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## THEORETICAL PERSPECTIVE

# The roles of rhetoric in the public understanding of science

Alan G. Gross

In the public understanding of science, rhetoric has two distinct roles: it is both a theory capable of analysing public understanding and an activity capable of creating it. In its analytical role, rhetoric reveals two dominant models of public understanding: the deficit model and the contextual model. In the deficit model, rhetoric acts in the minor role of creating public understanding by accommodating the facts and methods of science to public needs and limitations. In the contextual model, rhetoric and rhetorical analysis play major roles. Rhetorical analysis provides an independent source of evidence to secure social scientific claims; in addition, it supplies the grounds for a rhetoric of reconstruction, one that reconstitutes the fact and facts of science in the public interest.

## Introduction

In writing my book *The Rhetoric of Science*<sup>1</sup> I hoped that, by pressing the rhetorical analysis of biology and physics to its limits, I would contribute something new to the public understanding of science.<sup>2</sup> I would show not 'that scientists are really just rhetoricians, which is nonsense',<sup>3</sup> but that scientists are engaged in the process of persuasion in all of their professional and intellectual activities, not only in the forum, but also in the laboratory, the field, and the study. Newton's *Opticks* and Einstein's early papers were rhetorical to their cores, but so were Darwin's *Notebooks* and Boyle's experiments on the spring of the air. The import of this argument for public understanding is that science is *another* human activity, an object of study, of praise or blame but never of worship: probing the material world is an activity no more (nor less) worthy of public support than probing the social or ethical worlds. But in the book, with the exception of some closing remarks on the recombinant DNA controversy, I did not reflect on public understanding itself, what it could or should mean, what purpose it could or should serve: I did not reflect on the roles that the rhetoric of science could or should play in our understanding of public understanding.

With the inception of *Public Understanding of Science*, a forum now exists in which this question can appropriately be raised, a forum through which scholars of public understanding may be legitimately open to persuasion concerning the worth of a rhetorical perspective in their chosen field of study. I hope that these scholars will be

convinced by this paper that rhetoricians are worthwhile intellectual allies. But no intellectual ally is valuable who does not do a fair share of work.

### A rhetorical perspective on public understanding

Can a rhetorical perspective on the public understanding of science confirm existing insights, and yield new ones? I think it can. Before I begin my argument, however, I need to clarify what it means to call an analysis, a source of evidence, or a communication 'rhetorical'. It would be idle to argue that rhetoric has not earned its pejorative labels, phrases pointing, alternatively, to the cognitively nugatory ('mere rhetoric') and the ethically suspect ('rhetorical hair-splitting'). But the current revival of rhetoric derives not from these inauthentic manifestations, but from the analysis we owe to Aristotle's *Rhetoric*, the first extant treatise on public understanding. Aristotle saw that rhetoric was an activity central to the functioning of the Greek city state, an activity that affected simultaneously the structure of personal beliefs and actions and the workings of the polity. The speaker had as his task—for Aristotle's was essentially an oral and a male culture—'to see the available means of persuasion in each case' and to employ those means in the interest of reinforcing or changing belief and action.<sup>4</sup>

Aristotle's analysis presupposed the situated character of this rhetorical activity, its focus on the particular case. Indeed, it is situation that is rhetoric's defining characteristic, differentiating it from other artful forms of language. While nothing essential about stage plays or epic poems (or scientific or social scientific discourse, for that matter) depends on their particular occasions, rhetorical activity always exists as a specific response: Kennedy's Inaugural Address satisfied a particular exigence, as did Cicero's defence of King Deiotarus, and Churchill's first address to the House of Commons as Prime Minister. In the first case the occasion was ceremonial and the response *epideictic*; in the second case the occasion was legal and the response *forensic*; in the third case, the occasion was political, and the response *deliberative*. In one sense, of course, these speeches are timeless; we study them as exemplars of the epideictic, the forensic, the deliberative. But rhetorically speaking, they are timeless only in so far as they were timely.

To understand that rhetoric is situational is also to understand that only in the special circumstances of scientific and scholarly exchange, and perhaps not even then, can an unaided reason hope to prevail upon a public. It is because of this that Aristotle speaks of 'the available means of persuasion', means that may originate in the mind (or in the heart), or in the reason (or in emotions and values). Rhetorically speaking, the *sine qua non* of this process is trust. Because the public must trust those who are trying to persuade them, central to all situated utterances is a speaker who evokes appropriate emotions and endorses appropriate values, a speaker in whose virtue, good will, and good sense the public has confidence.<sup>5</sup>

In this evocation, style plays an important role. Especially important for the analysis of public understanding are two stylistic features: the figures of speech and thought known as metaphor and metonymy. Metaphor commits a deliberate category mistake. When you say, 'On the final, several students went down in flames', you are using metaphor; you are deliberately confusing human beings and mechanisms, the animate with the inanimate. Metonymy involves making a substitution that might otherwise be regarded as illegitimate.<sup>6</sup> When you say, 'Evelyn needs a strong shoulder

to lean on', you are using metonymy. You say shoulder; you mean person.

So used, metaphor and metonymy are ways of speaking. But they may also be ways of thinking. When you say, 'America is a melting pot', the metaphor is not just a figure of speech; it is also a way of thinking. When you select from a multi-causal reality a single cause, when, for example, you say, 'Your genes are *the* cause of your subsequent behaviour', the metonymy is not just a figure of speech; it is also a way of thinking. To support or to attack a thought-configuring metaphor or metonymy, to insist on its legitimacy or illegitimacy, is to perform a cognitive act.

It is also to take an ethical and political stand. As Aristotle saw, rhetorical activity is also ethical and political activity: nothing significant can be advocated in the public forum that does not entail judgments of right and wrong. If America is a melting pot (rather than a salad bowl), ethnicity is subverted (rather than privileged); if behaviour is in our genes (rather than in our environment), eugenics (and not educational improvement) is good public policy. For Aristotle, then, politics is not the politics of *politics as usual* or of *political science*, merely descriptive. Politics and ethics are allied disciplines: politics, the study of human beings as citizens; ethics, the study of human beings as persons. Rhetoric serves both of these disciplines, its goals the welfare of the state and the proper conduct of its citizens. As an art, it can of course be used *against* those interests. This was Plato's point in his brief against rhetoric. But Aristotle understood that the democratic state cannot exist without rhetoric, without the public means of coming to a public understanding concerning public issues. To banish rhetoric from the state was to banish the only means its citizens had for making common sense of a common past and for creating and coming to terms with a common future.

