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ABSTRACT

Factors pertinent to females in American science and mathematics-related disciplines are examined, focusing on explanations for the poorer representation of females, their lower rank, and their seemingly poorer productivity once within the professions. Using a multidisciplinary approach, some of the usual explanations for their poorer showing are reexamined, suggesting that ability, personality traits, and early sex-role socialization are hardly a match for the real world constraints and barriers women face in the educational and occupational sphere. A conclusion is drawn suggesting that the social processes involved in becoming a professional scientist are better explanatory variables than individual factors in explaining women's achievements. (Author/JN)

Women in Science: Reappraising Explanations for their Achievements

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ABSTRACT

Looking at women in American science and math related disciplines I wish to examine some of the common explanations for their poorer representation, their lower rank, and their seemingly "poorer" productivity once within the professions. Using a multidisciplinary approach I would like to reexamine some of the usual explanations for their poorer showing suggesting that ability, personality traits, and early sex role socialization are hardly a match for the real world constraints and barriers women face in the educational and occupational spheres. I conclude by suggesting that the social processes involved in becoming a professional scientist are better explanatory variables than individual factors in explaining women's achievements.

I. Introduction

Despite the fact that approximately equal proportions of women and men now enter schools of higher education, the occupational sex-segregative pattern still operates--with women still entering predominantly female-dominated fields. Between 1972 and 1975, for example, women were granted less than 10 percent of the doctorates awarded in scientific fields. Although today first year college women are more likely to choose traditionally male-dominated careers than they were two years ago, ultimately differential career paths between men and women have not been substantially reduced (Peng and Jaffee, 1979).

Furthermore, those women who do work in science and math based careers are disproportionately found in lower-level positions (Aldrich, 1978; Rossiter, 1978). Some researchers and writers believe that Federal Appointments and law suffice to remedy the problem. But alone such measures are clearly inadequate. Take, for instance, affirmative action. Cole argues that, in academia, affirmative action programs and policies cannot address macroeconimic forces which affect not only new appointments but also promotions and terminations:

> Since women and minorities comprise a high proportion of recently hired personnel, these two groups tend to be victimized to a greater extent than earlier appointments by economic retrenchment. Wherever a formal or informal seniority system determines employment terminations, those groups who have made the most significant recent gains will suffer the greatest immediate losses. Thus, when the proportion of junior faculty is cut in half, women and minorities are the most likely to suffer the greatest immediate losses (Cole, 1979:287).

Cole's argument that the interplay of social and cultural forces, as one progresses from one stage of the scientific career to another, is often neglected:

> The absence of an extended temporal perspective frequently does not allow observers to correctly understand how steps in the career at one point in time become conditions for possible steps in a later period. Careers are choreographed by both the performers and the audience. Affirmative action plans often underestimate levels of gender bias by not taking a larger perspective (1979:299).

Unemployment may be another key issue for the next decade. Western industrial countries are experiencing a decline in the number of opportunities available for young researchers both in government-supported research institutions and in universities. That is, the combined impact of slowing enrollment growth in universities and reduced government research expenditures has greatly reduced the number of openings. The Carnegie Council reports that "the fields with the smallest proportions of young doctoral faculty in 1977-8 were physics, biochemistry, botany, chemistry, and chemical engineering - all fields in which the percentage of young doctoral faculty was already quite low in 1974" (1981:376). The National Research Council Commission on Human Resources concluded in its report that:

> Even if enrollments and numbers of faculty stay constant and R&D support keeps up with inflation- and more optimism than that would be unwarranted even at the most prestigious institutions- the current age distribution of the faculty implies a significant reduction in new hires over the next ten years in some fields (1979:38).

The annual rate of change in young doctoral faculty as a percentage of total doctoral faculty has shown the rate of decline as particularly pronounced for the following disciplines: mathematics, physics, chemistry, and engineering. In these fields (except for chemistry) the percentage of elderly faculty is particularly low, indicating that few positions will be opening up because of retirement or deaths (Carnegie Council, 1981). This is a particularly pronounced problem for women who compose a growing proportion of Phd scientists.

