


Review Article

The New Naturalism

David Lynn Abel

Abstract

The New Naturalism extends scientific investigation into the previously abjured realm of Choice Causation. Mundane Proximate Teleology is carefully dichotomized from questions of ultimate transcendent metaphysical teleology. The many shortcomings of traditional physicalistic naturalism have been enumerated [1]. Mundane Proximate Teleology is needed to explore the Formalism > Physicality (F > P) Principle *on earth* [2, 3]. The everyday reality of purposeful controls needed to be addressed, as opposed to mere functionally-indifferent laws, constraints and forces [4]. The natural sciences of genomics, epigenomics, metabolomics and abiogenesis confronted us daily with the need to explain formal rather than mere physicydynamic causation of physical effects. Life in particular manifests undeniable engineering-like choice-based controls that prevail over every aspect of subcellular metabolomics. Homeostatic metabolism must be purposely steered toward functional success. Physicydynamics is blind to refined function and could not have pursued or generated it. Bench scientists should and can be free to study the repeatedly observable reality of intra-cosmic Choice Causation and its very real daily physical effects without paying the slightest attention to purely metaphysical questions of believed or disbelieved ultimate transcendent teleology.

Keywords: Mundane Proximate Teleology; Physicalism; Materialism; ProtoBioCybernetics; The Cybernetic Cut; Chance & Necessity; Biofunction; Synthetic Chemistry; Infogenesis; The Definition of Life; Life Origin; Abiogenesis; Computational Biology; Physicydynamic Incompleteness; The Formalism > Physicality (F > P) Principle; The Universal Determinism Dichotomy (UDD); The Genetic Selection (GS) Principle; ProtoCellular Metabolomics.

Introduction

The mechanistic school of so-called physicalistic naturalism long ago rejected the notion of a “vital spark,” “*Élan vital*” or “viral force” in dichotomizing life from non-life. Physicalistic naturalism has always eschewed “vitalism” and believed that physics and chemistry will eventually be proven to encompass life solely within inanimate physicydynamic laws and principles. “Nature is sufficient to explain life.” The prevailing belief within naturalistic science has been that there is fundamentally no difference between life and non-life, to which the New Naturalism defined by this paper and the one before it [1] says, “Nonsense!” When the question was asked, “Is Life Unique?” [5], the answer given in 2011 was:

“Is life physiochemically unique? No. Is life unique? Yes. Life manifests innumerable formalisms that cannot be generated or explained by physicydynamics alone. Life pursues thousands of biofunctional goals, not

Affiliation:

ProtoBioCybernetics/ProtoCellular Metabolomics, The Gene Emergence Project, The Origin of Life Science Foundation, Inc USA.

***Corresponding author:**

David Lynn Abel, ProtoBioCybernetics/ProtoCellular Metabolomics, The Gene Emergence Project, The Origin of Life Science Foundation, Inc USA.

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the least of which is staying alive. Neither physiodynamics nor evolution pursue goals. Life is largely directed by linear digital programming and by the Prescriptive Information (PI) instantiated particularly into physiodynamically indeterminate (inert so far as physico-chemical causation) of specific nucleotide sequencing. Epigenomic controls only compound the sophistication of these formalisms. Life employs representationalism through the use of symbol systems. Life manifests autonomy, homeostasis far from equilibrium in the harshest of environments, positive and negative feedback mechanisms, prevention and correction of its own errors, and organization of its components into Sustained Functional Systems (SFS)"[5]

The difference between life and non-life is found within the three fundamental categories of everyday down-to-earth reality:

1) Necessity (law), 2) Chance contingency and 3) Choice contingency. The difference between life and non-life is not some mysterious mystical "vital force." It is simply that life is *controlled rather than constrained* by the Cybernetic Processing of Efficacious Executable Choice-Commanded Causation and Control (CPEECCC) [1, 6, 7].

The demise of traditional scientific physicalistic naturalism has recently been proclaimed not in philosophy literature, but in well-indexed, peer-reviewed bench-science-journal literature ("Is Naturalism on Life Support? [1]). The New Naturalism studies the "How?" of a very real Choice Causation instead of disallowing it for fear of being metaphysically too "teleological." "The New Naturalism" includes in its investigation "Mundane Proximate Teleology"—those aspects of everyday, down-to-earth ontological *being* that demonstrate undeniable Choice Determinism and its very real physical effects.

Bench scientists should be under no imperatives to subject their natural science to purely metaphysical constraints or prohibitions [6-17]. The New Naturalism rejects the metaphysical shackling of scientific progress. We must finally obey Einstein's advice by preventing metaphysical presuppositions from interfering with scientific investigation. We thought we were doing that by excluding anything that sounded the least bit religious. Unfortunately, this exclusion was highly specific and prejudicial. It failed to reasonably exclude *all* metaphysical presuppositions and persuasions. It failed to recognize physicalism as the highly restrictive purely metaphysical belief system that it is.

Accusations of anthropomorphism, teleology and agency cannot be allowed to impede the full investigation of undeniable everyday down-to-earth empirical reality. All of the life sciences deal inescapably with formal controls, not just constraints[4]. When we observe choice-controlled causation and control at bona fide decision nodes in everyday life, we must admit it with self-honesty and integrity. And we must

fully investigate it with scientific rigor. If choice controls are what geneticists and molecular biologists repeatedly observe in living organisms on earth, then they should be free to explore that form of cause and effect.

The natural sciences should never be concerned with ultimate metaphysical or theological questions related to possible transcendent teleology. But science has no excuse for turning a blind eye to what is right under its nose in probably 85% of daily repeated observations—the other half of the Universal Determinism Dichotomy (UDD) [18]—Choice Determinism [1, 6-9, 11-17, 19-21]. All known effects within macroscopic time-space-mass-energy ontological being can be attributed to one of only two fundamental causation types: Physiodynamic Determinism (PD) or Choice-Controlled Determinism (CCD). This is the Universal Determinism Dichotomy(UDD) [18]. CCD of course marshals and uses physiodynamics, as is the case with ordinary engineering, but CCD itself cannot be reduced to physiodynamics. Physiodynamics alone manifests undeniable Incompleteness [17] in its description of everyday reality.

