Rose-Mary Sargent

THE DIFFIDENT NATURALIST

Robert Boyle and the Philosophy of Experiment

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SCIENCE AND ITS CONCEPTUAL FOUNDATIONS
David L. Hull, Editor

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Rose-Mary Sargent

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To Ernan

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was impossible—of compiling a catalogue of Boyle's unpublished papers and letters; it has since appeared as a guide for the microfilm collection of this material. In addition, he is presently working with Ted Davis on a new edition of Boyle's works that will finally correct the numerous infelicities present in the extant editions.

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INTRODUCTION

ROBERT BOYLE WAS NOT a scientific genius. Strictly speaking, he was not a scientist at all. Rather, he was a natural philosopher who devoted his life to developing the details of a new way of knowing that he called the experimental philosophy. Experimental practices were not new, of course. Experiments had been performed in the "low sciences" of medicine and alchemy for many years, and by Boyle's time they had been introduced into the mechanical and mathematical disciplines by Galileo, Pierre Gassendi, and Marin Mersenne, among others. What was new was the way in which Boyle sought to give experimental practices a rational foundation—to construct a "comprehensive method" that would lead to knowledge in all areas of human concern.[1]

Numerous studies have been produced in this century concerning Boyle's work, but there remains a marked lack of consensus among historians and philosophers about who he was and what he did. In part, such conflicting interpretations could be viewed as a result of the failure to treat Boyle as a philosopher and to see his works in their entirety. His publications covered a wide range of topics, including chemical, mechanical, and physiological investigations; theoretical speculations concerning the usefulness and justification of the corpuscular philosophy; and defenses of natural theology and the Christian religion. At first sight, such eclecticism may appear to be the result of an unrestrained or unreflective curiosity. Yet when these individual researches are taken together, it becomes clear that they were designed by him to contribute to one complex and coherent philosophical project.

My purpose in this work is to provide a primarily philosophical explication of Boyle's experimental program by examining how he drew upon the work of numerous predecessors in its construction, how his religious ideals contributed to his notion of what it meant to live the life of a natural philosopher, and how he developed a sophisticated account of scientific discovery and justification by immersing himself in experimental practice. First, however, a brief, and necessarily selective, review of the secondary literature on Boyle will be helpful in order to avoid confusion concerning the scope of the present

study. My intention is not to engage in theoretical debate about the merits of particular approaches to the study of past science but to lay out the terrain and locate my work within it so that the reader will not have false expectations concerning what is and what is not included here.

Overview

Aside from biographical accounts, there have been two dominant types of works on Boyle: "intellectualist" studies that have, for the most part, sought to provide rational reconstructions of Boyle's thought by referring to philosophical and scientific categories; and "contextualist" studies that have sought to explain Boyle's beliefs by an appeal to concepts developed in the field of the sociology of scientific knowledge.[2] Within the first genre, by far the most influential studies were those produced by Marie Boas Hall during the 1950s and 1960s. Hall used Boyle's published and unpublished works in order to provide comprehensive accounts of his mechanical and chemical theories.[3] Other scholars, such as Peter Alexander, James B. Conant, Norma E. Emerton, Thomas S. Kuhn, James G. Lennox, and Richard S. Westfall, also produced studies designed to exhibit the logical relations that held between Boyle's theoretical beliefs and the conceptual and empirical evidence that he brought forward in support of them.[4] Because these scholars primarily intended their works as examinations and explanations of Boyle's theoretical beliefs, they did little analysis of his methodology, although Alexander, Hall, and Westfall all noted that Boyle did not appear to follow a strictly empirical approach in his justification of knowledge claims about natural processes.[5]

One reason for questioning a straightforward empiricist interpretation of Boyle's methodology derives from the fact that he was an advocate of the corpuscular philosophy, which indicated, among other things, that he believed that physical processes could be explained by the deterministic causal action of the least parts of matter. Empiricists, on the other hand, normally maintain that human knowledge is limited to the discovery of descriptive accounts of observable regularities.[6] In the 1930s Philip P. Wiener offered a "pragmatic" interpretation of Boyle's epistemology in order to resolve the apparent tension between his methodology and his ontology.[7] Later works on Boyle's methodology tended to take the form of predecessor studies.[8] In the 1960s Larry Laudan, for example, noted the similarities between the corpuscular philosophies of Boyle and Descartes and argued that Boyle therefore followed a type of Cartesian "method of hypothesis."[9] In response to Laudan, G. A. J. Rogers argued for a stronger Baconian influence on Boyle's methodology, although he noted that a strict empiricist interpretation of either philosopher was not warranted.[10]

