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Rhetoric of Science: Oxymoron or Tautology?

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Science and Rhetoric: A Changing Relationship

Until recently, the notion of a "rhetoric of science" may have sounded oxymoronic.* Traditional conceptions of science as the embodiment of disinterested, objective knowledge of nature, coupled with perceptions of rhetoric as empty verbiage, subterfuge, or stylistic embellishment, made science and rhetoric appear quite incompatible. The split goes back to the seventeenth century, to the charter of the Royal Society, which called for members "to separate the knowledge of *Nature* from the colors of *Rhetorick,* the devices of *Fancy,* or the 'delightful deceit of *Fables*,' and to "reject all the amplifications, digressions, and swellings of style: to return to the primitive purity, and shortness, when men deliver'd so many things, almost in an equal number of words . . . bringing all things as near the Mathematical plainness as they can . . ." (qtd. in Pera 130. However, recent developments in the history of science (especially the work of Thomas Kuhn) and the sociology of scientific knowledge, coupled with conceptions of rhetoric more suitable to scientific discourse, have led to a gradual reconceptualization of the relationship between science and rhetoric. As a result, there appears to be now, at least among rhetoricians, "general agreement that science is indeed a rhetorical enterprise" (Selzer 6).

There is less agreement, however, on the extent to which science is indeed rhetorical, or even on the exact nature of science's involvement with rhetoric. Beginning in the mid-1970s and intensifying in the 1980s, work in what has come to be known as the rhetoric of science has advanced a variety of rhetorical approaches to science--from relatively commonsensical, focusing on the use of language in scientific writing, to radically anti-empiricist, challenging the very foundations of traditional views of science and scientific knowledge. The following review outlines the major premises underlying these approaches and then summarizes some major conceptions of rhetoric of science representative of the major issues and debates involved.

Science as Discourse

Some scientists may bristle at the very idea of a rhetoric of science as an implicit attack on the status of science, its epistemological claims, or even on the integrity of scientists. While some of the more radical claims of rhetoricians may indeed question traditional conceptions of science, the basic claim that science is to some degree and in some manner involved with rhetoric is only commonsensical: to the extent that science involves language (as well as other symbol systems, such as math, visuals, and various forms of symbolic notation), it inevitably involves rhetoric in some form. As the literary critic Northrop Frye observed many years ago, "anything which makes a functional use of words will always be involved in all the technical problems of words, including rhetorical problems." "The only road from grammar to logic," Frye insisted, "runs through the intermediate territory of rhetoric" (331).

In its most basic sense, rhetoric is an aspect of any use of language (or symbols); rhetoric constitutes the practical, situated, strategic aspect of discourse. The term "discourse" is more useful here than "language." Language is the abstract system (phonological, grammatical, semantic) that makes it possible for a community of speakers to communicate (thus, the rules of English, for instance, specify which sounds and written symbols can be combined in what ways to be perceived as meaningful by speakers of the language). Discourse, on the other hand, designates language as it is actually used by people in specific domains of action.

Discourse is typically associated with specific domains or institutionalizations; thus, we speak of technical discourse, business discourse, parliamentary discourse, media discourse, and so on. The central question of rhetoric is how a given discourse works to achieve its specific effects. The formulation "rhetoric of . . ." implies a description, or the possibility of a description, of rhetoric working in relation to a specific domain of discourse. Therefore, if one is willing to agree that there is an identifiable domain of discourse one is willing to call scientific (as opposed to everyday, political, or literary discourse), distinguished by characteristic manners, habits, or strategies of language and symbol use, then, *ipso facto*, one recognizes the existence, or at least the possibility, of a rhetoric of science: a description and theory of how scientists, not as individuals but as part of a defined community of knowledge and practice, articulate and communicate their knowledge.

The rhetorical view of science rests, at bottom, on the premise that science is, after all, not the world itself, not nature itself, but a representation of it, and any representation involves strategies of representation. As Evelyn Fox Keller, herself a scientist, has observed, while scientists may sometimes insist that data speaks for itself, data does not really "speak," nor is it usually meaningful out of context. People speak for it, and when they speak they inevitably face such problems as what to say (classical rhetorical theory calls this "invention"), to whom (audience), with what purpose (argument), how (arrangement and style), and in what manner or medium ("delivery" in rhetorical terminology)—the major dimensions of any act of human communication and the fundamental concerns of rhetoric.

At the most basic level, therefore, a rhetoric of science would be an account of how scientists decide what to say (invention); how scientific audiences differ from other audiences; why scientists communicate; what scientists argue about and how; how scientists present and articulate knowledge; and what genres, forms, and media scientists use to communicate that knowledge.

