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Women in American Science

HARRIET ZUCKERMAN AND
JONATHAN R. COLE

THE small numbers of women in the sciences, physical and biological, and in the other learned professions in the United States, result from early and cumulative discrepancies in the extent and character of educational attainment. Women are less likely to attend university or college than men. About a fifth of all women of university age were at university in 1969, compared to more than a third of the males of the same age.[1] Women who attend university or college are slightly less apt than their male classmates to continue to completion of their course of study.[2] Male undergraduates are about three times as likely as women to specialise in science and engineering, thus providing a largely male pool of potential scientists.[3] Finally, men who specialise in science as undergraduates are also more apt than women to go on to graduate studies; about twice the proportion do so.[4]

This successive filtering means, of course, that a far smaller proportion of women than men emerge from graduate schools in the United States with Ph.D.s in the physical and biological sciences. Only 10 out of every hundred doctorates in the physical and biological sciences and six out of every thousand in engineering were granted to women in 1972.[5] This

[1] United States Bureau of the Census, *Statistical Abstract of the United States*, 91st ed. (Washington, D.C.: U.S. Government Printing Office, 1970), p. 107. Although the proportion of all Americans of university and college age who have actually been attending such institutions has been increasing, the increase has been more rapid in recent years among women than among men. See Ferris, Abbot L., *Indicators of Trends in the Status of American Women* (New York: Russell Sage Foundation, 1971), p. 320.

[2] Computed from Ferris, A. L., *op. cit.*, p. 307, and United States Bureau of the Census, *op. cit.*, 1970, p. 131. Four years later, 41 per cent. of all bachelor degrees were awarded to women, *ibid.*, p. 131. Bernard reports consistently higher attrition rates for women university and college students than for men: Bernard, Jessie L., *Academic Women* (University Park, Pennsylvania: Pennsylvania State University Press, 1964), p. 70.

[3] Computed from United States Bureau of the Census, *op. cit.*, 1970, p. 131. Twenty-three per cent. of male college graduates specialised in science or engineering in 1968, compared with 7 per cent. of women graduates. The difference between the sexes, however, is largely due to the differences in their representation in engineering: 10 per cent. of all male graduates but less than one per cent. of female graduates received degrees in engineering.

[4] Sharp, Laure M., *Education and Employment: The Early Careers of College Graduates* (Baltimore and London: The Johns Hopkins University Press, 1970), p. 9. Four years after graduation, 60 per cent. of the male graduates of 1958, as against 29 per cent. of female graduates who specialised in science, had gone on to graduate studies. Among engineers, 31 per cent. of the men went to graduate school and 24 per cent. of the women. Even among those who specialised in science at the leading liberal arts colleges, women are half as likely to take doctorates as men; see Snelling, W. Rodman, Boruch, Robert F. and Boruch, Nancy B., "Science Graduates of Private and Selective Liberal Arts Colleges", *College and Unversity*, XLVI (Spring 1971), pp. 231–244.

[5] Office of Scientific Personnel-National Research Council, *Doctorate Recipients from U.S. Universities: Summary Report 1972* (Washington D.C.: National Research Council, May 1973), p. 1. Although the following data are not for the same cohort of recipients of bachelors' and doctoral degrees, the third column shows the extent to which selected sciences differ in the amount of filtering out of women between college and the Ph.D.

Percentage of Women among All Recipients of Bachelors and Ph.D.s in 1969, by Scientific Field

	% Bachelors (a)	% Ph.D's (b)	Ratio of (b to a)
Biological Sciences	28·0	15·4	·55
Chemistry	18·3	7·5	·41
Physics	5·8	2·4	·41
Geology	10·4	3·2	·31
Mathematics	37·4	6·2	·17

SOURCE: United States Bureau of Census, *op. cit.*, 1971, p. 130.

comes as no surprise. But what is surprising is that no greater share of all Ph.D.s awarded in the sciences in the United States go to women now than in the 1920s. Women received about 11 per cent. of all doctorates in the physical and biological sciences between 1920 and 1929, compared with 10 per cent. in 1972.[6]

Although their proportionate representation is much the same, absolute numbers of women receiving Ph.D.s in the sciences have increased since the 1920s when an average of about 50 women a year received degrees.[7] In 1972, the figure ran to 1,096.[8] The proportion of doctorates in the physical and biological sciences awarded to women has, however, fluctuated from its highest level of about 11 per cent. for the 1920s to its lowest level of 5 per cent. for the 1950s.[9] The present rate of 10 per cent. is a composite of the comparatively low rate of 7 per cent. for the physical sciences and the comparatively higher rate of 15 per cent. for the biomedical sciences.[10]

The more recent picture is somewhat different. Between 1960 and 1972, the annual number of doctorates conferred in the physical and biological sciences increased 2·7 times, but the number of women receiving these degrees rose 4·7 times. Thus the number of women receiving doctorates in the sciences rose faster than the total number of recipients. At the same time, the proportion of women among all scientific and technical employees has dropped slightly during the last 20 years, a period of rapid growth in the scientific population and of the increasing integration of women into the labour force.[11]

[6] Harmon, Lindsey R. and Soldz, Herbert, *Doctorate Production in United States Universities: 1920–1962* (Washington, D.C.: National Academy of Sciences-National Research Council, 1963), Publication no. 1142, p. 52, for statistics relating to 1920s; United States Office of Scientific Personnel-National Research Council, *op. cit.*, p. 1, for statistics relating to 1972.

[7] Harmon, L. R. and Soldz, H., *op. cit.*, p. 50.

[8] Office of Scientific Personnel-National Research Council, *op. cit.*, p. 1.

[9] *Ibid.*, p. 1; and Ferris, A. L., *op. cit.*, p. 321. Ferris reports that, after reaching a low point in the late 1950s, the proportion of women receiving doctorates in all fields began to increase and has continued at an irregularly increasing rate. According to United States Bureau of the Census, *op. cit.*, 1970, pp. 65, 227, about 7 per cent. of all physicians were women in 1960 and again a decade later. According to Law, Margaret (ed.), "Goals for Women in Science and Engineering" mimeographed, (Boston: Women in Science and Engineering, 1972), p. 23, the percentage of women among entering medical students is now increasing sharply and was estimated at 16·7 per cent. for 1972.

[10] Office of Scientific Personnel-National Research Council, *op. cit.*, p. 1.

[11] United States Bureau of the Census, *op. cit.*, 1965, pp. 233–234, and 1970, p. 525. In 1950, women comprised 11·4 per cent. of all scientific and technical workers, as compared

The Principle of the Triple Penalty

What social processes produce these distributions? How has the number of women scientists and engineers come to be so restricted? And what happens to the comparatively few who do embark on scientific careers?

We suggest that women encounter three barriers to becoming productive scientists. First, science is culturally defined as an inappropriate career for women; the number of women recruited to science is thereby reduced below the level which would obtain were this definition not prevalent. Second, those women who have surmounted the first barrier and have become scientists, continue to be hampered by the belief that women are less competent than men. Whatever the validity of this belief, it contributes to women's ambivalence towards their work and thereby reduces their motivation and commitment to scientific careers. And third, as we shall see, there is some evidence for actual discrimination against women in the scientific community. To the extent that women scientists suffer from these disadvantages, they are victims of one or more components of the triple penalty.