Because rhetoric is situational, its cognitive and ethical truths must be relative to particular publics. In the *Rhetoric*, for example, Aristotle defines happiness as wealth, good friends, good health; in the *Ethics* he defines it as 'activity in accordance with virtue', the highest of which is to be found only in the contemplative life.<sup>7</sup> There is no contradiction; no alteration in Aristotle's views need be hypothesized. The *Rhetoric* tells us what most people believe; the *Ethics* what they should believe. Rhetoric must start its task of persuasion where most people are. From this relativity of means, however, we cannot infer that the ethical and political ground of rhetoric is also relative, subjective in its pejorative sense. A rhetoric relative to the needs and capacities of particular publics is consistent with ethical and political realism, with the idea that ethical and political standards are *not* relative.

In the public understanding of science, rhetoric has two distinct roles. It is both a theory capable of analysing public understanding and an activity capable of creating it. From the perspective of its first role, Aristotle's *Rhetoric* is primarily a treatise on public understanding; from the perspective of its second, it is primarily a handbook for speakers seeking to co-create public understanding. Whatever the historical truth concerning this particular text, the analytic and active roles of rhetoric are co-dependent and equal in importance. Unless we analyse, we cannot understand the public interest; unless we turn analysis into activity, we cannot serve it.

## Two roles for rhetoric in public understanding

In its analytical role, rhetoric reveals two dominant models of public understanding in need of definition: the deficit and the contextual. The deficit model explores the

ramifications of its particular root metaphor (in Stephen Pepper's sense): scientific *sufficiency* and public *deficiency*.<sup>8</sup> In consequence, the deficit model is asymmetrical: it depicts communication as a one-way flow from science to its publics. Its practitioners do not try to persuade; they assume that the public is already persuaded of the value of science. They do not try to build trust; they assume that the public is already trusting. The deficit model implies a passive public: it requires a rhetoric that acts to accommodate the facts and methods of science to the public's limited experience and cognitive capacities. The goal is a better appreciation of science; the genre is epideictic. In this model, in accord with the prevailing ideology of science, communication is solely cognitive: knowledge alone is transferred; ethical and political concerns are ruled out as irrelevant. The preferred methods of the scholars of the deficit model—surveys of the public, content analyses of the media—assume the model's central focus: the state of science, not the situation of the public.

The contextual model explores the ramifications of its very different root metaphor: the *interaction* between science and its publics. In consequence, the contextual model is symmetrical: it depicts communication as a two-way flow between science and its publics. Its practitioners do not assume that the public is already persuaded of the value of science. They try to build trust; they do not assume that the public is already trusting. The contextual model implies an active public: it requires a rhetoric of reconstruction in which public understanding is the joint creation of scientific and local knowledge. The goal is a better integration of the needs of science and its publics; the genre is deliberative.<sup>9</sup> In this model, communication is not solely cognitive; ethical and political concerns are always relevant. The preferred method of the scholars of the contextual model—the analysis of case studies—assumes the model's central focus: not the state of science, but the situation of the public.

In the contextual model, rhetoric and rhetorical analysis play major roles. Rhetorical analysis provides an independent source of evidence to secure social scientific claims; in addition, it supplies the grounds for a rhetoric of reconstruction, one that reconstitutes the fact and facts of science in the public interest.

### **The deficit model of public understanding criticized**

Surveys of public understanding of science in Britain and of scientific literacy in the United States support the deficit model by consistently documenting public ignorance of science. John Durant and his British colleagues found, as did their American counterparts, that, while interest in science was high, understanding was low indeed: 'only 34% of Britons and 46% of Americans appeared to know that the Earth goes round the Sun once a year, and just 28% of Britons and 25% of Americans knew that antibiotics are ineffective against viruses'. Concerning the methods of science, the results were even more dismal. Asked what it meant to study something scientifically, 'fewer than 4% mentioned theory construction and hypothesis testing unprompted'.<sup>10</sup> These deficiencies imply the need for a responsible rhetoric of accommodation, one that adjusts the facts of science to public needs and limitations.

To see such a rhetoric in operation, we cannot turn to the media. Their coverage of science is characterized by inaccuracy, unwarranted certainty, and oversimplification. That the media report science inaccurately is the consensus of all content analyses I examined, the result, one presumes, of a continuing tension between the public interest and commercial interests. In 1948, Watson Davis could quote E. W. Scripps, a founder

of the Science Service in America, to the effect that 'its sole object should be to present facts in readable and interesting form—facts on which the reader could and probably would base his opinion on a subject of politics, sociology, or concerning his duty with regard to himself and his fellows'.<sup>11</sup> Davis's optimism has proved unfounded. In the case of nuclear power, for example, 'overall, the major print and broadcast outlets analysed failed to report the views of the scientific community accurately'.<sup>12</sup> Journalists valued sensationalism over accuracy. In this regard they fell well below government officials, industry representatives, and representatives of environmental advocacy groups.<sup>13</sup>

In addition to being inaccurate, journalistic popularizations routinely report the results of science with unwarranted certainty. An original paper on sexual difference in math comprehension excluded one sample from its analysis because of its small size, a mere 22. It is this sample, however, that the writers of *Newsweek* treated as typical, reporting that 'among eighth grade subjects in 1976, more than half the boys scored above 600 of a possible 800, but not one of the girls did'.<sup>14</sup> In his study of the effects of an influential review article on the causes of cancer, Stephen Hilgartner reports similar transformations. In their review, Richard Doll and Richard Peto opined that 'it may be possible to reduce US cancer death rates by as much as 35%' through dietary change. They emphasized, however, that this percentage was a 'guestimate' whose certainty and reliability they could not endorse. Although they were optimistic about the eventual efficacy of such changes, they felt that science was a long way from making responsible specific recommendations. Such hedges, however, did not deter *Reader's Digest* from entitling their popularization: 'At Last, An Anti-Cancer Diet'.<sup>15</sup>

Finally, popularizations illegitimately reduce complex effects to simple causes. There are of course legitimate reductions:  $f=ma$ ,  $E=mc^2$ . But the creators of a science museum exhibit, *Food for Thought*, refer to the reason for an increase in food poisoning cases, as if there were, or could be, a single reason.<sup>16</sup> In parallel fashion, without proper justification, the exhibit's creators locate the primary source of food poisoning in poor home preparation rather than in poor food industry or farm practice. Analogously, the editors of *Newsweek* unreasonably prefer a genetic over an environmental explanation of differences in math ability, while the editors of *Reader's Digest* unreasonably prefer a dietary over an environmental explanation of cancer.

Dismal survey results coupled with media distortions set the task for the public understanding of science according to the deficit model: a more responsible rhetoric of accommodation, one that avoids the inaccuracy, unwarranted certainty, and oversimplification that now characterize media representations. But it is a mistake to locate the problem of public understanding in public ignorance; the problem is the presuppositions of the deficit model itself. The deficit model has at least three defects: it embodies a mistaken view of science; it isolates science from contexts that give it public significance; and finally, it cannot address the ethical and political issues science raises, or ought to raise.

