Introduction

The Disciplinary Revolutions of Early Modern Philosophy and Science

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The period stretching from roughly the middle of the sixteenth century to the middle of the eighteenth witnessed foundational changes in the intellectual culture of western Europe. Among these developments were many new ideas – some appearing on the scene fully grown and difficult to overlook, sparking controversy or enthusiastic assent; some, more modest at first, growing steadily over subsequent years; and still others, initially invisible, yet persisting and sometimes erupting with dramatic effects. Eventually, these novel views coalesced into the intellectual traditions that have constituted the early modern canon. Of the myriad transformations involved in this period of ebullition, two were central. The first was an explicit reformation: Philosophers proclaimed the necessity to set aside the preoccupations of their predecessors in order to "start again right from the foundations."[1] The second was less declarative, but more profound: The explanations used to account for natural phenomena were radically revised.

Contemporary scholars have recognized the significance of these developments in the periodization used to study them. The "early modern period" is distinguished (sometimes sharply) from the "late Renaissance" that preceded it; and the "early moderns" are often seen as our direct ancestors, whose thought is much more connected to the present than that of previous eras. Historians of philosophy refer to "early modern philosophy" that departed from medieval and Renaissance precedents, especially Aristotelian Scholasticism. Historians of science even more dramatically refer to the "Scientific Revolution" that replaced various domains of natural knowledge – natural philosophy, the mathematical "mixed sciences," natural history, medicine, alchemy, and so on – with the modern amalgamation we simply (and anachronistically) call 'science'.

[1] Descartes (1984–1991, 2:12).

These transformations of philosophy and the sciences overlapped, and many figures – including René Descartes, Galileo Galilei, Francis Bacon, Pierre Gassendi, Robert Boyle, and Isaac Newton – feature prominently in both histories of philosophy and histories of science. Nevertheless, scholars traditionally have treated philosophy and the sciences separately, as the subjects of distinct disciplinary fields with radically different historiographical approaches. The chapters in this volume represent a countervailing trend of the last three decades that views the intellectual history of the early modern period as an integral whole, wherein "science" and "philosophy" cannot be readily pulled apart, not least because the historical authors themselves did not recognize the distinction. From this perspective, one sees that the emergence of modern philosophy and that of modern science were not separate phenomena, but facets of the same transformations, taking place in the same period, in texts often written by the same authors. The history of philosophy of the Scientific Revolution is inextricable from the history of early modern philosophy.

Essential Tensions

Recognizing the fundamental unity of early modern thought has led scholars to re-evaluate classic debates and traditional accounts, but it also has been accompanied by methodological difficulties. Disciplinary divisions are more persistent than we like to think. While historians of early modern philosophy have distanced themselves from the presentist intellectualism of older histories of philosophy, they have not embraced the contextualist social constructivism found in much history of science. As a result, the analyses in this book occupy a still unsteady middle ground. Whereas the individual chapters present the lessons of recent research, our overarching editorial aim has been to knit them together into a comprehensive story that acknowledges but also attempts to balance their methodological tensions. This editorial outlook gives structure to the volume, and deserves explication here.

The Contextualist Turn

A couple of generations ago, historians of philosophy in general, and scholars of early modern philosophy in particular, mined the work of past authors for material relevant to contemporary concerns. Early modern writers like Descartes and John Locke were made to speak to present-day debates in metaphysics, epistemology, ethics, and so on. Yet by conceiving historical and modern figures alike as participants in an ahistorical discourse, this

approach tends to analyze past thought according to present categorizations. It also encourages attempts to reconcile the various parts of an author's corpus into a unified, coherent system, and even to "rationally reconstruct" the best version of a philosopher's view – to elaborate what, e.g., Descartes *should* have said, even if he actually did not. These systematized versions of philosophers' thought are most valuable for solving current philosophical problems, but this method treats philosophical arguments, whatever their provenance, as disembodied, timeless, and unchanging. It removes texts from their contexts.[2]

In the 1990s, historians of early modern philosophy began to turn away from such attempts to reconstruct maximally coherent interpretations of texts. They became far more sensitive to the contexts in which those texts were produced.[3] In the years since, the distinction between text and context has been further blurred, as a new generation of scholars have realized that the traditional historiographies are not only insufficient, but often also misleading. Anachronistic categorizations, it has become clear, have obscured the rich and dynamic interactions between different kinds of thinkers and their ideas. The Descartes and the Lockes of the period developed their view in dialogue with a range of interlocutors and concerns that cannot be neatly delineated by the familiar (to us) categories of metaphysics, epistemology, and even philosophy.

