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Science Studies and Literary Theory

In 1978, George Rousseau published a retrospective essay in *Isis* entitled “Literature and Science: the State of the Field.” He charts work across the twentieth century, much of which was inspired by his mentor Marjorie Hope Nicholson, that helped define a field of study largely concerned with influence – how literature was influenced by or embodied the spirit of the sciences of its particular era.¹ Rousseau noted that in the 1970s the size of the field of Literature and Science – at least as measured by MLA participation – had taken a “sharp plunge.”² In part, he blames the emergence of structuralism in the American academy, singling out Michel Foucault as the most significant or perhaps pernicious influence, but Foucault was also accompanied by a more broadly construed critical pluralism: “linguists, semioticians, phenomenologists, Marxists, Maoists, hermeneuticists, neo-hermeneuticists, psychological critics, neo-Freudians, neo-Jungians, formalists just begin to describe the rampant proliferation” (590).

Far from describing the state of a dying field, Rousseau’s essay marks the moment when literary theory entered what had been a fairly traditional philological practice. Indeed, in the decades that followed, Rousseau played a key role in the assimilation of literary theory into science studies, particularly regarding Foucault but also through his work on the imbrications of literature and medicine. The chaos he describes was real. Most scholars are familiar with the impact “theory” had on the literary studies from the late seventies on, but the story of science studies takes a slightly different path. Put bluntly, science was seen as occupying a significantly different epistemological realm, so while theorists studying literature and culture might be able to pronounce confidently that everything is a text, that everything generally did not include the objects science enables us to know. Literary theory moved into science studies in fits and starts.

The year 1987 marked the first conference of the newly formed Society for Literature and Science (an organization now called the Society for Literature,

Science, and the Arts). Its conveners, Lance Schacterle and Steven Weininger, were trained in literature and science respectively, both teaching at Worcester Polytechnic Institute. Schacterle was a student of modern literature, and Weininger a chemist. The program of that conference did not differ significantly from the earlier state of the field as described by Rousseau. A vast majority of the papers concerned the influence of science on literary texts, and few of the abstracts name the usual suspects one would associate with 1980s literary theory. In the early years of the SLS, conference organizers tried hard to interest scientists in attending and presenting, so they discouraged what was then perceived as the overly abstruse language of high theory.

It took little more than a year to upset that strategy. The 1988 conference was still replete with traditional one-way influence arguments or interpretive strategies modeled on science (e.g. a number of papers using cybernetics as a critical framework), but along with this emerged a number of papers exploring language and metaphor in science proper. Although presenters continued to avoid high theoretical discourse, the thinkers who formed the basis for the new studies in Literature and Science were appearing: Jacques Lacan, Jacques Derrida, Gilles Deleuze, Michel Serres, and of increasing importance over the years, N. Katherine Hayles, Donna Haraway, and Bruno Latour. All three were keynote speakers at later conferences, and Hayles served a term as president of the organization.

Words

Evelyn Fox Keller was one of the keynote speakers in the second SLS convention. (The other was Nobel Prize-winning physicist Ilya Prigogine who, along with coauthor Isabelle Stengers, introduced complexity theory to a broad audience in *Order out of Chaos* [1984].) Trained in biology, Keller became a leader in what could be called first-wave feminist science studies, developing an approach focused primarily on language use. Her work, particularly in *Reflections on Gender and Science* (1985), examines metaphors and rhetorical strategies deployed in canonical scientific texts. Perhaps most memorable is her detailed discussion of Francis Bacon's depiction of nature as a woman to be alternately seduced or ravaged. Her work is characterized by an attention to gendered language and depended on the insights of structural linguistics: that language was, in itself, an epistemology, a position epitomized by what is sometimes called the Sapir-Whorf Hypothesis.³ Keller's approach can be linked to a range of other critics in the 1980s examining scientific textuality (Ludmilla Jordanova, the early work of Hayles and Haraway) and, in relation to science studies, marks

a significant intervention in the critique of science itself, something that makes Keller's position as a trained scientist that much more important.⁴ The sociology of science at least since Robert K. Merton tended to treat science externally on either the micro or macro level – as affected and influenced by the dynamics of a lab or broad external economic/social pressures.⁵ The textual critics took that a step further, arguing that language profoundly influenced scientists' epistemology and consequently the very framework through which their work was done.