II. Statistics on Women in Science and Math Based Careers

Despite the rapid and substantial increases of women and minorities in the number of earned degrees in the sciences and engineering (AAAS News, 1978), particularly in the 1970's, such increases have not been matched in employment nor advancement once within science based occupations. The most recent statistics indicate the following:

> At every degree level, in every field of science, within every age group, women continue to have higher unemployment rates than men. In 1977, the unemployment rate for women doctoral scientists and engineers was 3.6 percent compared to a rate of 0.9 percent for men. This shows little improvement since 1973 when male science and engineering doctorates again had a 0.9 percent unemployment rate compared to 3.9 percent for women.
>
> Relative unemployment rates are one measure of progress; another is salary differences. In 1977, as in all previous years, a large and significant difference in salaries continued to exist between fully comparable men and women scientists. Except for new baccalaureate graduates in engineering, men received higher salaries than women in every field, at every level of experience, at every degree level, and with every type of employer, and in many instances that salary difference has increased since 1970.
>
> Another important indication that women are not moving upward professionally at nearly the rate of their climb in educational preparation is their proportion of employment and academic rank among cohorts of academically employed doctoral scientists and engineers. Among all those who received their Ph.D.'s from 1970 to 1974, 4.4 percent of the men but only 2 percent of the women have reached the rank of professor. Among men, 29.5 percent

> are associate professors but only 17.8 percent of the women have reached this rank. At the bottom, only 10.8 percent of the men are still instructors or lecturers but 18.2 percent of the women hold this rank. The variance holds true in every field (AAAS News, 1978:507).

In addition AAAS News concludes that while minority men are progressing in the professional labor force at comparable rates to white men of similar credentials, minority women are statistically comparable to majority women in their slower advancement.

Moreover, comparisons to men only and outside of an historical pattern can be somewhat misleading. For instance, the proportion of women among all science and technical employees has dropped over the last 20 years, a period noted for its rapid growth in the science population and for the movement of increasing numbers of women into the labor force (Zuckerman and Cole, 1975). We get a better perspective on rates of change when we compare trends across time. For instance, only 10 out of every 100 Ph.D.'s in the physical and biological sciences and 6 out of every 1,000 in engineering were granted to women in 1972. Between 1920 and 1929, women received about 11% of all physical and biological science Ph.D.'s (Zuckerman and Cole, 1975:82). Furthermore the present rate of approximately 13% is a composite estimate. Stratification within the Ph.D. market is clear when we note that women are receiving only about 7% of the degrees for physics, atronomy and engineering and 15% for the biological sciences. Table 1 shows the distribution of women in the scientific work force.[1]

Furthermore, rates of increase do not answer the more critical problem of retention of women in science and math based fields and in the more

[1]Woman comprise approximately 13% of all U.S. scientists and less than 2% of engineers (1977 Fiscal Year).

Table 1

All science & engineering fields	9.7%	(27,282)
Math/computer science	6.9%	(1,151)
Physics/astronomy	2.5%	(646)
Chemistry	6.1%	(2,551)
Earth Sciences	3.6%	(332)
Engineering	0.5%	(231)
Life sciences		
agricultural	2.0%	(261)
medical	13.0%	(1,018)
biological	15.6%	(7,742)
Psychology	23.1%	(7543)
Social Sciences	14.0%	(5807)

Source: Gilford, Dorothy and Syverson, Peter. Summary Reports 1977 and 1978 Doctorate Recipients from United States Universities. Commission on Human Recources, National Research Council, February 1978; March, 1979. National Academy of Sciences.

*Note: National Center for Education Statistics reveals in 1976 40.7% of math B.S. were women, 34.0% M.S. degrees.

prestigious specialities; nor do they address the problem of retaining women in the prestigious science and math based professions. Are we producing second-class citizens in the science and math fields? For instance, the statistics suggest that, once within the field, women have a different career path pattern from that of men. Aldrich (1978:127) reports that women scientists and engineers are more likely than men to change from their doctoral specialty to another field after they have graduated. Ott (1978) found from a sample of 16 engineering schools that 68% of the women compared to 43% of the men who left engineering transferred to another major within the college or university. Further, more that 24% of the men compared to only 10% of the women departed because of academic failure (Ott, 1978). Regardless of differences in types of employment, women hold lower ranks than men in industry and universities (Parrish, 1962; Bernard, 1964; Simon, 1967; Bayer, 1973; Cole, 1979). Women are most often found in nonsupervisory positions and positions which do not provide permanent tenure (Bayer, 1973). Cole and Cole (1973) note that, among university faculty, although men and women may begin careers with the same rank, men generally hold higher rank seven years later, even when the quality of research output and seniority are held constant. Perhaps the clearest evidence of women's relegation to the lower echelons is that, even among scientists of both sexes who have never published, women do less well in rank and appointment (Cole and Cole, 1973). Cole's more recent reanalysis of earlier data suggests that differences in reputation and visibility (status) between men and women can be accounted for by men's greater productivity (in numbers of papers published). However, differences remain in academic rank (men higher than women) irrespective of productivity (1979).

