# Polanyi and Juarrero: From Tacit Knowing to Ontic Emergence

**Kyle Takaki**

*Key words*: boundaries, endogenous, importation, inextricably/irretrievably, inquiry, semiotics

## ABSTRACT

*There are potentialities to be harnessed in a fusion between elements of Alicia Juarrero's views and a Polanyian framework. In this brief response piece, I address the latent Polanyian dimensions of Juarrero's ontic approach to dynamical systems*.

"If all men were exterminated, this would not affect the laws of inanimate nature." So begins Michael Polanyi's essay, "Life's Irreducible Structure" (LIS), appearing to convey a sort of common-sense realism. However Polanyi's realism is not flatly commonsensical, for all inquiry irretrievably bears the marks of the embodied sorts of creatures we are, where our personal commitments make contact with (or enact) reality via universal intent. It should be kept in mind that Polanyi is neither an idealist (Hegelian or otherwise), a mere empiricist, nor even a transcendental idealist. Polanyi's philosophy is post-Kantian (and more generally post-critical), where his pragmatic realism is both commonsensical in its recognition of orders of being "greater than ourselves," as it were, and radical in its manner of grounding ontologies in tacit knowing's epistemic workings. Furthermore, this is a realism not adequately characterized as "mutualistic" if such a conception implicitly divides knower from known, placing what is to be known in dialectical relation to knower (forming a reticulatory arc between the two). Such a divide is something Polanyi struggled with in attempting to form a philosophical framework where knower and known are inextricably bound up in a *field* of (semiotic) inquiry rather than related via poles of implicit division.

Exactly how is Polanyi post-Kantian (and post-critical more generally)? A simple answer lies in inquiry's consequential dimension: given the sorts of creatures we are, our inquiries are bounded by these constraints that are simultaneously enabling constraints allowing for exploration and discovery. So one initial sense in which Polanyi is post-Kantian has to do with the ways in which he examines the nature and contours of inquiry, in its indefinite manifestations. Kant delimits reason's capacities; Polanyi, as it were, starts there and then fleshes out the various creative capabilities of inquiry (which, as discussed below, is a broader notion than "reason"). But there is a deeper element to Polanyi's post-Kantian investigations that actually subtly undermines the Kantian framework itself. The open-ended nature of inquiry, in tandem with commitments, made with universal intent, actually reflect back upon the nature of cognition itself and its Kantian assumptions: the self-reflexive arc of inquiry also applies to the nature of inquiries made, and thereby changes just what "reason" and the like are. Thus a deeper sense in which Polanyi is post-Kantian has to do with this opening up of the very limits of the Kantian project: inquiry is affective, imaginative, fraught with risk that comes from commitments, bound up with communities of inquirers, and makes contact with realities. Knower and known are crisscrossed (and not merely dialectically related), as are the rather static Kantian notions like theoretical and practical reason, aesthetic and pragmatic judgment, and the like. Noumena, which are transcendental conditions of knowing for Kant, would be for Polanyi inextricably ensnared with the consequential fruits of indefinite inquiry—or in Peircean fashion, of indefinite semiosis.[1]

This general picture of Polanyi's philosophical orientation I think has crucial bearing on the important work that Alicia Juarrero is doing in relating dynamical systems and emergence to a new metaphysics.

There are potentialities to be harnessed in a fusion between elements of Juarrero's views and a Polanyian framework. In this brief response piece, I hope to convey some of the promise that this synthesis may hold.

