

2008

The Sacred Emergence of Nature

Ursula Goodenough

Washington University in St Louis, goodenough@wustl.edu

Terrence W. Deacon

Follow this and additional works at: https://openscholarship.wustl.edu/bio_facpubs



Part of the [Biology Commons](#), [Genetics and Genomics Commons](#), and the [Religion Commons](#)

Recommended Citation

Goodenough, Ursula and Deacon, Terrence W., "The Sacred Emergence of Nature" (2008). *Biology Faculty Publications & Presentations*. 67.

https://openscholarship.wustl.edu/bio_facpubs/67

This Book Chapter is brought to you for free and open access by the Biology at Washington University Open Scholarship. It has been accepted for inclusion in Biology Faculty Publications & Presentations by an authorized administrator of Washington University Open Scholarship. For more information, please contact digital@wumail.wustl.edu.

HUMAN NATURE AND ETHICS

CHAPTER 50

THE SACRED
EMERGENCE OF
NATURE

URSULA GOODENOUGH AND
TERRENCE W. DEACON

REDUCTION AND EMERGENCE

Scientists have had spectacular success with reductionism. Take something like a human muscle, peer inside, and there are the muscle cells, contracting and relaxing in unison. Peer inside the cells and find actin and myosin polymers sliding past each other and generating the contractile forces in conjunction with ATP hydrolysis. Extract the polymers and discover that they're made of actin and myosin subunit proteins. Purify the subunits and learn that they're strands of amino acids that fold into shapes that allow them to interact with one another to generate force. Analyse the amino acids and encounter their component atoms and their bonding angles. Peer into the atoms, and it's a whole new world again. And finally, take a creature like an amoeba, find that the same kinds of actin and myosin proteins are propelling it along, and realize that our muscles are availing themselves of ancient evolutionary ideas.

Response to this success has been decidedly mixed. On the one hand, people slurp up the technologies and medicines that spin off from, and thereby validate, these reductionist understandings. On the other hand, they often decry the Humpty-Dumpty fragments that appear to be all that remains of their whole-egg world where the human is the point. And so we are awash in science wars and Darwin

wars even as we are also awash in cell phones and Viagra. There's a lot of existential and religious havoc out there, and the situation doesn't seem to be improving.

This essay offers some possible ways forward.

Whereas reductionism has yielded splendid results in science, there is an important sense in which it is artificial, and in this sense false. By starting from wholes and moving 'down' into parts, one is moving in the opposite direction from the way matters arise. To grasp how matters arise, one must run the muscle movie backwards, from the subatom to the atom to the amino acid to the protein to the polymer to the cell to the muscle to the contraction. To make such a movie, it is essential to begin with reductionist understandings—otherwise, there is no way to know what to put in the movie. But once the cast of characters is identified—once it is understood how proteins fold and myosin hydrolyses ATP and so on—it is possible to narrate such understandings in the correct temporal and spatial sequence, moving 'upwards' from one level to the next.

As scientists with casts of characters in hand engage in such 'upward' projects, they quickly arrive at an understanding that has in fact been around for some time (O'Conner and Wong 2002). Perhaps the most familiar phrase for stating this understanding is to say that 'the whole is greater than the sum of its parts'. A second phrasing is to say that as one moves 'up' in levels of scale, one encounters 'something more from nothing but' or, less euphoniously but more accurately, 'something else from nothing but'—since the point is not that one encounters something greater or something more, but that one encounters something else altogether. Importantly, this something else can, in turn, participate in generating a new something else at a different level of organization. That is, today's something else may be tomorrow's nothing but. The now widely adopted term to describe such dynamics is *emergence*.

Many are engaged in the religiopoetic project (Goodenough 2000*b*) of exploring the religious potential of our scientific understandings of Nature—an approach some are calling religious naturalism (Goodenough 2005*b*). In a book in this genre, *The Sacred Depths of Nature* (Goodenough 1998), the emergence concept is invoked both directly and indirectly, but the primary intent is to introduce the astonishing casts of characters revealed by reductionist approaches and to articulate religious responses to their foundational roles in the universe, in life, and in human mind and spirit.

In this chapter we assume familiarity with these characters, as in the foregoing examples of muscle → atoms and atoms → muscle, and will work from the emergentist perspective, running the movies in the emergent direction. We first give an overview of the emergentist view of nature, and then use these concepts to outline an emergentist view of the religious quest. We suggest that much—we would say most—of what religious persons seek is grounded in a thirst for the very emergent phenomena that in fact surround us. The concept of emergence, more than any other concept we have encountered, puts Humpty-Dumpty back together again in ways that are wonderfully resonant with our existential and religious yearnings.

EMERGENCE AS A GENERAL CONCEPT

Emergent properties arise as the consequence of relationships between entities. Robert Laughlin (2005) intriguingly suggests that emergent properties arise even at the level of relationships between subatomic entities—indeed, he suggests that the very ‘laws’ of nature may prove to be emergent—but since we are not trained in discourse at this level, we will begin with relationships between atoms.

Atoms interact with one another, and hence generate emergent outcomes, in accordance with two general features: their energy and their form. Thermodynamics describes the energy and the entropy parameters of an interaction, but critical as well are what we can loosely but conveniently call shape influences. Thermodynamically, two hydrogen atoms will interact to form H_2 because energy is released; NaCl will dissolve in water because energy is released and entropy increases. But there is more to chemistry than just thermodynamics. H_2 forms also because the electron shells of hydrogen atoms are conducive to a ‘fit’ between them, and the shapes of water molecules and their resultant dipolarity (charge separation) are conducive to separating and distributing the atoms of NaCl. These descriptors, and others offered below, may strike a scientifically challenged reader as too ‘hard’ and a scientifically sophisticated reader as too ‘simplistic.’ We ask you both to bear with us, since what’s important here are the concepts and not the details.

