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Operationalizing Scientific Realism

Zachary J. Mayne

History and Philosophy of Science, University of Pittsburgh, USA
Email: zachary.mayne@pitt.edu

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Abstract

Pragmatist philosophers of science often adjudicate realism debates by (1) deploying a unified ontological principle—that is, a unified rule for making ontological assertions—to all domains of empirical inquiry, and (2) comparing the ontological assertions made by realists and antirealists to the unified principle. By considering modeling practices in evolutionary biology, I motivate an alternative approach. Pragmatists should localize ontological principles to particular ontological questions in particular domains of empirical inquiry and adjudicate between various realisms and antirealisms in a radically piecemeal fashion.

1. Introduction

What are the pragmatic consequences of scientific realism? More precisely, what purpose for empirical inquiry is served by asserting that some theoretical entity is "real" or "not real," or that some modeling assumptions are more or less "realistic" than others? To the degree that one harbors pragmatist sympathies, the answers to such questions will determine what attitude one ought to adopt toward various realisms and antirealisms. This is because pragmatism is a method for doing philosophy that gives pride of place to the needs of empirical inquiry. It resolves otherwise interminable debates by analyzing philosophical proposals in terms of the practical differences they make to experience (James 1907).

Consider, then, the task of *operationalizing* scientific realism debates: to philosophically adjudicate between various realisms and antirealisms, pragmatists must analyze the ontological assertions made by their adherents in terms of the pragmatic consequences of those assertions for empirical inquiry. My choice of the term "operationalizing" here is meant to be suggestive of the common practice of *operationally defining* a theoretical postulate, within an experimental context, in terms of some measurable quantity. The pragmatic consequences of the ontological assertions made by realists and antirealists of various stripes can serve as the operational definitions for those positions, within the context of a pragmatist adjudication between them; and it is entirely on this basis that they are to be

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judged.[1] These operationalizations are qualitative, and they are "second-order," in that they measure how certain realist or antirealist assertions facilitate empirical inquiry, rather than serve as the targets of direct empirical testing.[2]

I distinguish between two methods for operationalizing realism debates: *global* operationalizing and *local* operationalizing. These methods differ in how they deploy what I call *ontological principles*. An ontological principle is a rule for making ontological assertions. Given a set of theories, hypotheses, or models with various degrees of empirical confirmation, an ontological principle instructs us what to assert about the *reality* or *mere instrumentality* of the entities or structures (etc.) in that set. For a pragmatist, an ontological principle must earn its keep by facilitating empirical inquiry, broadly construed. It should help us make sense of, and continue to actively learn about, the world we inhabit.

On the method of global operationalizing, one deploys a unified ontological principle to all domains of empirical inquiry. One then adjudicates between various realisms and antirealisms by assessing how the ontological assertions made by their adherents comport with the unified principle. That pragmatists commonly adopt the global method has gone unnoticed until now. It is exemplified, though not exhausted, by a reliance on coherence theories of truth and reality (Putnam 1981), or experimentalist criteria for ontological assertions (Hacking 1983; Sidzińska 2024), or some elaborated combination of the two (Chang 2016, 2022).[3]

By contrast, on the method of local operationalizing, one deploys ontological principles only to the particular questions and domains for which they demonstrably facilitate empirical inquiry.[4] One then adjudicates between various realisms and antirealisms in a radically piecemeal fashion, by assessing how the ontological

[1] The claim here is not that meaning is entirely exhausted in operational terms, *sensu* Bridgman (1927). The claim is just that, when it comes to adjudicating between realisms and antirealisms on pragmatist grounds, only their operationalizations matter.

[2] I construe the term "empirical" quite broadly. It is not restricted to immediate sensory impressions and laboratory experiments or field observations. It can also extend to more speculative forms of scientific theorization, and perhaps also to aspects of mathematics and logic, as well as to social and political life, including science communication (Chang 2022). It is a matter of degree just how empirical any of these forms of inquiry may be, with some closer to experience and some more remote (Norton 2024; Boyd 2018). Furthermore, I construe "inquiry" in an active and material sense, following Dewey (Dewey 1938; Brown 2012) and Chang (2022).