The deficit model is defective, first, because it falsifies science. Although it draws a firm line between science and its popularizations, sociological investigation indicates that no firm line exists. Hilgartner finds misrepresentations at all levels, scientific and non-scientific. Indeed, in his study, one of the most accurate representations occurs in *People* magazine. Hilgartner shows that accuracy, warranted certainty, and responsible inference cannot be assigned to the scientific side of a line that cannot be drawn with any confidence.

Nor can these qualities be assigned without reservation to science itself. A more

adequate understanding of the history of science undermines the deficit model by undercutting its presupposition that its methods routinely generate truths about the material world: 'overwhelmingly, the results of the conscientious pursuit of scientific inquiry are failures: failed theories, failed hypotheses, failed conjectures, inaccurate measurements, incorrect estimations of parameters, fallacious causal inferences, and so forth'.<sup>17</sup>

Two examples will serve to dramatize this general observation. William Freudenburg reports that the 1984 estimate of the velocity of light falls outside the range of standard error for the recommended values reported in the four decades beginning in 1930. He also summarizes a study that illustrates the failure of technological expertise at its highest level. A group of internationally known experts was asked at what height an embankment would cause a clay foundation to fail. Not one of them estimated a range of values that enclosed the true failure height.<sup>18</sup>

That such blunders are routine and predictable is confirmed by the findings of cognitive psychology. David Faust summarizes the results of the research as follows: 'The study of human judgment leads one to hypothesize that scientists' cognitive limitations necessitate the use of relatively simple reasoning structures and that such structures provide an underlying unity to supposedly complex assumptive networks'. This hypothesis entails 'a general description of the scientist as a limited being, one who is incapable of satisfying many of our scientific ideals and far less capable than we have generally assumed of managing complex problems'.<sup>19</sup>

The deficit model is defective for a second reason: it isolates science from contexts that give it public significance. The goal of the model, scientific literacy, is the source of the defect. Literacy itself is the mastery of a graphemic representation of a language. But what is scientific literacy? Let us unpack the metaphor. Surveys of musical literacy or enological literacy would undoubtedly discover that the British and American publics could not, by and large, tell a *tremolo* from a *fortissimo*, or define the *solera* process. But it is not necessarily a deficiency to be ignorant of these matters; most of us are ignorant of most matters. What is deficient, rather, is to be ignorant where it matters to you, in particular situations. If you want to play a sustained note on the mandolin, *tremolo* matters, not the term but the practice; if you want to drink sherry rather than cough syrup, *solera* matters, not the practice but the term.

Under what circumstances can it matter that antibiotics don't kill viruses, or that the Earth revolves around the Sun annually, two questions typical of surveys of the public understanding of science? Baruch Fischhoff puts the matter well:<sup>20</sup>

The [Institute of Medicine's] report noted, somewhat despairingly, that only 41 per cent of the general public knew that AIDS was caused by a virus. Yet, although this fact is elemental knowledge for medical researchers, it has relatively little practical importance for laypeople—in the sense that one would be hard pressed to think of any real decision whose resolution hinged on knowing that AIDS was a virus.

This criticism is deeply rhetorical and implicitly political. We cannot tell whether the viral nature of AIDS counts as public knowledge unless we can specify the public contexts in which such knowledge can make a significant difference. But so long as the allegation of public ignorance is consistently supported by survey results, such contexts need not exist: a public ignorant of science need not be consulted concerning its support and direction.

These defects suggest a deficit model with a more appropriate and limited goal: not



scientific literacy, but the transfer of relevant knowledge in situations where public health and safety are clearly at stake. Such a model presently operates in the field of risk communication. Workers like Baruch Fischhoff and Paul Slovic are creating a rhetoric of risk communication grounded in the same theories and findings of cognitive psychology that undermine unwarranted scientific certainty. According to cognitive theory, for example, 'outcomes that are merely probable are underweighted in comparison with outcomes that are obtained with certainty'. Slovic and his co-workers applied this finding to risk communication. They gave the same information about a hypothesized vaccination to two groups in two different forms. One group was told that this vaccination would protect half of them from a disease that was likely to afflict 20 per cent of the population. A second group was told that there were two mutually exclusive strains of a disease, each apt to afflict 10 per cent. It was as likely that they would be infected with one as with the other. But the vaccination would protect all of them from one of the diseases, not from the other. Although there is no actual difference between these outcomes, theory predicted and experiment confirmed that in their second formulation they would receive a more positive response.<sup>21</sup>

Properly employed, a responsible rhetoric of accommodation can certainly be helpful. It can respond appropriately to situations; for example, it can promote the use of seat-belts and encourage testing for genetic diseases for which successful therapies exist. But even a rhetoric of accommodation grounded in cognitive psychology and demonstrated need for public health and safety cannot overcome the final and most telling defect of the deficit model: its inability to turn a critical eye on the fact and facts of science. Of necessity, all rhetorics of accommodation deflect attention from the ethical and political issues science raises, or ought to raise: in the seat-belt case, the advisability of more effective passive restraint systems; in the case of genetic testing, the advisability of unconditional patient confidentiality. In fact, as we shall see, the situation is worse: in many cases, rhetorics of accommodation actually mask ethical problems.

Despite its limited success in well-defined areas, such as risk communication, the deficit model fails generally as a ground for public understanding and political action. It also fails generally as a paradigm for research. That this is not a defect in the model itself is seen in a paper by Durant and collaborators, a paper that uses 'a specific measure of scientific understanding [derived from survey results] as an analytical tool in the study of social representations of science'.<sup>22</sup> From this use, these scholars formulate and support the hypothesis that 'medical science may occupy a central, paradigmatic role within the popular representation of science in British culture'.<sup>23</sup> Although this hypothesis is interesting in itself, it is its derivation from survey results that is truly significant. Still, it remains to be seen whether such theoretical constructs will yield results important enough to breathe new life into research based on the deficit model.