The key concept: if one starts with something like a water molecule, it is nothing but two hydrogen atoms and one oxygen atom, but each molecule has something-else properties that cannot be ascribed to hydrogen alone nor to oxygen alone. The interaction between the three atoms entails a reconfiguration of electron orbitals and generates a trapezoid-shaped entity that is more electrically positive on one facet and more negative on the opposite facet. Compared with hydrogen and oxygen atoms, a water molecule has unprecedented attributes, because the joining of these atoms has distorted the shapes of each and produced a composite shape with its own intrinsic properties. In chemistry, shape matters.

Now we can consider what happens when water molecules interact with one another. Here we encounter the interesting fact that it depends. Ice forms when the kinetic energy of the average molecule is low and the molecules’ stickiness (capacity to form hydrogen bonds) overcomes their movement; liquid water forms when their movement is just sufficient to overcome the stickiness and allow them to slip over one another, forming hydrogen bonds with picosecond lifetimes; and steam forms when their relative velocities are high enough that collisions seldom allow sticking. The formation of each phase, and the transitions between phases, are generated by thermodynamics and shape, and the emergent outcomes are numerous. Thus ice displays buoyancy, crystalline organization, and hardness; water displays surface tension and viscosity. None of these properties is displayed by individual water molecules; what matter are dynamical regularities in the ways in which large numbers of these molecules interact with one another. And so we have here our first of

countless examples in which a composite structure that is 'something more' (a water molecule, from hydrogen and oxygen) turns around and serves as a 'nothing but' (for the emergent properties of ice and liquid water). Higher-order properties have emerged by virtue of the regularities of interactions between their constituents.

All sorts of molecules besides water can adopt alternate phases, and in each case the resultant emergent properties are slightly different: the hardness of crystalline quartz is distinctive from that of ice, and the viscosity of liquid mercury is distinct from that of liquid water, because thermodynamic interaction effects and shape effects both contribute to generate slightly different emergent outcomes. That being said, phases of matter share characteristic features—hardness, viscosity—irrespective of their specific micro-properties, features arising from global regularities in the interactions that tend to wash out the details.

But this is not always the case. Sometimes one or more micro-details can get amplified.

Snowflakes illustrate this kind of amplification effect. A snowflake, usually a single planar hexagonal ice crystal, is again nothing but water, but as an initial crystalline 'seed' moves through a given set of humidity, temperature, and pressure conditions in its fall to earth, additional crystal growth is influenced both by the 'initial conditions' (the configuration of the seed) and the 'boundary conditions' (what kinds of crystalline structures most readily grow in that particular set of conditions). What makes snow-crystal growth special is that the pattern generated by one stage of growth serves as the initial condition for the next as the snowflake falls into a new set of atmospheric conditions. Consequently, each snowflake that reaches the earth displays a unique morphology that reflects its individual history, embodying all the initial and boundary conditions, all the constraints and possibilities, that it has both encountered and generated during its growth.

Unlike the emergence of material phases, where interactions tend toward the average over time, structural and thermodynamic effects become, in effect, multiplicative during snowflake formation. The heat released by each new water molecule's accretion to the growing crystal is dissipated throughout the crystal structure, meaning that the temperature of each part of the crystal, and thus the probability that new water molecules will attach to any given part, is biased by the just prior configuration as well as by external conditions. Hence the thermodynamic tendency to distribute heat evenly progressively exaggerates the subtle biases of different crystallization patterns, and these patterns in turn affect how heat will be distributed. Each bias amplifies the just previous bias of the other. This amplifying effect of complementary dynamics is designated *morphodynamic* emergence (form begetting form), in order to emphasize the critical role that both shape and dynamical regularity play in the process (Deacon 2006a).

Snowflake formation, and crystal growth in general, is said to be *autocatalytic*. A catalyst is any entity that influences both the probability that, and the rate at which, a given interaction will occur. Crystal growth is described as autocatalytic because the accretion of new molecules to the crystal lattice increases the surfaces available for subsequent accretions to occur, and thus accretion rates increase with each new

accretion (as long as the supply of molecules and energetic conditions allow). In addition, the presence of the crystal lattice increases the probability that new molecules will link up to it in the same configuration.

More commonly we think of catalysts as molecules that increase the rate of some chemical reaction—e.g. the formation or breakage of chemical bonds to form new molecules—without themselves being chemically altered. Particularly interesting from an emergence perspective are cyclical chemical systems that generate catalysts during the course of forming new molecules, these being known as *autocatalytic cycles* (Kauffman 1996). A simple example might involve molecule A catalysing the chemical transformation of B into C, C then catalysing the transformation of D into E, and E then catalysing the transformation of F into A. As long as substrates B, D, and F are available to the system, catalysts A, C, and E will continue to be produced at ever greater rates as each traverse of the cycle generates more catalysts that can in turn catalyse the formation of more catalysts. An autocatalytic cycle, then, is a distinctive higher-order pattern of molecular interaction that alters the components that then alter the interaction pattern, the result being the self-amplification of both the dynamics and the relevant substrates. This recursive interaction pattern is made more probable by the complementary shapes of molecules, and the probability of interaction between such molecules is made more probable with each cycle as more are produced. As with the snowflake, micro-properties and interaction properties interact to reinforce each other, but strikingly different outcomes are possible once a system is circularly nested.

In the language of thermodynamics and morphodynamics, autocatalytic cycles are far-from-equilibrium dissipative systems that exhibit coherent behaviour by virtue of their dynamical regularity. They are usually transient in the non-living world because they, like all interacting systems, are dependent on initial and boundary conditions and proper energy/substrate flow, and these conditions are usually ephemeral. As we will see, life basically works by maintaining the conditions wherein such cycles can operate in a reliable fashion.

