment with mice by Larry Feig. During their adolescence, the mice were put in an environment, enriched with social interaction and different toys. It was not surprising that their memory functions were better developed than those of the mice kept in a stimulus poor environment. However, what was surprising was that the next generations had better memory too, even when they did not grow up in an enriched environment.[28] The study of inheritance of acquired reaction against viral infections by *C. elegans* (a small worm often used in genetic research) showed that this epigenetic mechanism was robust for over 100 generations.[29]

All of the empirical findings discussed necessitate a fundamental revision of the Neo-Darwinian paradigm. In the last part of this essay I will discuss some aspects of this revision, focusing on their implications for human nature and self-reflection.

3. Some Implications for Human Nature and Human Self-Understanding

Among the critics of Neo-Darwinism, the physiologist Denis Noble from Oxford University, renowned for his mathematical models of the heart, and pioneer in the field of systems biology, is an interesting voice for more than one reason. Although, as a biologist, he was raised in the tradition of Neo-Darwinism, his work on the complex feedback systems of the heart questioned some of its reductionist presuppositions, and he gradually became one of the most vehement critics of Neo-Darwinism. Guided by the credo that Darwin himself – accepting Lamarckian inheritance of acquired characteristics as a complement of natural selection – was not a Neo-Darwinist, Noble became a passionate advocate of a replacement of the Modern Synthesis by what he calls an Integrated Synthesis.

In 2006, he published *The Music of Life. Biology Beyond the Genome*.[30] A second reason to refer to Noble, this book was composed as a critical counterpart of Dawkins' *The Selfish Gene*, which celebrated its 30th anniversary that same year. Just like Dawkins, Noble has written his book for a general audience and, like Dawkins, he masterfully deploys metaphor to convince his readers. We should realize that this is not a trivial fact. Both in science and in everyday life metaphors do not just have an ornamental function, but a transcendental one as well: they structure and motivate our thinking and action.[31]

In *The Music of Life* Noble confronts the metaphor of the selfish gene with an alternative one: life is like a piece of music. This metaphor enables Noble to criticize Dawkins' ontological reductionism. Just as a piece

26) Marcus E. Pembrey, Lars Olov Bygren, Gunnar Kaati, Sören Edvinsson, Kate Northstone, Michael Sjöström and Jean Golding, "Sex-Specific, Male-Line Transgenerational Responses In Humans," *European Journal of Human Genetics*, 14, no. 2 (2006): 159–166.

27) Ian C.G. Weaver, "Life at the Interface Between a Dynamic Environment and a Fixed Genome: Epigenetic Programming of Stress Responses by Maternal Behavior" in: *Mammalian Brain Development,* ed. Damir Janigro (New York: Springer, 2009): 17–39.

28) Junko A. Arai, Shaomin Li, Dean M. Hartley, & Larry A. Feig, "Transgenerational rescue of a genetic defect in long-term potentiation and memory formation by juvenile enrichment", *The Journal of Neuroscience* 29, no. 5 (2009): 1496–1502.

29) Oded Rechavi, Gregory Minevish & Oliver Hobert, "Transgenerational inheritance of an acquired small RNA-based antiviral response in C. elegans", *Cell* 147 (2011): 1248–1256.

30) See Noble, *The Music of Life. Biology Beyond the Genome* (Oxford: Oxford University Press, 2006).

31) See Jos de Mul, *Romantic Desire in (Post)modern Art and Philosophy* (Albany, N.Y.: State University of New York Press, 1999). George Lakoff, & Mark Johnson, *Metaphors We Live By* (Chicago: University of Chicago Press, 1980).

of music cannot be reduced to the score, life cannot be reduced to the DNA code. Stating that the DNA code 'causes' life, Noble argues, is as absurd as supposing that the digital code on the CD 'causes' Schubert's piano trio. Without a CD player the CD can do nothing. Actually, the 20,000 genes in the nucleus function rather like the pipes of a large organ, which do nothing on their own, but need an accomplished organist to make the organ play and bring the music to life. Likewise, genes do things on their own, but have to be 'played' by the organs of the organism. The genome is not a program, that builds and instructs the living body, but rather a vocabulary, that needs a competent speaker in order utter meaningful sentences.[32]

However, Noble's musical metaphor is even more fruitful than the linguistic one, because, unlike spoken language, which is, like the genome, sequential, most music is polyphonic and is played by multiple instruments: belonging to different groups, such as strings, brass and wood-wind instruments and rhythm instruments. The same goes for the music of life, which consists of the close cooperation of many organs and systems. Like an orchestra, the body is an organic whole, and like a symphony, life consists of many different movements. Moreover, unlike a meaningful text, a piece of music does not necessarily have semantic value. Unless it is a song, it is a teleological whole without linguistics, a language without words. We find a similar idea expressed in Wilhelm Dilthey's 'hermeneutics of life', when he writes: "Lived experiences are related to each other as motifs in an andante of a symphony: they are unfolded (explication) and what has been unfolded is then recapitulated or taken together (implication)."[33]