Rhetoric and Epistemology

However, the modern view of rhetoric does not see it merely as something added onto an underlying substantive "message," "information," "content," or "knowledge" which exists somehow prior to articulation. While it is not clear what it might mean to know something if one did not have a language or other symbol system for structuring, embodying, expressing, and sharing that knowledge, it is clear that human knowledge is involved with language and discourse (and thus potentially with rhetoric) in a variety of ways that go beyond matters of presentation or communication.

First, discourse appears to be present in the process of creating, or, if one prefers, arriving at, scientific knowledge from the very beginning. Bruno Latour *(Science in Action)* sees the creation of scientific knowledge as originating in various practices of "inscription," from mechanically recorded data to symbolic notation, diagrams, laboratory notes, discussions, reports, presentations, papers, proposals, and articles. He claims that scientists use written texts throughout this entire process to argue about and negotiate emerging "knowledge" with other members of their communities, from collaborators and lab colleagues to reviewers, editors, conference participants, and others. Latour and Woolgar *(Laboratory Life)* see conversion of observational data into inscription (printouts, records, notes, formulas) and then into a variety of different texts (presentations, papers, proposals, etc.) as in fact the dominant mode of doing science and the major activity of scientists.

Second, to an extent and through mechanisms still not very well understood, discourse not only expresses but shapes emerging knowledge because it embodies (collective) perspectives, presuppositions, values, norms, and so on. Knowledge, many scholars believe, does not exist apart from knowers, and knowers do not exist apart from professional communities. As Keller has suggested, "all data presuppose interpretation. And if an interpretation is to be meaningful—if the data are to be 'intelligible' to more than one person—there must be participation in a community of common practices, shared conceptions of the meaning of terms and their relation to 'objects' in the real world . . . the sharing of a common language" (130). Sharing a language (or, we should say more accurately, discourse, since we are not talking about English as opposed to French or Russian), however, is "more than knowing the 'right' names" for things. It means also knowing the "'right' syntax in which to pose claims and questions" and "sharing a more or less agreed-upon understanding of what constitute legitimate questions and meaningful answers" (Keller 130). These, in turn, are circumscribed by unspoken presuppositions about what counts as an important question, a meaningful answer, a sensible explanation, an acceptable account, or a superior argument. Such presuppositions are collectively held and historically variable (Kuhn, Bazerman, Gross et al., Pera and Shea, Shapin).

A number of critics have also noted that scientific texts may bear a complex, dialectical relationship to both knowledge and practice. For example, many scholars, most notably perhaps Peter Medawar, have pointed out that the structure of scientific papers is, in spite of the popular myth to the contrary, not a reflection of the actual experience of doing science; the representation of the research process in published work rarely reflects the accidents, failures, insights, conversations, negotiations, and unexpected turns of actual laboratory work and of the intellectual processes of data interpretation and theory building, although the latter may remain latent in the published final text. The final text of a scientific publication is an outcome of complex processes not only of research, but of interpretation, articulation, discussion, composing, peer review, response, and revision—all of which involve continual negotiation and renegotiation of both ideas and language.

It is because ideas and language are so intertwined that rhetoric scholars maintain that "rhetoric is epistemic" (Scott), meaning that rhetoric (via language) is present in some way at the very origin of and in the very notion of "ideas." Ideas do not exist in some neutral space in Platonic forms, but emerge in response to and under the pressure of concrete circumstances, through action and exchange, and are so adjudicated. In addition, knowledge, including scientific knowledge, is imbricated in historically developed and culturally situated forms of rationality, interpretive frameworks, prior articulations, terministic screens, and so on. A rhetorician of science may thus ask: How scientists get their ideas and how are these ideas adjudicated? What implicit or explicit definitions of significance hold sway in different scientific disciplines at a given time or in a given context? How is significance established? According to what criteria are discovery claims credited? How are objects or facts defined and how do such definitions become established as standards on which subsequent work can be based? How are claims of novelty established? What arguments are considered rational? What terms function as “god terms” at any particular time or in any particular context and how do they determine on-going interpretations and articulations of phenomena?

Finally, as Thomas Kuhn has suggested in his influential study *The Structure of Scientific Revolutions,* scientific practice is always connected to a “metaphysic”: an ideological sphere of broader assumptions about the nature of nature, including social and political assumptions. Each school of scientific thought, Kuhn argues, from Ptolemaic astronomy to evolutionary biology and quantum mechanics, “derived its strength from its relation to some particular metaphysic” (12–13). A rhetoric of science may thus also attempt to identify the presence of such underlying “metaphysical” assumptions in scientific texts (see esp. the essays in Selzer, *Understanding).* Even the basic choice of what merits investigation may be motivated by socio-political factors. For example, at the time of this writing, there appears to be growing attention (at least in the media) in the United States to studies of the correlation between abortion and breast cancer (the presidential administration happens to be Republican). One wonders whether such attention will be followed by increased funding, which in turn will lead to more research. While the substance of the emerging knowledge may remain disinterested (to the extent that disinterest is possible), the fact remains that at least what is investigated as science is not insulated from the larger social, political, and ideological contexts and debates.

