The status of emergence

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The hard problem of emergence is its property of self-transcendence

I first read this classic paper on emergence by the American philosopher Paul Henle over ten years ago. Rereading it, I am surprised by several themes which did not strike me so the first time around. First is Henle's early avowal—this article is after all from the early nineteen forties and was published in the prestigious Journal of Philosophy—that the idea of emergence had become generally accepted as a corollary to the theory of evolution "and there can be little doubt as to its truth." Clearly the idea of emergence was not just a fly-by-night notion that was awaiting for complexity science to give it substance. On the contrary, Henle's paper and others like it around that time touched on many issues concerning emergence that were hotly debated, and fostered important insights which complexity science can learn much from and need not waste time by continually re-inventing the wheel. It appears to me that the divide between the two cultures, science and the humanities, that C. P. Snow so strongly derided is not only still with us, but may have grown wider, much to the detriment of both sides.

One particularly salient topic Henle took up was emergent novelty since he believed the soundness of the concept of emergence depended in large measure on whether the novelty it proclaimed was plausibly construed. This issue of novelty was closely connected to the way Henle thought emergence defied explanation although he, at the same time, somewhat paradoxically insisted that emergent phenomena necessarily retained a causal linkage with the substrate out of which they emerged. This is very much pertinent to current complexity science inspired disputes placing the idea of emergence against reductionist strategies of explanation.

Looking over these themes now, I suggest we view Henle's argument as his unique grappling with the central conceptual crux of the idea of emergence, what I'll call here the "hard" problem of emergence, borrowing the phrase (but altering the meaning a bit as I shall say more about below) from the Australian philosopher David Chalmers's famous characterization of the refractoriness of consciousness to scientific explanation (see, e.g., Chalmers, 1995-1997; see also Rosenberg, 2004, for an intriguing answer to Chalmers's hard problem by incorporating emergence into the fundamental nature of nature). Shifting from Chalmers's views on consciousness to the idea of emergence is not a far reach given two relevant facts. The first is that Chalmers studied for his Ph.D. under Douglas Hofstadter whose magnum opus, Gödel, Escher, Bach (1979) is a very long (742 pages!) speculation aiming to understand consciousness as an emergent phenomena, a proposal that comes to a head in the last several pages when the fertile notions of Gödelian "strange loops" and "tangled hierarchies" are employed in order to account for how consciousness could emerge from the brain. The relevant second fact has to do with a growing trend in consciousness studies that seeks to explain consciousness as emergent in ways apart from Hofstadter's meta-mathematical approach (see Freeman, 2001; and Clayton, 2006).

According to Chalmers, the "easy" problem of consciousness lies in coming up with credible scientific explanations, couched in terms of computational or neural mechanisms, of such phenomena as the ability to react to environmental stimuli, the integration of information by a cognitive system, the focusing of attention, and similar cognitive functions. The easy problem aims to explain cognitive or mental functioning according to constructs having to do with brain dynamics, the latter which I'll generalize as the substrate or component level. The "hard" problem of consciousness, though, concerns a far tougher challenge, viz., how experience itself, i.e., the subjective awareness of immediate "raw feels" or "qualia", can be explained by the same brain substrate. Thus, whereas for any act of perception there may be an information processing explanation, there occurs at the same time the undeniably subjective aspect of perception which does not seem accessible to scientific explanation—at least in the same way.

There are two things making the hard problem hard which can be transferred over to emergence. The first is the radical disjunction in qualities between the kinds of things that are to be linked in an explanation, that is, the qualities observed on the emergent level (not to be taken necessarily as vertical or hierarchical) and the qualities of the substrate components. In the case of emergence per se, however, unless one is considering an emergence based theory of consciousness, the qualities of emergent phenomena do not include qualia or awareness as such but instead include the properties of being: integrated or coordinated as in collective phenomena; dynamical or arising over time and not pre-given; unpredictable or ostensive in the sense of not able to be known before actually showing themselves as in a simulation; non-deducible from the substrate components; and irreducible to this same substrate (see Goldstein, 1999). It is the claimed incommensurability of these two different domains of qualities which renders explanations utilizing the idea of emergence baffling.