As the deficit model has been usually employed, however, its results are wholly predictable. Its surveys continue to find the public ignorant of a basic science generally irrelevant to its interests, and its scholars continue to argue in favour of popularizations that present these irrelevancies with greater accuracy. Despite their efforts, however, content analyses of the media continue to reveal serious deficiencies in the treatment of science. To the extent that this remains the case, the research programme that has the deficit model as its motive force is degenerating in Lakatos' sense: it does not, as would its progressive counterpart, '[lead] to the discovery of hitherto unknown novel facts'.<sup>24</sup>



### The contextual model of public understanding defended

In this section, I will suggest the contextual model as a candidate for the progressive counterpart to the deficit model. In the contextual model, rhetoric and rhetorical analysis play significant roles. This model, however, cannot be supported until it is defended against serious methodological criticism. Scholars who use the deficit model generally rely on the well-established methods of survey research and statistical analysis; their contextual counterparts generally have no such methodological security. This is because they depend on the analysis of cases, a method that, arguably, cannot lead to social scientific knowledge. The epistemological efficacy of case studies, then, is not a problem *for*, but a condition *of* their sociological and rhetorical analysis. Can case studies produce genuine knowledge of public understanding? In essence, the question is John Stuart Mill's. His answer is not encouraging: because case studies cannot be controlled, as experiments are controlled, he judges that they are not, properly, a method.<sup>25</sup> In other words, they pile up; they do not add up. To justify my preference for the contextual model as a mode of analysis, therefore, I must defend case studies as a social scientific method. Only after I have done so, will I be free to make the case for the significance of rhetoric and rhetorical analysis in the understanding of public understanding.

Two sociological studies of the effects of the Chernobyl disaster on Western Europe—Robert Paine's of Lapp reindeer herders, and Brian Wynne's of Cumbrian sheep farmers—seem to support Mill's criticism. They are parallel analyses of the impact of the same event, and of the same class of events: public *misunderstandings* of science rooted in official insensitivity to local needs. Nevertheless, they seem to be epistemologically incompatible, driven by very different theoretical presuppositions. Consequently, their narrative detail seems to support no single hypothesis, nor does it seem conceivable that one case could be a test of a hypothesis generated by the other. A comparison of these two studies, however, shows that Mill may have been mistaken; case studies may, in the aggregate, constitute the evidential base for social scientific knowledge about the public understanding of science.

A re-analysis of Paine and Wynne shows that, despite their apparent incompatibility, despite the fact that they share not a single citation, they are persuasive in the same way. The evidence for this claim does not reside in overt intent. Paine sees his study as 'a competition between two kinds of *knowledge*'; for him, 'the salient analytical issue is . . . the problematic relationship between *accident* and *routine*'.<sup>26</sup> Wynne sees his study in very different terms. He takes as his object of analysis 'the complex and multi-dimensional social basis of trust and credibility as a central factor in the reception or "understanding" of scientific advice'.<sup>27</sup> The evidence for the compatibility of these two studies lies instead in a rational reconstruction that makes their structures of proof explicit.<sup>28</sup> From the translation of the narrative detail of each account into a single, clear and testable hypothesis, a basis of theoretical comparison will emerge. This procedure is an adaptation of Alexander George's structured, focused comparison, just one of several means designed to add methodological rigour to case studies. To reduce unwanted degrees of freedom, George recommends the careful selection of contrasting cases, equally subject to structured interrogation. Especially important to George is the specification of the hypotheses to be tested.<sup>29</sup>

We begin structured, focused comparison with Paine's study. A careful reading reveals an interesting failure of perception: Paine's apparent inability to see that there is within his narrative of general misunderstanding and mutual distrust, one signal

instance of success. Both the Lapp reindeer herders and the Norwegian government wanted to reduce the radioactive contamination of the herds. One method involved insertion of a chemical cartridge in the animals' mouths, the other, selective feeding. The government experts favoured the former; the herders, however, chose selective feeding. The herders succeeded; as it turned out, the experts had neglected to take into consideration the enthusiasm with which the Lapps would embrace a method over whose application they had full social control, a method whose application depended crucially on local knowledge. This was a victory, not for local or for scientific knowledge, but for their joint product. The experts' doubts concerned the feasibility, not the validity of selective feeding, and it was precisely on the matter of feasibility that local knowledge counted.

We can account for this success by means of a qualitative hypothesis, reconstructed from Paine's own narrative: the hypothesis that there is a direct relationship between local confidence in government experts and the creation of public understanding as a joint product of the scientific and local knowledge. So construed, Paine's case study explains both the success of selective feeding and the general failure of Norwegian Chernobyl policy. The Lapp herders had good reason to distrust the experts on general grounds, but not, on Paine's recounting, in the specific case of selective feeding. The experts predicted that either proposed method, properly carried out, might be efficacious, and were disinterested enough to support the application of the alternative they did not favour, the alternative that maximized the social and epistemological control of the herders.<sup>30</sup>

This qualitative hypothesis also explains the failure of English Chernobyl policy, the subject of Wynne's parallel case study of the effect of the radioactive cloud on Cumbrian sheep farmers. A rational reconstruction of Wynne's recounting shows that the farmers' continued distrust was well grounded in the experts' persistent arrogance in the face of failure. Initially, experts radiated an optimism grounded on a scientific model later shown to be fundamentally mistaken, a false position that contributed significantly to the farmers' economic distress. In addition, by ignoring the farmers' well-grounded knowledge of local conditions, these same experts set up field trials which were bound to fail. In the event, the total lack of openness exhibited by the experts, the government, and the nuclear power industry led to a distrust so deep that it fuelled fantasies of conspiracy. Although actual conspiracy was not in evidence, a deep distrust had more than sufficient grounds.

Mill's attack on case studies must be balanced against Donald Campbell's recognition, after half a scholarly life-time of opposition, that in sociology and political science case studies might, after all, be useful, that the unacceptable degrees of freedom inherent in their uncontrolled use might be so drastically reduced that they would face epistemological difficulties no different in kind from those that face experimentation in the natural sciences.<sup>31</sup> Because in a case study we can never achieve the rigour of an experimental science, we must not assume that we can achieve nothing of cognitive value. Structured, focused comparison implies that careful choice and analysis can raise the epistemological status of a small number of cases, a number as small as two. The way is open for a rhetorical analysis of cases that will support sociological claims concerning the public understanding of science.

## Rhetorical evidence in support of social scientific claims

A quarter of a century ago, a rhetorical theorist argued 'that the situation is the source and ground of rhetorical activity—and . . . of rhetorical criticism'.<sup>32</sup> As an example of this principle, Lloyd Bitzer asserted that air pollution is 'a rhetorical exigence because its positive modification—reduction of pollution—strongly invites the assistance of discourse producing public awareness, indignation, and action of the right kind'.<sup>33</sup> Two decades later, sociologists Harry Otway and Brian Wynne argued for a new programme for studies in the public understanding of science, an alternative to the deficit model and its accompanying methodology of surveys and the content analyses. Its implementation would comprise an empirical effort that focused on 'case studies involving real people in real settings', and a theoretical effort 'to understand better the effects of context on communication'.<sup>34</sup>

Though from different disciplines, these scholars unite in their call for an empirical effort that examines the contents of communications in their contexts, and a theoretical effort that understands the rhetorical situation as an opportunity for, and a constraint upon, social interaction: one person's context of communication is another's rhetorical situation. But sociologists working within the contextual model can be productively sensitive to the social and political significance of figures of speech and the order of arguments only if rhetorical analysis is an *independent* source of evidence for securing their claims. To make the case for this independence, I will analyse a 'rhetorical' study already in the public understanding literature, Sharon Macdonald and Roger Silverstone's paper on a food-poisoning exhibit in a science museum.<sup>16</sup> I will show that Macdonald and Silverstone secure by 'rhetorical' means the same claim that Paine and Wynne secure by sociological means.

