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The emergence paradox

The evolutionary perspective turned the classic worldview on its head. Since Roman times, the world was understood to be hierarchic in structure, explained by a transcendent mind at the top. From there, the great chain of being cascaded down through angels, humans, frogs, protozoa, and finally stones. Inverting the chain of being switched mind from being the ultimate explanation of things, to being the mystery to be explained. As an early critic of Darwin protested, this theory assumes that “Absolute Ignorance” is the ultimate artificer, even of life and mind (MacKenzie 1868).

However, the notion that the distinctive properties of life and mind were produced by a blind mechanism from inanimate matter runs counter to a fundamental assumption of Western thought. It is expressed in the oft-quoted dictum of the Roman poet-scientist Lucretius: “ex nihilo nihil fit,” from nothing, nothing [can be] produced (1994 [n.d.]). Later, the principle was expressed another way by the medieval philosopher-theologians who borrowed a maxim derived from Roman secular law: “Nemo dat quod non habet,” no-one gives what he does not have. For the scholastic theologians, this maxim articulated their conviction that no creation can have more perfect characteristics than the cause that gave rise to it.

To imagine that modern science and philosophy have now fully abandoned this principle would be mistaken. The first law of thermodynamics states that neither matter nor energy can be created nor destroyed, and the second law tells us that, ultimately, orderliness always gives way to disorder. Physical change always and only involves a rearrangement of material and energetic properties that are already there. No chemical transformation will turn lead into gold, and perpetual motion machines, constantly recycling the same capacity to do work, are impossible. Because the capacity to do work depends on the second law – the spontaneous breakdown of ordered states – in the absence of outside interference, a more ordered consequence cannot arise spontaneously from a less ordered antecedent. This precludes the possibility of future orderliness bringing itself into being – a

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limitation that must be true of every physical process, including your reading and understanding these words.

Yet this familiar mental activity of reading exhibits characteristics that appear, at least on the surface, to violate this stricture. Presumably, your reading this text was initiated by considerations about what information it *might* provide you, though this was only a possibility. Moreover, the content conveyed by these words is neither the ink on the paper, the sounds they could refer to, or the neural patterns they have invoked. These are “intentional” phenomena in both senses of that word: (1) actions organized with respect to achieving certain consequences, and (2) relationships of reference in which something present is linked to something absent and abstract.

The evolutionary world-view assumes that the functional organization of living processes and the intentional and experiential nature of mental processes arose spontaneously, out of blindly mechanistic chemical reactions. And yet it also assumes that living functions are organized with respect to arrangements that are not immediately present, something merely possible, and perhaps not even that. For these end-organized features of life and mind to be genuine, and yet to have arisen from physical phenomena lacking any hint of these most fundamental attributes, the *ex nihilo* principle would have to have been violated.

Efforts to resolve this paradox have often led to simple denials of one or the other horns of this dilemma. One can either argue that functional and intentional properties are ultimately just mischaracterized complex mechanical properties – eliminativism; or that they were always already present even in the simplest mechanical interactions – panpsychism. However, if we wish to accept both assumptions, and thus argue that the resulting paradox is only apparent, we must demonstrate the coherence of a third causal paradigm – emergentism.

Pre-scientific delusions?

The evolutionary paradigm is assumed by many to represent the final victory of strict materialism over some version of purposive or end-directed causality in the world. Even where exquisitely adapted organisms are concerned, all are explained as complicated forms of efficient cause – just the pushes and pulls of blind mechanism. In the second half of the twentieth century, compelling new discoveries in diverse fields of science led many, such as the philosopher Paul Feyerabend, to claim that even our knowledge of our own minds might be deeply flawed. Our conviction that we are agents with ideas, feelings, and purposes is not an empirical fact, derived from simple direct experience, but is instead a theory-based conception, and could be false. As the original substances posited to explain fire and heat – phlogiston and caloric – were later abandoned by science, commonsense mental constructs such as “beliefs” and “desires” might be dispensed with when the causal details of neuroscience became understood. These, he argued, were part of a pre-scientific theory of mind that a mature science of brain function will replace with more fundamental, mechanistic accounts: an enterprise he called “eliminative materialism.”