The second component of the hard problem which is pertinent to emergence has to do with the very call for an explanation itself, which presumes that these two discrepant kinds of things can indeed be somehow causally linked. If there were no call for
an explanation, then the discrepancy or incommensurability could just stand as a brute fact. By not having to account for subjectivity of first person awareness, it might seem that the hard problem of emergence would prove to be less difficult than the hard problem of consciousness. Nevertheless, the singular qualities of emergent phenomena have shown themselves to be similarly obdurate to explanation. However, it should be noted that emergence, by covering so many different fields of study and therefore types of complex systems, does provide for a much greater variety of causal mechanisms and the other accouterments of explanation.

The main reasons why I interpret Henle as grappling with the hard problem of emergence involve both his discussion of the special novelty of emergent phenomena as well as his severing of causality from explanation. Henle wanted to retain causation in how emergents emerge from their substrate since, otherwise, their novelty could be understood as the sort of thing one sees in those types of random processes which lack a causal connectivity between antecedent and consequent states of affairs. But the genuine novelty of emergent phenomena implied for Henle that this necessary causal connection was not explainable as such, e.g., in terms of Aristotle’s famous four types of causes. At this juncture, Henle proffered such cryptic utterances as: “... emergence occurs where the formal cause of the efficient cause is inadequate to explain the formal cause of the effect” (p. 488). We’ll see that Henle was not content to rely on such enigmatic sayings, but tried to explicate how it could be both that causality was at work with emergence yet emergents at the same time surpassed explanation, at least how explanation was typically understood.

In order to indicate what is specifically problematic in the hard problem of emergence, I am suggesting that we phrase this conundrum in terms of the “self-transcending” property of emergence (Goldstein, 2002; 2004): emergents emerge out of a substrate, i.e., are caused somehow by this substrate, while simultaneously are novel with respect to or, in other words, transcend their substrate roots. The “self-” of “self-transcending” is unlike the “self-” of “self-organization” since the phrase is not trying to say anything about how emergence supposedly happens by itself or out of its own “self” resources. Instead, the “self-” of “self-transcending” is the substrate, and the explanatory models that are sufficient for this substrate, which are transcended during emergence by operations which bring forth novel emergent phenomena. It should be noted that “self-transcending” is not meant as some highfalutin phrase but simply as a concise description of this dual nature of emergence: continuous with the substrate in the sense of being causally related to it, but at the same time discontinuous with it in the sense of being novel with respect to the substrate.

The Nature of Emergent Novelty: The Unexplainable and the Non-deducible

Henle distinguished emergent novelty from that of a subjective experience such as seeing a certain color for the first time, taking an opposite direction than contemporary advocates of understanding consciousness as emergent. He wanted to make it clear that emergent novelty, by not being constituted by subjective experiences, did not possess just epistemological status. Yet, as we’ll see later on, Henle left off his paper suggesting that emergents were more epistemological than ontological. Although attending to the role of the observer, proto-emergentists such as the English philosophers C. D. Broad, Samuel Alexander, and Conwy Lloyd Morgan considered emergents as mostly of monumental, that is, ontological status, e.g., life as emerging out of the inert or new species taking place via evolutionary saltations (Goldstein, 1999).

Henle also averred that the novelty of emergent phenomena was not adequately captured by the coming into being of a new copy of something already existing, for instance, the very next Intel Quad processor, say, the 5432th chip. Henle here applied an Aristotelian interpretation of form imposed on matter as indicating what the emergentists had in mind: emergent novelty was of a novel form and not simply a copy of the previous 5431 microprocessors. Samuel Alexander (1939, 1966; Brettschneider, 1964; see also Gillette, 2008), one of the key proto-emergentist philosophers, had in fact appealed to Aristotelian form to characterize the new qualities demonstrating emergent novelty, borrowing this from Morgan’s earlier usage (Passmore, 1957).

