Does bias in science hold women back?

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"The heart of the problem is that equal talent and accomplishment are viewed as unequal when seen through the eyes of prejudice . . ." With these words, the MIT Women Faculty Committee summarized its 1999 report on obstacles faced by women in science (1). Gender bias and prejudice, born of conflicting beliefs about the "natures" of women and men, what they can and cannot, should and should not do, is now a well tilled field in the social sciences. Since gender bias and prejudice have been made visible, their impact is diminished. But, unequal evaluations can still be found. Are there other sources of prejudice that continue to hinder the advancement of women? I would argue that there are. Bias and prejudice born of conflicting beliefs about the "nature" of science can have a serious impact on the evaluation of scientific talent. Since all scientists agree on what constitutes good scientific evidence, if its quality were the only criterion for judgment, there could be no bias in evaluating the talent of any individual scientist. But, other factors also influence who is chosen, and who chooses to practice science. Personal and cultural perspectives are involved in a scientist's choice of what kind of science to do, and how to do it (2). They can also influence the criteria used to evaluate other scientists' choices. Einstein must have understood this when he wrote:

> *". . . science in the making , as an end to be pursued, is as subjective and psychologically conditioned as any other branch of human endeavor–so much so that the question "what is the purpose and meaning of science? "receives quite different answers at different times and from different sorts of people" (3).*

Since "different subjective and psychological conditioning" continues to describe differences between women and men, Einstein's precise analysis has, once again, provided insight into a puzzling phenomenon: how and why beliefs about science can create obstacles for women in science. Feminist scholars have paid particular attention to this phenomenon, showing how personal and cultural values (4), and "mythlike beliefs" (5) help to mold the flow of science. The powerful outcome is that, "What is studied—and what has been neglected—grows out of who is doing the studying, and for what ends" (6). Who does science does, indeed, matter (7).

Differing beliefs about the purpose and meaning of science matter. They influence opinions about what makes "good" science—and "good" scientists. Scientists' personal visions of what is "good" in science frame their choices of problems to address, and how to address them. They also influence the criteria each uses in evaluating the talent and achievement of others. Einstein's "different sorts of people" certainly include the public, whose perceptions of what makes science "good" frame attitudes and policies wherever society and science meet—notably, in allocation of resources for education and research. When evaluators express differing beliefs and attitudes, majority views will dominate and minority views will be filtered out. Is not the majority view then perceived as biased against those filtered out? Virginia Valian has coined the term "gender schema" to describe and explain gender bias in order to make it visible (8). She has used her analysis to

Fritz Goro (1955): MBL Scientist at work on radioactive tracers. (From the photo exhibit, Marine Biological Laboratory "The Early Years," http://www.mblwhoilibrary.org/exhibits/early_years/early_years15.html.)

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advance criteria for a fair and accurate evaluation of talent in science. Let's see if there are "science schema" as well as "gender schema" embedded in how we size up science and scientists.

SCIENCE SCHEMA

What differing views of science are held by scientists? Do they affect the evaluation of female talent? At a memorable 1978 conference, 15 natural and social scientists could not find agreement on the power and limits of scientific inquiry (9). Some argued that scientific knowledge represents humanity's highest achievement, so there should be no attempts to limit it. Others evoked higher values (*e.g.*, social stability) and therefore science should join with other modes of inquiry to support such values. Each scientist who spoke reflected a particular, personal, presumption about the nature of science. Half a century earlier, Karl Popper addressed such presumptions, suggesting three different "doctrines" that could cover the practice of science:

> *1) The scientist aims at finding a true theory or description of the world which shall also be an explanation of the observable facts. 2) The scientist can succeed in finally establishing the truth of such theories beyond all reasonable doubt. 3) The best, the truly scientific theories, describe the "essences" or the "essential natures" of things—the realities which lie behind experiences" (10).*

Each of Popper's "doctrines" not only suggests a different view of what constitutes good science, but also its relation to other sorts of human inquiry. Those who limit science's power to explaining natural phenomena likely support equal opportunity for all modes of human inquiry, and do not seek domination for science. Those who believe science can answer questions, not just about phenomena but about the "essence" of things, will likely value science's mode of inquiry above all others and tolerate no limits to its power. They are also more likely to believe that the power and practice of science should be open only to those who belong to an intellectual "elite."

The impact of personal and cultural values on a scientist's work is reflected in the kind of problems he/she chooses to address. From extensive historical studies of scientific investigations, Harvard's Gerald Holton has identified several categories (unpublished data). Some lines of investigation seek to challenge the prevailing scientific model or exemplar, or to reach principle-oriented findings. Others look for areas of basic scientific ignorance in an area of social or national interest, emphasizing the application of previously known science and engineering to technical and social problems; we now call this "translational research." Still others lines of investigation serve to synthesize previously unconnected theories and findings. Some, indeed, may entirely reject "androcentric" or "Western" science and technology and work out novel alternatives, As a result of any or all of these efforts, some scientists may seek wide dissemination of their work, peer recognition and personal reward after they have published–and some may not (11).