The claim is that such representational and teleological concepts are entirely unnecessary for a scientific account of mind. These presumed higher-order

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properties are simply the residue of a “folk psychology” that science will eventually replace. Like phlogiston, there is ultimately no such thing as a belief, a desire, or an intention, other than a specific arrangement of synaptic weights in a human brain. Correspondingly, this implicitly suggests that teleological concepts such as “function” and “adaptation” in biology are also mere heuristics that can be replaced by explicit descriptions of the component chemical and physical mechanisms.

Always already there

Eliminative materialism can be contrasted with panpsychism, in its various forms. Rather than arguing that mentalistic and teleological phenomena are merely incompletely analyzed and falsely characterized mechanistic processes, panpsychism argues just the opposite: the phenomena of intentionality, representation, and awareness are real and distinct from mere mechanical relationships, but they are present in attenuated form in every physical event in the universe. If the *ex nihilo* maxim is necessarily true, and these features of life and mind are undeniable, then a trace of these properties must be present in some form in all material processes.

Panpsychism doesn't necessarily imply an idealist metaphysics, however. William James, for example, argued that all physical events have a dual aspect – mental and material – a view he called neutral monism; and Alfred North Whitehead argued that each physical (even quantum) occasion involves a minimal precursor to experience and agency. By assuming that an active and outwardly directed aspect is basic to any causal interaction (a dynamic he termed “prehension”), more complex forms of awareness and agency can be explained as compositional variants of basic causality.

Critics argue that assuming that mind-like attributes are primitive merely postulates them into existence, and sidesteps the hard problem of accounting for their atypical properties. To this explanatory weakness is added the theory's inability to account for why there is no evidence of the unique properties of mind at levels of chemical or nuclear interactions, and why the distinctively teleological and intentional behaviors of mind, when they do occur, do so only in animals with nervous systems.

Emergence: seeking the middle ground

To many, these two extremes are both untenable. Beginning in the nineteenth century, a number of philosophers and scientists sought to unify our theoretical understanding of what we are, and our place in the physical universe, without denying either the validity of the facts and theories of the natural sciences, or our immediate experience of being living beings with beliefs, desires, agency, and so forth. The initial steps were taken by John Stuart Mill (1843). Mill was struck by the fact that two toxic and dangerous substances, chlorine gas and sodium metal, when combined together produce common table salt, an essential nutrient for animals and humans. Mill viewed this radical change in properties to be analogous to some special combinatorial logic that must have produced life from mere chemistry. He

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argues that although “organised bodies are composed of parts, similar to those composing inorganic nature [...] it is certain that no mere summing up of the separate actions of those elements will ever amount to the action of the living body itself” (*ibid.*: Book III, ch. 6, §1).

Mill reaffirms here the ancient claim that “the whole is greater than the sum of the parts.” Influenced by Mill’s arguments, the British essayist George Henry Lewes coined the term “emergence” in his five-volume work *Problems of Life and Mind* (1874–79) to characterize the way novel higher-order properties arise from such special compositional relationships. Efforts to define the metaphysical foundations for the concept were undertaken by three British scholars of the early twentieth century, the philosophers C. D. Broad (1925) and Samuel Alexander (1920), and the comparative psychologist Conwy Lloyd Morgan (1923). Each provided slightly variant accounts of what emergence entailed. Broad’s conception was close to that of Mill in arguing that the properties that emerged via compositionality could exhibit fundamentally discontinuous causal laws from those that characterized the components in isolation, and that distinct “bridging laws” are required to link levels of incommensurate causal organization. Alexander argued that there were indeed distinctive higher-order forms of causality associated with minds, compared with simple physical processes, and that the link between them was in some way fundamentally unpredictable from lower-order processes, though not a case of absolute discontinuity. This has two implications: emergence is a function of unpredictability, not ontological novelty; and emergent properties of mind must in some form permeate the world. Morgan argued that evolution exemplified emergent processes. As organisms reproduce and interact with the world, they spontaneously produce higher-order variant features that may exhibit unprecedented discontinuities of causal agency, such as occurred with the advent of human culture.

