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Viewing past science from the point of view of present science, thereby illuminating both: Philosophy versus experiment in the work of Robert Boyle

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ABSTRACT

The seventeenth century witnessed the replacement of an Aristotelian worldview by a mechanical one. It also witnessed the beginnings of significant experimental enquiry. Alerted by the fact that the methods involved in the latter, but not in the former, resemble those employed in later science, I argue the historical case that the emergence of the mechanical worldview and the emergence of science were not closely related and that it was the latter that was to develop into science as we have come to know it. The details are explored in the context of the philosophical and experimental work of Robert Boyle and the relationship between them.

1. Introduction

The idea that history of science can be usefully informed by current understanding of science tends to alarm many historians, and the reasons for that are not difficult to fathom. What relevance can contemporary knowledge have for understanding past practices if that knowledge was unknown to the practitioners? The notion that some claim within past science was acceptable at the time because it is true from a modern point of view does not withstand serious scrutiny, so that praising past scientists for getting things right and censuring them for getting things wrong as judged from a later standpoint impedes rather than contributes to historical understanding. An example of the kind of view of which historians can be rightly scornful involves the identification of the atomism of the Ancient Greeks as important beginnings of contemporary atomic theory. It is embodied in the position of Lancelot Whyte (1960, p. 3) according to which the 'conception of the atom has been the spearhead of the advance of science' and that 'the fertility of the Greek atomic philosophy proves the power of speculative reason'. I am more than ready to join any historian wishing to contest such claims on the grounds that it attributes to Greek atomism an influence and history that it did not in fact have and that it blurs rather than clarifies the relation between science and philosophy.

In this article I wish to illustrate various ways in which history of science can, and needs to be, informed by knowledge acquired after the time of the science being investigated and which are nevertheless not subject to the kinds of objection alluded to in the previous paragraph. My illustrations are centred on the work of Robert Boyle and mostly involve the relationship between experimental enquiry as it was evolving in the seventeenth century and the replacement of Aristotelianism by what came to be referred to as the mechanical philosophy. I seek to demonstrate the way in which we can learn much about the nature of experimental science by tracing the way in which it became divorced from philosophy, a divorce that is taken for granted in contemporary universities in which science and philosophy are housed in distinct Faculties.

If we are to take worries about projecting current categories onto the past so seriously as to outlaw any such projection then it is difficult to see how there can be any such thing as a history of *science* at all given that the term 'science' did not acquire its modern connotations until the nineteenth century. Once we take on the task of writing a history of *science* we have to hand some principal

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of selection which enables us to pick out relevant historical facts from irrelevant ones. Our modern perspective also provides a way of putting questions to history. Here is an example. While contemporary sciences differ from each other sufficiently to make identification of the 'essence' of science difficult if not impossible, they are alike insofar as they make general claims about the world that are to be vindicated empirically and experimentally in particularly demanding ways. Laboratories are essential for the sciences in a way that they are not for the conduct of philosophy or history. Given this situation, the question of the historical path by which it came about is a potentially fruitful one. It is one that I raise in the context of the seventeenth century. Our current knowledge provides us with a way of putting questions to history, a strategy that need not be problematic provided there are ways of ensuring that it is history that provides the answers.

There are limits to the extent to which the necessarily nuanced issues involved in applying modern categories to past history can be conveyed by way of generalities of the kind involved in this introduction. In the remainder of it I signal the topics which I will address in my attempt to grapple with the necessary detail.

The natural philosophers of the seventeenth century typically saw themselves as replacing the Aristotelian view of the world animated by forms by some radical alternative. By the 1660s those alternatives had come to be seen as sharing the common feature of being 'mechanical' is some sense of that term.[1] The seventeenth-century actors saw the replacement of an Aristotelian world view by a mechanical one as a key component of their accomplishment. Such a theme remains a common one among a number of contemporary historians.[2] Alongside a change in worldview from an Aristotelian to a mechanical one in the seventeenth century there also arose a kind of knowledge that involved, grew out of and was justified by reference to, detailed experimentation. Much of the following involves a detailed analysis of the relationship between the change in worldview, on the one hand, and the emergence of experimental sciences on the other. I challenge the presumption, whether held by seventeenth-century actors or modern commentators, that it was the former that spawned the latter. I argue, by contrast, that the emergence of experimental enquiry marks the beginning of the emancipation of science from philosophy.