[3] Note that any globally applied substantive theory of truth, including a correspondence or coherence theory, will entail a unified ontological principle (trivially: put into your ontology whatever you believe meets the unified criteria laid out by your theory of truth), but the reverse does not hold. Arthur Fine (Fine 1984, 1986), in his Natural Ontological Attitude (NOA), rejects all substantive theories of truth, but it remains ambiguous just how unified are the ontological principle(s) it recommends. At the very least, the NOA entails that the (possibly diverse) ways in which we should make ontological assertions across the sciences are all of a kind with the ways in which we make everyday ontological assertions. Despite Fine's proclamations that, unlike realism and antirealism, the NOA declines to add *global* interpretations on top of science, but rather accepts science's claims *locally*, on science's own terms (Fine 1984, 61–62; c.f. Ruetsche 2015), I therefore find that it does not fully commit to the local method.

[4] Asay (2019) has advocated for a "methodological localism" by arguing that realism should be adopted or rejected at the level of individual scientific disciplines, rather than the entirety of science. However, Asay is not obviously engaged in the pragmatist project of *operationalizing* realism debates, in the sense discussed here. Furthermore, inasmuch as Asay deploys ontological principles, he does not localize them to particular ontological questions.

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assertions made by their adherents comport with the localized principles for their respective questions and domains.

I will argue that pragmatist philosophers of science ought to abandon the method of global operationalizing and should adopt the method of local operationalizing. To start from a unified ontological principle is to assume that the purposes served by ontological assertions are homogeneous across all domains of empirical inquiry. This is an unjustified assumption, and if the purposes served by ontological assertions are *not* homogeneous, then a unified ontological principle will be counterproductive when applied to some domains of empirical inquiry. In Sections 2–4, I highlight a recent manifestation of this shortcoming of the global method by applying Hasok Chang's (2016, 2022) account of "pragmatic realism" to the context of modeling practices in evolutionary biology.

In Section 5, I explicate the local method. I first clarify how the correct level of "locality" is determined for an ontological principal: It is the ontological question under consideration that determines which domains of empirical inquiry are relevantly local. I then sketch the (fraught) path toward recovering a unified ontological principle while following the local method: This would require a demonstration, through integrated historical and philosophical analyses of scientific practice, that there is a unique best strategy for answering all ontological questions across all domains of empirical inquiry.

2. Chang's pragmatic realism

Hasok Chang (2016, 2022) has recently proposed a version of scientific realism that is meant to be useful for actual empirical inquiry. Chang sees "standard" scientific realism as metaphysically excessive and pragmatically irrelevant to the dynamic progression of empirical inquiry because realists typically conceive of scientific knowledge in terms of a static correspondence between our beliefs and the mind-independent structure of the world. Chang echoes Hilary Putnam's (1981, 49) critique of the "God's-eye point of view" of nature (Chang 2022, 7); for, even if such a point of view existed, it could play no productive role in our limited human discourse (c.f. Donna Haraway's [1988] criticism of the "god-trick"). What Chang aims to accomplish, therefore, is just what I have identified as the task of *operationalizing* scientific realism debates. I share Chang's motivations on all fronts thus far. Where we diverge is in the methods we adopt.

Chang proposes that in the context of empirical inquiry, we should reconceive of "truth" and "reality" in terms of "*operational coherence*" (explicated in the following text). This proposal relies on a more sophisticated version of William James's pragmatic theory of truth (James 1907). Chang suggests that once one adopts his proposal, one can and should affirm many of the characteristic claims of scientific realism, such as the claim that through scientific investigation, we can come to know truths about the existence of unobservable entities (Chang 2022, 205).

Note that whereas "coherence" is typically understood as a syntactic or semantic relation between propositions, Chang's notion of "*operational* coherence" is a pragmatic feature of activities and practices. An activity is operationally coherent with respect to some aim just to the degree that it promotes systematic, open-ended success in the pursuit of that aim. For instance, if the aim is to drink a glass of water,

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then lifting the glass to one's mouth is an operationally coherent activity, while lifting the glass to one's nose is not (ibid., 41).