EMERGENCE AND THE NATURE OF LIFE

Emergence not only surrounds us in the non-living world; it is also the key dynamic of living organisms, as in, for example, the emergence of contractility (something else) from the interaction of myosin and actin polymers (nothing but). Life has a number of additional features, however, and these are perhaps best appreciated by considering ways that life may have emerged from non-life. All origin-of-life hypotheses are by definition speculative, since the default assumption is that the original lifeform is no longer extant but went on to evolve into the DNA-based, lipid-membrane-enclosed, protein-mediated, single-celled organisms that served as

the common ancestors of all modern lifeforms. What is gained by exploring origin-of-life speculations is a grasp of what being alive entails.

Deacon (2006*b*) offers a scenario for the formation of hypothetical entities called *autocells* that display many, but not all, of the salient features of life by virtue of thermodynamics and morphodynamics alone. Their initiating feature is an autocatalytic cycle that is enclosed in a container whose subunits are generated by the cycle, making it more likely that they assemble around the catalysts. The container can on occasion be disrupted by agitation, spilling its catalytic components, initiating new component production and then re-forming to enclose new substrates. Disrupted containers may also release subunits that reassemble into more than one autocell, or may break into partial autocells, each of which reassembles into a whole. In this way autocells are capable of self-replication. Moreover, a given autocell may capture novel substrates during disruption and reassembly that permit the emergence of novel and more complex autocatalytic cycles. Hence autocells are capable of evolution in this minimal sense. Critically, any autocells that evolve mechanisms for undergoing more efficient cycles would tend to self-replicate more often than others. Hence autocells would be subject to a form of natural selection.

And finally, autocells can be said to be 'end-directed' (toward a specific configuration), to have features with 'functions' (e.g. to maintain the autocell architecture and potential), and even to be *about* something (to the extent that their features exist 'with respect to' environmental factors conducive to making autocells with these same features). These are all facets of an emergence dynamics of a higher order than the thermodynamics and morphodynamics of autocell components, a property Deacon calls *teleodynamics*. The teleodynamic concept is in fact quite nuanced and not easily summarized, and readers are referred to Deacon (2006*a*) and Deacon and Jeremy Sherman (2006) for careful developments of this seminal idea.

The autocell, then, displays key features of life—substrate acquisition, self-propagation, evolution/natural selection, and end-directedness—without possessing a separate coding mechanism to specify these features. A critical difference that distinguishes all examples of modern lifeforms from autocells is the presence of such a coding mechanism in the system. The precursor to all modern organisms evolved some means of representing some of its structures and dynamical interaction patterns in separate molecular patterns, which would eventually evolve into the RNA/DNA-based coding systems that are now ubiquitous in life.

A coding mechanism is inherently just that—a mechanism, consisting of a set of markers, like an alphabet, coupled with a process that can interpret it. Its interpretation acquires significance to the extent that it codes *for* an entity—e.g. an autocell feature or an idea—in a way that promotes preservation both of that entity and of the code responsible for specifying it. These are the features of a *semiotic* system. When semiotic systems are copied, the capacity to generate more such entities is introduced; when semiotic systems change (mutate), the capacity to generate novel entities arises.

Setting aside consideration of the many complex steps that would attend the evolution of even a simple molecular coding system, we can instead focus on how

this outcome would augment the teleodynamic process. In shifting from an autocell to an autocell containing an independent representation of its dynamical components, the process of autocell generation has undergone a division of labour: the autocell continues to operate in consonance with the thermodynamics, morphodynamics, and teleodynamics of its components, but its propagation and evolution are now also correlated with the genetic information that encodes those components. That is, an autocell with independently encoded features acquires some freedom from the constraints of its own dynamics. Internally coded structures are not inexorably tied to extrinsic conditions, allowing external materials to be used as generic building blocks and energy sources rather than specific structural precursors. By this means, an autocell dependent on encoded structures necessarily acquires an additional agenda: to provide conditions that permit the maintenance and propagation of this information as well as the system that contains it.

As we saw earlier, an autocell lacking encoded information still has the capacity to evolve if novel substrates happen to become incorporated into its container. The independent transmission of structural information provides an independent means by which structure can vary, since lineages can explore domains of possible structural and functional variants in a way that is unconstrained by what the environment offers in the way of variations. This is the power of representation. What continues through time is now not merely the pattern of a particular self-reproducing dynamics, but also the representation of potential alternative dynamics. With the addition of coding, autocells—and, by implication, living organisms—acquire a degree of freedom and autonomy from the specific configurations of matter and energy that constitute them, thereby generating a spectacular expansion in evolutionary potential.

With the addition of a metabolism that provides a continuous flow of materials and energy to maintain them in the non-equilibrium state necessary to incessantly run these processes, such entities can be said to be alive in the sense that biologists use the term. Life's emergent properties are no longer left to the vagaries of substrate diffusion and container disruption, but are now themselves independently embodied in that emergent property called genetic information, which takes physical form in DNA- or RNA-based genomes in present-day organisms.

It is important to pause at this juncture and address a key issue. One way to read this account—a misreading, we will argue, but a common one—is that the genes are driving the system, that genes are 'selfish', that genes rule. Not only is this misreading inherently depressing, and religiously sterile; it also misses the point. Genomes are in fact the handmaidens of emergent properties, not the other way around. Natural selection doesn't 'see' genomes, and indeed, we saw natural selection operating in its canonical Darwinian fashion with our hypothetical autocells that have no genomes at all. The whole point of life is to generate emergent properties that, if successfully executed, have the additional feature of permitting transmission of genomes. Genomes represent a splendid convenience, allowing emergent properties, and hence organisms, to be generated ever more efficiently and with increasing levels of complexity. But they are useless unless they contribute to maintenance of the

emergent dynamics that confer upon organisms the capacity to carry on. We can posit an autocyte without an operational genome, but a genome that fails to specify an emergent teleodynamical system, such as is minimally present in an autocyte, is dead on arrival.