Much of my historical analysis is focussed on the work of Robert Boyle. This suits my purpose insofar as Boyle was not only one of the most able articulators of the mechanical philosophy but was also an active experimenter, making practical contributions to pneumatics and chemistry in particular. What is more, Boyle frequently addressed the question of the relationship between the philosophy and experimental enquiry and some of his conclusions fit well with my own position, as we shall see. In the next Section, I distinguish between various interpretations of 'mechanical' and identify the strict sense involved in Boyle's articulation of the mechanical philosophy. In Section 3, I turn to experimental knowledge and its problematic relationship to the mechanical philosophy. I use a distinction between intermediate causes and ultimate causes introduced by Boyle himself to highlight the gulf between the claims and methods of the mechanical philosophy, on the one hand, and experimental enquiry on the other, and then struggle to comprehend Boyle's problematic but revealing stand on the relationship between the two practices.

In Section 4, I focus on the modes of argument employed in the defence of claims within the mechanical philosophy and in experimental enquiry. Mechanical philosophers defended their worldview by appealing to notions of intelligibility and by devising corpuscular mechanisms able to accommodate the phenomena. By contrast, explanations appealing to intermediate causes were justified by appeal to experiment.

Section 5 is concerned with developments in chemistry. I argue that seventeenth-century chemistry was hampered by the lack of viable notions of intermediate causes accessible to experiment. Boyle's attempt to rectify the situation by reducing chemistry to corpuscular mechanisms was no more helpful than the appeal to elements by Aristotelians or principles by Paracelsians. I illustrate my point by comparing Boyle's chemistry with that involving the notion of chemical combination and compound implicit in the use of affinity tables in the eighteenth century. Combining chemical substances could form the basis of an experimental chemistry in a way that combining corpuscles could not.

In a short concluding section I turn attention to developments subsequent to the seventeenth century, arguing that it was the experimental investigation of intermediate causes that blossomed into modern science, with the mechanical philosophy soon falling into insignificance as far as science is concerned.

2. The mechanical philosophy according to Boyle

I am concerned to defend the thesis that experimental practices emerged in the seventeenth century that were early versions of and developed into what is now called science and that it is this fact that warrants the term 'the Scientific Revolution'. I also wish to defend the claim that those developments owed little to the replacement of an Aristotelian world activated by forms with a mechanical world made up solely of particles of brute matter with an unchanging shape and size and capable of motion. I support the view that the Scientific Revolution involved the beginnings of the emancipation of experimental science from philosophy of the kind that aimed to characterize the ultimate structure of the world. It is not difficult to contemplate how my position could be branded as unacceptably Whig or presentist. For example, it could be suggested that I pick out, for example, the pneumatics that was defended experimentally by Pascal and Boyle, note that it was correct from a modern point of view and that the mode of experimental support also resembles modern scientific practice, and for these reasons hail this new practice as the beginnings of modern science. It could be further suggested that I note that the claim of the mechanical philosophers that the world is composed solely of corpuscles possessing shape, size and motion is false and that I conclude from this that the mechanical philosophy was unproductive as far as the emergence of science is concerned. Finally, it might be suggested that in distinguishing as I do between experimental philosophy and philosophical metaphysics I am imposing onto the historical situation a modern distinction that was yet to materialise. I do not have to speculate about the raising of such objections because they have been directed at me quite explicitly by William Newman (2010, p. 204). He describes my focus on the dichotomy between experimental science and the mechanical philosophy as involving a 'toggle switch' view of history of science which 'allows for no gradual development or nuance over the course of history'. According to him, my 'one-track modus operandi' leads me to see things 'in binary terms of approbation or denunciation' with the consequence that 'there is little room indeed for disinterested analysis of arguments, determination of the real issues at stake, or the tracing of sources and

[1] A paper that discusses the subtleties of applying the category of 'mechanical philosophy' to the seventeenth century that takes account of the fact that the term was not used prior to the 1660s is Garber (2012).

[2] Two classic works that ushered in the contemporary trend to focus on the replacement of Aristotelianism by mechanism as a key feature of the Scientific Revolution are M. Boas (1952) and E. J. Dijksterhuis (1961). The theme looms large in recent studies such as Dear (1995 and 2000), Steven Shapin (1996) and Newman (2006).