This "contextualist revolution"[4] in the study of early modern philosophy has entailed engagement with the history of the Scientific Revolution. The development of early modern philosophy was intertwined with the radical transformations in the understanding of natural phenomena produced by figures such as Nicolaus Copernicus, William Gilbert, Galileo Galilei, William Harvey, and others. It has become clear that one cannot properly understand Descartes, for instance, without taking into account his interactions with the mathematicians and "scientists" of his day; his sensitivity to the events of the "Galileo Affair"; or his reading of and correspondence with figures hitherto considered as belonging to the history of medicine. Hence, awareness of the history of science has become a necessary condition for contextualized readings of early modern philosophers. Indeed, such work has

[2] Jonathan Bennett is an archetype of the older approach. See Bennett (1971); Bennett (1984). An updated version is offered by Della Rocca (2015).
[3] Daniel Garber (especially Garber 1992) has been a standard-bearer. The papers in Garber and Ayers (1998) helped originate the trend. See also his responses to Bennett and Della Rocca (Garber 2013b; Garber 2015b).
[4] Mercer (2019).

shown that the stark separation of "philosophy" and "science" itself is an anachronistic imposition of latter-day conceptualizations.[5]

Gains and Losses: Abandoning Methodological Consensus

The contextualist turn has produced concrete gains. Sharpened sensitivity to how historical actors characterized their own practice has yielded a more sophisticated understanding of the extremely complex landscape of early modern intellectual life. We have learned much about the scientific work of those usually considered philosophers,[6] and about the philosophical contributions of "scientists."[7] Recent scholarship has encompassed a remarkable expanse of early modern theoretical disciplines – both scientific and philosophical. It has shown that "natural philosophy" was not the only important antecedent of modern science and philosophy. Pursuits formerly considered marginal, such as medicine and alchemy, have also been sounded for philosophical significance.[8]

However, the contextualist turn has had as an (unintended) consequence the dissolution of the field's methodological coherence. Recent studies, though successful individually, have become particularized – they do not share basic categorizations, aims, or vocabularies. It is therefore difficult to compile them into a general account, and this, in turn, causes problems for new scholarship and pedagogy. Whereas, for instance, it might have once been easy to place Descartes among the "Rationalists" and Locke among the "Empiricists" (and to teach courses organized along those lines), the realization that these categories are not historically valid has made it hard to say how the figures stand in relation to one another in the roiling intellectual landscape of the period. Likewise, the philosophical canon has been destabilized – a positive development, but one leading to hard choices. If Newton, for one, has earned a place in courses in the history of philosophy, which figure currently taught must make way? Even if the contextualist cause is ascendant, the "revolution" is not complete.[9]

[5] Studies that mix early modern science and philosophy are now common. See, e.g., Sorell, et al. (2010); Dobre and Nyden (2014); Garber and Roux (2013); Biener and Schliesser (2014).

[6] In addition to Garber (1992), see, e.g., Sasaki (2003); Anstey (2011b); Smith (2011).

[7] Newton is the foremost example of a scientist made philosophical (Janiak 2008; Harper 2011; Ducheyne 2012; Biener and Schliesser 2014). Robert Boyle and Francis Bacon have undergone similar reconsideration (Anstey 2000b; Gaukroger 2001; Hunter 2015; Jalobeanu 2015; Anstey 2018; Jalobeanu 2019). Others, like Émilie Du Châtelet, are poised to receive similar treatment (Zinsser and Hayes 2006; Hagengruber 2012).

[8] E.g., Clucas (2011); Nachtomy and Smith (2014); Distelzweig, et al. (2016).