## Boundaries and Implicit Importations

Polanyi's ideas on types of boundary conditions and how they relate to dual control, emergence, and hierarchies have received discussion elsewhere (e.g., see *TAD* 39:2 and 40:1). The new issue that Juarrero raises concerns the status of boundaries as they relate to second-order constraints. Specifically, she discusses the notion of endogenously generated, emergent constraints, most especially exhibited in chemical processes like the Belousov-Zhabotinsky (BZ) reaction. As Juarrero insightfully observes, it is probably not coincidental that chemist-philosophers like Polanyi, Ilya Prigogine, and Charles Sanders Peirce took special interest in emergence. What Juarrero is arguing for—beyond mere resonance with Polanyi's active boundary conditions that exhibit controlling principles—is the endogenous, autonomous (in the sense of being self-generating and sustaining) character of second-order constraints, which she thinks can ultimately divorce itself from Polanyi's notion of active boundary conditions. In other words, *even if* a Polanyian account were to be given of the BZ reaction using the language of dual control, emergence, boundary conditions, tacit intimations of hidden realities made manifest via connoisseurship and universal intent, etc., such an account would miss the significant *ontic* dimension of what the BZ reaction and other similar phenomena reveal, namely, the endogenous generation of second-order constraints whose emergent and actual properties act on the world in novel ways. Given the emergence of such stable/resilient phenomena, which have claim to a significant degree of autonomy (even as they depend-on-and-enable their lower-level processes), such phenomena can, as it were, jettison the purportedly epistemic categories of dual control (active boundary conditions, etc.) by which we, in coarse-grained fashion, understand such phenomena. Ontics trump epistemics, in a nutshell.

How might a Polanyian respond? I think extended reflection on some of Polanyi's writings on physico-chemical laws and their intersections with biology can address Juarrero's concerns, as I hope to reveal. Let's first start with some insights on how biology differs from chemistry and physics. In LIS Polanyi writes:

> In the light of the current theory of evolution, the codelike structure of DNA must be assumed to have come about by a sequence of chance variations established by natural selection. But this evolutionary aspect is irrelevant here; whatever may be the origin of a DNA configuration, it can function as a code only if its order is not due to the forces of potential energy. It must be as physically indeterminate as the sequence of words is on a printed page (1308).

What Polanyi is drawing attention to here, I suggest, is that however order arose, resulting in fixed accidents like DNA (or any sort of adaptive complexity at any phenotypic level), the point is that the laws of chemistry and physics underdetermine the code aspect of DNA. For such a code is not merely an informational configuration; it also functions algorithmically, processing particular kinds of information in structured ways.[2] To borrow a distinction from the eminent biologist and philosopher of biology Ernst Mayr, Polanyi can be interpreted as distinguishing between "teleomatic" and "teleonomic" processes. Teleomatic processes (purposive, mechanical types of behavior) are studied throughout the sciences, most especially in physics where, say, inanimate objects are modeled when tracking projectile motion, whose end-state would be the projectile's predicted target. Teleonomic processes or behaviors, by contrast, owe their "*goal-directedness to the operation of a program*."[3] It is a mistake to conflate these two sorts of phenomena, for example by collapsing a physico-chemical description of DNA with the coding/programming functions it serves, which occur at a higher-level of understanding. On this very point Polanyi has been critiqued, in hindsight, as being wrong about life's irreducible structure on the grounds

that the revolution in biochemistry (from roughly the 1960s on) actually bridged the gap between chemistry and biology, showing that life processes are essentially physico-chemical ones (e.g., *Chemical and Engineering News* 89:50, 3). Actually, a careful examination of this history by Horace Freeland Judson, in his classic work *The Eighth Day of Creation* (Touchstone 1980), reveals the importation of computational ideas into biochemical approaches to understanding life. Polanyi's prescient warning still holds generally: the importation of forms of dual control, determined by the connoisseurship of scientists, enabled a biochemical understanding of DNA and the like that expanded upon older conceptions of law-like behavior (mostly teleo*matic*) in chemistry and physics. In other words, teleo*nomic* resources were smuggled in, then thought to support a view of reducing biology (or more narrowly biochemistry) to physico-chemical processes, when in fact history supports quite a different view of biology's relation to physics and chemistry (a point that Mayr also hammers home in arguing how biology is an importantly different sort of science that cannot be reduced to physics or chemistry).[4]

