

# Modeling the Gender Politics in Science

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*Feminist science scholars need models of science that allow feminist accounts, not only of the inception and reception of scientific theories, but of their content as well. I argue that a "Network Model," properly modified, makes clear theoretically how race, sex and class considerations can influence the content of scientific theories. The adoption of the "corpuscular philosophy" by Robert Boyle and other Puritan scientists during the English Civil War offers us a good case on which to test such a model. According to these men, the minute corpuscles constituting the physical world are dead, not alive; passive, not active. I argue that they chose the principle that matter is passive in part because its contrary, the principle that matter is alive and self-moving, had a radical social meaning and use to the women and men working for progressive change in mid-seventeenth century England.*

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Whenever she tells a story, the storyteller has a story model, one that outlines how a good story should go. When Marie Boas told the story of Robert Boyle's contributions to physics and chemistry in the mid-Seventeenth Century, she put her account of Boyle's life in a chapter separate from chapters describing his scientific achievements (Boas 1958). In her biography we discover that Boyle (1626-1691) was the youngest son of the fabulously wealthy, unscrupulous Earl of Cork. Old Cork was killed defending his holdings in the Irish rebellion of 1643 and his sons spent most of the Interregnum recovering their property in both England and Ireland. The young Robert was aided in this endeavor by the Parliamentary connections of his sister, Lady Katherine Ranelagh. We learn that Boyle never married and that, although he lived for many years in Oxford, he lived the last twenty years of his life in London with his sister, Katherine. He died a very rich man. As we turn to the chapters delineating his work in science, we find nothing to indicate that Boyle's class and sex or the meanings given to them by the turmoil of the Civil Wars, influenced his discoveries or his scientific theories in any way. But we do learn of a clear demarcation between the budding science of chemistry and non-scientific activities like alchemy, and that it was really chemistry that Boyle was practicing despite his interest in alchemy, natural magic and the occult. His adoption of the "corpuscular philosophy"

in the mid-1650's followed upon his growing dissatisfaction with Aristotelianism and his search for a successor science. The story model that Boas' account follows is a familiar one. She adheres closely to the demarcation between science and non-science as well as to the distinction between an internal and an external account of science. Her account of Boyle's scientific achievements is an internal one, a history of scientific ideas making no reference to the political and social considerations that might have influenced Boyle's theory construction.

Clearly the philosophy of science Boas adopts will not allow a feminist story about science to be told. For one thing, traditional philosophy of science proscribes any feminist critique of Boyle's corpuscular theory as androcentric. On the traditional model of science, bad science is the result of social or personal influences infecting scientific procedures, while good science emerges from scrupulous adherence to scientific methodology. It follows that a rational reconstruction by historians and philosophers of science according to some favored logic of science is a sufficient explanation of good science. Thus, the feminist charge that Boyle's corpuscular philosophy rested on a sexist physical principle comes down to the claim that his theory is bad science because it was influenced by gender considerations. On Boas' story model, feminist scholars of science cannot argue both that Boyle was a good scientist who worked out a good theory *and* that gender politics influenced not only the inception and reception of his theory, but its content as well. But feminist scholars, along with other post-Kuhnian historians, sociologists and philosophers of science, have come to feel that considerations of race, sex and class may well belong in any adequate account of scientific work. Therefore, we need a way to understand science that will allow us to show how these considerations influence the way scientific theories are formulated.

The work of Mary Hesse, W.V.O. Quine and others offers a point of departure for understanding natural science in a way that will be useful for the new feminist accounts of science. In the following section, I will tell a feminist story about the adoption in England of the "corpuscular philosophy." The story illustrates the way in which a principle central to physical theory can be constrained by gender politics. Robert Boyle and other Puritan scientists who took up and developed the early atomic theory argued that the minute corpuscles constituting the physical world are dead, not alive; passive, not active. They chose the principle that matter is passive in part because its contrary, the principle that matter is alive and self-moving, had a social meaning and utility to the women and men working for change in mid-seventeenth century England. Because it collapses the distinction between an "internal" and an "external" history of science, my story can show how concern about gender influenced the formulation of a scientific theory. In the final section, I will show how what Mary Hesse calls a "Network Model" of scientific theories makes it clear *how* race, sex and class considerations can

influence the content of scientific theories.

