

Robert Boyle and the Masculine Methods of Science

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In her recent case study, Elizabeth Potter attempts to show how Boyle's experimental method was biased by gender considerations. Part of her argument focuses on the combination of the "invisibility" of women in Boyle's published work together with his unpublished comments on female chastity, and part concerns Boyle's rejection of the animistic explanation of his air pump experiments by Francis Line. I argue that the historical and biographical elements of the case make Potter's arguments questionable. In addition, I address whether and how such historical cases can shed light on current debates about gender issues and argue that Boyle's methodological writings could be used to better advantage in the feminist cause.

1. Introduction. Elizabeth Potter's study of Robert Boyle relies heavily on previous writers' attempts to uncover the supposed sociopolitical biases of modern science (Potter 2001; Hill 1986; Jacob 1972, 1978; Shapin and Schaffer 1985). Her overarching purpose is to show that Boyle's Law was gendered, although the two arguments that she uses to support her claim are related to matters of method. First she maintains that experimental practice explicitly excluded women and was self-consciously fashioned by Boyle and others as a masculine way to investigate nature. Secondly she argues that Boyle's defense of the gas law was motivated by his prior decision to accept only those explanations of physical processes that made reference to the mechanical operations of matter. Unlike some other feminist criticisms of science, therefore, Potter does not show that Boyle's law itself is fundamentally masculine, only that it was derived from theories and practices that contained masculine bias.

Because it is cleverly argued, Potter's book has the potential for wide use by philosophers who may disagree with her conceptual analysis but may nonetheless accept her characterization of the historical details. Given that her case study uses these historical details as crucial empirical evidence

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for her conclusions, however, it is necessary to assess the accuracy of this evidence first. After having done that in Section 2 below, I will then examine her arguments concerning Boyle's noncognitive goals in Section 3. The fourth section will conclude with suggestions for a more positive alternative account of the ways in which Boyle's methodological advice could be used in discussions of gender and science.

2. Modesty, Mechanism, and Gender Politics. Potter admits that there are passages in Boyle's published works where he conceded that women had the capacity for knowledge, but "Boyle never pursued these possibilities." Instead, she claims "that he worked to produce a new form of masculinity conducive to the new science as he envisioned it, and that he did so by reinforcing a traditional form of femininity, one necessary for the new man of science." This analysis leads her to conclude "that modern experimental science was intensely gendered at its inception and that Boyle's gender ideology was in turn shaped by the demands of experimental science" (Potter 2001, 3). The evidence for Potter's claim comes from a group of early letters in which Boyle displayed his preoccupation with issues of chastity, modesty, and "what it meant to be a woman and what it meant to be a man" (2001, 4). Based on her analysis of these passages, she argues that for Boyle, "chastity was the most important characteristic women could have" because it would in turn "keep men chaste" (2001, 5). In order to link the issue of chastity to science, Potter turns to Boyle's early *Seraphick Love* (1648), in which he wrote to his recently jilted brother that he should turn his love to God (Boyle [1772] 1965, 1: 249), and concludes that Boyle believed that the celibate undistracted male is the one best suited to serve God. She then turns to a brief passage in *Usefulness of Natural Philosophy* (1663) wherein Boyle talked of natural philosophers as the "priests of nature" (Boyle [1772] 1965, 2: 32, 62) and concludes that "Boyle held experimental philosophy to be the highest form of devotion to God, and inasmuch as celibacy is necessary for undistracted devotion, it is ipso facto necessary for experimental philosophy" (Potter 2001, 8).

The links in this chain of reasoning from sexual modesty to scientific practice are rather weak and the topic of Boyle's religious sentiment, to which I will return in the concluding section, is more complex than Potter allows (see Hunter 2000). First, however, it is necessary to examine the nature of Boyle's writing on feminine modesty and chastity in more detail. The two 'letters' that Potter cites most extensively are not actual correspondence but lengthy and complex literary compositions that Boyle wrote during his late teens and early twenties, at a time when he had visions of becoming a moral essayist (see Principe 1994, 1995). The main points of these compositions are left out of Potter's analysis. In the letter "Against