The "grand composer" of the music of life is evolution, Noble adds: "It has orchestrated the music of the genes, the harmony of the cells, the symphony of the various stages of life. It has achieved this by serendipitously winnowing down the possibilities".[34] However, like every metaphor, the metaphor of the music of life has it limits. Unlike a symphony of, let's say Beethoven, the Symphony of Life on Earth was not a creation by a conscious, divine composer. As Noble writes: "The grand composer was even more blind than Beethoven was deaf!" [35]

However, as the postgenomic research has shown us, although the mechanic algorithm of the natural selection – variation, reproduction, and selection – is an essential driving force in evolution, but it is not the only one. Just as in the performance of a symphony, organisms need a conductor. "Any well-regulated biological system must involve feedback controls."[36] However, unlike the case of the classical orchestra the organism's conductor is not a separate individual, but rather the network as a whole:

> There are no privileged components telling the rest what to do. There is rather a form of democracy, with every element at all levels having a chance to be part of a regulatory network. The coordinating hand is not so much an organist's as a conductor's. Or perhaps we should think rather of a 'virtual conductor' – the system behaves 'as if' it has a conductor. The genes behave 'as though' they are being played by this conductor – like some orchestras that play without a separate conductor.[37]

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32) P. Copland, "The Book of Life," *J Med Ethics* 31 (2005): 278–279. Personal communication, July 20, 2015. In *The Music of Life* and subsequent articles Noble also uses another metaphor and compares the genome with a database full of templates and switches. (See also Noble, *Music of life*, xii, 15, 21, 45, 130; Denis Noble, "Evolution beyond neo-Darwinism a new conceptual framework", *The Journal of Experimental Biology* 218 (2015): 7–13.

33) Wilhelm Dilthey, *Poetry and Experience. Selected Works. Volume V,* Edited by Rudolf A. Makkreel and Frithjof Rodi. Princeton, N.J.: Princeton University Press, 1985, 227; cf. Jos de Mul, *The Tragedy of Finitude. Dilthey's Hermeneutics of Life* (New Haven/London: Yale University Press, 2004), 176.

34) Noble, *The Music of Life*, 112.

35) Ibid.

36) Ibid., 46.

37) Ibid., 53–54.

Indeed, a simple organism looks more like a jazz combo than like a classical orchestra. However, as they are auto-poetic, teleological feedback systems, organisms organize themselves in the course of evolution to ever greater complexity. In this sense, the history of music resembles the history of life on earth. Both musical practice and evolution evolve. Whereas traditional music is often played without a conductor and written scores, the growing complexity of music led to the use of a written score and the emergence of a conductor. Likewise, in evolution the DNA code is a relatively late development. And it is not before the emergence of the nervous system that a separate conductor enters the stage, culminating in consciousness and self-consciousness: a 'feedback system' which, finally, endows *Homo sapiens* with the biotechnological control of organic life, including its own life-form. Natural evolution evolves into technological revolution. Man may turn out to be the first species on earth to construct its own evolutionary successor.

One of the key concepts Noble develops in this context is 'downward causation'. The fourth chapter of *The Music of Life* is actually called "The Conductor: Downward Causation," and the concept of downward causation refers to the feedback mechanisms in the organism. Higher organizational levels in the organism, such as tissues, organs, and finally the organism as a whole, trigger and influence action at the lower levels. This idea of downward causation is connected to the notion of strong emergence. "When aggregates of material particles attain an appropriate level of organizational complexity, genuinely novel properties emerge in these complex systems." These "emergent properties are irreducible to, and unpredictable from, the lower-level phenomena which they emerge."[38] The example worked out in detail by Noble, is the rhythm of the heart, which is not the work of some (metaphysical) vital force, but neither can it be reduced to a specific 'oscillator gene,' or any other lower-lever causal force. Actually, the heart rhythm is an emergent property of the organ as a whole. Of course, Noble does not deny upward causation, but his Integrated Synthesis implies that life involves both bottom-up and top-down causation. In a later article Noble connects this to what he calls "the principle of biological relativity", the idea that in living systems there is no privileged level of causation.[39]

It is especially this plea for 'strong emergence,'[40] which contrasts Noble's Integrated Synthesis with the reductionist paradigm of Neo-Darwinism, and of reductionist natural science as whole. Strong, or ontological, reductionism claims that all phenomena can be reduced to the level of elementary particles. It asserts, in other words, that the whole really is, in the final analysis, nothing but the sum of the parts and can be fully explained on this level. Physical systems are causally closed and there is no room for additional principles to operate.[41]

