Balancing Objects and Processes: Advocating Pluralism in Biology: Comment on "Thoughts and thinkers: On the Complementarity between Objects and Processes" by Chris Fields and Michael Levin

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Introduction

We laud Fields and Levin's proposal to abandon the dichotomy between "objects" and "processes" in biology. The intellectual ambition of Fields and Levin's synthesis is praiseworthy. The ambition of this thesis is clear and to be lauded: to dissolve long-standing Cartesian dichotomies and to unify static and dynamic views under a common information-theoretic framework. However, we note a few practical considerations that merit further discussion.

While this vision is philosophically provocative and mathematically elegant, its broad prescription warrants scrutiny. In many scientific domains, treating certain entities as objects remains a practical necessity. Taxonomies, ontologies, and models often rely on discrete categories and stable abstractions to organise knowledge. Moreover, maintaining multiple complementary viewpoints can be a strength rather than a liability: in complex systems it is common to explain phenomena at different levels or with different formalisms, each capturing distinct aspects of reality (for example, a gene as a molecule versus a component of a regulatory network). Here we examine the philosophical stakes and practical modelling consequences of Fields and Levin's proposal. We will argue that even if the object–process distinction is in some sense "construed", it often serves genuine epistemic and organisational functions. In practice, pluralistic models and the concept of objects remain essential tools in biology, cognitive science, artificial intelligence, and other fields. Abandoning them altogether risks losing valuable insight and clarity.

Philosophical Context

"You never enter the same river twice. It is not the same river. And you are not the same person" - *Heracleitus*

Fields and Levin align themselves with a rich tradition of process philosophy that dates back to Heracleitus and Whitehead. The Stanford Encyclopaedia of Philosophy describes this school as emphasising "modes of becoming and types of occurrences" over static substances. In process metaphysics, what we call an "object" is a temporary fixation of a flowing reality. This contrasts with the substance metaphysics of Aristotle and much of Western thought, which assumes that the basic units of reality ("substances") are internally undifferentiated and static. For example, process thinkers point out that atoms, organisms, and even societies are in fact constantly changing, and our perception of them as unchanging individuals is a snapshot. Fields and Levin explicitly reject this substance-metaphysical snapshot view claiming that it objectifies phenomena by enforcing a stipulated boundary that must remain stable over the time of interest. Their approach formalizes this insight using information theory to show that what we call objects are simply boundaries encoding memory, and processes are flows of information across boundaries.

As a matter of scientific practice, object-based categories serve organisational and communicative roles that cannot be easily dispensed with. The notion of an object is often a surrogate for complex constraints. For instance, when a scientist refers to "the serotonin transporter protein" that label references a relatively stable molecular structure across time and contexts. It would be highly inefficient to describe every drug-protein interaction as a completely new process each time. The object abstraction simplifies discussion. Fields and Levin's perspective does not deny this utility, but it would downplay it. Our position is that, while ultimately contingent, the object viewpoint remains essential in building models that humans can use, especially in taxonomy, systems biology, and information science. This does not conflict with deeper metaphysical interpretations; it merely acknowledges that science needs stable referents for communication and classification.

Plurality of models and complementarity of perspectives

"All models are wrong, some are useful" - *George Box*.

Sometimes we need multiple, coexisting explanations to capture different aspects of a phenomenon. A case

in point is the long-running debate between symbolic and connectionist models in cognitive science [1, 2]: each framework highlights different strengths and makes distinct predictions, and neither alone provides a complete picture. We therefore argue for a plurality of models and viewpoints.

Across disciplines, complementary modelling is common. In physics, wave–particle duality is a canonical example of two incompatible yet jointly necessary descriptions. In biology, the same organism can be seen as a genetic system (information processes) or as an organismic individual (an object with behaviour and boundaries). Both descriptions are used productively: geneticists trace alleles as if they were discrete objects moving through pedigrees, while ecologists study populations and ecosystems as functional units. Neither approach is truer than the other; they address different questions.

In artificial life and adaptive systems, the distinction is also blurred. For example, a roboticist might model an agent's behaviour with a state machine (objects = states) or as a continuous dynamical system (process). Depending on the problem (designing a control algorithm vs analysing stability), one model or the other may be more convenient. It would be dogmatic to insist that one representation is ontologically fundamental; yet it would be impractical to refuse the state machine model. The utility of multiple formalisms is recognised in science: *models are tools, and different tools suit different tasks.*

Cognitive science itself embraces multiple levels of explanation. A computer can be understood as logic gates, assembly code, Lisp code, or the problem it solves [3]. No single level fully captures everything; each level abstracts away details in different ways.

Processes at one scale can be seen as objects at another. Recognising this, scientists routinely switch models to suit the question: for instance, using symbolic grammars for language structure, and dynamical systems for motor control, often in the same theory. *This pluralism is exactly the point: complementary models coexist.*

Hence, we would like to echo Fields and Levin's message in a more moderate tone, tempered with pragmatism: it is the complementarity of models that drives progress. *Multiple specialized models, each tuned to a particular scale, question, or application, may still provide a lot of insight and practical value. However, this does not diminish the importance of efforts to integrate them within a broader, unified framework.*

Practical Concerns

In summary, Fields and Levin make a bold theoretical claim: that science would be better served by abandoning the object–process dichotomy. We respect and admire the ambition. We also recognise the value of dissolving outdated dichotomies.