Recruitment to Science

It is widely believed that women are neither fit for scientific and technical careers nor interested in them.[12] The evidence for these beliefs is equivocal. For one thing, women seem to be no less interested in science than are men. For example, the nation-wide survey of university and college graduates conducted by the National Opinion Research Center in 1964 indicates that about half of all men and women express interest in a career in scientific research. This is not the case for engineering, which is preferred overhelmingly by males.[13] The same survey also shows considerable differences between the sexes in self-appraisals of scientific ability. More university women than men believe they do not qualify for careers in science and engineering.[14] Women, more often than men, believe that careers in science, however interesting, require too great an investment.[15] Many women university and college students believe that they are unfit for

with 9·4 per cent. in 1970. According to United States Bureau of the Census, *op. cit.*, 1971, p. 515, the proportion of women in this occupational group dropped to its lowest point about 1964 and is now on the increase.

12 Mussen, Paul H., " Early Sex-Role Development ", in Goslin, D. A. (ed.), *Handbook of Socialization Theory and Research* (Chicago: Rand-McNally, 1969), pp. 707–732. We shall not examine here the complex evidence on sexual differences in intelligence and personality or the differences which may exist in childhood training; nor will we compare the status of American women in science with their counterparts in other countries. For a comprehensive review of research on sexual differences, see Maccoby, Eleanor (ed.), *The Development of Sex Differences* (Stanford, California: Stanford University Press, 1966).

13 Fichter, Joseph H., *Graduates of Predominantly Negro Colleges: Class of 1964* (Washington, D.C.: U.S. Government Printing Office, 1967), Public Health Service Publication no. 1571, pp. 91, 141. Fichter's study draws upon data collected by the National Opinion Research Center.

14 *Ibid.*, pp. 97, 138.

15 *Ibid.*, p. 143.

scientific careers; as a result, they are less often willing to undertake the rigorous training required for these careers, choosing instead occupations which they believe are more in line with their self-defined abilities. However, this evidence is now a decade old and thus does not convey changes in women's attitudes which may have occurred in the years intervening.

Women students in universities and colleges believe that scientific careers are open only to exceptional women.[16] Apparently, a considerable number of women reject careers in science long before the point at which they might be rejected by those who control admission, appointment, and promotion. Some of the women believe themselves to be unqualified and others believe that a scientific career, in conjunction with marriage, would be excessively demanding. For these reasons, it is believed to be an unrealistic occupational choice.[17]

The belief that a career in science, together with marriage and motherhood, form a combination too difficult for most women to handle is consistent with the attributes of the women scientists and engineers whom young women know or know about. The few who teach in universities or whose names and faces appear in the press and on television are apt to be extraordinarily competent, and a large proportion have not taken on the conventional female commitments of marriage and family. As exceptional women scientists, they may seem too remote to be effective models.[18] " Average " male scientists are more familiar to young persons than " average " women scientists, both because they are more numerous and because they are more apt to have regular posts in universities and industry. As a consequence of the small numbers of women in science, many women undergraduates never encounter a woman scientist at all. Although Madame Curie may serve as an inspiring model for some young women, for others she is all too remote and formidable a figure to emulate.[19]

Thus few women even consider science as an occupation. It is not known whether women who have the potential to become scientists choose other occupations considered more appropriate[20] for women, or whether they choose not to work at all and are thereby wasted resources. For women, then, the selection of occupations is, in part, the outcome of a self-fulfilling

16 *Ibid.*, p. 160.

17 Rossi, Alice S., " Barriers to the Career Choice of Engineering, Medicine, or Science Among American Women ", in Mattfeld, J. A. and Van Aken, C. A. (eds.), *Women and the Scientific Professions* (Cambridge, Massachusetts: Massachusetts Institute of Technology Press, 1965), pp. 92, 94–96.

18 Graham, Patricia Albjerg, " Women in Academe ", *Science*, CLXIX, 395 (25 September, 1970, pp. 1284–1290. Although many conclude that the presence of appropriate models is an important determinant of differences between the sexes in occupational choice, we know of no evidence that this is so.

19 Lubkin, Gloria, " Women in Physics ", *Physics Today*, XXIV, 4 (April 1971), pp. 23–27.

20 See Epstein, Cynthia F., *Woman's Place: Options and Limits in Professional Careers* (Berkeley, California: University of California Press, 1970), p. 152; and Coser, Rose Laub and Rokoff, Gerald, " Women in the Occupational World: Social Disruption and Conflict ", *Social Problems*, XVIII, 4 (Spring 1971), pp. 542 *ff.*, for further discussion of the implications of the association of certain occupations with one sex or the other.

prophecy.[21] Widely defined by themselves and others as inappropriate candidates for scientific careers, women are less apt to go into science and to choose occupations more in line with prevailing expectations. In doing so, they confirm beliefs about their inclinations, and apparently about their capacities as well.

That self-fulfilling prophecies contribute to differences between the sexes in the choice of scientific careers becomes more plausible when we remember that one of the most important determinants of differences in occupational attainment, social class, does not pertain here. Women, after all, share the same social origins as men; in matters of status they share characteristics and they should, other things being equal, appear in the scientific professions in the same numbers as males. But other things are not equal. As we have noted, women are less apt to be educated at university than men of the same ages.[22] This is the case in each social and economic stratum, at each level of academic aptitude.[23] In general, families have been less willing to invest in educating daughters than sons, a practice which is quite consistent with the expectation that the chief roles of women are to serve as mothers and wives rather than to move into the occupations requiring academic training.[24] Perhaps this explains why female scientists consistently come from families of higher social status than do male scientists.[25]

The ambivalence of many women about professional careers—with their demanding schedules, high levels of competition and potentials for conflict with family life—and about careers in the domain of science which are also considered to be masculine, is reflected perhaps in women delaying the decision to go to graduate school longer than men. Just over half of the women graduates of superior undergraduate colleges, contrasted with a third of the men, postpone their decision to go into graduate study until their senior year or later; this is the case even though both groups report that they become interested in science at about the same time.[26] These decisions are supported by the widespread belief that occupational achievement is unfeminine and that this is especially true of achievement in science and engineering.[27]

21 Merton, Robert K., "The Self-fullfilling Prophecy", in *Social Theory and Social Structure* (New York: Free Press, 1968, originally published 1948), pp. 475–492.

22 Ferris, A. L., *op. cit.*, p. 27.

23 Folger, John K., Astin, Helen S. and Bayer, Alan E., *Human Resources and Higher Education* (New York: Russell Sage Foundation, 1970), p. 310; and Sewell, William and Shah, V. P., "Socio-Economic Status, Intelligence, and the Attainment of Higher Education", *Sociology of Education*, XL, 1 (Winter 1967), pp. 1–23.

24 Kohn, Melvin L., "Social Class and Parental Values", *American Journal of Sociology*, LXIV, 4 (January 1959), pp. 337–351; and Sewell, William H., "Inequality of Opportunity for Higher Education", *American Sociological Review*, XXXVI, 5 (1971), pp. 793–809.

25 David, Deborah, "Career Patterns and Values: A Study of Men and Women in Science and Engineering", unpublished doctoral dissertation (Department of Sociology, Columbia University, 1971), Table 3–9; Astin, Helen S., *The Woman Doctorate in America* (New York: Russell Sage Foundation, 1969), p. 25; and Harmon, Lindsey R., *Profiles of Ph.D.s. in the Sciences* (Washington, D.C.: National Academy of Sciences-National Research Council, 1965), Publication no. 1293, p. 40.