[9] Christia Mercer declares victory in the contextualists' revolution, but admits that the "differences" among current historians of early modern philosophy "reside only in the projects selected and skills used to attain their goal" (Mercer 2019, 529). The 'only' here

The kernel of these difficulties is the fundamental opposition of analysis and narrative. The conceptual analysis needed to explicate a philosophical argument and the historical narrative needed to describe its development through time require contrary presumptions. Analysis supposes a theory's stability and independence; narrative supposes its malleability and dependence on antecedent conditions. In order to avoid the dilemma, scholars have tended toward the extremes. Historians of philosophy, at least in the anglophone world,[10] gravitate toward analysis, which brings a range of consequences. First, there is the tendency, noted above, to isolate texts from contexts and seek coherence within a corpus, so as to serve contemporary interests. This is attended by limiting attention to the narrow scope of canonical figures thought to be most informative on those issues. Second, since historical precedents are pushed to the background, historians of philosophy tend to view each historical figure as an innovator, without antecedent. This is especially true of the early modern period and the Scientific Revolution, which are seen (to adopt a geological metaphor) as catastrophic breaks with the past. Third, there is the inclination to restrict explanations to intellectual considerations. This is partly in the nature of philosophy, insofar as it is the study of reasoning, but it also stems from the muting of context, where social and cultural factors can play a significant role. History of philosophy inclines toward textual internalism, presentism, catastrophism, and intellectualism.

Scholarship in history of science provides an instructive contrast, since it gravitates toward narrative at the opposite extreme. There, the aim is less to draw lessons for present-day application than to get the history "as it really was." One finds much more emphasis on contextual factors, including material conditions and social roles, and there is far less adherence to a canon. This approach stresses the continuity of intellectual development, to the point that it has become standard to question the existence of a Scientific Revolution in the first place. History of science, that is, tends toward externalism, antiquarianism, uniformitarianism, and socio-cultural reductivism.[11] The contrasting features of history of

elides the many problems we emphasize. Also the "selection" of projects is typically motivated by non-contextual, presentist concerns. See, e.g., the historiographical wrangling in (Lærke, et al. 2013).

[10] Scholars in Europe and elsewhere have always been more sensitive to context, so the recent shift has not been as dramatic there.

[11] The literature on historiography of science is extensive. For a sampling, especially regarding the status of the Scientific Revolution, see Shapin (1992); Cohen (1994); Shapin (1996); Harrison (2007); Smith (2009).

philosophy and history of science are not binary – instead, they indicate spectra of historiographical approaches. But even if we over-generalize, the comparison illustrates the divergences motivated by the core analysis–narrative opposition.

Contextualism in the history of philosophy moves away from the traditional analytical extreme. But this has raised the problems of reconciliation that the extreme position avoids. How to combine analysis and narrative? How much of the context is explanatory – i.e., where does one draw the limits of relevance? Are social and political factors important, or can explanations be given solely in terms of intellectual motivations? Which figures deserve attention – how much should the canon be "exploded"? Does one tell stories in terms of continuous traditions or of sudden innovations?[12] Is one to use only actors' categories, or are anachronistic descriptions permissible? As the reader will discover in the following pages, a thoroughgoing consensus on such methodological questions has not yet emerged. Each of the contributors to this volume answers them in different ways. Some are closer to the analytical extreme of each spectrum, others to the narrative.

Incidentally, the contextualist turn, with the resulting methodological uncertainty, has been mirrored in the adjacent realm of philosophy of science, where an initial enthusiasm for the "integration" of analytical philosophy of science with narrative history of science has been frustrated by uncertainty about how to effect it.[13] This, too, has led to an array of disparate approaches that do not entirely cohere.[14] Though this volume is intended as a contribution to the history of philosophy, not to philosophy of science or history of science, it does intersect history of philosophy with the history of science. Moreover, its editors and many of its authors are practitioners of history and philosophy of science. Consequently, salient issues will inevitably arise, and historians and philosophers of science will find useful material for their own attempts to comprehend the Scientific Revolution. Likewise, the methodological strategies used here will translate to work there.

[12] Thomas Kuhn called this *the* "essential tension" (Kuhn 1977a).
[13] See Domski and Dickson (2010); Mauskopf and Schmaltz (2012); Herring, et al. (2019).
[14] Compare, for instance, the generally more analytical tendencies in scholarship associated with the Committee for Integrated History and Philosophy of Science (known as &HPS), where historical cases tend to serve presentist concerns, with the more narrative scholarship of the Society for the History of Philosophy of Science (HOPOS). For the former, see Arabatzis and Howard (2015); Stadler (2017); for the latter, see the Society's organ, *HOPOS*.