Chang stipulates that a proposition is true "*to the extent that there are operationally coherent activities that can be performed by relying on it*" (ibid., 167; emphasis in original). Similarly, Chang stipulates that an entity or event is real to the extent that "there are [operationally] coherent activities it can facilitate" (ibid., 123). Consequently, the claims of our best theories in contemporary physics are truer than the claims of flat-earth cosmology in virtue of the fact that we can rely on the former theories to carry out many other highly operationally coherent activities, such as predicting orbits and navigating using GPS, while flat-earth cosmology cannot facilitate any such activities (ibid., 41, 173).

By defining truth and reality in these terms, Chang effectively stipulates a unified ontological principle for all ontological questions in all domains of empirical inquiry. Namely, Chang's ontological principle is that we should assert that the theoretical posits of the sciences are "true" or "real" to the degree that they facilitate operationally coherent activities. Chang argues, quite rightly, that we should build ontologies that are useful for empirical inquiry. However, in the next section, I will demonstrate that Chang's proposal undermines its own pragmatist goals because it would be counterproductive for empirical inquiry if applied to modeling practices in evolutionary biology.

3. Idealized modeling in evolutionary biology

It is commonplace in science that idealized models with evidently false or unrealistic assumptions are relied upon to facilitate operationally coherent activities. Chang's account stipulates that we should treat modeling assumptions as *true* or *real* to the degree that they facilitate operationally coherent activities. But if it is sometimes more beneficial for empirical inquiry to treat such modeling assumptions as *false* or *unrealistic*, even though those modeling assumptions facilitate operationally coherent activities, then Chang's account would be counterproductive to empirical inquiry. Chang acknowledges this as an apparent problem, but he promises several reasons to think that his account remains unthreatened (Chang 2022, 185–86). A careful consideration of the manner in which certain idealized models are employed in evolutionary biology will show that none of the reasons Chang offers suffice to save his account from this problem, however.

Population geneticists commonly model the evolutionary dynamics of alleles under selection in very large populations as if they were perfectly deterministic.[5] The situation is summed up succinctly by Motoo Kimura, one of the leading evolutionary theorists of the twentieth century:

[5] This sense of "deterministic" should be understood in contrast to "stochastic" rather than "indeterministic." It is not a claim about fundamental physics. It is rather the claim that once certain *macrophysical* parameters are specified, such as the population's size and the selection coefficients and initial frequencies of the alleles, the population will, with probability 1, follow a particular trajectory through allele-frequency space.

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> Strictly speaking, [a deterministic model of selection] applies only if a population is infinitely large and is placed in an environment which remains constant or changes in a deterministic way. There are many circumstances in which this is sufficiently realistic as a first approximation. Furthermore, because of its simplicity, this approach is still the most useful, and is often the only manageable one for many problems. (Kimura 1964, 179)

Some care is needed when talking about hypothetical "infinite" populations (Abrams 2006). The more precise formulation of Kimura's point is that deterministic models of selection become increasingly good approximations of stochastic models as a population's effective size *goes to the infinite limit*.

No matter how weak selection may be and no matter how low the fitter allele's initial frequency may be, the probability of fixation for the fitter allele goes to unity as effective population size goes to the infinite limit (assuming selection parameters and initial frequencies are held constant). This is a highly robust result across many stochastic models of selection, and it comports with empirical observations that fitter alleles go to fixation more reliably when effective population sizes are larger.[6] This is why the field of conservation genetics, which deals with small and often inbred populations, is so intimately concerned with the effects of genetic drift (Woodruff 2001).

The limiting behavior of stochastic models of selection fully explains why, the larger a population is, the more confidently we can use deterministic models to approximate its dynamics under selection. The situation here is therefore quite unlike those discussed by Batterman (2001, 2009), in which certain idealizations play ostensibly crucial roles in explaining the behavior of certain physical systems.[7] No additional explanatory or predictive value is ascertained by introducing the claim that the dynamics of any large population is literally deterministic. This is why it is widely recognized in population genetics, as noted previously by Kimura, that deterministic models of selection apply *strictly* only in the infinite population limit but are nonetheless useful and accurate enough in very large, but still finite, populations.