26 Snelling, W. Rodman and Boruch, Robert, "Factors Influencing Student Choice of College and Course of Study", *Journal of Chemical Education*, XLVII, 5 (May 1970), pp. 327–328.

Graduate Study

Many academics believe that women students are as able as men, but women are still uniformly discriminated against in admission to graduate school, and those who are admitted tend not to be granted financial assistance.

Although intelligence tests are generally designed to eliminate sex differences in test scores, those women who obtain the doctorate in scientific subjects consistently do somewhat better than men in these standardised tests.[28] Cole's study of matched samples of women and men who have received doctorates shows that in each of five fields and at every level of prestige of university graduate departments, women had consistently higher intelligence scores than men although the differences between them were rarely significant. These consistent differences, although not large, deserve further investigation. Women's higher scores may result from the tendency of all but the very best female graduates not to pursue graduate studies, and from the relatively more rigorous selection which occurs in the course of their graduate training. At the very least, the evidence indicates that women who get doctoral degrees in the sciences are no less able than their male colleagues in the intellectual capacities which are measured by intelligence tests.

Although it is not known whether there are systematic differences in the criteria graduate schools use in admitting men and women, such evidence as is available suggests that members of both sexes are admitted in the same proportions as they apply. Since women apply in such small numbers, they ultimately comprise a small proportion of all graduate students.[29] Women candidates do receive slightly higher scores on tests of verbal facility incorporated into the nation-wide Graduate Records Examination, but men do considerably better than women on tests of quantitative skills.[30] The qualifications of applicants, male and female, would have to be known in much greater detail in order to discover whether discrimination has occurred, and since we lack this information it is impossible to say with authority

27 Rossi, A. S., *op. cit.*, p. 95.

28 Cole, Jonathan R., *Woman's Place in the Scientific Community* (New York: John Wiley, forthcoming); Bernard, J., *op. cit.*, 1964, p. 78. The fields refererd to in Cole's study are physics, mathematics, chemistry, biology, psychology and sociology. Astin, H. S., *op cit.*, 1969, is used as a source for information on females, while Cole provides a matched sample of men who took degrees from the same universities. Unlike Astin's data, his data follow some women for 12 to 13 years after they received their doctorates.

29 Pearce, R. H. *et. al.*, *Women in the Graduate Academic Sector of the University of California: Report of an ad hoc Committee of the Coordinating Committee on Graduate Affairs* (Los Angeles, California: June 1972); *The Study of Graduate Education at Stanford: Report of the Task Force on Women* (Stanford; Stanford University Press, June 1972).

30 *GRE: Guide to the Use of the GRE Scores in Graduate Admissions, 1970–1971* (Princeton, N.J.: Educational Testing Service, 1971).

whether or not women are discriminated against in admission. As for the allocation of financial assistance to women, once they are in graduate school the record is clear: about the same proportion of women are granted financial assistance as men [31]—at least this was the case in the 1950s and 1960s when graduate students in the sciences received much financial support in the United States. How the women's movement and the scarcity of resources will affect these findings is not known.

It is also widely believed by faculty members that more women are poor risks as graduate students. They are said to be less likely to complete their postgraduate degrees, and when they do, to take longer than men.

These beliefs appear to be essentially correct. Women in general are considerably more likely than men to withdraw from graduate studies before completion. At 24 American universities, 54 per cent. of the women graduate students and 36 per cent. of the men failed to complete their studies.[32] The rate of attrition has been even higher among the recipients of Woodrow Wilson fellowships, which are awarded nationally according to very exacting standards to graduates who intend to follow academic careers. Six to eight years after having begun graduate studies, 44 per cent. of the men who were Woodrow Wilson fellows and 64 per cent. of the women had neither completed their degrees nor were actively pursuing them. The differences in the rates of attrition between men and women was greatest among graduate students in the sciences: only 26 per cent. of the men had discontinued their studies, while 54 per cent. of the women had done so.[33]

High rates of attrition may be attributable in part to the negative attitudes of teachers towards women students. Thirty-five per cent. of faculty in the sciences questioned by the Carnegie Commission in the survey of American university teachers said that they believed that women students were not as dedicated as men—a considerably higher proportion than among teachers of history, English, political science and sociology.[34] But since attrition rates are higher in these fields than in the sciences, this seems an unlikely explanation.

Some have suggested that women graduate students have particular difficulty establishing themselves in relationships of master and apprentice and

[31] Astin, H. S., *op. cit.*, 1969, p. 103; Sharp, L. M., *op. cit.*, p. 130; and Feldman, Saul D., " Impediment or Stimulant? Marital Status and Graduate Education ", *American Journal of Sociology*, LXXVIII, 4 (January 1973), p. 992. According to Feldman, the national survey of American graduate students in 1968–69, sponsored by the American Council on Education and the Carnegie Corporation, showed that women were slightly more apt to have fellowships and men to have teaching or research assistantships.

[32] Tucker, Allan, Gottlieb, David and Pease, John, *Attrition of Graduate Students at the Ph.D. Level in the Traditional Arts and Sciences* (East Lansing, Michigan: Michigan State University, 1964), Office of Research and Development Publication no. 8.

[33] Patterson, Michelle and Sells, Lucy, " Women Dropouts from Higher Education ", in Rossi, A. S. and Calderwood, A. (eds.), *Academic Women on the Move* (New York: Russell Sage Foundation, 1973), pp. 85–86.

[34] See Sells, Lucy W., " Sex Differences in Graduate School Survival " (paper presented at meeting of the American Sociological Association, 1973 [mimeographed], p. 9) in which the author analyses the Carnegie Commission Survey of graduate students.

that they are thereby deprived of an important element in training for a scientific career.[35] Women students, in general, are less apt than men to identify themselves as apprentices or colleagues of their research supervisors.[36] In the sciences, however, this is not consistently the case. In physics and chemistry, there are no significant differences between men and women graduate students in the proportion reporting as being apprenticed to faculty members, although there are such differences between men and women students in the biological sciences and mathematics. In these latter sciences, men indicated more often than women that they were regarded by faculty members as apprentices or colleagues.[37]

Women obtain postgraduate degrees, on average, two years later than men.[38] This discrepancy is apparently not attributable to having begun their graduate studies later. It is partly the outcome of the greater propensity of women—married or unmarried—to study part-time.[39] This delay is as characteristic of the outstanding young women who win Woodrow Wilson fellowships as of the others.[40] Still, in part it is marriage and motherhood which slows women down. Married women, especially those with children, have therefore been poorer risks than their spinster or divorced colleagues.[41]

Many believe that women are less likely to have been trained at the most distinguished universities, since they are discriminated against in admissions and because their range of alternatives in choosing graduate schools are more limited than those of men. But women are just as likely to have received doctoral degrees from leading universities as men, with 51 per cent. of the one and 52 per cent. of the other being trained at these institutions. This holds in the sciences as well as in other fields.[42] Such information as there is, as we have already observed, does not strongly point to any pattern of discrimination in admission to graduate study. It seems that if the choices of women are constrained by the requirements of their husbands' careers, these constraints are not evident in the distributions of doctoral origins of men and women scientists.[43]

[35] Epstein, Cynthia F., " Bringing Women In: Rewards, Punishments, and the Structure of Achievements ", *Annals of the New York Academy of Sciences*, CCVIII (15 March, 1973), pp. 62–70.

