The Anthropology of Science Part II: Scientific Norms and Behaviors

JONATHAN MARKS

A major consequence of seeing science as a cultural activity is the ability to distinguish formally between the normative and expressed behaviors of scientists. Science progresses often in spite of the constraints and conflicting goals imposed on scientists; therefore studying science and studying scientists are not equivalent. Nevertheless, what scientists do is a starting point for understanding how science functions in modern society. The eugenics movement of the 1920s provides a paradigmatic example of how science is invoked as cultural authority, and of the importance in distinguishing among good science, bad science, and pseudo-science. While this may be easy in retrospect, retrospect is too late. Straddling the sciences and humanities, anthropology is situated in a unique position to mediate the "culture wars," by analyzing both the boundaries of science itself and the activities of scientists in society.

THE SOCIAL CONSTRUCTION OF KNOWLEDGE

Science approaches empirically valid explanations for things, but it does so asymptotically. That makes it especially difficult to use absolute words like "true" and "fact," which have common sense, legal, and mathematical meanings that differ somewhat from their uses in science. The common sense use of "fact" is largely ontological (concerned with what is), while the scientific use is largely epistemological (concerned with what we can know or decide about it). The confusion of these two senses (their distinction lies in the humanities) is at the heart of much of the contemporary tension about science.

The self-correcting nature of science guarantees that its history is littered with yesterday's scientific facts that have been supplanted by today's scientific facts. By the same token, it also guarantees that many of today's scientific facts will be supplanted by tomorrow's. For example, a biologist transported back to 1950 and claiming that humans have only 46 chromosomes, when all competent biologists knew that humans have 48 chromosomes,[1] would have been dismissed as a crackpot or an ignoramus. To a large extent, after all, being a competent scientist implies mastery of a canon of knowledge. That knowledge includes many classes of presumptive facts, some of which will be refuted or supplanted.

It is the canon itself, however, that defines the scholarly competence of scientists at any time. The negotiation between what is "out there" and what scientists think they know about it is the study of the social construction of knowledge.[2-4] In science, simply making statements about the world that someday turn out to be true (or false) is not valuable. What is valuable to science is making statements about the world that *can be shown* to be true (or false), which depends on the available technology and the ability to persuade the community of interest. It is what differentiates an Einstein from a Nostradamus.

This is also the source of widespread confusion. The process of science is concerned not so much with what is "out there" as it is with what *you can convince* someone is "out there." A scientist who knows something but cannot convince anyone of it has contributed nothing of value. The scientist's goal, therefore, is not merely private knowledge (gnosis), but convincing knowledge.[5]

For example, some scientists in the sixteenth century maintained that the blood circulates. However, this was difficult for them to demonstrate, for this necessitated reconceptualizing the body; it was bound to the diverse ideas that blood does not pass through the septum; that arterial and venous bloods are the same substance; that respiration vitalizes the blood rather than simply cools it off; and that circular motion is not restricted only to the celestial spheres. Michael Servetus, who maintained that the blood circulates, was burned for his various heretical ideas in 1553.[6] William Harvey's contribution, several decades later, was to transform the circulation of the blood from gnosis to convincing knowledge.

The scientific facts are — the scientific truth is — what the mainstream of the community believes, or has been convinced of, at a particular point in time. This is arrived at by ratiocination, not by caprice, and is conditioned to some extent by what is "out there." But it is not and cannot be an objective, perfect description. It is merely the best, or near-best, that can be done, given a particular time, place, ideology, and technology; thus, scientific facts are under-determined by the natural world. The fact that the count

Jonathan Marks is associate professor in the Department of Anthropology at Yale University, at least for the time being. His primary research focus is molecular anthropology, and he has published extensively on DNA and chromosome evolution in the Hominoidea. He is co-author of *Evolutionary Anthropology* (Harcourt, Brace, Jovanovich, 1992), and author of *Human Biodiversity* (Aldine de Gruyter, 1995).

of 2n = 46 for human cells was convincing in 1956 was a consequence of new technical feasibilities in cytogenetics that had not been in place earlier — and even so, it was still tempting to try and account for the "missing" two human chromosomes when counting them.[7,8]

Since science is to some extent both description and persuasion, it functions within a matrix of language and social relations. This makes the activity of science — the production of knowledge — as amenable to ethnographic analysis as other human activities are.[9,10]