The work of Thomas Kuhn helped articulate this strategy. Although not adopted directly by many literary theorists, his *Structure of Scientific Revolutions* (1962) argues that scientific “discoveries” or significant changes in scientific practice result from paradigmatic shifts – that scientific paradigms which include “law, theory, application, and instrumentation together” constitute a scientist's world view at any given point in history.⁶ From the perspective of intellectual history, Kuhn's work is very much a part of the structuralist moment and has much in common with a theorist whose work is more mainstream literary theory (and who continues to exert influence on science studies across a number of registers): Michel Foucault. It is hard to overestimate the shadow he casts over literary theory as it informs science studies. His early work, which was received as part of structuralism, was initially grasped as furthering the importance of language in articulating (and hence influencing) scientific practice. From *The Birth of the Clinic* (1963) with its “To see is to say” motto, Foucault's work pursued discursive practices that gave birth to the scientific object and formulated scientific knowledge. That early work culminated in *The Order of Things* (1966), titled *Words and Things* in France, and *The Archaeology of Knowledge* (1969) – his dense meditation on method. The English translation of the latter text included as appendix his influential essay “The Discourse on Language” (1971), which complicated and extended Kuhn's notion of the paradigm, introducing into critical discourse such terms as “the fellowship of discourse” and “the will to knowledge.” These were powerful tools for critics who were confronting the textual production of practicing scientists, enabling the unveiling (and occasional denouncing) of a range of social and cultural biases embedded in linguistic practice, defended by the closure of a fellowship of discourse, supported by a range of institutions structured around a will to knowledge, and showing that the vaunted objectivity of scientists was inflected by the discursive regimes they occupied.

The other major French philosopher who looms over this literary theoretical moment is, of course, Jacques Derrida. More than Foucault, Derrida was the poster child of literary theory in the eighties, and perhaps was the single reason the SLS continually asked its speakers to refrain from jargon.

In the 1980s, theorists of all persuasions reveled in the Derridean practice of neologism and typographic play, but one phrase taken very much to heart was the simple mistranslated comment, “there is nothing outside of the text.” In *Of Grammatology* (1967), Derrida wrote “*il n’y pas de hors-texte*,” which would more felicitously be translated “there is no outside-text,” itself a startling and profound claim, but one without the broader ontological implications of the more trendy version.⁷ (If there is nothing outside the text, then being is only accessible through language.) Derrida and Derrideans were not alone in this embrace of all things textual. Roland Barthes’s semiology was influential, and, from a completely different tradition, Fredric Jameson’s *Prison-House of Language* (1972) was also important. Although sometimes playful, all these thinkers were making serious contributions to philosophical, literary, and cultural understanding. Unfortunately, a caricatured version of their intense focus on textuality prompted vilification and a high degree of critical acrimony, a backlash that did a great disservice to serious students of science.

Even though many scholars developed insights into scientists by examining carefully the way they articulated their findings and strategies, many practicing scientists and technocrats felt threatened by any perceived effort to diminish the objectivity of their practices. Reducing the world to text and then deploying the critical tools sharpened by literary theory raised the ire of a number of practicing scientists who were, at the same time, facing decreasing funding from the governmental sources – although blaming a small cadre of literary theorists for macroeconomic policy decisions, particularly in the United States where philosophy is afforded minimal respect, seems absurd at best. Nevertheless, for readers who did not understand some of the fine-grained strategies of theoretical discourse, and particularly if those same theorists dared discuss the fine-grained texts of scientific theory, feathers were indeed ruffled. These tensions came to a head in 1996 when the journal *Social Text* published the infamous Sokal Hoax. Alan Sokal, a physicist at New York University, submitted an article entitled “Transgressing the Boundaries: Towards a Transformative Hermeneutics of Quantum Gravity,” which he later acknowledged as nonsense and devoid of scientific rigor. That event was possibly inspired by such books as Gross and Levitt’s *Higher Superstition* (1994) and was chronicled in Sokal’s own *Beyond the Hoax* (2008), along with responses by science studies scholars such as Robert Markley, Stanley Aronowitz, and a densely argued defense of Derrida’s mathematics by a mathematician and former student of Derrida, Arkady Plotnitsky.⁸ The dustup, usually referred to as “the science wars,” brought with it defensiveness, anger, a lot of mass media attention, and also a renewed call for rigor and understanding. One thing it also revealed was

that analysis purely on the level of the text, while giving insight into many perhaps unconsciously held attitudes by the language's users, cannot make large claims about science itself.