[36] Sells, L. W., *op. cit.*, p. 5.

[37] Sells, L. W., *op. cit.*, p. 5.

[38] Astin, H. S., *op. cit.*, 1969, p. 20.

[39] Feldman, S. D., *op. cit.*, pp. 984–985.

[40] Mooney, Joseph D., " Attrition Among Ph.D. Candidates: An Analysis of a Cohort of recent Woodrow Wilson Fellows " (Department of Economics, Princeton University), unpublished manuscript cited in Folger, J. K., Astin, H. S. and Bayer, A. E., *op. cit.*, p. 286.

[41] Feldman, S. D., *op. cit.*, p. 988.

[42] Folger, J. K., Astin, H. S. and Bayer, A. F., *op cit.*, p. 285, report these figures for recipients of doctoral degrees in 1961 from departments ranked " distinguished " or " strong " by the American Council of Education.

[43] The class of university where the doctorate was obtained may have different implications for the careers of women: see Berelson, *op. cit.*, pp. 109*ff*; Hargens, Lowell and Hagstrom, Warren, " Sponsored and Contest Mobility of American Academic Scientists ", *Sociology of Education*, XL, 1 (Winter 1967), pp. 24–38; and Crane, Diana, " The Academic Marketplace Revisited: A Study of Faculty Mobility Using the Cartter Ratings ", *American*

Patterns of Employment

Not only is it believed that training women to be scientists is a poor investment, but also that if they get their degrees, they marry, have children, and stop working. Among those few who return to work, skills and knowledge, which were once fully up to date, have become obsolete.

This view is contradicted by the best evidence available. Nearly nine out of 10 women Ph.D.s in the sciences were at work seven years after they took their degrees—presumably the period in which most would have had children if they were to have them at all—and three fourths were working full-time.[44] Women Ph.D.s rarely stopped working—eight out of 10 worked at their professions without interruption after receiving their degrees.[45] The 18 per cent. who suspended their professional work—to have children or to accommodate to changes in their husband's employment—were absent for an average of 14 months,[46] less time than the once usual absence of unexempted males in the military. Another study of over 42,000 teachers in American colleges and universities in 1972 showed that approximately a fifth of all women teachers had interrupted their professional careers for at least a year, but one fourth of the men had done the same, for military or familial reasons.[47] Of course marriage and motherhood are related to patterns of employment. Married women scientists with children more often give up employment than married women who are childless; and they in turn are slightly more often not at work than single women.[48]

The employment histories of women holding doctorates in science are remarkably stable. There was no difference between men and women holders of the Ph.D. in mean numbers of employers over their entire careers,[49] and when years spent with current employers are included in that

Journal of Sociology, LXXV, 6 (May 1970), pp. 953–964, for the familiar generalisation that where one is trained determines where one ends up. This may not be true in all instances; women's preferences for employment may differ systematically from those of men, and thereby attenuate the correlation between the rank of the university which awarded the degree and that in which the person is later employed. To the extent that discrimination persists, it will reduce the relationship even further. Current intensive efforts to recruit women to university teaching staffs may further modify the relationship by placing larger proportions of women in universities ranked higher than would be predicted from their doctoral origins, just as in the past rules regulating nepotism also modified that relationship.

[44] Astin, H. S., *op. cit.*, 1969, p. 57; and Folger, J. K., Astin, H. S. and Bayer, A. E., *op. cit.*, p. 289.

[45] Astin, H. S., *op. cit.*, 1969, p. 58. What is true for women with Ph.D.s does not hold for the rest. David, D., *op. cit.*, in Tables 6-3, 6-2, finds in the analysis of the Post-Censal Survey of scientific and technical manpower that 7 per cent. of women with Ph.D.s were not employed at the time of the survey, and 12 per cent. of those with master's degrees and 19 per cent. of those without any graduate education were not employed. In contrast with this, David finds only 2 per cent. of the men, regardless of educational level, were unemployed. She also finds that women engineers are no more apt to leave the labour force than are other women with similar education.

[46] Astin, H. S., *op. cit.*, 1969, p. 58.

[47] Bayer, A. E., "Teaching Faculty in Academe: 1972–1973" (Washington, D.C.: American Council on Education (2 August, 1973), Research Reports no. 8, p. 16.

[48] Astin, H. S., *op. cit.*, 1969, p. 56; and David, D., *op. cit.*, Table 6-3.

[49] *Ibid.*, pp. 6–20.

total, women with doctorates show more continuous employment with one employer than do men.[50] Those employers who are reluctant to appoint women because they are allegedly less dependable than men would do well, as one letter-writer to *Science* recently observed, "to adopt the more generally corrective principle of exacting the penalty after rather than before the crime is committed."[51] If they do not, they will bring still another self-fulfilling prophecy into being.

Female holders of the doctorate may work as much as men but they do not work for the same employers nor do they hold the same sorts of post. Women scientists are disproportionately under-represented in industry and over-represented in academic institutions.[52] Women are not relegated to appointments in colleges and minor universities as is commonly supposed. And this was so even before the official policy of "affirmative action" requiring universities to increase the proportions of women on faculties went into effect. The academic affiliations of women with doctorates[53] are about the same as those of men, but academic affiliation is one thing and academic rank quite another. Women with doctorates in science more often teach than men,[54] and two to three times the proportion teach full-time.[55] But the differences are not great: 39 per cent. of women faculty members in colleges and universities teach as many as 13 hours a week, as against 30 per cent. of men. However, while teaching more, women are less apt than men to report having teaching assistants: 30 per cent. do so as against 41 per cent. of the men.[56]

Scientific Performance

It is commonly believed that women scientists individually, and of course collectively, do not contribute as much to science as men; they are simply less productive.

Women are indeed less productive than men, according to one standard measure of productivity—the publication of scientific papers. Women scientists publish at a lower rate than men.[57] One interpretation of such

[50] *Ibid.*, table 6–18.

[51] Brues, A., "Letter", *Science*, CLXXIV, 3983 (7 May, 1971), p. 515.

[52] Harmon, L. R., *op. cit.*, 1965, pp. 6, 53; Rossi, A. S., in Mattfield, J. A. and Van Aken, C. A. (eds.), *op. cit.*, pp. 67*ff.*; Astin, H. S., *op. cit.*, 1969, p. 71; and Bolt, Richard R., "The Present Situation of Women Scientists and Engineers in Industry and Government", in Mattfield, J. A. and Van Aken, C.A. (eds.), *op. cit.*, pp. 139–162.

[53] Cole, J. R., *op. cit.*

[54] David, D., *op. cit.*, Table 6-12.

[55] Harmon, L. R., *op. cit.*, 1965, pp. 58–59.

[56] Bayer, A. E., *op. cit.*, 1973, pp. 23, 28.

[57] Some persons allege that the contributions of women to collaborative efforts are less often recognised by co-authorship than those of men and that this contributes to their lower rates of publication. This may be so. One current fact of scientific life is that the contributions which count for most, for both men and women, are embodied in the scientific literature, and that the standing of scientists among their colleagues rests on these contributions as registered in the authorship of research publications. See Bernard, J., *op. cit.*, 1964, pp. 152*ff.*; Hargens, Lowell, *The Social Contexts of Scientific Research* (Madison, Wisconsin:

differences in productivity is that women publish less because they are affiliated more often than men to academic institutions which neither expect research and publication nor reward them. But the facts are not consistent with this contention. Men in academic posts publish more than their women colleagues in the same institutions.[58] Thus, differences in productivity are not a consequence of differences arising from the differences in institutional affiliation of men and women scientists.

