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# ACHING VOIDS AND MAKING VOIDS

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A review of
Incomplete Nature: How Mind Emerged from Matter.

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Suppose a robot exploring an apparently uninhabited planet sent us back photographs of two items found on a beach: something that looked like a clamshell and something that looked like a clam rake—iron tines, wooden handle. Both objects are highly improbable from the perspective of the Second Law of Thermodynamics. They both imply makers. The clamshell-maker (a clam, or something of that ilk) must have been alive, and the clam rake-maker must have been not just alive, but something of a thinker. We would have found clear evidence of advanced intelligence on that planet. This is all intuitively obvious, perhaps, but can the principles behind these intuitions be explicitly articulated and marshaled into a theory that takes us all the way from the Second Law to conscious thought? Terrence Deacon gives it a fascinating try in this hugely ambitious book.

He is the latest—and best, in my opinion—participant in a tug of war that has been going on since Descartes put forward his mechanistic theory of the body and dualistic theory of the mind in the 17th century. The unbridgeable gulf between Descartes's two "substances" has not gone away, but in many regards the gap has been narrowed, as players on both sides of this opponent process have discarded unsupportable overstatements. The simplistic mechanism of Hobbes and La Mettrie, and Skinnerian behaviorism, have been largely abandoned on one side, while dualism and *élan vital* have been largely banished from the other (except among philosophers). But there are still potent manifestations of unresolved conflict. A recent Dilbert cartoon showed Dilbert opining: "Free will is an illusion. Human beings are nothing but moist robots. Just relax and let it happen." Are we "nothing but" moist robots? And if we are, does that have bleak implications for our sense of autonomy, our sense that our lives of striving can have meaning? Alternatively, if the computational perspective "leaves something out," just what is it that is missing, and is it really important?

There are no entirely apt labels for the opposing sides of this gulf, since the ongoing controversy turns every battle cry into a derogatory term for the other side. Reductionism, fie! Holism, fie! "Enlightenment" versus "Romanticism" is pretty close, as the reader can judge by considering what the following team players have in common; on the Enlightenment side: Darwin, Turing, Minsky, Dawkins, both Crick and Edelman (in spite of their antagonisms), Tibor Gánti, E. O. Wilson, Steven Weinberg, Paul and Patricia Churchland, and both Raymond Kurzweil and me (in spite of our antagonisms). On the Romantic side are arrayed Romanes and Baldwin, Kropotkin, Stephen Jay Gould, Humberto Maturana, Francisco Varela, Stuart Kauffman, Roger Penrose, Ilya Prigogine, Rupert Sheldrake, and the philosophers

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John Haugeland, Evan Thompson, Alicia Juarrero, John Searle, and—off the map, now—Jerry Fodor and Thomas Nagel. Many have been inoculated against the other side by the excesses of some of the participants. Can anybody knit up "the Cartesian wound that severed mind from body at the birth of modern science" (p. 544)? Deacon, defending the Romantic side, makes some real progress largely because he understands and appreciates both sides so well. He is a good evolutionist and cognitive scientist with insightful interpretations of the strengths and triumphs of evolutionary and computational thinking, and he is trenchant in his criticisms of Romantic lapses into mystery.

What is missing from the computational approach now so dominant in biology and cognitive science? According to Deacon, it is, well, *missingness*. Absence does not just make the heart grow fonder; in many places at many levels *absence* marks the ultimately thermodynamic asymmetries that power evolution and life, and reactions to absence play the foundational causal role in mental phenomena. The separation of the concept of information from the concept of energy, which for 50 years and more has been seen by many as a key enabling insight, enriching Darwin's world with Turing's world, was a premature divorce, Deacon argues, and we need to return to basics, enriching the context of our thinking by reaching back into Schrödinger territory, looking at the fundamental requirements of life from the point of view of physics. But rather than just alluding to Schrödinger, as we all do, he digs deeper and reconstructs the arguments about the Second Law of Thermodynamics, drastically revising the standard (and woefully out-of-date) ideas about causation that bedevil many—but not all—thinkers today. Then he can address, in outline, the phenomena in the prebiotic world that had to churn away for eons to set the stage for life. "Autogens" are Deacon's hypothetical nonliving but entropy-defying self-perpetuators. They are the ancestors—or more aptly, enabling predecessors—of the first living things, such as Gánti's "chemotons," the simplest hypothetical living things. Living requires *work*, and work requires constraining structure (the enclosing wall of a piston is a simple example), which in turn requires structure-making processes, but some of these must not be dependent on *external* inputs of energy, rather must grow out of intrinsic physical properties of the chemistry of their components. Crystal growth is a "morphodynamic" process, independent of, and prior to, life, and so are the processes that govern the self-assembly of some lipid membranes and, later, microtubules out of tubulin molecules, for instance, laying the foundations for the "teleodynamic" processes of life.