Disciplinary Histories

The lack of methodological consensus among recent historians of early modern philosophy poses an editorial problem: how should a book such as this be organized? Our solution has been to adopt *discipline* as the unit of analysis. This aligns with a typical strategy of investigation, which begins by analytically delineating a phenomenon to be examined, and then constructs a narrative carefully following the chains of influences that led to it or followed from it. Drawing these connections leads naturally to an examination of the features by which early modern thinkers identified themselves with peers or distinguished themselves from foes – the features, that is, that separate one discipline from another. By tracing these disciplinary boundaries, scholars become attuned not just to the argumentative positions historical authors have taken, but also to the alternative views to which they were responding. This also comports with an increased sensitivity to contextual factors, since early modern disciplines could be organized in many ways – they were not just areas of inquiry or theoretical commitments, but also social institutions (schools, sects, clubs, academies, etc.), conceptions of teaching and learning, and methods of knowledge production and administration. Even if they broadly agreed with one another, authors could end up on different sides of a disciplinary boundary. Histories that use disciplines as units of analysis accommodate these contextual considerations.

Once one adopts disciplinary history as a methodology, the story of the early modern period becomes one about the multiplication and reorganization of intellectual disciplines. Surveying the intellectual landscape of the period, one observes the emergence of a number of new disciplines around a variety of problematics and projects. Especially productive were moments where existing disciplines came into contact with one another – either antagonistically or cooperatively. In these situations, the competing ideologies and methodologies were called into question, so that resolving the impasse often created a new discipline, as authors drew together the tenets and methods of the previously disparate fields. One example is when mathematicians staked claims to the causal reasoning of natural philosophers, spawning various forms of "physico-mathematics" that eventually led to classical mechanics.[15] Another is when logicians attempted to import the curative methods of medicine into reasoning, generating a novel "art of thinking."[16]

[15] See especially the chapter by Van Dyck in this volume (ch. 14), and also those by Miller (ch. 17) and by Omodeo and Regier (ch. 13).

[16] See the chapter by Corneanu and Vermeir (ch. 8). Related issues regarding psychology are taken up in the chapter by Pécharman (ch. 19), and the one by Hamou (ch. 18) describes how instruments were thought to "cure" the senses.

From a retrospective, analytic viewpoint, one sees here the early modern germination of the novel ideas that produced our modern world. From above, so to speak, these "inflection points" look like new directions of thought – solitary green shoots in an empty field. But from below, taking a contemporary, narrative perspective, one sees a continuous tumult of activity. The ground is saturated with intra- and interdisciplinary disputes, and from this frisson grow new ideas and new traditions. Much of the activity is obscure to us only because it is about issues that no longer concern us.

Note that the contextualists' synthetic, middle-of-the-road approach de-emphasizes the notion of the "Scientific Revolution," but does not entirely efface it. Unlike more traditional histories, the "Scientific Revolution" is not identified with a thematic arc, such as "mechanization of the world picture" or "invention of science," that provides the armature upon which the narrative is constructed.[17] And yet careful attention reveals that the early moderns themselves thought something radically new was afoot, even if they could not adequately express exactly what it was. Once again, contextualists illuminate how the historical authors themselves set up dialectical oppositions between old and new. Consequently, instead of asking whether there was a "Scientific Revolution," they ask what 'new astronomy' meant for Johannes Kepler, what 'new science' meant for Galileo, what 'great instauration' meant for Francis Bacon, and so on. In this way, 'Scientific Revolution' becomes an abstract, generic term comprising all the specific, concrete innovations of the early modern period. Its vagueness, though, is not problematic, since it is not itself the focus of study. We need not get hung up debating its reality or its temporal bounds.

It is also worth noting what this historiographical approach does not do. For one thing, it eschews the imposition of latter-day ideological categorizations. "Rationalism" and "Empiricism" – so central to traditional history of philosophy – are not meaningful conceptualizations here. For another, it does not explode the canon, but rather historicizes it. If one carefully follows the disciplinary dialectics, one finds that certain figures play outsized roles. They show up again and again as authorities whose support lends credence to a position, or as *bêtes-noires* whose support renders a position suspect. Sometimes these figures are those who have long occupied the spotlight, like Descartes; sometimes they are those who have hitherto lurked in shadow, like David Gorlaeus.[18] Thus, scholars in this vein have not dispensed

[17] This is a feature both of older work, such as Dijksterhuis (1961); Westfall (1971a), and newer histories, like Gaukroger (2006); Wootton (2015).
[18] See the chapters by Garber (ch. 2) and Hattab (ch. 3) in this volume.

with the canon entirely. Their studies remain centered on a group of figures thought to be important – at the time, if not still at ours. Historians of philosophy might marvel at how comprehensive the volume is; historians of science at how exclusive.