Macdonald and Silverstone do not identify their study of the food-poisoning panels in the exhibit, *Food for Thought*, as rhetorical. Only redescription reveals that they are analysing a rhetoric of accommodation whose purpose is to absolve the food processing industry of responsibility for food safety. In the exhibit, with the exception of one reference to a factory contamination, buried in small type in one phrase of the third panel, no causal connections are made between food poisoning and the way domestic animals are raised, processed or sold. That consumers, not producers or processors, must bear the responsibility for the safety of food is the explicit message of the text, and the implicit message of nearly all of the illustrations and of the interactive unit, a domestic cooking utensil accidentally contaminated through careless washing. In so far as food is a product of science and industry, the exhibit says, it is safe; in so far as food is dangerous, the fault is the consumer's.

This rhetoric of accommodation is not entirely successful. Concerning the danger food poisoning poses for the consumer, the message of the panels is blatantly self-contradictory. Each panel is topped by a menacing skull and cross-bones, but the first mentions food poisoning mortality only in passing in the smallest type size and the second presents food-poisoning etiology and symptomology in inappropriately comic cartoon format. We do not know whether to be alarmed by a menace that requires political as well as personal action, or to dismiss food poisoning as a nuisance, like dyspepsia. But this failure of accommodation, which can be traced to conflicts that arose in the deliberations that led to the creation of these panels, is unlikely to be noticed by visitors. I have already mentioned that food poisoning is marginalized conceptually by severing its connection with the food-processing industry. In the exhibit, it is also marginalized physically: the panels are placed in the short corridor

between the sections on 'Food and the Body' and 'Food in the Factory', and take up no more than one per cent of the total allocated space.

An acknowledgement of the rhetorical nature of Macdonald and Silverstone's study licenses a further analysis of the exhibit, one that reveals causal linkages between deep-seated conceptual schemes, apparently casual turns of phrase, and the arrangement and allocation of physical space.<sup>35</sup> In the planning phase, one team member worried that the exhibit could 'become a hymn to the food processing industry'; at the end of the planning phase, another team member affirmed the decision to marginalize the food poisoning controversy by equating the team with its object of representation: 'we are the Science Museum after all'.<sup>36</sup> The layout of the exhibit concretizes the metaphor in the first phrase and metonymy in the second. The layout is a physical representation of the underlying conceptual structure of the exhibit, a structure that privileges the food-processing industry and its warranting science by representing them as objects of reverence rather than as contingent social products subject to criticism and revision. Food processing is allocated the most exhibit space by far; moreover, that space is privileged: the exhibit is roughly in the shape of a cathedral with two 'aisles' leading a 'nave' surrounded on both sides by 'shrines'.

The physical layout reinforces the message of the food-poisoning panels: to discourage the making of causal connections between the food the consumer buys and the facts and defects of farm and factory. There are two entrances to the exhibit. The public can begin its viewing at either, so that the order in which the exhibit is seen depends on chance: first for some will be last for others. The passivity expected of the public in its relationship to science and industry is embodied in the physics of the so-called 'interactive' unit: the only 'action' required is the pressing of a button that lights up the 'contaminated' areas of a domestic cooking utensil, making visible through the power of 'science' the otherwise invisible order of 'nature'.<sup>36</sup>

In Paine and Wynne, by means of sociological analysis, we see science maintain its authority, not by the standards it acknowledges, but by narrowly political means, at the cost of public trust; in Macdonald and Silverstone, by means of rhetorical analysis, we see the same process at work, though the cost is not apparent. The social and political dynamics that Paine and Wynne reveal parallel those of Macdonald and Silverstone, though the former rely exclusively on sociological theory and the latter analyse the persuasive effects of verbal and visual nuance in a text.

From the point of view of my argument at this stage, what counts is not the truth or falsity of the claim that science maintains its authority by narrowly political means; what counts is the fact that this claim can be generated or secured as a consequence of *either* sociological *or* rhetorical analysis. In my view, this methodological ambidexterity legitimates rhetorical analysis as an independent source of evidence for sociological claims within the contextual model.

### Rhetoric as action

In addition to securing social scientific claims within the contextual model, rhetorical analysis provides the grounds for action in the public interest. This role is especially important in view of a current and general deficiency in the social sciences. When the social and the political became sciences, a gain in rigour was matched by a loss in scope: in general, the study of political and social behaviour was severed from ethics on the positivistic ground that *ought* statements, being emotive, can only be preferred,

not rationally defended. It is one of the paradoxes of intellectual advance that this positivism can itself no longer be rationally defended. But an inhibition against the language of ethics remains generally in force, an inhibition that is especially damaging to the contextual programme because real people in real settings must decide social and political issues in situations charged with ethical imperatives.

Because it insists that deliberation is the common processural ground of ethical as well as social and political decision-making, rhetoric helps overcome this inhibition. In addition, it helps because it comprises a tradition in which ethical debate has been central from the beginning. For these reasons, its perspective creates a theoretical and historical link between the cognitive and the ethical. This link is exemplified in sociologist Joseph Gusfield's openly rhetorical analysis of automobile accidents, *The Culture of Public Problems*. In this book, Gusfield analyses the creation of a 'moral order', the cultural distribution of ethical and legal responsibility, a distribution backed by political and social imperatives, and reinforced by a rhetoric of accommodation.<sup>37</sup>

Gusfield knows that automobile accidents are not rhetorical but real events. These have complex causes: road and traffic conditions, speed limits, the condition and structure of the automobile including its safety features, and driver competence. Driver competence is itself a complex variable: it may be impaired by poor vision, night driving, driving in rain or snow, poor distance judgment, reckless habits, age, sleepiness, and, of course, drugs, including alcohol. Even if a driver involved in an accident is under the influence of alcohol, it is far from clear that that accident was the result of alcohol. This is true regardless of the blood alcohol level, because no two people react to alcohol in the same way, and the same people react differently under different conditions, say after a full meal.