Deacon makes a powerful case that the problem of the origin of life is not independent of the problems of intentionality and consciousness, and that getting clearer about the preconditions for the former sets the table for a similarly articulated account of the preconditions for minds, conscious or unconscious. In both cases we need to understand the interplay between "orthograde" and "contragrade" processes; the former, such as free fall in gravity and dissolution under the aegis of the Second Law of Thermodynamics, but also the "fall" into attractor states in a "teleodynamic" regime, do not require work; they just happen on their own, without further input from outside. Contragrade processes, such as reproduction, self-repair, and active perception and problem solving, require *work*, a concept that gets a definition carefully extended beyond its grounding in physics. Hydroelectric power depends on structure that can exploit the orthograde process of water falling downhill in order to produce or enlarge a difference that can make a difference, an asymmetry that permits work to be done. Where is the absence? There has to be some empty place for the water to go. Similarly, problem solving and theory building depends on structures in the brain that have to be built and maintained against dissipation. Mental fog is an analog of heat death, and any theory of intelligence that does not incorporate such a dynamical perspective is going to distort the phenomena, sweeping problems under the rug that will later emerge to haunt theory.

For instance, Shannon's brilliant idealization, defining a communication channel between a sender and a receiver, and putting some constraints on the signals that could be sent along the channel, nicely captured one important aspect of information in its everyday sense. The utility of the Shannon concept of information, measured in bits, is borne out every day in our confident calculations of bandwidth and the capacity of our USB sticks. Bioinformatics could not exist without it. But if we are going to have a proper account of *information that matters*, which has a role to play in getting work done at every level, we cannot just discard the sender and receiver, two homunculi whose agreement on the code defines what is to count as information for some purpose. Something has to play the roles of these missing signal-choosers and signal-interpreters. Many—myself included—have insisted that computers themselves can serve as adequate stand-ins. Just as a vending machine can fill in for a sales clerk in many simplified environments, so a computer can fill in for a general purpose message-interpreter. But one of the shortcomings of this computational perspective, according to Deacon, is that by divorcing information processing from thermodynamics, we restrict our theories to basically parasitical systems, artifacts that depend on a user for their energy, for their structure maintenance, for their interpretation, and for their raison d'être. Roboticists may reply that they have postponed consideration of such phenomena as energy capture, unaided reproduction, self-repair, and open-ended self-revision, expecting to reap the benefits of this simplification by first getting clear about the purely informational phenomena of learning and self-guidance (a kind of autonomy, however incomplete). Nobody would dream of complicating the design of a chess-playing computer by requiring it to obtain its energy from sandwiches and soft drinks, obliging it to monitor not just its time but its depleting reserves of usable energy. Human chess players have to control their hunger pangs, and such emotions as humiliation, fear, and boredom, but computers can finesse all that with impunity, can they not? Deacon is not alone in insisting that postponing consideration of these all-too-human phenomena is a big mistake—this is the theme song of the Romantics, you might say—but he does the best job yet of demonstrating this in terms that do not beg the question against the Enlightenment vision. Those who think they have taken the measure of the Romantics in their earlier encounters should reserve judgment until they see what Deacon does with these familiar ideas.

A residual disagreement between the Enlightenment and the Romantics is about whether brains *compute*, and one way of asking that question is to ask if the organization that orchestrates the activities of billions of neurons is properly considered to be enough *like* a computer program to underwrite computational neuroscience (for instance). Deacon says no, but he does acknowledge "[c]omputationlike processes" (p. 537), and would agree, I think, with the rejoinder that at least many of the *thinking methods* we human beings have devised and then imposed on the underlying organization of the neurons, exploiting their labor in effect, are enough like programs to warrant being considered computational. Here, as elsewhere, the details matter more than the general (ideological) picture.