In some sciences, notably human evolution, the importance of linguistic structures, metaphors, and narrative modes has been acknowledged.[11-15] In other areas, the use of key metaphors is so powerful that we often invoke them without even realizing their metaphoric or linguistic nature. Thus we have the genetic "code," which is not literally a language, but a classic metaphor by Schrödinger,[16] and we speak of RNA "transcription" and "splicing," although RNA is not literally a book or a tape. By the same token, we speak of genes "for" ABO blood group (equivalent normal states), cystic fibrosis (defined by pathological breakdowns from a single normal state), and aggression (with no known referent for a context-dependent phenotype) as if they were conceptually equivalent hereditary units.[17,18]

Once again, these observations in no way undermine the utility of science or its success in understanding and manipulating nature. They do suggest modes by which the next generation of scientists can improve upon the current generation's comprehension and presentation of it.

THE NORMS OF SCIENCE AND THE BEHAVIOR OF SCIENTISTS

Science is at root the search for a comprehension of how nature works, and ideally its actors follow the four norms set out by Robert K. Merton in 1942.[19] The first is "universalism," by which is meant the transcendence by scientific results of time, place, and ideology. But regardless of how it comes out in the long run, the local institutional adoption of false and idiosyncratic scientific principles (such as scientific racism) may have a catastrophic effect on individual lives. Surely such science is meaningful and nontrivial in spite of being nonuniversal.[20] Merton's second norm is "communism," which refers to the locus of scientific knowledge being in the public domain. Again, however, the privatization of scientific knowledge is not uncommon and may have major transformative effects on science, whether by virtue of patent issues, institutional funding patterns, or simply the influx of venture capital.[21] The third norm is "disinterestedness," an expression of the life and career of a scientist being separated from ideas and advances, although priority of discovery is a constant and well-known source of contention in science.[22,23] The last norm is "organized skepticism" — though scientists are notoriously susceptible to trendy ideas, from punctuated equilibria and selfish genes to cladism and mass extinctions caused by extraterrestrial impacts.[24,25]

...the use of key metaphors is so powerful that we often invoke them without even realizing their metaphoric or linguistic nature. Thus we have the genetic "code," which is not literally a language, but a classic metaphor by Schrödinger, and speak of RNA "splicing," though RNA is not literally a rope or tape.

Much of the perceived threat to science has its roots in scientists' misrepresentation of these norms as their own actual behaviors. But the properties of science (a socio-cultural process) are not necessarily to be found in microcosm in the constitutions of scientists (the actors).[26] The relationship between the two — how a cultural system perseveres and advances as a result of the culture-bound activities of its members — is in fact a classically anthropological question.[27]

Science is presently carried out by professional scientists. Many years ago, it was the occupation of an independently wealthy class of citizens, who imposed their cultural values on their work, a fact that can generally be recognized in retrospect. Sometimes they faced overt pressure to conform their science to ideological positions, as when the Count of Buffon was forced by the theology faculty of the Sorbonne to retract his cosmological and geological speculations in the mid-eighteenth century.[28] At least, however, the scientists of that era were not subject to the more mundane pressures of holding down a job and supporting a family by doing science.

Science in the late twentieth century, however, is a job, no longer the leisure pursuit of an idle wealthy class.[29] And just as auto workers can come to care more about preserving their jobs than the integrity of the products they produce, so too with scientists. "Publish or perish," for example, is not intrinsic to the nature of science, but to the nature of *occupational* science. Thus we find that an objective search for nature's workings has to be balanced against a variety of factors: maintaining a steady stream of articles, networking, propping up the "party line" in intellectual controversies, politicking for funding, and defending one's reputation in the literature against the criticisms of upstarts — to name just a few.[24] In some cases, of course, the activity of science is overbalanced by the pressures of actually conducting a career in science: the result is misconduct or fraud.

