DRAFT: COMMENTS WELCOME :)

Aimless Progress and the Myth of the Constitution-Promotion Distinction

KABIR S. BAKSHI
History and Philosophy of Science, University of Pittsburgh
kabir.bakshi@pitt.edu

Abstract A central question in philosophy of science and epistemology of science concerns the characterization of the progress of science. Many philosophers of science and epistemologists have developed accounts of scientific progress, laying down desiderata for and providing success criteria of any account of scientific progress. Extant accounts of scientific progress are surveyed and critically assessed and it is shown that all face the same problem. The *constitution-promotion distinction* – a commitment shared by all the accounts – is identified as the root of the problem for the extant accounts. In their place, a novel way of understanding scientific progress – inspired by pragmatic philosophy of science and zetetic epistemology – which rejects the problematic constitution-promotion distinction, and importantly, which provides a vision of scientific progress without depending on the aim of science is developed.

1 INTRODUCTION

Science progresses. It progresses – maybe not all the time and maybe sometimes not as fast as others – but that it does seems *so* natural, *so* obvious, *so* plain. This thought is so natural that one finds it proclaimed in all sorts of places: from the United States Constitution to pages of fiction novels and from bills in the Congress to the Universal Declaration of Human Rights.[1] The idea of scientific progress is, in a very real sense, constitutive of our image of science. On this image, science cannot still be science if it stands still, if scientists do not discover more, if it does not change for the better, if it does nor progress.

Given the importance of scientific progress to our image of science, it is unsurprising that conceptual theorizing about scientific progress has been one of the central questions in philosophy of science and epistemology of science (Bacon wrote about it and so did Whewell and Huxley and Koyre and Carnap and Kuhn and Longino and Daston (Kiernan 2000; Rees 2004; Whewell 2013; Huxley 2012; Koyré 2008; Carnap 1966; Kuhn 2012; Longino 1990; Daston 2023).) The question of how best to characterize scientific progress has been asked many times. However, in recent years it has regained an urgency with theorists in philosophy of science and epistemology bringing new ideas from their fields to offer different accounts of scientific progress (Bird 2007; Bird 2010; Bird 2019; Bird 2023; Dellsén 2016; Dellsén 2018; Dellsén and Norton forthcoming; Dellsén 2021; Shan 2019; Shan 2022; Stegenga 2024; Niiniluoto 2014; Niiniluoto 2022; Rowbottom 2008; Rowbottom 2010; Rowbottom 2015).[2]

In this paper, I argue that present contemporary theories of scientific progress are incomplete and ill-suited to the scientific practice. Contemporary theories occupy an uneasy position, judging erroneous developments to progress science but judging the bulk of scientific work – including science done everyday in laboratories and on chalkboards and the development of methods and techniques – to be devoid of any value in progressing science. Hence they neither provide sufficient nor necessary criteria for identifying scientific progress. I locate the root of the failure of contemporary accounts on

1 The Patent and Copyright Clause of the United States Constitution grants the Congress the power "to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries" (U.S. Const., art. I, § 8, cl. 8.). The title of the bill that founded the NSF – the National Science Foundation Act of 1950 – is "An act to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and other purposes" (H.R.4346 1950). See also Article 27(1) of the UDHR ("Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits") and Article 15(1)(b) of the International Covenant on Economic, Social and Cultural Rights ("The States Parties to the present Covenant recognize the right of everyone:. . . b) To enjoy the benefits of scientific progress and its applications").
2 Some in the pages of this very journal: Bird 2007; Dellsén, Lawler, and Norton 2022.

the incoherence of an assumption common to all accounts – *the constitution-promotion* distinction. In light of these pathologies these theories must be rejected. But instead of providing an alternative cast in the same mold, I shift the discussion of scientific progress away from one conceptualized in terms of ideal end goals and the fulfillment of aims toward a conceptualization of scientific progress which is aimless. This paradigm shift – from a paradigm of progress conceptualized as progress toward to a paradigm of progress as progress from – affords the development of a new kind of account of scientific progress, inspired by recent developments in pragmatic philosophy of science and zetetic epistemology, which is better fit to scientific practice and paints a fuller picture of contemporary science.

If the view espoused here is right, the implications are fourfold. First, the core argumentative strategy used by all parties in the presently hotly contested debate on scientific progress is undermined. The discussions in this paper call into question the efficacy of defending an account of scientific progress and criticizing others by appealing to vignettes of scientific episodes (both historical and hypothetical) (Bird 2023; Dellsén, Firing, et al. 2024; Rowbottom 2015; Niiniluoto 2022). The identification of the myth of the constitution-promotion distinction points to the exact locus of these difficulties.

Second, the discussion places a strong constraint on future theories of scientific progress. On the one hand, any theory which relies on a constitution-promotion like distinction will face similar pathologies involving erroneous judgments. On the other, explaining scientific progress in everyday non-revolutionary and practice-informed science is identified as a positive duty which any theory of scientific progress must discharge. As I argue, contemporary theories fail on both of these constraints.

Third, the conceptual framework through which progress is analyzed is modified. Instead of conceptualizing progress teleologically, progress is conceptualized in an atelic ‘aimless’ fashion. Scientific progress is not thought of as marching toward a final ideal goal and a development is not to be judged on its movement toward it. Rather, scientific progress is better thought of as a move away from the current state and the progressiveness of a development is judged on the difference it brings about with respect to the current state. Progress is not directed toward the future, it is directed away from the past.

This change in conceptualizing scientific progress has implications in areas of philosophy far-away from philosophy of science and epistemology, including metaethics (Kumar and May forthcoming; Forst 2017), social philosophy (Kitcher et al. 2021; Buchanan and Powell 2018), and aesthetics (Agassi 2003) to list a few.

And finally, meditating on these important questions of progress, scientific change, and aims of science has ramifications for meta-philosophy generally. In particular, a closer integration of general epistemology and philosophy of science is not only on fruitful but necessary for making progress on these questions. The framework of zetetic epistemology bears on the debate on scientific progress in the philosophy of science which in turn has a deep impact on unresolved questions in zetetic epistemology (Friedman 2017; Friedman 2020; Friedman 2024). In this spirit of broad discipline-level aim, a sustained meta-philosophical point drives throughout this paper: the 'received' methodology of general accounts of scientific progress proffered by epistemologists and philosophers of science relying on a 'Laudanian' model of confrontation of philosophical theses by hypothetical and historical cases is unsatisfactory and ill-suited (Donovan, L. Laudan, and R. Laudan 1988; Schickore 2011).

The structure of the paper is as follows. Section 2 highlights the importance and centrality of methods and techniques in science and to scientists. Three contemporary theories of scientific progress are presented in section 3 and it is argued that none of them are able to judge developments in methods and techniques as progressing science unless they appeal to the constitution-promotion distinction (section 4). Section 5 contains considerations against the coherence of the constitution-promotion distinction, bringing forth the problem of irrelevant developments. A new atelic account of scientific progress which ditches the paradigm of progress as progress toward an ideal end goal and adopts the progress as progress from paradigm is introduced and developed in sections 6-8. These sections also contain discussions of the influences on the account from zetetic epistemology and pragmatic philosophy of science, along with a presentation of some features of the account. Section 9 concludes by touching on the consequences of this paper on some wider issues in general philosophy, away from the narrow ambit of epistemology of science and philosophy of science.

2 THE IMPORTANCE OF METHODS AND TECHNIQUES

Here is a fun tidbit: of the hundred most cited scientific papers, about eighty papers are exclusively about development in scientific methodology or techniques (Noorden, Maher, and Nuzzo 2014). Surprisingly, most works often considered to have precipitated scientific revolutions are not to be found in the top hundred. Neither any of Einsteins *annus mirablis* papers nor Watson and Cricks 1953 DNA paper are included in the list for example. The most cited scientific paper describes an assay to determine the amount of protein in a solution (Lowry et al. 1951).[3] Compared with Einsteins 1905 Special Relativity paper – "On the Electrodynamics of Moving Bodies" – Lowry et al. 1951 has around eighty-five times more citations. Of course, citation metrics are imperfect and comes with many caveats. And of course, this is not to say that the analysis in Noorden, Maher, and Nuzzo 2014 imply that Lowry et al. 1951 is eight-five times more influential than Einstein 1905!

The point I am making here is much more modest: the fact that the vast majority of the most cited scientific papers are exclusively about methods and techniques unambiguously shows that scientific methods and techniques are highly prized by scientists and the scientific community. A new technique, an improved method, a quicker algorithm, or an efficient tool has vast importance for science and scientists.[4]

This point can be made in a bit more detail by looking at an example of a scientific technique: Feynman diagrams in physics (Feynman 1949). Very roughly, in quantum electrodynamics (QED) and quantum field theory (QFT), Feynman diagrams help in calculating amplitudes in sub-atomic interaction processes. The diagrams make the calculations comparatively extremely simple and intuitive. It is uncontroversial to say the least that Feynman diagrams

3 As of January 2025, Lowry et al. 1951 has been cited 234,261 times (via Google Scholar). The method described in the paper is now called the Lowry method after the lead author of the paper.
4 An objection to using citation metrics to show my point can be raised: citations are influenced by lots of sociological and contingent matters and hence the data from citations is full of noise and useless. Suffice to note that a cursory glance at Nobel prizes and other awards and signifiers of professional achievements show that same point: discoveries and improvements of scientific methods and techniques tools are highly prized. Thanks to [omitted for review] for raising this point.