One of the weaknesses of Deacon's book flows from his decision to coin a host of new terms—*absential, entention, contragrade, orthograde,* and *teleodynamic*—piled on top of the usual jargon—*emergence, attractor*—in which to couch his arguments. This burdens readers with the extra task of rehearsing these not obviously obligatory novelties. One of strengths of the volume is that Deacon does not try to bludgeon the skeptic with proofs of the necessity of his position and the futility of theirs. Instead, he is content to let the details pile up, showing how his perspective has good things to say about many topics the Enlightenment has not yet been successful at addressing, such as—at one extreme—the order in which the obligatory features of living things must have emerged in the prebiotic world, and—at the other extreme—the way some emotions tire us out and others ease the passage to discovery. In the former case, starting with physics allows Deacon to describe "teleodynamic" systems simpler than the simplest living systems we know today (simpler, even, than viruses) but still primitively self-sustaining, thanks to the synergy between autocatalysis and self-assembly of membranes. Most "origin-of-life" scenarios make use of parts that are themselves products of teleodynamic processes of living things—Frankencells, composed, like Mary Shelley's monster, of cadaver parts, not suitably "raw" materials. Starting with physics also allows Deacon to construct an imaginative scenario in which nucleotide chains, quite robust but functionless, could gradually evolve into the representing medium for reproduction. At the other extreme, he can offer a (very sketchy) account of "what it feels like" in terms of the brain's tendency to change in the direction of "work minimization." He wants to arrive at the conclusion that "[c]omputations and cybernetic processes are insentient because they are not teleodynamic in their organization" (p. 536) and although he has given us ways to see the differences between teleodynamic systems and other complex systems, this step is less persuasive—because less worked out in detail—than the earlier steps.

Curiously, the philosopher Ned Block's (1978) thought experiment about the Chinese Nation can be put to good use to locate Deacon's position, as I understand it. Block imagines harnessing the entire population of China into a gigantic hand-simulation of a massive artificial intelligence program simulating a human being's mind, with each Chinese citizen assigned a small computational role in implementing the whole kaboodle. Would the resulting implementation be conscious? Block assures us it would not, without giving any arguments for this "obvious" verdict. Deacon would say that the reason the Chinese efforts would not sustain consciousness in the subject whose brain they were simulating is that the individuals are being turned by the giant program into computers! If they were given more autonomy, and the right teleodynamic organization, there *would* be a conscious super-subject composed by their activities, and they would be just as oblivious to its content as our neurons are to ours. "Looking for mental information in individual neuronal firing patterns is looking at the wrong level of scale and at the wrong kind of physical manifestation" (p. 516). The right organization would involve higher-order teleodynamics, and something like negotiation, alliance formation, and the exploitation of "noise" in the system. This is at least a tempting idea, worth further exploration.

There has been a deeply regrettable controversy about Deacon's book, involving charges of intellectual theft, not plagiarism of explicit formulations, but plagiarism of ideas from other recent books that deal with many of the same issues (see http://theterrydeaconaffair.com/ and http://terrydeacon.berkeley.edu/plagiarism-investigation-exonerates-terrence-w-deacon). The constellation of problems Deacon addresses has been a hotbed of theorizing and interpretation for some years across several fields, including philosophy, and with hindsight we can judge that Deacon, a prodigious citer of earlier work, overlooked some clearly relevant anticipators. I myself have been trying in recent years to say quite a few of the things Deacon says more clearly here. So close and yet so far! I tried; he succeeded, a verdict I would apply to the other contenders in equal measure. Alicia Juarrero (1999) and Evan Thompson (2007) have both written excellent books on neighboring and overlapping topics, but neither of them managed to win me over to the Romantic side (see, e.g., Dennett 2011), whereas Deacon, with his more ambitious exercise of reconstruction, has me re-examining my fundamental working assumptions. I encourage others who see versions of their own pet ideas emerging more clearly and systematically in Deacon's account to join me in applauding.

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