Painting,” for example, Boyle criticized the fictional Corisca’s use of makeup and patches because it indicated that she valued superficial and artificial beauty over other more important qualities (Boyle Papers, vol. 37, fols. 204–208, published in Boyle 2000, 13: 49–54). While it is certainly true that Boyle had Puritanical views about both male and female sexuality, his preoccupation with such issues in these compositions reflects an early stage in his life. From the age of twelve to seventeen Boyle toured the continent in the care of a Calvinist tutor, with whom he lived for the last two years in Geneva staying at the house of Jean Diodati (Hunter 2000; Sargent 1995). At the age of seventeen, he returned home to the high society of London. Shortly thereafter, as a young man trying to work his way through gender identities, he wrote the ‘letters’ quoted by Potter. It is important to note that he did not revisit these issues once he began his work in experimental science.

Another significant problem arises from the fact that Boyle was more outspoken about the intellectual equality of women than the material from Potter would lead one to conclude. As we saw above, Potter writes that Boyle only conceded the possibility that women had the capacity for knowledge. This impression results from the way that she has edited Boyle’s words, however. In Potter’s selection from the preface to *The Martyrdom of Theodora* (originally drafted before 1650) she writes:

Robert Boyle once said, “I will not here examine whether the ignorance wont to be imputed to women be their fault, or that of their accusers; and whether it is any natural want of capacity, or rather want of instruction, that keeps most of them from knowledge, though this regards not sexes. [Nor will I inquire] whether it be not our interest, or our envy, that makes women what we are wont to decry them for being. . . .” He is convinced that “to attain a great proficiency in knowledge,” it is not necessary to be “so much as a man.” (Potter 2001, 3)

The full passage from Boyle actually ends like this:

But without inquiry, whether it be not our interest or our envy, that makes women what we are wont to decry them for being, I shall not scruple to own, that I have sometimes had the honor to converse with ladies, that convinced me, that to attain a great proficiency of knowledge, it is not necessary to be a doctor of divinity, or so much as a man, since they discoursed of divine things with no less wit than piety. (Boyle [1772] 1965, 5: 260)

In this preface (written for publication in 1687), Boyle was defending himself against both those who would call into question his use of a woman as the protagonist of his story and those who would call into

question his boldness in writing on theological matters despite the fact that he was not a doctor of divinity.

In addition to his early essays, Potter appeals to the “invisibility” of women in most of Boyle’s published scientific works that she takes as an indication of his belief that he found their presence in experimental settings to be inappropriate. She discusses one instance, from his *New Experiments Physico-Mechanical* (1661) where Boyle mentioned the “presence of witnesses” of different classes and genders, which she notes “appears to be quite democratic” (Potter 2001, 17, referring to Boyle [1772] 1965, 1: 106–107). She argues that the names of women “are never among those Boyle mentions as attesting his veracity,” however, and thus concludes that they “are unfit for serious witnessing or experimenting” (Potter 2001, 18–19). Because in one instance Boyle recorded that the women asked him to end an experiment and free the animal that was suffering in his air pump, Potter adds that “in fact their presence turns out to disrupt the experiment altogether” (18–19). This interpretation is problematic. Not only did Boyle explicitly refer to the women as “witnesses”, but in his lengthy discussion of these experiments on respiration Boyle recorded many times when he himself disrupted an experiment in an effort to save an animal’s life (Boyle [1772] 1965, 1: 99–113; see Guerrini 1989 and Oster 1989).

In order to dismiss this evidence and other evidence that I provided in previous work about how Boyle did use women as credible witnesses (see Sargent 1995, 152, 289, 304), Potter draws a distinction between two types of witness. She contrasts Shapin and Schaffer’s use of the word ‘witness’ as a “technical term meaning someone who provides authoritative corroboration that an experimental matter of fact is as claimed,” with what she calls my “looser sense” of “someone who provides testimony” (Potter 2001, 189; see Shapin and Schaffer 1985, 218). Accordingly, “women and other non-scientists, then *watch* his experiments, virtuosi, including doctors and mathematicians, *witness* them and attest to the facts produced thereby” (Potter 2001, 18–19). Potter’s distinction does not counter all of the evidence, however. For example, although it is true that Boyle did not always name women, this does not appear to have been a policy. He mentions Lady Kent’s medicinal recipes more than once in his works (Sargent 1995, 152, 289). In other instances while women remain unnamed, Boyle chose to refer to them in ways that reveal his respect for their ability. In his *Mechanical Origin of Electricity*, for example, he referred to one woman as “no ordinary virtuosa” and to another as “eminent for being ingenious” ([1772] 1965, 4: 351–352). Finally, Potter is rather dismissive of the influence of Boyle’s sister Katherine, Lady Ranelagh, whom she characterizes as little more than a surrogate wife/hostess. In addition to these roles, however, Katherine was well known as Boyle’s