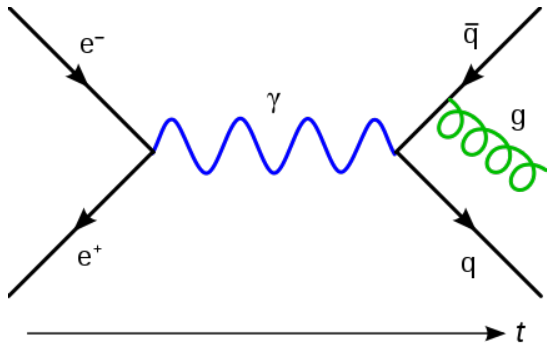

Figure 1: A Feynman Diagram representing a e^+e^- interaction.

progressed science. Heres Nobel prize winning physicist Frank Wilckzek:

> Feynman diagrams remain a treasured asset in physics ... The calculations that eventually got me a Nobel Prize in 2004 *would have been literally unthinkable without Feynman diagrams*, as would my calculations that established a route to production and observation of the Higgs particle. (Wilckzek 2016, emphasis mine)

Wilckzek makes a strong claim: without Feynman diagrams, not only would have his discoveries been difficult, but they would also have been unthinkable. David Kaiser in his book length treatment of the influence and impact of Feynman diagrams in post-war physics shows that Feynman diagrams revolutionized all areas of theoretical physics (Kaiser 2005, p. 156).

Example illustrating the importance of methods and techniques in science and to scientists are numerous and spread across all sciences (and not just high energy physics or molecular chemistry). Indeed a look at the contemporary landscape (and not just historical development of a science) proves this point clearly. From techniques used in DNA sequencing in biochemistry to proof assistants in mathematics (Hartnett 2020; Scholze 2021) and from data visualization techniques in ecology and developmental biology (Weinstein 2008) to AI and LLMs that predict protein folding structures (Google DeepMind 2020) major advances, major *progresses* in science happen with the development and improvement of methods and techniques.

Thus any theory of scientific progress must be able to capture the importance of methods and techniques in science and must be able to judge developments in them to progress science.

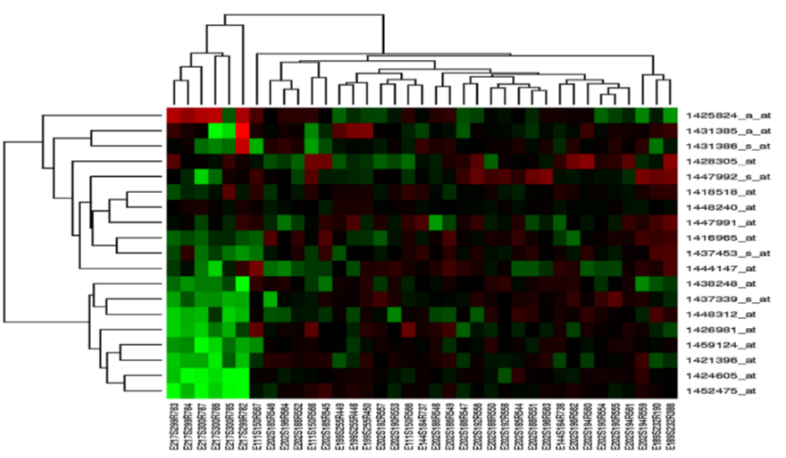

Figure 2: A cluster heatmap based on Eisen et al. 1998. The columns represent genes, the rows samples, and the color of each cell is correlated with the degree of expression of the gene.

3 THE FAILURE OF CONTEMPORARY THEORIES

Contemporary theories of scientific progress are unable to explain either the importance of methods and techniques in science or the positive appraisal of their development by scientists. This explanatory deficiency makes them unsuitable as theories of scientific progress. In this section I will focus on three major contemporary theories of scientific progress and show how they all fall short.[5]

The three contemporary theories I evaluate are:

EPISTEMIC On the epistemic theory, a scientific episode progresses science just in case there is an increase in the accumulation of scientific knowledge between the start and the end of the scientific episode (Bird 2007; Bird 2022; Bird 2023). Thus, scientific progress is identified with an increase in scientific knowledge.

5 The most famous theory of scientific progress which I won't engage with here is what is sometimes called the *functional-internalist account* of scientific progress. On it, scientific progress is identified with the successful achievement of some specific function (for e.g. problem solving) (Kuhn 2012; L. Laudan 1977). I will not engage with this account in this paper because (i) my argument showing the inability of the contemporary theories to explain the importance of methods and techniques apply mutatis mutandis and (ii) I feel the force of earlier arguments raised against the functional-internalist accounts (Bird 2007, §2.2, §4).

veracious On the veracious theory, a scientific episode progresses science just in case there is an increase in the accumulation of true propositions between the start and the end of the scientific episode (Niiniluoto 2014; Niiniluoto 2022; Rowbottom 2015).[6] Thus, scientific progress is identified with an increase of truth.[7]

noetic On the noetic theory, a scientific episode progresses science just in case there is an increase in the scientific understanding between the start and the end of the scientific episode (Dellsén 2016; Dellsén 2021; Dellsén, Firing, et al. 2024). Thus, scientific progress is identified with an increase in scientific understanding.

Consider the class of techniques and methods (for e.g. separation of variables) that are classified under calculus, something an undergraduate studying engineering or chemistry might learn. The developments and improvements in these techniques and methods (for e.g. development of methods to solve partial differential equations) have nothing to do with the accumulation of more truths (or to an increase in verisimilitude). The development of (say) the finite volume method to solve partial differential equations is not true anymore than the development of the Allen wrench is true. Of course, that the development of the finite volume method led to more truths (or an increase in verisimilitude) is undeniable, but that the development in or improvement of the finite volume method itself increases the accumulation of truths is infelicitous and a category mistake. The veracious theory is unable to explain the importance of these and other methods in (and which are central to) science and is thus an unsatisfactory theory of scientific progress.

Arguably the development of techniques and methods of calculus increased scientific knowledge. After the development of (for e.g.) the theory of Bessel

6 Since his publications defending the veracious account, Rowbottom has recently distanced himself from it (Rowbottom 2023).
7 What I call the veracious theory is better known in the literature as the semantic theory. I use the my terminology because I think 'semantic' brings in unintended implications from the heated semantic-syntactic debate in philosophy of science. For what it is worth I think that the veracious account is not wedded to a semantic approach to scientific theories (on which scientific theories are thought to be a set of propositions in a language) and can be straightforwardly modified to the syntactic approach (on which scientific theories are thought to be a collection of models). I bracket this point since it is orthogonal to my considerations in the present paper.

functions, we knew how to solve a certain class of differential equations. But lets jump to the twentieth century and consider the development of Niobium-titanium (Nb-Ti) superconducting magnets. Nb-Ti magnets are currently the most widely used superconducting magnets because of their desirable properties, including easy workability and cost effectiveness. They have been put in use for many different applications: MRI scanners, Maglev trains, and particle accelerators. Consider, in particular, the development of the Nb-Ti magnets used in the Large Hadron Collider (LHC). The NB-Ti superconducting magnets are essential to the LHC. More than ten-thousand of them are used for various purposes in the LHC, including directing and stabilizing the particle beams, measuring the particles produced in the collisions, and cleaning the beam after collisions.[8] In proton-proton colliders (and synchrotrons more generally) – like the LHC – the beam energy (E) is directly proportion to the field strength in the dipole magnets (B) and the bending radius of the dipole magnets (R):

$$E \approx 0.3\,B\,R \quad (\text{TeV; tesla; km})$$

So, to get to a desired energy level (the LHC currently runs at 13 TeV center-of-mass energy or 7.5 TeV for each of the two beams at the LHC) the strength of the magnets is crucial. At the LHC, the Nb-Ti dipole magnets produce fields of 8.3 tesla and have a bending radius of 2.8 kms. This allows the LHC to produce collisions of 13 TeV, almost 10 times larger than any predecessor collider (Rossi 2010; Evans 2007). The development of the superconducting magnets used in the LHC represent a clear case of scientific progress. For instance, much like Wilckzeks assertion about Feynman diagrams, the detection of the Higgs Boson in 2012 would have been unthinkable without the development of magnets.

The epistemic theory of scientific progress is unable to explain the importance of these superconducting magnets. Claim: there was no knowledge creation in the development of the *specific* Nb-Ti magnets used in the LHC. The development was the magnets used at the LHC was a technological achievement and not an epistemic achievement. Technological progress can sometimes be scientific progress (as in the case of the LHC magnets) and thus a theory of scientific progress which cannot accommodate this is unsatisfactory.

8 Currently, the LHC has 1734 large magnets, 1232 main dipole magnets, and 7724 smaller size superconducting corrector magnets (CERN 2012).

