Juarrero, Polanyi, and Complexity

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ABSTRACT

Alicia Juarrero's insights have much to offer Polanyians, and vice versa. Her works suggest the potential for cross-fertilization between her ideas on dynamical systems and Polanyi's epistemic approach to ontology. I hope to create a "hybrid space" for future inquiry, based on what I think are Juarrero's most important ideas for Polanyians interested in ontological hierarchy and complexity.

Affinities Between Juarrero and Polanyi

Alicia Juarrero is Professor Emerita of Philosophy at Prince George's Community College, and has authored and edited a number of articles and books dealing with complex systems. I believe her insights have much to offer Polanyians, and vice versa. I shall approach her works in a rather general way, with the aim of starting a dialogue based on what I think are Juarrero's most important ideas for Polanyians interested in ontological hierarchy and complexity. Like Polanyi, Juarrero's interests are broad and she develops a framework that applies to diverse realms of inquiry (see Juarrero 1991, 1999, 2008, 2009). At the core of Polanyi's philosophy is the notion of tacit knowing, which generates tacit knowing's realm, a realm that spans a significant region of human experience. For Juarrero, the analogous core of her work is the notion of self-organized dynamics, which similarly serves as a basis for a wide range of things like action and intention.

My latent allusion here to a mathematical metaphor will be used to indicate the areas of broad overlap between these two research programs, as well as where there might be space for rapprochement. The metaphor also highlights some of the mathematical notions Juarrero appeals to in her works (which I will explore further below). The mathematical notion of a vector space can be informally understood as a space in which a variety of vectors "push" and "pull" in varying combinations. For example, a sailing ship's trajectory is viewable as a combination of force vectors like wind and friction, which together describe and also account for many of the ship's movements. A vector space is the projected range of possible vector combinations, where the ship's trajectory actualizes a tiny region within that overall possibility-space. Moreover, a vector space can be compressed into a series of core generators (vector units which form what is called a "basis") that capture the essence of the diverse range of vector behaviors (what is called the "span" of the unit vectors).

As the above generator metaphor applies to Polanyi and Juarrero, for Polanyi tacit knowing serves as a "basis" that captures the essence of what tacit knowing projects—a continuum of diverse human experiences. These experiences presuppose the tacit integration of various particulars into what Polanyi calls "comprehensive entities." Such entities, in brief, exhibit self-organized dynamics that characterize living beings and make possible, for example, survival, achievements, and acting as an agent—all skillful modes of being. For Polanyi, knowing (and in general all skillful modes of being) is active and all forms of knowing are either instances of tacit knowing or are rooted in tacit knowing. Similarly, for Juarrero intention is an action, and all forms of intentional action are either instances of dynamical systems or are underwritten by dynamical-system considerations. In this sense, dynamical systems generate ontologies, ranging from the physical (e.g., the Belousov-Zhabotinsky reaction) to the intentional.

One noticeable difference between Polanyi and Juarrero arises from this metaphor: ontology emerges from epistemology for Polanyi, where emphasis is placed on our projected (hierarchical) epistemic-ontologies; by contrast, Juarrero is more concerned with ontic claims, and at times downplays epistemic concerns. I suspect her view of epistemology is analytically informed, serving as a foil for her ontic claims about complex dynamical systems (e.g., Juarrero 2000, 32). In similar fashion, her rightful dissatisfactions with the quagmires of analytic action theory and its various shortcomings serve as a foil for her introduction of ontic claims about intention as a dynamical system (see Juarrero 1999, Part I). I think Polanyi would be generally sympathetic to Juarrero's views, but would most likely urge a reconceiving of epistemology and its relation to ontology. This would perhaps bring Polanyi's "positive" account of epistemology-via-tacit-knowing ("positive" in the sense of cashing out how tacit knowing works and is applied) closer to Juarrero's at times "negative" assessment of mere epistemic claims ("negative" in the sense that it serves as a contrast to what she wants to highlight, namely the ontic status of dynamical systems). Additionally, if Polanyi were to delve into contemporary action theory, I suspect he would be inclined to start his inquiry elsewhere (or, more radically, he might not recognize action theory's problems as problems at all, akin to Wittgenstein's dissolving of philosophical problems once it is recognized that these problems are entrapped by their own presuppositions).