So, a successful life outcome is to promote the transmission of information conducive to maintaining the emergent dynamical logic that gives it its meaning—that is, to promote the production of emergent outcomes (called *traits* in biology) that collectively make their own continuation more likely. It is traits that rule; genes follow in their wake. Traits common to all organisms include such non-depressing and religiously fertile capacities as end-directedness and identity maintenance; traits common to all animals include awareness and the capacity for pleasure and suffering; traits common to social beings include co-operation and meaning making; traits common to birds and mammals include bonding and nurturance; traits common to humans include language and its capacity to share subjective experiences, and thus to know love. Transmission of genomes is the steady background drumbeat; emergence is the music.

THE HOW AND THE WHY OF TRAIT GENERATION

All modern organisms generate their traits in basically the same way, meaning that the common ancestor to all modern organisms, posited to have appeared more than 3 billion years ago, also employed these strategies. The core idea is that genes encode proteins that fold into useful shapes under the aegis of thermodynamics. Some of these proteins, such as actin and myosin, go on to mediate cell organization and behaviour; others, such as lactase, catalyse metabolism and hence mediate energy transduction; others, such as insulin, mediate cell-to-cell communication, where behaviour, metabolism, and communication are all emergent properties, the outcome of thermodynamics, morphodynamics, and teleodynamics, with countless variant manifestations.

Particularly interesting proteins mediate an emergent process called *regulation of gene expression*. Each gene comes equipped with an adjacent switching element, also made of DNA. When the switch is turned on, the gene is ‘expressed’ or ‘transcribed’, and the protein encoded by that gene is produced by the cell; when the switch is turned off, the protein is not made (the gene is ‘not expressed’ or ‘not transcribed’). The switches are operated by proteins called ‘transcription factors’, some serving as activators and others as repressors of gene expression, that often act in concert on a given switching element—that is, the ‘on’ or ‘off’ command is the emergent outcome of complex interactions between these regulators and the components of the switch.

Each transcription factor is itself encoded by a gene that also has its own switch, which is subject to regulation by additional transcription factors. Hence the outcome is an elaborate system of feedback loops, where the genes can be considered as passive elements responding to protein commands. By virtue of these complex interaction dynamics, emergent patterns of gene expression are produced, resulting in emergent molecular and cellular interactions. In a real sense, then, proteins, and not genes, rule (though genes must be present to encode the proteins), and the emergent consequences of these protein interactions, with each other and with the genes, are the ultimate determinants of organism traits.

As different species' genomes have been sequenced, an initially surprising finding has been that complex organisms don't have all that many more genes than do simple organisms. A unicellular alga, for example, has about 17,000 genes, and a human has about 23,000 genes. Moreover, well over half of these genes encode 'housekeeping proteins'—actin, myosin, metabolic enzymes, and so on—that are present in both kinds of organisms. What has happened during evolution, then, is not so much the acquisition of new genes as changes in the patterns of expression of existing gene families such that novel combinations of proteins appear in a given cell at a given time, interact with one another, and generate novel emergent properties.

This strategy is particularly creative in multicellular organisms that begin as fertilized eggs and cleave to form embryos and eventually mature forms. Individual cells in the embryo set up novel patterns of gene expression such that cell A might produce and secrete hormone X and cell B might produce and display a receptor for hormone X. Hormone–receptor interactions then influence transcription factors such that genes are expressed in cell B that are not expressed at that stage in cell A, and the resultant proteins allow cell B to initiate a distinctive cell lineage whose activities go on to influence the gene expression patterns of cell C. And so on. In other words, embryogenesis can be thought of as a vast autocatalytic cycle—a metacatalytic cycle perhaps—made up of countless subcycles, feeding forwards and backwards in space and time under the aegis of protein–protein and protein–switch interactions, with genes obligingly responding when they are called upon to do so. A given gene may be switched on at the four-cell stage of development, switched off at the sixteen-cell stage, and then switched on again in one of the cells in a 256-cell embryo. The protein produced by this cell will encounter partner proteins that were not expressed at the four-cell stage, and their interactions will generate emergent properties in that cell's lineage only. The gene may be switched on again in primordial liver cells, again in concert with a distinctive set of partners, to generate novel liver-specific emergent outcomes. And so on. New kinds of embryos and hence new kinds of mature multicellular organisms result primarily from using the same old protein families in novel combinatorial patterns.

The important concept to grasp here is that the genome in no way represents a 'blueprint' for a multicellular organism—there exists no top-down design entity that can be analogized to an architect's blueprint. Nor is the organism assembled from pre-existing 'parts', like a house or a car. Rather, the organism literally builds itself, bottom-up, assembling tiny parts that modulate the assembly of the next set of tiny

parts, where the same old protein families are used in novel combinatorial patterns along the way, all under the aegis of initial conditions and boundary conditions established and maintained by the information encoded in housekeeping genes. Thermodynamics, morphodynamics, and teleodynamics set up the constraints and possibilities, but organisms are not predetermined—even if they come into being in remarkably predictable ways. Their features predictably emerge because these emergent features are made almost inevitable by the hierarchy of biases of lower-order emergent features.