#### GENDER POLITICS IN THE MECHANICAL PHILOSOPHY

Christopher Hill sees two revolutions in the history of mid-seventeenth century England. The Puritan revolution successfully abolished feudal tenures and arbitrary taxes, and established the sovereignty of Parliament and common law. But Hill properly discerns

another revolution which never happened, though from time to time it threatened. This might have established communal property, a far wider democracy in political and legal institutions, might have disestablished the state church and rejected the protestant ethic. (Hill 1982, 15)

Hill neglects to mention that it might also have established some degree of sexual equality and greater freedom for women, a measure of relief from the rule that women must be chaste, silent and obedient.

The radicals who worked for the failed revolution held a natural philosophy that grew out of certain theological heresies. These heresies in turn derived from the natural magic tradition whose sources included works attributed to Hermes Trismegistus, believed by Renaissance thinkers to have been an Egyptian priest at the time of Moses. Hylozoism, the principle that all matter is alive, was central to Hermeticism. We find in the *Corpus Hermeticum*, for example, that "All that is in the world, without exception, is in movement, and that which is in movement is also in life. Contemplate then the beautiful arrangement of the world and see that it is alive, and that all matter is full of life" (Yates 1964, 31 and 34).

Paracelsus, the sixteenth century physician, clearly conjoins the natural magic tradition with political dissent. "Magic," he said, "has power to experience and fathom things which are inaccessible to human reason." As a champion of the poor and oppressed, he held that law aids only the rich, not the poor; though he charged the rich high fees, he cured poor people for free. He advocated a reformation of religion and of society, including a redistribution of wealth and was nearly killed for supporting the peasants in the great 1525 uprising (Easlea 1980, 102).

The association between the natural magic tradition and political rebellion became clearer as the turmoils of the Seventeenth Century began. In 1600, Campanella was tortured by the Inquisition for rebelling against Spanish rule in Naples in order to set up a "universal republic." Campanella describes the republic in his *City of the Sun*, published in 1623 while he was imprisoned: it is led by a Hermetic magician and characterized not only by eugenics but also by communal ownership of property. Campanella imagines an ideal human community living together in love which mirrors his view of nature:

the basic constituents of both are credited with life and consciousness. Bodies "enjoy being together and cherish their reciprocal contact with one another," so much so that they abhor any vacuum that would destroy their "community" (Easlea 1980, 105).

In England, the pre-eminent Digger Gerrard Winstanley offers a clear case of the sectarian debt to the natural magic tradition. He held a kind of materialist pantheism which identified God with the created world and so placed the spirit of life and cause of motion within terrestrial and celestial bodies themselves:

To know the secrets of nature is to know the works of God.  
 . . . And indeed if you would know spiritual things, it is to know how the spirit or power of wisdom and life, causing motion or growth, dwells within and governs both the several bodies of the stars and planets in the heavens above; and the several bodies of the earth below, as grass, plants, fishes, beasts, birds and mankind. (Quoted by Hill 1982, 142)

These beliefs about nature harmonized perfectly with a revolutionary commitment to human equality.