A possible rejoinder may be to appeal to the notion of knowledge-how and argue that there was knowledge creation in the development of those magnets because there was an accumulation of knowledge-how: an increase in the knowledge of how to manufacture Nb-Ti magnets. But that is incorrect. The theoretical and practical knowledge of how to make Nb-Ti magnets were established well before the specific magnets used in the LHC were actually manufactured (Berlincourt and Hake 1963). The magnets used in the LHC were produced by the Superconducting Magnet Division of the Brookhaven National Laboratory during the 2000s which in the 1980s, first also constructed Nb-Ti magnets to be used in the doomed Superconducting Super Collider (Laboratory 2025). All the following stages progressed science: there was progress when the theoretical viability of the Nb-Ti magnets was first established, there was progress when the practical know how of the magnets became know, and there was progress when the *specific* magnets used in the LHC were manufactured. Depending on what positions one holds about the relationship between knowledge-that and knowledge-how (Pavese 2022), the epistemic theory may validate some of the three stages as episodes of scientific progress but fails to do for all three.[9]

As far as one considers understanding to be a species of knowledge the above considerations also show the failure of the noetic theory to explain the importance of methods and techniques in science (Williamson 2000; Bird 2024). Eitherway, the noetic account faces other similar challenges. Sticking with methods and techniques employed in the LHC, consider the usage of machine learning techniques in the LHC.[10] Electronic triggers using machine learning algorithms are used in the detectors in the LHC to select potentially important collisions from the millions of collisions which happen every second in the LHC. In addition to capturing interesting collisions, machine learning techniques are used in a whole host of different applications at the LHC. They are used to reconstruct particles track; identify particles, for e.g. identify electrons, photons and the τ; distinguish interesting events from background

9 Thanks to [omitted] for discussion on this point and for encouraging me to expand on it.
10 The use of machine learning techniques is widespread in modern science and is only continuing to become more prevalent and integral. Most notably, machine learning techniques are heavily used in climate modeling, disease detection, epidemiological research, cancer detection, and even in paleontology. For general epistemic issues raised by the usage of machine learning see Winsberg 2010.

events; classify jet-flavours; and search for particles, for e.g. t(op) quark and Higgs boson.

The indispensability of machine learning techniques in the LHC, and in modern science more generally, is problematic for the noetic theory. Indeed, recent works in the philosophy of science and the philosophy of AI, for example Roxlo and Reece 2018 and Sullivan 2022, have stressed that on the present conceptions of understanding, it is difficult to attribute understanding to machine learning procedures. Roxlo and Reece summarize the concerns with the use of machine learning techniques in the high-energy physics:

> However, machine learning solutions in general and neural networks in particular often have the problem of being relatively opaque in their operation. ... it is fair to say that the black box nature of neural networks remains a concern for many working particle physicists. (Roxlo and Reece 2018, p. 2)

Machine learning techniques are indispensable in modern science and their development represents a clear case of scientific progress. A theory of scientific progress like the noetic theory which cannot accommodate it is unsatisfactory.

The strategy adopted here may seem unoriginal. After all, the main philosophical move in the debate on scientific progress in philosophy of science and epistemology has been to provide vignettes or case studies which aim to show that a particular conception of scientific progress is untenable. These case studies can be hypothetical or historical. For example Bird 2023 considers hypothetical cases where a development leads to a loss of verisimilitude and Dellsén 2016 uses Einstein's explanation of Brownian motion to argue against Bird's epistemic theory. However what the strategy used in this paper is different and novel. Instead of looking toward scientific episodes (hypothetical and historical) to adjudicate between different theories of scientific progress, the methodology adopted here is to focus on not the content of one specific case study but to focus in general on the importance of methods and techniques for scientific progress. This move away from relying on specific case studies has three immediate benefits. First, internal to history and philosophy of science there are many concerns about the applicability in drawing philosophical conclusions using case studies from science (Schickore 2011; Chang 2012). Second, internal to the philosophical debate on scientific progress, relying on case studies has lead to a constant back-and-forth arguing about the specificities of cases and whether a case supports one theory of scientific progress over the other, shifting the focus away from the conceptual question of progress to questions about the correct interpretation of historical events. This consequence of focusing on specific case studies is illuminated in the exchange between Bird and Rowbottom about the case of the discovery of N-rays (Bird 2007; Rowbottom 2008; Rowbottom 2010). And third, focussing on methods and techniques brings the philosophical debate on scientific progress closer to practice-informed philosophy of science, something which has been not yet been fully appreciated.

This leads to a central point of this paper: the identification and the demythification of the constitution-promotion distinction.

4 THE CONSTITUTION-PROMOTION DISTINCTION

There is a standard approach to explain the importance of methods and techniques in contemporary accounts of scientific progress. This involves by drawing a distinction between the promotion of scientific progress and the constitution of scientific progress. Call this the *constitution-promotion* distinction. The constitution-promotion distinction creates a two-tiered classification of developments: developments that constitute scientific progress and those that merely promote it (as we will see later in section 5, the constitution-promotion distinction actually creates a three-tiered classification but for exposition purposes I am here presenting it creating a two-tiered classification):

- **CONSTITUTION** A development *constitutes* scientific progress just when it results in the attainment of the aim of science.
- **PROMOTION** A development merely *promotes* scientific progress when it results in progression toward the aim of science but does not itself result in the attainment of the aim of science.

As is clear, in this bipartite framework, scientific progress can happen in two distinct modes. In the first, corresponding to **CONSTITUTION**, scientific progress happens when developments which constitute scientific progress. In the second mode, corresponding to **PROMOTION** , scientific progress happens when developments merely promote scientific progress. Consider an analogy: I need to get up early tomorrow morning to drop my daughter off at her swimming practice. My aim: waking up early tomorrow. If I wake up early tomorrow, I will attain my goal and hence will constitute progress. To increase the chance that I wake up early tomorrow, I set up an alarm. Succeeding in setting up an alarm is not equivalent to the attainment of my goal but (at least under normal circumstances) it leads to the attainment of my goal by moving me toward my goal of waking up early. Waking up early constitutes progress, setting an alarm for it merely promotes it. Both represent progress toward my goal.

The constitution-promotion distinction is widely employed (both implicitly and explicitly) by all theorists in the discussions on scientific progress to bracket the problem of methods and techniques raised above (explicit endorsements of the distinction can be found in Bird 2023; Dellsén 2018; Niiniluoto 2022). The move is straightforward: developments of scientific methods and techniques do not constitute scientific progress, but merely promote it. So the epistemic theory can explain why the developments of the specific Nb-Ti superconducting magnets used in LHC progress science: they do so not because in their development new scientific knowledge was gained, but because their development led to other developments which increased the accumulation scientific knowledge (for e.g. the discovery of the Higgs boson). The same kind of appeal to the distinction is made by the other two theories. If there is a principled distinction to be made between the mere promotion and the constitution of scientific progress, then this distinction can be used to explain the importance of methods and techniques in the veracious, epistemic, and noetic theories. But the constitution-promotion is incoherent as a distinction.

5 THE MYTH OF THE CONSTITUTION-PROMOTION DISTINCTION

A distinction can be a coherent distinction but be ill-suited for its function. One of the most famous instances of a coherent but (according to some) an ill-suited distinction in contemporary philosophy of science and epistemology of science is Bas van Fraassen's observable-unobservable distinction (Fraassen 1980). Van Fraassen draws a line between entities in a scientific theory which are observable and entities which are unobservable where he takes an entity to observable (roughly) when there are circumstances where a human can observe the entity unaided (Fraassen 1980, p. 16). In principle and depending on the scientific theory and the context the van Fraassenian observable-unobservable distinction can be made clearly, but whether it is a good distinction to be made and relevant to the purposes of the scientific realism/anti-realism debate is another matter. Many philosophers of science do not think that the van Fraassenian observable-unobservable distinction is a good distinction. For example one can push back on the distinction by arguing that it implies observable and unobservable entities to have different modal characters, something which is at odd with van Fraassen's construtive empiricism (Ladyman 2000). In contrast to a coherent but ill-suited distinction – where discussions about the ill-suitedness of the distinction are what's at stake – a distinction can be incoherent. The question of whether the distinction is fit for its purpose does not arise in this case. A philosophical theory relying on an incoherent distinction faces a much more serious challenge than a philosophical theory (like van Fraassen's constructive empiricism) which relies on a coherent but arguable ill-suited distinction. The constitution-promotion distinction employed by contemporary theories of scientific progress belong to the former.

The constitution-promotion distinction is incoherent because there is no stable way to partition developments such that they correspond to one of three categories: developments which (i) merely promote scientific progress (**promotion**); (ii) constitute scientific progress (**constitution**); *and* (iii) have no impact on scientific progress. This is important and something which has no-yet been recognized. Conceptualizing the constitution-promotion distinction as a bipartite partition of all developments misses out on developments which have no impact on whether science progresses or not. In other words, **constitution** and **promotion** do not exhaust all developments. To capture fully the landscape of all developments an additional category is needed:

- **irrelevant** A development is *irrelevant* to scientific progress just when its occurring or not has no impact on the attainment of the aim of science.

There are innumerous developments which can be categorized as **irrelevant**: the abbreviation for the lactose operon Jacques Monod, François Jacob and André Lwoff used in their work on their work on gene regulation (they abbreviated it as 'lac'), the number of guns on the HMS Beagle during its second voyage when Charles Darwin was on-board (it had ten), or the calendar date on which Chien-Shiung Wu performed her parity violation experiments (it was December the 27th). These developments have nothing to do with scientific progress and any theory of scientific progress must be able to categorize these developments as irrelevant.

An appeal to the constitution-promotion distinction makes such the categorization of irrelevant developments as irrelevant impossible. Thus, the constitution-promotion distinction, and theories of scientific progress which rely on it – face the *problem of irrelevant developments*. The claim here is that however the constitution-promotion distinction is drawn, it quickly dissolves, making all kinds developments (including cases of **IRRELEVANT**) cases of **PROMOTION**. The only way out is to not appeal to the constitution-promotion distinction. But without it the contemporary theories of scientific progress fail to discharge the key duty of explaining the importance of methods and techniques in scientific progress.