As mentioned above, macroscopic reality consists of three fundamental categories, not two: Necessity, Chance Contingency and Choice Contingency [22]. The Formalism > Physicality (F > P) Principle [2, 3] prevails *within* the cosmos. This Principle is not just some metaphysical belief in ultimate transcendent teleology. Natural science must investigate and pursue explanation of down-to-earth everyday Mundane Proximate Teleology (MPT: Choice Causation and its effects on earth).

Like the mathematical force constants and laws of motion in physics, Choice Control is an aspect of abstract, nonphysical, conceptual formalism. Nonphysical formalisms predate and govern physicality [2, 3]. Not everyone agrees with this perspective [23, 24]. But serious problems result from attempts to reduce Mundane Proximate Teleology (MPT) to nothing more than constraints and order rather than controls [4] and formal organization [25, 26]. Our ability to mathematically predict future physical interactions cannot be reduced to nothing more than learning from prior sequential events. Many previously unexperienced phenomena have been predicted by mathematics alone, and only later discovered and confirmed. For example, the mathematical prediction that light would eventually be found to be an electromagnetic wave; the successful prediction of the Standard Model of particle physics and the weak nuclear force; the prediction and formulation of general relativity; the prediction of antiparticles years before their discovery. That these aspects of reality were mathematically predicted prior to discovery lends much support to the Formalism > Physicality (F > P) Principle [2, 3]. In addition, functionality cannot be explained by Physiodynamics alone. Psychodynamics is blind to function. Chance and necessity know nothing of utility, and cannot pursue or generate refined function. The role and

significance of Choice-Controlled Determinism (CCD) on earth is far greater in the long run than that of Physicodynamic Determinism (PD). The existence of extensive engineering success could not have occurred if the $F > P$ Principle were not valid. The $F > P$ Principle alone explains science's "How?" of everyday design and engineering effects.

The Major Formalism of "Function."

What exactly is function? Does physiodynamics know what function is? Does it care? How did usefulness, function, utility, and pragmatism arise in inanimate nature? What would have noticed if function arose? Was function valued by anything? What would have been the motivation to pursue, achieve, maintain, and refine function? How did "algorithmic optimization" ever arise in the first place? These seem to be mostly metaphysical questions. However, when it comes to abiogenesis science, many of them quickly become very down-to-earth natural science questions. They are questions rightly assigned to Mundane Proximate Teleology. Exactly what happened on prebiotic earth to generate "usefulness"? If we had proof of astro-biological life, we could expand the question to more cosmic proportions. But we don't. So, for the time being, we will stick to life-origin questions on earth.

Let's start with the question, "How would inanimacy have recognized and identified function?" Does any logic or empirical evidence exist to suggest that physiodynamics has ever sensed function, let alone valued or pursued it? Some might argue that refined function has never been detected, valued or pursued except by agents—living organisms that can choose from among real options not precluded by laws and constraints. But everything we know about the simplest known agents—Monera and Protista—is that they could not possibly exist without themselves having been the product of exquisite subcellular functional choice commands. Even theoretical protocellular *models* require exquisite functional controls. Subcellular function would have had to pre-exist any agent of the simplest kind. So, we have a real dilemma here. Inanimate nature was blind to function unless agents existed to identify, value, pursue and refine it. But agents could not have existed except by already-existing extraordinary subcellular efficacious executable choice commands. These choice commands had to be processed by sophisticated devices into biofunction. As is usually the case with life-origin science, we immediately encounter still another chicken and egg paradox. Why is that? Could these nagging paradoxes be the result of having started science with a faulty presupposition illegitimately graduated into an axiom?

To even discuss "usefulness," we find ourselves in an epistemological quagmire of function defined within our human minds to which physiodynamics is blind. This is unfortunate, because we always seem to conflate our epistemology with historical objective prebiotic ontology. What we need to know is how function arose historically in a

purely objective sense, before human mentation ever existed. The kind of function we are most interested in is the earliest form of biofunction. We have good reason to believe that this is where function began. For life to have gotten started required a tremendous amount of Prescriptive Information (PI) [27-29] of function, and a heritable system of PI right off. No Metabolism-First model could have sustained itself. Initial life required some sort of heritable genome of symbolized efficacious executable commands that could be replicated, cybernetically processed and evolve.

We know that nucleosides had to have been actively selected prior to phenotypic function in order to instantiate Prescriptive Information (PI) into polynucleotide semantics and syntax [27, 30]. Thus, we are talking about how a simple linear digital Functional Sequence Complexity (FSC) could have arisen in a prebiotic environment. If there is any hope of our solving the chicken and egg paradoxes of infogenesis, it will come through a study of the simplest notion of linear digital Functional Sequence Complexity (FSC) [30-33] as it related to The First Gene [34] and the earliest biofunction [35]. We understand that life is actually dependent upon tertiary molecular structure and four-dimensional genomic factors rather than just linear digital sequence complexity. But we also know that primary polynucleotide sequencing *prescribes* much of minimum Gibbs-free-energy folding. We also know that the sextet Translational Pausing Code [36] that is superimposed on the triplet Codon Code also uses functional sequence complexity (FSC) to help determine protein folding. Even chaperone proteins that assist folding are themselves prescribed by FSC. So, let us use FSC as our model to try to understand the origin of function in inanimate nature.