intellectual confidante and was designated his literary executor in his will (Royal Society MS 194, fol. 8r, reprinted in Boyle [1772] 1965, 1: clix).

Although more could be said on this topic, the discussion so far should indicate that Potter's historical details about Boyle's gender attitudes are questionable at best. The second component of her historical evidence concerns the conflict between mechanistic and animistic accounts of nature. According to Potter, political radicals who argued for gender equality during the civil war found support for their position in hylozoism. She then assumes that those opposed to hylozoism would be so because they would equate it with "radical class and gender politics" (Potter 2001, 184). Given the problems with Potter's account of Boyle's beliefs about women, however, independent evidence is required to support the argument that he accepted mechanical principles because of his gender politics. It is not obvious that mechanism is inherently masculine. Indeed far from supporting the political "status quo" of Boyle's time, the mechanical philosophy was revolutionary, unlike the animism expressed in the Aristoteleanism of figures such as the Jesuit Francis Line (Sargent 2003). Potter has no direct argument about how mechanism is masculine. Instead, she provides two considerations drawn from Boyle's methodological practices to argue for her case.

3. Two Methodological Issues. Potter's first argument is based on her claim that Boyle had no detailed method that could provide a rational justification for his acceptance of the spring of the air. In previous work, I have discussed how Boyle's general methodological principles could be summed up by his attempt to achieve what he called a "concurrence of probabilities." This approach required that all of the relevant empirical and rational evidence then available was to be used to determine whether a hypothesis is "likely to be true" (Sargent 1995, 52–61, 82–84). Concurrence is a decidedly fallible procedure, qualified as it is by the criterion of availability and by its reliance on judgments of relevance. Potter does not disagree with my account of Boyle's method. Instead she dismisses it as too broad and too vague. She seems to have a positivist or Cartesian conception of method as something that would require a set of universally applicable rules that, if followed, will yield conclusive proof. According to Potter, the methods Boyle described do not work because "exactly when and how an experiment provides evidence for a hypothesis is not obvious" (Potter 2001, 166). Accepting Shapin and Schaffer's previous analysis where they maintained that "Boyle had no detailed method for proving his hypotheses" (1985, 50), she argues that "we should not expect to find 'a method' that was the source of Boyle's success; instead historical investigation reveals how important religious and political concerns were

to Boyle's success" (Potter 2001, 168). She then uses this conclusion to argue her second methodological point.

According to Potter, because Boyle's acceptance of the gas law was not based on methodological grounds, and was not "determined solely by the data," it must have been motivated by his prior acceptance of mechanical principles. In addition, she argues, it is possible to construct an alternative to Boyle's law, equally compatible with the data, based on the account of Francis Line who explained the air pump phenomena by postulating the existence of a "funiculus" (a vapor-like membrane that, in conjunction with the spring of the air, was somehow able to uphold a column of mercury in the evacuated receiver of the air pump). It is true that Boyle's acceptance of the gas law was based on the mechanical philosophy, which in turn was based on more than empirical grounds. Just as concurrence requires, he appealed to rational criteria as well, especially intelligibility and simplicity. Potter maintains that Boyle's appeal to intelligibility begs the question against Line's equally intelligible hylozoic explanation. Although "Linus's non-mechanistic assumption . . . might be false" it was "not inconceivable" because "Nature having consciousness and feelings is no less intelligible than God's having them." Boyle's belief in God shows that he had "accepted a Spirit himself," and he was thus "not entitled to reject the world spirit as unintelligible" (Potter 2001, 156).