Particularly ‘underdetermined’ is the process of mammalian brain formation, albeit, again, features emerge in a predictable fashion—all gorilla brains, for example, are far more similar to one another than they are similar to the brains of any other species. While genes again switch on and off in various cell lineages at critical junctures during brain development, most of the action entails cell–cell interactions via protein receptors and hormones as the neurons move up into the cranium and establish connections with one other. Moreover, most of these hormones and receptors are not brain-specific: again they’re the some old protein families put to use in a neurogenesis context. When one absorbs the fact that a mature mammalian brain may contain 100 billion neurons, each in synaptic communication with some 1,000 other neurons, all put together under the watch of a genome with some 20,000 genes, one comes to understand why it is so inaccurate to speak of a gene as being ‘for’ a particular mental capacity. True, a mutant gene encoding an aberrant protein may in some cases generate an aberrant brain function outcome, but this is not because that gene encodes that outcome; it’s because the aberrant protein is defective in pointing neurogenesis in a particular emergent direction.

Embryogenesis occurs in environmental contexts—soils, ponds, nests, the uterus—and all brains, even clam brains, are capable of learning from experience. More generally, all creatures come into being and make a living in environmental contexts, where each ecosystem represents a rich interdigitation of the organic and inorganic, of organisms and planet. Genomes are transmitted to offspring when, and only when, all of this comes together. Life is not about survival of the fittest; it’s about fitting in.

THE EMERGENT HUMAN

Deacon offers a bold emergentist claim in his book *The Symbolic Species* (1998): ‘Biologically we are just another ape; mentally we are a whole new phylum of organism.’ Our ‘whole new’ traits—symbolic languages, cultural transmission of ideas via languages, and generation of an autobiographical self—are of central importance to our lives and our religious lives, and much remains to be understood

about how they operate from a reductionist perspective. At this juncture, however, the concept to take in is that these human-specific traits are quintessentially emergent: they are constructed bottom-up and then deeply influenced by environmental contexts; they make use of ancient protein families that are deployed in novel patterns and sequences. We are aware that this is a claim and that other concepts of human origins and essence are on offer, concepts that set humans apart; but from our perspective, the understanding that human-specific traits are emergent—something else popping through from all that has gone on before and continues to surround us—is fully consonant with what we now know about the course of natural history, and a deeply satisfying way to think about who we are.

What is particularly interesting about the course of human evolution is that it has entailed the co-evolution of three emergent modalities—brain, symbolic language, and culture—each feeding into and responding to the other two and hence generating particularly complex patterns and outcomes (Deacon 1998). While we don't know, and probably will never know, the actual details of the sequence, here is a plausible course of events.

- Initial social evolution of very simple symbol systems drives changes in children's brains that make the acquisition of symbolic abilities easier and easier, where the symbol systems, transmitted via culture, themselves evolve so as to be learnable by the evolving children's brains.
- These more complex symbolic abilities make possible the internalization of a 'public perspective': imagining an outside representation of self, one that can be superimposed on to real self-experience.
- This creates contexts for the juxtaposition of emotional states that would be otherwise mutually exclusive (e.g. love thine enemy).
- Out of this bisociation of emotional-cognitive experiences emerge unprecedented emotional experiences and perspectives.
- Hominid brains continually impacted by such unprecedented emotional states begin to evolve with respect to these states, developing modalities for integrating these experiences and cultural symbolic supports that both utilize and buffer them.
- Symbolic cognition, that is, precipitates a cascade of reorganizational cognitive and co-evolutionary events that eventually produce a brain with a capacity for the kind of mindfulness, intersubjective projection, aesthetic sensibility, and empathy that is now possible.

Absent from this account are such standard hominid milestones as upright posture, opposable thumbs, and tool use. While these showed up along the way and are important to who we are, their acquisition can be readily modelled using standard vertebrate embryology paradigms. By contrast, our emergent mentalities to date lack reductionist explanations, even if most neuroscientists are confident that such explanations will be forthcoming. As with life, moreover, analysing all the pieces is just the first step, not the final explanation. Making sense of brains will also entail an elaborate reconstruction to discern their emergent dynamics and what they entail.

Importantly, when the details become available, they will in fact have no impact on our experience of being self-aware beings, any more than our understanding of oxytocin's participation in romantic attachment impacts on our experience of being in love. Reductionist understandings of how minds work are fascinating, but they are also irrelevant to what it's like to be minded. While we don't know what it's like to be a bat, we know what it's like to be a human, and it entails a whole virtual realm that doesn't *feel* material at all. The beauty of the emergentist approach to mind is that it suggests that to experience our experience without awareness of its underlying mechanism is exactly what we should expect from an emergent property. The outcome has been given reverent names, like spirit or soul, names that conjure up the perceived absence of materiality. But we need not interpret this as evidence of some parallel transcendental immaterial world. We can now say that the experience of soul or spirit as immaterial is simply a reflection of the way the process of emergence progressively distances each new level from the details below.

We can now turn the page. What is the religious potential of the emergentist perspective?

WHAT IS MEANT BY RELIGIOUS?

In any such undertaking it is important to make clear what one means by religious, since every reader harbours a unique perspective on this adjective. We are not suggesting that our readers agree with or adopt our meanings, but only that they understand them.

We can begin by contrasting 'religious' with 'religion'. Loyal Rue proposes (1999) that a *religion* is a cultural entity, grounded in metanarratives indicating how things are and which things matter, which offers personal wholeness and social coherence to its adherents. In his recent book (2005) Rue argues persuasively that the common goal of a religion is to educate the emotions of its adherents such that the goals of the cultural tradition are realized.

A *religious* person—and we would say that all persons are religious—may or may not self-identify with a religion. Rather, a religious orientation encompasses three spheres of human experience (Goodenough 2003, 2005*b*): (1) The *interpretive* sphere (a.k.a. theological, philosophical, existential) describes responses to the Big Questions, such as, Why is there anything at all rather than nothing? Does the universe, or my life, have a Plan? a Purpose? How do I come to terms with death? Why is there evil and suffering? (2) The *spiritual* sphere describes such inward personal responses to existence as gratitude, awe, humility, reverence, assent, transcendence, and at-oneness. (3) The *moral* sphere describes outward communal responses such as care, compassion, fair-mindedness, responsibility, trust, and commitment.