The trajectory of the career of one figure whose work has exerted a strong influence over science studies is instructive in this regard. Initially trained in anthropology doing work on the Ivory Coast, Bruno Latour wrote a grant to do an anthropological study of a scientific laboratory, a novel idea but one that led to the small but important subfield of "laboratory studies" (an area that includes Sharon Traweek, Karin Knorr-Cetina, and Donald McKenzie).⁹ Latour found himself at the Salk Institute in La Jolla, California, working as a participant-observer in Nobel Prize-winner Roger Guillemin's laboratory isolating brain peptides. The result, published as *Laboratory Life* (1979) with coauthor Steve Woolgar, is in many ways a classic anthropological study of a hitherto unstudied tribe. Careful reading of this text shows Latour's attention to the broad range of artifacts that go into the construction of a scientific fact – buildings, equipment, slaughterhouse brains, funding, scientists and technicians of many different stripes, and texts – lots and lots of texts.

One of the most important claims Latour was to make in his later discourse on method – *Science in Action* (1987) – is that a scientific fact depends not simply on its status as "truth," but more importantly on those who pick it up and carry on its trajectory. The same fate holds true for his first book, and what was picked up from *Laboratory Life* was the claim that scientific facts are constructed and not discovered – a claim he has had to continually explain, defend, and rearticulate across his career. And there is the lesser but still influential idea that a disproportionate amount of the time spent by scientists involved shuffling a lot of paper, at one point noting that his anthropologist observer "was able to portray laboratory activity as the organization of persuasion through literary inscription."¹⁰ Latour and Woolgar offer a much more complex discussion in the rest of the book so it was by no means a justification for a science studies based primarily on textual interpretation. Nevertheless, *Laboratory Life* did call attention to Latour as a thinker and to questioning how his work fit into the increasingly large constellation of figures inhabiting the field of theory.

Bodies

In *Science in Action*, Latour introduces the term "technoscience" in an effort to show how science, no matter how purely practiced, is caught up in a broad range of technologies and that technological innovations are implicated in science. The idea of science studies usually carries with it, as related inquiry,

technology studies. The concept of technoscience helps make problematic a purely textual approach, foregrounding as it does material mechanisms and, even more important, the bodies that use them. Parallel to a science studies informed by literary theory and focused on textual production, is one attempting to understand and theorize the body, initially and particularly the human body. Once again, Foucault's work figures large. Although early efforts to position Foucault tend to link him to a Structuralism derived primarily from structural linguistics, close attention to his texts finds them populated by bodies: mad (*Madness and Civilization* [1961]), diseased (*The Birth of the Clinic*), and criminal (*Discipline and Punish* [1975]). Although it is fair to describe his work as the history of institutions or bureaucracies, when you include the three-volume *History of Sexuality* (1976–1984), a retrospective reading is that his work is a history of the human body, the way it is constituted by scientific observation, but equally the way it is articulated by sociotechnical practices. Although this complex of critical strategies goes by many names, science studies seems to have settled on the terms derived from the introduction to the *History of Sexuality*: biopower and its attendant term biopolitics remains an important field of inquiry.

A key point where theorizing bodies becomes vital in science studies is for people asking how humans are constituted by biology, medicine, and literature. Fundamental to this was Elaine Scarry's *The Body in Pain* (1985), a book where bodies were problematized in novel fashion. Once again, gender provided a key point of interaction as a broad range of theorists begin to question the scientific construction of sex. Parallel but following a different trajectory was the study of the historical construction of race, led in part by the work of Sander Gilman.¹¹ The turn toward forms of embodiment energized a generation of people working in science studies as it drew together biology, medicine, history, and politics. Judith Butler importantly prompted a turn from bodies as objects to race and gender as something performed.¹² Though much of her influence has been in the discipline of performance studies, her reconstitution of bodies in action helped open the door for a broad range of analyses, particularly in film and media studies, where bodies could be regarded as biological and cultural, stable and fluid.