If Boyle had simply declared mechanical principles to be the only intelligible ones, then he would be guilty of begging the question. But in addition to the manuscript source to which Potter refers, Boyle had an essay on the *Excellency and Grounds of the Corpuscular or Mechanical Hypothesis* ([1772] 1965, 4: 69–78) where he discussed in detail what he meant by simplicity and intelligibility. In line with the simplicity criterion, Occam's Razor would tell us that the spring alone is a more simple explanation than the spring plus a funiculus. Potter argues that Boyle could not legitimately use the simplicity criterion against Line because Boyle did not follow it "when he made God an explanation of the origin of motion" (Potter 2001, 157). This charge of inconsistency is ill founded, however, because it assumes that Boyle turned God into a scientific hypothesis, which he did not. As he wrote in *Excellency and Grounds*: "having first premised once for all, that presupposing the creation and general providence of God, I pretend to treat but of things corporeal, and do abstract in this paper from immaterial beings, (which otherwise I very willingly admit,) and all agents and operations miraculous or supernatural" (Boyle [1772] 1965, 4: 77).

Potter also seems to assume that because Boyle demanded experimental proof for particular hypotheses, he was required to provide empirical proof for his acceptance of the mechanical philosophy. But in his *Excellency and Grounds* he never claimed to have based his acceptance of the me-

chanical philosophy on experimental and observational evidence, although he did argue that it was compatible with such evidence and used some empirical examples for illustration. The reason he gave for accepting mechanical principles was that he wanted to restrict natural philosophy to a study of what is natural. His intelligibility criterion amounted to the position that explanations of natural events were to be given by references to natural processes with which we were already familiar. As he wrote earlier in *Excellency and Grounds*: “if an angel himself should work a real change in the nature of a body, it is scarce conceivable to us men, how he could do it without the assistance of local motion” (73). In a further elaboration of the intelligibility criterion he wrote,

For, if recourse be had to an immaterial principle or agent, it may be such an one, as is not intelligible; and however it will not enable us to explain the phaenomena, because its way of working upon things material, would probably be more difficult to be physically made out, than a mechanical account of the phaenomena. And, notwithstanding the immateriality of a created agent, we cannot conceive, how it should produce changes in a body, without the help of mechanical principles, especially local motion (78).

One might argue that Boyle wrote the above defense of mechanical principles to hide his gender bias behind the veil of rationality. But, if the underdetermination of Boyle’s law by the experimental data is to count as independent evidence for Boyle’s gender bias, then that argument would beg the question. Although some studies have shown how mechanistic biological models of gender production in the twentieth century appear to betray socially and politically motivated assumptions about the genetic determination of gender (Longino 1990), it is not obvious that all mechanical projects must be gender biased. Further, Potter’s general methodological claim seems at best to be a very problematic use of the underdetermination thesis (see Pinnick 1994, Rolin 2000). Simply because Boyle’s evidence is not conclusive in the deductive sense it does not mean that one can therefore infer that gender bias must have been at work in his preference for the mechanical philosophy.

4. Conclusion. Potter’s study gives rise to many questions. How can historical cases shed light on gender debates about methodology today? Is it the method or the way the method has been applied that is at issue? Is there something essential within experimental methods that would cause them to embody some type of masculine bias? If experimental methods are fundamentally biased, as Potter seems to want to indicate by attempting to trace the bias back to the inception of experimental investigation, is there an alternative? What would the alternative look like?

Potter and others are right to remind us that alternative explanations are always possible. It is not clear, however, that this claim leads to anything more significant than the point that like all human endeavors, science is a flawed and fallible procedure. As its critics have been quick to point out, science in the Western world has been characterized by a theoretical confidence and a technological hubris that has resulted in the diminishing of alternative models of thought. My contention is that in Boyle's society (and the subsequent historical practice of science) the masculine was privileged, but that there is nothing inherent in his methodological writing that would necessarily support gender bias. Indeed, a retrieval of Boyle's attitude could provide a valuable resource for addressing such critical issues today. There are at least four elements embedded within Boyle's justification of experimental inquiry that are particularly relevant for such a project.