The findings in the now classic pieces on women in science in the 1960's (Mattfeld and Van Aken, 1964; and Rossi, 1965)--that women in sciences were paid less, were in lower-level specialties, and tended to be unmarried--are still evident today. Explanations for such findings often hinge on some faulty assumptions about women's "trustworthiness" as professionals. One such myth is that women do not use their talents. There is ample documentation, however, that educated women do indeed use their talents in the paid labor force. As Deckard (1978:86) reports, the more educated the woman, the more likely she is to work. Among women with a high school education, 31.6% are in the labor force. For high school graduates, the percentage increases to 52.5% and for those with four years of college to 64.1%.

Even more impressive are the data reported by Simon (1967) in her study of Ph.D.'s. Fully 96% of unmarried women and 91% of those married worked full time. Of those married with children 85% were working, 60% full time and 25% part time. Astin (1973) supports Simon's findings. Among women who received their Ph.D.'s in 1957-8, 91% were working, 81% full time. Seventy-nine percent (79%) of those women had not interrupted their careers in the decade following the receipt of their doctorate. In fact, Cole notes that there is no indication, either historically or contemporarily, that marriage hurts published productivity of either sex, although it does, he notes, help the productivity of men more that it does that of women (1979:252).

Employment histories of women holding doctorates in science are remarkably stable. There are, for example, no differences between men and women holders of Ph.D.'s in the mean number of employers they have over their entire career (Harmons, 1965). Furthermore, professional women show no more tardiness or absenteeism than professional men (Deckard, 1978:147).

It does not appear that women are less "trustworthy" in their careers. Perhaps then to explain their lower ranks, we should look to their academic achievements. On standardized tests women do not appear less intellectually able. In fact, women who obtain doctorates in scientific subjects do somewhat better than comparable men on standardized tests (Zuckerman and Cole, 1975; Cole, 1979).

Another explanation offered for women's lower ranking within the occupations is that women are less productive than men (Zuckerman and Cole, 1975). Cole's analysis of four scientific professions (chemistry, biology, sociology and psychology) reaffirms his earlier conclusions about women's "inferior" productivity. Both Reskin (1980) and Mason (1980) have roundly criticized Cole's analysis. Mason questions Cole's measures of research quality. "This measure is based on the number of citations of a scientist's work appearing in other scientist's papers (those published in journals at least): the count is made irrespective of the number of papers the scientist has published. Because women publish fewer papers than men do, the seeming low quality of their work as measured by Cole may result entirely from the relatively low rate at which they publish, not from any lack of intellectual merit in individual publications" (Mason, 1980:277). After computing partial correlations between sexual status and research quality, while controlling for number of publications, Mason concludes that on a "per-publication basis" women's contributions are as significant as men's. Therefore she notes that only in number of papers, not quality, are women's contributions and productivity inferior to men's.

Reskin's work (1978; 1976) on productivity rates among chemists openly challenges Cole's conclusions. She suggests that the evidence on productivity is mixed and inconclusive. Although she reports that male chemists outpublish women chemists, she notes that they do so to a lesser extent than imagined (most differences were too small to attain significance) and that explanations for these differences have not been pursued (Reskin, 1979). Reskin's work reflects on some of the key problems facing women in science and math based careers. Women, unlike men, cannot seem to translate their resources into advantage once within the marketplace. In her summary of her work done on the relationship between postdoctoral experience and later occupational status and productivity, Reskin writes:

> The male sample members' careers exhibited the expected pattern of relationships; calibre of professional training and graduate school performance were associated with receipt of a prestigious award, which in turn was associated with high-status positions and scientific productivity, illustrating the accumulation of advantages... In contrast the female chemists accumulated no advantages with respect to the postdoctoral experience... (1976:609).

If women seem to equivocate or falter once recruited into science and engineering, we might look to some of the structural sources for such equivocation. Attrition rates do seem to be higher for women students in science (54%) than for men (26%) in those fields (Zuckerman and Cole, 1975:88). We should note, however, that women's attrition rates are lower in sciences than they are in history, English, political science and sociology (Sells, 1973). In addition, women, more than men, do seem to delay their decision to pursue graduate work in science based careers, even though they exhibit an interest in science at about the same time as males (Zuckerman and Cole, 1975). Why the equivocation?