The sequence of Figure 1 through Figure 3 helps us understand the origin and realization of function. Traditional physicalistic naturalism typically seeks to explain function from order, complexity or some combination of the two [37, 38]. Complexity and order are intimately tied to chance and necessity. Figure 1 shows the relationship between order and complexity based on Kolmogorov's work [39, 40], and how both might relate to chance and necessity. Note that function is nowhere to be seen in Figure 1. That is because neither order nor complexity (or any combination of the two) necessarily have anything to do with function. Function cannot possibly be appreciated from Figure 1.

Ultimate Necessity produces a theoretical certainty—a probability of 1.0—with zero Shannon uncertainty. Ultimate Chance is represented by randomness with maximum uncertainty and maximum bits of uncertainty (usually misnamed bits of "information," which they are not). It is imperative that we understand that neither order nor complexity (or any combination of the two) are capable of producing formal organization or the orchestration of refined function.

Maximum Order	Randomness
OSC	RSC
————— Increasing complexity —————>	
Minimal Uncertainty	Maximum Uncertainty
Low Shannon bit content	High Shannon bit content
Maximum compressibility	Minimum compressibility
Most patterned	Least patterned

Figure 1: The inverse relationship between order and complexity as demonstrated on a linear vector progression from high order (Ordered Sequence Complexity [OSC]) toward greater complexity (Random Sequence Complexity [RSC]) (modified from [33]). Neither order nor complexity have anything directly to do with function:

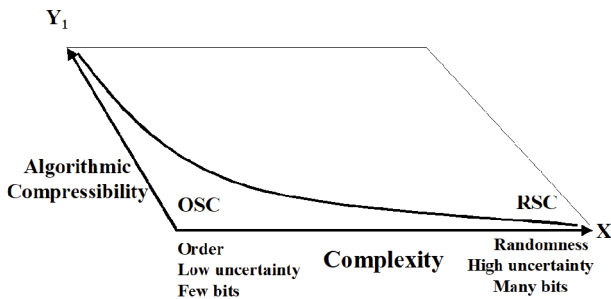


Figure 2: The adding of a second dimension to Figure 1 allows visualization of the relationship of Kolmogorov algorithmic compressibility to complexity. The more highly ordered (patterned) a sequence, the more highly compressible that sequence becomes. The less compressible a sequence, the more complex is that sequence. A random sequence manifests no Kolmogorov compressibility [39, 40]. This reality serves as the very definition of a random, highly complex string. Notice that this graph still tells us absolutely nothing about “usefulness” or “function” of any sequence, ordered or complex. Neither order nor complexity are the key to functionality. An additional dimension is needed to create, engineer, identify or appreciate formal function.

Figure 3 presents the first visualization of any degree of function. *Function is invisible until the third dimension is added allowing us to identify and see the effects of Choice Determinism.* The tall W FSC curve represents any degree of utility. Functional Sequence Complexity (FSC) is located within this curve. Any plot within this curve does something useful because each plot within the curve was the product of choice causation in successful pursuit of function. What exactly is this Z (Y_2) dimension that allows visualization of the W FSC curve? The answer is the dimension of Choice Causation—the very dimension forbidden by the now deceased physicalistic naturalism. The W FSC curve depicts what “works” in a formal utilitarian sense, not the physics sense of “work.” The W FSC curve depicts varying degrees of any non-trivial refined function and formal orchestration/organization. Small “w*” represents the choice-based algorithmic optimization that produces peak utility—the best formal function.

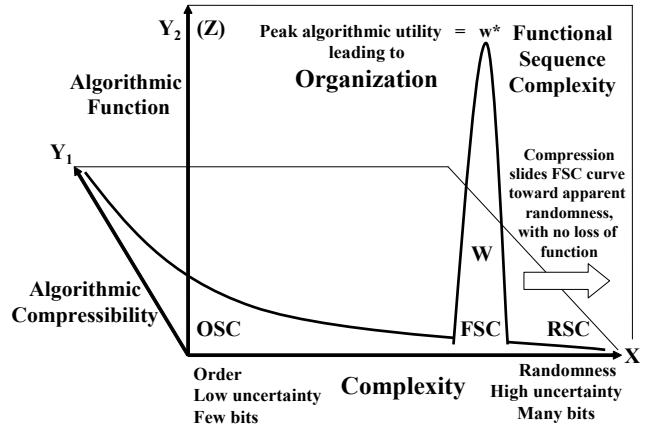


Figure 3: Superimposition of Functional Sequence Complexity onto Figure 2. The Y_1 axis plane plots the decreasing degree of algorithmic compressibility as complexity increases from order towards randomness. The Y_2 (Z) axis plane shows where along the same complexity gradient (X -axis) that highly instructional or efficacious executable command sequences are generally found. The Functional Sequence Complexity (FSC) curve includes all algorithmic sequences that work at all (W). The peak of this curve (w^*) represents “what works best.” The FSC curve is usually quite narrow and is located closer to the random end than to the ordered end of the complexity scale. It just looks like a mostly random sequence because of the freedom of unconstrained selection. Syntaxes of very functional choices frequently manifest minimal patterns. Compression of an instructive or efficacious sequence of commands slides the FSC curve towards the right (away from order, towards maximum complexity, maximum Shannon uncertainty, and *seeming* randomness) with no loss of function. Decompression restores choice-command induced function and slides the curve back towards order. Used with permission from: Abel DL, Trevors JT: **Three subsets of sequence complexity and their relevance to biopolymeric information.** *Theoretical Biology and Medical Modeling* 2005, 2:Open access at <http://www.tbiomed.com/content/2/1/29>.

To disallow Choice Causation is to disallow this dimension of visibility of “usefulness” in everyday earthly reality. This is why it is so essential that the New Naturalism includes within its study Choice Determinism and Mundane Proximate Teleology (MPT). First, the Universal Determinism Dichotomy (UDD) must be acknowledged [18]. Second, Choice Determinism must be acknowledged as a real cause of real effects in the ordinary everyday physical world. This must be the subject of naturalistic scientific study. The W curve of functionality can only be visualized within the Z dimension. The W curve is irrefutable evidence of the existence of down-to-earth ordinary Mundane Proximate Teleology (MPT). *MPT has nothing to do with questions of ultimate transcendent metaphysical teleology of interest to philosophers.* MPT is instead a legitimate subject of ordinary natural science investigation within the cosmos, and especially on *terra firma*.

