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Idealizations in Science and Interventionist Causation

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Angela Potochnik's *Idealization and the Aims of Science* sorts out a number of debates on the epistemology and metaphysics of scientific representations that prove usefully false. Such purposely false representations Potochnik calls "idealizations," and she argues that because idealizations rarely undergo excision from science, philosophy needs to account for their role in the explanation of phenomena and the organization of scientific methods (2). The main corollary of her argument is that science pursues understanding rather than truth, and so she expects metaphysical import from science to be minimal.

Chapter 1 primes the intuition that whatever the purpose of idealizations in science, they are *not* means to a complete and perfect theory of the universe. To support her claim, Potochnik highlights the dependency of scientific pursuit on the aims of "limited human beings . . ." (7). She documents a change over time in field observations and research topics within primatology, for example, a change which according to Potochnik resulted from women entering the mostly-male discipline. Nor does Potochnik surmise that scientists actually

pursue or expect to achieve a teleological end of scientific inquiry. To motivate the contrary view, she examines the Human Genome Project. While praising its collaborative successes, Potochnik points out that researchers still face obstacles to predicting disease incidence from gene correlation, and that the project accounts for neither microbial nor environmental effects on human traits. Her point is that the profitable study of a complex world requires the employment of idealizations: analyzing human heritability "*as-if*" (57) the influences of microbiome and environment can be neglected.

Potochnik's technical term for 'effect' and 'influence' is "causal pattern," (23) which she defines in Chapter 2. By "patterns," she means "regularities exhibited by phenomena" (27), and by 'causal' she means analyzable according to a manipulability or interventionist account of causation, such as that found in James Woodward's *Making Things Happen* (published 2003), which Potochnik endorses (29). To employ a manipulability account (roughly characterized), a theorist holds certain system variables 'fixed'; then the theorist toggles an unfixed variable to ascertain if other unfixed variables toggle, inferring a cause according to certain rules of counterfactual dependence. The agent's role in assessing the manipulability relation, moreover, is what Potochnik finds (28) to justify "rampant and unchecked" (41) idealizations in science. Idealizations are rampant, because they exist in the "best" theories (41); they are unchecked because few scientists "eliminat[e]" them from theories (42). Potochnik affirms that idealizations are "positive" representations of causal patterns (50), not abstractions that merely 'ignore' or 'omit' certain details (55). As an example, she depicts a passenger rail map. Rail stations are *not* evenly spaced in a straight line through San Francisco, but such an idealization is *precisely* what renders the map useful to commuters (50-51). In accord with her metaphysical reservations, Potochnik declines to treat causal patterns as laws that obtain of necessity. Regularities in the world tend to have exceptions (28, 155).

In Chapter 3, Potochnik surveys idealizations more scientific than railway maps. Behavioral ecologists discriminating "reciprocal altruism" from "kin selection" or

"group selection" (63) models of food-sharing among vampire bats, for example, find the prisoner's dilemma model salient for representing reciprocal altruism. Such salience depends, however, upon the researchers' purposefully (mis-)representing the bats 'as-if' they reproduce asexually and number infinitely large. Yet as Potochnik clarifies, each of the three model types facilitates the same, scientific "aim" of studying the causal pattern of natural selection (67). She concedes that more causes than natural selection affect the evolution of traits, and that reciprocal altruism may not obtain for all evolutionary timescales. Thus Potochnik reviews similar trade-offs and philosophical controversies about idealizations in behavioral and molecular genetics (human aggression), climate research, and the physical sciences (Batterman on fluid dynamics, Bokulich on electron orbitals).

Having portrayed idealizations in science as a "division of labor" (74) among useful falsities, Potochnik commences Chapter 4 and its self-titled thesis, "Science Isn't after the Truth." Transcending the trivial claim that no laborer expects perfection, Potochnik denies that most scientists even seek "successive approximation" to truth (90). They instead seek *understanding*. Potochnik distinguishes understanding as both "a cognitive state and an epistemic achievement" (94). As cognitive, understanding depends for its existence on the psychological states of understanding agents, a dependency that Potochnik finds unnecessary for truth (94). On the other hand, to render understanding an achievement, Potochnik does incorporate a "threshold requirement" for truth (95). As she parses Catherine Elgin, "a claim must be 'true enough' to be epistemically acceptable" (95), and on Potochnik's account, acceptable means *understandable* (100). Thus she renders truth an instrumental (117), threshold function of understanding, a threshold that varies with scientific aim (96). Qualifying her claim, however, Potochnik denies that understanding is the *solitary* aim of science. She observes that science sometimes promotes "action within a short time span," or "accurate prediction…" (98). Anticipating the charge of scientific antirealism, Potochnik denies it, maintaining that "truths of causal patterns are by and large partial truths about

phenomena, accomplished with the use of idealizations" (119). Causal patterns are "real," Potochnik explains, but phenomena are that which become understood (119).