The point, however, is that part of understanding science is understanding the motivations of scientists, which can be more complex and contradictory than we would ideally have them be. Precisely because science is a social enterprise carried out within a bureaucratic hierarchy, it should be no surprise that blowing the whistle on misconduct is as generally perilous

a behavior as blowing a whistle in any other organization.[30]

Fraud is by nature interesting because it represents a subversion of the generally accepted norms and goals of science. Whether the commission of fraud is a pervasive problem[31] or a rare aberration,[32] it has been repeatedly observed that institutional responses to fraud are inadequate.[33]

Thus, there is another distinctively modern and culture-bound aspect of science: Though scientists regard honesty as fundamental to their endeavor,[34] they are often paradoxically willing to accommodate themselves to dishonesty or to tolerate it more loosely than one might expect, given the norms expressed by practitioners[35] and thus expected by the public. Small wonder, then, that an observer can easily see rampant hypocrisy in the scientific community.[36,37]

Thus, while the number of major examples of scientific fraud remains small (especially in proportion to the amount of scientific research carried out), the number of admirable institutional responses to it is far smaller. Fraud is interesting precisely for the way in which it highlights the difference between normative values and expressed behaviors in the social network of science — again, a classic ethnographic situation. As a policy issue, the study of fraud by scientists may be crucial to improving the public perception of science.

BAD SCIENCE AND PSEUDO-SCIENCE

Errors are acceptable to scientists, as we all commit them. As philosopher David Hull notes,

> Publishing fabricated data is the worst sin that a scientist can commit. Publishing the results of sloppy research is considered to be bad, but somehow not quite so bad, even though the effects on anyone using fabricated and sloppy research are indistinguishable.[38]

Consequently, acceptable error is often the primary defense of a scientist accused of unacceptable data falsification.[39,40] Errors may often have few consequences other than leading other scientists to pursue phantoms briefly. In some cases, however, they may have significant impacts on people's lives. This is because a major role of science in contemporary society is as a validation mechanism.

The power of science as a persuader was recognized decades ago by advertisers, whose phrase "Nine out of ten doctors agree..." is now a cliché. Whether it was that smoking Brand X is actually good for you or that eating one or another high-fat, low-fiber, sugary food is healthy, the ability to get doctors to say it was recognized as a selling point.

The fact that science carries authority means that scientific statements are not value-neutral.[41] Scientists have been slow to appreciate the responsibilities entailed by this, as the arguments over *The Origin of Races* in the 1960s[42] and *Sociobiology* in the 1970s[43–45] showed. In the former instance, despite the acknowledgment from both racists[46] and antiracists[47] of the book's political significance, the author poignantly (or disingenously?) maintained its value-neutrality.[48]

Of course, the value-ladenness of science is not as evident in some fields as in others. One can productively contrast the mathematician G.H. Hardy's attraction for his scientific field with the anthropologist Ashley Montagu's attraction for his:

> [Mathematics] has no practical use: that is to say, it cannot be used for promoting directly the destruction of human life or for accentuating the present inequalities in the distribution of wealth.[49]

> Anthropology has an important contribution to make towards the improvement of the social order. This is not simply because of the grandeur of the story it has to tell, but by virtue of the very appreciable contribution it makes to the better understanding of ourselves and of our fellow [people], in a world where such understanding is not too widely distributed.[50]

It is not difficult to imagine how a lifetime devoted to, say, entomology might not provide adequate preparation for the responsibilities incurred in making a scientific declaration about humans.

One of the more tragic episodes in the recent history of science was the popularity of the eugenics movement among mainstream geneticists of the 1920s.[51–53] Here, sterilizing the lower classes and restricting immigration, in order to cut off the stream of defective germ-plasm into the United States, was presented as the scientific remedy to social problems.[54] There was a compelling, if simplistic, materialism to its logic: Bad genes caused bad brains, which caused bad minds, which caused bad thoughts, which caused bad deeds; therefore, bad genes caused bad deeds. American genetics of the 1920s was a direct inspiration for German genetics of the 1930s;[55] consequently, it yields many valuable lessons for understanding the social implications of scientific ideas. Yet the response of the American genetics community to their history in the aftermath of World War II was long-term collective amnesia or denial,[53,56] which virtually guaranteed a failure to learn those lessons.[57–59]

Though science and pseudo-science seemingly are mutually exclusive categories, the boundary between them can sometimes be surprisingly porous, as the examination of biosocial movements of the early twentieth century also helps to show. Pseudo-science generally fails to meet agreed-upon standards of evidence, is carried out externally to the scientific community, and, in seeking the legitimacy of science, misrepresents itself as science. Which was eugenics, science or pseudo-science? It seems that only hindsight can actually relegate it to the latter category. *The Passing of the Great Race*, published in 1916, interpreted the history of the world through the biological superiority of Nordics.[60] Though its author was a (well connected) layman, the book contained a glowing preface by a distinguished scientist, and was reviewed favorably by scientists in leading journals, including *Science*.[61] This would seem to necessitate its incorporation within science — indeed, presumably within "good" science. Yet in 1936, Huxley and Haddon repeatedly and pointedly dismissed it as pseudo-science.[62] The

work in question, therefore, was not transformed from good science to bad science, but from science to non-science. This raises questions about the relationship between good science, bad science, and pseudo-science that are not as evident as the judgment of history would make it.