And yet, it cannot be denied that the practice of sometimes modeling actual, finite populations as if they were deterministic serves to facilitate operationally coherent activities in population genetics more than the practice of using stochastic models alone. Being able to make "good-enough" predictions in a timely and efficient manner does indeed promote open-ended and systematic success in the pursuit of the epistemic aims of the field of population genetics. Even though technological advances have made stochastic modeling much more computationally tractable since Kimura wrote the previously mentioned passage, deterministic models of selection continue to routinely find operationally coherent uses in evolutionary biology, including in coalescent theory, evolutionary game theory, and in the evolution of large microbial populations (Wakeley 2008; Nowak 2006; D'Agata et al. 2007).

[6] This behavior can be seen clearly in the model analyzed by Sarkar (2011), who draws the formal structure from Karlin and Taylor (1974, 114).

[7] In Norton's (2012) terminology, deterministic models of selection would not even qualify as proper "idealizations" but would rather be mere "approximations."

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So, here we have an apparent counterexample to Chang's account. Population geneticists clearly find it useful to treat the assumption of deterministic dynamics under selection as a less realistic, or less "true," assumption than that of stochastic dynamics under selection; and yet, in many cases, the deterministic assumption is uniquely relied upon to facilitate operationally coherent activities in population genetics.

3.1. Objections and responses

Chang provides fives responses to this general form of counterexample. First, Chang suggests that although some of the assumptions of an idealized model may be false, the specific assumption upon which some operationally coherent activity uniquely depends could be worth calling "true" (Chang 2022, 185). This response fails to defuse the counterexample we are presently considering. It is precisely the assumption of deterministic dynamics under selection upon which some operationally coherent activities in population genetics uniquely depend, and it is precisely this very same assumption that is resolutely considered to be less realistic, or less "true," compared to the alternative assumption that selection is stochastic.

Second, Chang suggests that an idealized modeling assumption might be, while not *completely* true, still "true enough" in some limited sense (ibid.). I could happily concede that the deterministic assumption might not be completely false in all respects for very large populations (it is, after all a very good approximation!), but this concession still would not defuse the counterexample. The problem here is that the deterministic assumption is patently *less realistic* than the stochastic assumption for all real populations, even though the former is in some cases a *more useful* assumption than the latter, in the relevant sense.

Third, Chang suggests that an idealized modeling assumption might be treated as a provisional or working hypothesis that will later be dropped, if it cannot be shown to facilitate operationally coherent activities (ibid.). But population geneticists do not treat the deterministic assumption as a hypothesis of uncertain utility. They have known full well for many decades that the deterministic assumption is always *less realistic* than the stochastic assumption *and* that the former is in many cases *more useful* than the latter, in the relevant sense.

Fourth, Chang suggests that an idealized modeling assumption might simultaneously be true by operational coherence in its own limited domain of application and yet be false by comparison to a more robustly true modeling assumption. For instance, Chang claims that the theory of atomic orbitals is true in some limited domains of chemistry because it facilitates operationally coherent activities, even though it is judged false when compared to models of electrons in contemporary quantum mechanics, which are more robustly true across more domains (ibid., 186). However, because all actual populations are finite and are thus subject to the stochastic influence of genetic drift, however slight that influence may be, there is no domain in which population geneticists take the deterministic assumption to be more realistic than the stochastic assumption, even though there are limited domains in which the former facilitates more operationally coherent activities than the latter.

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Fifth and finally, Chang suggests that he could tenably couple his account to the view that models are nonpropositional, so that the question of truth would never arise (ibid.). Although Chang does not ultimately endorse this view, it is worth pointing out that this is not a tenable solution for his account in the first place. Even if one concedes that a model is not *itself* a set of propositions, the issue of truth would still arise for propositions regarding how the model should be interpreted and whether the model's assumptions, suitably interpreted, are realistic or not. To completely prevent the question of truth from arising for idealized modeling assumptions, one would have to deny that models can be meaningfully interpreted. In addition to the fact that this would do great violence to ordinary scientific practice, it would also undermine Chang's project of defending a version of scientific realism because it would effectively revoke all license to make knowledge claims regarding the existence of unobservable entities.

4. Generalizations on the method of global operationalizing

Chang's account of pragmatic realism conflicts with well-established practices of ontological assertion in evolutionary biology. Consider: What if philosophers were to implore population geneticists to begin asserting that deterministic models of selection are, in some domains, more realistic than stochastic models of selection? There is little pragmatic value to be gained, and much conceptual and linguistic clarity to be lost. More seriously, this could have drastic ramifications for the direction of empirical inquiry in the field of population genetics.