That problem of irrelevant developments is pathological to the constitution-promotion distinction can be seen by revisiting the condition under which a development counts as progressing science on the contemporary theories. Bird, in his defense of **EPISTEMIC**, puts the consensus position on this issue the clearest. According to him, a development progresses science insofar as "it achieves X, achieves more of X, achieves X better, gets closer to achieving X, or promotes the achievement of X", where X is taken to be the aim of science (Bird 2023, p. 40). Consider an uncontroversial case of **IRRELEVANT**, say the improvements in the living standards of a community. But these improvements lead to scientific progress by, for example, more funding to scientific projects or making it possible for people in the community to spend more time on research rather than worrying about sustenance. Therefore, improvements in living standard of a community promote progress, collapsing a case **IRRELEVANT** into **PROMOTION**. Thus, relying the constitution-promotion distinction and the above condition of the identification of scientific progress provided by Bird, leads to the problem of irrelevant developments.

However it is not out of the question that improvements in livings standards progress science. Indeed, there is a rich tradition of thought – particularly in feminist philosophy of science and the science and values literature – which highlights the importance of societal progress to scientific progress.[11] I am quite sympathetic to these positions and the positive proposal sketched in sections 7-8 is indebted to these positions. The point here however is that if the constitution-promotion distinction is used, there is no point where the

11 Thanks to [omitted] for bringing this point to my attention.

regression of **IRRELEVANT** cases into **PROMOTION** stops. Even if it is possible to consider the improvements of living standards as progressing science, there are innumerous other cases where the problem of irrelevant developments arises. To take a related but sharper scenario which can be found in many historical cases of scientific progress, consider a peace treaty between two warring states. This will, under normal, circumstances lead to (among other things) more investment in education and research which in turn will lead to (among other things) developments which constitute scientific progress. This reasoning can be extended back quite a bit. Using the constitution-promotion distinction, it can be asserted that a general losing a decisive battle which (among other things) led to a peace treaty, progressed science. Sentences like:

(1) The defeat of Confederate forces led by Robert E. Lee at the Battle of Appomattox Court House progressed science.

turn out true if the constitution-promotion distinction is used. This is an unwelcome result because (1) is correctly characterized as a case of **IRRELEVANT**. Put another way the problem of irrelevant developments is the failure of contemporary theories of scientific progress, relying on the constitution-promotion distinction, to differentiate between cases like

(1) The defeat of Confederate forces led by Robert E. Lee at the Battle of Appomattox Court House progressed science.

from cases like

(2) The development of Feynman diagrams progressed science.

If the proponents of the contemporary theories deny that cases of **PROMOTION** progress science, then both (1) and (2) will be developments which do not progress science. If, however, they hold that cases of **PROMOTION** progress science (as Bird in his quote above holds), then both (1) and (2) progress science, leading to the problem of irrelevant developments. What is needed is a more subtle way of characterizing progress on which cases like (2) progress science but cases like (1) do not. The constitution-promotion distinction, and the contemporary theories which rely on it, are too coarse-grained to capture this difference.

There may be a way out of this muddle for the contemporary theories. This however leads to a structural addition to the theories to rule out the problem of irrelevant developments. In their writings, both Bird and Dellsén appear to indicate a further distinction in cases of PROMOTION, leading to some cases of PROMOTION which progress science and other cases which do not progress science (Dellsén 2016, p. 73). Here's Bird:

> Not just anything that promotes the aim of X constitutes progress. The large grant awarded to a research team may well promote knowledge, but is not itself scientific progress. On the other hand developing a new technique, such as X-ray crystallography, or refining an old one, so that we have new experimental tools for testing theories and investigating phenomena, does count as a contribution to progress. The difference is that the latter are directly connected to the cognitive goal of science whereas the former is only indirectly connected. (Bird 2023, p. 40)

The strategy then is to bifurcate PROMOTION into two

- PROMOTION-PROGRESS A development which merely promotes progress counts as progressing science when the development is directly connected to the aim of science.

- PROMOTION-STATIC A development which merely promotes progress does not counts as progressing science when the development is either indirectly connected or not connected to the aim of science.

This partitioning makes the constitution-promotion distinction more subtle, allowing to distinguish cases like (1) from cases like (2). Using this addition, (1) is a case of PROMOTION-STATIC while (2) is a case of PROMOTION-PROGRESS. It thus solves the problem of irrelevant developments which plagues the contemporary theories of scientific progress. The line between developments which progress science and which do not is now drawn between those developments which are directly connected to the aim of science and which are not so-connected.

But this is addition to the theories of scientific progress are unhelpful at best and circular at worst. Just what is meant by a development being "directly connected to the cognitive goal of science" is unclear. Consider the EPISTEMIC theory. In it, a development being "directly connected" cannot just mean that the development is directly connected to the accumulation of knowledge just in case that there is more (quantity of) knowledge after the development than before the development. For if that were the case, then the development will count as constituting scientific progress and not just as merely promoting scientific progress. Conceived any other way, this suggestion cannot provide a resolution to the worrisome problem of irrelevant developments. If a case of **PROMOTION-PROGRESS** is possible precisely when a development is directly connected to knowledge, then the suggestion seems to be equivalent to saying that if an development furthers the aim of science, then it is correctly connected to the aim of science. This sounds true, but it borders on unhelpful.[12]

Given the difficulties why has the myth of the constitution-promotion distinction been stuck? I suspect that the distinction has an implicit axiomatic status in the literature because it is indispensable to the contemporary theories. As stressed above, without the distinction, not only will developments of methods and techniques not count toward scientific progress, but many other uncontroversial cases will also not count toward scientific progress. Contrary to this high standard, we would like to say that modern science progresses most of the time, even if not all the time. So, whats the way out? Say that those developments which do not constitute progress (and thus do not meet the high standard) are not actually non-progressive. Instead, they are a special class of progress non-constituting developments, i.e. cases of **PROMOTION-PROGRESS**.

The user of the constitution-promotion however cannot fully reify these lesser, merely promoting, developments because that will threaten a monist conception of scientific progress (knowledge, understanding, or truth). Neither can the user neglect these lesser developments because that clashes with commonsensical judgments about scientific progress. So, the user employs the problematic constitution-promotion distinction to create a classification of developments into **CONSTITUTION**, **PROMOTION-PROGRESS**, **PROMOTION-STATIC**, and **IRRELEVANT**. The indispensability of the distinction also explains well the current terrain of the discussions on scientific progress. A look at the current literature on scientific progress paints the following rough picture. (Admittedly this is a rather crude characterization, but I think it gets the point across.) The proponent of a specific theory (say theory A) argues that her theory of scientific progress is better than some other (say theory B) by providing historical and hypothetical cases where the analysis offered by A and B diverge. Then the proponent of A argues that our intuition or historical prece-

12 I am grateful to [omitted] for discussion on this and similar issues which resulted in making the ideas presented here sharper and clearer.

dent agrees with the judgment offered by A and not by B. The proponent of A goes through the all the other theories in a similar fashion and concludes that A is the true theory of scientific progress. In cases where A is unable to judge that a development constitutes progress in contrast to intuitive or historical considerations, the proponent claims that the development still progresses science because it promotes progress (and is "directly connected" to the aim of science).

6 PROGRESS AS PROGRESS FROM, NOT PROGRESS TOWARD

> MARATHON Suppose you are planning to run a marathon five months from now. To prepare yourself for the marathon, you build a training regime to ensure that you are in the best position to finish the marathon. Starting now you do a weekly training run until a week before the marathon. How do you track your progress?

One way to track your progress in situations like MARATHON is to compare your current state of preparation to the state you desire and aim for. So if you ran 15 miles in week n and 17 in week n+1, you can see that progressed in your marathon preparation because you moved from being 11.2 miles away from your goal to 9.2 miles away. You progressed because you moved closer *toward* your goal. Call this conception of progress – in which progress is measured with respect to a goal, a telos – the *progress toward* paradigm of progress and theories in this paradigm *telic* theories of progress. All extant theories of scientific progress (including the three contemporary theories but also including the functional-internalist theories of Kuhn and Laudan) are telic theories of progress. But progress as progress toward is not the only paradigm to conceptualize progress. Indeed, the considerations in this paper are an argument for a paradigm shift in thinking about scientific progress (and progress in general) from a paradigm of progress as progress toward to progress as progress from.

Here's a different way to think about your progress in MARATHON. Between week n and week n+1, you progressed in your marathon training because you improved the distance you ran from the last week. You ran two more miles in week n+1 compared to week n, that is an improvement, and thus this represents progress. In this way of thinking about progress, no appeal is made to a final goal. There is no telos that your doing is aiming toward. Progress is not measured with respect to how much a development moves toward a goal but it measured with respect to how much a development improves from the previous state. Call this conception of progress the *progress as progress from* paradigm and theories of progress in this paradigm *atelic* theories of progress. An atelic theory of scientific progress is a better theory of scientific progress compared telic theories. But before sketching such a theory in the next section and arguing that it provides a better account of scientific progress, presented here are a couple of more points – putting more philosophical flesh – on the progress toward and progress from paradigms. These points also help bring out the influences zetetic epistemology (in this section) and pragmatic philosophy of science (in the next section) on atelic theorizing.

First, atelic theories are generally simpler than telic theories. The details, of course, will depend on the particular theories of scientific progress but this holds true at the general level we are at right now. Telic theories require the existence of an end state, the goal of an activity, to measure the progress of a development. Without explaining and appealing to this final, not yet realized, end state telic theories are unable to adjudicate on questions of progress. Atelic theories, on the other hand, do not appeal to or have any need for any end state. Atelic theories of progress are able to adjudicate questions of progress with a sparser explanatory structure. The import of theoretical virtues like simplicity in philosophical theorizing is controversial but I highlight the simpler character of atelic theories to appeal to many philosophers who believe that theoretical selection and methodology in philosophy is anti-exceptional, to those philosophers who believe that virtues like simplicity, unification, etc. play an important role in theory selection in philosophy (Williamson 2018; Sider 2020; Priest 2012).