The implication is that scientists apparently can be rather easily forced by their ideological prejudices into accepting work as good science that is not even science at all. There is, consequently, a need for such pseudo-science to be opposed by countervailing ideology. Yet how can we be sure which side represents the science and which represents the pseudo-science? Is it discernible only in retrospect? Are scientists who cannot identify pseudo-science when confronted by it themselves pseudo-scientists?

It seems that a strong dose of humanities might be called for. Even the merest introspection has shown that gender, class, and race are just the top three ideologies that have permeated the natural sciences for as long as those sciences have existed.[63-65]

ACADEMIC COMMUNICATION

The authors of the recent *Higher Superstition* are especially critical of bad writing in the humanities. Bad academic writing is a perennially popular target,[66] and academics have occasionally been too willing to confuse unclarity of expression for depth of thought. It is not, however, as if scientists have a monopoly on crisp, readable prose: Not only is the poverty of scientific writing also lamented periodically,[67] but one can find eye-crossingly incomprehensible verbiage in the first two sentences of probably any paper in any technical journal outside one's own specialty.

An unarticulated assumption here is that professional humanities writing should be more intelligible to a scientist than professional science writing should be to a humanist. The basis for this assumption is presumably that the intellectual apparatus of science is harder and denser, and the concepts more difficult to express, than are those of the humanities. But explaining any complicated thought to a naive audience is difficult and cannot be taken for granted. There is, after all, a very small number of scientists who write for a "popular" audience successfully. It may suffice to quote one of them, Peter Medawar: "[N]o one who has something original or important to say will willingly run the risk of being misunderstood; people who write obscurely are either unskilled in writing or up to mischief."[68]

Medawar's comments assume even greater significance in the context of the departing words of *Nature* editor John Maddox:

> It used to seem that *Nature's* contributors wrote clearly, but no longer...The obscurity of literature now is so marked that one can only believe it to be deliberate. Do people hide their meaning from insecurity, for fear of being found out or, in the belief that what they have to say is important, to hide the meaning from other people?[69]

An unarticulated assumption here is that professional humanities writing should be more intelligible to a scientist than professional science writing should be to a humanist. The basis for this assumption is presumably that the intellectual apparatus of science is harder and denser, and the concepts more difficult to express, than are those of the humanities.

The industry of science journalism has developed largely in compensation for this scientific problem. The cliché is that scientists know more and more about less and less. But science journalism is not a panacea for narrowness of intellectual scope and poverty of communication skills. After all, what makes for good science is methodological rigor, but what makes for good science journalism is a sexy conclusion. The two goals may be concordant, but relying too heavily on the conclusion-oriented focus of science journalism may serve to undermine the actual science.[70-72] Science journalists, however well intentioned, are generally less qualified to evaluate the results they report than are scientists who often, given the constraints on their time, rely on those reports to form their judgments. This places science journalists in the position of actually shaping scientific opinion in addition to simply reporting it.

CONCLUSION: ANTHROPOLOGY AND THE CULTURE WARS

One consequence of basing academic promotions for science faculty strictly on funding and research, as is customary at major universities, is the widespread devaluation of the quality of teaching in the sciences. Scientists generally receive far less teaching experience while in graduate school and fewer teaching responsibilities while on the faculty than do their counterparts in the humanities. If practice makes perfect, then, an average scientist might be expected to develop into a less perfect pedagogue than an average humanist.

Yet consider the following thought-experiment from *Higher Superstition*. If the humanities faculty of a university

> ...were to walk out in a huff, the scientific faculty could, at need and with enough released time, patch together a humanities curriculum, to be taught by scientists themselves. It would have obvious gaps and rough spots to be sure, and it might with some regularity prove inane, but on the whole it would be, we imagine, no worse than operative. What the opposite situation — a walkout by scientists — would produce, as the humanities department tried to cope with the demand for science education,

we leave to the reader's imagination.[73]

To one reader's imagination, at least, the result might well be a science curriculum with "gaps and rough spots" but, on the whole, far better taught than previously. The basis for the supposition that a humanities curriculum could be better administered by scientists is unclear but seems to be possessed of no little arrogance.[74] C.P. Snow's anonymous scientist who confessed, "Well, I've tried a bit of Dickens"[75] has the ring of hyperbole, but makes the point well: Science is difficult but, well, so are other scholarly venues.