Together with White (1970), Epstein (1971) was among the early writers interested in studying the informal, subtle social processes that affect women's participation in male-dominated professions. It was White (1970) who identified the information which is "caught" not "taught" as critical for educational and professional success. Because women have traditionally been ascribed to a "deviant" status within male-dominated disciplines and occupations, they often have been excluded from crucial learning arenas. The failure to include women in the informal professional socialization processes remains one of the primary constraints women face in their career development. Because of this exclusion they are denied the social control mechanisms, the seminal mentor-protege relationships, and the appropriate information about how they are perceived which, in turn, helps to formulate an accurate self-perception.

There appears to be some evidence that women do not perceive themselves as having been "mentored" in graduate school as much as men (Sells, 1973). Women faculty rarely initiate mentoring relationships with either male or female students accoring to Moskros, Erkeet and Spichiger (1980)'s study of 40 professors from two selective liberal arts colleges in the Boston area. Perhaps even more interesting, however, is the finding that when women did mentor they tended to be less directive than men and seemed uncomfortable with the idea of influencing or directing students (1981). Men also tended to maintain their mentor-protege relationship over a longer period of time than women.

Once within the professions, women find themselves with limited access to resources and less fully integrated into the scientific community within their field of specialization (Zuckerman and Cole, 1975). Vetter (1976) notes that science remains a man's world, "dominated by a male fellowship in which few women have an opportunity to participate fully (1976:720)."

She writes:

> No women scientists can yet be elected to membership in the prestigious Cosmos Club in Washington, D.C.; only twenty-five women are among the 1,134 living members of the National Academy of Sciences, and six of these twenty-five were elected in 1975. Among these, are only one chemist, two physicists, and one ecologist (1976:720).

If the informal socialization processes, wherein competence and professional identity are built up, seem denied to women, the structural reality presents no more sanguine a picture. There is ample evidence that women are paid less. Furthermore, the gap between women's and men's earnings appears to be increasing. In 1970 the median annual salary for women in all scientific fields was $11,600, or 76% of the $15,200 median salary for men. In 1974, women earned $14,400 (median) compared to $19,700 (median) for men. This represents a decrease to 73% of men's earnings. In 1972, for instance, all engineers with 11 years experience were compared. The median salary for women was $14,200 compared to $16,700 for men. This is at the same time that women in engineering had increased from 7,000 to 19,000 in numbers, growing at about four and a half times the rate of men. The pattern is consistent in other science based professions. That is, among full professors of physics women earn 90% of what men do and among microbiologists they earn 75% of what men do (Handbook on Women Workers, 1975). In 1977, the median salary for women Ph.D. scientists and engineers was only $20,700 compared to a median salary of $26,000 for employed Ph.D. male scientists and engineers (National Academy of Science).

III. Individual Factors in the Educational and Career Development Process: Ability, Personality and Sex Role

In the remainder of this paper I would like to summarize some of the key arguments that have been used to explain women's pooreer achievements compared to men in science and math based professions. My main purpose is to bring together research literature from different disciplines generally not reviewed together. My purpose is two-fold: to encourage an interchange among those researching and writing about women but in different academic disciplines; and to encourage, through this interdisciplinary effort a more compelling critique of the usual explanations offered for women's poorer showing in math and science related professions.

A favored arena, certainly through the 60's and 70's for research on male and female achievement patterns has come from the early child development literature and mostly from a psychological and social psychological perspective. It is in the early child reering experiences that children are thought to learn achievement oriented behavior and develop the accompanying personality characteristics necessary to succeed. A high need to achieve is considered important for the persistent effort and striving for excellence which is thought important in the pursuit of math and science based careers.

Many writers have argued in various ways that female achievement behavior is motivated not by the need for achievement but rather by the need for affiliation (Crandall, 1963; Field, 1953; French and Lesser, 1964; Crandall, Dewey, Katkovsky and Preston, 1964; Veroff, 1969; Hoffman and Maier, 1966; Carey, 1958; Hoffman, 1972). The distinctions are more than academic. Achievement efforts based on affiliation motivation are thought to be dependent on external social rewards such as praise and love. Achievement efforts based on achievement motivation are thought to be based on internalized standards of excellence rather than reinforcement from others. Therefore while girls achieve well academically, certainly in the early years, and often better than male children, their achievements are theoretically described as based on the wrong motivation. Persistent striving toward excellence and the risk taking necessary for scientific accomplishment are thought to be better served by achievement rather than affiliation motivation. Interestingly the empirical data have not necessarily supported the imputed sex differences in motivation. For instance, sex differences in regard to social approval and disapproval have not been consistent. That is, elementary school and college student females have shown as high if not higher effort and performance as males even when their performances have been criticized (Hill, 1967; Stern, 1969; Cotler and Palmer, 1971; McManus, 1965; Heatherington and Ross, 1963; Yonge, 1964). Authors of two major and exhaustive research reviews come to almost the same conclusions. Stein and Bailey agrue that while social skills are a central achievement concern for many females, this does not imply that their achievement efforts "are instigated primarily by affiliation motives or desire for social approval per se" (1976:245). O'Leary in her perceptive review also notes that young girls value academic "achievement and set high standards for their own performance" (1977:101). Furthermore, recent research has suggested that achievement striving in young males may be as dependent if not more dependent on the approval of others than heretofore claimed (Veroff et al, 1975; Kipnis, 1974; see also M. Brewster Smith for an early critique, 1968).