Sectaries like Winstanley, however, were not the only ones who adopted views derived from the natural magic tradition. Under the influence of Jan Comenius and his disciple, Samuel Hartlib, Robert Boyle and many other mainstream Puritan reformers also adopted such views. Peter Rattansi (1968) observes that Boyle mentions in a letter that he was studying nature aided by "the glosses of Aristotle, Epicurus, Paracelsus, Harvey, Helmont, and other learned expositors of that instructive volume." He also says that "he was weaned away from Aristotelian principles partly by the opposition of Telesio, Campanella ('and his ingenious epitomist Comenius'), Bacon, Gassendi and Descartes among others." As Rattansi notes, ". . . many of the problems that obsessively recur in [Boyle's] work are of the sort that were of central importance for Hermeticism: the curative power of amulets and weapon-salves; stellar virtues; the Alkahest; and transmutation. No doubt, they are all explained in impeccably mechanical terms . . . , but their importance for him becomes less puzzling in the context of his earlier commitments" to hermeticism, alchemy and natural magic (Rattansi 1968, 131 and 139). And Boyle was typical of a group of moderate reformers who found in the natural magic tradition a promising alternative to the now defunct Aristotelian dogmas, all of whom played recognized roles in developing modern science: John Evelyn, Seth Ward, John Wilkins, John Wallis, William Petty, Walter Charleton and Christopher Wren (Rattansi 1963 and 1968).

In the late 1640's and early 1650's, these men repudiated the natural magic tradition and turned to atomism, to the corpuscular theory which Descartes and Gassendi formulated upon the basis of a revival of Epicurus and

Democritus. The traditional view that their conversion was brought about by recognition of the overwhelming superiority of the corpuscular theory avoids completely the social and political issues at stake. If we collapse the distinction between an “internal” and an “external” account of the conversion, we can see that the momentous shift to atomism was overdetermined, influenced by both “internal” and “external” considerations.

Boyle and his compatriots shared a widely held conviction that the natural order on one hand and the moral and social order on the other are mutually reflective. We see this clearly in the use made by sectaries of their natural philosophy to support their social philosophy. Winstanley, for example, urges that men can know God’s will for themselves by looking at the world around them and do not need priests and bishops as intermediaries to tell them God’s will because *all* of nature is full of God or Reason. Not only tithes, but the entire institution of a state church should be abolished. The depth of this challenge would have been clear to Charles I, whose famous aphorism, “No Bishop, no King,” records his conviction that the monarchy and the state church were interdependent institutions.

For all their interest in the natural magic tradition, Boyle and the other moderate reformers wished to distinguish their views as sharply as possible from those of the sectaries whose class interests they opposed. This was tricky business. Simply adopting the corpuscular philosophy was insufficient to make the distinction since one of the most important principles at issue was whether matter is alive, full of the vital spirit and so able to *guide* and *move* itself. As long as God or the World Soul inhabits even the atoms, it inhabits all men and allows them to know all that they need to of spiritual matters without priestly mediation. Refutation of the sectaries’ natural and social philosophies demands, then, at least that matter be passive, dead, brute or inert. Thus Boyle, in one of his first statements of the mechanical view, is very concerned to argue against hylozoism:

. . . methinks we may, without absurdity, conceive, that God,  
 . . . having resolved before the creation, to make such a world  
 as this of ours, did divide . . . that matter, which he had  
 provided, into an innumerable multitude of very variously  
 figured corpuscles, and both connected those particles into such  
 textures or particular bodies, and placed them in such  
 situations, and put them into such motions, that by the  
 assistance of his ordinary preserving concurrence, the  
 phenomena, which he intended should appear in the universe,  
 must as orderly follow, and be exhibited by the bodies  
 necessarily acting according to those impressions or laws,  
 though they understand them not at all, as if each of those  
 creatures had a design of self-preservation, and were furnished

with knowledge and industry to prosecute it; and as if there were diffused through the universe an intelligent being, watchful over the publick good of it, and careful to administer all things wisely for the good of the particular parts of it, but so far forth as is consistent with the good of the whole. . . . (Quoted in Jacob 1972, 18)

Although atoms behave as if they consciously and continually follow the dictates of a world soul, in fact they are brute bits of dead matter, put in motion by God.