It may be worth noting that the year before *The Two Cultures*,[75] geneticist Conway Zirkle published an essay entitled "Our Splintered Learning and the Status of Scientists."[76] Lamenting the intellectual narrowness he saw in some of his strictly scientific colleagues, Zirkle went so far as to construct a mock diploma, whereby the university "certifies that John Wentworth Doe does *not* know anything but Biochemistry. Please pay no attention to any pronouncement he may make on any other subject, particularly when he joins with others of his kind to save the world from something or other. However, he has worked hard for this degree and is potentially a most valuable citizen. Please treat him kindly."

Decades earlier, José Ortega y Gasset bluntly criticized the radical specialization of modern scientists as comprising a new class of "learned ignoramus ... ignorant, not in the fashion of the ignorant man, but with all the petulance of one who is learned in his own special line."[77] My own opinion is that *Higher Superstition* and the *Social Text* hoax do little to falsify Ortega y Gasset's assessment.[78]

Neither Zirkle nor Ortega criticized science; rather, they criticized scientists. Science and scientists have now become the objects of analysis, and such scholarly reflexivity should be enlightening and welcome to those who wish to improve the quality and role of science and the state of science education. Anti-intellectualism, after all, comes in many forms, and imperils not simply science but the entire scholarly community.

Consider, for example, the misrepresentation of creationism as science (from outside of science) and the misrepresentation of genetics as a social panacea (from within science).[79] Creationism is insidious because by misrepresenting itself as competent science it promotes ignorance. But neo-hereditarianism, also misrepresenting itself as competent science, is insidious as well. Is either threat greater than the other? As far as I am aware, no one has ever been killed or involuntarily sterilized in the name of creationism. From the standpoint that ignorance is bliss and death probably is not, we might consequently do well to be at least as skeptical of the judgments of scientists as those of anti-scientists, at least where people's welfare and lives may be concerned. Indeed, until such a time as modern social ethics becomes a required subject for science students, we might do well to be even more skeptical of the social judgments of scientists than those of other citizens. As one commentator has noted, "[W]ithout any reference to the interaction between science and society, [science education] will tend to produce naivety [*sic*], xenophobia, and intellectual arrogance."[80]

Because of the strides made by science, it is now possible for poor, unethical, or pseudo-scientific judgments to affect more people's lives more catastrophically than ever before. Science thus needs humanities now more than ever. In the words of Jacques Barzun,

> Nothing is easier nowadays than to believe in the conclusions and also the fantasies of science; nothing harder than to take a simple, unaffected view of the truths of poetry or religion. The predicament of the age is to regain the high ground where the thoughtful man can be at ease with his repressed intuitions and satisfy through many means his equally many capacities for reason and belief.[81]

Anthropology affords an intellectual venue by which to integrate science into our contemporary culture and to acknowledge science as a significant part of it, while at the same time valuing other cultural subsystems. The efficiency with which we can actually use science to help solve problems of health and welfare in a global community may depend on how effectively we are able to accomplish this.[82]

ACKNOWLEDGMENTS

For their comments on early drafts of this manuscript, I thank. Matt Cartmill, John Fleagle, George Hersey, Anna Roosevelt, Penelope Laurans, Jeremy Sabloff, Eugenie Scott, and Werner Wolf.

REFERENCES

1 Kottler M (1974) From 48 to 46. Cytological technique, preconception and the counting of human chromosomes. Bull Hist Med *48*:465–502.

2 Berger P, Luckmann T (1966) *The Social Construction of Reality*. New York. Doubleday.

3 Latour B (1987) *Science in Action*. Cambridge. Harvard University Press.

4 Knorr-Celina K (1981) The Manufacture of Knowledge. New York. Pergamon.

5 "In science the credit goes to the man who convinces the world, not to the man to whom the idea first occurs." Epigram attributed to both Sir Francis Darwin and Sir William Osler by Mackay A (1991) A Dictionary of Scientific Quotations)Bristol. Institute of Physics Publishing.