The emergence debate

Despite these efforts, the fundamental dilemma posed by the *ex nihilo* maxim would not go away. As early as 1926, a serious criticism of emergentism was leveled by the American philosopher Stephen Pepper. He argued that the British emergentists’ theories can’t avoid two implicit dilemmas: Since emergence must be understood as a physical change or shift, either there is a causal regularity that links the emergent state to the previous state, or else the properties ascribed to the emergent state are nothing more than the totality of the lower-level properties. And if the emergent state is absolutely unpredictable from the prior state, then it is pure chance and no physical principle is required to account for it, otherwise it must be predictable.

Slight variations on the emergence concept were subsequently developed to work around these criticisms. For example, the Nobel laureate psychologist Roger Sperry (see e.g. Sperry 1980) suggested that the emergence of consciousness from neural processes was due to configurational effects that imposed “top-down” causal influences on lower-level neural processes, in much the same way that being combined into a wheel alters the movement capabilities of its constituent parts. And a related variant on the emergentist theme, known as “functionalism,” became popular in

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cognitive theory in the 1970s (see e.g. Putnam 1975). It is often characterized using a computer analogy, arguing that higher-order (such as software) functions might be seen as indifferent to any specific substrate (such as hardware). In this case, their functional (causal) powers would arise from their organization, and not from any specific material substrate properties. In the terminology of this paradigm, functional consequences are “multiply realizable.”

These modern variants of the “more than the sum of its parts” view were dealt a devastating blow by the contemporary philosopher Jaegwon Kim. In a series of articles and monographs in the 1980s and 1990s, Kim (e.g. 1993, 1999) argued that if all causal interactions must ultimately be embodied by interactions of material and energetic constituents that can neither be created nor destroyed, then assigning causal power to various higher-order configurations of these constituents is to do double book-keeping. So-called higher-level properties are all realized by their lower-level constituents and their relationships to one another. There isn’t any extra causal power over and above that which is provided by this physical embodiment (such as the operations of the hardware). Everything else is a gloss or descriptive simplification of what goes on at that level.

Kim’s criticism is almost certainly right, given the assumptions of this part/whole conception of causality, but rather than undermining the concept of emergence, it suggests that certain assumptions must be wrong. A number of contemporary emergence theorists have answered this criticism by arguing either that the notion of compositionality is not as simple as Kim and most eliminativists have assumed, or that the assignment of causal power to the lowest possible level of compositionality is a mistake. Determining simple decomposition into proper parts is, for example, a problem when it comes to the analysis of organisms. The vast majority of molecules constituting an organism are enmeshed in a continual process of reciprocal synthesis, in which each is the product of the interactions among many others in the system. They exist, and their specific properties are created by one another, as a result of this higher-order systemic synergy. With cessation of the life of the organism – that is, catastrophic dissolution of these critical reciprocal interrelationships – the components rapidly degrade as well. So their properties are in part derived from this synergistically organized higher-order dynamic.

Paul Humphreys (e.g. 1997a, 1997b) has argued that the most basic quantum components of the universe suffer a related problem, one that he calls “fusion,” in which component properties are not just recombined at higher levels. Because of the intrinsically probabilistic dynamics of quantum interactions, the lower-level properties effectively disappear or get dissolved as the higher-order properties emerge. Nobel laureate physicist Robert Laughlin similarly argues that higher-order material processes are in effect “protected” from certain details of these lower-order quantum processes, and thus enjoy a level of causal autonomy. Both approaches can be seen as modern augmentations of Mill’s original molecular argument, but taking quantum effects into account. They suggest that what constitutes a part may depend on its involvement in the larger dynamical configuration. But if so, then Kim’s eliminativist causal power assumption is called into question.

Notice that these criticisms of the part/whole assumption make dynamics an essential factor. If the compositionality of physical phenomena is a consequence of

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dynamical relationships, then there are no ultimate entities that possess all the causal power. Mark Bickhard thus responds to Kim's assumptions about physical compositionality by pointing out that "particles participate in organization, but do not themselves have organization." Indeed, he argues, point particles without organization do not exist (and in any case would lead to other absurd consequences). The particles of contemporary quantum physics are the somewhat indeterminate loci of inherently oscillatory quantum fields. Oscillatory phenomena are irreducibly processual, and thus are intrinsically dynamic and organized. So if *process organization* is the irreducible source of the causal properties at the quantum level, then, according to Bickhard, it "cannot be delegitimated as a potential locus of causal power without eliminating causality from the world" (Bickhard 2003).