The adoption of the principle that matter is dead thus had clear implications for the class struggle in England during the Civil War. As Margaret and James Jacob point out, the mechanical philosophers produced a theory which "outlawed" radicalism from the universe" (1980, 254). But the issue of whether matter is active or passive had implications for gender relations as well as for class relations. The Seventeenth Century saw the development of the ideal woman as a bourgeoisie who was to marry and to stay at home minding the house; while married, she was to own no property. She had no voice in the Church or State (Thomas 1958, 43). Puritan marriage manuals continually reinforced the view that "the man when he loveth should remember his superiority" (Quoted by Thomas 1958, 43) and William Gough, in his popular manual *Of Domesticall Duties* of 1622 and 1634, flatly declared that "the extent of wive's subjection doth stretch itself very far, even to all things" (Stone 1977, 197).

The rise of sectarianism, with its view that God is in everything and everyone, threatened the sexual status quo. Keith Thomas points out that "[f]rom the very beginning the separatists laid great emphasis upon the spiritual equality of the two sexes. . . . And once admitted to the sect women had an equal share in church government. 'It followeth necessarily', wrote John Robinson, 'that one faithful man, yea, or woman either, may as truly and effectually loose and bind, both in heaven and earth, as all the ministers in the world'" (Thomas 1958, 44).

In England during the 1640's, women of the independent churches debated, voted, prophesied and even preached. The Leveller John Lilbourne remarked that "Every particular and individual man and woman that ever breathed in the world since [Adam and Eve] are and were by nature all equal and alike in power, dignity, authority and majesty, none of them having (by nature) any authority, dominion or magisterial power, one over . . . another."

Leveller women played their part in politics side by side with their husbands and brothers, and were among those who, for the first time in English history, acted politically *as women*. The story merits telling in some detail. In 1642, a group of women petitioned the House of Lords ". . . That Religion may be established, and present aid and assistance transported into Ireland for

the reliefe of the distressed Protestants" (Quoted in Higgins 1973, 185). On February 1, 1642, about 400 working women, artisans, shop-girls and labourers gathered at parliament to get an answer to their petition. When the Duke of Lennox cried "away with these women, we were best have a Parliament of women," some of the women blocked his way and broke his staff of office (Higgins 1973, 185).

In August 1643, women, apparently about two or three thousand strong, again demonstrated at Parliament to demand an end to the war and to ". . . cry out for their slain and imprisoned husbands." The women grew restive and

. . . From words they fell to blowes, [for after noon the women] came againe to the doore of the House at the upper staires head, as soone as they were past a part of the Trained Band that usually stood Centinell there, they thrust them downe by the head and shoulders, and would suffer none to come in or out of the Parliament house for two hours together . . . at last ten Troopers . . . came to passe by the women . . . whereupon they drew their Swords, and laid on some of them with their Swords flatwayes for a good space, which they [the women] regarded not, but enclosed them [the soldiers]; upon this they then cut them on the face and hands, and one woman lost her nose . . . and about an houre after the House was up, a Troope of horse came, and cudgelled such as staid, with their Kanes, and dispersed them . . . (Higgins 1973, 193 and 195)

The women demonstrated at Parliament off and on throughout the 1640's, their activities reaching a pitch in 1649. Their petition of April, 1649, apparently signed by 10,000 women, demanded the release from prison of the four Leveller leaders, Lilbourne, Wedwyn, Prince and Overton, and complained of high food prices and taxes. Although the House of Commons refused at first to receive the petition, since women had no legal standing, on Wednesday, April 25, "The House of Commons sent out the Sergeant at Armes to the women to fetch in their Petition . . . but sent them this answer by the Serjeant at Armes to tell them by word of mouth . . . 'Mr Speaker (by direction of the House) hath commanded me to tell you, That the matter you petition about, is of an higher concernment then you understand, that the House gave an answer to your Husbands; and therefore that you are desired to goe home, and looke after your owne businesse, and meddle with your huswifery.'" But the women replied, "we are no whit satisfied with the answer you gave unto our husbands." This uppitiness prompted one newspaper to declare that the women petitioners were really demanding "let women weare the breeches" (Higgins 1973, 202-203, 213).