Results such as these are forcing psychologists and other social scientists to rethink explanations for different achievement between the sexes. A related area of research that has come under scrutiny is the motive to avoid success studies. Coming from the same formulations (expectancy-value theory of achievement) as the motive to achieve, the motive to avoid success (fear of success) was popularized by Matina Horner in 1968 and continues to be described by her as a stable characteristic of the personality acquired early in life in conjunction with sex role standards. "It can be conceived as a disposition (a) to feel uncomfortable when successful in competitive (aggressive) achievement situations because such behavior is inconsistent with one's <u>femininity</u> (an <u>internal</u> standard)..." (Horner, 1978:49).

Subsequent research has been weak in the support of some of the early formulations about the motive to avoid success. After his exhaustive review and critique of the fear-of-success research, Tresemer concludes: "FOS has shown no relationship to gender-role identification" (Tresemer, 1976:229). In other works, the numerous scales, measures, and questionnaire items designed to discriminate high and low achievers in relation to sex role beliefs and attitudes have proved inconclusive. Identification with stereotypically traditional sex-roles appears to have little or no relation to the degree of one's fear and anxiety concerning successful achievement.

Perhaps even more critical to the fear of success formulations was the notion that this anxiety syndrome was found more among women than among men. Using only those samples in which both males and females from the same subpopulation were assessed, Tresemer found no overall evidence of greater incidence of fear of success among women. He even partitioned the data by date of collection, age of subject, and/or rough estimates of the achievement-related atmosphere but still could find no greater differences between men and women. Therefore the cumulative records for either motive to achieve or the motive to avoid success has shown that neither are particularly good explanations for different achievement patterns between the sexes.

Another personality trait often used to explain women's different achievements from men's is dependence. It is presumed that independence and self-reliance produce in males the greater analytic and mathematical abilities necessary for the pursuit of a scientific or engineering career. Are little girls more dependent than little boys? Eleanor Maccoby the senior author of one of the best compendia to date on the psychology of sex differences virtually recants on some of her earlier writings about girls' greater dependence than boys'. In her own words she begs her readers indulgence for previous sins and states:

> The 1966 Maccoby paper attempted to explain some portion of the sex differences in intellectual performance in terms of sex differences in personality structure... These arguments have not stood up well under the impact of new evidence appearing in the intervening years... there is now good reason to doubt that girls are more dependent in almost any sense of the word than boys (1974:132).

Later on in that same chapter she notes that sex differences in fear, timidity, anxiety or competitiveness among young children remain open to debate because there is too little evidence or because the findings are ambiguous. That is, key sex differences thought to make a difference in the pursuit of a successful professional career and thought to have been acquired early in life--- such as dependence--- are open to debate because there is too little evidence for scientifically supporting them. Other traits believed to have been incorporated into the personality in conjunction with early sex role socialization have also come under scrutiny. Maccoby and Jacklin (1974) report that there are virtually no differences between the sexes with regard to achievement motivation, risk taking, task persistence or other related skills.

Biologically based differences are often used as an explanation for women's poorer showing in math and science based careers. Perhaps the current biological explanations are not as ludicrous as the turn of the century obsession with women's wombs and small brains but the title of a recent Science magazine article suggests that the biological concern is still with us. The article: Math and Sex: Are Girls Born with Less Ability? has stirred an old controversy. Chipman in her letter to the editor of Science responded to the article by noting that while very high SAT math scores can be found among junior high school boys than girls, it is invalid to conclude from such findings that boys are born with more math ability than girls. For instance, she notes that similar results are not found in the general population of students. In a second Math Assessment in 1977-8, thirteen year old females performed better on computation items while males performed slightly better on problem solving items. The difference in algebra performance favored females although it was not statistically significant (Chipman, 1980). Chipman also notes that a secondary analysis of the longitudinal Project Talent sample indicates that course enrollment accounts for most of the sex difference at grade twelve, specifically stressing that only one fifth of one percent of the variance could be attributed to sex. In fact, most sex differences (for the general population of students) emerge after 10th grade when most advanced math courses become elective. A relevant fact is that females choose fewer math courses than males. Fennema and Sherman (1977) suggest that the average math achievement scores for males and females are very close among those students who have taken the same number of courses.