Efficacious Executable Choice Commands alone created the biological W FSC curve. These choice commands were instantiated into linear digital nucleoside active selections. Each nucleoside next to polymerize had to be actively selected—chosen. Each choice was physiodynamically inert (uncoupled from physico-chemical causation). What would be the motive for selection of a certain nucleoside over others in a prebiotic environment? Does inanimate nature have motives, desires, pragmatic interests? Yet the syntax must have the correct linear digital sequencing to prescribe sophisticated biofunction. Each active selection of each nucleoside must not only be efficacious, the choice must be made prior to the realization of any proven usefulness—prior to computational halting. How did inanimate nature and protolife outsmart Turing and Church’s halting problem before these cyberneticists ever stated it? Our finest most intelligent programmers today cannot outsmart the halting problem. These are the questions that Mundane Proximate Teleology must pursue.

Controls also arise from specific promoter, operon and enhancer active selections. In addition, various epigenetic means of choice command controls regulate when genes are turned on and off, and how they are alternatively spliced. The w^* peak of ideal phenotypic fitness results only from *genomic* algorithmic optimization [41]. Genomics and epigenomics produces peak function, not phenotypes. Phenotypes are an effect, not a cause. Before any phenotype can manifest greater fitness, that phenotype must be genomically programmed and cybernetically processed into computational halting. This is called the GS (Genetic Selection) Principle [41]. Genetic selections must be active, not passive or secondary. Fittest phenotypes do not program anything. *No fittest genomic prescription—no survival of the fittest phenotype!*

What is this thing we call “Choice”?

Choice is the active selection of something at a bona fide decision node from among multiple options, the choice of which is not precluded or mandated by laws and constraints. Choice is real. Choice is everyday ordinary reality. Choice is a *natural* aspect of mundane ontological *being*. It is not just some ethereal transcendent superstitious or religious metaphysical belief. Most of the down-to-earth everyday reality with which we are most familiar cannot be generated apart from Choice Determinism.

Physiodynamics cannot explain purpose, efficacy, steering, controls, function, usefulness, benefit, formal organization or orchestration. Life, especially, must be studied in a newly defined naturalistic context as Mundane Proximate Teleology within “The New Naturalism.”

Science can no longer continue to deny the Universal Determinism Dichotomy (UDD) [18] *within* nature. It is science’s responsibility to investigate *all* of the “Hows?” of the natural world. Choice Causation is perfectly natural.

It is only philosophers who try to declare it illegitimate and unnatural for purely metaphysical reasons. The value, effectiveness and pragmatism of Choice Causation at decision nodes cannot be overstated. The ability to actively select from among real options what is useful is the single most important cause of effects on earth. Natural science is long overdue to stop deliberately turning its back on this form of ordinary down-to-earth causation.

Science must address *how* very real earthly Choice Causation arose. Choice Causation is just too big a component of objective reality for science to ignore or dismiss. If the old naturalism is a responsible adequate worldview, then it must explain in naturalistic purely physiodynamic terms the derivation of Active Selection in pursuit of function at bona fide decision nodes. If it cannot, the worldview is bankrupt. It’s perimeter is too small to encompass all of the pieces of the ontological cosmological puzzle. However, questions of ultimate transcendent metaphysics are of no concern to bench scientists who have no choice but to admit to the reality of Mundane Proximate Teleology.

Notice we are not talking about any transcendent metaphysical questions here. We are just talking about physics, chemistry and biology. We are on the earth’s surface addressing everyday reality. We are also observing that physical humans can land on the physical moon with *mathematical* planning and prediction. We observe that synthetic chemistry requires careful formal steering and tightly controlled chosen starting conditions for each successive reaction step. We study genomics and observe that nucleosides must initially be actively selected prior to any realized utility. The choice of where on DNA to methylate or not methylate determines whether genes are turned on or off. Choice Determinism is real on earth even outside of human minds at the subcellular level. *Choice Determinism must be included in scientific investigation, not just sterile inanimate physiodynamics.*

Physicalism should never have been introduced into science as its most fundamental axiom. “Every day down-to-earth reality,” should be the subject of scientific investigation and discovery, whether teleological or not. Bench scientists need to take exception from philosopher’s edicts. Science needs to investigate all of ontological being, not just Chance and Necessity [22].

Stand-alone chaos, complexity and catastrophe should never be confused with our theories and what we intelligent humans do using abstract conceptual nonlinear dynamic models. Life-origin science is not especially interested in:

1. Modern-day human applications of nonlinear dynamical systems theory.
2. Investigator involvement (artificial selection) in chaos, catastrophe, and complexity experimental designs.

- Information defined in terms of the reduced uncertainty of subjective “observers” and “knowers,” whom we claim did not exist for 99.9% of life’s history.

The Orchestration of Homeostatic Metabolism Far from Equilibrium

Formal organization on earth and within the cosmos is impossible apart from Choice Causation and Mundane Proximate Teleology (MPT). Organization cannot be generated from Chance and Necessity. Prigogine’s “dissipative structures” of chaos theory can “self-order.” But self-ordering phenomena have nothing whatever to do with formal organization or function. Formal organization and function always require Choice Causation and MPT.