And second, and prescient to the point above, is a concern about atelic theories implicitly presupposing a goal. The worry is that without an implicit appeal to an end state, it is impossible for atelic theories – and progress as progress from paradigm generally – to be able to adjudicate questions of progress. The implicit end state induces a directionality that is necessary for judgments of progress in atelic theories. Without this directionality a development cannot be judged to improve with regards to the previous state and hence judgments of progress are not possible. This worry can be seen in the working example of MARATHON. In that case the concern is that the final goal of running 26.2 miles induces a directionality according to which running x+1 miles is an improvement over running x miles. It is only in virtue of this that your run in week n+1 (17 miles) was a case of progress compared to your run in week n (15 miles). Without the directionality induced by the implicit end state, it is impossible to choose between a run of (say) 13 miles or a run of 19 miles as being the one which represent progress in your marathon training.

This way to think about progress seems natural but, I want to stress here, it seems natural only because progress is still thought of in progress as progress toward paradigm. As with other paradigm changes a gestalt switch is needed to appreciate the progress as progress from paradigm (Kuhn 2012). The directionality of improvement (for example in **MARATHON** that x+1 miles is an improvement with regards to x miles) need not be grounded in an end state but may be grounded in the previous or past state of the activity. This claim is supported by appealing to recent developments in epistemology, particular in "zetetic epistemology" (Friedman 2017; Friedman 2020; Thorstad forthcoming).

Unlike traditional epistemology which mainly focuses on doxastic attitudes (the prime example being belief) and identifies epistemic norms with "norms that bear almost exclusively on having, forming, revising, maintaining (etc.) beliefs and other belief-like attitudes", the focus of zetetic epistemology is on norm governing inquiry (Friedman forthcoming, p. 4). For example, questions of interest in zetetic epistmology include questions of evidence gathering, double-checking ones beliefs, and the aim of inquiry (Hall and Johnson 1998; Christensen 2007; Friedman 2024). Of particular interest for this paper is the question of the aim of inquiry. An influential account is presented in Friedman 2024 in which Friedman argues that inquiry has no constitutive aim. She points out – in contrast to some other epistemologists – that inquiry as an epistemic activity is unlike a game (like chess) which has an end state (for example, in chess it is to checkmate the opponent). Instead of focusing on what the aim of inquiry is, Friedman urges epistemologists and philosophers to focus on the activity of inquiry itself and the norms that govern it (Friedman's own preferred way to do this is to concentrate on what she sees the close relationship of inquiry to questions and the activity of questioning by inquirers (Friedman 2024, p. 521).):

> Rather than beginning at the very end of inquiry and focusing on how that

> endpoint casts its shadow back over the activity, this approach tries to focus on the activity and its participants directly on the aiming (as it were) rather than what is aimed at. (Friedman 2024, p. 520)

Appropriating ideas and tools from zetetic epistemology ameliorates the worry raised above. Having an end state is not the only way to impose a directionality of improvement in developments. Activities themselves and the norms governing those activities can impose the required directionality without an appeal to an end goal. Consider Friedman 2024's account in which questioning is central to the activity of inquiry. On such a framework, the directionality of improvement in an inquiry, and thus of progress of the inquiry, is grounded in the activity of inquiry itself; that is in the activity of questioning and answering. If an inquirer's position with regards to questioning and answering is improved – by far example following what Friedman 2020 calls the *Zetetic Instrumental Principle* or by ignoring irrelevant evidence – then progress is made in the inquiry. Analogously, in **marathon** it is the norms within the activity of long-distance running itself which induces a directionality of improvement. The activities are thus construed to be *thick* in the progress as progress from paradigm (Kirchin 2017; Alexandrova and Fabian 2022). The activities are in-build with norms and evaluative criteria which induces directionality and hence a measure of progress for developments of the activities .

7 A NEW ACCOUNT OF SCIENTIFIC PROGRESS

So here is where we are. The contemporary theories of scientific progress (**epistemic, veracious, noetic**) are either (i) unable to explain the importance of methods and techniques to scientific progress and in science or (ii) face the problem of irrelevant developments which is the problem of categorizing developments which are irrelevant to the progress of science (such as the development in (1) The defeat of Confederate forces led by Robert E. Lee at the Battle of Appomattox Court House progressed science.) as progressing science. This is because the contemporary theories rely on the constitution-promotion distinction, a distinction which is incoherent. Further all extant theories of scientific progress are theories of progress as progress toward, involving an end goal in light of which progress is measured. However progress as progress toward, although the current default, is not the only way to conceptualize progress. Rather, the progress as progress from paradigm in which theories of progress (atelic theories) do not involve an appeal to an end goal and which dovetails nicely with considerations from zetetic epistemology, is better suited as an account of scientific progress. What is left is to provide such an account. This section contains a sketch of this project.

On the account sketched here scientific progress is not identified with a move toward an aim like knowledge, understanding, or truth. Scientific progress is instead identified with a move away from and an improvement on the current state of scientific inquiry. Since the state of scientific inquiry obviously depends on the particular inquiry under consideration, the actors undertaking the inquiry, and the context of the inquiry, this new account is a context-sensitive pragmatic account of scientific progress. This leads to the following broad-level characterization of scientific progress:

> **MELIORISM** A development is a case of scientific progress for a group of scientists in a context and pertaining to an act of inquiry if and only if the development is an *improvement* in the inquiry for the scientists.

This account of scientific progress is straightforward but because of its broad characterization more needs to be said. But this is a feature and not a bug of the account. Depending on the local context, details will be filled in making the implementation of **MELIORISM** tailored to specific contexts. The immediate task then is to expand on what is meant by 'improvement in inquiry'. In doing so, the pragmatic philosophy of science and zetetic epistemology heritage of **MELIORISM** will come to the centre-stage.

Right away, the influence of pragmatic philosophy of science can be seen by comparing **MELIORISM** to the philosophical theories of scientific understanding. Understanding is an area of philosophy and epistemology of science which has recently seen a lot of sustained work in the pragmatic philosophy of science tradition. One of the most influential contemporary theories of scientific understanding is the pragmatic *intelligibility* theory of understanding by Henk W. de Regt and collaborators (DE REGT and DIEKS 2005; DE REGT 2017; DE REGT and BAUMBERGER 2019). On the intelligibility theory of scientific understanding:

> A phenomenon P is understood scientifically if and only if there is an explanation of P that is based on an intelligible theory T and conforms to the basic epistemic values of empirical adequacy and internal consistency. (DE REGT 2017, p. 92)

where one way to cash out the intelligibility of a scientific theory T is to demand that scientists (in a context) be able to "recognize the qualitatively characteristic consequences of T without performing exact calculations" (de Regt 2017, p. 102). In both the pragmatic theory of scientific understanding and the **meliorism** account of scientific progress presented here, agential doing or agential activity and context are central. While in **meliorism** the focus is on agents doing an inquiry and the context associated with it, in the pragmatic theory of understanding the focus is on agents performing the act of explanation (scientists are able to "recognize qualitatively characteristic consequences" of a theory) and the context associated with it. This focus on agents and on doings is a hallmark of pragmatism, whether classical (James 2023; Dewey 1908) or contemporary (Price 2011; Chang 2022) and whether pragmatic philosophy in general (Price et al. 2013) or pragmatic philosophy of science in particular (Mitchell 2023).

In both cases, a general broad level characterization is to be enriched with more details depending on the particular local contexts. *Locality* is a feature of **meliorism** which distinguishes it with all contemporary and extant theories of scientific progress. Unlike other theories of scientific progress which appeal to universal factors (like knowledge or truth or understanding) without any considerations of particular contexts, **meliorism** appeals to local contexts and to the improvement of inquiry which depends on the local context and might change from context to context. **meliorism** is thus a local account twice-over. In shifting the focus of discussions on scientific progress from a global to a local perspective, the **meliorism** account is in good company: in recent decades calls to shift away from universal all-encompassing accounts of scientific phenomena (understanding, explanation, realism) to local accounts have become widely influential. In addition to De Regt's of understanding (discussed above) and Kitcher's account of explanation (discussed below), James Woodward account of explanation and understanding also underscores the advantages of a local approach to questions in philosophy of science:

> ...I believe that an account that attempts to capture the common elements in everything we may wish to call explanation is unlikely to tell us much about what is distinctive about causal explanation and the role it plays in inquiry. In the theory of explanation, as in science itself, generality is not always a virtue. (Woodward 2003, p. 5)

A similar moral – about the ineffectiveness of global accounts – but for the scientific realism/anti-realism is drawn most forcefully by (Magnus and Callender 2004).[13]

Another, closely-related, pragmatic philosophy of science heritage of **meliorism** is brought out in filling more details about the notion of improvement in inquiry at play. The inspiration is a recent pragmatic theory of scientific explanation developed by Philip Kitcher. Kitcher's recent account of scientific understanding is an exciting and innovative development in a topic which has been central to the discipline of philosophy of science since its inception (Hempel 1942; Braithwaite 1953; Hempel 1965). Abandoning his previous conceptualization of scientific explanation as unification (Kitcher 1981; Kitcher 1989), Kitcher argues for a shift in focus from the "ideal terminus" of explanation (which is often scientific understanding) to the diverse factors at the start of a call to explain. He is interested in tracing why agents in different situations came about to try to explain a phenomenon and "addresses the misunderstanding that prompted that question in that context" (Kitcher manuscript, p. 7). This leads Kitcher to what he labels a "radical pluralism" with regards to explanation, a view which abandons the Hempelian ideal of providing a universal account of explanation for the entirety of science. In developing his view, Kitcher appeals to concerns about fixation with the end state of explanation parallel to those raised above about the fixation with the aim of science in discussions of scientific progress. Instead, Kitcher takes a note from pragmatism and calls for a different starting point. His insightful analysis is worth quoting at length:

> A feature of all three of the classical American pragmatists [Peirce, Dewey, and James] is their commitment to meliorism. They are concerned with improvements, with transitions that yield progress in some domain, not with ultimate goals or ideals instantiated or perfection. A pragmatist approach to justice would focus not on specifying a utopia, but on ways to identify the injustices of the age. The hopeful line Martin Luther King borrowed from the nineteenth century abolitionist Theodore Parker would be rephrased: The moral arc of the universe bends away from injustice. So too with respect to the theory of explanation: An adequate answer to a why-question addresses the misunderstanding that prompted that question in that context.