Another difference brought to the fore by the generator metaphor concerns the strong use of mathematical concepts in Juarrero's works. I think her use of dynamical-systems ideas is largely metaphorical, where her novel and groundbreaking work at the time (most especially *Dynamics in Action*) presented a series of root-metaphors for a new framework accommodating intention, action, and beyond (for her more current works that extend her framework to ethics, aesthetics, religion, etc., see Juarrero 2008, 2009). However, at moments she writes as if the mathematical structures of dynamical systems theory are actually in the world. As a result, she might be accused of committing a Deweyan fallacy of mistaking one's categories of thought for the things themselves (some reviewers of her *Dynamics in Action* have alluded to roughly similar objections; see, for example, Pols 2000 and Tuomela 2003). In any event, this can be finessed by remembering that her ambitious and novel framework is just that—a philosophical framing of a new research program deserving serious attention by philosophers, whose root-metaphors provide new ways of philosophical understanding. I conjecture that if Polanyi's comprehensive entities map significantly to Juarrero's dynamical systems, this objection can be further finessed by keeping in mind the always present role of living systems with tacit powers of integration.[2] That is, the estimation that such mathematical structures are in the world is itself a skillful estimation, as are the developments of dynamical systems theory and its conceptual root-metaphors.

What are these root-metaphors? There are a number of them, but I think the one that is most important is the notion of causality as constraint. Juarrero first draws a distinction between behavior and action (a "species" of behavior). She writes: "I postulate that behavior constitutes action when self-organized dynamics, as characterized by consciousness and meaning, originate, regulate, and constrain processes such that the resulting behavior 'satisfies the meaningful content' embodied in the complex dynamics from which it issued" (2000, 28). The resonance with Polanyi's features of tacit knowing is remarkable. Translating roughly into Polanyian language, the above would read: the meaningful subsidiaries bearing on focal objects of awareness jointly originate, regulate, and constrain the resulting trajectory of what tacit knowing projects—a continuum of comprehensive entities (that in turn constitute and enable a significant portion of experience). What both tacit knowing and Juarrero's notion of action highlight is the "autopoetic" nature of meaningful modes of engagement with the world—the self-generating and self-regulating nature of knowing and skillful modes of intentional action; or perhaps better yet, to quote from Juarrero's borrowing of "Chuck Dyke's (1988) great phrase," intentional action and tacit knowing are "structured structuring structures" (2000, 31). This is a wonderful phrase indeed, and one that captures the essence what dynamical complexity is about.

Juarrero's notion of causality as constraint is homologous to Polanyi's notion of a type of boundary condition that enables comprehensive entities; what she is drawing attention to by the idea of constraints aren't merely boundary conditions that delimit one region of experience from another, but rather qualitatively different sorts of "levels" that enable-and-enact the very levels themselves. Boundary conditions/constraints of this generative sort are interpretable as structured structuring structures that afford and bring into being Polanyi's heterarchical (dynamic and not static) ontological hierarchy, which is composed of comprehensive entities (see Mullins 2013a).

Let me further discuss some of the specifics of Juarrero's intriguing and important notion of causality as constraint. She first spends quite a bit of time in *Dynamics in Action* outlining several notions of causality operative in the Western tradition of action theory. Two sources come to the fore when tracing our modern sense of what "causality" means, namely Aristotle and Newton. In brief, efficient mechanistic causality is what is normally understood when "cause" is invoked, and is often implicitly at work in various modern metaphysical contexts. What Juarrero specifically attributes to Aristotle that carries through to modern times is the latent assumption that causes cannot cause themselves—they cannot be autopoetic. Think, for example, of Hume's analysis of cause: events E1 and E2 appear to be connected causally. But whether cause is genuine or a product of custom, the point remains that sequential, linear causality is presumed in the background. There is no consideration of self-causation.

Juarrero observes that Kant was one of the first philosophers to consider something like self-causation in his *Critique of Judgment* (which he relegated to the realm of regulative judgment, not having the resources at the time to make a more ontic assessment; see Juarrero 1985, 1999). She traces the first genuine ontic version of self-causation to Prigogine (and Stengers) and his work on dissipative systems. So firstly, by "causality as constraint" Juarrero has in mind self-causation as a relatively new conception of cause brought forth by the somewhat messy and new science of complex systems (a conception that does not neatly fit into either Newtonian or Aristotelian conceptions of cause). And as for the "constraint" aspect, Juarrero reflects on this new science and provides what I think are novel and apt philosophical characterizations of the variegated work coming from inquiries into complexity. As far as I can tell, she is one of the first to articulate these ideas that, while having a longer philosophical history, are really phenomena starting in the late twentieth century (see for example her co-edited work highlighting the historical roots of emergence, Juarrero and Rubino 2008).