Intra-cosmic sophisticated function must be prescribed by active purposeful selections from among real options. Life accomplishes this first by active selection of nucleosides next to polymerize. Many other active selections take place, such as the choice of each specific aminoacyl t-RNA associated with each amino acid. Aminoacyl t-RNA synthetases are protein enzymes requiring still more purposeful choices. Choices are made as to what syntactical code will represent what needed function to achieve. Genomic programming and its superimposed codings (e.g. the sextet translational pausing code superimposed onto the triplet codon code) [28, 42] come into existence only by the choice of formal rules, not laws. Epigenetic factors such as methylations, acetylations, alternate-lncRNA splicing, transcription factor binding sites, promoter, operon & enhancer selections, and other “regulators” all require choices at bona fide decision nodes. Controls must be steered, directed, and chosen. Laws, constraints and forces are blind to function. The notion and desirability of function arise only from the far side of The Cybernetic Cut [43-45].

Life is computation [11, 15]. Life is programming and cybernetic processing of that programming by very sophisticated nanocomputers and molecular machines [6, 7]. Life engineers those devices into existence. Only after many unforced sequential steps, biochemical pathways lead to functional and pragmatic success to which the laws of physics and chemistry are blind [12-14, 16, 17, 19, 20]. Biosystems are controlled, not constrained [4]. Configurable switch-settings integrate ingenious circuitry [25, 30, 46-48]. In short, life is orchestrated, not merely self-ordered, by abundant abstract, conceptual formalisms no more reducible to physicality than the mathematical laws that govern physicality [1, 2, 29].

Ongoing Programming Refinements

Programmed Genomic Rearrangements (PGRs) [49-57] is a form of ongoing algorithmic optimization that improves genetic prescription real time. Secondary phenotypic survival has nothing to do with the genetic programming that produces the fittest phenotype in the first place, and constantly improves

it. Natural selection only proves after-the-fact that the genomic programming and formal computation successfully “halted.” Programming optimization and computation are formal, not physical. But, of course, formalisms can be recorded (instantiated) into Material Symbol Systems (MSS) that employ physical tokens as representational symbols of meaning and purpose. Syntax of physical tokens greatly expands that potential.

What does “Natural” now mean in “Natural Science”?

Science must *redefine the “natural” in “naturalism”* to include all of the down-to-earth abstract formalisms that should have been viewed as natural on earth all along. These governing abstract formalisms should be the subject of bench science’s investigation of *Mundane Proximate Teleology*.

“The New Naturalism” represents a major Kuhnian paradigm shift in “natural” science that

- 1) Redefines what is “natural” in scientifically addressable reality.
- 2) Broadens the field of scientific investigation to include all of mundane reality, not just physiodynamics.

Includes study of the third fundamental category of ontological *being* besides 1) Necessity and 2) Chance Contingency: 3) *Choice Contingency* [22].

Acknowledges the real physical effects of Choice Causation in the natural world.

Acknowledges that functionality and other purposely pursued formalisms are essential elements of the natural everyday world.

Admits into scientific investigation phenomena that are clearly steered and controlled toward “usefulness.”

Explores *the cause* of steered, directed controls.

Investigates how nature came to recognize, value and pursue utility.

Ceases to view the reality and role of formalisms as only metaphysically teleological. The New Naturalism points to Mundane Proximate Teleology as scientifically addressable causation.

Challenges the suggestion that the controlling role of mathematics in physics is “unreasonable” [58-61].

Recognizes life, its biosignatures and controls as being natural.

Admits to the innumerable outrightly engineered aspects of subcellular and multicellular life.

Acknowledges agency as real within the natural world and worthy of full scientific investigation.

Seeks a causative explanation for the Efficacious Executable Choice Commanded Causation and Control (EECCC) that defines life [6, 7] and makes life's programmed halting computations possible [11, 14, 15].

Decries the dismissal of Choice Causation as being too anthropocentric or teleological for scientific investigation.

Includes engineering science as a subject of legitimate scientific investigation that never should have been excluded from natural science in the first place.

Anything that is repeatedly observed in reality should be considered "natural" by scientific investigation. What would be the justification for *not* studying the cause and origin of intra-cosmic formalisms, agency and teleology? We cannot practice science without them. Where did they come from?

If we are going to insist on defining "natural" only in the old physicalistic way, most of everyday reality cannot be "natural." It has too large a formal component. We currently have physics, chemistry and biology, all supposedly natural sciences, with extensive non-physicalistic, non-naturalistic components that we refuse to acknowledge and admit. We cannot logically reduce any of them to the current purely physicydynamic definition of "natural." The only hope of preserving natural science is to redefine "natural" into "The New Naturalism." We must either exclude the entire science of biology, synthetic chemistry and physics from the natural sciences, or painfully admit that the natural world includes a lot more formalisms than physicalists were ever willing to admit. Even if we excluded biology from the natural sciences, we would still have the problem of "The Unreasonable Effectiveness of Mathematics in the Physical Sciences" [58-61]. The truth is that there is absolutely nothing unreasonable about the reality of abstract formalism in nature. The only thing that is unreasonable is putting on blinders and refusing to admit the full nature of nature. The purely metaphysical pontification that "Physicality is Sufficient" does not hold water.

Physicalism has precluded honest acknowledgement and study of the single most important aspect of ontological reality: Choice Determinism. It has blocked scientific investigation from progressively discovering all of reality and its causes. The purely physicalistic axiom has denied the very definition of life [6] and the key to understanding all of its biosignatures. It has prevented understanding the origin and means of achieving refined function of any kind.