It follows that, if the organization of a process is the fundamental source of its causal power, then fundamental reorganizations of process at whatever level they occur can be associated with the emergence of novel forms of causal power as well.

Dynamical systems: one leap forward, one step back

In the second half of the twentieth century, questions about emergence began to be asked in a new way, with a focus on dynamics. New terms of art became common: fractals, strange attractors, butterfly effects, order out of chaos, non-linear dynamics, and especially self-organizing processes. These effects were studied in both the non-living world and the living world, in processes as diverse as snow crystal growth and the foraging of ant colonies. New computing tools played a critical role in this research by simulating these processes through the repetition of simple algorithmic operations enormous numbers of times at very high speeds. A pioneer of this field, John Holland, summarizes the thrust of this work as attempting to answer the question "how can the interactions of agents produce an aggregate entity that is more flexible and adaptive than its component agents?" (Holland 1998).

One of the major contributors to the understanding of self-organization was Nobel laureate Ilya Prigogine (see e.g. Prigogine and Stengers 1984), who demonstrated that the spontaneous generation of order from non-order in physical systems can occur in persistently far-from-equilibrium thermodynamic processes. This little-understood thermodynamic process, by which higher-order regularity spontaneously arises from lower-order unorganized interactions, showed clear parallels with processes demonstrated in groups of organisms and computer models, even though the mechanisms of interaction might be radically different. Recognizing the universality of these effects offered a new paradigm within which to conceive of emergent transitions, and made empirical investigation of emergent phenomena a scientifically attractive new area of research. An additional benefit was that it began to offer a new way of understanding concepts of *order* and *disorder*, which are often claimed to exist either merely in the eye of the beholder, imposed by interpreting something in terms of an abstract model of form; or as shaped entirely by extrinsic forcing. The realization that non-linear and far-from-equilibrium systems can regularize spontaneously, and can recover regularity after extrinsic disturbance – as does a whirlpool in a stream – exposed a non-equilibrium loophole in the second law.

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As a result of these discoveries, emergence was no longer considered merely a philosophical issue, and gained scientific credibility. The thrust of this approach was not, however, to explain the purposive, representational, experiential, and normative features of life and mind. The goal was instead to explain complexity. If the iteration of simple, non-linear interactions could produce complex and even chaotic structures and dynamics, then it might be possible to understand the complexities of living organisms and brain functions as products of these sorts of interactions.

In the realm of the cognitive sciences, the shift to non-linear dynamical systems theory was seen by its proponents to be the definitive antithesis of the eliminative account suggested by the dominant computational theory of mind. Whereas computation is based on the assumption that mental processes are direct mechanistic embodiments of “symbolic” inference (such as rule-governed token manipulation where the tokens represent features of the world), dynamical systems researchers argue that there are no representations *per se*, just holistic effects of non-linear dynamical processes. The neuroscientist Walter Freeman, who pioneered one of the most sophisticated dynamical systems models of perception (of odor), makes the implicit representational eliminativism of this approach unambiguous when he says that “The concept of ‘representation’ [...] is unnecessary as a keystone for explaining the brain and behavior” (Skarda and Freeman 1987: 184).

So, despite the emergence framing, and the instructive empirical examples it provides, the concept of emergence developed in dynamical systems approaches includes a decidedly eliminativist attitude toward semiotic and normative phenomena. The implication is still that intentional and teleological concepts can be eliminated once tools for handling complex dynamics are made available.

There are, however, reasons to doubt that non-linear complexity alone accounts for the counter-intuitive nature of these phenomena, because even quite simple systems must be able to exhibit intrinsic, end-directed, and normative properties. These properties characterize living processes, and the first spontaneously arising precursors to life must have been simple.

Emergence, configuration, and constraint

So the dynamical systems approach to emergence can be seen as a critical contribution and a partial retreat. It helps address issues of the origins of synergy and organization, while at the same time avoiding confronting issues of function, intentionality, teleology, and value. Another tacit assumption implicit in all these approaches may be responsible for their failure adequately to address these original challenges: the assumption that the (emergent) whole is greater than the sum of its parts (and their relationships). In contrast, Deacon (2006) argues just the opposite. His contention is that the key to understanding emergent phenomena is to understand organization in terms of what is not included, not realized, not present – a property he describes as “constitutive absence.” In other words, the configuration, form, or order of something is constituted both by what is present and what is absent. Focusing only on what is present is what leads to the apparent paradox of emergence. The emergent attributes we need to explain are all, in one way or another, defined by something absent.

