MENTORING EXPERIENCES OF WOMEN AND MEN IN ACADEMIC PHYSICS AND ASTRONOMY

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1. INTRODUCTION

Women scientists have been described as occupying the "outer circle" of scientific disciplines in the 1990s.[1] Although women have made inroads into scientific careers previously reserved for white males, women have had a more difficult time than men attaining influential positions in science. The marginalization of women in science limits career options for women scientists and diminishes incorporation of women's perspectives into scientific work.

One frequently-discussed barrier to women's progress in science is access to effective mentors during doctoral and postdoctoral training. Several studies have suggested that women scholars have a more difficult time finding mentors,[2] collaborate less with mentors,[3,4] and join research teams less often and later in their training[5] when compared with men of similar talent and training. Further, some writers suggest that maintenance of successful cross-gender mentoring can be particularly problematic for men. Such relationships can be misperceived as inappropriate romantic liaisons,[3,6] or junior women scholars might be perceived as "professional wives" of male mentors, capable of producing high quality work only under the mentor's guidance.[7]

Most studies of mentoring have focused only on the availability of mentors for women, not the dynamics of mentoring relationships. Further, little research has considered that mentoring might have negative as well as positive outcomes (*e.g.,* the fostering of overdependence instead of autonomy or the formation of exploitative rather than productive relationships). This paper reports on a study designed to explore dynamics of mentoring relationships for women and men and the impact of mentoring on career growth for women and men in physics and astronomy in academic settings.

2. NATIONAL SURVEY OF SCIENTISTS

A questionnaire study was carried out in 1991 with physicists and astronomers employed in regular tenured or tenure-track positions in departments of U.S. universities granting doctoral degrees. This was a part of a larger study that also included academic chemists and sociologists. The research addressed scientists' experiences with doctoral, postdoctoral, and other mentors, productivity rates, and current involvement in mentoring of students and more-junior scholars.

Mail-back surveys were sent to random sample stratified by gender of 400 physicists and astronomers, 200 women and 200 men. The sample of women physicists and astronomers was drawn with the assistance of the Committee on the Status of Women in Physics, which also provided a letter of introduction. A random sample of male physicists and astronomers was drawn from the 1990–91 edition of the *Graduate Programs in Physics, Astronomy, and Related Fields*, published by the American Institute

of Physics. Two mailings and a reminder postcard yielded an overall response rate of 47 percent, which compares favorably to other studies of physical scientists. In physics and astronomy, as in the other disciplines, women responded at higher rates than men (58% versus 37%), perhaps signaling the greater centrality of issues covered by the study for women scientists in comparison to men. Fewer than 5 percent of respondents were ethnic minorities, consistent with the representation of these groups in these departments. (An in-progress interview study being conducted by the second author focuses on minority scientists and should provide information on how their experiences compare with those of white scientists.)

Examination of characteristics of respondents and nonrespondents suggested that male astronomers were under-represented in the sample. Of the 21 astronomers in the sample, 17 were women. Comparisons of responses of women astronomers and women physicists indicated few significant differences between these groups. (Women astronomers had more publications and funded grants than physicists, but predictors of productivity were the same for each group.) Because of the small number of male astronomers, similar comparisons could not be made for men.

3. EFFECTIVENESS OF DOCTORAL AND POSTDOCTORAL ADVISERS

Women and men physicists and astronomers were asked to rate the effectiveness of their doctoral advisers as mentors for them on a four point scale, with possible responses of 4=very effective, 3=moderately effective, 2=somewhat effective, 1=not very effective. Female and male respondents rated their advisers toward the higher end of the scale, but men's ratings were significantly higher than those women's: 2.67 for women and 3.07 for men, a difference significant at the $p < .05$ level. Greater than 96 percent of scientists had had male doctoral advisers, precluding comparisons based on gender of adviser. The majority of physicists and astronomers had completed at least one postdoctoral position, with no significant differences between women and men in this regard. Ratings of first postdoctoral adviser on the same scale as above yielded no significant differences in ratings by women and men: 2.45 for women compared with 2.20 for men. Notably, ratings for postdoctoral supervisors were lower overall than ratings of doctoral advisers.

Since prior research has suggested that women might have less access than men to the particularly eminent advisers who can provide special advantages to beginning scholars,[8] the study examined the proportions of women and men who had worked with advisers who were members of the National Academy of Science and/or Nobel Laureates. While there were no significant differences related to NAS members, male physicists and astronomers were significantly more likely than women to work with Nobel Laureates. Six men but only two women had Nobel Laureates as doctoral advisers, while 5 men and only one woman had Laureates as postdoctoral supervisors. Thus, male scientists were advantaged in this regard, although only a small proportion of physicists and astronomers had eminent mentors.

Women and men were equally likely to have collaborated with their doctoral advisers on at least one conference paper, publication, or research grant proposal: 81% versus 82.4%. Women were less apt than men, however, to have collaborated with postdoctoral advisers (65.9% versus 79.7%), although this difference does not quite reach

statistical significance at the $p < .05$ level. Men tended to collaborate more extensively with advisers, however, producing several papers or grant proposals rather than a single one.

4. OTHER MENTORS

Women physicists and astronomers were more likely than men to report working mentors other than doctoral and postdoctoral advisers and to report more additional mentors overall in comparison with men (a mean of 1.37 vs 0.72, $p < .05$). Other mentors included a wide range of persons, including academics in other departments and institutions; persons outside of academia, such as high school teachers, scientists in the private sector; or friends and kin, both scientists and nonscientists. Men tended to identify as mentors those inside academia who had made specific contributions to career growth in physics and astronomy. Women tended to define mentoring more broadly, identifying persons who had given them instrumental or emotional support for a broad range of intellectual endeavors at various points in life. A woman physicist, for example, named as a mentor her high school humanities teacher: "The first person to recognize that I had a good brain, that I had a lot of options." Women also identified peers and professional organizations and conferences, especially those oriented toward women in their professions, as important sources of mentoring and encouragement for them.