Within the field of science studies, the influence of Donna Haraway (the keynote speaker for the third SLS conference) has been profound. Trained as a biologist (Yale PhD), her early work (published as *Crystals, Fabrics, and Fields* [1976]) is very much part of the textual critique of science, exploring as it does metaphor in biology. But in 1985 she published her "Cyborg Manifesto," perhaps the most influential essay in late twentieth-century

science studies. There she questions directly the efficacy of postmodern focus on textuality: “‘Textualization’ of everything in poststructuralist, postmodernist theory has been damned by Marxists and socialist feminists for its utopian disregard for the lived relations of domination that ground the ‘play’ of arbitrary reading.”¹³ Haraway’s turn is both toward the body, but also the material and semiotic systems within which it functions. The figure of the cyborg does not stabilize the body; instead it blurs boundaries, both material and disciplinary. Although she characterizes it as post-gender, the “Manifesto” provides a perspective on gender by calling attention to boundaries and helping to understand how they are policed. Crucially, she distances herself from Foucault and what she sees as a less effective form of political theory, describing her cyborg as “not subject to Foucault’s biopolitics: the cyborg simulates politics, a much more potent field of operation” (163). Where Foucault generally describes overpowering institutional structures that define the body and the biopolitical, Haraway celebrates the potency of her cyborg precisely because it refuses categorization, rejecting institutionalization, and works across all such attempted forms of capture. Speaking at least in part because of her scientific credentials, but also through her own Marxist feminist stance, Haraway launches a direct critique of Western science’s complicity with the perpetuation of white male patriarchy’s domination of the global (nonwhite nonmale) other. For her, the task is not to use a social constructionist argument to dismiss scientific claims of access to knowledge about the material world, but instead to show how all arguments are necessarily partial and situated, a point she makes in the oft-cited essay first published in 1988, “Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective.”¹⁴ There she asserts, “We need the power of modern critical theories of how meanings and bodies get made, not in order to deny meaning and bodies, but in order to live in meanings and bodies that have a chance for a future” (187).

Haraway, Butler, Foucault, and a myriad of other thinkers produced a materialist theoretical perspective for the scientific construction of bodies with meaning. At the same time focus began to shift to the specific technologies that enabled and authorized those bodies to exist. As a consequence there was an effort to articulate a non-naïve materialist or even realist critical position. It is of some consequence that in 1989, Rutgers University hosted a conference convened by eminent Darwin scholar George Levine called “Realism and Representation.” Albeit in a humorous fashion, the attendees were invited to choose sides via T-shirts marking their allegiance. As it was a conference attended primarily by literary scholars, the representation shirts outnumbered those of the realists. The “realists” in attendance generally acknowledged a “real” world out there that governed and even determined

meaning, while the “representationalists” generally located all meaning within representational (usually textual) systems. Needless to say, the conference did not settle the question, though a volume of essays published in 1993 edited by Levine articulated a broad range of responses.¹⁵ What was obvious at that particular historical moment was dissatisfaction with positivist realism, but at the same time, a clear recognition existed that a pure representationalist or social constructionist model was also untenable. An increasingly complex and nuanced move toward a different ground has followed, one more rooted in materiality, less dependent upon the instability of the text.

One perspective presented at the Rutgers conference was the notion of a “constrained constructivism” offered up by N. Katherine Hayles. Initially trained in chemistry, Hayles went on to get her PhD in literature from the University of Rochester. Her early book, *The Cosmic Web* (1984), focuses on language and metaphor in literature and science, and her second book, *Chaos Bound* (1990) brought a clear-sighted understanding of complexity theory to literary studies. But *How We Became Posthuman* (1999) has probably had the strongest impact, responding as it does to the problem of materiality, bodies, and informatics in a way that moves beyond an overly simplistic realism/representation binary. Hayles addresses many of the same questions as Haraway – for example, the function of informatics – although not from a Marxist feminist perspective. Instead *How We Became Posthuman* is a historical examination of information theory and computation. In it Hayles describes in detail how the idea of code (biological and computational), as a bioinformatic system, traverses bodies, machines and information retrieval, and in 1999, therefore helps set the stage for the posthuman turn.

Things

The twenty-first century marks the beginning of the posthuman era. Often wrongly figured as an expression of humans’ cyborg nature, the concept extends far beyond the simple recognition that human bodies are traversed, augmented, and supplemented by technological prostheses (ideas made popular not so much by Haraway as by science fiction). In *The Order of Things* Foucault already claims that

[M]an is an invention of recent date. And one perhaps nearing its end. If those arrangements were to disappear as they appeared, if some event of which we can at the moment do no more than sense the possibility . . . were to cause them

to crumble, as the ground of Classical thought did, at the end of the eighteenth century, then one can certainly wager that man would be erased, like a face drawn in the sand at the edge of the sea.¹⁶

Despite the apocalyptic tone, what Foucault describes is the end of modernity structured by and through a knowing liberal humanist subject. The posthuman is not (necessarily) the disappearance of a species nor its technological transcendence, but instead is the moment after humanism.