13 Thanks to [omitted] for pointing out the connections between the view developed here and Woodward's work on scientific explanation.

> Sources of misunderstanding, I shall argue, are diverse. Inquirers, in everyday life and in the practices of the sciences, are moved by lacks, confusions, and difficulties that come in many guises. Its highly likely, I suggest, that, as we continue to learn more about nature, new types of deficiencies in our cognitive lives will become apparent to us. If you make a gestalt switch, looking hard at the initial state not at the ideal terminus, radical pluralism becomes almost irresistible(Kitcher manuscript, p. 7)

The account of scientific progress espoused here is a close relative of this way of looking at things. Progress is conceptualized not as progress toward an ultimate goal, it is rather conceptualized as progress from the current state. MELIORISM involves, to borrow Kitcher's phrase, a commitment to meliorism: a commitment to better, to improve the state of inquiry which agents currently find themselves at. Kitcher's thought can be adapted to think about scientific progress – as presented in MELIORISM – without any damage to its spirit:

> A feature of all three of the classical American pragmatists is their commitment to meliorism. They are concerned with improvements, with transitions that yield progress in some domain, not with ultimate goals or ideals instantiated or perfection. **A pragmatist approach to scientific progress** would focus not on specifying an aim, but on ways to identify the **improvements of inquiry**. The hopeful line Martin Luther King borrowed from the nineteenth century abolitionist Theodore Parker would be rephrased: The moral arc of the universe bends away from injustice. So too with respect to **the theory of scientific progress: An adequate answer to the question of scientific progress addresses the current conditions and context of science.**

The proposal thus is to understand 'improvement of inquiry' in MELIORISM in this thick, zetetic, and pragmatic (and if one follows Kitcher, radically pluralist) fashion. These traditions combine to provide an array of tools regarding norms of inquiry, directionality of improvement in scientific developments, contexts of inquiry, role of agents, and identification of current conditions to paint a fuller, richer, and better picture of scientific progress which is sensitive to the day-to-day development and practice-orientedness of science. Before closing by touching on some wider in general philosophy, the next section contains a discussion of some of the attractive features of MELIORISM, many of which have been touched upon throughout the discussion.

8 FEATURES OF MELIORISM

This paper started with highlighting the centrality of methods and techniques in science and to scientists. Any theory of scientific progress, it was argued, must be able to judge some developments in scientific methods and techniques to progress science. How does **MELIORISM** fare on this count? Favorably. This is straightforward to see. Methods, techniques, and tools are aids in inquiry for an agent and their development is an improvement in the inquiry. Take examples presented in section 2. The Lowry method improved countless chemical and biochemical inquiries by providing a way to assess the concentration of protein in a chemical solution (Lowry et al. 1951). Similarly, Feynman diagrams improved countless inquiries in high-energy physics (and physics more widely) by providing a way to calculate scattering amplitudes without the need to perform complicated integrals (Feynman 1949). This same line of reasoning can be applied to the other examples discussed in sections 2 and 3 including data visualization techniques used in ecology and developmental biology, machine learning methods used at the LHC, and proof assistants in mathematics.

Furthermore, on **MELIORISM**, not all developments in methods and techniques progress science and not all developments progress science equally. For example, an algorithm to predict protein folding structures thousand times faster than current techniques is more of an improvement than an algorithm which predicts twice as fast as current techniques. Also **MELIORISM** provides no help with deciding prospectively which methods and techniques will improve inquiry: there's no infallible way to predicting whether a method will progress science before actually putting it to use. This is a fantastic feature, not a bad bug of the account. Scientists may of course have a good guess whether a novel technique may work but history of science and contemporary practice of science are full of tales of promising ideas which ended in cul-de-sacs and serendipitous ideas which changed the trajectory of scientific inquiry (Merton 1948; Andel 1994; Pievani 2024).

The way out for contemporary theories of scientific progress to judge developments of methods and techniques as progressing science is to employ the incoherent constitution-promotion distinction. Because **MELIORISM** is based on the progress as progress from paradigm, and not based on the progress as progress toward paradigm, it has no need for the constitution-promotion distinction and unlike the contemporary theories does not create a three-tiered classification of scientific developments (**constitution**, **promotion**, and **irrelevant**). Developments can be judged to progress or not progress science independently of whether they move toward some ideal end goal. It is only in virtue of the improvement of the current state of inquiry for (a group of) agents – which depends on the context, norms of inquiry, and the values of the agents – that judgments of progress are made. **meliorism** thus steers clear of the problem of irrelevant developments on the one side and the problem of failing to judge developments of methods and techniques as progressing science on the other.

Another feature of **meliorism** is its applicability to everyday science. Conceptual work in philosophy of science – and especially in discussions of scientific progress – has a 'revolutionary fetish'. By this I mean that revolutionary flashy science gets the most attention and innumerous pages devoted to it. Everyday science, which is by orders of magnitude the more common mode of scientific practice, is relatively neglected in these discussions. For example, all the debate regarding the contemporary theories of scientific progress revolve around examples like Einstein's explanation of Brownian motion (Dellsén 2016) or hypothetical discoveries of new phenomenon (Bird 2022). There has been no discussion of the vast majority of science: scientists working everyday in their labs, on their computers, or just discussing and exchanging approaches and ideas with each other. Discoveries like Einstein's are once in a generation events and if theories of scientific progress take these kind of flash events as their paradigmatic explananda then the view of scientific progress which emerges will be an ill-fit to the vast amount of scientific practice. Indeed, highlighting the importance of methods and techniques to science and scientists from the start of this paper was a deliberate choice to counteract this revolutionary fetish.[14]

meliorism is a view of scientific progress which is sensitive to and appreciative of non-flashy everyday science. If **meliorism** is a good way to think about scientific progress, then science progresses everyday in a number of distinct ways. It is this Kitcherian radical pluralism of **meliorism** that makes

14 I am indebted to [omitted] for discussions on this topic.

it suitable as a general account of scientific progress and not just an account of the progress of science through revolutions. On **MELIORISM**, science progresses everyday. The graduate student working late at night in her lab to grow cultures can progress science, scientists meeting together at a conference to exchange ideas and appreciate and get inspired by each others work can progress science, and the technician who designs the wiring system for a ultra cold atom experiment can progress science. And these everyday humble acts progress science in the same way as Einstein did, there's no tiered-classification of developments in **MELIORISM**. The importance of everyday scientific practice, and the shift away from revolutionary science to scientific practice, has gained considerable influence in recent philosophy of science. This 'practice-turn' in philosophy of science has seen interesting new ideas being produced in values in science (Douglas 2009), feminist science (Intemann and Crasnow 2020), philosophy of experiment (Radder 2003; Schickore 2020), philosophy of science policy (Parker 2015), and of course pragmatic philosophy of science (Soler et al. 2014; Andersen and Mitchell 2023). The view of scientific progress presented here is in the same spirit as these wider developments in philosophy of science. It is also interesting to note that the revolutionary fetish identified here in the context of scientific progress is not new. Already in the 1960s, Paul Feyerabend identified that the single attention paid to revolutions in science was misguided and advocated for a philosophy of science centered on individual agents (Feyerabend 1970, p. 211).

And finally, **MELIORISM** provides a view of scientific progress on which science can be construed broadly to include not just the hard or the natural sciences but also sociology, archaeology, economics, history, and other disciplines. It is an account of progress for *Wissenschaft*, including *Naturwissenschaft* and *Geisteswissenschaft*. The singular focus on natural sciences – and in particular on physics – is again, like revolutionary fetish, a remnant of a more traditional approach to philosophy of science and something which also has been come under recent critical scrutiny. Exciting works in philosophy of paleontology (Currie 2018; Currie 2019), geology and earth sciences (Bokulich and Oreskes 2017; Bokulich 2020), and economics (Hausman 2012), to name a few, have appeared in recent years which fit well with the wide applicability of **MELIORISM**. And again, the importance of focusing on the broad of gambit of sciences, including natural, social, and human sciences, is not something new to the twenty-first century. As far back as the nineteenth century, around the time of the genesis of history and philosophy of science, appeal were made to study epistemology and methodology of science as a whole (Dilthey 1988; Dilthey 1989).

These recent developments in the epistemology of science and the philosophy of science are good tidings for **meliorism**. It plays a complementary role to these developments and provides a view of scientific development in line with and in the spirit of these developments.