The "constraint" aspect of causality-as-constraint will take a bit of work to unfold, and I shall try to be as clear as I can while aiming to maintain sufficient representational accuracy. Juarrero draws a distinction similar to Polanyi's distinction between his two types of boundary conditions (I alluded to the second enabling sort above). As with Polanyi, her constraints are contextual, where she accordingly makes a distinction between "first-order contextual constraints," similar to Polanyi's notion of boundary conditions that delimit realms of experience in rather ordinary fashion, as a test tube delimits an artificial site in which a chemical reaction can be studied, and "second-order contextual constraints," similar to Polanyi's notion of boundary conditions that enable-and-enact levels of inquiry (see Takaki 2011; Mullins 2013a and 2013b).[3] First-order contextual constraints are "context-sensitive constraints operating at the same level of organization" (1999, 141), as a test tube and the reaction taking place within occur at the same level of interest. Second-order contextual constraints are more important, so I will concentrate on unfolding what Juarrero has to say about them. She writes:

> [In the Belousov-Zhabotinsky reaction] once molecule Z catalyzes A and the autocatalytic loop closes, a phase change takes place: the autocatalytic network's organization itself suddenly emerges as a contextual constraint on its components. I call these *second-order contextual constraints*. Top-down, second-order contextual constraints serve as

the boundary conditions in which the components are located—and to which they are now systematically, not just externally related. All virtual governors are examples of such top-down, second-order contextual constraints (1999, 141).

Juarrero cites a number of very good examples of second-order constraints (the B-Z reaction is an exemplar in the literature on complexity and also receives treatment in Prigogine's work). To avoid technicalities as much as possible, I will try to map the above notions to Polanyi's chess example, as it illustrates his second type of boundary condition.

Firstly, Polanyi claims that the rules of chess are boundary conditions whose boundaries enable interest not by what the rules themselves strictly indicate, but by the strategies they afford when actually playing chess. Polanyi is gesturing towards the dynamic aspects of chess—the strategies and counter-strategies, the gambits, the evolving space of changing possibilities as a game unfolds, and so forth. Interesting games of chess explore not mere possibility-spaces, but regimes of order that can be novel, creative, and brilliant achievements. Thus the rules are not merely first-order constraints, even though they can be viewed this way in the sense that the "state space" of chess—the space of total possible moves and games—occurs at one level (when chess is viewed in this very coarse-grained manner). Rather the complexity of chess concerns the other type of boundary condition regarding the enabling-and-enacting of intricate games of interest. How does this map to second-order constraints? Second-order constraints build on the first-order state space of possible chess games, where they are second-order in the sense of exploring dynamic, concrete, and interesting configurations—adaptive peaks of interest, as it were—within that background state space.

Secondly, the "top-down" aspect of playing chess concerns the moves made and strategies deployed that actually change the possibilities and probabilities of a game's trajectory. We shift from a state space representation to families of "phase space" representations—the dynamical unfolding of specific trajectories in state space—where there are a series of conditional probabilities signifying a *structural* shifting of possible attractors. These moves and strategies, as a game progresses, are not simply "externally related" to what future moves can be made, akin to Juarrero's remarks about the B-Z reaction. Recall that with the B-Z chemical reaction, emergent boundaries "systematically" constrain the components in a new relational way (I should also note that some of the best examples of systematic constraint are exhibited in biology: function is form and form function, a principle showing itself at numerous scales of resolution, from microbiology to paleontology). So likewise a brilliant chess move shifts the trajectories of available moves, further constraining the state space, introducing new relations between the components (not merely the chess pieces, but the possible moves in "move-space," as it were—a further constraining of possible phase space trajectories). What are these new systematic relations? They would correspond to "new" attractors (or a newly disclosed constrained range of phase space trajectories)—the opening up of new ways to get to checkmate that occur in an emergent move-space simultaneously disclosing brilliance.

