



Semiotic and Physical Requirements on Emergent Autogenic System

Commentary on ‘How Molecules Became Signs’ by Terrence W Deacon

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Abstract

In “How Molecules Became Signs”, Prof. Deacon outlines a plausible mechanism whereby biochemical systems could be understood to fulfill the conditions of being “alive” in the context of the two broad families of requirements, namely the energetics of metabolism and the informatics of coding. In so doing, he addresses head-on how to account for the origin and the action of coding in physical systems, and thereby the necessary and sufficient conditions for life. I review some of the relevant issues around the interlocking potential necessary and sufficient conditions whereby these two phenomena are included within systems of interpretation in organisms.

Keywords Origins of life · Semiotics · Autogens

In (Deacon, 2021), Deacon outlines a learned and intriguing hypothesis of a plausible mechanistic evolutionary trajectory of biochemical systems which could conceivably be understood to fulfill the conditions of being “alive”. He does so in consideration simultaneously of the two broad families of such conditions required, namely the energetics of metabolism and the informatics of coding. In so doing, he addresses head-on the greatest challenge in biosemiotics, namely, how to account for the origin and the action of coding in physical systems, and thereby, at least for many researchers, the necessary and sufficient conditions for life.

Deacon well emphasizes the crucial distinction between the copying and the interpretation of the sign record, recalling the ambiguity about the transmission vs. the meaning of “information” which has echoed down the decades since Shannon. More specifically, in living systems, coding supports two functions, that is copying of the sign record and the system in which it is hosted (reproduction), distinctly from

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the interpretation of the same sign record, together with the resulting downstream consequences of the interpretation process. In a nutshell, how are sensory response loops related to reproduction? How is the control over energetics to maintain systems far from equilibrium related to the models of reality implied by the existence of robust systems of coding and interpretation? Are these mutually necessary and sufficient in living systems, or merely always present in extant life forms?

In the case of living systems the result of interpretation is the energetic constraint on other biochemical processes within the cell. One wonders whether reproduction and interpretation in this sense are mutually necessary or sufficient for each other in general: is a natural system capable of reproduction but not interpretation, or dually interpretation but not reproduction, even conceivable? But the bottom line is that copying is not sufficient for sign processes in living systems.

Deacon's "central dogma of semiotics" is a statement of the complete "unmotivation" (in Eco's (1986) sense) of the interpretation of sign vehicles in virtue of their properties. While clearly true for symbols, I believe this must be somewhat less true at least for icons, if not also indices. One wonders whether *anything* at all can truly be taken as a sign vehicle or token to be interpreted? Paraphrasing Deacon later, what are the necessary and sufficient conditions for some phenomenal situation to serve as a sign vehicle, to be related by a coding function to some unmotivated phenomenon, manifested through a physical process of interpretation? Ultimately this depends even on the philosophical issues around object identity, distinguishing objects from (portions of) substances existing in regions of space, in the sense that only distinct objects can be recognized as distinct sign vehicles in the first place. In any event, dwelling on these questions remains essential: what are the necessary and sufficient conditions for something to be interpretable? To be an interpreter? For interpretation to have occurred?

As we enter the meat of the paper, we see a great advantage of Deacon's approach is to ground each step in a plausible specific biochemical process. I am not a sufficient chemist to be able to give strong opinions on any of these stages, or the transitions among them. But I'm definitely prompted to ask, in effectively each instance, if the kinds of molecular systems and subsystems actually exist, either nakedly in a natural setting, or as clearly incorporated within known biological systems. Is this sequence merely a thought experiment, or does it intersect with actual natural history in a concrete way?

The first step is the generation of "autogens", autogenic work cycles mediated by the dual processes of self-assembly and reciprocal catalysis. It's noteworthy that a central requirement for this to be a recurrent process is that the capsids at some point in time suffer extrinsic damage and become breached, so that self-assembly is again required. There is little to no discussion of the nature and origins of such breaches. Presumably these occur through thermal action, chemical, both? Surely certain capsids would be more or less vulnerable to such breaches, depending on the local environment? Does the necessity for such breaches imply some effective form of apoptosis at some level? In any event, they are themselves part of the energetic and chemical landscape in which all of these systems operate, and thus within the broader metasystem in which our proto-cells are embedded, as Deacon acknowledges. It's not clear to me to what extent this issue is worthy of more attention, but it's a striking aspect of this critical development in the paper early on in Deacon's sequence.

Still in this first sequential step, it is offered that these early autogens will “tend to acquire and exchange molecules with their environment”, thereby creating “variant autogen lineages”. What is being sought at this stage is the origins of alphabets for coding and interpretation, what will become a pool of specific nucleotides and amino acids. These are necessarily distinct molecular species from those making up the substance of the autogen. What is the mechanism for the retention, selection, and error correction for this diversity of molecular species?

To my best understanding, as we traverse Deacon’s plausible history, what we are ultimately seeking is the origin of transfer RNA, the mechanism to physically manifest interpretation of the genetic codons to amino acid sequences, and thus protein synthesis, according to the actual genetic code. In this sense, DNA is the molecule which is a sign vehicle, protein synthesis is its interpretation, and tRNA (in the ribosome) is the interpreter. This is truly symbolic, in the sense of codons being discrete tokens (sign vehicles) which are unmotivated in sharing no properties with the interpretations (amino acids).

In describing tRNA very late in the paper in the context of “referential displacement”, Deacon illustrates the severe challenges in attributing semiotic concepts throughout the biochemical processes. That’s because, returning to the earliest autogens described above, Deacon is already attributing semiotic properties: “This enables constraints to preserve a trace of past instantiations and past work—i.e. reference— demonstrating that these constraints are analogous to the genetic information of a virus.” But, at this stage, so far we are still just copying. There is not yet interpretation, in the sense of something being taken for something else through a code interpreting an unmotivated (again, in Eco’s sense) functional relationship between a sets of entities (codons) and some interpreted phenomena (amino acids). This is *not* reference.

I learned a tremendous amount from this paper, and applaud Deacon’s superb work in advancing these ideas bridging the philosophical and the conceptual and grounding them in plausible biochemistry. As a student of Prof. Pattee, it is both exciting and heartwarming to return to these shores, and I am grateful for the opportunity.

Declarations

Conflict of Interest I declare no conflicts of interest.

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