However, one way or another, strong reductionism must be incorrect, as downward causation not only seems to be evident in all living systems, but is part of everyday human experience. My intention to raise my hand evidently triggers and influences the movement of my body. As the French philosopher of science Michel Bitbol formulates this paradoxically: "Downward causation looks impossible as a concept, but is well established as a fact".[42]

Several attempts have been made to solve this paradox, for example, by appeal to the indeterminism of quantum physics, or the intrinsic imprecision of the laws of physics that is due to the finite computational resources

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38) Chrabel Nino el-Hani and Antonio Marcos Pereira, "Higher-level Descriptions: Why Should We Preserve Them?" in *Downward Causation: Minds, Bodies and Matter* (Vol. Conceptual Foundations of Emergence Theory 29, p.118–142.), ed. Peter Bogh Andersen, Claus Emmeche, Niels Ole Finnemann & Peder Voetmann Christiansen, (Aarhus: Aarhus University Press, 2000), 133.

39) Denis Noble, "A Biological theory of relativity: no privileged level of causation", *Journal of the Royal Society Interface Focus* 2 (2012): 55–74.

40) Ibid., 61.

41) Paul Clayton and Philip Davies, *The Re-emergence of Emergence: the Emergentist Hypothesis from Science to Religion* (Oxford: New York: Oxford University Press, 2006), xii.

42) Michel Bitbol "Downward Causation Without Foundations," *Synthese* 185 (2012): 233–255.

of the universe. Maybe the most promising perspective is to consider the universe as an open system, which "would enable 'external' or global principles to 'soak up' the slack left by the openness."[43] It could also explain the radical openness that characterizes human nature and the fact that humans are 'artificial by nature.' However, it is clear that many questions are still open here, and I don't have the pretension to be able to solve them.

Instead I will make some concluding remarks on the impact of the Integrated Synthesis proposed by Noble for human self-understanding. What it makes clear, first and foremost, is that genes do not solely determine our life. Nor are we sheer vehicles for their reproduction. Noble summarizes this pointedly by rewriting a key passage from *The Selfish Gene,* in which Dawkins characterizes genes as follows:

> Now they swarm in huge colonies, safe inside gigantic lumbering robots, sealed off from the outside world, communicating with it by tortuous indirect routes, manipulating it by remote control. They are in you and me; they created us, body and mind; and their preservation is the ultimate rationale for our existence.[44]

In Noble's rewriting, the passage now reads:

> Now they are trapped in huge colonies, locked inside highly intelligent beings, moulded by the outside world, communicating with it by complex processes, through which, blindly, as if by magic, function emerges. They are in you and me; we are the system that allows their code to be read; and their preservation is totally dependent on the joy we experience in reproducing.[45]

However, as life consists of both downward and upward causation, it is clear that we are not autonomous agents who have complete control over our lives. We are controlled by lower level processes as much as we control them. Many diseases have genetic components, our drives often are not under rational control, and the physical and social environment have a strong influence on our thinking and actions as well. In light of this, human agency is autonomous in the sense Descartes and Kant thought it was, believing in a mind residing somewhere beyond our bodily existence. Human freedom seems to be more restricted.

Maybe a more realistic account of human agency can be found in Greek tragedy. We may think about Medea, standing next to her children with the knife in her hand, wrestling with her daemons that try to take over her actions.[46] Medea is torn between the love for her children and the feelings of revenge towards her husband, who has humiliated her deeply by leaving her for another woman and is about to expel her from the country as an unwanted stranger, which will certainly result in her being murdered (both events sound quite topical in our ears). Medea is a tragic heroine, not because of her intense suffering (not all suffering is tragic), but because she takes responsibility for her decision to accept her *daimon* of revenge, the benign nature spirit, who prompts her to kill her children, as part of her own. Medea cannot be called free as neither the situation nor her character was chosen by her. In that sense, she was not free to choose whether to kill her children or not. Her *daimon* was too strong for this to happen. But this did not imply that Medea had not choice whatsoever. She could choose to 'go along' with her *daimon*, or to resist it in some way or other. By accepting the

43) Clayton & Davies, *The Re-emergence of Emergence*, xii.

44) Dawkins, *The Selfish Gene,* quoted in: Noble, "A Biological theory of relativity", 12.

45) Ibid.

46) De Mul, *Destiny Domesticated. The Rebirth of Tragedy out of the Spirit of Technology*, 139–199.

daimon as her *own daimon*, Medea took "responsibility without freedom."[47] That choice, we might add, is what constitutes Medea as a moral subject.