Even if alcohol is implicated in a particular accident, it is a legitimate question whether the responsibility of the individual driver is not mitigated when a particular society not only condones, but makes convenient the consumption of alcoholic beverages, even late at night and close to highways. A reasonable approach to automobile safety, then, might involve distribution of moral and legal responsibility among the manufacturers of automobiles, the builders of roads, the manufacturers and purveyors of alcohol, governmental authorities, and the individual driver. Such an approach might even seek out for criticism the original decision to prefer the automobile; it might try to reduce automobile usage by encouraging public transportation.

Despite the complex causal nature of automobile accidents, it is the cultural consensus in the United States that the individual driver is their primary agent, especially drivers under the influence of alcohol. They are the 'drunken drivers', morally and legally responsible for the havoc they initiate by their reckless behaviour. As Gusfield makes clear, this is a rhetorical transformation. In Aristotelian terms, it is a metonymic shift, one in which one aspect of causation is made to stand for the whole. This shift is reinforced by the creation of those serio-comic characters, the 'drunken drivers', staggering, reeling, figures of fun were it not for the havoc that they wreak, the tragedy for which they are solely responsible.

The 'drunken driver' is only the most dramatic creation of a rhetoric of accommodation designed to mask a moral order than shifts the responsibility for accidents away from the automobile industry, distillers, brewers, bar and liquor store owners, and government. The automobile industry has accepted responsibility for safety only reluctantly: the manufacturers of automobiles showed little concern before the issue was brought forcefully to their attention by the consumer rights pioneer Ralph Nader.

Even today, if someone dies because a passenger air-bag is lacking, the manufacturer incurs neither opprobrium nor liability. Distillers, brewers, bar and liquor store owners occasionally remind drivers to avoid alcohol, especially over the New Year, but otherwise do everything they can to encourage sales, regardless of the consequences, aware that even in a highway accident in which alcohol is implicated, even under circumstances where a particular bar or liquor store might be implicated, they will incur neither opprobrium nor liability. Federal, state, and local governments pass and enforce traffic regulations; unsurprisingly, they incur no liability for the building of superhighways that encourage speeding or for the poor road maintenance that contributes to accidents.

Gusfield sees that 'the process by which authority is established in the area of drinking-driving serves to hide from its users and from those toward whom it is used that there are moral choices by which selection and adherence are developed'. He realizes as well that the creation of a rhetoric of accommodation with the drunken driver at its centre is a political act; it is '[one] way in which ruling groups create legitimation and functional response to their power and interests . . . by construction of a cognitive and moral reality, a set of motives and directions in the ruled which are consonant with the needs and interests of ruling groups'.<sup>38</sup>

Nevertheless Gusfield backs away from judging the quality of the moral order his rhetorical analysis so clearly reveals: simplification and distortion are, he feels, inevitable consequences of the transformation of the results of scientific investigation into social policy. They are; but it is not inevitable that the responsibility of automobile manufacturers, distillers, brewers, bar and liquor store owners and government officials should be shifted to the individual driver, as in the case of this particular moral order and its rhetoric of accommodation.

Gusfield's is a critique of a moral order already firmly in place, and reinforced not only by a rhetoric of accommodation, but also by strongly entrenched economic and political interests and a virtually unbudgeable physical superstructure of expressways, businesses, and suburbs. In order to entertain the realistic possibility that Gusfield's rhetorical unmasking can be not only a cognitive and ethical analysis, but also a cognitive and ethical act, an opportunity to forward the legitimacy of public participation in the creation of the moral order, we need a case in which the moral order is in the process of formation, a process that can be readily and legitimately interrupted. The Human Genome Project is such a case.

In a foreword to *Gene Mapping*, Nobel prize winner James Watson recognizes that the Project will create ethical problems. Because of this, he avers, our growing knowledge of genetics must be 'informed by the experiences of families at risk for genetic disease, by accurate accounts of public perceptions and historical precedents, by well-researched and articulated policy alternatives, by religious perspectives and ethical considerations'. As a consequence of this complex need, 'the American public . . . is investing substantially in the Human Genome Project's efforts to anticipate its social consequences'.<sup>39</sup>

Rhetorical analysis reveals this display as a rhetoric of accommodation that, by reference to public concern, control, and benefit, masks the elitist politics of the Project. Joel Davis has high praise for Watson's effort: 'At his insistence, three percent of the NIH's Genome budget will be devoted to studying the ethical implications of mapping the human genome. That's about \$6 million a year out of an annual budget of \$200 million, and close to \$90 million over the proposed 15-year span of the Project. That is undoubtedly the most money ever spent specifically on biomedical



ethics—or perhaps any kind of ethics'.<sup>40</sup> A less enthusiastic reading of the evidence would emphasize, not the \$90 million allocated for ethics, but the \$3 billion allocated to the mapping itself. The decision to spend the bulk of Human Genome funds on genetics, rather than the ethical problems that genetics will create, was not made on the basis of the relative state of maturity of our ethical as opposed to our scientific knowledge. If it were, ethics would get the three billion. As a result of this disproportion in funding, scientists continue to increase their knowledge of genetics faster than philosophers increase our knowledge of ethics: the gap between our understanding of the cognitive and ethical implications of the Project continues to widen, a gap the rhetoric of accommodation works strenuously to mask.

Another Nobel prize winner implicated in the Project, Walter Gilbert, provides a perfect example of these rhetorical efforts. He appears deeply concerned about the Project's social and ethical implications. He says of gene typing and genetic mapping that they 'could also have very strong social effects. However, the problems posed by the knowledge are not insurmountable and can be dealt with in a democratic society'.<sup>41</sup> Gilbert would be correct only if the public were to participate in and continue to oversee the Project. This is not the case. Moreover, at the same time that the public is denied control of knowledge that will affect them intimately, the denial is itself denied by rhetorical sleight of hand. We are not told about those who will lose their health insurance because they will suddenly have become 'responsible' for their genetic make-up. Instead, we are told in obnoxiously sexist bombast that '*Homo sapiens*, the creature of Nature, has transcended her. From a product of circumstances, he has risen to responsibility. At last, he is Man. May he behave so!'<sup>42</sup> We are not told that the therapeutic advantages of genetic engineering lie far in the future, that identifications of the 'genes' for schizophrenia and manic depression, made respectively in 1987 and 1988, were later withdrawn. We are told instead that 'the search for the biological grail has been going on since the turn of the century, but it has now entered its culminating phase with the creation of the human genome project, the ultimate goal of which is the acquisition of all of the details of our genome. That knowledge . . . will transform our capacities to predict what we may become and, ultimately, it may enable us to enhance or prevent our genetic fates'.<sup>43</sup>