Latour's short but important work, *We Have Never Been Modern* (1991), extends this questioning of the modern liberal humanist subject, seeing it, like Foucault, as a never-quite-accomplished historical figure. Through his own study of science, Latour argues that the anthropological distinction between modern and primitive is both naïve and porous, and that the modern distinction between a knowing subject and natural object is belied by the proliferation of hybrids or quasi-objects/subjects in the lived world.¹⁷ A key insight of Latour's regarding the idea of modernity was that the birth of the modern human subject was necessarily accompanied by the birth of the natural object. Posthumanism does not simply displace the knowing subject; it also creates room for an entirely different articulation of things – as active, vibrant, and having agency.

Early in his career, Latour and several colleagues (John Law, Michel Callon) worked out what they called actor-network theory (ANT), an attempt to articulate the agency of both human and nonhuman actors as they function within extended sociotechnical networks. As seems obvious, such a theory requires an expansive concept of agency, a move Latour has continually had to defend, even as recently as his 2005 Clarendon Lectures, *Reassembling the Social: An Introduction to Actor-Network-Theory*. Nevertheless, reconceptualizing agency by turning to the nonhuman has found support in several other philosophical strands – Bill Brown's "Thing Theory," some of the thinkers associated with object-oriented ontology (Graham Harman, Ian Bogost, Timothy Morton), as well as the more recent work of Jane Bennett, particularly her *Vibrant Matter* (2010).¹⁸ More closely associated with science studies is the work of Karen Barad, a theoretical physicist who proposes a "*posthumanist performative* approach to understanding technoscientific and other naturalcultural practices that specifically acknowledges and takes account of matter's dynamism."¹⁹ She argues for "agential realism," which rearticulates the real as active agents: "*agency is a matter of intra-acting; it is an enactment, not something that someone or something has*. It cannot be designated as an attribute of subjects or objects (as they do not preexist as such)" (178). Barad is acknowledging that "the

world kicks back,” but that in and of itself does not constitute reality (215). Indeed, the thing to understand is the kick – the material agency of the world.

Another scientist concerned with how the world “kicks back” is Belgian philosopher Isabelle Stengers. Initially trained in chemistry, Stengers collaborated with Ilya Prigogine on several books (including the previously mentioned *Order out of Chaos*), as well as with others on histories of psychoanalysis and chemistry.²⁰ The early work with Prigogine explored the long ignored problem of the “arrow of time” (irreversibility) in science, bringing with it a new perspective on uncertainty in scientific practices. Her deep engagement with the investigations of Gilles Deleuze and his sometimes collaborator Félix Guattari lay the philosophical ground for a series of short books on the philosophy of science which were later collected and published in two English-language volumes as *Cosmopolitics I* and *II*.²¹ Those books, along with several other collections, brought her to the attention of larger group of English-speaking science studies scholars.²² Stengers’s wide-ranging subjects include not just the history and philosophy of science but also political activity surrounding such issues as drug policy, environmental degradation, and genetically modified crops (on the latter, see in particular *In Catastrophic Times*). Central to her work and where she can be directly connected to her friend and collaborator Bruno Latour, is her attention to scientific practice – the complex dance of individual scientists with their technologies, colleagues, government policies, and the material objects they study. Her “Cosmopolitical Proposal” is a manifesto that asks everyone (scientists, policymakers, everyday people) to pay due attention to the broad “political ecology” of scientific practices and policies.²³ To this end she invokes Deleuze’s figure of “the idiot,” taken from Dostoevsky, to invite naïve questioning, slow processes down, and ultimately question those who claim the authority to speak for objects of nature and for other humans. It is what she calls in another essay a plea for “slow science,” one that listens, trying to account for and engage the complexity produced by the competing voices of these many human and nonhuman actors.²⁴

While the idea of nonhuman agency was washing away the face Foucault drew in the sand, research in cognitive science was also decentering human cognition and knowledge – the mainstay of modernity – by displacing it from the mind to the body and, in the case of theories of distributed cognition, onto a broad range of sociotechnological systems.²⁵ Part of this move is exemplified by Rodney Brooks’s work on embodiment and artificial intelligence at the MIT robotics lab. Using what he called “subsumption architecture,” Brooks developed a series of robots with very simple perceptor/effector affordances and let them wander about, bumping into their world.