Usefulness of science.—In his essays Boyle discussed at length the charitable uses to which he hoped his work would contribute, and often prefaced his experimental histories with suggestions for how his investigations could aid human health and welfare (Sargent 1995, 35–41). By focusing on gender issues, it is easy to miss the explicit social, political, and charitable motivations and implications of Boyle's research. Yet, contra Merchant (1980), although his experimental program was designed in part to yield useful knowledge, Boyle did not advocate an unbridled manipulation of nature. He maintained that "it is erroneous to say in the strictest sense that everything in the visible world was made for the use of man." He added, however, that "many parts of the material world" could be considered "highly useful" to man, "as he is a rational creature, that is capable, by contemplating the great and admirable works of God, to raise his mind to the acknowledgement of the divine Architect's power, wisdom, and beneficence, and thereby find produced in him due sentiments of veneration, gratitude, and love" (Boyle [1772] 1965, 5: 416).

Respect for nature.—The religious sentiment reflected in the above passage gave rise to Boyle's charitable impulse and also to his respect for nature as God's other "great book." Because of such respect, the ill effects of modern science need not be thought of as the necessary consequence of experimental manipulation, but merely as historically contingent outcomes that need not be accepted. As Boyle noted, knowledge in itself may be a good thing, even when the uses to which it is put are not. It is, he insisted, "not through the fault of the learning, but by the fault of the man, who being vitiously disposed himself, makes use of a thing, in its own nature good, to a bad end" (Royal Society MS 195, fol. 171v). Simply from the fact that Boyle's extreme religiosity may be unusual by today's standards (see Hunter 2000) it does not follow that a political or gender interpretation is required to explain it. Further, Boyle's respect for the

complexity of natural processes was not solely based on his religious views, but was also derived from his own practice of studying nature. He urged his readers to remember that “to discern particular things is one thing,” but “to discover the intercourse and harmony between all truths, is another thing, and a far more difficult one” (Boyle [1772] 1965, 4: 466).

Intellectual modesty.—Given the complexity of the world and the fallibility of human reason, intellectual modesty is a necessary requirement of experimental investigation. The experimentalist must remain open to the possibility that new theories or improved technologies may radically alter the way in which inquiry proceeds. While we may study nature in order to learn how to use it to help further human welfare, we must remain cautious. Boyle was keenly aware of the real limits, both theoretical and technological, that constrained his investigations and warned that we are prone to error because of the various contingencies that surround our attempts at experimental manipulation. This was one reason why his procedure for achieving a concurrence of probabilities had to remain somewhat vague. Although such vagueness gave his criteria flexibility, the criteria were not easily satisfied, and thus Boyle argued that experimentalists must remain diffident and open to the dynamic development of inquiry. Because of the “connection of physical truths, and the relations that material bodies have to one another,” he wrote that an “inquisitive naturalist” in any age will find “his work to encrease daily” because even his successful trials will “but engage him into new ones” (Boyle [1772] 1965, 4: 36).

Cooperative research.—Finally, because of the vast amount of work involved in the study of nature, inquiry had to be pursued by a large body of investigators. In addition, in order to mitigate the influence of individual and collective biases, which were the basis of Bacon’s discussion of the idols of the mind, the investigative process had to be opened up to many segments of society (Bacon 1874, 4: 53–66). Although this democratic integration was not achieved in Boyle’s day, his works are full of arguments for why it should take place (Sargent, 1995, 1999). Kristina Rolin’s paper for this symposium has an interesting and insightful section on the benefits accruing to the distribution of research effort in which she develops Longino’s (1990) arguments about how an expanded investigative basis can further the interests of knowledge. Boyle’s arguments actually fit well within this line of reasoning. He urged natural philosophers to visit the shops and workhouses of artisans and laborers, for example, dismissing those who believed that such converse would be beneath their dignity (Boyle [1772] 1965, 3: 400–401). There are numerous places in his published works where he cited the testimony that he received from such unnamed but still authoritative sources and where he argued

for the inclusion of information received from the illiterate members of society. In his *Usefulness of Natural Philosophy*, for example, he wrote:

the knowledge of physicians might be not inconsiderably increased, if men were a little more curious to take notice of the observations and experiments, suggested partly by the practice of midwives, barbers, old women, empiricks, and the rest of that illiterate crew, . . . and partly by the Indians and other barbarous nations, without excepting the people of such part of Europe itself, where the generality of men are so illiterate and poor, as to live without physicians (Boyle [1772] 1965, 2: 162; see Sargent 1995, 145–158).