Nevertheless, we caution that the wholesale rejection of objects (or even processes) in models may be impractical. Objects as abstractions are not mystical essences; they are tools. The fact that a boundary must be posited for modelling purposes does not make it invalid; it simply means that we acknowledge it as a convenient fiction: a summary of lower-level detail.

Complex systems require multiple explanatory perspectives. Higher-level categorizations allow us to make general predictions without knowing all micro-details [3]. This is the case in systems biology or ecology: often an organ or gene class is modelled as if it were an object because it behaves sufficiently coherently for the question at hand. Such ontological commitments are always provisional, but they are essential for tractable science.

A balanced philosophical stance is pluralistic: we do not commit a logical fallacy by speaking of objects at one level and processes at another. In fact, this is the standard scientific approach.

Ultimately, the value of Fields and Levin's work may lie less in prescribing the language scientists must use, and more in encouraging us to remain aware of the assumptions behind our categories. They remind us that any object we draw around a system (a species, a cell, a memory trace) is a provisional delineation. That is a healthy reminder. However, it is also crucial to remember that such delineations enable science. They enable taxonomies that organize biodiversity, ontologies that enable data-sharing, and cognitive models that let us reason about the world.

This is especially evident in the study of life-like systems, where emerging research suggests the utility of a taxonomy (or even a continuum) of such systems [4–7]. Life-like phenomena may be arranged along a scale-free spectrum, from minimal autocatalytic networks to engineered bio-hybrid agents in artificial life [4, 8]. Classifying these entities can support meaningful comparisons: between chemical protocells, self-replicating metabolic systems, and hybrid synthetic-biological constructs. Developing and refining such a taxonomy not only clarifies relationships among life-like phenomena but may also guide the design of novel adaptive systems and synthetic organisms.

The push for complementary perspectives is indeed valuable: science thrives on metaphorical shifts.

Our critique is that we should embrace complementarity without throwing away the concrete scaffolding that objects provide in many domains. In conclusion, Fields and Levin's complementarity-of-objects-and-processes thesis is a stimulating contribution to theory. However, when it comes to doing science, the object perspective remains indispensable in many cases. A pluralistic approach acknowledges the legitimacy of both object- and process-based models. Like wave and particle, substance and process, or symbolic and connectionist models, object and process views should be held together in tension. It is the dialogue between them that may yield the richest understanding across biology, cognitive science, AI, and beyond.

Conclusion

> "Once upon a time, I dreamt I was a butterfly, fluttering hither and thither, to all intents and purposes a butterfly. I was conscious only of my happiness as a butterfly, unaware that I was myself. Soon I awoke, and there I was, myself again. Now I do not know whether I was then a man dreaming I was a butterfly, or whether I am now a butterfly, dreaming I am a man." - *Zhuangzi.*

Fields and Levin's 'object-process complementarity' is an ambitious attempt to unify biology, physics and information under a common conceptual umbrella. We applaud their breadth of vision.

Douglas Hoffstadter in *The Mind's I* [9] wrote : "There seems to be no alternative to accepting some sort of incomprehensible quality to existence. Take your pick. We all fluctuate delicately between a subjective and objective view of the world, and this quandary is central to human nature". The suggestion is that we always use multiple (potentially conflicting) points of view to look at a problem. This underscores the value of embracing multiple, sometimes conflicting perspectives (much like wave–particle duality), where "all models are wrong, but some are useful".

Fields and Levin suggest that the object–process distinction is an artificial construct that obscures understanding, and its abandonment would benefit scientific inquiry. But we urge a balance: scientific practice often benefits from retaining both objects and processes as complementary abstractions. We advocate a pluralistic stance: *retain both objects and processes as complementary tools, each serving distinct epistemic and organizational functions depending on scale and question.*

E.O. Wilson, when attempting to unify biology and sociology, wrote [10]: "This comparison may

seem facile, but it is out of such deliberate oversimplification that the beginnings of a general theory are made. The formulation of a theory of sociobiology constitutes, in my opinion, one of the great manageable problems of biology for the next twenty or thirty years". E.O. Wilson may as well have been talking about process philosophy applied to biology. We recognize that Fields and Levin have made many simplifications; it is indeed out of such simplifications that the beginnings of a general theory are made. Thanks to Fields and Levin we are beginning to see the dim outlines of what a theory of "scale-free biology" might look like. A full theory that integrates complementary viewpoints will take more time to develop, but Fields and Levin have helped us take our first steps. We commend them for charting a path that challenges us to hold objects and processes in productive tension, and to keep pluralism at the heart of scientific inquiry. For now, however, more practical concerns beckon.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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