Chipman's main critique is leveled at the notion that math ability is truly measured by math SATs. She notes that the complicated human cognitive function associated with ability has not been successfully linked to testing. She writes: "Content analyses have shown tests labeled as aptitude or ability to be indistinguishable from achievement tests" (1980:2). Furthermore, while math tests may measure knowledge, math reasoning is more closely linked to performance on word problems. Girls are often reported to do less well than boys on word problems. Chipman points out, however, that analyses of the content of SAT and other test problems have found the content to favor males in a way that can affect problem solving performance. Chipman specifically points out that girls perform well on tests of computation and algebra where such content bias is not a possibility. It seems then that the real question has less to do with ability and more to do with exposure to math experiences, rewards, and opportunities to develop skills.

Perhaps a bit ironically it appears that women Phds on average have slightly higher (not significantly) I.Q. scores than that of male Phds; and that at every level of doctoral department prestige, on the average, women have higher I.Q.s than their male colleagues (Cole, 1979:159). In addition, there is less variability in average I.Q. Scores between departments of varying ranks for women than for men (Cole, 1979:159). Therefore on standardized intelligence tests, although we might not know exactly what is being measured, we do know that female Phds have more of it than male Phds.

In fact, in the areas considered critical for those entering science and math based careers, Maccoby and Jacklin (1974) emphasize that, although the findings still indicate that boys do better in math and visual-spatial tasks and girls in verbal tasks, such differences do <u>not</u> emerge until relatively <u>late</u> in development and the magnitude of such differences has <u>not</u> been established. They argue that the greater skill adolescent boys display on visual-spatial tasks (usually embedded figures tests) should <u>not</u> be generalized to the belief that boys are superior in analytic thought processes. Sherman (1976) notes that analytic tests that do not have spatial components show <u>no</u> significant differences between males and females. Maccoby and Jacklin (1974) also report that <u>both</u> sexes shift toward higher level problem solving strategies from childhood to adulthood at the <u>same</u> rate and with <u>equal</u> success. Sherman's (1976) review of the data on biologically-based gender differences strongly suggests that, if any differences do exist between the sexes, they can easily be overcome by training. Socialization processes in the early years, which are presumed to promote differential motivation, ability, or personality traits between the sexes, do not appear to be the most fruitful line of inquiry when explaining women's poorer performance in science and math based careers.

In general, since sex differences in the areas presumably related to science and math based careers do not appear until adolescence, a more fruitful inquiry might focus on the ways in which the schools affect such development. Minichin (1966) has offered some direct evidence that less traditionally oriented schools tend to produce youngsters with fewer sex based behavior differences than more traditionally oriented schools. In addition, Fennema (1976) suggests that the measurement of sex based differences might be affected by the characteristics of populations under study. For example, since more teenage boys than teenage girls drop out of school, she conjectures that the sample from which data is collected for boys is more homogeneous (higher achieving boys remain in school) than the heterogeneous sample of girls (1976:348).

From the earliest of schooling experiences, the research data indicate that teachers' expectations influence children's performances (Rist, 1970; Insel and Jacobson, 1975; Rosenthal and Jacobson, 1968), although the effects are not always entirely clear or in the expected direction (Kohn, 1975). Insel and Jacobson (1975) conclude from their work that teachers vary the quality of their relationships with students depending on their expectations of them. Levy (1972) has documented that stereotypes lead to different expectations; for example, teachers expect males to be dominant, independent and assertive, while they expect females to be submissive, unassertive and concerned about their appearance. Later schooling experiences channel women into gender-roles as well. Whitehurst (1976) notes that high school girls more often join "future homemaker" clubs and "pep" clubs, while boys join science and math clubs. Perhaps even more depressing are Astin's findings (1973) that high school girls who had had job counseling were more likely to select office work and the role of housewife than were those who had no counseling. Fox (1977) suggests that sex typing of math as a male occupation or assumptions that girls would not need it later in life are powerful explanatory forces for patterns of course enrollment in math. Strauss (1981) notes that a lower percentage of women than men enter college wanting or academically prepared for scientific or technical degrees.