The other conventional explanation of women's lower rates of publication, namely, the responsibilities of marriage and motherhood, also does not fit the facts. Unmarried women scientists and those who are married and have no children publish slightly more than half as many papers as men with the same marital and parental status.[59] Among men and women scientists who are parents, motherhood, more than fatherhood, results in reduced publication.[60] The more children a woman scientist has, the fewer papers she publishes.

The correlation between early and later productivity is substantial for men, but considerably weaker for women.[61] Women who are productive early in their careers are less apt than men to continue to be productive, and are more apt to disappoint those who might have tried to facilitate their work. In the process, women reinforce the belief that even the best of them do not realise their promise.

The observed differences between the sexes in scientific productivity need not be attributed to discrimination. In fact, a smaller proportion of women than men are interested primarily in research, and the difference is most marked in universities: 39 per cent. of men and 15 per cent. of women who hold academic appointments in universities count themselves as being primarily interested in research.[62] In part, interest in research probably determines rate of publication and may be reinforced by it.

Turning from quantity of publication to its quality, once again we find that women do less well than men. It is difficult to assess the quality of published scientific work. Frequency of citation in the scientific literature is

Department of Sociology, University of Wisconsin, 1971), unpublished Ph.D. thesis, pp. 288–289; and Reskin, Barbara F., *Sex Differences in the Professional Life Chances of Chemists* (Seattle, Washington: Department of Sociology, University of Washington, 1973), unpublished Ph.D. thesis, pp. 303*ff*. It is also alleged that women publish fewer papers than men because referees for scientific journals systematically discriminate against them in decisions on publication. The correlation between sex and published productivity does not however differ in fields in which " blind refereeing " is the custom and those in which referees are given the names of the authors whose papers they evaluate.

[58] Cole, J. R., *op. cit.*, p. 27.

[59] Simon, Rita James, Clark, Shirley Merritt and Galway, Kathleen, *op. cit.*, p. 231, also report that women scientists regardless of marital status are less productive than men, but their samples seem to be incomparable.

[60] Cole, J. R., *op. cit.*

[61] These findings on female Ph.D.s parallel Maccoby, Eleanor, *op. cit.*, 1966, where it is stated that the relationship between early school performance and later achievement is weaker for girls than for boys. See also Maccoby, Eleanor, " Feminine Intellect and the Demands of Science ", *Impact of Science on Society*, XX, 1 (January–March 1970), pp. 13–28.

[62] Bayer, A. E., *op. cit.*, 1970, p. 15.

however considered a rough but valid measure.[63] Differences in the frequency of citation to the publications of men as compared to those of women scientists are considerable, but not quite as great as the differences in rate of publication. Women scientists publish less than men and what they do publish appears to have less impact on their field.[64] The reasons for differences in rates of citation are not self-evident. It may be that women work in comparatively less popular specialities and thus have fewer resources to permit them to work at the forefront of their fields, or it may be that they have less sense than men of " good problems ".[65]

There are some grounds for thinking that men are better integrated into the network of informal scientific communications. Women are less apt than men in the same fields and at the same rank to receive preprints from other scientists or to send their own work out for comment. Those women who go to scientific meetings report fewer productive conversations about their work. However, about the same proportion of women faculty members as men report being in frequent communication with others in their specialities.[66] Although we do not know what effects, if any, informal communication has on scientific work, we do know that the reverse holds. Highly productive scientists are more often in close touch with other scientists than are unproductive ones.[67]

Although women apparently are as often associated with leading universities as men, there are indications that they spend less time on research, have more limited access to resources for it, and are less fully integrated into the scientific community within their fields of specialisation, thus reducing the probability of carrying on useful scientific inquiry.

Rewards and Rank

Regardless of differences between the sexes in types of employment, they hold ranks lower than men.[68] This is the case both in industry and in universities, in women's colleges as well as in co-educational institutions.

[63] Cole, J. R. and Cole, Stephen, " Measuring the Quality of Sociological Research: Problems in the Use of the Science Citation Index ", *American Sociologist*, VI, 2 (February 1971), pp. 23–29.

[64] Although women scientists are statistically under-represented among those honoured for truly significant contributions to science, it is not yet known whether this is the result of discriminatory practices or differences in scientific performance.

[65] Zuckerman, Harriet, " Nobel Laureates in Science: Patterns of Productivity, Collaboration, and Authorship ", *American Sociological Review*, XXXII, 3 (June 1967), pp. 391–403; and Zuckerman, Harriet, *Scientific Elite: Nobel Laureates in the United States* (Chicago: The University of Chicago Press, forthcoming).

[66] See Bernard, J., *op. cit.*, 1964, p. 158; and Bayer, A. E., *op. cit.*, 1970, p. 18.

[67] Price, Derek J. de S. and Beaver, Donald, " Collaboration in an Invisible College ", *American Psychologist*, XXI, 11 (November 1966), pp. 1011–1018.

[68] Parrish, John B., " Women in Top Level Teaching and Research ", *American Association of University Women Journal*, LV, 2 (1962), pp. 99–107; Bernard, J., *op. cit.*, 1964, pp. 189–191; and Simon, Rita James, Clark, Shirley Merritt and Galway, Kathleen, " The Woman Ph.D.: A Recent Profile ", *Social Problems*, XV, 2 (Fall 1967), pp. 221–236. Bayer, A. E. and Astin, H. S., *op. cit.*, 1968, however, report equality for academic men and women in science, but not in social science.

Women are usually concentrated in non-supervisory positions [69] and in positions which do not provide permanent tenure. Men and women scientists begin their careers at the same rank but men generally hold higher rank seven years later, and this is so even when the quality of their research output and seniority are held constant.[70]

Thus far, we have reported scant evidence of discrimination against women in science. Although the processes affecting their recruitment to scientific occupations are external to the community of scientists, they nonetheless affect women's aspirations, access to higher education, and willingness to embark upon demanding careers. Yet there is little to suggest the existence of discrimination once women have begun postgraduate study. They are admitted to the same universities and seem to have an equal chance of financial support. When women move into the occupational world, however, they are discriminated against in the matter of rank. The extent to which this is so varies in universities and industrial corporations and among sciences. Within universities, women in physics do better than women in the biological sciences, and both are ranked higher than women in the social sciences and humanities.[71]

The differences between men and women in academic rank need not be attributed to discrimination alone. They also reflect some measure of self-conscious choice by women. The tendency to interrupt their careers and to work part-time [72] clearly increases sex differences in rank.[73] Such choices reflect women's accommodation to domestic responsibilities. Nevertheless, since furloughs from work and part-time employment come just at the time in the scientific career when others are in the process of moving from the status of junior research worker to senior investigator and are preparing for positions of greater responsibility, these accommodations have important consequences for the careers of women scientists. They fall behind at the very time that men are moving ahead. Even though the costs of marriage and motherhood to their careers are self-imposed, they are costs nevertheless—costs which do not have to be met by men of science.