At this point, it might be objected that I am doing violence to Juarrero by appropriating her into a Polanyian framework. Whence then is the difference and why bother with any dialogue (for if true, this would appear to be an unhappy case of absorption or perhaps conversion)? While I've mapped Juarrero's first-order and second-order constraints to Polanyi's two types of boundary conditions, this has been an exercise in starting a dialogue based on similarity, not identity. I think Polanyi is a proto-complex systems thinker who didn't have access to the modern phenomena of complexity; by contrast, Juarrero firmly starts with Prigogine and builds on recent work on complex systems in developing a *philosophy* of dynamics. In short, this is not an exercise in appropriation, but one of hopeful bridge building, noting along the way overlapping regions of interest, and how both views I think can mutually inform and enrich one another.

Problems and Future Areas of Inquiry

For the remainder of the paper, I'd like to discuss in greater detail possible avenues of mutual enrichment (at times raising potential problems), areas of future inquiry, and some speculative metaphysics. Let me start by further discussing the chess example. As noted above, new systematic relations map to new ways of getting to checkmate occurring in an emergent move-space. More generally, Juarrero writes that a "new 'type' of entity, one that is functionally differentiated appears [emerges]. In turn, the newly organized hierarchy [a new emergent move-space] constrains top-down its components' behavior [the new possible moves in this emergent move-space] by restructuring and relating them in ways they were not related before" (1999, 129). This last point is crucial and deserves further consideration.

As Juarrero notes, constraints "are relational properties. But they are not simply relationships among components within a system…[constraints] are relational properties components acquire in virtue of being embedded in a higher level system" (1998, 234). This sounds very much like Polanyi's writings on boundary conditions that embody higher-level principles. As alluded to earlier, a difference of emphasis, not of kind, between Juarrero and Polanyi is that Juarrero's access to modern ideas on thermodynamics, information theory, chaos theory, and so forth enable more precise philosophical characterizations of complexity. I submit that Polanyi's "looser" characterizations of these principles—which can be critiqued precisely on these grounds—is also potentially a strength if viewed at an appropriate level of resolution (see Takaki 2013). And conversely for Juarrero, the virtue of greater precision might simultaneously be critiqued as "too narrow" given the heterogeneous range of complexity-related phenomena. What I am hoping to create is a space for mutual enrichment ("vigor") via a hybridization of Polanyi and Juarrero.

Allow me to expand on the potentially "too narrow" objection. I think most importantly Juarrero argues that "constraints not only reduce the alternatives—they also create alternatives. Constraints, that is, can also *create* properties which a component exhibits in virtue of its embeddedness in a system, properties it would not otherwise have" (1998, 234). To clarify what she is gesturing towards, note that Juarrero distinguishes two sorts of constraints nearly identical to her earlier distinction between first-order and second-order constraints. She uses conditional probability to frame and illuminate how new properties emerge via constraints. Informally, given some B, conditional probability says that some A becomes more or less likely in the presence of the probability space that B induces. As this is applied to emergent phenomena, the intuition that conditional probability accommodates and makes more precise is the idea that given an appropriate set of conditions, the emergence of property P becomes more likely, which perhaps can be illustrated by the autocatalytic emergence of amino acids given the Miller-Urey set-up of appropriate initial conditions.

This use of conditional probability provides a good coarse-grained outlining of complexity, but is not by itself the whole of Juarrero's novel account. For it could be objected that conditional probability by itself doesn't really get at the structural properties of emergence, as conditional probability can be and is applied to a wide range of cases, many of which are not viewed as cases of emergence. What matters more is what she does with conditional probability by relating it to the second sort of constraint (second-order constraints), where a real sense of creativity arises. These second-order constraints actually create heterarchical hierarchies according to Juarrero, making these phenomena ontically real and not merely "epistemological" (in a non-Polanyian sense) tools of our understanding. Constraints of the second-order sort are, in addition to conditional probabilities that constrain some event A relative to B, "alterations in the probability distribution of a system's state space" (1998, 240). That is, if conditional probability operates at one level in a particular probability space, second-order constraints not only induce-by-constraining probability niches within the overall state space—they also create and alter the very niches themselves, creating new relationships (more mathematically, they are conceivable as the introduction of new operators/

functionals remapping the "given territory").