Religious naturalism, in this context, describes a person's interpretive, spiritual, and moral responses to our understandings of nature, in this case our emergentist

understandings of nature, where these spheres are ordinarily not experienced as separate categories, but rather as an overall orientation. Since the authors are religious non-theists who do not self-identify with a given religion, our responses will be offered in this voice. (Willem Drees, Chapter 7 above, provides an excellent overview of the many forms taken by religious naturalism.) The responses are not intended to be comprehensive, but rather to suggest the religious potential of the emergentist world-view.

INTERPRETIVE RESPONSES

Creation and Purpose

All religious traditions offer ways to think about creation. A single Creator God is central to the Abrahamic faiths; creation myths are central to polytheistic faiths; and the Buddhist tradition includes the challenging concept of beginninglessness: all that is has always been, and was therefore never created. The emergence perspective offers us ways to think about creation, and creativity, that do not require a creator. Emergence can be thought of as nature's mode of creativity, giving rise to ever more complex outcomes by virtue of thermodynamics, morphodynamics, and teleodynamics.

In theistic traditions, creation is invariably coupled with purpose. There is some reason why creation occurred, and there exists a plan for what has been created, most prominently a plan for the human. It follows that a central focus of the theistic religious quest is to discern and attempt to act in accordance with that plan, finding guidance in texts and revelation and prayer. The emergence perspective, while not ruling out purpose or plan, is coherent without invoking either. Living beings, including humans, need not derive from, or be in the name of, some higher-order trajectory; instead, they can be understood to have followed trajectories made possible by planetary and ecological conditions and opportunities.

Jeffrey Dahms, Australian surgeon and naturalist philosopher, expresses these ideas as follows:

For me, the universe as a created object, no matter how subtly that concept is conceived, is unbearably depressing. Why would I want to live in a universe that is about me? For sure, a universe purposely built to generate complexity or life or primates or humanity is a cosmically impressive act, particularly if no tweaking is allowed after the initial roll of the dice.

But no thanks, I'd rather find another place to call home—a place that has no Purpose—a truly wild place—yes! A universe that spawns life and consciousness without instruction, just because it is . . . Ah, now that is really something one can get excited about. It's the difference between inconceivably awesome cosmic skill and the purely magical. Naturalists are in love with the magic of the open, the magic of the possible. The very contingency of life is what makes it so unbearably sweet and precious. (Personal communication)

This stuff is clearly not for everyone (cf. Goodenough 2000a). For some, a self-creating universe generates angst and anomie; for others, orientation and excitement. For some, to think of purpose as an evolved emergent capacity is to destroy the very meaning of purpose; for others, purpose so understood is rendered meaningful, even sacred, for the first time. For some, to understand human-specific mental and emotional capacities as emergent is to violate their sense of self; others celebrate all that has gone on before us as setting the nothing-but stage for these spectacular something-else lives that we live. We count ourselves among the second group.

Contingency

Dahms ends his passage by invoking the contingency of life, and Stephen J. Gould (1989) has famously emphasized contingency as well, suggesting that if one were to ‘re-wind the tape of evolution’, it is highly unlikely that the same kinds of organisms would have evolved a second time. Confucian scholar Michael Kalton (2000) lifts up the challenges, and the saliency, of the contingency concept:

The biocentered life orientation locates its center of value, meaning, and purpose squarely within the realm of the contingent, the very kind of irredeemable contingency identified with meaninglessness and absurdity within conventional frameworks. Indeed, contingency itself is a central element of its salvific message. Until we grasp our radical contingency, we have small chance of really understanding the nature of what is at stake.

Emergentism offers fresh ways to think about contingency. Whereas contingent is often understood to mean accidental or fortuitous, its etymology (*contigere*, to touch, meet) carries the sense of dependency, of something being conditional on something else, and this certainly maps on to the core understanding of the emergentist perspective. In the history of life, and indeed the history of the planet and the universe, things happen in the context of what has gone on before and the opportunities thereby generated—in Kauffman’s (2002: 142) phrase, ‘the adjacent possible’. Crystals build on crystals, traits build on traits, ideas build on ideas.

Once a planet with Earth’s properties came into being, moreover, the emergence and evolution of life as we know it can even be considered as something expected. As developed by Richard Dawkins (2004), evolutionary history documents that the same *kinds* of emergent adaptations—e.g. vision, audition, flight, intelligence—keep popping through in diverse and independent lineages because niches that render such adaptations useful have been continuously available on this planet. Hence the same *kinds* of organisms, if not the same phenotypic details, would be expected with a Gouldian rewinding.

These perspectives go far to counteract the misunderstanding that evolutionary theory is about randomness. The variation itself is random, happily, since otherwise the possibilities for novel trajectories would never arise, but the emergent paths taken are contingent and, in an important sense, anticipated.

The Emergent Human

Evolutionary theory asks us to situate the human in the natural world, and this can generate cognitive dissonance given that our mental capacities would seem to place us 'above' the natural world and our cultures 'above' the natural order. The emergentist perspective allows us to see ourselves not as 'above' but rather as remarkably 'something else'. For all we know, and quite probably for all we will ever know, we are the only creatures in the universe who write psalms and sculpt marble and know how stars work. We inhabit a virtual reality of symbols and ideas (Goodenough 2005*a*), and we are uniquely endowed with the capacity to teach as well as to imitate.