6 Mason S (1962) *A History of the Sciences*. New York: Macmillan.

7 Tijo JH, Levan A (1956) The chromosome number of man, Hereditas *42*:1–6. The authors of this classic paper studied embryonic lung fibroblasts and related a story of colleagues who counted the chromosomes of embryonic liver cells, but abandoned their studies, discouraged at consistently being unable to find the "last" two human chromosomes. See also ref. 1.

8 Hsu TC (1979) *Human and Mammalian Cytogenetics*, pp 20–29. New York: Springer.

9 Latour B, Woolgar S (1979[1986]) *Laboratory Life* Princeton: Princeton University Press.

10 Charlesworth M, Farrall L, Stokes T, Turnbull D (1989) *Life Among the Scientists*. New York: Oxford University Press.

11 Turbayne CM (1970) *The Myth of Metaphor*. Columbia, SC: University of South Carolina Press.

12 Stepan NL (1986) Race and gender: The role of analogy in science. Isis *77*:261–277.

13 Landau M (1984) Human evolution as narrative. Am Sci *24727*:262–268.

14 Landau M (1991) *Narratives of Human Evolution*. New Haven: Yale University Press

15 Cartmill M (1993) *A View to a Death in the Morning*. Cambridge: Harvard University Press.

16 Schrödinger E (1944) *What Is Life?* Cambridge: Cambridge University Press.

17 Lloyd E (1994) Normality and variation. In *Are Genes Us? The Social Consequences of the new Genetics*, pp 99–112. New Brunswick, NJ: Rutgers University Press.