IV. Structural Factors and Social Processes in the Educational and Career Development Process: Constraints and Opportunities

The structural barriers to women in schools of higher education have received almost as much treatment as those of early educational experiences. Roby (1972) has discussed the organizational patterns and practices which hinder women in obtaining higher educational degrees. The discriminatory practices against women (in admissions and financial support) have been documented by other researchers as well (Freeman, 1979). Women transferring or returning to school have been plagued by many of these problems and more: residency or instate requirements for regular tuition, full-time status expectations, difficulty in transferring credits. Usually these are married women changing college campuses to be with their spouses (Tittle and Denkar, 1977).

Without institutional supports married women may find the dual role of graduate student overwhelming. Feldman (1974) notes that the most committed and active graduate students were the divorced women. While women apparently freed themselves from a conflicting situation, men, when divorced, seemed to lose a supportive relationship. It is perhaps no wonder that only 50% of all women with doctorates in science are married and living with their spouses compared to 90% of men (Astin, 1969).

A review of the literature leads one to wonder, as Samuel Johnson once did about women preachers, not how well they do but that it is done at all. A look at the survivors indicates that women who do embark on engineering and science studies seem to differ on family background. For instance, Dement (1963) in his study of 129 female California college students in engineering and science indicates that they frequently are offspring of fathers of either very high or very low education. He claims that highly educated fathers seem amenable to "all areas of knowledge" for their daughters, while less educated fathers view such a career choice as practical. Dement (1973) also found that undergraduate women who choose and persist in science or engineering curricula have had a long cuiosity-arousing early experience. Gropper and Fitzpatrick (1959) indicate that women who enter graduate school are more apt to be influenced to do so by experiences in undergraduate school than are the men who enter.

Strober and Reagan (1976) report that women who majored in economics as undergraduates were more likely to have made an early (precollege) decision to be an economist and to have taken more years of high school math than the average student. Field (1961) reports that high school and college teachers are a primary influence for over one quarter of a group of forty-eight (48) doctoral candidates at Penn State University. Field (1961) concludes that, in general teachers are more influential among graduate students in the natural sciences from lower SES levels than among those from higher social status backgrounds.

What little data we have on black women suggests that they are more career-oriented than their white counterparts. For instance, Wilson (1969) found that black students who were attending highly slective women's colleges were more likely to aspire to academic and professional careers <u>in addition</u> to marriage and family than their white classmates. They were also more likely to view college as preparation for a career than as the foundation for a well rounded personality. They were also more likely than their white classmates to aspire to graduate or professional training. In addition, Steinmann and Fox (1970) found that black women undergraduates, more than white women, believed that men want women to have both self-actualizing and family-oriented goals.

Mentoring either in the form of an early significant other or directly in the form of a mentor-protege system seems important for women's educational and occupational achievements. However, the literature on role modeling is ambivalent. Although there are data which suggest that same sex-role models are important for recruitment into and maintenance in nonstereotyped fields for women (Thompson and Leven, 1977), the sex of a woman's role model, at least at Dartmouth, seems not to have affected a woman's decision to major in a certain field. There is clearly a paucity of research in this area. In effect, we know very little about the "everyday" life of students and those issues which impact upon them the most in their career development.

We know even less about women once they have embarked on their careers. We do know that they are tracked into the lower echelon level jobs; we do know that they are paid less than men with equal training and equal qualifications;

and we do know that they are less likely to be tied into the informal networks. For instance, Kaufman (1978) suggests that academic women either by choice or force are excluded from the informal collegial networks. Many researchers have theorized that such exclusion severely reduces women's access to the necessary resources for their advancement (White, 1970; Epstein, 1971; Lorber, 1975). My focus on academic women's exclusion is particularly important, since "academe is the training ground for scientists, is the locus of over half of the basic research done in America, is proportionally a greater employer of women scientists than are industry and government, and is the home base for most of the scholars who have written about women in science (Aldrich, 1978:135)."

The research suggests that we are very delimited in our understanding of the work conditions women face, particularly at the interpersonal level, as they enter the male-dominated professions. We know a good deal about attitudinal data and preferences, but we know very little about the reality of their work-a-day lives as they progress from one stage to another. Cole writes:

> Although it seems intuitively obvious that women suffer from accumulating disadvantage throughout their careers, the particularities of this process are largely uninvestigated. We know very little about specific points in the life histories of women that make more or less of a difference in distinguishing their aspirations from those of men; we know next to nothing about key pressure points in their histories; we know almost nothing about the ways that cultural pressures interact with individual traits, such as talent, to influence specific occupational choices. We have hypotheses. We need adequate data and analysis (1979:284, underlining mine).