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For example, a dynamical regularity, like a whirlpool, forms as possible trajectories of movement become progressively restricted due to the interaction of the components. The term for this restriction of features is “constraint:” That which reduces the possible degrees of freedom of a process. From the dynamical systems perspective, a limitation on the degrees of freedom to change is merely something less than random or chaotic, and thus conversely determines some degree of regularity and correlation. This conception of organization recognizes that it exists irrespective of any comparison with an extrinsic or ideal model. From this perspective, self-organization is merely an intrinsically arising asymmetric change from more to fewer dynamical tendencies, which results when a system is continually perturbed, or pushed away from thermodynamic equilibrium.

The second law is not a necessary law. It is a ubiquitous tendency, but a tendency can have exceptions. The ubiquity of the second law tendency is due to the fact that in any real system there are a great many opportunities for trajectories of change and dimensions of interaction. Random (unconstrained) interactions will, statistically over time, explore all corners of this “opportunity space.” The net result is a breakdown of constraints, an increase in disorder, and a reduction of regularity. A system that is far from equilibrium is one that is characterized by certain constraints not being dissipated; either the prevention of certain dynamical interactions (e.g. by barriers) or persistently redistributing features in an asymmetric way (e.g. by introducing a temperature gradient). When interactions can proceed unimpeded (e.g. when extrinsic constraints are removed), intrinsic constraints on the distribution of component attributes will tend to break down. But partially impeding this spontaneous process – for example, by allowing it to proceed only in limited ways, such as confining the expansion of hot gases within a cylinder to only one direction – is a constraint on possible dimensions of change that can be tapped to do work, and thus to impose constraints on some other system (such as propelling a vehicle against the drag of friction or the pull of gravity).

As the second law’s spontaneous dissipation of constraints results in a reduction of the capacity to do work, so, too, the creation of new kinds of constraints offers the potential to do new kinds of work. This complements Bickhard’s view that process organization is the ultimate source of causal power. If novel constraints can be intrinsically generated under certain special (e.g. far-from-equilibrium) conditions, then novel forms of causal power can emerge. Emergence results from the spontaneous exploitation of this capacity of constraints to engender further constraints.

From constraint to self-organization to organism

In his insightful 1968 Nobel presentation, Michael Polanyi pointed out that a machine is a mechanism defined by “boundary conditions” imposed by the designer through the choice of materials and the way they are allowed to interact. This is as true of a computer as of an internal combustion engine. So its function is defined not so much by the dynamical laws that it realizes, but by the possibilities of dynamics that are not expressed – its constraints. Thus a machine breaks down when these constraints are violated in some significant way. The loss of function is

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due to an increase in the degrees of freedom. Polanyi made a similar argument about living organisms. There are no new laws of chemistry involved in life, but rather highly specific and complex constraints on the allowed chemistry that constitutes an organism. Thus the loss of life results from a significant increase in the degrees of freedom of component processes. This insight still overlooks a critical difference between organisms and machines, however: Organisms generate their own critical constraints, intrinsically.

The importance of this extrinsic/intrinsic distinction was made explicit almost two centuries earlier by the philosopher Immanuel Kant. He distinguishes organism from machines with respect to two attributes: “An organized being is, therefore, not a mere machine. For a machine has solely motive power, whereas an organized being possesses inherent formative power, and such, moreover, as it can impart to material devoid of it – material which it organizes. This, therefore, is a self-propagating formative power, which cannot be explained by the capacity of movement alone, that is to say, by mechanism. The definition of an organic body is that it is a body, every part of which is there for the sake of the other (reciprocally as end, and at the same time, means)” (Kant 1952 [1790]). The parts or elements of an organism are constrained to interact in such a way that they produce one another, reciprocally. In this way, unlike a mere machine, the form of the interactions generates the components that interact, and the form of the components constrains the interactions they engage in. A vast many critical constraints are generated intrinsically by virtue of this reciprocity.