These observations on married women need to be put into context. Only half of all women with doctorates in science are married and living with their spouses, as compared with something like 90 per cent. of the men.[74] The combination of marriage and a scientific career does present difficulties —in budgeting time and in dealing with conflicting obligations—as women

[69] Perrucci, Carolyn Cummings, " Minority Status and the Pursuit of Professional Careers: Women in Science and Engineering ", *Social Forces*, XLIX, 2 (December 1970), p. 250; and Morlock, Laura, " Discipline Variation in the Status of Academic Women ", in Rossi, A. S. and Calderwood, A. (eds.), *op. cit.*, p. 268.

[70] The association between rank and gender is stronger eight years after the doctorate than it is four years later, when more scientists, men and women, have been promoted. Cole, J. R., *op. cit.*, 1974.

[71] Morlock, L., *op. cit.*, p. 268.

[72] Astin, H. S., *op. cit.*, 1969, pp. 57, 63.

[73] Cole, J. R., *op. cit.*

[74] Astin, H. S., *op. cit.*, 1969, p. 27; David, D., *op. cit.*, table 5-3.

college graduates often anticipate. Yet about half of women scientists—those who are unmarried at any given time—do not face these difficulties. But whatever the reasons for their frequently unmarried state, women scientists are " damned if they do and damned if they don't ". Universities and business firms are reluctant to appoint married women whose domestic responsibilities are assumed to interfere with their work, and they are also reluctant to appoint unmarried women who, they say, will marry and acquire these responsibilities. This contributes to the ambivalence about work which women experience. Such beliefs about women employees make for self-fulfilling prophecies. As a consequence, young women are apt to conform to the expectations others have of them. The social processes involved in self-fulfilling prophecies thus have strong implications for recruitment to science, for actual access to opportunity, and for motivation as well.

If one outcome of the obstacles encountered by women scientists is that they are less productive scientifically, another is that they are less well rewarded, in salary and in honour. Almost every inquiry—in industry and the universities—shows that women are paid less than men for the same work.[75] Data for the sciences alone suggest that differences in salary between men and women increase with ascent in rank. This is only partly the result of the wider range in salaries paid at higher ranks. There are also differences between the various sciences; among full professors of physics, women earn about 90 per cent. as much as men, and in microbiology, about 75 per cent. as much as men. These figures, however, do not take into account variations associated with institutional affiliation, nor do they adjust for individual differences in productivity.[76] To the extent that women scentists are less productive and less motivated to do research because of the obstacles they encounter, they also receive fewer offers of employment, and thus are less able to bargain for higher salaries. However, women on average are paid less than men after taking into account a variety of individual and institutional attributes, including education, class of university or college, rank, length of tenure, and productivity. When the same variables which account for differences in salary among men are applied to women, it seems that women were underpaid in 1969 by about $1,040 annually.[77]

[75] For the general pattern, see the following: Fuchs, Victor R., " Differences in Hourly Earnings between Men and Women ", *Monthly Labor Review*, XLIV, 5 (May 1971), pp. 9–15; Madden, Janice Fanning, *The Economics of Sex Discrimination* (Lexington, Massachusetts: Lexington Books, D. C. Heath, 1973); and Suter, Larry E. and Miller, Herman P., " Income Differences between Men and Career Women ", *American Journal of Sociology*, LXXVIII, 4 (January 1973), pp. 962–974. For particular manifestations in academic life, see Astin, H. and Bayer, A. E., *op. cit.*, 1973; McCurdy, Patrick, " A Man and a Woman ", *Chemical Engineering News*, XXVI, 43 (October 1970), pp. 26–28; and La Sorte, Michael A., " Academic Women's Salaries: Equal Pay for Equal Work? ", *Journal of Higher Education*, XLII, 4 (April 1971), pp. 265–278. Two case studies of university salary scales show however that sex differences in salary can be explained by length of service, rank and discipline.

[76] Morlock, L., *op. cit.*, p. 288. The reasons for these differences are not examined.

[77] Astin, H. S. and Bayer, A. E., *op. cit.*, 1973, pp. 349, 353–354, is the most thorough

It would not be correct to infer that all difference in remuneration is attributable to discrimination or to lower levels of performance. In an unknown proportion of cases, women choose types of work which pay less, or they leave the field for a time, thus reducing their seniority.[78] Women, in general, and women scientists, in particular, put greater emphasis on the intrinsic satisfactions of the work and less on remuneration.[79] This is as much true now as it was a decade ago. They sometimes avoid more remunerative appointments in favour of those they find more congenial or which do not conflict with their domestic obligations. And since women are less often under financial pressure than men, they are free to refuse promotion to managerial posts which paradoxically entail renouncing research for adminstration. Greater fidelity to research may be a luxury which women are better able to afford than men. While it might appear that decisions of this kind would give women more opportunity for research than comparable men, family and home life usually claim their time. Whatever their reasons, some women prefer positions which pay smaller salaries. Yet more women who have attained the doctorate feel discriminated against in the matter of salaries than in any other aspect of their careers.[80] If some women voluntarily refuse promotions involving increased administrative responsibility, they do not reject academic promotion. Women nonetheless are promoted less rapidly than comparable men.[81]

Promotion and Recognition

There is a widespread belief that women scientists are consistently underrewarded with regard to promotion, the class of university to which they are appointed, and recognition, regardless of the quality of their work. The relation between the performance of women scientists and the rewards they receive is however more complex than is often supposed. The question is, of course: Under what conditions are men and women treated differently and under what conditions are they treated the same? Do men and women scientists who are highly productive and whose work is widely esteemed hold the same ranks in higher educational institutions of approximately the same standing? In other words, when there is little question about competence in research, are men and women scientists by and large treated as equals? Men and women scientists are equally likely to be

investigation of salary differences to date; it does not, however, treat the sciences separately, but covers academics in all fields.

[78] Since differences in remuneration between the sexes often reflect part-time or part-year work, it is necessary to compare the salaries of those who work full-time throughout the year.

[79] Rosenberg, Morris, *Occupations and Values* (Glencoe, Illinois: The Free Press, 1957), p. 49; Turner, Ralph, " Some Aspects of Women's Ambition ", *American Journal of Sociology*, LXX, 3 (November 1964), pp. 281–285; Sharp, L. M., *op. cit.*, 1970, p. 78; David, D., *op. cit.*, Table 8-1. Underhill, Ralph, " Values and Post-College Career Change ", *American Journal of Sociology*, LXXII, 2 (September 1966), pp. 163–172, reports that in studies of values and occupational choice in which individuals can choose, their values almost always affect their decisions rather than the other way round.

[80] Astin, H. S., *op. cit.*, 1969, p. 179.

[81] Astin, H. S. and Bayer, A. E., *op. cit.*; and Cole, J. R. *op. cit.*, 1974.

affiliated to major universities but women are less highly ranked than men, even when their different rates of productivity are taken into account. Among scientists of both sexes who have never published a paper and thus for whom there is scant evidence on which to appraise their research performance, women do less well than men in the rank they attain and the class of institution in which they find appointment.[82] In short, gender, in principle a functionally irrelevant characteristic, affects the allocation of rewards particularly strongly when there is no relevant criterion by which capacity or achievement can be judged.

Two recent psychological experiments support this finding. In one, descriptions of psychologists, matched in all respects but sex (implied by first names) were sent to 155 department heads who were asked to indicate the appropriate level of appointment for each candidate and to appraise the psychologist's desirability as a member of the department. Women were just as often judged desirable members as men but they were significantly more often considered for posts at the rank of assistant professor or lower than were men.[83] The chairmen who replied to the questionnaire may well have followed the economic principle of considering applicants—in this case, women—for lower rank who, experience told them, would accept appointment at a lower rank. Whatever the chairmen's motives, this suggests that, other things being equal, the sex of candidates may affect the ranks of appointment for which they are being considered.