Physics must face the reality of a controlling, predictive, formal mathematics. The tight controls needed for synthetic chemistry are formal, not physical. The orchestration of even protocellular metabolism clearly required active selections [34, 35]. Even prebiotic molecular/chemical evolution required active selection [19]. Active ongoing *Processing of Efficacious Executable Choice-Commanded*

Causation and Controls (PEECCCC) is required for life. PEECCCC alone accounts for subcellular life's existence and computations. This fact falsifies physicalism at every step in homeostatic metabolism. Refusal to acknowledge the reality of The Formalism > Physicality (F > P) Principle precludes traditional naturalism from being the most fundamental axiom of science. The metaphysical perimeter defined by current concepts of Physicalism cannot possibly encircle all of the pieces of reality's puzzle. Too many formalisms from the far side of The Cybernetic Cut [43-45] have to be acknowledged as components of ontological *being*. Innumerable programmed biological controls in particular press the point. There is nothing "material" about biofunction and homeostatic metabolism far from equilibrium. There is nothing physical about life's programming, cybernetic processing, its nanocomputers, molecular machine devices, or its halting computations. Yes, these abstract conceptual formalisms are recorded using physical symbol vehicles (tokens) in a Material Symbol System (MSS) [62, 63]. Yes, physical results are realized from the computations similar to how cybernetic programming and three-dimensional printers produce physical products. But all of life's processes are still fundamentally formal. Life is ever so much more than mere physicydynamics, irreversible nonequilibrium thermodynamics included. Cybernetics and computation are the bottom line of life, not physicydynamics. Life is fundamentally nonmaterial, the same as the governing mathematical laws of physics—the same as the formal controls of synthetic chemistry required to choose the initial conditions and environment of each successive reaction step. Refusal to admit this produces only black tar. Black tar cannot be chemically reversed into biogenic molecules or metabolic pathways. Once the chemistry is ruined by inexact lab procedures, the damage is irreversible. Even when no mistakes are made, prebiotic environment simulations make it almost impossible to make any biogenic molecules, homochiral ones especially.

According to the current concept of naturalism, abstract, formal conceptual complexity is *not* natural. Any hint of agency is seen metaphysically as being too teleological. Agency and teleology are considered, at least in some sense, transcendent to physicydynamics. Yet, simultaneously, the vehement argument continues that abiogenesis was purely natural. NASA and physicalistic abiogenists all argue that both agency and teleology are ultimately natural. Consciousness is viewed as a product of physical natural brain. The current naturalism is caught in a nasty web of inconsistency generated by its own making.

The New Naturalism views life and biofunction as being natural. In the case of Mundane Proximate Teleology (MPT), even the far side of The Cybernetic Cut is viewed as natural and intra-cosmic. If life and biofunction are not natural, then natural science cannot explore and elucidate anything about

life. Natural science has to decide which of these two models it is going to pursue. If the contention is that life *is not* natural, then all of the opposition to vitalism for the last few centuries goes down the drain. If life *is* natural, then “natural” must be re-defined to include the formalisms from the far side of the Cybernetic Cut. This includes the Choice Determinism upon which life depends. Life has been formally defined as the active on-going Cybernetic Processing of Efficacious Executable Choice-Commanded Causation and Control (CPEECCCC) [6, 7]. This definition is fully testable and potentially falsifiable. It can be universally applied to all known life forms. Organisms in suspended animation are not currently living. Viruses and viroids are inanimate thumb drives. Prions are nothing more than misfolded non-living proteins.

But we are still in the process of redefining exactly what “natural means” in natural science. We tend to view the physicality of mass/energy conversions and interactions as being “natural.” As a result, naturalism usually views reality in a physicalistic or materialistic way. But the natural sciences of synthetic chemistry and biology, especially, have come to thoroughly embarrass that antiquated view of what is “natural.” Even before that, the role of abstract, nonphysical, formal mathematics in physics exposed the folly of physicalism as the starting axiom of scientific epistemology. “The New Naturalism” fully unifies *mathematical* physics with all of the physical sciences. No longer is the controlling role of nonphysical formal mathematics to be considered “unreasonable” [58-61]. The mathematics of physics is now unified with the sciences of synthetic chemistry, molecular biology, genomics, epigenomics and even the science of human engineering. The $F > P$ Principle is what unifies them. Abstract, nonphysical formalisms can now be directly investigated by science. Formalisms not only describe, but preceded, prescribed, organized, orchestrated, and continue to govern and predict physicality. Their investigation cannot be excluded from scientific inquiry:

“The Formalism $>$ Physicality ($F > P$) Principle is an axiom that defines the ontological primacy of formalism in a presumed objective reality that transcends both human epistemology, our sensation of physicality, and physicality itself. The $F > P$ Principle works hand in hand with the Law of Physicodynamic Incompleteness, which states that physicochemical interactions and thermodynamics are inadequate to explain the mathematical and formal nature of physical law relationships. Physicodynamics cannot generate formal processes and procedures leading to nontrivial function. Chance, necessity and mere constraints cannot steer, program or optimize algorithmic/computational success to provide desired nontrivial utility. As a major corollary, physicodynamics cannot explain or generate life. Life is invariably cybernetic. The $F > P$ Principle denies the notion of unity of Prescriptive Information (PI) with mass/energy.

The $F > P$ Principle distinguishes instantiation of formal choices into physicality from physicality itself. The arbitrary setting of configurable switches and the selection of symbols in any Material Symbol System (MSS) is physiodynamically inert and indeterminate—decoupled from physicochemical determinism.” [2, 3].

Die-hard proponents of physicalism appeal instead to “a system of ordered constraints.” Constraints do not and cannot steer events toward usefulness. We might also ask, “What is a system?” “System” suggests some sort of formal organization of the constraints—even maybe some element of effectiveness or pragmatism to the organized “system of constraints.” How did mere Chance and Necessity generate such a system? When constraints are purposefully selected, they are no longer constraints. They become formal controls [4]. If constraints are not selected, sophisticated function has never been observed to spontaneously arise in nature. The next problem with a “system of ordered constraints” is that mere order cannot generate formal controls or systems. Self-ordered states are devoid of choice in pursuit of function. Prigogine’s dissipative structures can self-order. But they have never been observed to generate refined formal function. Tornadoes and hurricanes only destroy organization; they never produce formal organization. A lot of people who should know better continue to fail to dichotomize mere physiodynamic order from formal organization. They are not the same [25].

Mere combinatorial complexity is not the answer, either. A plateful of spaghetti noodles is complex, What function does it perform? The issue is not mere complexity. The issue is abstract efficacious conceptual complexity.