The “formative power” that Kant refers to is not, then, merely constraint on motion or change, but constraint on the production of constraints. This is where the loophole in the second law becomes important – where native constraints of molecular form and patterns of energy flow translate into constraints of dynamic form such that more orderly processes derive from less orderly ones – where self-organizing processes play the critical role. But, while self-organizing dynamics do not in themselves provide an account of the intentional and teleological features of life and mind, they may provide an essential bridge from simple thermodynamics to this realm of consequence-organized processes. The tendency of far-from-equilibrium processes to develop intrinsic regularities (constraints) in response to persistent perturbation away from equilibrium is the key to the “formative power” invoked in Kant’s characterization.

Most self-organizing processes in the non-living world are fragile and transient. They are entirely dependent on a steady flow of energy, and sometimes of matter. They quickly dissipate if these boundary conditions change in any significant way. Self-organizing systems thus succumb easily to the dissipative tendencies of the second law unless they are supported and held in place within a larger, self-maintaining, non-equilibrium system. What allows an organism to maintain its component self-organizing subsystems in existence, and to use them as vital subsystems of its own general dynamic, is that its various self-organizing processes are arranged in precise reciprocity with respect to one another, so that they are (as Kant surmised) alternately and collectively both product and producer. Their synergy is in this way maintained by this very reciprocity. It is a higher-order self-organizing dynamic composed of lower-order self-organizing chemical processes. Moreover, the capacity to synthesize all

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essential components and their interrelationships reciprocally also constitutes the capacity to *reproduce* this whole individuated dynamics using entirely new components. With this capacity, the possibility of evolution is born.

Adaptation, representation, and normativity

This convoluted means by which intrinsic constraint-generation processes come to support their own propagation is what separates intentionality from mere dynamics. Correspondence is a necessary condition for both adaptation and intentionality, but not a sufficient one. There are innumerable correspondences in the world that have no functional value and are not representations. The preservation and reproduction of constraints by a lineage of organisms is the basis of the memory that enables trial-and-error testing of the correspondence between the requirements of this process and available environmental resources. Without this, natural selection could not increasingly converge toward functional correspondence.

For an organism to survive and reproduce, the raw materials and energy required for its far-from-equilibrium form-generating (constraint-producing) processes must correspond to what its environment allows. Thus the sleek lines of fish are fitted to their need to move through water, and the long tongues of certain insects and birds are fitted to the deep necks of their favorite nectar-producing flowers. This correspondence is like a mirror image or photo negative of these environmental features. But notice that the way correspondence arises in biological evolution is different from the way it arises as a river cuts its way through a variable terrain so that its deviations correspond to this topography. Though both are consequences of a recurrent process, in organisms it is not merely due to mechanical interaction, but is a necessary consequence of its incessant form-generating nature. An organism's forms and behavioral tendencies in this way come to re-present certain configurational features of its environment because this correspondence promotes the perpetuation of these same synergistic processes. In Darwinian terms, this results from the generation of numerous variants of a given process in different individuals, and the elimination of those with variants that don't sufficiently correspond to the environment. In this way, configurational features of the environment relevant to the perpetuation of the whole synergistic complex become reflected in its component dynamics. It is the intrinsic generation of constraints that embody (or re-present) some aspect of the environmental constraints that contribute to the process that makes this re-presenting possible, that is, survival.

Interpretation processes more generally also involve a generate-test-cull logic to bring the generation of semiotic forms into correspondence with one another and with relevant environmental features. Although this comparison does not directly address the subjective features of conscious experience, it is a first step toward demonstrating how any process or artifact can come to be *about* something else, that is not present. We can thus understand the generation of semiotic forms in brains as self-organized attractors in neural circuits, as have some dynamical systems theorists. But now we can additionally understand these as representations of non-present features, by virtue of the way that many must synergistically complement one

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another in order to persist stably and be tested against supportive or non-supportive extrinsic phenomena as their generation becomes action and actions produce consequences. So, by analogy, mental representation can be seen as a higher-order internalization of this general attribute of life, though in terms of a neurological virtual ecology. In this virtual ecology, the forms generated are purely dynamical and fleeting, the adequacy or inadequacy of a given adaptive process leads only to preservation or extinction of a mental habit, and the capacity to assimilate new forms into the formative process builds skills (dynamics) and memories (constraints), not bodies.