In the other study, chairmen of 179 science departments were asked to evaluate pairs of *curricula vitae* of " candidates " for appointment as associate professors. One pair included sets of qualifications of two average candidates, differing only in sex; the other set included a male candidate with mediocre qualifications and a female candidate with superior qualifications. The departmental chairmen preferred the superior woman scientist to the mediocre man, but the same chairmen also preferred the average man to the average woman when the absence of outstanding achievement provided no basis for distinguishing between them.[84] If this is so, then we would expect even greater differences in rewards between men and women of similarly undistinguished quality than between men and women whose achievements are clearly superior.

Few women have been elected to the National Academy of Sciences in the United States or have won major scientific awards, including the Nobel prize. Just over 1 per cent. or 13 of the 986 members of the Academy in 1974 are women, although women comprise something like 6 per cent. of the Ph.D.s in the comparable age strata from which members of the

[82] Cole, J. R., *op. cit.*

[83] Fidell, L. S., " Empirical Verification of Sex Discrimination in Hiring Practices in Psychology ", *American Psychologist*, XXV, 12 (December 1970), pp. 1094–1098.

[84] Lewin, Arie Y. and Duchan, Linda, " Women in Academia ", *Science*, CLXXIII, 4000 (3 September, 1971), pp. 892–895. Since the statistical findings on which the authors based their conclusions are not presented in this paper, the results reported should be treated with caution.

Academy are drawn.[85] It may be more to the point to observe that the few women who are now members of the Academy received their doctoral degrees at 27, which was the same age as all members of the Academy, but they were promoted to the rank of full professor at 48, which was 10 years later on the average than the rest. In the aggregate, they were elected to the Academy at the age of 59, nine years after the average male counterpart. This difference cannot be explained by variations in the age of election of physical and biological scientists. We do not know, however, whether these women scientists produced important research at ages comparable to male academicians.

Among the 294 scientists who have won Nobel prizes, five are women and three of the five shared their awards with their husbands—Marie Curie, Irene Joliot Curie, and Gerty Cori. Dorothy Hodgkin and Maria Mayer, both married, became Nobel laureates independently. Gerty Cori was not promoted to a full professorship until the year she received the Nobel prize. The other women laureates, although promoted before they won their prizes, became professors later than their husbands and the male Nobel laureates.

What, then, can be said about the allocation of rewards among men and women of science? In some measure, the difference in the distribution of rewards reflects lower levels of performance by women and the choices women make in decisions about careers. And, in some measure, as we have noted, discrimination contributes to these differences, for it is not only that women hold lower ranks than men but that they are deprived of the perquisites that accompany rank. In academic life, low rank is usually accompanied by limited clerical help and little free time for research. Almost three times the proportion of male compared to female faculty members spend a minimum of 13 hours per week on research.[86] Low rank also means heavy teaching loads[87]—it should be remembered however that women, more often than men report a preference for teaching—and often exclusion from applying for research funds as principal investigator.[88] In

[85] Women are somewhat more numerous in the Royal Society of London, making up about 3 per cent. of the fellowship. They became eligible for membership in 1919 when it became illegal to disqualify persons on the basis of sex from membership in bodies having a royal charter. Kathleen Lonsdale, a crystallographer, and Margery Stephenson, a biologist, were the first women to be proposed for membership just 25 years later and were actually elected the following year, according to Kathleen Lonsdale's own report in " Women in Science: Reminiscences and Reflections ", *Impact of Science on Society*, XX, 1 (January–March 1970), pp. 45–60. Florence Sabin, an anatomist, became the first woman to be elected to the United States National Academy of Sciences in 1925, where she sat alone until Margaret Floy Washburn, a psychologist, was elected to membership six years later.

[86] Bayer, Alan E., *College and University Faculty: A Statistical Description* (Washington, D.C.: American Council on Education, 5 June, 1970), Research Reports no. 5, p. 13.

[87] Bayer, A. E., *op. cit.*, 1973, p. 24.

[88] There is no systematic evidence available on the distribution of applicants for research funds by sex. Douglass, Carl D. and James, John C., in " Support of New Principal Investigators by N.I.H.: 1966–1972 ", *Science*, CLXXXI, 4,093 (20 July, 1973), p. 243, report that the proportion of women among new principal investigators on projects funded by the National Institutes of Health has risen slightly from 6·2 per cent. in 1966 to 8·1 per cent. in 1972. These data, however, tell us nothing about the proportion of women applying for funds, nor the proportion of women among all recipients of grants. Given the NIH's prohibition on applications from part-time research workers and the fact that some universities will not permit members without regular academic appointments to apply for research grants on their own, there is reason to suspect that proportionately fewer women than men are in a position to apply for support. This matter is, of course, altogether different from the question of whether all applications for funds are evaluated on their merits. Douglass and James cite an unpublished study by Kaufman (1973, p. 244) which is said to show that " the approval rate[s] of research project applications from male and female investigators do not differ significantly ".

short, these concomitants of low rank reduce women's opportunities to do scientific research, lower their chances to perform as well as men of approximately similar scientific capacity, and thus restrict their access to honorific awards. Given the complex interaction between discrimination, motivation, and level of performance, and the paucity of systematic data on these, it is not at present possible to estimate their relative contribution to differences in rewards between the sexes.

This brings us to more subtle aspects of the problem: to the relations between scientific colleagues. Since so few women have elected to become scientists their presence in the world of science is not taken for granted. They are apt to be treated with excessive courtesy or with excessive hostility. As a consequence, women tend to be uncertain about the response they will receive and are themselves either unduly reticent or unduly defensive. Discrimination against women has become so salient an issue among academics that it often elicits strong and inappropriate responses from both sexes. Beyond this, men have not been quick to recognise the implications of their attempts to preserve the " men's club " character of academic and corporate life. The scheduling of meetings where women are not welcome is just one of the more obvious ways in which this practice continues. Women who move into predominantly male settings will not have an easy time, at least initially, nor will some of their male colleagues.

Overcoming the Triple Penalty

The principle of the triple penalty, as we have observed, asserts that women scientists are triply handicapped: first by having to overcome barriers to their entering science, second by the psychic consequences of perceived discrimination—limited aspiration—and third by actual discrimination in the allocation of opportunities and rewards. Discrimination often reduces motivation to perform; those subjected to it come to feel, regardless of their competence, that nothing they do will make any difference to their ultimate attainments. This motivational component of the triple penalty is usually combined with restricted access to the resources necessary for outstanding accomplishment. Judged on the grounds of performance in research alone, that is, in extending scientific knowledge, women do not in the aggregate perform as well as men. In consequence, women scientists have tended over the course of their careers to be deprived of resources needed to do good work, a condition which widens the gap between their scientific achievements

and those of men and makes for cumulative disadvantage.[89] Such cumulative differences in scientific achievement tend to confirm and reinforce beliefs that women are less competent and less motivated than men, and in their turn maintain the conditions, which first made for different levels of performance.