Juarrero continues: "As enabling constraints operating bottom up, contextual constraints free up a set of states which the higher level system of relationships they create can now access" (1998, 240). Metaphorically, if first-order constraints are viewed as a first-generation software package, the software "frees up" or enables a new range of things that can be done with the software (for the chess example, this would correspond to a strategy opening up a new horizon of possible moves). Second-order constraints build off of these first-order constraints: "Systems of relationships themselves can in turn become related… thus evolving into systems of ever higher level relationships with creative new properties of their own. Once the higher level system is in place, it acts as a top-down selective constraint on the (now) lower level components from which it organized, altering the number of ways they can be arranged" (1998, 240-1). Metaphorically, new sorts of meaningful tricks with the software can be performed, creating their own "forms of life," as it were, that also systematically constrain what the original software package does, relative to these new practices (for the chess example, given a certain "first-order" strategy deployed, this would correspond to the altered trajectories of moves and counter-moves in move-space).

Does my use of these metaphors muddy and detract from the more mathematically precise cases of emergence that Juarrero discusses? While there might be truth to this charge, matters are more complicated as objections to Juarrero can be made on two fronts (aspects of which were mentioned earlier). On the one hand, her use of conceptual root-metaphors appears too loose and doesn't do justice to the mathematically precise cases of dynamical complexity. After all, there is no explicit appeal to classes of differential equations, which form the mathematical core of dynamical systems as exhibited in mathematical physics (see Tuomela 2003). And on the other hand, it appears she reifies these largely mathematical concepts (state space, probability distribution, etc.) that may not have clearly defined ontic standing (how, for example, are we to physically interpret the ideal precision that such concepts present?). In addressing these objections, I think we can begin to hybridize Polanyi and Juarrero, avoiding more generally the Scylla of not being precise enough and the Charybdis of being "too narrow."

I shall sketch some responses, intentionally keeping them brief to indicate future areas of inquiry. Juarrero's major work, *Dynamics in Action*, has been (gently) critiqued in various ways, but in my estimation none of the critiques prove damaging to her overall project. Quite the opposite, I believe that she can strengthen her position by bringing a Polanyian perspective to bear. For example, she could respond to criticism that her account is not precise enough (in not appealing to explicit uses of differential equations) by arguing that her conceptual framework would be hindered by such precision (in earlier works she does make more precise use of Prigogine's work on autocatalytic cycles, which simultaneously, and I think unfairly, opens herself up to the charge that such cases do not generalize to any reasonable degree in the sciences). Polanyi's grounding of ontology in epistemology (non-analytically conceived) holds that what scientists tacitly estimate always and already presupposes intuitive ideas guiding their skillful inquiries. What Juarrero is doing in my estimation is cashing out these intuitions, shifting attention from the foci tacitly projected by scientists like Prigogine to the "philosophical subsidiaries" making possible such projections. In Heideggerian fashion, she is doing a kind of fundamental ontology on these presuppositions, drawing out the contours and nuances of what Prigogine and others ontically project. Thus the objection that her account lacks mathematical precision misses the point and value of her philosophical project. Herein lies one area of further investigation: how might a Polanyian view of epistemics (especially his notion of comprehensive entities) fit with and perhaps enrich Juarrero's ontic (and ontological?) concerns?

Given Juarrero's greater emphasis on ontology, might her reifications of mathematical concepts need softening, which I think would bring her closer to Polanyi? Also might Polanyians benefit from a bit of reification and the benefits that arise from these projections? I think both can be answered in the

affirmative. For example, in *Dynamics in Action* (and her 1998 article) Juarrero argues that second-order contextual constraints enable (or some variant thereof) emergent boundaries with genuine ontic standing. She seems to shift slightly in her 2009 article "Downward Causation and Religion," where she claims in more bold (reified?) fashion that second-order contextual constraints "serve as—indeed *are*—the boundary conditions in which the components are located and to which they are now systematically and not just externally related" (119). The thin line between one's epistemic categories of understanding and what they project seems to be erased; they now are constitutive of what is really happening in Nature. This is both a problem and a significant advance. In her earlier work, she notes that Kant's understanding of self-cause was novel at the time, and given the absence of what the contemporary tools of complex-systems thinking afford, he could only assign his speculative thoughts to the regulative role of judgment. In other words, Kant didn't know if autopoesis is anything more than an artifact of the limits of our understanding, thus he acknowledged the need for new ideas applied to life-like (telic) phenomena falling within the realm of judgment—judging, but not constituting, what we think holds for telic phenomena. Juarrero, from the benefit of hindsight, boldly moves beyond Kant (and other historical precursors traced in her 2008 co-edited work) by moving to the realm of constitution in claiming that our categories of understanding—specifically second-order contextual constraints—actually "are" the boundaries themselves (see also Juarrero 2010). She may be right, and if so, this would present a strong case addressing some of Tihamér Margitay's concerns (Margitay 2010, 2013).