With the rise of life, there is one more attribute that is a defining characteristic of intentional and teleological process: normativity. In the parts of the universe that are completely describable in terms of basic physics and chemistry, there is no useful or un-useful, no right or wrong, no good or bad. But because organisms are far-from-equilibrium systems, maintained only by their intrinsically self-organizing composition, they are continually being undermined and, as a result, their persistence is far from guaranteed. If, in the process of generating forms that might correspond with relevant attributes of the world, the correspondence is not sufficiently close, they will likely perish along with the form-generative characteristics that distinguish them. Similarly, for the internalized form-generating processes that constitute the discriminative and behavioral adaptations of a nervous system, those that are insufficiently correspondent to the world with respect to achieving some supportive consequence will either be forgotten, become inhibited, or lead to further adaptive efforts to converge toward sufficient correspondence. This suggests that the self-supportive synergy of life is paralleled by a coherence-promoting tendency among interdependent mental processes. Thus representations, like biological adaptations, can be more or less accurate with respect to some semiotic synergy, and can fail in their correspondence in a way that undermines the higher-order system of form-generating (sign-generating) processes for the sake of which they were produced. In this respect, the normative character of an adaptation or representation is a function of the self-realizing tendency implicit in the self-organizing processes that constitute the “self-propagating formative power” from which both life and mind emerge.

Emergence ex nihilo

Ironically, this approach to emergence agrees with the great medieval theologians who inform us that no-one gives what he does not have, as well as with Lucretius’ “no free lunch rule” – the proscription against getting something from nothing. Although this approach to the emergence problem provides a process by which the novel properties associated with life and mind can have emerged – for example, function, information, representation, normativity, and eventually sentience and consciousness – this explanation requires no addition (or subtraction) to the matter, energy, or fundamental physical laws of nature.

Everything that has emerged is the result of a hierarchy of constraints – specific forms of absence that give rise to further, even more complex forms of absence. What is novel is the new forms of constrained dynamical process, from simple, self-organizing

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processes to the formative synergy of organisms. Each emergent step upwards from thermodynamic processes creates a platform for yet further levels of constrained dynamics, and thus the possibility of novel forms of work. The higher-order reciprocity of self-organizing processes, which provides organisms with the ability to acquire, preserve, and reproduce constraints in correspondence with the world, is the basis of both the informational and normative features of life.

The physical efficacy of these conserved constraints that constitute the content of representations and the functions of adaptation neither cheats the first law nor violates the second law. No new material or energetic properties are added, and no form or direction toward an end is imposed from without. As new forms of constraint emerge from prior constraints, they merely bring new capacities to perform work into being. This is why information and representation are always relationships between something present and something that is *not*, and why function, purpose, and sentience are always dynamical processes organized with respect to something they are *not*.

Amazing new properties have been, and are being, emerged, and there is nothing new being added. There is no *thing* new. No new laws. What is “new” and “more” are new modes of *not being*, new forms of constraint. So indeed, nothing *does* give what it doesn’t have.

This conclusion may seem counter-intuitive because of our conviction that the emergence of life and mind has increased, not decreased, our degrees of freedom (free will). Increasing levels and forms of constraint do not immediately sound like contributors to freedom. In fact, however, they are essential. What we are concerned with is instead *freedom of agency*, not lack of restriction on all causal possibility. And by agency we mean the capacity to change things in ways that, in some respects, run counter to how things would have proceeded spontaneously without this intervention. So what we are concerned with is not some abstract conception of causality, but rather with the capacity to do work, to resist or counter the spontaneous tendencies of things. But as we have seen, this capacity depends on the creation of the appropriate constraints. The evolution of our higher-order capacities to create and propagate ever more complex and indirect forms of constraint, from the self-organizing processes that build our bodies to the production of scientific theories that guide our technologies, has in this way been the progressive emergence of an ability to restrict sequences of causal processes to only very precise options. It’s the ability to produce highly diverse and yet precise constraints – absences – that provides us with our nearly unlimited capacity to intervene in the goings on of the natural world. It is in this strange, convoluted sense that our freedom emerges from nothing.

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