Rhetorical approaches to science thus begin with different assumptions about the relationship between practice, discourse, and knowledge and attempt to arrive at a more or less coherent account of science as a specific domain of discourse. While the aim of some initial studies of scientific rhetoric was indeed to undermine science’s pretense to privileged, objective, neutral, and “true” knowledge of the world, more recently rhetoric of science has become part of a larger philosophical effort to rethink the nature of human knowledge in light of broader debates brought about by post-modernism, post-structuralism, deconstruction, and so on (for a summary of these debates, see for instance Rorty *Consequences of Pragmatism).* As a consequence, such work is being conducted with increasing methodological rigor and with increasing participation by scientists to ensure that enthusiastic but naive rhetoricians do not run away with unfounded generalizations or misguided conclusions (see Gaonkar and Gross and Keith for methodological critiques and debate).

The remainder of this essay will be devoted to a brief review of selected approaches to the rhetoric of science in order to highlight the major issues and problems presented by them. Some of these approaches focus more on the “textual” features of scientific discourse (argument, arrangement, style, etc.), while others emphasize an epistemic problematic. However, all serve to show that the textual and epistemic are somehow interconnected. It is the nature of this interconnectedness, as well as its exact implications, that have become the focus of major debates in rhetorical studies of science.

Major Approaches to a Rhetoric of Science

Rhetorical Aspects of Scientific Discourse

In one of the first book-length studies on the subject, Lawrence Prelli defines rhetoric as the general theory and practice of effective expression, and a rhetoric of a specific domain of discourse is a "theory of systematic, communicative practice" (6). The rhetoric of science, then, is "a specific theory based on the practices of scientists, to explain what scientists do when they engage in the many discursive activities that are part of doing science" and when they "make and evaluate discourse as science" (6). Prelli's rhetorical view of science focuses on five dimensions of scientific discourse.

One dimension is "symbolic inducement": scientists induce others to "share an orientation for evaluating and 'making sense' of situated phenomena and the relationships among them" (Prelli 90). Research and writing both involve decision making, negotiation, judgments, and selection. Selectivity, in turn, especially in the rendition of laboratory procedure into a coherent exposition and argument, involves motivated choice. This choice is to a significant extent determined—explicitly or implicitly—bywhat Thomas Kuhn has called a paradigm: the reigning interpretive model or theory that at any time constrains and directs attention, research, and observation. Kuhn argued that during the periods of normal science (the period between scientific revolutions, when scientific work proceeds within a relatively established set of general assumptions), the discourse of scientists reflects the interpretive frameworks, ways of seeing, criteria for judgment, standard problems and exemplary solutions that may be applied to new problems as exemplars, standard procedures, methods, and preparations, as well as the terminology of the reigning paradigm. During such times, the rhetorical task of scientists is, according to Prelli, "to induce assimilation of an indeterminate and potentially disputable claim into the comparatively determinate and stable paradigmatic framework" (93). To be acceptable, a claim must be shown to be consistent with this framework, or to extend it in fruitful ways. During the period of change and paradigm shift, on the other hand, or when the research area attracts scientists who represent different paradigmatic perspectives, scientific discourse exhibits increased persuasive orientation and becomes the site of contending interpretive frameworks. During such periods, the resources of "symbolic inducement" are employed in the service of contending interpretive frameworks.

Another major rhetorical dimension of scientific discourse is its situatedness. General rhetorical theory sees all rhetorical acts as grounded in a situation. Rhetorical situations consist of an exigence—a problem, issue, or event that calls for a response—as well as a context of audience expectations, conditions, constraints, conventions, and other elements that in some way shape, direct, or delimit the range of possible appropriate responses and constitute the conditions of appropriateness or failure for possible responses. Rhetorical skill consists largely of successfully working within the rhetorical situation and its constraints to achieve one's rhetorical purpose: to convince, critique, secure funds, etc. (It is in this sense that one should understand Aristotle's classic definition of rhetoric as "the faculty of discovering in the particular case what are the available means of persuasion," *Rhetoric* 7.) Scientific discourse is situated in the rhetorical sense: scientists work, speak, and write in a variety of settings that constitute rhetorical situations, with attached expectations, constraints, and opportunities. As Prelli suggests, "[s]cientific advancement is the result of dynamic and interdependent relationships between scientists' efforts at persuasion and adjudication by audiences in actual and specific, temporal and physical situations" (100).