As Gusfield's model predicts, beneath the colour of these inflated claims, beneath this rhetoric of accommodation, a new moral order is being created, a metonymy in which 'genetic risk for a disease has been reified as the disease itself, even in the absence of obvious manifestations of illness'.<sup>44</sup> This identification is part of a broader equation, one that reduces the 'uniquely human' to each person's genetic make-up. Gilbert makes this point dramatically: 'Three billion bases of sequences can be put on a single compact disk (CD), and one will be able to pull a CD out of one's pocket and say, "Here is a human being; it's me!"'.<sup>45</sup> It is the feminist and rhetorician Evelyn Fox Keller who sees the ethical flaw implicit in these metonymic reductions of crudely deterministic import: 'if culture is to be subsumed under biology, and if it is our biological or genetic future that we now seek to shape, where are we to locate the domain of freedom by which this future can be charted?'.<sup>46</sup>

Rhetorical analysis applies not only to the transformation of science into science policy, but also to the creation of science itself, as Edward Yoxen shows in his discussion of the construction of the idea of 'genetic disease', a disease whose cause is a defect in the genome, a disease to be cured, presumably, by the correction of that defect. Currently, for example, diabetes is *not* a genetic disease in this sense, since, from a medical perspective, it is, like beriberi, the result of a deficiency, to be cured by



making up for that deficiency.<sup>47</sup> It is this metonymic extension of the medical model to defects in the genome that licenses the perhaps legitimate search for the 'gene' for Alzheimer's, and the certainly illegitimate search for the 'gene' for criminality, suicide or . . . homelessness. When asked why the government did not spend funds on homelessness in preference to mapping the genome, Daniel Koshland, the editor of *Science*, responded that 'What these people don't realize is that the homeless are impaired . . . Indeed, no group will benefit more from the application of human genetics'.<sup>48</sup> The point isn't that Koshland seriously believes there is a gene for homelessness; the point is that in an unguarded moment the editor of *Science* has revealed to us the yawning gap between rhetoric and reality.

By means of an analysis of the rhetoric of accommodation that characterizes the Human Genome Project, we see a moral order in the process of formation, an order that gives individual human beings the central responsibility for their genetic make-up; at the same time, it puts the control of their genetic fates, not in their own, but in the hands of private industry and the state. This order and the paradoxes it generates flow from the transformation of biology into social policy. But it is within biology that the seeds of ethical confusion and of social and political coercion have initially been sown. *Public understanding of the Human Genome Project is just the knowledge that public understanding has not been achieved*: a moral order is being formed that is *not* the joint creation of scientific and local knowledge.

The public comes into being in a culture whose moral order has been formed, and is being formed, largely without its knowledge or consent. Because this is so, the public must be able to reconstruct the moral order in a way that incorporates its social and political will. Gusfield's rhetorical analysis supplies one means to this end, especially in cases like the Human Genome Project where the formation of the moral order is in its early stages. But this insight cannot be put to use unless there is in place a forum for reconstruction, a social and political instrument that facilitates the creation of public understanding from the interaction of scientific and local knowledge.

### Forums of reconstruction

In retrospect, we can see in the Chernobyl studies of Wynne and Paine and the museum study of Macdonald and Silverstone attempts by the public or its representatives to reconstruct the moral order in the public interest. Wynne's Cumbrian sheep farmers, Paine's Lapland reindeer herders, and Macdonald and Silverstone's museum staff—each is faced with a parallel problem, a rhetoric of accommodation backed by a political and social order that marginalizes the public interest. To counteract this rhetoric and its corresponding power structure, the sheep farmers and the reindeer herders insisted on the validity of local knowledge; the museum staff insisted on the worth of scientific controversy. The efforts of the sheep farmers and the museum staff ended in failure; local concerns were successfully marginalized. The reindeer herders succeeded; public understanding was generated as the product of local and scientific knowledge. But their success at reconstruction is fortuitous, their circumstances unduplicable.

If success is to occur regularly, we cannot rely on chance: a forum must be available that insures the political equality of expert and lay representatives and guarantees closure. John Dewey hoped that the methods of science would be employed with profit in the activities of everyday life. But in this forum another epistemology

must prevail, a rhetorical epistemology; in this forum, what counts as a fact depends not on science, but on the trust the public bestows on scientists; what counts as a fact's significance is not the significance science bestows, but the significance the public bestows on scientific knowledge. In what follows, therefore, I relativize the truth of claims to a public's trust in the person making them. I do this in accordance with Aristotle's dictum in the *Rhetoric* that 'character is almost, so to speak, the controlling factor in persuasion'.<sup>49</sup> I take this to mean that when our access to the facts is mediated by experts—a situation that always pertains when lay panels deliberate on issues of science policy—the assessment of their character must be an element in rationally motivated understanding.

We have at least one model of a forum for public debates concerning science policy, the model created by the Cambridge Experimental Review Board (CERB) to address the continuation of recombinant DNA research at nearby Harvard University. CERB constituted a public decision-making body of eight knowledgeable and disinterested citizens selected by the City Manager: a businessman and former mayor (the chair), a nurse and hospital administrator, a physician specializing in infectious diseases, a nurse and social worker, a philosopher of science, a structural engineer, and two community activists. The issue was determined by the City Council and framed by the City Manager: 'whether research on recombinant D.N.A. which is proposed to be conducted at the P3 level of containment in Cambridge may have any adverse effects on public health within the City'.<sup>50</sup> After an initially frustrating experience concerning their inability adequately to cross-examine expert witnesses, this 'citizen jury' decided to arrange a debate between experts with competing views, a debate that would permit peer cross-examination.

In such a debate, what counts as a fact is relative, not to the material world as realized by science, but to the trust a public body thinks it prudent to bestow on a scientific expert, or on a group of experts who advocate a particular policy. According to Aristotle's *Rhetoric*, such trust is generated in a public if it feels that a speaker is a good person, exhibits good sense, and has its best interest in mind. In the Cambridge case, there was a general perception on the part of CERB that those who opposed the continuation of research were not exhibiting Aristotle's good sense. Opponents ignored the broader implications of the research for the improvement of clinical medicine, and exaggerated its risks. In addition, they did not support their worries with concrete reasons, nor did they consider the possibly greater risks that a ban might create.<sup>51</sup>

Considered in themselves, the views of CERB look like empirical claims, to be supported by facts; in their context, however, they are supported not by facts, but by arguments from character, grounded in the personal judgments of its members. From a rhetorical point of view, this grounding makes the negotiated closure that issued from the deliberations of the CERB 'jury' no less rational; indeed, it is just the consensus underlying this closure that constitutes public understanding of the dangers of recombinant DNA research to the city of Cambridge. In the CERB model, rhetoric assumes its proper place as an art central to civic life, a theory of persuasion designed to resolve the cognitive, ethical, and political dilemmas created by science through the deliberation of particular cases.