It is this kind of tragic agency – which we also find in Nietzsche, a notion which is connected with his admiration of the tragic worldview of the Greeks – which makes us human. The idea of being completely determined by external forces – be it in the form of religious fatalism, or genetic determinism, undermines this tragic humanism.

In human beings, the 'music of life' becomes a tragedy, or opera, in the sense that the music now is supplemented by narrative, and thus with meaning and reasons. In human nature downward causation takes the form of steering one's life with the help of meaningful narratives (whether artistic or scientific), consisting of motives, reflections, and reasons. Both Dawkins and Noble organize the results of biological research in a metaphorical narrative. The scientific facts and the narrative mutually constitute, like the *Forschung* and *Darstellung* in historiography. As such, the choice of narrative is crucial for the way we self-reflectively constitute identity. Some metaphors are better than others, both in the sense that they might be more adequate vis a vis the biological facts, and in the sense that they may be more desirable from a normative point of view.

In my introduction, I pointed out that reflections on human nature may range from Homo sapiens as a species, to the life of a single person. Let me, as a kind of coda, conclude my reflections on human nature with the tragic story of the Dutch literary author Joost Zwagerman, who committed suicide on September 8, 2015 at the age of 51, leaving behind three children, a girlfriend, relatives, and many friends. Joost Zwagerman was a popular author of successful novels, poetry, and essays that have since been translated into a dozen languages. As a regular guest on television shows, he was a kind of celebrity and his suicide – one day before the release of his new book, *The Silence of Light* – shocked the nation. One of the reasons of the perplexity his death caused was that Zwagerman was also known for his firm rejection of suicide. In 2005, after his father attempted to commit suicide, Joost Zwagerman published a book on this subject in which he focused on the dreadful effects suicide has on the bereaved. Although he was very open about the fact that he suffered from depression, nobody expected that he would ever come to commit suicide. A couple of days after his death a magazine published the last interview Zwagerman has given on his own initiative, and one of the main subjects in the interview was suicide.

After the interviewer mentioned the suicide attempt of his father, Zwagermans said:

> Everybody sometimes will think: if my life will become miserable, I might step out of it. This is typically human. Many will have these kinds of comforting thoughts. In the small book I wrote about this subject in 2005 I quoted Nietzsche: 'Der Gedanke an den Selbstmord ist ein starkes Trostmittel: mit ihm kommt man gut über manche böse Nacht hinweg.' [The thought of suicide is a powerful comfort: it helps one through many a dreadful night.] After my father attempted to commit suicide, this thought no longer comforts me. The attempt of my father is too emotional, *and the idea that the inclination to commit suicide is sometimes genetically transferred from one to the next generation, is terrifying:* not only with regard to myself, but especially when I think about my children and my future grandchildren and great-grandchildren. I wish I could personally remove this gene from our family tree. Because when the thought of suicide pops up in my mind, if only for a second, I immediately think: of, my father's genes." After the interviewer interrupts him with the question if he had ever considered suicide, he answered: "Absolutely, but only as a comforting

47) C. Fred Alford, "Responsibility Without Freedom. Must Antihumanism Be Inhumane? Some implications of Greek tragedy for the post-modern subject", *Theory and Society* 21, no. 2 (1992): 157–181.

> thought. Later I have made a taboo of it. It really has always been a no-go area for me: especially because of my children. I have attempted to write it away en to look the monster right in the eye. This book has been the only book […] I wrote for a specific class of readers, namely the bystanders, the bereaved after a suicide. I wrote it for my mother, and maybe it has comforted her.

Of course, I am not claiming that the human condition as described by Neo-Darwinism has caused Zwagerman's suicide. Such tragic events have multiple, and often complex, reasons. In the interview, Zwagerman also speaks of the regret caused by his divorce, and he reveals that he suffered from Bekhterev's disease, a chronic inflammatory disease of the axial skeleton. However, the way he emphasizes an alleged genetic curse that might have cause him to commit suicide, sounds like a self-fulfilling prophesy.

Although our life is not a story, it is a quest of narrative,[48] and the way we narrate our lives makes a difference. Narrative is our way of conducting our lives. Of course, it does not provide us with total control over our lives. On the contrary, narratives often deal with uncontrollable fate and tragic events. That which we cannot explain and control, we must narrate. However, even in those cases, or better, precisely in those cases, narratives may help us to live with fate and tragedies. That is how – in light of twentieth century discoveries that have undermined the narrow Neo-Darwinism – we should look at our very nature: human nature transformed into humane nature.

48) Paul Ricouer, "Narrative Identity", trans. Marc M. Muldon, *Philosophy Today* 35, no. 1 (1991): 73–81.