Beginning in the 1960s and continuing today, another group of scholars, including Gary B. Deason, Eugene M. Klaaren, Barbara J. Shapiro, and Henry

G. van Leeuwen, has studied Boyle's theological beliefs in an attempt to reexamine the content of his ontological ideas, which in turn could possibly be used to resolve the apparent tension between his ontology and his epistemology.[11] Although theology was taken to be "external," and thus irrelevant, to scientific concerns in the earlier positivist tradition, these works showed how, in the absence of an explicitly stated metaphysical position, Boyle's ontology could be constructed from an examination of his religious writings. Despite the existence of alternative interpretations of Boyle's epistemology and the doubts expressed about his empiricism, work in this area has led to the widespread acceptance of an empiricist interpretation of Boyle's epistemology.[12] One of the most influential studies was that produced in 1972 by J. E. McGuire.

McGuire cited passages in which Boyle spoke of the passivity of matter and the unlimited power of God, to argue that for Boyle the universe was composed of a set of nonrelated particulars, which in turn indicated that what was then the "received view" about Boyle's commitment to a mechanistic universe was incorrect. According to McGuire, Boyle believed that there was no true physical causality in the world. All natural phenomena are produced by the immediate activity of a God who is able to change the order of things at any time, and thus knowledge about the world must be limited to the discovery of phenomenal laws about manifest occurrences.[13] While such an interpretation of Boyle's ontology is consistent with passages in which he appeared to advocate an empiricist methodology, it did not completely resolve the tension, because it left unexplained those other passages where Boyle spoke of the predictive power of hypotheses and the "discovery of the true genuine causes" operative in nature.[14] McGuire's work did show, however, that in order to understand Boyle's method, it would be necessary to ascertain his general ontological beliefs about the nature of the world as the object of study for which he had devised his method.

In the 1970s scholars committed to a more contextualist approach to the history of science began to express opposition toward intellectualist histories. In particular, traditional historians of ideas were criticized for their reliance upon an "internalist" understanding of past science. It was said, for example, that their rational reconstructions were based almost solely upon textual analysis and that their decisions concerning the selection of relevant factors that could be used for the explanation of past scientific episodes were based upon twentieth-century philosophical categories that were historically inappropriate. Unlike earlier Mertonian studies dating from the 1940s and 1950s, in which social categories were employed only for the explanation of "irrational" elements in past science, contextualist studies were designed in order to produce a more "symmetrical" treatment by which past successes as well as failures were to be explained via categories of interest as developed in the sociology of scientific knowledge (SSK).[15]

David Bloor, a leading exponent of the "strong programme" in SSK, has maintained that because theoretical beliefs are underdetermined by empirical evidence, such evidence cannot adequately explain actors' beliefs, and the student of past science must therefore look to social interests in order to achieve a complete explanation for actors' decisions.[16] He believes, for example, that "it is necessary to look at the social context" in order to explain Boyle's preference "for an inert and passive rather than an active and self-moving matter."[17] Bloor's position has found support in the work of contextualist historians such as Christopher Hill, James R. Jacob, Margaret C. Jacob, and Charles Webster.[18] According to the Jacobs' influential 1980 study, for example, Boyle's matter theory was "designed to combat two threats, heresy and social insubordination," and his advocacy of corpuscularianism can thus be explained by reference to the function that it played in Restoration society. Building upon McGuire's analysis, they argue that because Boyle's corpuscular philosophy postulated the passivity of matter and the necessity of God's governance of the world, it could be used to support the conservation of the social order that followed from a dominant Anglican Church. While monistic natural philosophies, such as Hobbesian materialism, "tended to dissolve hierarchy, . . . hierarchical social order found support in the Christian dualism newly shored up by the corpuscular philosophy of the reforming Puritans."[19] As Bloor sees it, the corpuscular philosophy thus gained acceptance because in it "the world was made to prefigure the dependence of civil society on an involved, active and dominant Anglican church," and thus the view could be used "to bolster up the social and political policies" of Restoration England.[20]