Furthermore, for Alexander, a novel emergent form was more than just the organization of the substrate components, organization as such has become a staple of how emergence has been conceived by complexity inspired philosophers as well as scientists (see Bechtel & Richardson, 1993). For example, Alexander’s form included the idea of self-regulation (presaging later concepts of homeostasis which is certainly not presumed in organization per se. Indeed, for Alexander, it was novel forms which could attain the “requisite complexity of integration is attained” [sic] (Alexander, 1939). The positing of emergent novelty as a new form can be appreciated by considering how the notion of form had been appropriated by Aristotle from earlier ancient Greek philosophers. For instance, in the cosmogony of Philolaus which was influential on both Plato and Aristotle, the very beginning of the world (what could be a grander novelty than that?) marked the imposition of intelligible form on unintelligible matter (Barnes, 1979). And, Timaeus, the philosopher who synthesized many of the pre-Socratic philosophical positions in the famous dialogue of Plato by that name, offered a cosmogony whereby originary forms established the natural kinds of things which distinguish one kind from another (Zuckert, 2009). Emergent novelty as novel forms consequently is to be understood more along the lines of a difference in kind, not just degree, but kinds as understood in the primordial Aristotelian sense which Alexander had appropriated and which it seems that Henle had done as well.

For Henle, the emergent novelty of emergent phenomena was also understood as a function of their not being accessible to explanation which, as we noted above, is problematic since Henle maintained at the same time a necessary causal linkage between an emergent and its substrate. Non-deducibility, accordingly, must amount to something different than excluding
causal connectives. Indeed, the establishing of emergent novelty on the basis of non-deducibility has served as a dominant theme since proto-emergentist days, and a very brief review of some trends in this direction can be helpful in developing a sense of what Henle was aiming at:

1. The transordinal nature of the laws operative on the emergent domain, that such laws transcend the laws operative in the domain of the substrate components (see Broad, 1925; Stephan, 1999; O’Connor & Hong Yu Wong, 2002). The philosopher James Van Cleve (1990) understood transordinal laws with the following analogy: a body A in relation to Body B and C: if B was the only present object A would be attracted to it, if C, then A would be attracted to C, but if B and C were both together A would be attracted to point between B and C; but this last fact could not be deduced from A and B alone or A and C alone. Here we could also place Ryan’s (2007) topological classification of a Mobius strip which, as a one-sided, one-edged, and non-orientable surface with boundary, possesses a topological property not present in the substrate which in this case are the subsets of disjoint simplicial triangles;

2. In mathematical logical terms as:
   1. “Observational” emergence to which the Danish mathematical physicist Nils Baas and the Danish philosopher Claus Emmeche (Baas & Emmeche, 1997) classify ‘Gödel sentences’ in a formal system (reminiscent of Hofstadter’s meta-mathematical approach) as well as the property of membership of the Mandelbrot set and most Julia sets, the latter similar to the philosopher David Newman’s (1996) description of being in the basin of a strange attractor in a dynamical system as an instance of emergence;
   2. The Existence Theorem for Emergent Phenomena proposed by Ian Jack Cohen and Ian Stewart (1994) which uses a Gödel/Turing-like argument to informally demonstrate that in any sufficiently rule based system there exist simple true statements (emergents) whose deduction from the rules is necessarily enormously long and complicated (i.e., deductions via substrate);
   3. In the abstract algebraic terms of category theory, the non-existence of an isomorphism between specific diagrams or specific categories given some functor connecting them (i.e., particular mapping functions) (Ehresmann & Vanbremeersch, 2007; and Guitart, 2009; see also Baas and Emmeche’s “hyper-structure” model of emergence which borrows from the work of Ehresmann and Vanbremeersch);
   4. In terms of the laws of physics, the Constructionist Hypothesis put forward by the Nobel Laureate physicist Philip Anderson (1972) which helped get the whole neoemergentist program started: although it might be possible to reduce nature to certain simple, fundamental laws, this did not entail a similar ability for re-construc-ting the universe from these simple laws since each new level of complexity requires the consolidation of entirely new properties and laws not appearing at the lower levels.

