SOCIOLOGY OF SCIENCE

Testing Theories for the Gender Difference

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An appropriate alternative subtitle for Yu Xie and Kimberlee Shauman's *Women in Science* would be "everything you need to know to prove or discredit all those theories about why so few women become scientists and engineers." For almost four decades, scientists, administrators, and policy-makers have followed the numbers of women in science and engineering, puzzling over the relatively slow increases and the considerable variations among disciplines. Currently, 55% of undergraduates and 54% of graduate students in the United States are women, but the numbers of women in science and engineering do not reflect these female majorities. In 1996, women received 50% of the undergraduate degrees in the biological and life sciences, 37% in the physical sciences, 33% in the geosciences, 28% in computer science, and only 18% of the degrees in engineering. In 1997, women earned 41% of the Ph.D.'s in biological and agricultural sciences, 22% in physical sciences, 24% in geosciences, 16% in computer science, and 12% in engineering (*1*). Although still in the minority, women in all areas of academia now constitute 35% of U.S. faculty overall. However, they are more likely to hold positions at the lower ranks and in less prestigious institutions. Women make up less than 20% of American science and engineering faculties (including the social sciences), and they represent only 10% of the full professors in these fields at four-year colleges and universities.

In other professions (such as law and medicine) that also require significant investments in education and training beyond the undergraduate level, women have begun to reach parity—as least as recipients of degrees if not in terms of advancement and promotion. Given the increasing dependence of our society on science and technology as well as the demands for a competent technological work force, it is not surprising that considerable research has focused on the continuing dearth of women in science and engineering.

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Explanations of the persistence of the gender difference in the face of efforts to eliminate it have highlighted particular claims and tendencies: High-school girls participate in fewer math and science courses, they indicate less interest in choosing careers in science and math, and they fear they will be unpopular with boys if they are perceived as a science-math nerd. Women in college choose different majors than men. Female undergraduates prefer human-centered majors; they avoid majors leading to careers in technology and science, which they see as incompatible with having a family; they avoid equipment-intensive majors. Women choose not to pursue graduate studies in science and engineering because they see the demands of such studies as conflicting with starting a family; female science and engineering graduate students often drop out when they marry a man in the same field. Women scientists who complete their doctorate prefer jobs in liberal arts colleges over research institutions because the former are perceived as allowing them to devote more time to their families. Women scientists and engineers face more problems with dual-career issues than other professionals or men scientists. Married women scientists are promoted more slowly. Women scientists publish less than men scientists. Geographic immobility contributes to the slower advancement and lower productivity of women scientists. The time required to have and raise children is the real reason that women scientists and engineers are less productive. Many of these potential explanations are applicable to particular age ranges or specific events in a scientist's life cycle. Thus, for some time researchers have recognized critical junctures—middle to high school, high school to college, college to graduate school, graduate school to job, and promotion to senior rank and leadership—as transitions during which women disproportionately drop out of the pipeline.

Women in Science
Career Processes and Outcomes
by Yu Xie and Kimberlee A. Shauman
Harvard University Press, Cambridge, MA, 2003. 336 pp. $59.95, £38.95, €55.30. ISBN 0-674-01034-5.

Image not available for online use.

Engineer at work. Cynthia Breazeal, a professor at MIT's Media Lab, is training the robot Kismet to interpret and respond to human expressions.

CREDIT: COURTESY MIT

Xie and Shauman (sociologists at the University of Michigan and the University of California, Davis, respectively) challenge this leaky-pipeline metaphor, the model that has dominated the interpretation of research data and development of policies to attract and retain women in science and engineering. The authors recognize that many of the theories leading to the pipeline model have not been tested empirically and they question the metaphor itself. They note that a leaky pipeline implies loss at each stage, leading to diminished numbers of women scientists, especially at more senior levels. The pipeline metaphor suggests policies that are focused on stopping the leaks. Because a pipeline has one initial entry point, the metaphor does not lead to policies that encourage women to enter science and engineering at different times throughout their lives.

In *Women in Science*, Xie and Shauman empirically test the theories proposed for the dearth of women scientists and engineers using 17 nationally representative data sets that are drawn from different stages of the life course. The authors cover the career trajectory of women scientists from middle school onward. They summarize their findings from sophisticated statistical analyses of gender differences at various career stages. To ascertain which theories can be rejected or supported, they focus their analyses primarily on individual and institutional choices and settings. The picture that emerges from these analyses is a complex one. No single, simple theory appears to account for the dearth of women in science. Therefore, they argue, the pipeline metaphor is not appropriate and no one policy will provide a magic solution.

