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Career Patterns of Women and Men in the Sciences

Even women who earn elite postdoctoral fellowships encounter social obstacles and may pay penalties in career success for a careful research style

Gerhard Sonnert and Gerald Holton

The current status of women in science is a blend of decisive advance and unfulfilled promise. For more than two decades, discrimination against women in the sciences (as in other professional fields) has been outlawed in the United States, and consequently the gender gap has shrunk. Nevertheless, disparities remain in several areas and fields. A recent National Science Foundation report on women, minorities and persons with disabilities in science and engineering concluded, "On essentially all variables examined here, women fare less well than men." Whether the glass appears half full or half empty, a gender gap persists.

Why is it so? The explanations that have been advanced in the social-science literature can be categorized under two main headings. One, which we call the *deficit model*, is based on structural explanations of scientific careers. It posits the existence of mechanisms of formal and informal exclusion of women scientists. Women as a group, according to this model, receive fewer chances and opportunities along their career paths, and for this reason they collectively have worse career outcomes. The emphasis is on structural obstacles—legal, political and social—that exist (or that, in their most blatant forms, existed earlier) in the social system of science.

The *difference model*, on the other hand, posits the existence of deeply ingrained differences in behavior, outlook and goals between women and men. In this model the root cause of gender disparities in career achievement is internal to the individual. It is said to lie in gender differences—be they innate, or the result of gender-role socialization or cultural patterns. To a significant degree, the argument goes, these differences shape the behavior of individuals as well as the character of social institutions.

Within the difference model, the literature has discussed the possibility of several types of gender differences, of which we find three particularly relevant. First, females may be more likely than males to be socialized with general orientations and attitudes that serve to reduce the drive for professional success in any field. Second, particular attitudes about science may define it as a male field and thus tend to encourage males to participate while discouraging females. Third, some writers assert that deep-seated epistemological gender differences exist that may make science, as practiced today, not sufficiently compatible with "women's ways of knowing."

These two main explanatory models should not be regarded as mutually exclusive. Elements of both can be reinforcing factors in shaping career outcomes. In its dynamics over time, a scientific career path can be viewed in terms of the "kick-reaction" model developed by Jonathan R. Cole and Burton Singer: It is formed by a sequence of (positive or negative) "kicks" from the environment, followed by reactions to these kicks by the individual. Deficit-model obstacles would roughly correspond to negative "kicks" and difference-model obstacles to inopportune reactions.

A good reason to pay attention to the possibility of interactions between structural impediments and behavioral-attitudinal issues is that it seems no longer possible to explain gender disparities by pointing to a few dramatic and clear-cut career obstacles for women scientists. Blatant barriers have receded, although they have not disappeared, as discrimination has been formally abolished. So one must look closer, considering the possibility that small and subtle disadvantages might accumulate over the course of a woman's career in science, along the lines of Robert K. Merton's concept of the accumulation of advantages and disadvantages.

The Project Access Study

In this article we take such a closer look by reviewing the results of our research project, named Project Access, which studied in detail a sample—the largest of its kind—of female and male scientists, to determine both the degree of gender disparity in the average career outcome and the causes for the disparity. The results of the study suggest that significant differences in outcomes can indeed be found by

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cliffe College, or who had been Bunting finalists. Our sample included scientists in all fields as well as mathematicians and engineers: here we shall use the term "scientists" to encompass all these groups.

In focusing on a group of especially promising scientists who had, so to speak, set forth from the same starting line, our study differs from those that concern themselves with samples representing the whole population of scientists. We aimed to complement such studies by providing an in-depth look at an important subgroup. It seemed sensible to try to track and understand the causes for attrition or other disadvantages among that relatively small fraction of women who had stayed in science to the point of gaining prestigious postdoctoral fellowships, if only to find out what became of the heavy investments they and society had made in their scientific careers.

A study of this group, we reasoned, ought also to help sort out the merits of the "glass ceiling" and "threshold" hypotheses. The glass-ceiling hypothesis postulates an invisible but real barrier that impedes women from reaching top positions in their professions. The alternative hypothesis rests on the concept of a threshold. In this view, women who have succeeded in overcoming earlier barriers might have passed a threshold beyond which gender no longer matters in careers.