Again, what seems to be the problematic central issue regarding the claim of the non-deducibility of phenomena is what I term above as the “self-transcending” nature of emergence, that emergents are causally related to but non-deductive (explainable) from their substrate. This was even more evident in Henle’s characterization of emergent novelty as logical novelty, which was closely associated to the unpredictability of emergents (in complexity theory unpredictability is more likely expressed as the ostensive property of not being able to be foreseen except through the actually occurring run of a simulation—see Darley, 1995). The logical novelty of emergent novelty implied unpredictability but in explicating what he meant, Henle offered a strange digression that I believe is fundamentally unsound. Specifically, Henle contended that it was theoretically possible that Newton could have anticipated Einstein by predicting the Michelson-Morley experiments on the constancy of the speed of light. The only thing amiss would be that Newton’s theory would not have been the “simplest” explanation which Henle demanded for a credible explanation. Yet, in my estimation, while it is indeed true that Newton’s theory can be considered a limiting case of Einstein’s theory of special relativity this is only for non-relativistic velocities, and it simply doesn’t make much sense to hold Newton capable of this feat, particularly so in the context of what Henle offered as an early statement of what later were called “bridge laws” to facilitate explanation. So a short digression on bridge laws is in order.

In the usual model of reductionist explanations, the context is taken to be an intertheoretic reduction whereby a reducing theory reduces a reduced theory. However, the domains of both the reducing and the reduced theory may be so disparate that there needs to be some way to bridge over them; hence the need for bridge laws, the basic idea of which was formulated by the eminent philosopher of science Ernst Nagel (cited in Batterman, 2007) twenty years after Henle’s article. By uniting the two domains, bridge laws are supposed to help make predictions by supplementing the explanation with boundary conditions, limiting assumptions, approximations, and other addenda (Sklar, 1967). As the noted philosopher of science Lawrence Sklar has pointed out, if in order to move forward in a reductive fashion, a scientific explanation must have recourse to bridge laws at all implies there must be a great deal of preliminary groundwork to effectuate the needed fit between levels. This preparatory spadework has been described by the philosopher Jaegwon Kim (1993), otherwise known for his analysis of the emergence-like notion of supervenience, as a strong enough “connectivity” or “co-extensivity” between the levels. Sklar points out how the
Bridge laws, then, can be seen as a way to buttress a reducing theory and thus render the system under examination more predictable. Henle though wanted to keep unpredictability by pointing out how it was always relative to the knowledge gained about a system, that is, to available evidence. Thus, to strengthen his view on emergent novelty he posited logical novelty as that which would transcend any available knowledge or scheme of explanation or specific system of logic, even any supplementation by way of bridge laws. Indeed, bridge laws don’t come without a whole slew of additional problems as the philosopher of science Robert Batterman (2007) points to: Which bridge laws are suitable, e.g., are they “established by linguistic investigation alone? Are they factual discoveries? If the latter, what sort of necessity do they involve? ...”

Henle’s logical novelty as the criterion for emergent novelty can be interpreted as another instance in emergentist thought (see other examples in the classical papers on emergence and their introductory essays in Richardson & Goldstein, 2008) where a bar is set as to the kind of novelty demanded by emergent phenomena. If the novelty can surpass this hurdle, then we have a case of emergence. For Henle the bar was quite high: “Imagine the simplest possible system of the world, or theory comprehensive enough to link together all of the characteristics exemplified by nature to date. An emergent then is a characteristic whose appearance calls for a revision of this all-embracing system...an emergent halts reason in its attempt to map the cosmos” (p. 491). Note that Henle suggested that this “halting” of reason may not be permanent. This appears to imply that Henle had accepted that the view of emergence being a provisional matter until a “re-drafting” occurred coincident to an advance in knowledge (see Goldstein, 2000).