Understanding the human as the emergent outcome of natural history, and in particular the outcome of a co-evolution of language, brain, and culture, allows us to understand who we are in exciting new ways. Deacon (2001 3: 306) lifts up one such perspective:

Human consciousness is not merely an emergent phenomenon; it epitomizes the logic of emergence in its very form. Human minds, deeply entangled in symbolic culture, have an effective causal locus that extends across continents and millennia, growing out of the experiences of countless individuals. Consciousness emerges as an incessant creation of something from nothing, a process continually transcending itself. To be human is to know what it feels like to be evolution happening.

SPIRITUAL RESPONSES

Enchantment

Dahms uses the word 'magical', a word often associated with supernatural miracles or the unexplainable. The emergentist perspective opens countless opportunities to encounter and celebrate the magical while remaining mindful of the fully natural basis of each encounter. There is a way in which the universe is re-enchanted each time one takes in its continuous coming into being, and there is a way in which our lives are re-enchanted each time we realize that we too are continually transcending ourselves.

Transcendence and Reverence

Transcendence is commonly used to denote a discontinuity, as in the 'top-down' agency of transcendent deity. But transcendence also aptly describes the phenomenon of emergence, where discontinuities (something elses) arise from, while remaining tethered to, their antecedents (nothing but). This mode of understanding

transcendence—Kalton (2000: 190) describes it as ‘horizontal transcendence’ (cf. Goodenough 2001)—facilitates deconstruction of the hubris that so often afflicts human sensibility, replacing it with reverence, the capacity to carry the sense that our context is vastly larger and more important than our selves (Woodruff 2001; Goodenough and Woodruff 2001). We can, in this framework, offer reverence not only to the living but also to the non-living. Here is Kalton again:

A reexamination of how we regard the ‘non-living’ aims to open the possibility of a mode of self-identification which transcends the boundary of biotic life. Once the boundary is down, an arena of immediate access to horizontal transcendence is created. What the poet Robinson Jeffers has referred to as ‘the massive mysticism of stone’ surrounds us, inviting us to discover the patterning that lives in geologic time or even cosmic time, substrate to patterns manifest in the rapid complexity of life time. What is it from which we have emerged, and to which we return at death? It cannot be less than us, for we are formed of it, belong to it, manifest it. (Kalton 2000: 199)

Gratitude

Gratitude is the most important facet of the spiritual life, allowing us to acknowledge and express our awe and our reverence. A universe that ‘spawns because it is’ generates our capacity to spawn because we are, inviting us to wrap our arms and minds and hearts around this astonishing whole to which we owe our lives and of which we are a part, and gasp our stammering gratitude.

MORAL RESPONSES

Emergent Morality

Probably the most commonly voiced concern about evolutionary theory is that it represents the slippery slope to moral relativism. Without some ‘higher’ authority, the argument goes, without some arbiter of plan and purpose, there is no ontological basis for human moral behaviour; therefore, anything goes. Many go further, arguing that the perceived moral decline in our culture has been caused by the dissemination of evolutionary understandings. Tom DeLay (R-TX) famously claimed that the Columbine massacres were a result of exposure to evolutionary theory, that ‘our school systems teach the children that they are nothing but glorified apes who are evolutionized [*sic*] out of some primordial soup’.

Inherent in this mode of thinking is the notion that animals are ‘brutes’ and that therefore, if we ‘evolutionized’ from brutes, we are by nature brutes as well. Intensive studies of other primates refute this notion, however, instead documenting that these

animals self-organize into highly effective and coherent social systems wherein are readily discerned versions of respect, friendship, co-operation and reciprocity, empathy, humour, loyalty, nurture, forgiveness, and so on (de Waal and Tyack 2003; van Schaik 2004). In primatologist Franz de Waal's words, the non-human apes are 'good-natured'. In this light, to be glorified apes is a promising moral starting point.

So in what ways, and by what means, have humans differentiated on the moral axis? We have considered this question in some depth (Goodenough 2003; Goodenough and Woodruff 2001; Goodenough and Deacon 2003). Basically, the idea is that during the brain/language/culture co-evolutionary trajectory outlined earlier, the pro-social emotions of our common ancestor with chimpanzees were not left in the evolutionary dustbin. Nor, however, are these emotions experienced as those common ancestors experienced them, nor as modern chimps experience them. Rather, they are experienced as humans experience things: via the cognitive-emotional juxtapositions that undergird our symbolic subjectivity. One's moral framework is not some instinct that just bubbles up. It is something that each of us constructs, amplifying and reconfiguring primate social emotions in the context of cultural stimuli and teachings. In Aristotle's words, 'We have the virtues neither by nor contrary to our nature. We are fitted by our nature to receive them.'

Importantly, the outcome of developing one's capacity for virtue is to experience pleasure and incur admiration: those who are courageous, reverent, fair-minded, and compassionate report deep satisfaction with these frames of mind—they are experienced as good, as beautiful—and they are held in high esteem by others. Geoffrey Miller (2000), in fact, goes on to argue that such developed traits are adaptive, in that they are substrates for sexual selection: persons who display these qualities may be more likely to be chosen as mates and to nurture their children with care and wisdom.

In any case, the emergentist perspective allows us to understand the human not as some discontinuous moral entity but as an emergent moral entity, expanding core primate capacities and sensibilities and celebrating their beauty and value in art, literature, and religious teachings. Indeed, the myths and metaphors that come to us from thousands of religious traditions convey timeless hopes and understandings of how best to be good.

Amorality

To look at the primates and lift up only their pro-social capacities is of course to tell only part of the story. Self-interest is central to the nature of all organisms (Goodenough 2003), and always lurking in the wings of primate self-interest are its 'darker' manifestations. It is here that the project of naturalizing morality encounters for many its insurmountable hurdle. When we remember that apes are also observed to injure and even kill one another, to use force in sex, to be cruel and rejecting, and to display robust xenophobia, and when we confront analogous behaviour in the human, as chillingly documented by Jonathan Glover (2001), gloom can descend.