Why do scientists choose to do what they do? The National Science Foundation reports that the public believes scientists are motivated by a "Search for Truth and Beauty" (12). Other motivations show up when scientists write their autobiographies and in less subjective writing: they may say to that their aim is to help people and society; to solve challenging problems; to satisfy curiosity; to seek societal and economic recognition and rewards; to assist human development; to follow in the steps of a mentor; to leave something lasting to society and humanity; to concentrate upon a particular problem. Since a similar spectrum of motivations can be found among those choosing other professions, the motivation shared by all scientists must be to do science—to solve their problem of choice using scientific inquiry. On this all scientists agree!

HOW DOES ONE DO SCIENCE?

Choices of where to work, and what methodologies and technologies to employ, are severely constrained by the resources and the mentors available. Whatever the work, personal tastes and styles set the mold. In a remarkable review of scientific styles in German biochemistry laboratories from 1870 to 1930, Joseph Fruton identified laboratory styles that range from a "quasi-military director to a senior counselor in the independent efforts of junior associates." He came to an incisive conclusion about relations of scientific style to scientific productivity, "the scientific productivity of the laboratories led by scientists with broad views of their field, and great interest in encouraging their junior associates, was significantly greater than the output of laboratories with autocratic, dictatorial leaders who treated students as disciples rather than as independent scientists." (13) Personal style and taste matters.

Other studies of scientists' tastes and styles categorize them as "collectors, classifiers and those that compulsively tidy," and as "poet-scientists, philosopher-scientists and even a few mystics." Some are detectives and some are explorers, some artists, and some artisans. Some seek synthesis while others seek analysis; some are "classicists" and some "romanticists." They can be compared as "rational" *vs.* "empirical", or, "theoretical" *vs.* experimental. Scientists enjoying field work, whether in the Antarctic or the Amazon, space shuttles or deep ocean submarines, tell of their particular taste for nature and its emotional and physical, as well as intellectual, challenges (14). Reflecting on all this diversity, Peter Medawar wrote, "What sort of mind or temperament can all these people be supposed to have in common must be very rare, and most people who are in fact scientists could easily have been something else instead." (15) One size does not fit all scientists.

"FEMALE" SCIENCE SCHEMA

How does discrimination against groups relate to all this individual diversity? In a research study of successful young female and male scientists, Gerald Holton reported that more men than women thought being a "good scientist" included being aggressive, combative, and self-promoting (16). "Women were more likely to see that science is gorgeous, leaving to a lesser place the hope to make a grand career, no matter what." Their "good" was less related to influence and power. The Harvard physicist, Howard Georgi relates this phenomenon to "unconscious discrimination." When "our selection procedures tend to select not only for talents that are directly relevant to success in science, but also for assertiveness and single-mindedness. This causes problems for women (and others as well)" (17). When evaluators' schema for what makes science "good" filters out those not holding the same view, are they not biased against the tastes and styles, needs and interests of those filtered out? When women evaluate men's talent in science, would their evaluation be biased against aggressive, combative styles?

Other "group" differences between female and male scientists are recognizable. In a study of female and male scientists in "elite" and lower status universities, the authors made this observation:

"The women we studied were interested and successful in places where curricular or occupational activities and the meaning of the term "science" that they inspired encouraged broader and more flexible commitments of time, space, and professional identity than the "greedy" activities and meanings of elite science. In sites of elite science, regardless of content, achieving high status required more of one's time, tighter constraints on appropriate workplaces, and narrower identities and networks of power than in lower-status sites. We suspect that many young women (and many men) find the greedy demands of elite science simply too costly" (18).

The workplace climates the women in this study preferred are exactly those that Fruton described above as most productive for men. For the good of science, and its practitioners, should these not be welcomed? Other differences between male and female attitudes stem from women's cultural responsibility for children, family, and/or community. Reasons women give for choosing to leave the study and practice of science most frequently cite lack of humanistic approaches and attitudes (19).

DIVERSE PERSPECTIVES ADD VALUE

Studies of scientific practices note how senior scientists often select students and faculty congruent with their own personal and scientific perspectives. The wish to "clone" oneself is understandable, and has some merit, but may not work well for the long-term good of science. Diverse perspectives can and do add value to science. To cite one example, "it would be hard to even imagine a collection of people more different from each other in origin, education, manner, manners, appearance, style, and worldly purposes than James Watson, Francis Crick, Lawrence Bragg, Rosalind Franklin and Linus Pauling." (20) Nicholas Negroponte, founder and leader of MIT's Media Laboratory, highlights relationships among creativity, innovation, and diversity: "The ability to make leaps of thought is a common denominator among operators of breakthrough ideas. Usual this ability resides in people with very wide backgrounds, multidisciplinary minds, and a broad spectrum of experiences." (21) As usual, Karl Popper summarizes these arguments succinctly: "Diversity makes critical arguments fruitful." (22)

EQUAL OPPORTUNITY, EQUAL "SCHEMA"

An open, democratic society responsive to the needs, interests, and values of its citizens needs to have these represented in its scientific enterprise. To this end, evaluation of talent for science should provide equal opportunity for a broad diversity in personal, cultural, and scientific perspective. The selection and advancement of students and scientists ought to be open to those who exhibit the wide variety of tastes and styles, needs and interests that characterize today's productive community of science. Since one size does not fit all successful scientists, selection should not be limited to those who fit any pigeonhole, be it gender, class, or mental "schema." And if we want to bring groups currently underrepresented to the table of science, let us teach them that different tastes and styles, needs and interests, and, yes, gender are good at the banquet of science.

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