The third rhetorical dimension of scientific discourse, according to Prelli, is that it is addressed. Like other kinds of discourse, scientific discourse is to a large extent transactional: oriented toward gaining acceptance for one's ideas or findings, securing interest in one's work, locating one's work within what is considered current or "hot" in the field, and associating one's work appropriately within the networks of professional connections, authorities, and debates.

Scientific discourse also presents itself as reasonable. Scientific claims are made and judged not solely on the basis of formal logic, nor according only to criteria of reasonableness that hold for other kinds of discourse (i.e. political or religious) but according to criteria of reasonableness specific to science: criteria such as what constitutes reasonableness of premises, relevance of data, precision of measurements, consistency results, or the warrantedness of conclusions. Prelli identifies four major categories of such criteria:

- problem-solving (experimental competence, experimental replication, corroboration, observational competence, experimental originality, explanatory power, predictive power, taxonomic power, quantitative precision, empirical adequacy, significant anomaly, and anomaly solution),
- evaluative (accuracy, internal consistency, external consistency, scope, simplicity or parsimony, elegance, and fruitfulness),
- exemplary (examples, analogies, metaphors); and
- ethical (universality, skepticism, disinterestedness, and communality).

The criteria may change over time, may be foregrounded or challenged as part of the argument, or may even themselves become the object of debate, especially in periods of paradigm change. Knowledge of such criteria is an essential component of the professional and rhetorical competence of scientists.

The fifth and final rhetorical dimension of scientific discourse, and one that subsumes the other four, is that it is “invented,” in the sense that scientists do not merely ramble on about their findings or theories, but engage in a coherent argumentative and presentational performance. This performance involves, among other elements, identifying an appropriate purpose for the argument, identifying the exact point of departure or issue at stake (what classical rhetoric calls “stasis”), situating themselves within existing knowledge, and adhering to conventional criteria for reasonableness and efficacy. To speak of a discourse being invented in this sense does not mean that it is made up, fictional, or somehow dishonest, but that it is deliberately composed out of available data, knowledge, and formal elements. (It is perhaps in this sense that one may interpret Jean-Francois Lyotard’s famous quip that a scientist is “before anything else a person who ‘tells stories’” (60). For Prelli, the possibility of the rhetoric of science originates mainly in the realization that scientific texts are neither exercises in formal logic nor idiosyncratic, but they are “invented” in the rhetorical sense.

Alan Gross, Joseph Harmon, and Michael Reidy’s *Communicating Science* examines the development and evolution of a major genre of scientific communication, the scientific article, from its debut in the 17th century to the present. Gross et al. focus on three dimensions of the scientific article: style, presentation, and argument. Style includes the syntax of sentences and the choice of words. Gross et al. trace the development of scientific style from its epistolary and essayistic beginnings in the 17th century, which was close to everyday speech, to its present character as “a highly specialized register designed to convey information of great cognitive complexity from expert to expert” (42). Presentation, which includes both organization of the text (what classical rhetoric calls arrangement) as well as display of data, evolved from predominantly narrative and essayistic forms into “a master finding system designed to promote efficient and opportunistic reading, and dependent on the ‘reading’ of tables and figures as well as text, a ‘visible’ acknowledgement that scientific articles are meant less to be read than to be mined as a resource for further investigation” (42). Finally, argument is “the actual ensemble of means scientists employ to support their claims” (9) and “to make and support their assertions” and, in particular, “to establish new facts about the material universe and offer explanations for them” (49). Over the last three centuries, argument in science evolved from tolerance of a wide range of verificative means, reliance on the five senses, and trust between gentlemen (see Shapin) to close argumentation "founded on scrupulously produced experimental evidence" and adherence to a "professional code that transcends personal trust" (Gross, et al. 9–10).

Gross et al. show that the stylistic, presentational, and argumentative apparatus of modern science evolved largely in response to the changing contexts of doing science, the changing tools of science, the increasing volume of knowledge, the need to adjudicate increasingly conflicting accounts of phenomena, the growing professionalization of science (from science as something performed and read by enthusiasts to something increasingly done by specialized professionals), and the need to navigate the increasingly complex nature of scientific information, as well as to larger socio-political changes in Western society.

Charles Bazerman's *Shaping Written Knowledge* focuses on the development and evolution of scientific discourse as a specific way of describing "reality." Scientific discourse differs from other discourses mainly in what Bazerman calls "accountability": the way a text connects to the world which is represents. Various kinds of texts (scientific, legal, literary, philosophical) use different strategies of accountability and thus are beholden in different ways and to different degrees to the "real" they presume to embody and represent. Such bodying forth of "reality" is a product of a certain set of strategies of representation and connection, strategies that are a fundamental element of knowledge-making in the given discipline. Bazerman asks: "How does a world of events get reduced to the virtual world of words? How did the conventions and procedures for this reduction develop? What are the motives and assumptions implicit in the rhetoric and procedure? And what are the accountabilities that limit statements, ensuring the influence of the evidence of the world on human conception?" *(Shaping* 62). In his book, Bazerman seeks answers to these questions by examining the historical emergence of the genre of the experimental report.