9 Conclusion

This paper started with a simple, yet central question, in the study of science: 'when does science progress?'. Highlighting the importance of methods and techniques in science and for scientists, it was shown that contemporary philosophical theories of scientific progress fail to judge developments in methods and techniques as progressing science, unless an appeal to the constitution-promotion distinction is made. But I argued that the constitution-promotion distinction is incoherent leading to bad results. In place of presenting another slightly-tweaked theory of scientific progress, a call for a change in the paradigm of conceptualizing progress was made. This allowed to think about progress not as a progression to an ideal end goal but as an improvement away from the current state. Building on work done in pragmatic philosophy of science and zetetic epistemology, a novel atelic account of scientific progress was presented which is able to judge developments in methods and techniques as progressing science without using the incoherent constitution-promotion distinction. The resultant account also has other desirable features including sensitivity to progress in everyday science and a respect for practice-oriented philosophy of science. I close here with some thoughts on the consequences of the view espoused here on wider issues in general philosophy and the interplay between them.

The framework of progress developed here has implications on other areas of philosophy, far outside the narrow ambit of epistemology of science and philosophy of science. The notion of progress is a central, and often hotly-contested, topic in various areas of philosophy, including ethics (Forst 2017), social and political philosophy (Buchanan and Powell 2018), and aesthetics

(Agassi 2003). In almost all of these and allied discussions, the orthodox way to conceptualize progress is in the progress as progress toward paradigm. For example, famously John Rawls contends that the liberal democratic ideal he espouses in his *Political Liberalism* is attainable (Rawls 1996). A switch to the progress as progress from paradigm, in tune with the view of scientific progress presented here, can bring new perspectives on long standing issues which have become entrenched. This is also true for recent works in metaphilosophy which the question of 'when and how does philosophy progress?' (Chalmers 2015; Dellsén, Firing, et al. 2024).

On the more methodological side, what I hope to have implicitly conveyed throughout this paper is the fruitfulness of a close integration between philosophy of science and general epistemology. The contemporary debate on scientific progress, much to its credit, has been sensitive to both its epistemology side and its philosophy of science side. However the account of progress presented in this paper takes a further step, not just being sensitive but integrating both of these sides in its very foundation. Without tools, ideas, and results from pragmatic philosophy of science and zetetic epistemology this would not have been possible. Other topics in the methodology and epistemology of science including debates in evidence in science, empiricism, and values in science would benefit a ton with a closer integration. For example, discussions in values in science and the value-free ideal have developed largely independently of questions of pragmatic encroachment investigated in recent works in epistemology (Rudner 1953; Fantl and McGrath 2002; Douglas 2009; Ross and Schroeder 2014). This seems like an oversight: both sides have lots to gain from a closer integration.

References

Agassi, J. (2003). "Progress in Science and in Art". In: *Science and Culture*. Dordrecht: Springer Netherlands, pp. 260–269.

Alexandrova, A. and M. Fabian (2022). "Democratising Measurement: or Why Thick Concepts Call for Coproduction". In: *European Journal of Philosophy of Science* 12.7.

Andel, P. V. (1994). "Anatomy of the Unsought Finding. Serendipity: Origin, History, Domains, Traditions, Appearances, Patterns and Programmability". In: *The British Journal for the Philosophy of Science* 45.2, pp. 631–648.

Andersen, H. K. and S. D. Mitchell, eds. (2023). *The Pragmatist Challenge: Pragmatist Metaphysics for Philosophy of Science*. Oxford, UK: Oxford University Press.

Berlincourt, T. G. and R. R. Hake (1963). "Superconductivity at High Magnetic Fields". In: *Physical Review* 131 (1), pp. 140–157.

Bird, A. (2007). "What is Scientific Progress?" In: *Noûs* 41.1, pp. 64–89.

— (2010). "The Epistemology of Science–a Bird?s-Eye View". In: *Synthese* 175.S1, pp. 5–16.

— (2019). "The Aim of Belief and the Aim of Science". In: *Theoria: An International Journal for Theory, History and Foundations of Science* 34.2, p. 171.

— (2022). "The Epistemic Approach : Scientific Progress as the Accumulation of Knowledge". In: *New Philosophical Perspectives on Scientific Progress*. Ed. by Y. Shan. Routledge.

— (2023). *Knowing Science*. Oxford University Press.

— (2024). "Knowledge-First Philosophy of Science". In: *Putting Knowledge to Work: New Directions for Knowledge-First Epistemology*. Ed. by A. Logins and J.-H. Vollet. Oxford University Press.

Bokulich, A. (2020). "Calibration, Coherence, and Consilience in Radiometric Measures of Geologic Time". In: *Philosophy of Science* 87.3, pp. 425–456.

Bokulich, A. and N. Oreskes (2017). "Models in the Geosciences". In: *Springer Handbook of Model-Based Science*. Ed. by M. Lorenzo and B. T. Wayne. Springer, pp. 891–911.

Braithwaite, R. B. (1953). *Scientific Explanation: A Study of the Function of Theory, Probability and Law in Science*. Cambridge University Press.

Buchanan, A. and R. Powell (2018). *The Evolution of Moral Progress: A Biocultural Theory*. New York: Oup Usa.

Carnap, R. (1966). *Philosophical Foundations of Physics;* New York: Basic Books.

CERN (2012). *Pulling together: Superconducting electromagnets*. URL: https://cds.cern.ch/record/1997395.

Chalmers, D. J. (2015). "Why Isn't There More Progress in Philosophy?" In: *Philosophy* 90.1, pp. 3–31.

Chang, H. (2012). "Beyond Case-Studies: History as Philosophy". In: *Integrating History and Philosophy of Science: Problems and Prospects*. Ed. by S. Mauskopf and T. Schmaltz. Dordrecht: Springer Netherlands, pp. 109–124.

— (2022). *Realism for Realistic People: A New Pragmatist Philosophy of Science*. Cambridge University Press.

Christensen, D. (2007). "Epistemology of Disagreement: The Good News". In: *Philosophical Review* 116.2, pp. 187–217.

Constitution of the United States (1787).

Currie, A. (2018). *Rock, Bone, and Ruin an Optimist's Guide to the Historical Sciences*. MIT Press.

— (2019). *Scientific Knowledge and the Deep Past: History Matters*. Cambridge University Press.

Daston, L. (2023). *Rivals: How Scientists Learned to Cooperate*. Columbia Global Reports.

de Regt, H. W. (2017). *Understanding Scientific Understanding*. New York: Oxford University Press.

de Regt, H. W. and C. Baumberger (2019). "What is Scientific Understanding and How Can It Be Achieved?" In: *What is Scientific Knowledge?: An Introduction to Contemporary Epistemology of Science*. Ed. by K. McCain. Routledge, pp. 66–81.

de Regt, H. W. and D. Dieks (2005). "A Contextual Approach to Scientific Understanding". In: *Synthese* 144.1, pp. 137–170.

Dellsén, F. (2016). "Scientific Progress: Knowledge Versus Understanding". In: *Studies in History and Philosophy of Science Part A* 56.C, pp. 72–83.

— (2018). "Scientific Progress: Four Accounts". In: *Philosophy Compass* 13.11, e12525.

— (2021). "Understanding Scientific Progress: The Noetic Account". In: *Synthese* 199.3-4, pp. 11249–11278.

Dellsén, F., T. Firing, et al. (2024). "What is Philosophical Progress?" In: *Philosophy and Phenomenological Research* 2, pp. 663–693.

Dellsén, F., I. Lawler, and J. Norton (2022). "Thinking About Progress: From Science to Philosophy". In: *Noûs* 56.4, pp. 814–840.

Dellsén, F. and J. Norton (forthcoming). "Dejustifying Scientific Progress". In: *Philosophy of Science*.

Dewey, J. (1908). "What Does Pragmatism Mean by Practical?" In: *Journal of Philosophy, Psychology and Scientific Methods* 5.4, pp. 85–99.

Dilthey, W. (1988). *Introduction to the Human Sciences: An Attempt to Lay a Foundation for the Study of Society and History*. Ed. by R. J. Betanzos. Detroit: Wayne State University Press.

— (1989). *Wilhelm Dilthey: Selected Works, Volume I: Introduction to the Human Sciences*. Ed. by R. A. Makkreel and F. Rodi. Princeton University Press.

Donovan, A., L. Laudan, and R. Laudan (1988). *Scrutinizing Science: Empirical Studies of Scientific Change*. Springer Nature.

Douglas, H. (2009). *Science, Policy, and the Value-Free Ideal*. University of Pittsburgh Press.

Einstein, A. (1905). "On the Electrodynamics of Moving Bodies". In: *Annalen der Physik* 17, pp. 891–921.

Eisen, M. B. et al. (1998). "Cluster analysis and display of genome-wide expression patterns". In: *Proceedings of the National Academy of Sciences* 95.25, pp. 14863–14868.

Evans, L. (2007). "The Large Hadron Collider". In: *New Journal of Physics* 9.335.

Fantl, J. and M. McGrath (2002). "Evidence, Pragmatics, and Justification". In: *Philosophical Review* 111.1, pp. 67–94.

Feyerabend, P. K. (1970). "Consolations for the Specialist". In: *Criticism and the Growth of Knowledge: Proceedings of the International Colloquium in the Philosophy of Science, London, 1965*. Ed. by I. Lakatos and A. Musgrave. Cambridge University Press, pp. 197–230.

Feynman, R. P. (1949). "Space-Time Approach to Quantum Electrodynamics". In: *Physical Review* 76 (6), pp. 769–789.

Forst, R. (2017). "69The Concept of Progress". In: *Normativity and Power: Analyzing Social Orders of Justification*. Oxford University Press. eprint: https://academic.oup.com/book/0/chapter/150656848/chapter-ag-pdf/44980580/book_6638_section_150656848.ag.pdf.

Fraassen, B. C. van (1980). *The Scientific Image*. Oxford University Press.

Friedman, J. (2017). "Inquiry and Belief". In: *Noûs* 53.2, pp. 296–315.