In April of 1649 the Leveller women decided to petition "considering, That

we have an equal share and interest with men in the Commonwealth." By May the women were claiming that

Since we are assured of our creation in the image of God, of an interest in Christ equal unto men, as also of a proportionate share in the freedoms of the commonwealth, we cannot but wonder and grieve that we should appear so despicable in your eyes as to be thought unworthy to petition or represent our grievances to this honourable House. Have we not an equal interest with the men of this nation in those liberties and securities contained in the *Petition of Right*, and other the good laws of the land? (Higgins 1973, 217)

These events were sure to generate alarm among men of the dominant classes. Sound Englishmen were quick to recognize in the new sectarian views—that all people are equal, and in particular, that women are at least spiritually equal to men since everyone alike has the spark of life within them—a serious threat to the sexual status quo. In 1646 Thomas Edwards vigorously opposed the granting of religious toleration on the grounds that men “should never have peace in their families more, or ever after have command of wives, children, servants” (Quoted by Stone 1977, 155).

Boyle, and others who later became mechanicians, were in and out of London in the late 1640's and would have read and heard accounts of the outrageous activities of women at Parliament. It was precisely during this period that Boyle wrote what we might call his “essays on women.” These include the “Letter to Fidelia,” dated London, December 2, 1647; the “Letter to Mrs. Dury,” dated Stalbridge, April 15, 1647;<sup>1</sup> “The Duty of a Mother's Being a Nurse” and “The Martyrdom of Theodora.” The Boyle revealed in these seldom-read texts eagerly resisted radical change in the social position of women or in the ideology of women. The “Letter to Mrs. Dury,” for example, inveighs against Corsica's painting because painting “invites loose gallants to tempt them [the women who paint],” and may have been written in support of a bill then before Parliament forbidding women to wear makeup, while “The Duty of a Mother's Being a Nurse” argues that mothers should breastfeed their own children instead of hiring wet nurses for them. In these non-scientific works, most of them intended for a private audience, Boyle saw fit to expose a relentless concern that women occupy the domestic space being created for them by bourgeois liberal ideology. The exclusion of these concerns from his scientific writings may be more than a mere generic convention. Boyle was not the only mechanician concerned with gender issues. Walter Charleton repudiated the natural magic tradition in favor of the mechanical philosophy in the early 1650's and produced a very important translation of Gassendi's work on atomism in 1654. But he was also the author of *The Ephesian Matron*, whose hero exclaims of women:



You are the true *Hiena's*, that allure us with the fairness of your skins; and when folly hath brought us within your reach, you leap upon us and devour us. You are the traitors to Wisdom; the impediment to Industry . . . the clogs to virtue, and goads that drive us to all Vice, Impiety, and Ruine. You are the Fools Paradise, the Wiseman's Plague, and the grand Error of Nature. (Quoted by Easlea 1980, 242)

When Charleton represents women as "Errors of Nature," he suggests that a corrected nature would exclude the voice of women heard so often among the sectaries. At a metaphoric level, at least, he recognizes that his own and Boyle's gender politics were excluded from their scientific arguments by sheer force.

Boyle's famous lab assistant, Robert Hooke, on the other hand, plainly makes the connection. Body and Motion are, he claimed, the "Female" and "Male" of Nature, Body being the "Female or Mother Principle," "therefore rightly called by Aristotle and other Philosophers, *Materia*, Material Substance, or *Mater*; this being in itself without Life or Motion, without form, and void, and dark, a Power in it self wholly unactive, until it be, as it were, impregnated by the second Principle [Motion], which may represent the Pater, and may be call'd *Paternus*, *Spiritus*, or hylarchick Spirit. . . ." (Hooke 1682, 171-172).