Such a bold move could be seen as a projection of tacit knowing by Polanyians since constitution conveys a sense of universal intent. Moreover such a projection for both Juarrero and Polanyi would not be "merely epistemic." In this regard, what Juarrero can offer Polanyians is an updated picture of realism via complexity, boundary conditions, and so forth whose (fallible) constitutive status is part and parcel of pursuing universal intent. And on the other side, what Polanyi can offer Juarrero is an easily overlooked reminder that reality, whose features are revealed by the consequential fruits of inquiry, are still irrevocably grounded by the operations of tacit knowing (and the comprehensive entities of which they form a part)—ontics are "fundamentally" grounded in the negotiations and renegotiations of what tacit knowing projects for communities of inquirers pursuing reality (thus alleviating the problematic aspects of reification, highlighting instead the consequential elements of her bold move).

Let me illustrate through an example how Polanyi and Juarrero can further enrich and complement one another. As Juarrero and Rubino correctly observe, Poincaré is key in the history of complexity because of his discovery of chaotic dynamics, which marks a philosophical shift from a view of nature based on mechanics alone (classical or otherwise) to a thermodynamic perspective. "We have not, Poincaré concludes, managed to resolve the enormous difficulties involved in reconciling mechanics with thermodynamics, and it is unlikely that we ever will" (2008, 8). There are epistemic and ontic issues these difficulties raise that remain open ended, even with significant subsequent advances (think, for example, of the still quite messy state of interpreting statistical mechanics). Perhaps more troubling, there have been certain resolutions since Poincaré's discovery of chaos that rather oddly have unclear bearing on these difficulties. In particular, I'm alluding to Poincaré's investigations of the n-body problem, where he gleaned tangles that he thought might never be undone (chaos seemed to imply non-integrability; Poincaré's introduction of the notion of qualitative phase spaces signifies both the intractability of many dynamical problems and a way to get around such intractability).

A result not widely advertised is that the n-body problem has been solved (Wang, 1991), perhaps in part because its solution yields practically no new light on the problem (Diacu, 1996). That is, even with a theoretical resolution of the n-body problem, the solution offered doesn't shed any light on the structure and nature of dynamical n-body systems unfolding. In essence, we know that the problem is solvable—that a solution exists—yet we have no practical idea of what the solution really looks like or

how to manage the tangles that chaos introduces. There is a large body of work surrounding the n-body problem, where various illuminating but approximative techniques help to tame the problem and also shed significant light on the structural dynamics of the problem. In other words, *even if* "ontically" we were to claim that the n-body problem is unsolvable (as Poincaré was inclined to think), epistemically we would be left in the same situation of struggling to understand the dynamics of n-body systems. We might be inclined to think from the successes of this burgeoning body of work that there really is chaos in nature, and that the problem maps to genuine ontic regimes of order and disorder ("solvable and nonintegrable regions," as it were). In analogous fashion, we might like Juarrero argue that the successes of applying mathematical techniques to understanding complexity justifies projecting ontic standing to levels, (heterarchical) hierarchies, and the like.

This may be right, but as with the n-body problem, we conceivably could encounter a similar puzzling situation: suppose complexity turns out to "reduce" theoretically to some parallel general solution. Would this then mean that levels, hierarchies, and so forth aren't really real? Would it mean that our approximative techniques and models used to study the messiness of complex systems are "merely" epistemic tools of our limited understanding? I suggest that Juarrero can avoid the potential pitfalls of strong ontological claims (think, for example, of debates in the philosophy of science over realism and antirealism, which strike me as similarly dissatisfying as Juarrero's assessment of analytic action theory) on the one hand and the weak status of "mere" epistemic claims on the other by taking a cue from Polanyi. How does tacit knowing relate to the deployment of mathematical techniques of understanding? What do they project, and how do we get from "epistemology" to "ontology," both of which are significantly reconceived by Polanyi? What are some of the more fine-grained features of this reconception, especially concerning how tacit knowing might relate to intention as a dynamical system? Does intention map to the from-to aspect of tacit knowing, or more generally is intention itself a comprehensive entity? What is the relation between intention as a dynamical system and dynamical systems "out there"—are they the same, informational, do they exhibit scaling relations, are they all comprehensive entities, etc.? Perhaps most importantly, what new philosophical picture emerges from these considerations? For certainly it would not be listed among the usual suspects (supervenience, various types of antireduction, analytic conceptions of emergence, and so forth), whose careful but coarse-grained logical considerations tend to exhibit the shackles of modes of thinking from which Polanyi, and I think Juarrero as well, is trying to break.