— (2020). "The Epistemic and the Zetetic". In: *Philosophical Review* 129.4, pp. 501–536.

— (2024). "The Aim of Inquiry?" In: *Philosophy and Phenomenological Research* 108.2, pp. 506–523.

— (forthcoming). "Zetetic Epistemology". In: *Towards an expansive epistemology: Norms, action, and the social sphere*. Ed. by B. Reed and A. K. Flowerree. Routledge.

Google DeepMind (2020). *AlphaFold: a solution to a 50-year-old grand challenge in biology*. URL: https://www.deepmind.com/blog/alphafold-a-solution-to-a-50-year-old-grand-challenge-in-biology..

H.R.4346, 1. C. (1950). *National Science Foundation Act of 1950*.

Hall, R. J. and C. R. Johnson (1998). "The Epistemic Duty to Seek More Evidence". In: *American Philosophical Quarterly* 35.2, pp. 129–139.

Hartnett, K. (2020). *Building the Mathematical Library of the Future*. URL: https://www.quantamagazine.org/building-the-mathematical-library-of-the-future-20201001..

Hausman, D. M. (2012). *The Philosophy of Economics: An Anthology*. 3rd ed. Cambridge University Press.

Hempel, C. G. (1942). "The Function of General Laws in History". In: *Journal of Philosophy* 39.2, pp. 35–48.

— (1965). *Aspects of Scientific Explanation and Other Essays in the Philosophy of Science*. Free Press.

Huxley, T. H. (2012). *Collected Essays: Volume 1, Methods and Results*. Cambridge University Press.

Intemann, K. and S. Crasnow, eds. (2020). *The Routledge Handbook of Feminist Philosophy of Science*. New York, NY: Routledge.

James, W. (2023). "What Pragmatism Means (1903)". In: ed. by J. Kaag and J. van Belle. Princeton University Press, pp. 265–281.

Kaiser, D. (2005). *Drawing Theories Apart: The Dispersion of Feynman Diagrams in Postwar Physics*. University of Chicago Press.

Kiernan, M., ed. (2000). *The Oxford Francis Bacon IV: The Advancement of Learning*. Clarendon Press.

Kirchin, S. (2017). *Thick Evaluation*. New York: Oxford University Press.

Kitcher, P. (1981). "Explanatory Unification". In: *Philosophy of Science* 48.4, pp. 507–531.

— (1989). "Explanatory Unification and the Causal Structure of the World". In: *Scientific Explanation*. Ed. by P. Kitcher and W. C. Salmon. Univ of Minnesota Press, pp. 410–505.

— (manuscript). "The Theory of Scientific Explanation: An Obituary". In: pp. 1–19.

Kitcher, P. et al. (2021). *Moral Progress*. Ed. by J. Heilinger. New York: Oxford University Press.

Koyré, A. (2008). *The Astronomical Revolution: Copernicus - Kepler - Borelli*. Routledge.

Kuhn, T. S. (2012). *The Structure of Scientific Revolutions: 50Th Anniversary Edition*. University of Chicago Press.

Kumar, V. and J. May (forthcoming). "Moral Reasoning and Moral Progress". In: *The Oxford Handbook of Metaethics*. Ed. by D. Copp and C. Rosati. Oxford University Press.

Laboratory, B. B. N. (2025). *LHC Dipole Magnet Program*. url: https://www.bnl.gov/magnets/lhc_ir_dipoles/.

Ladyman, J. (2000). "What's Really Wrong with Constructive Empiricism? Van Fraassen and the Metaphysics of Modality". In: *British Journal for the Philosophy of Science* 51.4, pp. 837–856.

Laudan, L. (1977). *Progress and its Problems*. Routledge and Kegan Paul.

Longino, H. E. (1990). *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton University Press.

Lowry, O. H. et al. (1951). "Protein Measurement with the Folin Phenol Reagent". In: *Journal of Biological Chemistry* 193.1, pp. 265–275.

Magnus, P. D. and C. Callender (2004). "Realist Ennui and the Base Rate Fallacy". In: *Philosophy of Science* 71.3, pp. 320–338.

Merton, R. K. (1948). "The Bearing of Empirical Research upon the Development of Social Theory". In: *American Sociological Review* 13.5, pp. 505–515.

Mitchell, S. D. (2023). "The Bearable Thinness of Being: A Pragmatist Metaphysics of Affordances". In: *The Pragmatist Challenge: Pragmatist Metaphysics for Philosophy of Science*. Oxford University Press.

Niiniluoto, I. (2014). "Scientific Progress as Increasing Verisimilitude". In: *Studies in History and Philosophy of Science Part A* 46, pp. 73–77.

— (2022). "The Semantic Approach : Scientific Progress as Increased Truthlikeness". In: *New Philosophical Perspectives on Scientific Progress*. Ed. by Y. Shan. Routledge.

Noorden, R. V., B. Maher, and R. Nuzzo (2014). "The Top 100 Papers". In: *Nature* 514.7524, pp. 550–553.

Parker, W. (2015). "Environmental Science". In: *The Oxford Handbook of Environmental Ethics*. Ed. by S. M. Gardiner and A. Thompson. Oxford University Press USA.

Pavese, C. (2022). “Knowledge How”. In: *The Stanford Encyclopedia of Philosophy* Fall 2022 Edition.

Pievani, T. (2024). *Serendipity: The Unexpected in Science*. Boston: MIT Press.

Price, H. (2011). *Naturalism Without Mirrors*. Oxford University Press.

Price, H. et al. (2013). *Expressivism, Pragmatism and Representationalism*. Ed. by S. Blackburn et al. Burlington, VT: Cambridge University Press.

Priest, G., ed. (2012). *An Introduction to Non-Classical Logic: From If to Is* (*2nd edition*). Cambridge University Press.

Radder, H. (2003). *The Philosophy Of Scientific Experimentation*. University of Pittsburgh Press.

Rawls, J. (1996). *Political Liberalism*. Columbia University Press.

Rees, G., ed. (2004). *The Oxford Francis Bacon Volume XI: The Instauratio Magna Part II: Novum Organum and Associated Texts*. Clarendon Press.

Ross, J. and M. Schroeder (2014). “Belief, Credence, and Pragmatic Encroachment”. In: *Philosophy and Phenomenological Research* 88.2, pp. 259–288.

Rossi, L. (2010). “Superconductivity: its role, its success and its setbacks in the Large Hadron Collider of CERN”. In: *Superconductor Science and Technology* 23.3.

Rowbottom, D. P. (2008). “N-Rays and the Semantic View of Scientific Progress”. In: *Studies in History and Philosophy of Science Part A* 39.2, pp. 277–278.

— (2010). “What Scientific Progress is Not: Against Bird?s Epistemic View”. In: *International Studies in the Philosophy of Science* 24.3, pp. 241–255.

— (2015). “Scientific Progress Without Increasing Verisimilitude: In Response to Niiniluoto”. In: *Studies in History and Philosophy of Science Part A* 51, pp. 100–104.

— (2023). *Scientific Progress*. Cambridge University Press.

Roxlo, T. and M. Reece (2018). “Opening the black box of neural nets: case studies in stop/top discrimination”. In: *arXiv: High Energy Physics - Phenomenology*.

Rudner, R. (1953). “The Scientist Qua Scientist Makes Value Judgments”. In: *Philosophy of Science* 20.1, pp. 1–6.

Schickore, J. (2011). “More Thoughts on Hps: Another 20 Years Later”. In: *Perspectives on Science* 19.4, pp. 453–481.

— (2020). *About Method: Experimenters, Snake Venom, and the History of Writing Scientifically*. University of Chicago Press.

Scholze, P. (2021). *Half a year of the Liquid Tensor Experiment: Amazing developments*. url: https://xenaproject.wordpress.com/2021/06/05/half-a-year-of-the-liquid-tensor-experiment-amazing-developments/.

Shan, Y. (2019). "A New Functional Approach to Scientific Progress". In: *Philosophy of Science* 86.4, pp. 739–758.

— ed. (2022). *New Philosophical Perspectives on Scientific Progress*. New York: Routledge.

Sider, T., ed. (2020). *The Tools of Metaphysics and the Metaphysics of Science*. Oxford University Press.

Soler, L. et al. (2014). *Science after the Practice Turn in the Philosophy, History, and Social Studies of Science*. Routledge.

Stegenga, J. (2024). "Justifying Scientific Progress". In: *Philosophy of Science* 91, pp. 543–560.

Sullivan, E. (2022). "Understanding from Machine Learning Models". In: *The British Journal for the Philosophy of Science* 73.1, pp. 109–133.

Thorstad, D. (forthcoming). "The Zetetic Turn and the Procedural Turn". In: *Journal of Philosophy*.

Weinstein, J. N. (2008). "A Postgenomic Visual Icon". In: *Science* 319.5871, pp. 1772–1773.

Whewell, W. (2013). *The Philosophy of the Inductive Sciences: Founded Upon Their History*. Cambridge University Press.

Wilckzek, F. (2016). *How Richard Feynmans Famous Diagrams Almost Saved Space*. url: https://www.wired.com/2016/07/feynman-diagrams-almost-saved-space/.

Williamson, T. (2000). *Knowledge and its Limits*. New York: Oxford University Press.

— ed. (2018). *Doing Philosophy: From Common Curiosity to Logical Reasoning*. Oxford University Press.

Winsberg, E. (2010). *Science in the Age of Computer Simulations*. Chicago: University of Chicago Press.

Woodward, J. F. (2003). *Making Things Happen: A Theory of Causal Explanation*. New York: Oxford University Press.