The evolutionary outcomes of very large populations are not perfectly consistent, even when initial genetic compositions, selection pressures, and other basic evolutionary factors, like migration and mutation rates, are held constant in controlled experimental conditions (Blount et al. 2018). If we were to suppose that the dynamics of very large populations under selection were literally deterministic, then these slight inconsistencies should lead us to conclude that our theory of evolutionary dynamics is in need of a radical revision. We would need to set out in search of the missing deterministic macrophysical factors that vary surreptitiously between populations in controlled experimental conditions.

Instead, empirical inquiry in population genetics is kept on a productive track by the well-established practice of asserting that deterministic models of selection, despite their utility, are always less realistic than stochastic models of selection because all actual populations are finite. This assertion serves as a reminder that genetic drift is a potentially relevant factor in the explanation of all actual evolutionary outcomes, even when selection is strong and populations are large. Empirical inquiry can therefore proceed under a consistent theoretical framework, for instance, by investigating how genetic drift manifests and interacts with selection, migration, and mutation in the context of experimental evolution in large microbial populations (Heffernan and Wahl 2002).

It is often more useful for empirical inquiry if we model evolutionary dynamics under selection as deterministic rather than stochastic; it is also more useful for empirical inquiry if we consistently assert that the former modeling assumption is always *less realistic* than the latter, rather than the reverse. It follows that to build ontologies that are useful for empirical inquiry, we should not simply put every

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modeling assumption that is useful for empirical inquiry into our ontologies, as Chang's account would have it.[8]

One might hope to maintain the global method and propose another unified ontological principle. However, we should suspect that this alternative principle may also be counterproductive when applied to some domains of empirical inquiry. Take, as just one more example, Ian Hacking's (1983) "experimental realism." According to Hacking, we should affirm the existence of entities that we can experimentally manipulate, but we should not affirm that our models represent the real behavior of those entities.

It is notable that this view was developed primarily with unobservable entities, such as electrons, in mind. Regardless of how experimental realism fares in its original domain of particle physics, it can readily be seen that if we treat it as a universal principle, it fares poorly in the domain of population genetics. The existence of the relevant entities—in this case, populations of organisms—is not in dispute. But the fact that experimental realism is flatly antirealist with respect to models means it cannot endorse the assertion that stochastic models of selection are more realistic than deterministic models of selection. This is a problematic result because, as we have seen, this particular assertion serves an important purpose in the practice of population genetics.

I have only discussed two instances of the global method here. It would be impossible to argue conclusively that all unified ontological principles must fail. However, the success of any unified principle would require that the purposes served by ontological assertions are homogeneous across all domains of empirical inquiry, and this is an empirical posit that has not yet been adequately furnished with evidential support.

5. The method of local operationalizing

The local method tackles questions of realism in a radically piecemeal fashion, prioritizing the needs of particular domains of empirical inquiry. It does this by adopting or rejecting the ontological assertions recommended by various realisms and antirealisms on particular questions in particular empirical domains. However, there are no strict boundaries between domains of empirical inquiry. In any application of the local method, the question at hand will determine what counts as "local," that is, which domains are relevant.

Questions about the relative realism of stochastic and deterministic models of selection can be handled by considering the practice of evolutionary biology. If there is an ontological principle to be extracted from our consideration of these models in the previous sections, it might look something like this: If models *A* and *B* are both predictively successful, but *B* is recovered only as a special case of *A* in some limit under conditions that do not ever occur, and *B* is not needed to explain any phenomena that *A* cannot explain, then *A* should be regarded as more realistic than *B*. This is inherently a somewhat localized principle because it only applies to models that stand in a specific relation to one another; but we also should not assume blindly

[8] Neither should we, in all cases, remain staunchly quietist on the relative realism of individual modeling assumptions (c.f. Andersen 2023).

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that it is the right principle to follow in domains beyond evolutionary biology. We should not blindly assume, for instance, that it fares well in the domains of particle physics and chemistry, where Hacking's and Chang's accounts were developed.