In brief, this importation—smuggled in, ontically projected, and then ossified in certain (inaccurate) renditions of biochemical history—is the very sort of "non-personalistic" maneuver that Polanyi was pointing out in LIS (and his closely related "Life Transcending Physics and Chemistry" [LTPC]). Here's the point: might a similar importation occur in Juarrero's philosophical accounting of Prigogine's new and significant type of emergence? She calls Polanyi's science—still partially beholden, she thinks, to a positivist legacy—"science 1.0," which stands in contrast to "science 2.0" instigated by Prigogine and modern investigations into complexity and emergence. I suggest that Polanyi's science is more akin to science "1.5," as it were, and is actually closer to Prigogine than it may appear.[5] To draw out this claim, and how an implicit "importation" has occurred, let's continue with the quote from LIS above:

> As the arrangement of a printed page is extraneous to the chemistry of the printed page, so is the base sequence in a DNA molecule extraneous to the chemical forces at work in the DNA molecule. It is this physical indeterminacy of the sequence that produces the improbability of occurrence of any particular sequence and thereby enables it to have a meaning—a meaning that has a mathematically determinate information content equal to the numerical improbability of the arrangement (1308).

In alternate terminology, DNA's coding aspect exhibits higher-order properties, whose dual structure allows for it to act as a boundary condition, thereby granting meaning (the relevant enabled reduced space of informational configurations) made possible by these very constraints. Bound up with this novel ontic projection—DNA's coding aspect—are the epistemic ways by which scientists understand such phenomena. Before ontics can trump epistemics, the right sorts of epistemics need to be settled upon by a community of inquirers. And such ontics, if carefully reflected upon, still bear the marks of our epistemic projections. I suspect that a similar epistemic importation occurs in Juarrero's accounting of the emergence of second-order constraints, whose epistemic traces, I suggest, can never be wholly erased. If so, this suggests a bridge between Polanyi and Juarrero's new view of dynamical systems.

## Boundaries: Tacitly Projected *and* Endogenously Generated

There is a parallel between endogenous emergence in the BZ reaction and the epistemic importations concerning the algorithmic aspect of DNA. The Polanyian point here is that what is endogenous is a latent function of what inquirers take interest in when making contact with reality. Even though in the BZ reaction there are no external boundary conditions (BCs)—either human-induced, or physically imposed like in Bénard convection—the identification of self-cause and the emergence of second-order constraints are still *phenomena of interest* whose ontic import is inextricably bound up with what we are trying to understand.[6] In this sense, such new forms of endogenous emergence remain with the (semiotic) field of inquiry, making it problematic to separate knower from known.

It might be objected that this doesn't really address the endogenous, self-generating aspect of the emergence of second-order constraints in the BZ reaction. For even acknowledging the above, we can, as it were, let go of our categories of understanding in coming to see what reality does of its own accord. Furthermore, ossifying to some extent our categories of understanding seems warranted in stable/resilient cases like this, so even if epistemics allow for grasping such phenomena, it is really the world we are after and not merely the ways in which we come to understand such matters. This good objection actually strengthens the Polanyian framework in my estimation, as when pushed further it reveals the inextricable ways in which tacit knowing is bound up with projected ontics. Before expanding on this point, a brief rhetorical detour is in order.

Are boundaries really real? It surely seems that way; think of lakes, mountain ranges, islands, planets, the "outer skins" of organisms, and so forth. But remove our categories of understanding. Now does nature really have these things? More generally, does it really have colors (secondary properties, perhaps); wavelengths (mathematical abstractions); initial conditions (tools of grasping, taming, and understanding phenomena—all embodied notions); top-down processes (which presuppose embodied orientation); boundaries (further reflection indicates how fuzzy these often are, making problematic just what they are and where they occur); and so on?[7] Metaphysically speaking, perhaps all we can say is that *natura naturans*, and the rest is the human story of striving to understand—in irretrievably embodied ways—our relations to nature (or more accurately, our semiotic "en-naturing").