VI. Conclusion

It seems clear that we need the insights of many disciplines in order to balance our interpretations of women and their scientific achievements. A balanced approach allows us to view performance as a dynamic and continual process. We need not assert that attributes or motivations thought to be formulated in conjunction with early sex role learning are rooted forever in the personality or that they will remain the same throughout the life course. They will change with the social context and the opportunity structure available. I'd like to conclude by reexamining the issue of productivity. For herein we can juxtapose powerful kinds of explanations for women's poorer showing campared to men's. Is men's greater productivity due to greater natural ability, research skills, and motivation or to the context in which they work, the facilities, assistants, sponsorship, and networking available? Although both explanations might well work in conjunction with one another to answer the question it is important to unravel the critical issues in this debate and the sequencing of events in the scientific career cycle.

Cole and Cole's work (1973) offer an interesting perspective on the sequencing of events. They write: "People who have done well at time 1 have a better chance of doing well at time 2, <u>independently of their objective role-performance</u>; the initially successful are given advantage in subsequent competition for rewards" (1973:235, underlining mine). Long, after completing a longitudinal study of Phd biochemists, notes the following: "Our results suggest that those who receive prestigious positions at time 1 have a better chance of doing well (in terms of productivity) at time 2, independently of their earlier productiviey" (1978:905). But Long argues that his findings differ from Cole and Cole's on one very important issue. He writes: "Advantage accumulates not to those who have been successful at time 1, but to those who have received the advantage of a prestigious position for reasons <u>independent</u> of their <u>productivity</u> at time 1" (1978:905, underlining mine).

Long argues that his data suggest that productivity does not significantly affect one's first job placement. If this is so then perhaps the evaluation of one's work, one's achievement per se, is less critical than one's educational career background (e.g., presitge of graduate school, mentors, etc.). There is some evidence, however, that even if men and women were to share the same educational background (i.e. presigious graduate department) their experiences within these departments would be quite different.[2] Their mentoring experiences appear to be different. Moreover, as Reskin points out, at least among chemists, women seem to accumulate no advantage, especially with respect to job placement, from their postdoctoral experience the way man do.

Interestingly, if departmental prestige affects productivity and not vice-versa, Long questions just what it is about departmental prestige that promotes productivity. Perhaps, states the author, the relationship between productivity and departmental location may be due to departmental characteristics other than prestige (e.g., opportunity for collaboration). Therefore one's positional location (either in academe or industry) becomes as key an issue in the productivity debate as skill or motivation.

In response to Coles assumption that fewer publications rather than discrimination account for women's poorer showing in the scientific world than men's, Mason reflects on the issue of positional location:

> For if women publish fewer articles than men because, on the basis of their gender, they are denied access to the "means of production". in science- to research facilities, collaborative arrangements, graduate student assistants, professional sponsorships, secretarial help, or time off

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[2] Cole's data suggest that contrary to common assumptions, women recieve their training at distinguished universities as much as men (1979:213).

> from teaching- then to find that the immediate cause of women's low status is their publication rate hardly proves that the reward system of science is universalistic in any but the narrowest sense. Cole himself speculates that male faculty may be reluctant to sponsor female students because of the sexual motives of colleagues might attribute to their doing so, but he apparently fails to recognize that such situations, in which women's careers are determined not by their scientific talent or performance but rather by the mere fact of their being female, are indeed a matter of discrimination. Thus, to argue that science is basically fair because women and men become equal once their publication records are taken into account makes no more sense than to argue from simple sex differences that discrimination clearly exists. To draw sound inferences, the cause of women's low publication rates must be understood (1980:278).

Zero order correlations cannot tell us much about the qualitative experiences women have as graduate students and fledgling professionals. If such experiences are different for men and women (and the growing number of biographical essays about women attest to that) then we must account for such realities in our discussions of productivity. Women's lower rank than men's (even in Cole's data there is an increase in the gap between women's and men's academic ranks as their careers progress) is another important positional difference between the sexes. For as Mason writes: "... rank has important consequences for scientists' careers: for example, rank partly determines academic salaries and may also influence access to the 'means of scientific production'" (1980:278). To understand women's poorer showing in science we need to investigate the social processes which have led to this scientific state of affairs. The realities women face in their day to day lives as professional scientists may prove to be a far richer source of explanation than early sex role experiences, ability, or personality traits.

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