In this type of contextualist study, the focus tended to be restricted to an analysis of how the sociopolitical interests of involved scientists influenced their acceptance of particular theoretical constructs concerning the constitution of the natural world. A newer trend, however, has emerged in the past two decades that is directed more toward the examination of scientific practice as distinct from the theoretical products of that practice. H. M. Collins, David Gooding, Bruno Latour, Michael Lynch, Andrew Pickering, and Steve Woolgar, for example, have attempted to understand how the evidence that is used for the justification of knowledge claims is itself constituted by social conditions surrounding the practical life of the laboratory.[21] In Boyle studies, this newer focus can be seen in Steven Shapin and Simon Schaffer's 1985 study, *Leviathan and the Air-Pump*. Shapin and Schaffer sought to investigate the means by which various boundaries, such as that between the natural and the social worlds, came to be established in the seventeenth century and to explore how experimental procedures at the same time came to be accepted as reliable indicators of factual claims concerning the natural world. Their analysis moved the discussion of Boyle's experimentalism to another level of sophistication, as they

recorded in minute detail, for example, the numerous problems faced by Boyle and his contemporaries in their attempts to replicate intricate pneumatic experiments.

Although Shapin and Schaffer's focus follows the newer trend, their work is not as radical as that by Latour, Lynch, or Woolgar. As I will discuss more fully below, these writers have questioned the explanatory categories employed by traditional SSK theorists such as Bloor and Collins. Shapin and Schaffer, on the other hand, made extensive use of such sociological categories in their analysis of Boyle's experimental practice.[22] They showed quite well, for example, that the boundaries set up by Boyle and his contemporaries were not self-evident and that other methods and boundaries were equally acceptable, but they then went on to explain why Boyle's program proved successful by referring to the way in which the practices embedded within it for "the generation and justification of proper knowledge were part of the settlement and protection of a certain kind of social order."[23] They argued that the experimental program itself, by setting up boundaries between the factual and the theoretical and admitting the testimony of only those witnesses deemed credible by the closed community of experimenters, carried an important social message, by which the acceptance of experimental practice can be explained: "The general form of an answer to the question of Boyle's 'success' begins to emerge, and it takes a satisfyingly historical form. The experimental form of life achieved local success to the extent that the Restoration settlement was secured. Indeed, it was one of the important elements in that security."[24]

The numerous and often acrimonious debates that have ensued between intellectualist and contextualist historians of science are in large part the result of the fact that both parties are engaged in the same type of explanatory project. Both approaches seek to explain the reasons for actors' beliefs, and the major difference between them resides in the choice of which factors will be deemed explanatory. The intellectualist historian tends to find an appeal to the logical relationship that obtains between evidence and theory as sufficient to explain the acceptance of particular knowledge claims, whereas the contextualist finds such an appeal whiggish or naive and insists instead upon locating the social and cultural factors that caused actors to view the theoretical beliefs as adequately supported by the evidence.[25] In this sense, both approaches advocate a global understanding of science. Although contextualists have criticized intellectualist historians for their use of "cherished philosophical norms" through which they attempt to explain past scientific episodes by subsuming them under an idealized understanding of scientific practice, SSK theorists have merely replaced such norms with their own equally global explanatory categories, particularly with what Pickering has called the "distinctive sociological concept of interest."[26]

Recent Trends

In the 1990s a number of sociologists have become more vocal in their criticism of the explanatory project of traditional SSK studies. Lynch, for example, has advocated an ethnomethodological approach to the study of science, wherein his main design is to "describe the ensemble of actions that constitute a practice," and has rejected Bloor's contention that such an approach reduces to a type of "anticausal irrationalism."[27] In a different but related criticism, Latour has argued that the type of "social realism" advocated by Bloor and Collins is unwarranted because social concepts cannot be used as unproblematic explanatory resources. As Latour sees it, the global concept of interest embedded within traditional SSK explanatory accounts of science is actually a remnant of "modernism" that serves to perpetuate the positivist distinction between the natural and the social worlds.[28] For this reason, while he generally approves of the way in which Shapin and Schaffer displayed the historical origin of such a distinction in *Leviathan and the Air-Pump*, he remains critical of their work because they failed to go beyond the traditional explanatory project of SSK and thus tended to reinforce the very distinction that they had sought to deconstruct.[29]