My endorsement of the CERB model and, as a consequence, the class of forums that enables rhetorics of reconstruction, implies no Luddite sympathies. To question whether the Human Genome Project is worthwhile in comparison to other priorities is not to attack science, but only to engage in the democratic process. To question

whether the Human Genome Project should exist at all is, of course, another matter. It is to raise the ethical issue of whether there is some knowledge we are better off *not* having. No issue seems more difficult to address squarely in American society; in fairness, however, it is not I, but the development of science in the last half-century that makes the issue salient.

My endorsement of the rhetoric of reconstruction implies no Marxist sympathies either. The examples I have given contain more than a whiff of the class struggle; all are instances of the consolidation of power in political elites. In my view, though we ought to agree that this consolidation will generally be in evidence, we ought to eschew any class melodrama said to follow. In the first place, in these struggles, there are ordinary people on both sides; whoever wins, many ordinary people gain, not just the James Watsons and the Walter Gilberts. This is what makes these quarrels so difficult to resolve, even when they are addressed at early stages. In the second place, if scientists have no special wisdom, neither does the public. In the examples I have given, I have consistently shown scientists in an unflattering light. I have done this as a corrective to their air of self-importance and self-righteousness that often characterizes science's public stance. But it needs to be said that the public is equally capable of arrogance and foolishness. According to Paine, for instance, the Lapp reindeer herders have insisted on consuming reindeer meat full of radioactive contamination on the grounds that such consumption preserves their cultural heritage. This is public *misunderstanding*.

## Conclusions

Rhetorical analysis reveals two dominant models for the public understanding of science, the deficit and the contextual. The first of these is open to serious criticism. Its assumption of public ignorance implies a rhetoric of accommodation that adjusts the complexities of the sciences to the intellectual limitations of their non-scientific publics. It follows that the status of public understanding is epistemologically diminished. Moreover, even at its most responsible and useful, the deficit model, by casting the public in a passive role, endorses political quietism. This quietism is reinforced because the deficit model marginalizes, indeed its rhetorics of accommodation actually mask, the ethical and political implications of science.

The contextual, the other dominant model for the public understanding of science, avoids these difficulties. In this model, public understanding is the joint product of scientific and local knowledge. So conceived, public understanding has genuine, not diminished epistemological status, different in kind, but not in significance from the epistemological status conferred by the methods of science. Its cognitive conclusions need not defer to those of science; in the case of its ethical, social, and political conclusions, it is science that must defer. For this model, the preferred strategic research site for the public understanding of science is a particular case of an interaction between the public and science. This preferred site need not place students of public understanding at an epistemological disadvantage. Properly employed, the case study method creates legitimate social and political knowledge.

The cases that exemplify or fail to exemplify public understanding of science are legitimately subject to rhetorical, as well as to social and political analysis. Rhetorical theory, because it provides an explanatory model and a set of analytical techniques for the interpretation of the complex texts generated by particular cases of interaction, can

legitimately supplement sociological and political theories already in use. Rhetoric also legitimates a movement from the cognitive to the ethical, one that current social and political theories make only with difficulty. In this latter role, rhetoric can participate centrally in the reconstruction of the moral order within the confines of the democratic process.

## Acknowledgments

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- 28 The claim that these papers are persuasive in the same way is not, it will be noticed, secured by rhetorical analysis.
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- 35 Macdonald and Silverstone have made rhetorical re-analysis feasible by presenting the food-poisoning panels in full. But rhetorical analysis that compares these panels to the conferences that led to their creation is necessarily partial and suggestive, because transcripts were not available. Rhetorical re-analysis of the studies of Paine and Wynne is not possible because interview transcripts were not available.
- 36 The metaphorical use of 'interaction', evident in the food-poisoning exhibit, is general in the literature of the public understanding of science. An article by John Durant, otherwise unusually sensitive to the driving force of conceptual metaphor, provides an excellent illustration. Visiting the San Francisco Exploratorium, Durant was 'impressed by the quality of the interactive exhibits, and in particular by a "hands-on" neurophysiology experiment in which visitors were able to elicit electrical activity in a living nerve-muscle preparation'. In this instance, the metaphor is particularly elaborate: 'interactive', 'hands-on', 'experiment', and 'elicit', all of these expressions connote activity in a context that is in fact entirely passive. This revealing use of metaphor in an 'unimportant' context—a narrative of introduction—is apt to be missed by those not vigilantly in search of verbal nuance. See Durant, J., 1992, Brain research, animal awareness, and human sensibility: scientific and social dislocations. *So*

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  - 43 Kevles, D. J., and Hood, L., 1992, *The Code of Codes: Scientific and Social Issues in the Human Genome Project* (Cambridge, MA: Harvard University Press), p.vii. 'In Medieval Romances, [the Grail is] a vessel possessing spiritual powers and qualities, and affording, under certain conditions, mystical benefits to its beholders' (see Cross, F. L., 1958, *The Oxford Dictionary of the Christian Church* (London: Oxford University Press), under 'Grail, the Holy'). In entitling this paper 'A Vision of the Grail', Gilbert makes this analogy explicit, presumably putting himself and his fellow scientists in the position of Tennyson's Galahad, whose experience of the vision depends on his purity of heart.
  - 44 Nelkin, D., 1992, The social power of genetic information. *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, edited by D. J. Kevles and L. Hood (Cambridge, MA: Harvard University Press), p.188.
  - 45 Gilbert, W., 1992, A vision of the grail. *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, edited by D. J. Kevles and L. Hood (Cambridge, MA: Harvard University Press), p.9.
  - 46 Fox Keller, E., 1992, Nature, nurture, and the human genome project. *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, edited by D. J. Kevles and L. Hood (Cambridge, MA: Harvard University Press), p.297.
  - 47 Fox Keller, E., 1992, Nature, nurture, and the human genome project. *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, edited by D. J. Kevles and L. Hood (Cambridge, MA: Harvard University Press), p.291ff.
  - 48 Fox Keller, E., 1992, Nature, nurture, and the human genome project. *The Code of Codes: Scientific and Social Issues in the Human Genome Project*, edited by D. J. Kevles and L. Hood (Cambridge, MA: Harvard University Press), p.282n.
  - 49 Aristotle. 1991, *On Rhetoric: A Theory of Civic Discourse*, translated by G. A. Kennedy (New York: Oxford University Press), 1.2.4.
  - 50 Quoted in Waddell, C., 1989, Reasonableness versus rationality in the construction and justification of science policy decisions: the case of the Cambridge Experimental Review Board. *Science, Technology, and Human Values*, 14, 10.
  - 51 Waddell thinks that these arguments exceed CERB's charge. But the first, which seems irrelevant at a first pass, actually concerns the 'broader implications' to public health.

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