We might also be curious whether we should think of the probabilities in stochastic models of selection as representing objective dynamical possibilities or merely our own uncertainties, as well as how those probabilities relate to the probabilities of physics (e.g., relations of reduction or autonomy). Questions like these will not necessarily respect any strict border between evolutionary biology and statistical mechanics or quantum mechanics. When seemingly disparate domains of inquiry come into contact, the local method demands that we settle upon the ontological principles that outperform their competitors at facilitating empirical inquiry in each domain, and in their intersections. This situation may call for a single ontological principle, or many.

It is important to recognize that the local method makes no antecedent commitment against the unification of ontological principles *as an end result*; it only makes a commitment against this unification *as a methodological starting point*. By the same token, the local method makes no antecedent commitment to realism or antirealism on any particular issue. The ontological principle I extracted from the previously mentioned population-genetics case study only concerns relative realism, and so it only rules out the strictest of antirealisms. This may be unsatisfying to many. But it must be appreciated that the local method will dissolve realism debates rather than declaring a decisive victor whenever the debate has no consequences for empirical inquiry. From the pragmatist perspective, this is a strength of the local method.

It may also be unsatisfying that the local method is described only briefly here in this article. But little more can be said about the local method here without simply applying it to new case studies from the practice of science. What will result from such repeated applications of the local method is a landscape of small victories, defeats, or apathetic draws for the many realisms and antirealisms on offer.

A unified ontological principle could be recovered from the local method just in case the value of that principle could be demonstrated for all ontological questions in all domains of empirical inquiry. Admittedly, this is a daunting task, but this merely indicates the implausibility of the hypothesis that there can be any fruitful unified ontological principle. However, if such a fruitful unity were achievable, it could be uncovered by leveraging a methodology that is already quite familiar to pragmatist philosophers of science: integrated historical and philosophical investigations of actual scientific practice.[9]

Pragmatists have, to this point, tended to employ global ontological principles. But the pragmatic utility of this strategy depends on whether the purposes served by ontological assertions are homogeneous across all domains of empirical inquiry, and this is an empirical posit that has not been furnished with sufficient evidential support. With no small measure of irony, it is therefore fitting to conclude with C. S. Peirce's famous dictum: "Do not block the way of inquiry!" (Peirce [1898] 1958).

[9] Hasok Chang is a notable pioneer of this very methodology of integrated history and philosophy of science (HPS) (Chang 2004, 2012). My contention is that integrated HPS ought to be coupled with the method of local operationalizing.

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References

Abrams, Marshall. 2006. "Infinite Populations and Counterfactual Frequencies in Evolutionary Theory." *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 37 (2):256–68. https://doi.org/10.1016/j.shpsc.2006.03.004.

Andersen, Holly. 2023. "Trueing." *In The Pragmatist Challenge: Pragmatist Metaphysics for Philosophy of Science*. Oxford University Press. https://philarchive.org/rec/ANDT-3.

Asay, Jamin. 2019. "Going Local: A Defense of Methodological Localism About Scientific Realism." *Synthese* 196 (2):587–609. https://doi.org/10.1007/s11229-016-1072-6.

Batterman, Robert W. 2001. *The Devil in the Details: Asymptotic Reasoning in Explanation, Reduction, and Emergence*. Oxford University Press. https://doi.org/10.1093/0195146476.001.0001.

Batterman, Robert W. 2009. "Idealization and Modeling." *Synthese* 169 (3):427–46.

Blount, Zachary D., Richard E. Lenski, and Jonathan B. Losos. 2018. "Contingency and Determinism in Evolution: Replaying Life's Tape." *Science* 362 (6415):eaam5979. https://doi.org/10.1126/science.aam5979.

Boyd, Nora Mills. 2018. "Evidence Enriched." *Philosophy of Science* 85 (3):403–21. https://doi.org/10.1086/697747.

Bridgman, Percy Williams. 1927. *The Logic of Modern Physics*. New York: Macmillan. http://archive.org/details/logicofmodernphy00brid.

Brown, Matthew J. 2012. "John Dewey's Logic of Science." *HOPOS: The Journal of the International Society for the History of Philosophy of Science* 2 (2):258–306. https://doi.org/10.1086/666843.