Women scientists who have been awarded prestigious postdoctoral fellowships should have accumulated significant advantages up to that point, and should be highly qualified and motivated to pursue a successful research career. If these promising women scientists as a group turn out to be less successful than comparable men in attaining high positions, this may indicate the existence of a glass ceiling of gender-specific obstacles in the later stages of their professional careers. On the other hand, if they have overcome certain earlier barriers and passed a threshold beyond which gender no longer matters in careers, one might expect to see less evidence of later professional stratification along gender lines.

Here we shall consider first what our study suggested about the persistence of the gender gap. Then we shall look at factors that may be at play in different ways in different fields of science—at gender-influenced social and professional styles, the self-perceptions of scientists, the interaction of career and family life and the role of serendipity.

Career Outcomes of the Study Group

As we turn now to summarizing a few key results from Project Access (whose findings are presented in detail in two books, Sonnert and Holton 1995a and 1995b), we should emphasize that we did not find monolithic blocks of women scientists on one side and men scientists on the other. Rather, we typically observed great variations within each gender group and a great deal of overlap between them. Yet, as will be shown, some differences between the average experiences are striking, and overall

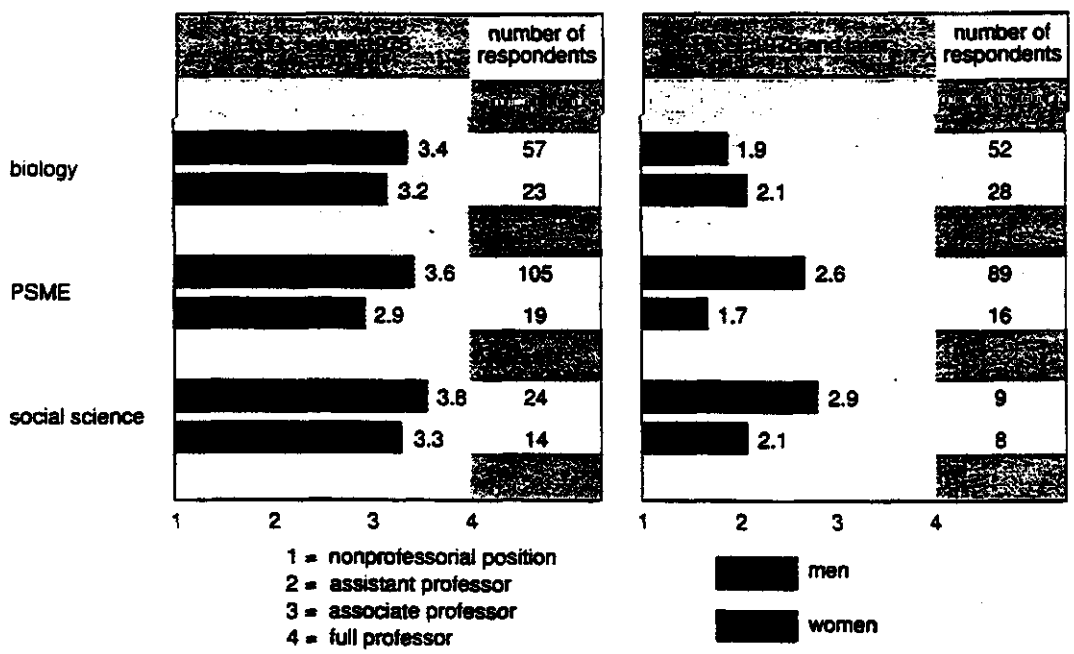

Figure 2. Statistical differences between the career outcomes of men and women appeared in the Project Access sample when the academic-rank achievement of the recipients of postdoctoral fellowships was compared. In biology, virtually no differences appeared between the career progress of men and women; however in the physical sciences, mathematics and engineering (lumped together as "PSME" above) a significant gap separated the average academic rank achieved by women and men, particularly among the younger cohort. The disadvantage in PSME persisted when the authors controlled for the level of publication productivity.

picture that was partly counterintuitive and certainly more complex than any simple relation between women's numbers (and the resulting availability of mentors and role models) and women's success. Women in our questionnaire sample who had been affiliated with female advisors during their postdoctoral fellowships later left science at a *higher* rate than those who had not (16.7 percent *vs.* 9.7 percent), whereas the reverse was the case for men with female advisors (0 *vs.* 8.7 percent). The small number of respondents with female advisors limits our confidence in this finding, but it was echoed in the comments of a woman interviewee who eventually left science. She indicated that she was deterred, rather than attracted, by the example of her female advisor in college. "The more you got to know her, the more you realized she'd given up all personal life to be a scientist. She had a very lonely and isolated life." On the other hand, reports of the positive influence of female mentors and role models were more common.