Even without an overriding computer “brain” or some form of cognitive map, Brooks’s robots began to demonstrate what to an outside observer seemed intelligent behavior. His work has had a profound impact on research in robotics and AI, and in science studies helped turn the focus away from minds thinking toward bodies interacting in the material world. In cognitive science, this move has been called “the affective turn.” Of course, the role of emotions in the constitution of the human has long been recognized, but late twentieth-century research in affect as it relates to conscious thought began to provide a more complex understanding. Philosophically at least, Deleuze and Guattari loom over this perspective, and Brian Massumi, the translator of *A Thousand Plateaus* (1980) into English, has extended the implications of their work in his *Parables for the Virtual* (2002).²⁶ In neurobiology, Antonio Damasio explores the importance of the affective body in the production of human knowledge. His *A Feeling of What Happens* (1999) helped bring a noncognitive body back into science studies, and *Descartes’ Error* (1994) sharpened the critique of mind/body dualism. Francisco Varela, whose work with Humberto Maturana on autopoiesis strongly influenced Deleuze and Guattari, also worked out models of affect, cognition, and ethical practice.²⁷

In addition, Maturana and Varela’s concept of autopoiesis was adapted to social systems by Niklas Luhmann, and his systems theory, along with that of Gregory Bateson and Heinz von Foerster, helped a number of scholars of Literature and Science, including Cary Wolfe and Bruce Clarke, begin to articulate the complexity of human/nonhuman systems on a global scale.²⁸ The twenty-first century is not only posthuman but now also the geological era of the Anthropocene. Precisely when this era commenced is a matter of debate, but the recognition that the earth as system is dynamic and mutable, that humans are but part of an incredibly large and diverse system of actants, and at the same time they are transforming the earth on a global scale, has led to this designation. Of course it is not without some irony that we have moved into a posthuman world at precisely the moment we name the geological era after our species.²⁹

On a slightly less global scale, the posthuman turn in environmental science studies is best characterized by the emergence of animal studies, particularly in Wolfe’s *What Is Posthumanism?* (2009).³⁰ The theorists framing much of the discussion amongst animal studies scholars include Derrida, whose classic *The Animal That Therefore I Am* (1997), along with Giorgio Agamben’s *The Open* (2004), Emmanuel Levinas’s varied writings on animals, and Haraway’s *Companion Species Manifesto* (2003), delineate the stakes in understanding how important animals have always been in propping up the idea of the humanist subject, even as that very notion

fades. Derrida and Agamben make explicit philosophy's debt to animals as the nonhuman other used to define human being. Agamben's amplification of Martin Heidegger's notion of the animal as being "poor in world" (in *The Four Fundamental Concepts of Metaphysics* [1929–30]) is perhaps the clearest example. Moving from Heideggerian Being, Deleuze and Guattari's notion of "becoming animal" has also informed animal studies as in, for example, Ron Broglio's reading of biopolitical art in *Surface Encounters* (2011). Although not as well established as animal studies, scholars are also turning to plant studies, using a similar posthuman perspective, with Michael Marder taking the philosophical lead. His *Plant-Thinking: A Philosophy of Vegetal Life* (2013) works out the implications of the plant-as-other through readings of Heidegger, Nietzsche, and Derrida.

In many ways, the introduction of the Anthropocene, coupled with a complex understanding of climate change – the dynamic stability of the earth as a whole, and the increasingly fragile habitat or *umwelt* that humans occupy – leverages yet another turn, nonhuman: conceptualizing of a world without humans, a question addressed most directly by science and media scholar Eugene Thacker, whose *In The Dust of This Planet* (2011) draws together medieval scholasticism, Dante's *The Inferno*, horror films, and Black Metal music to try to think the world without humans. This question was also addressed in a 2012 symposium convened by science and media scholar Richard Grusin at the Center for 21st Century Studies at the University of Wisconsin, Milwaukee. Called "The Nonhuman Turn," it included presentations by Bennett, Massumi, Erin Manning, Morton, and Bogost among others.³¹ Together, these critiques set the stage for a theoretically informed science studies of the Anthropocene, armed with a clearly articulated posthuman position where actors are constituted by the positions they occupy in larger assemblages, one that sees the human species as both fragile and destructive and as part of a much larger fragile and destructive world. From that perspective, the very idea of subjects and objects seems almost quaint.