Granularity and Composition

Analysis of early modern disciplines has proven rewarding, in that it yields problematics fruitfully addressed in recent contributions to the literature, many by authors in this volume. These issues can be distinguished according to three levels of granularity. At the coarsest level, scholars have been concerned with how early modern actors divided themselves up in the first place – what, that is, were the early modern disciplines? This question entails tracing the contours of disciplinary bounds, but also grappling with the very meaning of 'discipline' in the early modern milieu.[19] At a finer level of resolution, scholars have elucidated the activities of the various disciplines that populated the period. This includes analysis of the disciplines' methodologies and core suppositions, as well as description of the problems their participants sought to resolve and the debates about proposed solutions.[20] Finally, there is a group of questions relating to the specific points of contact between disciplines, where representatives of distinct intellectual spheres argue with one another. These "inflection points" garner particular attention since they often generate what appears, to later authors, as radical change – new problems and novel solutions.

These granularities also provide the basic structure of this volume – though, of course, comments on all these interrelated issues can be found throughout. The chapters in the first part engage with questions regarding the early modern disciplines in general. They survey the disciplinary landscape from the beginning to the end of the period, noting especially the

[19] This question of discipline formation is what Richard Rorty calls *Geistesgeschichte* (Rorty 1984). One example is the debate about "natural philosophy" in Grant (1999); Cunningham (2000); Lüthy (2000b). Another is the proposal to use 'chymistry' to distinguish early modern matter theory from later 'chemistry' (Newman and Principe 1998). A recent proposal has been to redefine disciplinary boundaries in terms of unities of practice. See, for example, discussions of the disciplinary unity of early modern "books of secrets" (Eamon 1994; Eamon 2011), the new epistemic genre of "recipes" in medicine and magic (Borrelli 2020), or the formation and evolution of an early modern science of vegetation (Jalobeanu and Matei 2020).

[20] An interesting case is that of the discussions and debates around the early modern set of the disciplines characterized as 'experimental philosophy', or, as Anstey and Jalobeanu call it (ch. 12), 'experimental natural history'. See Harrison (2011); Anstey (2014); Jalobeanu (2015); Feingold (2016).

different ways in which disciplines bounded themselves in relation to each other. The chapters describe how early modern disciplines were organized around the classical texts recovered by the Renaissance (Levitin), and how commentators themselves, like present-day scholars, struggled to characterize and classify the novelty they recognized in their midst (Garber). The essays here also problematize the coherence of "Aristotelianism" (Hattab) and the "Mechanical Philosophy" (Roux, Bellis), usual beginning and ending points in traditional narratives of the Scientific Revolution. Finally, the roles of "external" factors beyond philosophy and science – confessional sects (Blank) and gender and public and private institutions (Detlefsen) – in the formation of disciplines are explored.

The second part of the volume takes up the activities of individual disciplines across the period. The chapters show how these disciplines established themselves upon theoretical problems and how they reached solutions. The essays study the work of early modern practitioners of the "art of thinking" (Corneanu and Vermeir); natural magic (Clucas); the mechanical arts (Klein); learned medicine (Distelzweig and Ragland); the Baconian *scientia* of natural and experimental history (Anstey and Jalobeanu); the "science" of the stars (Omodeo and Regier); mixed-mathematics (Van Dyck); pure mathematics (Guicciardini); and post-Newtonian mathematical physics (Hepburn and Biener). In each case, the authors note developments that significantly impacted the ensuing scientific and philosophical traditions.

Finally, the third part of the volume takes up significant episodes in early modern thought. Of particular interest are instances where disciplinary frameworks faced acute challenges, leading to the formation of new disciplines. These include: Galileo's intrusion of mathematical astronomy into natural philosophy (Miller); the effect of new optical instruments – telescopes and microscopes – on all the empirical sciences (Hamou); the debate about the ontology of the mind arising from Cartesian metaphysics (Pécharman); the reorganization of anatomical science surrounding Harvey's assertion of the circulation of the blood (Manning); the reinterpretation of natural laws following the advent of mathematical physics (Stan); and the important controversies about the ontology of corporeal substances (Gorham and Slowik), God's relation to the natural world (Janiak and Thomas), and which quantity is conserved in physical interactions (Rey).

Altogether, the chapters collected in this volume explore philosophical lessons of the Scientific Revolution, presenting the results of recent work and indicating areas of future interest. Each contribution is "a survey and a step" – a survey of existing literature on the topic and a step toward a novel