Can we retheorize science in a way that allows us to show how gender concerns of the sort Boyle, Charleton and Hooke display get into their scientific work?

#### ARTICULATING THE MODEL

To many feminists, my account of Boyle's adoption of the hypothesis that matter is dead will not seem very heretical. It seems a likely story. That is because we have post-Kuhnian models of science very different from Marie Boas' and we recognize that feminist accounts of science require the collapse of traditional distinctions honored in Boas' account. But how we articulate a model is important. Some articulations will be useful for feminist scholars and others will not. We need to understand how making a scientific theory can be connected in myriad ways with other social and political activities. Traditionally, science studies concerned with social influences on science have followed Boas' model and have limited themselves to examining how scientists are influenced as they decide what questions to address. Just so, Ruth Doell argues that two sets of interests have prompted the development and use of in vitro fertilization (IVF) and the human genetic engineering it has made possible. On one hand, women in our society desire to bear children and want the option of bearing children when they are sterile. On the other, the

scientists have a professional interest "in promoting the expansion of the research establishment and may, in this era of commercial application of biotechnology, have entrepreneurial interests as well" (Doell 1986, 11).

Although very important for our understanding of the relations between science and society, these studies leave undisturbed the assumption that the contents of scientific theories are, or should be, pure, uninfected by non-scientific considerations. Operating under that assumption, philosophers of science traditionally defended the purity of science against revelations such as those of Doell by distinguishing the "context of discovery" from the "context of justification." Thus motives leading a scientist to undertake research (the context of discovery) have no logical relation to the theory produced by the research (the context of justification). In the same way, the theory is logically independent of the uses and abuses to which it is put. The fundamental assumption here is that if political, economic, gender, racial or other non-scientific considerations influence the work of producing the scientific theory, the result will be bad science.

On this view, only bad scientific theory is infected by social and other illegitimate concerns; good science is objective, neutral science. Feminists have come to suspect, however, that even scientific theories that are "good" by all the standard criteria—e.g., they are simple, elegant, fruitful, internally consistent, externally coherent with the received paradigm, predictive and so on—are androcentric or sexist.<sup>2</sup> A useful model would then do two things: as well as allowing us to examine the masculinist interests influencing the inception and subsequent use of scientific theories, it would also allow us to show how those interests affect the content of scientific theories. Second, in doing that, it would show us how it is possible for a scientific theory "good" on all the traditional criteria to be androcentric or sexist. A really useful model of science will allow us to say not only that an otherwise unimpeachable theory was *initiated* for reasons that are inimical to the interests of women and has been *used* in ways that are bad for women, but also that and how an otherwise unimpeachable theory may *be* sexist or androcentric even when it is cognitively virtuous and is produced by men and women of good will. We begin to see that the dichotomy between "good science" and "bad science," like the dichotomy between internal and external accounts of science, hinders rather than helps a feminist understanding of science. If we are forced to say *either* that the early atomic theory was good because it was fruitful, coherent and covered the data, *or* that it was bad because it rested on a principle with androcentric, upper class social meanings, we are hindered in our attempt to understand the relations between the gender and the "technical" considerations that go into theory construction and the relations between, for example, women's activities at Parliament and Boyle's experimental activities at Lady Ranelagh's house.

For feminist purposes, a natural science model should allow theoretically

not only for social changes in the structure of scientific institutions (e.g., more women scientists), but also for changes in the way theories are constructed. If a model doesn't allow analysis of real science, it can't show us where our problems lie and where changes must occur. But if a model describes actual scientific theories, not merely ideal ones, it should account for the possibility of feminist science in such a way as to allow it to be socially useful as well as cognitively virtuous and rigorous.