NOTES

1. See for example her *Newton Demands the Muse: Newton's Opticks and the 18th Century Poets* (Princeton, NJ: Princeton University Press, 1946), and *Science and Imagination* (Hamden, CT: Archon, 1976).
2. George Rousseau, "Literature and Science: the State of the Field," *Isis* 69 (1978): 583–91, at 589.
3. The idea behind what is referred to as the Sapir-Whorf (or the Whorfian) hypothesis is that language structures the possibilities of thought in a given culture.

4. See Ludmilla Jordanova, ed., *Languages of Nature: Critical Essays on Science and Literature* (New Brunswick: Rutgers University Press, 1986); N. Katherine Hayles, *The Cosmic Web: Scientific Field Models and Literary Strategies in the Twentieth Century* (Ithaca: Cornell University Press, 1984), and *Chaos Bound: Orderly Disorder in Contemporary Literature and Science* (Ithaca: Cornell University Press, 1990); Donna J. Haraway, *Crystals, Fabrics, and Fields: Metaphors of Organicism in Twentieth-Century Developmental Biology* (New Haven: Yale University Press, 1976), and *Primate Visions: Gender, Race, and Nature in the World of Modern Science* (New York: Routledge, 1989).
5. Most important was Robert K. Merton, *The Sociology of Science* (Chicago: University of Chicago Press, 1973).
6. Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: University of Chicago Press, 2012), 10.
7. Jacques Derrida, *Of Grammatology* (Baltimore: Johns Hopkins University Press, 2016), 172.
8. See Robert Markley, "After the Science Wars: From Old Battles to New Directions in the Cultural Studies of Science," in *After the Disciplines: The Emergence of Cultural Studies*, ed. Michael Peters (New York: Praeger, 1999), 47–70; Stanley Aronowitz, *Science as Power: Discourse and Ideology in Modern Society* (Minneapolis: University of Minnesota Press, 1988); and Arkady Plotnitsky, "'But It Is Above All Not True': Derrida, Relativity, and the 'Science Wars,'" *Postmodern Culture* 7.2 (January 1997): <https://muse.jhu.edu/article/27605/>.
9. See Sharon Traweek, *Beamtimes and Lifetimes: The World of High Energy Physicists* (Cambridge: Harvard University Press, 1988); Karin Knorr-Cetina, *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science* (Oxford: Pergamon Press, 1981); and Donald McKenzie, *Inventing Accuracy: A Historical Sociology of Nuclear Missile Guidance* (Cambridge: MIT Press, 1990).
10. Bruno Latour and Steve Woolgar, *Laboratory Life: The Construction of Scientific Facts* (Princeton: Princeton University Press, 1986), 88.
11. See Sander L. Gilman, *Difference and Pathology: Stereotypes of Sexuality, Race, and Madness* (Ithaca: Cornell University Press, 1985), and *Freud, Race, and Gender* (Princeton: Princeton University Press, 1993).
12. See in particular Judith Butler, *Bodies That Matter: On the Discursive Limits of "Sex"* (New York: Routledge, 1993).
13. Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late Twentieth Century," in *Simians, Cyborgs, and Women: The Reinvention of Nature* (New York: Routledge, 1991), 149–81, at 152.
14. Haraway, *Simians, Cyborgs, and Women*, 183–201. The use of the term "construction" by many theorists in this period brings a host of problems and misunderstandings. Although it can be value-neutral, simply an acknowledgement that scientific knowledge is built up through theories, instrumentation, and material interactions, when the term is paired with the social as in "social construction," it can seem to imply that scientific facts are merely social and not also material and technical.