While critics such as Latour, Lynch, and Woolgar have different motivations for their opposition to traditional SSK studies, one thing that they share is their perception of the increasingly conservative and dogmatic attitude expressed by their opponents. Contextualist historians in the SSK tradition tend to be satisfied with the present state of science studies and are dismissive toward those studies that are not firmly within their camp.[30] Philosophers and philosophically-minded historians are not likely to agree with the extreme forms of relativism championed by these radical critics of SSK, yet a similar reaction against the entrenchment of social contextualism can be seen in some newer works in the history and philosophy of science. In particular, contextualists are being criticized for their failure to provide any new insights into the intellectual dimension of past science. As Shapin noted early on, the contextualist project is designed to build upon intellectualist history: "The demonstrated connections between one set of ideas and another are the necessary starting points for historians who would put an additional set of contextualist questions to the materials."[31] Such a description of this project seems to betray an assumption that the history of ideas is in some sense complete. As the contextualists have repeatedly pointed out, however, the accuracy of the earlier intellectualist histories may be questioned because of the way in which logicist and positivist conceptions of science were used in their construction. A fresh examination of the intellectual content of past science therefore seems to be required, and such attempts should not be dismissed simply on the grounds that they are not in line with the current fashionable status of contextualist studies.

These criticisms should not be confused with earlier responses toward SSK that involved debates about which categories ought to be used for the explanation of past scientific episodes.[32] Today's critics are not calling for a return to the older forms of rational reconstruction. As Michael Hunter has described it, the goal of these newer historical studies is to provide more nuanced accounts of individual thinkers while resisting the temptation to reduce their thought to some set of putatively timeless philosophical, scientific, or sociological categories.[33] In reaction to the "derogatory attitudes" of some in the SSK camp toward those who wish to "study scientists in their own rights," Thomas Söderqvist has suggested that this new approach could be called "existential" because these studies attempt to display the meaning of science "for each individual in a particular culture in a particular era."[34] Such a project calls for a more localized approach than either of the two earlier ones.[35]

There is a shift of emphasis in these newer studies away from the explanatory and toward the descriptive. When explanations are provided, they are much more complex than those offered by previous studies, because the goal of the newer approach is to identify all of the factors relevant for understanding an individual's thought, whether social or epistemic, in the actor's own categories. Epistemological categories such as "empiricism" or "rationalism," for example, are rejected because they do not provide sufficient explanatory power, particularly for historical figures who lived and worked prior to the philosophical elaboration of such categories in the nineteenth century. The vague historical category of "influence" is also questioned by this newer approach. Predecessor studies may provide significant insights into the intellectual development of a particular thinker, but they become unduly speculative and of little explanatory value when the attempt is made to reduce a past thinker's work entirely to that of another based upon a small set of select similarities. Equally problematic is the practice employed by many contextualists who use the social status of a thinker to speculate about which sociopolitical interests exerted a direct causal influence on the intellectual decisions made by that individual.

Two significant book-length studies on seventeenth-century scientific figures manifest this newer approach. In his recent study of Bacon, Antonio Pérez-Ramos acknowledges that contextualists have aided our understanding of the social context of past science, but he also notes that because they have neglected the analysis of past ideas, their work remains "philosophically unilluminating."[36] He has sought to provide a more "general level of conceptual exploration and analysis." While broadly intellectualist, the study is more localized and historically sensitive than earlier rational reconstructions, particularly in the way in which Pérez-Ramos has attempted to correct common interpretations of the Baconian notions of *inductio*, *forma*, and *opus* by tracing their intellectual roots and examining the role that they played in Bacon's entire system.[37] Daniel Garber has displayed a similar purpose in his study of Descartes, in