There is another feature of the dilemma of women scientists. Those persons who are characterised by an unusual combination of roles, such as black physicians, youthful presidents of corporations, or women scientists, never quite know which of their roles is being responded to in social intercourse. Are they being appraised as blacks or as physicians, as a person who is young or as one who heads the corporation, as a woman or as a scientist? They are affected by what Professor Robert Merton has called " the haunting presence of functionally irrelevant statuses ". The " haunting presence " leads persons who possess these unusual combinations of characteristics to believe that positive and negative evaluations are responses to irrelevant characteristics rather than to those which are appropriate to a particular function or task. Such a person is often diverted from the obligations of his principal status and role to unproductive ruminations. Women scientists are apt to blame their failures and their successes on their being women rather than on their actual performance, and to feel unjustly deprived or unjustly rewarded as a consequence. At the very least, many feel that they do not receive an appropriate response to their work and thus are deprived of the opportunities which men have of having their research criticised and corrected.[90]

The principle of the triple penalty does not apply to women scientists in every aspect of their careers. The small number who earn doctoral degrees are no less likely to have received first-class training than men, nor is their distribution among academic institutions, later on, appreciably different. But they seem to do less well in rank, remuneration and perquisites. Self-selection by women as well as discrimination contribute to these differences. The difficulties faced by women scientists—like those of other women—are not altogether remediable by reforms which would extend the allocation of

[89] Briefly introduced in Merton's paper 1942 on the ethos of science, the notions of " accumulation of advantage " and of disadvantage in systems of social stratification, which relates to the notions of the self-fulfilling prophecy and the Matthew effect, has been developed in a series of investigations: Merton, Robert K., *The Sociology of Science: Theoretical and Empirical Investigations* (Chicago, University of Chicago Press, 1973), pp. 273, 416, 439–459; Zuckerman, H. A., " Stratification in American Science ", *Sociological Inquiry* XL, 1 (Spring 1970), pp. 235–257, esp. p. 245; Zuckerman, H. A. and Merton, R. K., " Age, Aging and Age Structure in Science ", in Merton, R. K., *op. cit.*, 1973, pp. 497–559, esp. p. 532; Cole, J. R. and Cole, Stephen, *Social Stratification in Science* (Chicago: University of Chicago Press, 1973), pp. 237–247; Allison, Paul D. and Stewart, John A., " Productivity Differences Among Scientists: Evidence for Accumulative Advantage ", *American Sociological Review* XXXIX, 4 (August 1974), pp. 596–606; Zuckerman, H. A., *op. cit.*, forthcoming, Chap. 3, passim.

[90] Merton, Robert K., " Columbia University Lectures " (New York: Columbia University, 1972, unpublished). See also his " The Self-Fulfilling Prophecy ", in Merton, R. K., *op. cit.*, 1968, pp. 475–490, and " The Matthew Effect in Science ", in Merton, R. K., *op. cit.*, 1973, pp. 439–459. Jonathan R. Cole develops the formulation of the " haunting presence " in *op. cit.*, 1975.

rewards and resources in science. Even if it were possible to eliminate discrimination and its secondary effects, the problems associated with being a woman in American society would remain. It is in this respect that sex can be said to influence women's performance of the scientific role.

Accommodations of some sort have to be made to the responsibilities of parenthood, but women need not be the only ones to make them. Until recently, of course, women who wished to have serious professional careers were expected to forgo marriage and motherhood or to accept a compromise by seeking full-time help and part-time work. Neither of the latter alternatives, it now seems, is practicable, the former being increasingly scarce, and the latter carrying its own penalties by impeding serious work and the advancement of career.[91]

If the institution of government policies designed to increase the proportion of women in science makes more pressing the need to deal effectively with the extra-professional responsibilities of women, the institution of the same policies raises important questions for science and its practitioners. First, what will be the effects of the contracting market for scientific skills on the success of the efforts to alter the sexual composition of scientific occupations? Second, what impact will increases in the proportion of women have on the prestige of science and thus on its capacities? Third, and most important, how will such increases affect the quality of scientific research?

It is self-evident that the number of males entering science would have to be reduced substantially in order to keep the size of the number of scientists in line with demand and at the same time increase the proportions of women. The present labour market in science, with its restricted employment and opportunities for promotion, provides an inhospitable environment for elevating women into posts which they have not had previously. In some fields, there is now a surplus rather than a shortage of trained scientists. Although the evidence on the rates of unemployment of scientists is fragmentary, it does appear that the general contraction of the market for Ph.D.s in scientific subjects has hit women harder than men.[92]

When opportunities for employment are restricted, efforts by government

[91] Epstein, C. F., *op. cit.*, 1970. Since part-time workers, almost by definition, contribute less to science and are less committed to it than those who work full-time, it is more or less inevitable that rewards should be concentrated among those who work full-time. As a consequence, if part-time employment is largely confined to women, the chances for equality of rewards between the sexes are small. Moreover, it may be difficult to do scientific research part-time, and especially on command during the hours at which a baby-sitter is available. If this is so, then part-time work will not enhance women's opportunities for doing outstanding scientific work. Finally, settling for part-time work as a solution to the problems of women professionals puts off the more difficult question of how domestic obligations might be reallocated so that women's opportunities for occupational achievement might be made equal to those of men.

[92] Porter, Beverly F., Botish, Sylvia F. and Sears, Raymond W., " A First Look at the 1973 Register ", *Physics Today*, XXVII, 4 (April 1974), pp. 23–33, esp. p. 27; Astin H. S., " Career Profiles of Women Doctorates ", in Rossi, A. S. and Calderwood, A., *op. cit.*, pp. 139–162.

and women's groups to alter the sex composition of the scientific professions are apt to run into difficulty.

Fears about a reduction in the prestige of science as women scientists become more numerous rest on two assumptions: one, that the prestige of occupations is affected by the proportion of women in them; the other, that increasing the number of women will discourage competent young men from choosing that occupation. These assumptions may have some basis in fact. By and large, the greater the proportion of males in an occupation, the greater its prestige and, by available measures, the better the quality of its recruits. (Although the correlation is well established, its causes are not clear.) Compare, for example, the standing of medicine, law, and science with that of teaching, social work and nursing.[93] If the sciences are pressed harder than other occupations to recruit and to elevate women, their comparative prestige may decline. Since all professions in America are now being subjected to pressures for equality of the sexes, increasing the representation of women in science in particular should not alter its relative prestige or its ability to recruit able prospects.

Finally, we come to the troublesome question of the quality of achievement. Fear of the consequences of greatly increasing the number of women scientists in universities and in industry is partly based on the assumption that the pool of qualified women is smaller than the demand for them. The size of that pool and its character is an empirical question about which we know far too little. We do not, for example, know whether the supply of qualified women scientists is now large enough to meet the changed requirements of universities and industry. It is at least possible that the supply of comparably qualified women is not equal to the rapidly increasing, effective demand for women scientists.

How many women scientists have actually overcome the triple penalty so that their scientific performance is equivalent to that of male scientists? The answer is not known. For the present it is probably not enough. In the long run, with an enlarged pool of talent on which to draw, the quality of the scientific population is not apt to deteriorate. But what will probably be good for science will still have its costs for female practitioners who try to meet the obligations of the scientific profession and of family simultaneously.

[93] Hodge, R. W., Siegel, P. M. and Rossi, P., "Occupational Prestige in the United States: 1925–1963", *American Journal of Sociology*, LXX, 3 (November 1964), pp. 286–302.