In hitting upon stabilities/resiliencies like the BZ reaction, we often forget just how slathered such phenomena are with our projected embodiments. What emerges? *Colored, visual patterns* of *interest*. How do we *understand* such phenomena? By *symbolic* representations of the feedback cycle and how specific types of catalysts issue in a self-sustaining dynamics, through which endogeneous emergence (the *inner* process of coming into *view*) occurs. How does the entraining occur which issues in "phase-transition-like" emergence (note the latent element of *connoisseurship* required here)? Fractal accounts (another symbolic device) are sometimes deployed to *explain* the transition. From a broader perspective, inquires about what makes possible such emergence have been carried out using cellular automata *simulations*, which indicate that there is a range of enabling initial conditions and BCs by which the BZ reaction can take place (see note 6). Emergence occurs apparently at the edge of chaos and order (a *metaphoric* image). These notions tend to be so completely immersed in embodied projections and (accredited) judgments taken for granted that we can, perhaps fortunately, *focus* on what they project, and thereby discount the tacit elements making possible such wondrous understandings.

But alas, tacit knowing remains throughout. Even the all-too-human tendency to be "natural dualists" in separating off what is known from how it is known carries a hidden assumption: the already present, enabling powers of tacit connoisseurship committed to make contact with hidden realities. Polanyi not only recognized this and built a philosophical framework respecting such a fundamental insight, he also incorporated its dimensions into all aspects of inquiry.[8]

## Semiotics, Science 1.5, and Beyond

Umberto Eco, in a piece on Charles Sanders Peirce and unlimited semiosis, writes that when "Peirce provides his famous definition of lithium as a packet of instructions aimed at permitting not only the identification but also the production of a specimen of lithium, he remarked: 'The peculiarity of this definition is that it tells you what the word *lithium* denotes by prescribing what you are to *do* in order to gain a perceptive acquaintance with the object of the word' (*CP* 2.330)."[9] From a Peircean (and Polanyian) point of view, there is really no hard divide between knower and known, as how we come to know what we know is irretrievably mediated by our semiotic activities: our use of symbols (e.g., schematic symbols

representing the BZ reaction), reasoning (arguments for how to understand the chemical autocatalytic cycle), citing of evidence (employing tools that are probes of our extended embodied cognition), and so forth. It is a general Polanyian insight that our projected, focal preoccupations with ontic matters still remain subsidiarily ensnared in (and enabled by) semiotic "thickets."[10]

Such thickets ensnare as well the origins of emergent phenomena like in the BZ reaction. While it may appear that we can peel off Polanyi's account of boundary conditions[11] and inquire about the independent status of the origins of emergent phenomena—a latent Cartesian seduction—it still remains that such inquires are semiotically grounded, mediated, and projected, and are either instances of tacit knowing or rooted in it. For what we choose to focus on (e.g., emergent phenomena), what we choose to investigate (the origins of such phenomena), what accounting we give of such matters (symbolically rendered), and what we deem to be irrelevant or choose to selectively ignore, cannot remove this element of personal knowing.

As all this bears on Polanyi's science 1.5, Polanyi writes that the "laws of chemistry have similar limitations. …Generally, to have a definite chemical process, we must frame it by boundary conditions not fixed by the laws of chemistry" (LTPC, 61). But chemistry has progressed, and some of these very "definite chemical process[es]" have in turn evolved from "fixed conditions" to "control principles" (LTPC, 61) in the form of endogenous emergence—the origins of which Polanyi was not aware of, yet nevertheless his account of tacit knowing applies through and through. That is, understanding such endogenous emergence—even in this expanded "2.0" realm of chemical "laws"—is thoroughly ensconced in semiosis, where there is already present an implicit use of dual control in grasping such originative dynamics (see again note 6 below).