Chang, Hasok. 2004. Inventing Temperature: Measurement and Scientific Progress. *Oxford Studies in Philosophy of Science. Oxford: Oxford University Press.*

Chang, Hasok. 2012. *Is Water H2O? Evidence, Realism and Pluralism*. Boston Studies in the Philosophy of Science 293. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-3932-1.

Chang, Hasok. 2016. "Pragmatic Realism." *Revista de Humanidades de Valparaíso* 8:107–22. https://doi.org/10.22370/rhv2016iss8pp107-122.

Chang, Hasok. 2022. *Realism for Realistic People: A New Pragmatist Philosophy of Science*. Cambridge: Cambridge University Press. https://doi.org/10.1017/9781108635738.

D'Agata, Erika M. C., Pierre Magal, Damien Olivier, Shigui Ruan, and Glenn F. Webb. 2007. "Modeling Antibiotic Resistance in Hospitals: The Impact of Minimizing Treatment Duration." *Journal of Theoretical Biology* 249 (3):487–99. https://doi.org/10.1016/j.jtbi.2007.08.011.

Dewey, John. 1938. *Logic: The Theory of Inquiry*. New York: Henry Holt and Company, Inc. http://archive.org/details/JohnDeweyLogicTheTheoryOfInquiry.

Fine, Arthur. 1984. "And Not Anti-Realism Either." *Noûs* 18 (1):51–65. https://doi.org/10.2307/2215021.

Fine, Arthur. 1986. *The Shaky Game: Einstein, Realism, and the Quantum Theory*. Chicago: University of Chicago Press.

Hacking, Ian. 1983. *Representing and Intervening: Introductory Topics in the Philosophy of Natural Science*. Cambridge: Cambridge University Press.

Haraway, Donna. 1988. "Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective." *Feminist Studies* 14 (3):575–99. https://doi.org/10.2307/3178066.

Heffernan, Jane M, and Lindi M Wahl. 2002. "The Effects of Genetic Drift in Experimental Evolution." *Theoretical Population Biology* 62 (4):349–56. https://doi.org/10.1016/S0040-5809(02)00002-3.

James, William. 1907. *Pragmatism*. Dover Publications, Inc.

Karlin, Samuel, and Howard M. Taylor. 1974. *A First Course in Stochastic Processes*. 2nd ed. Academic Press.

Kimura, Motoo. 1964. "Diffusion Models in Population Genetics." *Journal of Applied Probability* 1 (2):177–232. https://doi.org/10.2307/3211856.
Norton, John D. 2012. "Approximation and Idealization: Why the Difference Matters." *Philosophy of Science* 79 (2):207–32. https://doi.org/10.1086/664746.
Norton, John D. 2024. *The Large-Scale Structure of Inductive Inference*. Calgary: University of Calgary Press.
Nowak, Martin A. 2006. *Evolutionary Dynamics: Exploring the Equations of Life*. Cambridge, MA: Belknap Press.
Peirce, Charles S. 1958. *Collected Papers of Charles Sanders Peirce, Volumes VII and VIII: Science and Philosophy and Reviews, Correspondence and Bibliography*, edited by Arthur W. Burks. Cambridge, MA: Belknap Press.
Putnam, Hilary. 1981. *Reason, Truth and History*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511625398.
Ruetsche, Laura. 2015. "The Shaky Game +25, or: On Locavoracity." *Synthese* 192 (11):3425–42. https://doi.org/10.1007/s11229-014-0551-x.
Sarkar, Sahotra. 2011. "Drift and the Causes of Evolution." In *Causality in the Sciences*, edited by Phyllis McKay Illari, Federica Russo, and Jon Williamson, 445–65. Oxford University Press.
Sidzińska, Maja. 2024. "A Pragmatist Interpretation and Defense of Entity Realism." *European Journal of Pragmatism and American Philosophy* XVI (1). https://doi.org/10.4000/11p4w.
Wakeley, John. 2008. *Coalescent Theory: An Introduction*. Greenwood Village, CO: W. H. Freeman.
Woodruff, David S. 2001. "Populations, Species, and Conservation Genetics." *Encyclopedia of Biodiversity*, 811–29. https://doi.org/10.1016/B0-12-226865-2/00355-2.

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