Socialization

Socialization is a key issue in discussions of women's career paths. It is often reported that many women are hampered in their careers by a lack of confidence in their own abilities. We found evidence to support this statement: Even our group of women, who had achieved recognition for their accomplishment at the doctoral level, differed on average from their male cohorts in their estimation of their own self-confidence, ambition and related traits.

Substantially more men than women among our interviewees reported that they considered their scientific ability to be above average (men, 69.7 percent; women, 51.5 percent). More women considered their ability to be average (men, 18.0 percent; women, 34.7 percent). And when asked whether they should have handled their career obstacles in a different way, many more women than men thought they should have had more confidence or should have been more assertive (25.3 percent *vs.* 4.6 percent of the men). In addition, more than three times as many women as men (15.9 percent *vs.* 4.4 percent) in our interview sample said they had vague or unclear career aspirations when they started out in science.

These self-assessments can be looked at in two ways. Approaching the evidence using the difference model, one would consider such attitudes to be among the causes that make women scientists, on average, less successful than men in career achievement. But the deficit model also offers an explanation: Women whose careers were impeded by structural obstacles may have adjusted their ambitions and self-expectations downward. Our data cannot determine causality. But they suggest that it is useful to look at whether internal and external processes at work in women's and men's science careers might interact to develop a tendency for gender-specific ways of doing science.

Scientific and Professional Styles

Do men and women "do science" differently? Yes, said many of our interviewees. Somewhat more women than men (60.8 percent *vs.* 49.4 percent) said that they believed in the existence of gender differences in the work of scientists in general.

In addition, substantially more women than men interviewees thought that their own gender influences the way they pursue their work. Of the women interviewed, 51.2 percent thought their gender plays a role in their own professional conduct and interaction with other scientists, whereas 25.6 percent of the men perceived such an influence. Fewer interviewees thought that their gender influenced their choice of research subjects (men, 15.7 percent; women, 40.0 percent) and their ways of thinking in science (men, 20.0 percent; women, 36.0 percent). Still fewer interviewees perceived gender differences on the methods they used in their scientific work (men, 9.9 percent; women, 34.8 percent).

Scientists' perceptions and self-reports are not, of course, necessarily based in reality. Nonetheless, it is worth noting that a sizeable proportion of the scientists in our study considered gender a relevant variable for interpreting the behavior of working scientists.

When the people we interviewed talked about these gender differences in "scientific style," certain themes emerged. Both men and women commonly observed that, in their professional style, men seem to have what one woman called more "entrepreneurial spunk." Male scientists are, in this view, more aggressive, combative and self-promoting in their pursuit of career success, and so they achieve higher visibility. In short, they are better at playing the political game of career advancement.

Some women interviewees reported that men have a way of "showing off" at conferences. The

A woman describing "professor talk":

A lot of the connections that people make at meetings and so on, I couldn't do, because what men did is they stood in the hallways and found the great men and went over and shook their hands or asked them to have a drink with them or something, and women couldn't do that in my day. So you couldn't initiate anything.... But if you were in a group of people who managed to connect with that person, then you could try to talk to him. But more often than not, when you were in a group like that, the men showed off for each other. They took themselves terribly seriously and they said any kind of thing that came to their head. I call it "professor talk"... and I found that a waste of my time.

average, and inclined toward more comprehensive and synthetic work, one would expect that they would produce a smaller number of publications per year. And this fact might have a deleterious effect on career progress whenever the sheer number of publications is taken to indicate excellence—for instance, during a competition for an academic position.

A research scientist's claim that he or she trades off quantity for quality can, of course, be a self-serving explanation of low productivity. However, we found some indirect factual evidence that women scientists may tend to publish articles that contain more substantial or comprehensive work. In a small study using a subsample of 25 former NSF fellows in biology who are now academic scientists, we examined (among other inquiries) the citations in the scientific literature to these biologists' articles. The articles written by women in this small sample received significantly more citations per article, on average, than did men's articles—24.4 *vs.* 14.4 citations (Sonnert 1995). This greater citation impact might indicate that the content of the women's articles, on the whole, was more noteworthy. We cannot place a great deal of confidence in this statement, given the small sample size. But in a study of a large sample of biochemists, J. S. Long found a gender difference in citations per article in the same direction (Long 1992). Such results support current efforts to shift the scientific reward system toward a more qualitative evaluation of publication productivity when important decisions about scientists' careers are made.