15. See George Levine, ed., *Realism and Representation: Essays on the Problem of Realism in Relation to Science, Literature, and Culture* (Madison: University of Wisconsin Press, 1993).
16. Michel Foucault, *The Order of Things: An Archaeology of the Human Sciences* (New York: Vintage, 1973), 378.
17. Quasi-object and quasi-subject are terms Latour adapted from Michel Serres.
18. See Bill Brown, "Objects, Others, and Us (The Refabrication of Things)," *Critical Inquiry* 36.2 (2010): 183–217; Graham Harman, *The Quadruple Object* (Alresford: Zero Books, 2011); Ian Bogost, *Alien Phenomenology, or What It's Like to Be a Thing* (Minneapolis: University of Minnesota Press, 2012); Timothy Morton, *Hyperobjects: Philosophy and Ecology after the End of the World* (Minneapolis: University of Minnesota Press, 2013); Jane Bennett, *Vibrant Matter: A Political Ecology of Things* (Durham: Duke University Press, 2010).
19. Karen Barad, *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (Durham: Duke University Press, 2007), 135.
20. See Ilya Prigogine and Isabelle Stengers, *Order out of Chaos: Man's New Dialogue with Nature* (New York: Bantam, 1984), and *The End of Certainty* (New York: Simon and Schuster, 1997); Léon Chertok and Isabelle Stengers, *A Critique of Psychoanalytic Reason: Hypnosis as a Scientific Problem from Lavoisier to Lacan* (Stanford: Stanford University Press, 1992); and Bernadette Bensaude-Vincent and Isabelle Stengers, *A History of Chemistry* (Cambridge: Harvard University Press, 1996).
21. See Isabelle Stengers, *Cosmopolitics I* (Minneapolis: University of Minnesota Press, 2010), and *Cosmopolitics II* (Minneapolis: University of Minnesota Press, 2011).
22. See Isabelle Stengers, *Power and Invention: Situating Science* (Minneapolis: University of Minnesota Press, 1997); *The Invention of Modern Science* (Minneapolis: University of Minnesota Press, 2000); and *In Catastrophic Times: Resisting the Coming Barbarism* (London: Open Humanities Press and meson press, 2015, free access online).
23. Isabelle Stengers, "The Cosmopolitical Proposal," in *Making Things Public: Atmospheres of Democracy*, ed. Bruno Latour and Peter Weibel (Cambridge: MIT Press, 2005), 994–1003.
24. Isabelle Stengers, "Another Science Is Possible! A Plea for Slow Science" (2011): http://we.vub.ac.be/aphy/sites/default/files/stengers2011_pleaslowscience.pdf.
25. See, for example, Edwin Hutchins, *Cognition in the Wild* (Cambridge: MIT Press, 1995).
26. See Adam Frank's essay in this volume for an account of central features of the affective turn that do not derive from Deleuze and Guattari. Also see Gilles Deleuze, *Essays Critical and Clinical* (Minneapolis: University of Minnesota Press, 1997) for a sampling of essays by Deleuze on literary figures.
27. See Francisco J. Varela, Evan T. Thompson and Eleanor Rosch, *The Embodied Mind: Cognitive Science and Human Experience* (Cambridge: MIT Press, 1991); and Francisco J. Varela, *Ethical Know-How: Action, Wisdom, and Cognition* (Stanford: Stanford University Press, 1999); as well as Humberto R. Maturana

- and Francisco J. Varela, *Autopoiesis and Cognition: The Realization of the Living* (Dordrecht: Reidel, 1980).
28. See Niklas Luhmann, *Social Systems* (Stanford: Stanford University Press, 1996); Gregory Bateson, *Mind and Nature: A Necessary Unity* (New York: Dutton, 1979); Heinz von Foerster, *Understanding Understanding: Essays on Cybernetics and Cognition* (New York: Springer, 2002); Cary Wolfe, *Animal Rites: American Culture, the Discourse of Species, and the Posthumanist Theory* (Chicago: University of Chicago Press, 2003), and *What Is Posthumanism?* (Minneapolis: University of Minnesota Press, 2010); Bruce Clarke, *Neocybernetics and Narrative* (Minneapolis: University of Minnesota Press, 2014), and *Earth, Life, and System: Evolution and Ecology on a Gaian Planet*, ed. Bruce Clarke (New York: Fordham University Press, 2015).
 29. See Claire Colebrook, *Death of the PostHuman: Essays on Extinction, vol. 1* (Ann Arbor: Open Humanities Press with Michigan Publishing, 2014).
 30. Also see Stacy Alaimo, *Bodily Natures: Science, Environment, and the Material Self* (Bloomington: Indiana University Press, 2010).
 31. See Richard Grusin, ed., *The Nonhuman Turn* (Minneapolis: University of Minnesota Press, 2015).