Although his manner of expression may not be acceptable today, the sentiment revealed in such passages certainly remains worthwhile.

Given the above points, even if one maintains that Boyle's arguments in favor of usefulness, respect, modesty and cooperation were little more than fake posturing for political interest or gain, it remains the case that these arguments are integral to his defense of experimental practice. Rather than looking for bias at its inception, one should instead study how any suspected gender bias may be a result of experimental practice having been pursued in male-dominated societies. Once the historically contingent nature of any bias has been shown, then it should be easier to see that there is no reason to continue in such a manner. The epistemic justification of experimental practice as a knowledge-producing enterprise requires an expanded and inclusive society of investigators that explicitly recognizes and addresses the social and political purposes to which their work may be put.

REFERENCES

- Bacon, Francis (1874), *The Works of Francis Bacon*, 14 vols., James Spedding, Robert L. Ellis, and Douglas D. Heath (eds.). London: Longman.
- Boyle, Robert ([1772] 1965), *The Works of the Honourable Robert Boyle*, 6 vols., Thomas Birch (ed.). Reprint. Hildesheim, Germany: Georg Olms.
- (2000), *The Works of Robert Boyle*, 14 vols., Michael Hunter and Edward B. Davis (eds.). London: Pickering and Chatto.
- Guerrini, Anita (1989), "The Ethics of Animal Experimentation in Seventeenth-Century England", *Journal of the History of Ideas* 50: 391–407.
- Hill, Christopher (1986), "'A New Kind of Clergy': Ideology and the Experimental Method", *Social Studies of Science* 16: 726–735.
- Hunter, Michael (2000), *Robert Boyle (1627–91): Scrupulosity and Science*. Woodbridge, UK: Boydell Press.
- Jacob, James R. (1972), "The Ideological Origins of Robert Boyle's Natural Philosophy", *Journal of European Studies* 2: 1–21.
- (1978), "Boyle's Atomism and the Restoration Assault on Pagan Naturalism", *Social Studies of Science* 8: 211–233.
- Longino, Helen (1990), *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*. Princeton, NJ: Princeton University Press.
- Merchant, Carolyn (1980), *The Death of Nature*. New York: Harper and Row.

- Oster, Malcolm (1989), "The 'Beame of Diuinity': Animal Suffering in the Early Thought of Robert Boyle", *British Journal for the History of Science* 22: 151–180.
- Pinnick, Cassandra L. (1994), "Feminist Epistemology: Implications for Philosophy of Science", *Philosophy of Science* 61: 646–657.
- Potter, Elizabeth (2001), *Gender and Boyle's Law of Gases*. Bloomington: Indiana University Press.
- Principe, Lawrence M. (1994), "Style and Thought of the Early Boyle: Discovery of the 1648 Manuscript of *Seraphic Love*", *Isis* 85: 247–260.
- (1995), "Virtuous Romance and Romantic Virtuoso: The Shaping of Robert Boyle's Literary Style", *Journal of the History of Ideas* 56: 377–397.
- Rolin, Kristina (2000), "Can Gender Ideologies Influence the Practice of the Physical Sciences?", *Perspectives on Science* 7: 510–533.
- Sargent, Rose-Mary (1995), *The Diffident Naturalist: Robert Boyle and the Philosophy of Experiment*. Chicago: University of Chicago Press.
- (1999), "General Introduction", in Francis Bacon, *Selected Philosophical Works*, Rose-Mary Sargent (ed.). Indianapolis: Hackett Publishing Company, vi–xxxvi.
- (2003), "Constructing Boyle's Gender Politics" (review of *Gender and Boyle's Law of Gases* by Elizabeth Potter), *Metascience* 12: 113–116.
- Shapin, Steven, and Simon Schaffer (1985), *Leviathan and the Air-Pump: Hobbes, Boyle, and the Experimental Life*. Princeton, NJ: Princeton University Press.