However, because of this dependency of emergent novelty on some particular conceptual system, Henle was led to conclude that emergence only rises to the level of epistemological and not metaphysical (or ontological) significance. The reason is that any conceptual system works on the basis of hypotheses and the criterion for selecting one hypothesis as more true than another rests on its “logical simplicity” which comes down to an epistemological based judgment: “Emergence can be given a metaphysical status only if a similar status can be given to logical simplicity. Indications are that this is not the case and that emergence has to do with our knowledge only...” (p. 493).

**Logical Novelty and Self-Transcending Constructions**

Henle’s final conclusion about emergence’s epistemological status seems to go against the grain of most of his thinking in this paper, which tended more to establishing the credibility of emergence as having to do with the actual “furniture of the world”. However, if we take his idea of logical novelty as a hurdle over which emergent novelty had to pass, there can be a way around the seeming self-contradictory nature of Henle’s argument: by considering this hurdle as hinging on what we are able to know as of yet so that, if emergent novelty in a particular case passes over the epistemological hurdle of emergent novelty, then it can be taken as ontological although this latter status may be in a condition of ongoing transition back into epistemology *per se*. In other words, the provisionality of granting ontological significance to any particular manifestation of emergence becomes just another way that emergence involves an ongoing transcendence of whatever models have been devised up to the point of the emergents showing themselves. Then, if we interpret emergent novelty as bringing about the appearance of new forms or natural kinds, then these new forms or kinds exhibit the ontological import of emergence. Moreover, a similar fate would befall certain already existing natural kinds, e.g., new species during the course of evolution. An example is Lyn Margulis’s idea of *symbiogenesis* (see Reid, 2009) in which a kind of biological emergence has been used to reinterpret what has already occurred in primordial times in the origin of eukaryotic cells by way of ingesting protokaryotic and cells.

Moreover, if we take Anderson’s Constructionist Hypothesis and link it up to the complexifying operations described in terms of category theory on the part of Ehresmann and Vanbremeersch as well as Baas and Emmeche, then we can understand emergence as a set of constructional operations on already existing natural kind building blocks, more specifically, a self-transcending kind of construction (Goldstein, 2002, 2004) which, at the same time, includes the role of the observer and subjective experience. Understanding emergence in terms of self-transcendence has the benefit of transcending the way that the hard problem of emergence has become a major stumbling block getting in the way of a wider appreciation of the concept of emergence. On the one hand, this hard problem has led those of a more reductionist bent to simply reject the whole notion of emergence in order to dispose of the troublesome aspect of its self-transcending nature. On the other hand, this same hard problem of emergence has led others to see in emergence the work of a supra-natural, vitalist, or holist impetus precisely because the emergent phenomena are not amenable to explanation as in Henle’s sense. The hard thing about the hard problem of emergence is how to somehow keep both poles, the continuous and discontinuous, in conceptual tension. This is the road emergentists need to walk, a fact even the early emergentists recognized when they saw what they were doing as steering between, on one side, vitalism, and, on the other side, mechanism (their word for reductionism). The perspective of self-transcending constructions doesn’t lead to easy answers whether of the reductionist or holistic variety but it does try to justice to the claims of emergentist thinkers for the past century.

From the perspective of self-transcending constructions, Henle’s and the other descriptions of the non-deducibility of emergents can be read as sources of insight into what these self-transcending constructions must consist in so that they have the potency of bringing about phenomena with the quality of emergent novelty. So far, much of the uneasiness with the idea of emergence...
can be traced to a failure of imagination in conceiving the possibility of naturalistic processes with the power of self-transcending constructions in generating emergent phenomena.

**Note**


**References**