Polanyi's science (especially in LIS and LTPC) is not science 2.0, yet it is closer to science 2.0 than it is to science 1.0. Most importantly, his framework for personal knowing, coupled with indefinite semiotic inquiry, the ever-expanding continuum of tacit knowing, and his corresponding heterarchical hierarchy continue to engender and enact science 2.0 and beyond. This is perhaps the crucial upshot of taking Polanyi seriously regarding his bearing on complex-systems thinking and Juarrero's insights: ongoing inquiry—tacitly grounded, accredited, and projected—can not only be accommodated within Polanyi's general epistemic-metaphysical framework; even stronger, such semiotic inquiry and the framework itself, by their very open-ended nature seeking to make contact with reality, are "complex adapting systems" that accommodate Juarrero's insights as well as science 2.0 and future versions beyond.

## ENDNOTES

[1]See also J.E. Tiles 1988, "Iconic Thought and the Scientific Imagination," *Transactions of the Charles S. Peirce Society* 24:2, pp. 175-177.

[2]Compare Robert Causey's 1969 article, "Polanyi on Structure and Reduction" (*Synthese* 20:2, 230-237), which I think misses the point of Polanyi's argument. Much of what I say in the essay indirectly addresses Causey's critiques of Polanyi.

[3]Ernst Mayr, *Towards a New Philosophy of Biology* (Cambridge: Harvard University Press, 1988), p. 45.

[4]It should be noted that we need not bring on board any "Spencerian baggage" in this modern (revisionist?) defense of Polanyi; for it is consistent with his project to emphasize the *consequential* aspects of inquiry and the *ever-expanding* continuum of tacit knowing's projected, heterarchical hierarchy—neither of which should be interpreted as instances of Hegelian "manifestation" or Spencerian "preformation-

ism." Indeed, in line with this modernized approach to Polanyi, see David Agler's sympathetic defense of a Polanyian view of development and emergence: "Emergence from Within and Without: Juarrero on Polanyi's Account of the External Origin of Emergence" [in this issue of *TAD*, ed.]. Note further that we need not read a Polanyian reconstruction of morphogenetic fields and the like in vitalistic fashion given recent advances in evolutionary developmental biology (see *PK* pp.357-9, 383 fn.2; and then compare Scott F. Gilbert *Developmental Biology, Eighth Edition* [Sunderland: Sinauer Associates, 2006], Sean B. Carroll *Endless Forms Most Beautiful: The New Science of Evo Devo* [New York: Norton, 2005], and Scott F. Gilbert et al. 1996, "Resynthesizing Evolutionary and Developmental Biology" in *Developmental Biology,* 173 and 357–372). Indeed, Polanyi's parallel between comprehensive entities and morphogenesis can be read as expressing the projected embodied tools by which we come to grasp ontics.

[5]The characteristics of science 1.0 are dubious as they relate to Polanyi. Concerning the first characteristic Juarrero lists, it isn't clear that Polanyi shows the symptoms of having a philosophical fixation on causality (especially mechanical); rather as a once practicing scientist, his writings seem if anything to indicate a concern with *patterns*, whether physical, chemical, mathematical, etc. Concerning the second characteristic, it isn't clear that Polanyi holds that there cannot be self-causation (given his background as a chemist, it seems he would be open to this idea); and the other feature—there must be as much reality in the cause as the effect—definitely does not apply to Polanyi, since cobblestones, for example, are less real (and their "effects" can be more real). Concerning the third, there doesn't seem to be a commitment to universals as such, but rather universal intent (metaphysics is grounded in epistemology for Polanyi); and secondary qualities wouldn't be merely epiphenomenal—the very opposite if anything, since personal knowing and its phenomenological dimensions ground the whole Polanyian project.