In scientific texsts, Bazerman argues, accountability involves successful mediation among four different contexts: the object under discussion (frames of reference within which the object is identified, types of information conveyed about it), prior literature and existing knowledge in the field (establishment of the research problem, location of the problem and method within existing knowledge and literature), audience (knowledge and attitudes assumed in the anticipated audience, structure of the argument in view of the anticipated audience attitude), and the author's own persona or ethos (how that persona is represented in the text, how ethos is established and invoked, how the scientist as a concrete individual appears in, or is erased from, the text).

Bazerman agrees with the traditional view that science is a rational, cumulative, corporate enterprise, but concludes that this enterprise is "realized only through linguistic, rhetorical, and social choices, all with epistemological consequences" (183). He does not, however, argue that science is nothing but rhetoric or that science is reducible to rhetoric, only that the rhetorical aspect of science is a crucial, if often overlooked, aspect of the enterprise.

Science as Argument and Persuasion

Rhetoric is often identified with argumentation and persuasion, and many rhetorical approaches to science indeed focus on argument in science. These approaches generally derive from Aristotle's rhetoric and its later adaptations in the work of Chaim Perelman. Perelman sees rhetoric as argumentation in "nondemonstrative discourse," where "reasoning is not limited to formally correct inferences or to more or less mechanical calculations" (5). The crucial distinction is between demonstration, where the conclusion can be deduced from premises in a formal manner, and argumentation, where different solutions confront each other. In the latter case, rhetoric and persuasion are not opposed to or incompatible with truth, but a necessary aid to it. Truth is not necessarily self-evident; it has to be argued for, and in fact it emerges only through discussion and debate, in which arguments often embody fundamental values and agreements of a community. Thus, from Perelman's point of view, even if one wished to insist that science is the pursuit of "truth" and its result is true knowledge of the world, one might still allow for rhetoric in science as encompassing the ways of arguing for or about scientific truth. As Thomas Kuhn and many other scholars have pointed out, if science were only a matter of demonstration and truth, there would be no way to explain the fact that the history of science is largely a history of discarded theories and change. When one looks at the history of science, however, instead of objective, uniformly progressive knowledge one sees knowledge as human and fallible, arising out of change and controversy pursued by a strongly institutionalized community of knowledge, in which new ideas must be presented for consideration, defended, and evaluated in a manner relevant to a discipline's proper methodology and values.

An account of scientific rhetoric based on Perelman's premises was developed by Marcello Pera. Pera's approach originates in what he calls "the paradox of the scientific method," namely, that "science is characterized by scientific method, but a precise characterization of scientific method destroys science" *(Discourses* 28). Pera notes that actual scientific practice does not square with the idea that a universal and precise method exists for distinguishing science from nonscience. In scientific practice, Pera argues, "there is *more than one* procedure and *more than one* set of rules, each with differing levels of adequacy and precision" (28–29). Scientific rules thus constitute what Kant called "imperatives of prudence": pragmatic recommendations that help experienced practicing scientists make judgments concerning such things as whether a theory is well-tested, an argument convincing, a model satisfying, or a theory promising. Actual scientific practice is thus underdetermined by the commonly accepted rules of scientific procedure and method.

It is this underdetermination that creates openings for rhetoric. Such openings, according to Pera, occur especially when choosing a suitable methodological procedure when confronted with unfamiliar data or with problems that do not appear amenable to existing explanations or accounted for by standard theory; interpreting a methodological rule and applying a rule to a concrete case; justifying one's premises; establishing the plausibility of, or defending, a hypothesis; and criticizing rival hypotheses.

Pera defines scientific rhetoric as including "those persuasive forms of reasoning or argumentation that aim at changing the belief system of an audience in scientific debates" (as opposed to scientific dialectics, which he defines as "the logic or canon of validation of those forms") *(Discourse* 58). In examining the arguments scientists use in various contexts, he identifies many classic strategies of arguing already described by Aristotle in his *Rhetoric,* such as argument by definition, by counter-example, by analogy, by comparison, by division, and so on. He also identifies argumentative strategies characteristic of moments of theory change: the strategy of crucial test (when a disagreement between rival theories is decided by a test of observable fact), of empirical balance (when a theory is shown to satisfy certain requirements better than a rival theory), of theoretical balance (when facts themselves are not sufficient to decide an issue and the argument has recourse to other factors), of dragging strategies (when some assumption related to a theory is shown to be superior or inferior to one associated with another theory and thus the entire theory is indirectly either vindicated or discredited, "dragged"along, as it were), and the strategy of achieved or lost results (when a theory or assumption is praised, or condemned, by suggesting that certain widely admired, or condemned, results would never have been achieved without it).