Finally, we would be suspicious of any model of the natural sciences that conflicted with much of the insightful work that feminist scholars have produced heretofore. For example, many feminist scholars of science have used Marxist grounds to argue that male scientists have an unconscious desire to dominate and control women and nature and that this desire leads to an unconscious bias toward theories that allow and foster domination and control. Using object relations theory, other feminist scholars have made very similar arguments (Keller 1983a and 1983b; Harding and Hintikka 1983). Thus, it would be well if our model could show *theoretically*, with some precision, how non-scientific assumptions, including particularly evaluative assumptions such as the desirability of domination and control, influence theoretical content.

A model such as Mary Hesse's Network Model will, if pushed far enough, be useful to feminists in the ways set out above (Hesse 1974). Hesse understands a scientific theory as a system of laws which has a very complex relation to nature. When the scientist establishes a law, Hesse argues, she classifies phenomena on the basis of resemblances among them. An astronomer might decide, for example, that this star is a red dwarf because it is similar to other red dwarfs; a neuroendocrinologist might try to determine whether the role of nitrogen 1 and nitrogen 3 of the imidazole ring of histidine in TRF is the same as their role in LRF. Any scientist is, then, constantly faced with decisions as to whether two things are similar enough to be classed together. But since phenomena are similar in some respects and different in others (none are identical; they differ at least in occurring at different times or occupying different locations), the question becomes, "Which respects are more important, the similar ones or the dissimilar ones?" When the data are all in—here observations of the respects in which phenomena do and do not resemble one another—decisions must be made about which data are significant. This is a fundamental case of "interpreting the data." Data alone, observations alone, do not determine a law or generalization; for example, we observe that whales swim in the water and so are like fish; but we also observe that they are live-bearing like mammals. Are they fish or mammals? Because similarity is not transitive, a decision must be made on grounds other than observed similarity. That is, *b* may resemble *a* and *b* may resemble *c*, but *a* and *c* do not therefore resemble one another; how, then, should we classify *b*? As an *a* or as a *c*? Since any decision here is underdetermined by

the data, it has to be determined on other grounds.

One criterion at work in such a case is logical coherence throughout the system; however, we cannot claim that this criterion alone is sufficient to account for theory production. Scientists do not always decide between conflicting observations on the grounds that one generalization provides coherence with the greatest number of other generalizations. The problematic generalization may instead be the occasion to decide that most of the generalizations in the theory are wrong.

At this point, the mainstream philosophers who adopt a network model argue that scientists either do or should have recourse to cognitive virtues. Scientists hold or should hold certain assumptions about what constitute good systems of laws or "good theories." Just so, Quine has argued, the assumptions that good theories are "conservative" or are "simple" guide the scientist to make the decision that conserves most of what has been held true in the past, or the one that makes the system simpler (Quine 1978). Hesse refers to the virtues as "coherence conditions" and argues that they include assumptions such as the goodness of symmetry and of certain analogies, models and so on (Hesse 1974, 52). However, feminists, as critical science scholars, want to know, not what mainstream philosophers of science think scientists should do, but what scientists actually do. That is, we need to *look and see* what assumptions scientists actually hold to when they decide between conflicting generalizations. The feminist working hypothesis is that the assumptions guiding classificatory decisions may be androcentric or sexist.<sup>3</sup>

Unless we extend the Network Model by recognizing gender, class and race assumptions as "coherence conditions," the model will not be useful to feminists because it will not really collapse the internal/external distinction or the other distinctions hindering a feminist understanding of science. Symmetry, favored analogies and models, like the traditional cognitive virtues, are still "technical" considerations, suitable for an internalist account of scientific theory production. But if we crack the Network Model open by looking with feminist eyes at actual cases in order to discover coherence conditions, the model shows us how androcentric or sexist assumptions influence the content of scientific theories. At least for those cases in which a particular generalization is underdetermined by the data, as the generalization that matter is dead was when Boyle considered it, the decision as to which generalization to adopt must be based on other grounds than simple observation. Because all the generalizations in a system are logically interrelated, the adoption of one of a pair of conflicting generalizations such as "matter is dead" or "matter is alive" will have repercussions throughout the system and throughout related systems. The assumption of some cognitive virtue(s) can determine which repercussions are desirable, but so can the assumption of some other principle, for instance that male behavior is the norm, that male behavior is crucial to evolution, that hierarchies are