The authors' analyses undermine many proposed explanations of the observed lower numbers of women scientists and engineers compared to men. Hypotheses and factors that do not have the importance others have claimed include: Girls are not as well trained in high school math training. (This gap has now closed.) Girls do not participate as much in high school math and science coursework. (Participation in physics remains an exception.) While in high school, girls fail to declare interest in a college major in science and engineering. (Most female college science and engineering majors initially intended to pursue majors outside of science and engineering.) Dual-career marriages constrain women scientists because of geographic mobility. (This is only true for married women with children.) Women scientists publish barely more than half as much as men. (This gender difference has narrowed with each decade, especially when structural features of institutions are controlled.) Remaining single is best for a scientific career. (Both married men and women publish more than single individuals; children, not marriage, decrease a woman's productivity.) Immigrant scientists—who occupy positions that otherwise might be taken by native-born women and minorities—of both genders are promoted faster than native-born scientists. (Although true for males, this does not hold for female scientists, who typically immigrate because of their spouse.)

The analyses support several alternative theories and suggest new ideas and policies: They indicate that individual choice is a powerful determinant of gender differences in science and engineering careers, with the caveat that career choices reflect the broad social structure and reinforce gender segregation of occupations. For academic women scientists who delayed childbearing and rearing throughout their training and wish to become parents, the competition between the tenure clock and the biological clock becomes intense. The authors note that balancing career with family weighs especially heavily on women scientists, but not men scientists, with preschool children. Thus the socialization that reinforces women's role as the primary caregiver, especially for young children, differentially deters the careers of women scientists and engineers.

Although the use of these large, representative data sets (which included the U.S. censuses for 1960 though 1990) permits empirical testing across the trajectory of science careers, the data also impose some limitations. For example, most of the data sets are quite old, with data collection ending in the late 1980s or early 1990s—1993 is the latest collection point for any of the 17 sets. This raises the question of whether the significant persistent gender differences in publication rates that the authors found still exist. The data do show that the gap has decreased from women publishing 58% the amount published by men in 1969, through 63% in 1973 and 70% in 1988, to 82% in 1993. In a similar fashion, one wonders whether the finding that immigrant women are only 32% as likely as immigrant men to be promoted still endures. The authors' analysis used data from the U.S. Census Public Use Microdata Samples through 1990. Those familiar with U.S. immigration policies and trends in the science and engineering work force will recognize that these data exclude the effects of the change in the H-1B visa levels and developments in the different countries (including the former Soviet Union) from which the scientists and engineers tended to emigrate to the United States in the 1990s.

Despite the limitations imposed by their data, Xie and Shauman's analyses represent the most comprehensive and rigorous empirical test of the numerous conflicting theories spawned during two decades of intense research on women and science. The work they so effectively describe in *Women in Science* suggests a path and future direction among the myriad of conflicting policies. Providing multiple entry points to science and engineering at all levels—but especially early in the college years—would make it easier for women to switch to majors in these fields. And the critical problem of balancing career and family must be addressed by family-friendly institutional policies: stopping the tenure clock, providing on-site childcare, permitting active service with modified duties at times of transitional life events, and encouraging employment for dual-career couples.

Reference

1. National Science Foundation, *Women, Minorities, and Persons with Disabilities in Science and Engineering, 2000* (NSF 00-327); http://www.nsf.gov/sbe/srs/nsf00327/.

BROWSINGS

Almost Heaven. **The Story of Women in Space. *Bettyann Holtzmann Kevles*. Basic (Perseus), New York, 2003. 288 pp. $25.95, C$39.95. ISBN 0-7382-0209-6.**

In the early 1960s, 13 women pilots who attempted to become the first female astronauts were laughed at by NASA and the U.S. Congress. Wanting to prove women could survive in space—as they would have to if space colonies were to become a reality—the Soviets, in contrast, chose Valentina Tereshkova as their sixth cosmonaut. But after she circled Earth for three days in June 1963, nearly two decades passed before the Soviets sent the second female into space. Since Sally Ride's 1983 flight on the shuttle *Challenger*, almost 40 women from seven countries have orbited. Kevles bases her authoritative account on meticulous research, including interviews with many of these pioneers. She discusses the institutional and cultural changes that allowed women to become the pilots, scientists, engineers, and physicians that the space programs desired. And her enjoyable narrative helps the reader understand why these women struggled to take part in space exploration.