Pera calls his model a "dialectical" model of science, as opposed to the methodological model (which insists on the self- validating claims of methodological rigor) and the counter- methodological model (which emphasizes the role of non-empirical elements, such as idiosyncrasy, accident, and exception in scientific work). In the dialectical model, science is characterized by a specific rationality, which consists of following the best argument for accepting a certain view of the way the world works. What the best argument is in each case is decided through a debate that involves a specific kind of dialectic and specific kinds of adjudicative judgments (for example, judgments of validity). It is the logic of this dialectic and the criteria underlying these judgments that constitute the rhetoric of science.

Ultimately, Pera suggests, science is a way of talking about reality, but not a description or reflection of reality, because it is necessarily mediated by language and other symbols. Rather than referring directly to external reality, scientific statements constitute "putative reference," which Pera defines as "an element of reality as established *through* certain experimental operations and *within* a given theoretical framework that interprets the results of these operations" (158). Pera argues that science is not so much concerned with capturing reality as knowing objects and facts, where an object is "the putative reference of a concept about which there is consensus," while a fact is "a shared state of objects" (160). Objects and facts are constructed together out of accepted observations and interpretations. The objects and facts constructed in this intersubjective, consensual way constitute the objectivity of science. "Science is not objective, however, in the sense that it describes, or makes assertions corresponding to, reality in itself, for objects and facts [as they exist in and for science] are constructions, not carbon copies, images, or icons of reality" (161).

Anti-Foundationalist Rhetorics of Science

Anti-foundationalist approaches to the rhetoric of science carry Pera's notion of "putative reference" a step further to argue that science is fundamentally rhetorical at its core (that is, its knowledge is a self- referential "text" whose relationship to object-reality remains at best unclear). Steve Woolgar, the most prominent representative of the anti-foundationalist persuasion among sociologists of scientific knowledge, sees science as "a highly institutionalized form of representational practice" (100) and scientific rhetoric (meaning here the stylistic characteristics of scientific discourse) as perhaps the most pure manifestation of the rhetoric of realism. In critiquing that rhetoric, Woolgar takes Pera's notions one step further by insisting that the scientific "fact" or "object" is only a "temporarily stable upshot" of complex social and rhetorical processes (60), and that scientific "discovery" can be more productively thought of as a process of creation of an entity, in which rhetoric plays a central role: "Facts and objects in the world are inescapably textual constructions" (73). The implication is that scientific discourse to a significant extent creates and constitutes the very object "about" which it presumably only reports (73).

The premise that the objects and phenomena of the natural world that are the subjects of scientific discourse do not preexist their representations but are to a significant extent constituted by these representations (including conceptual, symbolic, verbal, and visual representations) is central to radically anti-empiricist rhetorical views of science. Or, to put it another way, facts and objects of scientific knowledge are to a significant extent (although the precise measure and character of that extent may be arguable) constituted both by the practices of knowledge (research methods, data-gathering techniques and measuring apparatuses) and by rhetorical practices (representation, persuasion, negotiation, citation, etc.). Such a "strong" rhetorical view of science assumes that for most data there are possibly a number of competing accounts or explanations and that “scientific” evidence and reasoning underdetermine any particular conclusions. The gap between abstract principles and concrete conclusions or accounts in any specific case can only be bridged by rhetorical means. In its most extreme version, the anti-empiricist perspective implies that there is no evidence or reasoning that in any way determines or establishes anything of importance, only people do, and any fundamental principles as well as any perception or conception of evidence are in any case also already established through rhetorical means.

Alan Gross’s *The Rhetoric of Science* represents an attempt to construct a coherent rhetorical theory of science from the anti-empiricist perspective. Similarly to Pera, Gross sees rhetoric as persuasion. In contrast to Pera, however, Gross sees science as persuasion “all the way down” and builds his approach on the “the possibility that the claims of science are *solely* the products of persuasion” (3, emphasis added). Such an assumption, he argues,

does not deny “the brute facts of nature”; it merely affirms that these “facts,” whatever they are, are not science itself, knowledge itself. Scientific knowledge consists of the current answers to three questions, What range of “brute facts” is worth investigating? How is this range to be investigated? What do the results of these investigations mean? Whatever they are, the “brute facts” themselves mean nothing; only statements have meaning, and of the truth of statements we must be persuaded. These processes, by which problems are chosen and results interpreted, are essentially rhetorical; only through persuasion are importance and meaning established. (4)

The central tenets of his approach assume, first, that, discovery in science is better understood as invention in the rhetorical sense: not, of course, in the sense of being a product of imagination, but rather as a deliberate conceptual construct that expresses an intelligible, defensible, and coherent understanding or interpretation of a phenomenon. For Gross, “discovery” is therefore not a descriptive term but a metaphor. If scientists “discover” the way nature really is, there is no way to explain change in science, except as a history of error; however, if that history is seen as a history of changing interpretations and of argument about the best “story” (always contingent on new data or new intellectual currents) to capture the common sense of the way things are, then the history of change in science makes sense and becomes, in fact, a rhetorical history: a history of ways of talking about, explaining, and arguing about the nature of nature.