A full consideration of the interplay between self-interest and pro-sociality, particularly as each plays out in its emergent manifestations, is well beyond the scope of this chapter, but a few observations are germane.

First, it is important to point out that the existence of self-interest, and its darker forms however defined, does not negate the existence of pro-sociality. Pro-social capacities are not just the absence of asocial capacities. They have emergent lives of their own.

We can then recall that primates, both non-human and human, most often engage in asocial behaviours when they are subjected to stress, and particularly to prolonged stress. Under these circumstances, we hunker down and engage in self-interested survival patterns, the default behaviour of all creatures, and these often take forms that are antithetical to pro-sociality.

One way to stack the deck in favour of morality, therefore, is to ameliorate the conditions wherein humans find themselves physically or emotionally impoverished, threatened, defeated, abused, humiliated, lonely, or insecure. Such conditions foster the dehumanization and demonization of those identified as the 'cause' of our frustrations, allowing them to become targets of exclusion and brutality (Glover 2001). Such conditions also render humans vulnerable to rigid fundamentalisms—many carrying morality labels—that activate our fear and greed in their promises of deliverance.

Ecomorality

Our ability to reconfigure the core social emotions also allows us to enlarge our moral vision such that we can come to care not just about family and troop and tribe but about conserving ecosystems and sustaining biodiversity. Ecomorality is a religious stance that flows effortlessly from emergentist understandings, asking not only for our allegiance but also for our continuous participation in protecting and celebrating that from which we have come.

REFERENCES AND SUGGESTED READING

- DAWKINS, RICHARD (2004). *The Ancestor's Tale: A Pilgrimage to the Dawn of Evolution*. Boston: Houghton Mifflin.
- DEACON, TERRENCE W. (1998). *The Symbolic Species*. New York: W.W. Norton.
- (2003). 'The Hierarchic Logic of Emergence: Untangling the Interdependence of Evolution and Self-Organization', in B. Weber and D. Depen (eds.), *Evolution and Learning: The Baldwin Effect Reconsidered*, Cambridge, Mass.: MIT Press, 273–308.
- (2006a). 'Emergence: The Hole at the Wheel's Hub', in Philip Clayton and Paul Davies (eds.), *Re-Emergence of Emergence*, Oxford: Oxford University Press, forthcoming.
- (2006b). 'Reciprocal Linkage between Self-organizing Processes is Sufficient for Self-reproduction and Evoluability', *Biological Theory* (in press).

- and SHERMER, JEREMY (2006). 'The Pattern which Connects Pleroma to Createra: The Autocell Bridge from Physics to Life', *Biosemiotics* (in press).
- DE WAAL, FRANZ B. M., and TYACK, PETER L. (2003) (eds.). *Animal Social Complexity*. Cambridge, Mass.: Harvard University Press.
- GLOVER, JONATHAN (2001). *Humanity: A Moral History of the Twentieth Century*. New Haven: Yale University Press.
- GOODENOUGH, URSULA (1998). *The Sacred Depths of Nature*. New York: Oxford University Press.
- (2000a). 'Causality and Subjectivity in the Religious Quest', *Zygon*, 35: 725–34.
- (2000b). 'Religiopoiesis', *Zygon*, 35: 352–5.
- (2001). 'Vertical and Horizontal Transcendence', *Zygon*, 36: 21–31.
- (2003). 'Religious Naturalism and Naturalizing Morality', *Zygon*, 38: 101–9.
- (2005a). 'Reductionism and Holism, Chance and Selection, Mechanism and Mind', *Zygon*, 40: 369–80.
- (2005b). 'Religious Naturalism', in B. Taylor and J. Kaplan (eds.), *Encyclopedia of Religion and Nature*, Bristol: Thoemmes Continuum, 1371–2.
- and DEACON, TERRENCE W. (2003). 'From Biology to Consciousness to Morality', *Zygon*, 38: 801–19.
- and WOODRUFF, PAUL (2001). 'Mindful Virtue, Mindful Reverence', *Zygon*, 36: 585–95.
- GOULD, STEPHEN J. (1989). *Wonderful Life: The Burgess Shale and the Nature of History*. London: Hutchison Radius.
- KALTON, MICHAEL (2000). 'Green Spirituality: Horizontal Transcendence', in M. E. Miller and P. Young-Eisendrath (eds.), *Paths of Integrity, Wisdom and Transcendence: Spiritual Development in the Mature Self*, London and Philadelphia: Routledge, 187–200.
- KAUFFMAN, STUART A. (1996). *At Home in the Universe: The Search for Laws of Self-Organization and Complexity*. New York: Oxford University Press.
- (2002). *Investigations*. New York: Oxford University Press.
- LAUGHLIN, ROBERT B. (2005). *A Different Universe*. New York: Basic Books.
- MILLER, GEOFFREY F. (2000). *The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature*. New York: Doubleday.
- O'CONNOR, TIMOTHY, and WONG, HONG YU (2002). 'Emergent Properties', in *Stanford Encyclopedia of Philosophy*; <<http://plato.stanford.edu/entries/properties-emergent/>>.
- RUE, LOYAL D. (1999). *Everybody's Story: Wising Up to the Epic of Evolution*. Albany, NY: State University of New York Press.
- (2005). *Religion is Not about God: How Spiritual Traditions Nurture our Biological Nature*. New Brunswick, NJ: Rutgers University Press.
- VAN SCHAIK, CAREL (2004). *Among Orangutans: Red Apes and the Rise of Human Culture*. Cambridge, Mass.: Harvard University Press.
- WOODRUFF, PAUL (2001). *Reverence: Renewing a Forgotten Virtue*. New York: Oxford University Press.