[6]Polanyi writes that certain mechanisms, "whether man-made or morphological, are boundary conditions harnessing the laws of inanimate nature, being themselves irreducible to those laws" (LIS, 1311). As I read this, insofar as those laws operate at one level of inquiry, they by themselves do not suffice to bring into view the phenomena of interest; it is the imposition of the relevant BCs that then enables and brings into view the objects of study. This is likewise true of simulations of the BZ reaction, suggesting that such reactions are only endogenous *once tacit connoisseurship is taken for granted* in parameterizing various BCs and initial conditions (see, for example, Alasdair Turner 2009, "A Simple Model of the Belousov-Zhabotinsky Reaction from First Principles," http://eprints.ucl.ac.uk/17241/1/17241.pdf; and Adamatzky et al. 2008, "Universal Computation with Limited Resources: Belousov-Zhabotinsky and Physarum Computers," *International Journal of Bifurcation and Chaos* 18:8, 2373-2389). The focal objects of emergent interest—in this case the endogenously generated, emergent phenomenological patterns witnessed in the BZ reaction—are still irretrievably framed by the subsidiary workings of tacit knowing.

[7]In a related vein, Matteo Mossio and Alvaro Moreno have written on "organizational closure" in biology, which is congruent to Juarrero's discussion of second-order constraints (e.g., "Organisational Closure in Biological Organisms," *History and Philosophy of the Life Sciences* 32 [2010], 269-288). Most interestingly, in their discussion on constraints and how self-maintenance relates to closure, they discuss Howard Pattee, whose core claim is that we make "epistemic cuts" in order to have any hope of grasping and projecting ontic claims (without epistemic impositions of BCs and initial conditions, scientists don't have systems, models, and so forth by which to study phenomena of interest). I suggest there is a definitive, yet submerged Polanyian element at work here that remains always-already present.

[8]One of the authors Juarrero cites is Paul Cilliers, whose work comes closest to Polanyi yet still falls short of how radical Polanyi's vision is. Cilliers' historical-contextual view of knowledge doesn't fully appreciate the crucial Polanyian dimension of inquiry as forward-looking.

[9]Umberto Eco, "Unlimited Semeiosis and Drift: Pragmaticism vs. 'Pragmatism'" in *Peirce and Contemporary Thought: Philosophical Inquiries,* edited by Kenneth Ketner (Fordham University Press, 1995), pp. 216-217. The referece to CP is to *The Collected Papers of C. S. Peirce*, vols 1-6, ed. Charles Hartshorne and Paul Weiss; vols. 7-8, ed. A. W. Burks (Cambridge: Harvard University Press), 1931-1958.

[10]This holds even for Stanley Salthe's semiotic explorations of development (e.g., *Development and Evolution: Complexity and Change in Biology* [Cambridge: MIT Press, 1993], p.15). Crucially, what Salthe seems to miss in his appropriation of Peircean semiotics is how for Peirce all inquiry is an exercise in semiotic activity, which is also a key link between Peirce and Polanyi (See *TAD* 38:3 for several articles that explore the connections between Peirce and Polanyi).

[11]For example, Juarrero's employment of information as it applies to boundaries invokes Leon Brillouin's discussion of information, which is based on the incompleteness of physical systems (*Science and Information Theory* [New York: Academic Press, 1962], p.xii) and correspondingly how systems are individuated or "chosen" so as to then impose statistical measures (Brillouin, pp. 8-10). The point is that while Brillouin (and Juarrero) distinguish "human" senses of information from measurable in-forming patterns, what remains in the background are epistemic cuts (see Pattee, *Laws, Language, and Life* [New York: Springer, 2012]) making possible the individuation of systems that *then* bring into focus talk of measurable information, "negentropy" and the like. In other words, such ontic projections are grounded and sustained by tacit knowing's explorations and operations. (Pattee, it should be noted, goes on to divide knower from known, and is guilty of some degree of Cartesianism; this same Cartesian "error" can similarly be found in Robert Ulanowicz's use of information, e.g., *Ecology, the Ascendent Perspective* [New York: Columbia University Press], p. 65).