functional, that hierarchical models are better than nonhierarchical ones, or, as I have argued in Boyle's case, that women should be kept in a secondary social position. The suggestion here is that feminist studies of theory construction in the sciences should look carefully at the constraints affecting the choices scientists make between conflicting generalizations. On a network model each generalization in the system is—at any given time, though not at all times—corrigible, so there is nothing theoretically to prevent us from discovering that even the most innocent choice is constrained ultimately by an androcentric or sexist assumption.

The flexibility of any system of generalizations means that choices among generalizations can be made that allow at once some degree of empirical adequacy, of coherence, of fruitfulness, simplicity, faithfulness to preferred analogies or models *and* the maintenance of androcentric or sexist assumptions. Thus, the model makes it clear that even good scientific theories, by all the traditional criteria, can be androcentric or sexist in the sense that a sexist or androcentric assumption constrains the distribution of truth values throughout the system. Just so, the early atomic theory, as worked out by Gassendi, Descartes, Boyle and the others, had a reasonable degree of empirical adequacy, was fairly coherent, was certainly fruitful and so on. But one of its fundamental principles had a sexist as well as a classist social meaning. Since the hylozoic principle meant, if not full equality for women, then at least spiritual equality and certain corresponding liberties, for example, to speak and to act as their own consciences directed them, any passivity principle meant the loss of equality and of the corresponding liberties.

The flexibility of theoretical systems also allows the possibility of new and different theory constructions. We might speculate about how an atomic theory based on the hylozoic principle would have developed just as we might speculate about the current possibilities for feminist ways of doing science. Theories could be constructed that base classificatory decisions on feminist assumptions instead of antifeminist ones. The maintenance of a feminist assumption, such as the assumption that women were significant in human evolution or that nonhierarchical, organismic models are better than hierarchical ones, or that women and men should be allowed equal social positions, would have repercussions throughout the classificatory system and would still allow, just as nonfeminist assumptions have, some degree of empirical adequacy, of coherence, of fruitfulness, simplicity, faithfulness to preferred analogies or models, and so on.<sup>4</sup> In her book, *The Principles of the Most Ancient and Modern Philosophy*, Boyle's contemporary, Anne Conway (1982), began work on an atomic theory based on the principle that all matter is alive and conscious.<sup>5</sup> The full story of her work remains to be told, but a network model shows theoretically that such a corpuscular philosophy could have exhibited, just as Boyle's corpuscular philosophy did, a reasonable degree of empirical adequacy, coherence and fruitfulness, and could still have been

politically progressive for women.

## NOTES

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1. I include these letters because they are clearly set pieces written to a fictitious character (Fidelia) or about a fictitious character (Corisca).

2. Here an "androcentric" hypothesis is one that rests on assumptions made only from a male point of view, while a "sexist" hypothesis is one that rests on the assumption that women are inferior to men.

3. David Bloor (1982) argues that coherence conditions should include any social interests that influence the choice a scientist makes between competing hypotheses. Although he never mentions gender considerations, he might include androcentric or sexist social interests as coherence conditions. But there is a problem with the notion of "social interest" here: a woman scientist might well adopt a sexist or androcentric coherence condition even when it is against her social interest to do so (Cf. also Longino 1983). On the model set out here, what Longino refers to as "background assumptions" determine scientists' classificatory decisions.

4. The sociobiological theories of Sara Hrdy (1981), Nancy Tanner (1981) and Adrienne Zihlman beautifully illustrate this point (Cf. Hrdy 1981, Tanner 1981, Tanner and Zihlman 1976, and Zihlman 1978).

5. Carolyn Merchant (1980) discusses Conway's work and argues that Leibniz' monadology was developed under its influence (Merchant 1979).

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