Choice Causation and its effects are just as real as Physicodynamic Causation and its effects. Choice Causation should be as subject to the scientific method of investigation as any other cause of effects in the natural world. Anything that is repeatedly observed in every-day down-to-earth reality should be considered “natural” by scientific investigation.

Science addresses “How?” questions. Science is not doing its job if it does not investigate how Choice Causation generates such ingenious effects.

Genomics is all about the ability of the Functional Sequence Complexity (FSC)’s semantics and syntax *to issue efficacious executable choice commands*. Choice causation is the dimension that alone can create functionality. What can see this dimension? Only a processing system that recognizes the Choice Command dimension, and obeys those commands. Both the programmer and processing device must follow the same pre-prescribed formal rules, not laws, of operation. All known life is programmed and cybernetically processed [6, 7, 12-16, 19, 20, 64] Nano-computers and incredible molecular machines do the processing in every cell. All of these players have to be in place at the same time for any

cybernetic function to be realized. The important thing is that nothing relating to formal function ever arises from inside of the physiodynamic realm itself. All formal refined utility originates from the formal Far Side of The Cybernetic Cut [43-45]. But, of course, the Choice Control dimension must enter the near physical side of The Cybernetic Cut across the narrow one-way Configurable Switch (CS) Bridge [45]. The configurable switches themselves are physical. Their setting is altogether nonphysical and formal. In the case of Material Symbol Systems (MSSs)[62, 63, 65] use of the CS Bridge, the physical symbol vehicles (tokens) must be formally chosen to create message meaning and to introduce efficacious executable choice commands into physicality on the near side of The Cybernetic Cut.

Agency

A non-trivial function is a purposeful activity or computational task yielding a useful result. Formal components of this definition of functionality include “purpose,” “computation,” “task,” and “useful.” Nontrivial function results only from operations with aim and mission. Only agents pursue such missions. A “task” is work-motivated by desire or need. “Useful” is a value judgment made only by agents. “Purpose” implies a pragmatic intent to achieve some utility that does not spontaneously occur. What in nature cares about pragmatic intent other than agents? Agents are living organisms. “Computation” requires a set of well-defined instructions consisting of efficacious executable choice-based commands. Computation is a process that performs sequential well-defined algorithmic operations on input data that produces useful outcomes. Programmed operations are not necessarily numerical, as Ada Lovelace, the first computer programmer, pointed out in 1850. Numbers are often just used to represent commands. The operations are not necessarily mathematical calculations. The Choice-based commands dictate the sequence and manner in which operations are to be executed. Algorithms are sets of stepwise well-defined instructions prescribing how to solve a problem or to perform a task. Operations are performed to fulfill a purpose and need. The inputs are transformed into a sequence of logical operations.

The generation of functionality requires agency. But agency is the very thing that physicalistic naturalism disallows. The metaphysics that Einstein warned us about is found to preclude scientific discovery and elucidation of subcellular metabolomics. Nontrivial function requires executable choice commands. Active selections must be made at bona fide decision nodes. These commands are worthless without their execution by highly engineered subcellular nanocomputers and very sophisticated molecular machines. The active on-going processing of these choice commands by these stunning devices is the essence of “being alive” [1, 6, 7]

The scientific method itself can only be practiced by

choice-contingent “agents.” Agents are organisms that can make purposeful choices. But agents are not necessarily higher animals. Unicellular organisms can purposefully choose whether to approach food sources or avoid noxious stimuli. Archaea and bacteria are a part of the natural world. The source of agency in Archaea and bacteria should be the subject of natural science investigation the same as anything else in “the natural world.” Naturalistic science must acknowledge that empirically, formalisms and function have never been observed independent of agents (choosing living beings), not inanimate things. Chance and necessity could not have produced agents, or the refined function that agents pursue and generate. Natural science must address how active selection first arose in an inanimate, prebiotic environment. This is a legitimate scientific “How?” question, and the real question of abiogenesis.

And while we are at it, is there some legitimate reason the new natural science should not include the entire field of engineering? The only reason we dichotomize engineering from natural science is because we know that engineering requires purposeful choices. But why should the origin of purposeful choices be excluded from scientific investigation? Does not every lifeform on earth manifest subcellular Choice Causation and Control? Ever since Darwin, we have been arguing that life is “natural.” If life is natural, then Choice Causation at the subcellular level must be natural. If we observe subcellular engineering, then engineering is natural, whether the biosignature is observed within the cell or at the hands of humans. The field of human engineering should never have been religiously excommunicated from natural science. We only did so for faulty metaphysical reasons.

Engineering of any kind is the most significant cause of real physical effects in all of reality, far more so than mere inanimate physiodynamics. Human choice causation is no different from subcellular choice causation. Both require active selections, whether some pretzel-brained philosopher insists on labeling it teleological or not. We repeatedly observe subcellular active selections in all lifeforms. Active selections are therefore natural. Science is just going to have to “deal with it,” teleological or not. Both human and subcellular engineering should be fair game for scientific inquiry.

Science has shot itself in the foot

Science is severely crippled by its refusal to include one of the two major categories of causation. It compartmentalized Choice-Command Causation (CCC) from so-called “natural” science. This is the reason the science of Engineering was excluded. The “excommunication” of Engineering science from natural science effectively labeled engineering science as being “unnatural.” We got away with this for centuries until the natural science of Biology also proved itself to be an undeniable engineering science. The current situation is intolerable. We cannot conceive of divorcing biology from

the natural sciences. Yet we can no longer include Biology in the natural sciences based on the same criteria we used to exclude Engineering Science from the natural sciences. This is the most fundamental crisis forcing adoption of a New Naturalism. It requires redefining what is “natural” in science.