18 Marks J, Lyles RB (1995) Rethinking genes. Evol Anthropol *3*:139–146.

19 Merton RK (1942) A note on science and

democracy. J Legal Political Sociol *1*:115–126.
20 Barkan E (1992) *The Retreat of Scientific Racism.* New York: Cambridge University Press.
21 Kornberg A (1995) *The Golden Helix: Inside Biotech Ventures.* New York: University Science Books
22 Watson J (1968) *The Double Helix.* New York: Atheneum.
23 Maddox J (1993) Competition and the death of science. Nature *363*:667.
24 Hull DL (1988) *Science as a Process.* Chicago: University of Chicago Press.
25 Glen W (1994) *The Mass-Extinction Debates: How Science Works in a Crisis.* Stanford: Stanford University Press.
26 Medawar PB (1979) *Advice to a Young Scientist.* London: Harper and Row.
27 White LA (1959) *The Evolution of Culture.* New York: McGraw-Hill.
28 Buffon Comte de (1753) *Histoire Naturelle, Generelle et Particuliere*, vol IV. Paris, Imprimerie Royale.
29 Ziman J (1984) *An Introduction to Science Studies.* New York: Cambridge University Press.
30 Rossiter EJR (1992) Reflection of a whistle-blower. Nature *357*:434–436.
31 Swazey JP, Anderson MS, Lewis KS (1993) Ethical problems in academic research. Am Sci *81*:542–553.
32 Committee on the Conduct of Science, National Academy of Sciences (1989) *On Being a Scientist.* Washington, D.C: National Academy Press.
33 Hamilton DP (1992) In the trenches, doubts about scientific integrity. Science *255:1636*
34 Panel on Scientific Responsibility and the conduct of Research, National Academy of Sciences (1992) *Responsible Science.* Washington, D.C.: National Academy Press.
35 Conant JB (1947) *On Understanding Science: An Historical Approach*, pp. 7–8. New Haven: Yale University press.
36 Ghiselin MT (1989) *Intellectual Compromise: The Bottom Line.* New York: Paragon House.
37 Marks J (1993) Scientific misconduct: Where "Just say no" fails. Am Sci *81*:380–382.
38 Hull DL (1988) A mechanism and its metaphysics: An evolutionary account of the social and conceptual development of science. Biol Phil *3*:129.
39 Sarasohn J (1993) *Science on Trial.* New York: St. Martin's Press.
40 Lewin R (1988) DNA clock conflict continues. Science *241*:1756–1759.
41 Proctor RN (1991) *Value-Free Science?* Cambridge: Harvard University Press.
42 Coon CS (1962) *The Origin of Races.* New York: Alfred E. Knopf.
43 Wilson EO (1975) *Sociobiology: The New Synthesis.* Cambridge: Harvard University press.
44 Wade N (1976) Sociobiology: Troubled birth for new discipline. Science *191*:1151–1155.
45 Alper S, Beckwith J, Chorover SL, Hunt J, Inoye H, Judd T, Lange RV, Sternberg P (1976) The implications of sociobiology. Science *192*:424–427.
46 Putnam C (1967) *Race and Reality: A Search for Solutions.* Washington, D.C.: Public Affairs Press.
47 Dobzhansky T (1968) More bogus "science" of race prejudice. J Hered *59*:102–104.
48 Coon CS (1968) Comment on "Bogus science." J Hered *59*:275.
49 Bernal JD (1939 [1967]) *The Social Function of Science*, p 9. Cambridge: M.I.T. Press.
50 Montagu MFA (1945) *An Introduction to Physical Anthropology*, pp. 7–8. Springfield, IL: Charles C. Thomas.
51 Haller M (1963) *Eugenics.* New Brunswick, NJ: Rutgers University Press.
52 Ludmerer K (1972) *Genetics and American Society.* Baltimore: The Johns Hopkins University Press.
53 Paul DB, Spencer HG (1995) The hidden science of eugenics. Science *374*:302–304.
54 Kelves D (1985) *In the Name of Eugenics.* Berkeley: University of California Press.
55 Kühl S (1993) *The Nazi Connection.* New York: Oxford University Press.
56 Marks J (1993) Historiography of eugenics. Am J Hum Genet *52*:650–652.
57 Comings DE (1989) Presidential address: The genetics of human behavior — Lessons for two societies. Am J Hum Genet *44*:452–460.
58 Koshland DE Jr (1990) A rational approach to the irrational. Science *250*:189.
59 Stone R (1992) HHS "violence imitative" caught in a crossfire. Science *258*:212–213.
60 Grant M (1916) *The Passing of the Great Race.* New York: Charles Scribner's Sons.
61 Woods FA (1918) Review of *The Passing of the Great Race.* Science *48*:419–420.
62 Huxley JS, Haddon AC (1936) *We Europeans.* New York: Harper and Brothers.
63 Fedigan LM (1986) The changing role of women in models of human evolution. Ann Rev Anthropol *15*:25–66.
64 Chase A (1980) *The Legacy of Malthus.* Urbana, IL: University of Illinois Press.
65 Levins R, Lewontin R (1985) *The Dialectical Biologist.* Cambridge: Harvard University Press.
66 Limerick PN (1993) Dancing with professors. *The New York Times Book Review.* 31 October 1993, p.3.
67 Gregory MW (192) The infectiousness of pompous prose. Nature *360*: 11–12.
68 Medawar P (1969 [1984]) Science and literature. In *Plato's Republic*, p 52. New York: Oxford University Press.
69 Maddox J (1995) Validiction from an old hand. Nature *378*:522.
70 Rensberger B (1978) What makes science news? Sciences *18*:10–13.
71 Burnham JC (1987) *How Superstition Won and Science Lost.* New Brunswick, NJ: Rutgers University press.
72 Taubes G (1993) *Bad Science: The Short Life and Weird Times of Cold Fusion.* New York: Random House.
73 Gross PR, Levitt N (1994) *Higher Superstition.* Baltimore: Johns Hopkins.
74 Standen A (1950) *Science Is a Sacred Cow.* New York: Cambridge University press.
75 Snow CP (1959 [1993]) *The Two Cultures.* New York: Cambridge University Press.
76 Zirkle C (1955) Our splintered learning and the status of scientists. Science *121*:513–519.
77 Ortega y Gasset J (1932) *The Revolt of the Masses.* New York: W.W. Norton.
78 Klotz IM (1996) Postmodernist rhetoric does not change fundamental scientific facts. *The Scientist*, 22 July 1996, p.9. This essay purports to criticize contemporary science studies, but begins with the extraordinary anti-intellectual admission that "few natural scientists have heard of philosophers Paul de Man, Jacques Derrida, and Michel Foucault..."
79 Nelkin D, Lindee MS (1995) *The DNA Mystique: The Gene as a Cultural Icon.* New York: W.H. Freeman .
80 Dixon B (1973) *What Is Science For?* p 68. London: Penguin.
81 Barzun J (1964) *Science. The Glorious Entertainment.* New York. Harper and Row.
82 Hahn R (1995) *Sickness and Healing.* New Haven: Yale University Press.