Second, seen as a rhetorical enterprise, science consists of arguments concerning, and principled answers to, such problems as what is to be investigated and explained, what constitutes evidence, what constitutes an adequate explanation, or which explanation is better. Argument is thus central to science, and scientific knowledge as it exists at any time is largely the result of argument. This argument follows principled patterns and is adjudicated in principled ways (although these ways also change historically). Such patterns, values (explicit or implicit), and judgments constitute the rhetorical heart of science, and they are learned by scientists as part of their training in how to see, think, and talk like a scientist.

Third, the arrangement of scientific papers, and especially experimental papers, is “a realization of the principles of Baconian induction” (Gross 85). Gross argues that experimental papers are “not so much reports as enactments of the ideological form of experimental science: the unproblematic progress from laboratory results to natural processes” (16). This progress “satisfies a recurrent need to justify the enterprise of experimental science in the face of the problematic nature of the induction on which science relies for the creation and certainty of its knowledge” (86). Gross refers to this rhetorical effect as the “myth of induction”: “the myth that inductive science . . . can lead directly from sensory experience to reliable knowledge about the natural world” (91).

Fourth, scientific style, which largely consists "of devices by which language may be said to refer unproblematically to the real world" (Gross 44), is a way of creating "referential presence," the effect of which is that nature itself appears to speak, that things themselves appear to stand revealed independent of human interpretations or language. Yet, scientific discourse, like all uses of language, depends crucially on analogy and metaphor and on standard tropes of scientific thinking (see Lakoff and Johnson for more on the centrality of metaphor in language). Gross argues that many, if not most, critical scientific terms and concepts are actually explicit or implicit metaphors. Metaphors are central to science because scientific research programs are largely focused on establishing relationships, and metaphor is by definition an expression of a relationship. For instance, the heart is a "pump" with "valves," a biochemical process is a cascade" that exhibits "feedback mechanisms." Underlying such metaphors as these is "a way of talking that turns living cells and processes into their presumed mechanical and computer counterparts" (81). The metaphors are imposed at the beginning stages of observation and inquiry on phenomena; however, as this inquiry proceeds, the initial tentative metaphoric formulation begins to implicitly direct the research effort and to get entrenched by repetition (since any change in the ruling metaphor would in time constitute a theoretical claim or challenge, and precedent is on the side of the initial formulation). Thus, while a biological object may initially be described by analogy with a certain sort of mechanism, subsequent effort will be directed at establishing in greater detail its precise workings. In time, as enough work is accumulated along this line, the object will appear to be that kind of machine and to change its representation in a major way becomes very difficult indeed.

If one defines ideology, after Clifford Geertz, as the ensemble of established ways of thinking about and articulating our reality, than one might suggest, as Gross does, that " [s]tyle in science is not a window on reality, but the vehicle of an ideology that systematically misdescribes experimental and observational events" by inscribing them into metaphoric frameworks that define our relationship to the world we inhabit (for instance, by implicitly suggesting that the world is made up of "machines" and quantities in certain relations to each other) (84). From this perspective, major scientific controversies may appear less as issues of physical or observational accuracy, or of theoretical disagreement, and more as issues of ideology. For instance, creationism vs. evolution is a clash of radically different metaphoric and ideological frameworks and, on a less extreme scale, so is the debate over adaptationism (for a detailed rhetorical study of a representative text of this debate, see Selzer). Because of this imposition of metaphoric frameworks, which are inevitably imported into science as it is articulated in language, and with them the larger ideological frameworks implied and activated by the metaphors, the creation of scientific knowledge, Gross insists, is rhetorical from the very start: "there is no empirical or theoretical core, no essential science that reveals itself all the more clearly after the rhetorically analyzed components have been set aside" (49).

Anti-empiricist rhetorical perspectives on science, such as the one represented by Gross in his *Rhetoric of Science,* are part of the broader philosophical attitude that Richard Rorty calls "textualism": the view that "all problems, topics, and distinctions are language-relative—the results of our having chosen to use a certain vocabulary, to play a certain language game" (139). From the textualist perspective, science is just another vocabulary, one among many and not particularly privileged in general over everyday language, but one which "happens to be handy in predicting and controlling nature" (139).