What promotes understanding, on Potochnik's account, is scientific explanation (123), the topic of Chapter 5. Potochnik claims that explanations prove "adequate" (though not necessarily "*good*", p. 158) when representations of causal patterns, "together with idealized assumptions, must entail the explanandum…" (155). To this definition of explanatory adequacy, she proposes two caveats. Firstly, the 'entailment' cannot be a hard, logical entailment, since as mentioned above, "causal patterns tend to have exceptions" (156). Secondly, Potochnik argues that non-idealized entailments lack "scope," or an identification of the "range of circumstances" (136) under which to expect or apply the causal pattern of interest. An agent resembling Laplace's Demon, for example (Potochnik does not mention Laplace, but the similarity in her example is obvious), who knows both the present configuration of all matter and all laws of physics, lacks the scope to explain anything (cf. 140). Potochnik criticizes philosophers such as Michael Strevens and David Lewis for over-emphasizing the Laplacian "ontic approach" to explanation (127), and she demonstrates advantages of non-ontic, "communicative" approaches (123) in two explanations of bird coloration; explanations that vary by "research program…" (150-151).

With agency, understanding, and explanation thus prioritized in her philosopohy of science, Potochnik concludes her book with criticisms of metaphysics. In Chapter 6, she calls for a wholesale abandonment of talk about "levels" in mechanistic explanation, and in other, scientific domains (185). Levels, as Potochnik describes them, purport to structure the "composition, scale, metaphysical determination, and causal dependence" of phenomena (161). Against this purported utility, she demonstrates not only a research-aim *relativism* about levels, but also the "incomparable" functions that an entity may perform at different levels (183). Her examples include the non-metaphysical reality of camouflage in nature, and the integration of levels within an ecosystem, an integration that she finds to defy traditional hierarchy (171).

Chapter 7 again recommends "caution" (207) against extracting metaphysical insights from a science filled with idealizations.

Overall, Potochnik's book proves informative and well-sourced, and she summarizes each chapter and major idea with a clarity not exhibited by other philosophers. Two criticisms, however, bear mentioning. Firstly, she ignores an embarrassing counterexample to Woodward's interventionist causation. As demonstrated by Eric Hiddleston in 2005 ("Causal Powers," doi:10.1093/phisci/axi102), a Woodwardian[1] agent threatened with a potential, poisonous terror attack, who pre-emptively ingests an antidote to the poison, but then emerges from his bunker the next day to learn that no poison was in fact released, still has to credit the antidote as a *cause* of his survival in that particular instance. Now, what is a scientist to think of this counterexample? Endorsing it as a 'vehicle for understanding' (cf. Potochnik, 123) would be sardonic at best, and dangerously bogus medical advice at worst. I do not claim that Woodward has no possible responses to Hiddleston, but Potochnik should paint a more sober picture of pending challenges.

Secondly, I picked up *Idealization and the Aims of Science* because of my interest in the most widespread, scientific idealization of all: mathematics, and its curious (or not) applicability to science. To my chagrin, Potochnik treats very little of mathematical themes, relegating them at a stroke to the domain of 'non-causal' explanation (143), and that somewhat unfairly. For example, when she claims that "there is simply no basis for asserting that scientific representations relate metaphysically" (175), I ask: What about the mathematical relations between representations? (Cf. Potochnik, 18, where she almost engages this point.) In Potochnik's own words, scientific progress sometimes depends on "refined relatives of [some] original pattern" (121), but in my view, such refinements are unquestionably often *mathematical* refinements. What explains the success of mathematical refinement? And are not mathematical relations paradigmatically *true*, if anything is? For a second example, on the topic of explanation, Potochnik identifies one explanandum as "heritable variation in smoking initiation among humans" (154). But what is variance? According to science, variance is

standard deviation *squared*, a *mathematically* defined concept. Even if 'variation' is not strictly 'variance' (I cannot tell from the context), no public health researcher long ignores variance. Thus, a word on why mathematics seems to help *all scientists* achieve understanding would have been enlightening. The ironic upshot is that realist sympathies for the efficacy of mathematical idealizations do not seem strongly muted by Potochnik's book.

Notes

[1] Hiddleston (2005) does not explicitly mention Woodward, but the account he attacks finds endorsement in Woodward's *Making Things Happen*, pp. 83-84ff.

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