Speculative Metaphysics

This brings me to the last topic concerning a speculative metaphysics that blends Polanyi and Juarrero. I don't know if there is strong support for these considerations in either thinker's writings, but I suspect that such speculations may present fertile soil from which to construct a hybrid "metaphysics" (in the sense, beyond ontic considerations, of presenting an overarching philosophical vision). On the Polanyian side, I think it is fair to say that a key feature of his overall philosophy is something like the regulative ideal of the pursuit of truth, which can be gleaned from his fiduciary framework guiding how we get from epistemology to ontology. And as for Juarrero, in her writings I think one can discern—in addition to her shift from Kant's regulative judgment to a constitutive principle concerning emergence and autopoetic systems—what might be characterized as the pursuit of heterarchical, stable hierarchies, what she sometimes calls "safe-fail" systems (Juarrero 1991).

Polanyi's pursuit of truth ought not flatly to be conceptualized as inquiry's "asymptotic" convergence to a single unified and monolithic "Truth." Rather more subtly, it is a fallibilistic project rooted in tacit knowing, where a continuum of diverse modes of knowing (fiduciarily) hones in on stable realities by way of achievements. Thus what tacit knowing projects is a heterarchical, dynamic hierarchy of ongoing achievements that are imbued with universal intent. Polanyi's pursuit of truth is a regulative project

emphasizing the never-ending process of articulating universal intent, the unending consequential fruits of inquiries, and the ever-expanding continuum of achievements that are centered by comprehensive entities. By contrast, it might seem that Juarrero offers a framework moving beyond regulation to constitution. However, this would be too quick an assessment, for many of her critiques are directed at philosophical views that Polanyi likewise contests. For example, concerning Platonic "Truth" and object-subject divisions, she writes:

> Recent developments in the philosophy of science, and considerations drawn from features characterizing complex dynamical systems such as dissipative structures, in particular their openness and coupling, as well as their capacity to process information, all suggest that the ideals of absolute [Platonic] Objectivity and Truth—and perfect Societies—are unattainable because the model of Reason from which they issue ignores the realm of the particular, the contextual, and the temporal. Once these are incorporated into a broader notion of reason, one can begin to understand reason dynamically and so an alternative to the objective-subjective dichotomy opens up. One comes to appreciate that the concept of truth makes sense only within the cultural milieu which gives it meaning, that culture, history, and tradition serve as the contextual framework in terms of which events and phenomena are interpreted as meaningful (1991, 1776-7).

In general, Juarrero moves beyond Kant's notion of regulative judgment, and also contests much of the Western philosophical tradition whose object-subject dualities and disembodied views of Reason and Objectivity do violence to the phenomena of complexity. In a sense she is doing two things simultaneously: she is moving beyond Kant and yet is not falling prey to the "antinomies of reason" by her constitutive move, as she also rejects Platonic accounts of "Objectivity and Truth."

Thus firstly, we have opened a space for accommodating Juarrero's constitutive principles within a Polanyian regulative fiduciary framework. For as with the n-body problem, many of whose lessons can be generalized, even *if* there were some analogous sort of ultimate Platonic "reality-solution," it would give us no genuine sense of how actual dynamics work. Thus Polanyi's regulative fiduciary framework would offer guidance in exploring and understanding dynamics in action, where Juarrero's constitutive principles would be the enriched analogue of Polanyi's achievements. Secondly, there is a "symmetrical" way in which Polanyi can also be accommodated within Juarrero's framework. What Juarrero offers Polanyians is a metaphysical softening of the pursuit of truth, emphasizing contextual particularities and thus the crucial role of exercising practical wisdom when cultivating what tacit knowing projects—a gentle reminder to Polanyians of tacit knowing's humanistic contours. She writes:

> Complex dynamical systems [in particular, intention as a dynamic system] suggest… [we] have the ability both to impart through example and to acquire as an exercise in *personal responsibility* the sensitivity to contextual nuances (spatial, historical, and cultural) in others and ourselves that will enable us to better understand the dynamics and behavior of both [gesturing towards a "participatory realism," as it were]. With that ability comes the obligation [a fiduciary commitment] to nurture the practical wisdom with which we can make reasoned, reflective judgments about ourselves and the messy, complex world in which we live—and to *act from that wisdom* (1999, 260; emphasis mine).