Conclusion

In the end, the really interesting and provocative question is not whether science involves rhetoric; such a formulation is implicitly tautological insofar as any discourse, and especially highly regulated professional discourse, is rhetorical, provided a certain definition of rhetoric: things are said in a principled way, within specified contexts, for a variety of purposes, and to definable audiences; utterances fall into recognizable genres that consist of conventional and predictable elements; communication involves representation governed by representational conventions; and so on. Rhetoric is, at its most basic, the study of such variables as they pertain to a particular discourse. In this sense, the rhetoric of science is a description and a theory of the "architecture" of these components as they work together to constitute science as a specific domain of discourse and knowledge.

Things become more complicated, however, when one begins to deal with the problematic of representation and the relationship between language (and other kinds of symbolic representation) and nature. The question then becomes not whether science is rhetorical, but how deep into the heart of science this rhetoricity goes, whether, ultimately, science contains some objective, empirical core capable of resisting textualization and rhetorical analysis, that remains unaccountable in historically contingent, social, and ultimately discursive terms. Or, to put it another way: is there anything between the obduracy of the physical universe "out there" (which is neither science itself nor knowledge itself) and the symbolic constructions of "science" analyzable in distinctly human, social, cultural, and historically contingent, and ultimately discursive and rhetorical, terms?

Charles Bazerman provides a way of thinking about this question in a way that avoids both simplification and polarization. He agrees that, in general, there is "no guarantee of an essential link between the object of nature and the words and equations scientists formulate to describe these objects and their behavior" (223) and that in this sense scientific discourse "cannot be taken as absolute, a transparent and congruent presentation of nature as it is" (223). Scientific discourse as discourse is inevitably a social, symbolic creation As Bazerman puts it, "scientific questions would not exist without scientists to find motives and ways to vex each other and nature with peculiarly human concerns of understanding and control" and the results, descriptions, and arguments advanced to address and answer these questions are no less human constructions (223). In this sense, they are to a significant extent also rhetorical creations that fulfill rhetorical tasks: to articulate, to frame, to argue, to persuade, to define, to describe, and so on. It is in this sense that scientific rhetoric is inevitably mixed with epistemology.

Yet, such a realization does not have to lead to radical textualism á la Rorty or radical anti-empiricism á la Woolgar. The rhetorical choices that go "all the way down" to the problematic of representation and interpretation are constrained, Bazeman argues, by the available data, the potential of the equipment, the range of potentially acceptable interpretations, and the framework of applicable theory. Within these constraints, scientists attempt to present their work as accurately, precisely, and clearly as possible, aiming at the "best possible representation of the material" within the theoretical, experimental, and linguistic scope available to them (223). While scientific discourse is thus not *merely* a faithful description of nature as it really is and cannot be said to simply and unproblematically refer to external realities, neither is it completely detached from them; in Bazerman's words, "the scientist's hands, eyes, ears, and the laboratory apparatus stand between the physical events and the symbolic representation" in discourse (224). In this sense, the scientist is "neither a fiction writer nor a mute mechanic" (224).

Awareness of the rhetorical dimensions of science, and of questions implicit in this awareness, is important to both non-scientists and scientists alike. For example, Greg

Myers sees rhetorical analysis of scientific texts as a way of promoting change in the public attitudes toward science: specifically, he would like non-scientists to “read more science, to read it more critically, to read it with an awareness of the social processes and negotiations that produce it, and to question the authority with which science is sometimes presented in cultural and political contexts” (249). Scientific texts are important not just to scientists but to all because they are “central to the processes of constructing facts, methods, and authority in a field that is central to our view of ourselves and of society” (250). At best, attention to the rhetorical aspects of scientific texts can invite not only examination of one’s own and one’s field’s specific knowledge-making practices, but also reflection on, and a reexamination of, as Keller has put it, “the terms in which our understanding of science [and, one could add, of nature itself] is constructed” (175–76).

None of this should be interpreted as in any way diminishing science or its immense capacity, demonstrated daily, to influence and change the world around us. As Bazerman has put it, the corpus of scientific writing is “one of the more remarkable of human literary accomplishments” (13). This should not be taken to mean that scientific writing is just another kind of literature, or that it does not qualitatively differ from literature, or that it amounts to little more than fiction. What it does mean is that scientific writing represents a unique and historic accomplishment: “the development of linguistic means for statements that move toward relatively stable meaning and assent among people sharing wide numbers of social variables.” Moreover, “these statements seem to give us increasingly immense control of the material world in which we reside. These symbolic representations have literally helped us move mountains and know when mountains might move on their own” (13–14).

Note

* The title of this essay was inspired by a question posed by Charles Bazerman in “The Production of Technology and the Production of Human Meaning.” *Journal of Business and Technical Communication* 12.3 (July 1998): 381–387, 382.

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