The Roots of Scientific Style

In sum, our respondents reported gender differences in scientific style, but the differences were much more in the social aspects of science than in the areas of epistemology and methodology. Rather than being iconoclasts, women tended to uphold to a particularly high degree the traditional methodological standards of science, such as carefulness, replicability and connection to fundamentals. As a group, women, as relative newcomers to science, adopted—or were taught to adhere to—an extra-high measure of conformity to the formal norms of conducting research. All the while, they may still be standing somewhat on the margins in regard to the more informal aspects of social interactions and professional conduct among scientists, but these aspects may be crucial elements in the search for career success.

Differences in the ways women approach science may spring from various roots. Approached from the perspective of the difference model, women might be seen as socialized to be less competitive, so that they choose their own niche rather than enter the fray with numerous competitors working on the same topic. They may be more sensitized to criticism and therefore try harder to produce perfect work that is above any possibility of criticism.

Viewed in terms of the deficit model, the same difference may be thought to arise from a collegial environment particularly hostile to women who deviate from accepted standards. A woman scientist reported that "there's always somebody watching for me to make a mistake." Another woman concurred that women scientists find themselves often "under the magnifying glass." In the view of these scientists, the burden of proof is reversed for women: Whereas male Ph.D.'s are considered competent scientists until proven otherwise, their female counterparts have to demonstrate their competence fully before it is generally accepted.

Figure 4. A harmonious marriage is widely thought to have boosted the career of Antoine Laurent Lavoisier, the founder of modern chemistry. Marie Anne Pierrette Paulze, who married Lavoisier at 14, took notes, translated scientific works from English into French and made illustrations. A large group of the former postdoctoral fellows interviewed as part of Project Access, both men and women, considered marriage a positive factor in their success in their scientific careers; in particular, male and female scientists valued the intellectual support of a spouse who was also engaged in science. The most common disadvantage mentioned was a loss of mobility. (Portrait, *Antoine Laurent Lavoisier and His Wife*, by Jacques-Louis David.)

Getting and Taking Chances

Any analysis of the factors that impinge on science careers must emphasize the role of luck. Many of the people we interviewed mentioned that they had benefited markedly from luck and serendipity during career decisions, a fact that makes overall statistical conclusions particularly difficult. An overwhelming majority of both men and women acknowledged that good luck had affected their careers (men, 89 percent; women, 85 percent). Bad luck was acknowledged by a higher proportion of women than men (men, 34 percent; women, 49 percent).

Luck in a science career can take various shapes. Both conceiving a creative hypothesis and having that hypothesis quickly corroborated by experiment depend to some degree on luck. Good luck may be being in the right place at the right time, for instance, in a research program or a field that is "hot." Serendipity is also often involved in meeting the right people—leading scholars who inspire a young scientist, powerful figures who make introductions and connections, people who make an impact with personal integrity and kindness, or mentors who teach the young scientists how to play the political career game.

A key problem for career-minded scientists, then, is to recognize and take advantage of serendipitous situations—to realize the potential effects of a "kick" and respond with a proper reaction. In a male interviewee's words, "the way people really succeed is being able to recognize when a good thing has happened, and take advantage of it."

Do women scientists have equal access to such chances, and are there obstacles that keep them from taking advantage of them? The collective outcomes suggest a larger accumulation of disadvantages than of advantages, although gender disparities were not uniform across the board. They were concentrated in the top ranks of achievement and in fields outside of biology. Very large and very obvious gender differences and disparities were absent. But even the women in our specially selected group faced gender-specific career obstacles, particularly in fields where women are greatly underrepresented.

It may now be futile to search for the "big remaining obstacle" to women's career parity in the sciences. Rather, the accumulation of subtle structural disadvantages, as suggested by the deficit model, together with the attitudinal and behavioral disadvantages offered by the difference model, may afford a partial explanation of the glass ceiling where it persists. Policymakers should keep this in mind when trying to influence the social system of science. No single policy can be expected to produce general success. A great variety of targeted efforts may be more advantageous. And in the lives of individual scientists, our study shows that attention paid to career strategies can be important—a lesson of particular use, perhaps, for women who are making their way as strangers through territories of science that are relatively new to their gender.

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