It is not enough to pursue truth, that regulative non-Platonic ideal, heterarchically and dynamically conceived. For mere connoisseurship in pursuing truth does not do justice to the crucial personalistic aspect of Polanyi's thought. What inextricably comes with genuine commitments of the sort Polanyi

recommends is an invested sense of personal responsibility to inquiry and to one's self, as it were, which is a calling to pursue wisdom—an ideal for non-sages (i.e., most of us) pursuing, but not yet having, wisdom. As Juarrero might remind Polanyians, tacit knowing is not simply skillful "subsidiary" practical wisdom (broadly conceived, in accordance with tacit knowing's continuum) directed upon various foci of one's engagements; it is perhaps most crucially itself a commitment made to *act* on that pursuit of wisdom, which reinscribes these various foci as they bear back upon one's subsidiaries.

If these speculative remarks are right, it would make greater sense of Polanyi's contesting of various traditional views of science (often reductionistic and/or based on Cartesian assumptions). For a modern tendency, taking its cue from the successes of the "harder" sciences, is to isolate problems, to ossify that isolation to an extent, and then inductively to generalize whatever successes arise. This image of reason—perhaps more aptly characterized as scientistic rather than scientific—I think has done significant damage to the humanistic ideal of pursuing wisdom. It certainly infects a fair amount of modern academic philosophy; for example, one sometimes hears teachers of philosophical ethics claiming that they may be interested in the study of ethics, but that doesn't imply that they are thereby ethical. This is surely an important distinction, but for who, and in support of what implicit framework? Polanyians ought to be wary of such "important" distinctions, as the latent dualities they contain threaten to undermine the radical wisdom of what Polanyi's post-critical philosophy offers. We cannot study systems of whatever sort in pure isolation, nor can we forget that our various reductive tools of examination—as important and as powerful as they are—require reintegration within wider systems as well as in relation to our personalistic commitments. The pursuit of truth *as a commitment* is interrelated to a variety of values, perhaps the preeminent of which is the pursuit of wisdom. Without the commitment to pursuing wisdom first, other ideals threaten to undermine Polanyi's framework, as well to further fragment an already fragmented world. Echoes of this are found in Juarrero:

> Now that there is no denying that top-down causality, in the sense [of causality as constraint], is ontologically real, there is even less reason to deny the causal efficacy of such ideals [concerning values, ethics, and morals], which after all can now be understood to embody the "integration achieved by a supervenient level of relatedness," in [C. Lloyd] Morgan's words (2009, 121).

Regulative ideals like the pursuit of wisdom and the pursuit of truth are ideals that enact the worldviews they project (in open-ended and fallibilistic fashion). The realism they create and are created by is a new sort of epistemic-ontology that I hypothesize can be fruitfully developed within a Juarrero-Polanyian framework. This realism is not merely a realism "out there"; it is part and parcel of putting wisdom into action. In this sense, it aims to rehabilitate an ancient view of philosophy, namely philosophy as a "way of life" (see Hadot 1995). Perhaps a hybridization of Polanyi and Juarrero can explore the contours of this rehabilitation in hope of healing some of the innumerable fractures of modern life.

Endnotes

[1]Thanks to Phil Mullins, Paul Lewis, and Andrew Grosso for their helpful feedback on earlier drafts of this paper.

[2]I am indebted to Phil Mullins for this important insight.

[3]In Polanyi's later writings he refines his account of boundary conditions through his notion of the principles of marginal control, which operate in top-down fashion and "*govern the boundary conditions of an inanimate system*" (*TD* 40). He appears to subsume both sorts of boundary conditions under his notion of dual control, and his higher-level principles are expressed via marginal control. It would be an interesting project to undertake a detailed investigation concerning the extent to which Juarrero's first-

order constraints map to dual control, and second-order constraints map to marginal control. Thanks to Andrew Grosso for suggesting this insight. My suspicion is that the "devil is in the details," from which the differing aspects of the mapping will be further revealed by the differing implications Polanyi and Juarrero draw regarding their views of evolution, issues relating to biosemiotics, how heterarchical their hierarchies are, and so forth.

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