Science itself cannot exist or be practiced without formalisms. Can we practice physics without abstract, conceptual, nonphysical, formal mathematics? The scientific method itself consists almost entirely of formalisms. How far would we get in science today without designed and engineered laboratory devices? How would we sequence DNA, for example, without advanced means of computation? How would we communicate research findings without formal language? How would we evaluate reasoning apart from formal logic theory? How could data be organized and conclusions be drawn? Is the concept of weighing and measuring physical? How would ethics be defined in reporting results? How would plagiarism be judged? All of these aspects of the scientific method are formal, not physical. They all involve choice-based controls. Science must be able to investigate *all* of reality, not just its physycodynamic aspects.

The purpose of functional molecules cannot be divorced from their cause. How were the molecules synthesized without the choice of starting condition constraints for each successive algorithmic chemical step? The choice of constraints renders those constraints to be controls [4].

Evolutionary literature often states, “This evolved *in order to* . . .” Nonsense. Nothing evolves “in order to . . .” Evolution has no goal.

Science can no longer be shackled by traditional naturalistic presuppositions, even when limited to methodological naturalism. The latter disallows acknowledgment of much of everyday down-to-earth choice-caused reality. This is Mundane Proximate Teleology (MPT), a legitimate subject of scientific investigation.

Abiogenesis

Abiogenesis science has been stymied for many decades. Neuroscience’s attempt to naturalize/physicalize consciousness has gotten nowhere. Explaining genomics and epigenetics in the absence of formal prescription and control has been a joke. Adaptive polymorphisms are prescribed, not spontaneous [13]. Until we acknowledge the reality of Prescriptive Information (PI) and controls in the mundane proximate cosmos, science will remain shackled. As long as life continues to be viewed by abiogenists, astro/exobiologists, and naturalistic biologists in general as being nothing more than physical complexity, biology will be crippled in its discoveries. If we feel the sciences have continued nicely in their discovery despite such obtuseness, it is only because the logical inconsistencies caused by our starting axiom have been swept under the rug.

We cannot even come close to generating life in the lab with nothing but laws, constraints, kinetics, irreversible nonequilibrium thermodynamics, quantum mechanics, humongous phase spaces, hydrothermal vents, wet/dry clay cycles, Shannon Uncertainty measures, etc.[21] Everything about subcellular life is controlled, not just constrained.[4] Controls require choices. All known life is programmed with executable commands, cybernetically processed by subcellular nanocomputers and incredibly sophisticated molecular machines. Life is literally computed. Halting computations are formal, not physical.

The most fundamental principle of life is active selection from among real options. Not even pre-biotic, pre-Darwinian, molecular evolution is possible without active selection [64]. Natural selection is passive, secondary, and after-the-fact of program processing. Spontaneous mutations have never been observed to program anything [12, 13, 19]. They only mutate existing programming, almost always for the worse. Evolution knows nothing of programming. Evolution is nothing more than the differential survival and reproduction of the fittest already-programmed, already-cybernetically processed, already-living organisms. Four-dimensional genomics prescribes and produces life, not the environment. Phenotypic fitness is produced only by genomic algorithmic optimization [41, 66]. Natural selection is way down the line of causation. Evolution never does generate life. It only eliminates less than optimal life.

Life is not just complex. Life is conceptually complex. Conceptual complexity originates only from the far side of The Cybernetic Cut [43-45]. It crosses into the near physycodynamic side across the narrow one-way Configurable Switch Bridge [43-45].

The abiogenic challenge for all die-hard physicalistic naturalists

For those many bench scientists who continue to believe that mere constraints are sufficient to explain all of reality, including life origin:

Let us try to make a simple 5-carbon ribose molecule in a simulated prebiotic environment with nothing but constraints—with no bona fide choice controls [4] in selecting the starting conditions of each step.

Even if we succeed, and we won't, see if we have a pure population of right-handed only homochiral riboses.

Then, we need to see if we can make, without any controls at all, *a* ribonucleotide—one ribonucleotide molecule.

Then, we need to try to make a homochiral polynucleotide with no side chains and exclusive 3'5' bonds, with no 2'5' bonds (only one of which would poison life's generation). Over 60% of such bonds in a prebiotic environment are normally 2'5.'

Then, we need to see if we can make, without any controls in a prebiotic environment, ribonucleotides with no unwanted side chains (which would poison life).

Then, we need to see if we can polymerize any more than three mers into an RNA in an aqueous environment, whether reducing or oxidizing, since dehydration synthesis is required for condensation.

Then, we need to ask how much Prescriptive Information (PI) this stochastic ensemble of ribonucleotides would have. What instructions or efficacious executable commands would be represented by the syntax of this stochastic ensemble polymer?

Then, we should ask what good eons of time would do when the half-life of a short 200-mer RNA is only 4 hours. The half-life rapidly decreases with the much longer lengths of lncRNAs needed for life [9].

Then, at that point, we should re-address the purely metaphysical fanatical religion of “the all-sufficiency of mere constraints” in life origin.

Conclusion

This paper is *not contesting* that life and the required synthetic chemistry are natural. We define everything within ontological being to be natural. Life is a major component of reality, and arguably the most important component. Of course, life is natural in that sense. But is life “natural” in the sense of being nothing more than physicydynamic? Absolutely not. What this thesis is contesting is metaphysical naturalism’s *definition* of “natural.” The natural sciences of Mathematical Physics, Synthetic Chemistry, Molecular Biology, Genomics (and epigenetics) have long since falsified naturalism’s traditional *physicalistic* definition of “natural.” Life and intra-cosmic reality in general have been shown by multiple natural sciences in countless ways to be fundamentally formal rather than just physical. Either metaphysical naturalism must change its definition of “natural,” or the worldview is utterly bankrupt. If the definition of “natural” is not adjusted, most of the natural sciences must be excommunicated from “real” science. Natural science must be willing to investigate ordinary earthly Choice Determinism [18] and Mundane Proximate Teleology [1].

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