5. ADVANTAGES AND DISADVANTAGES OF MENTORS

Scientists were asked to comment about advantages and disadvantages of doctoral and postdoctoral advisers as mentors to them. Men's and women's descriptions of advantages of mentors were similar, with both genders valuing mentors who possessed combinations of good scientific abilities and strong interpersonal skills. The comments of a woman physicist were typical of many women's and men's discussions of mentors' advantages:

> Very professional. A very kind person. Excited about my projects, although the group focus at the time was in another area. Always available when I needed him. Always pushed me to make a paper or publication very solid. As my work progressed, began to treat me more as a colleague than an assistant. Never missed an opportunity to promote my career. Very helpful on the job market.

Both male and female scientists disliked advisers who were poor scientists and/or administrators, unavailable or aloof, difficult to deal with interpersonally, and who failed to give fair credit for work performed. Women particularly prized advisers and postdoctoral supervisors who were sensitive to discrimination against women in the profession and who encouraged them or tried to combat sexism. Women, however, had particular problems with overt and covert sexism, insensitivity to women's needs, paternalism, or trivialization of their work. Women were more apt than men to have worked with junior faculty and therefore noted disadvantages linked to their mentor's junior status, such as diminished resources, limited networks, and lack of clout in departments.

Women often commented that male advisers paid more attention to work by men or promoted men more enthusiastically on the job market. One woman complained of an adviser who had turned down a desirable postdoctoral post for her, without

her knowledge or consent, because he judged the move to be disadvantageous for her husband, also his advisee. Others objected to advisers' attempts to channel their job searches in directions they did not want to go, such as to women's colleges only, to undergraduate programs only, or to nonacademic jobs only. Some had advisers who had difficulty relating to women as colleagues or as persons with family as well as scientific interests, as in the following comments:

> Hopeless sexism. Awkward with women generally. Incapable of collaboration with women.
>
> * * *
>
> Had problems with my pregnancy and childbirth my last year. Tried not to rehire me. Wrote on a form to the department that he didn't want me ending up as a bad mother and a bad researcher by trying to do two things at once.

Only a few women reported that they had faced serious sexual harassment, but those who had reported long-lasting negative impacts of these experiences. Women either endured hostile working climates, which they believed diminished their career progress, or left the setting, often losing work and resources in the process.

6. EFFECTS OF MENTORING

A series of ordinary-least-squares regression equations were estimated to explore the impact of effectiveness of mentors and collaboration with mentors on two important forms of productivity: publication of journal articles and funded research grants. These analyses used controls for professional age (men received degrees, on the average, 11 years earlier than women). Controls also were introduced for marital and parental status, which in prior research have shown inconsistent relationships to career productivity, especially for women.[8] Initial estimates also included tests for possible interaction between effects of parental and marital status by gender, but these were not significant and thus were eliminated from final analyses.

With year of degree controlled, there are no significant gender differences in publication of journal articles or funded research grants. The signs of these coefficients indicate a tendency toward women's publishing more and receiving more research grants compared with men at similar career stages. Despite significant gender differences in evaluation of effectiveness of doctoral advisers, the quality of the relationship with doctoral adviser has no impact on journal articles published or research grants funded for women or men. Nor are there significant effects of marital or parental status, though signs of the coefficients are generally positive for marital status (toward higher productivity for married women and men) and negative for parental status (toward less productivity for women and men with children).

Thus, despite the fact that women might be subtly disadvantaged in mentoring relationships, these disadvantages do not have career-long negative impacts for women who attain tenured or tenure-track positions in doctoral-granting departments. The latter is an important qualification, however. Women with less effective mentoring experiences may be unlikely to reach such positions, and lack of mentoring might be one factor contributing to the still-scant representation of women in these departments.

7. MENTORING ACTIVITIES OF WOMEN AND MEN

Finally, the study suggests that women scientists do more mentoring than do males of white women and minority women and men scholars. This is particularly evident at the master's level and in ad hoc and special mentoring activities, such as programs for undergraduates or programs sponsored by professional societies for women and other under-represented groups. Women physicists and astronomers are more apt than male counterparts to view mentoring, especially of under-represented groups, as an activity which counts at least somewhat in tenure and promotion decisions—a judgment that might or might not be accurate. However, open-ended comments reveal a tension between women's feelings of a responsibility to mentor others and a recognition that mentoring counts less than other activities in building one's own career.

8. IMPLICATIONS

Not surprisingly, the successful women and men scientists surveyed report positive mentoring experiences. Nevertheless, women's relationships at the doctoral level are slightly less effective than men's and women work less with the eminent mentors whose sponsorship might boost them into the inner circle of scientific disciplines. Women also face gender-specific disadvantages in some mentoring relationships, such as paternalism or diminished attention to their work, that might keep them in the outer circle of scientific disciplines. The findings suggest that mentoring of women can be improved. Also, it is probable that less favorable mentoring experiences might have discouraged persistence of some capable women, or diminished the likelihood that they attained employment in doctoral-granting departments. This topic demands further study, most likely with a prospective research design.

Although women physicists and astronomers have less access than men to the most influential and effective mentoring relationships, they do not appear to be disadvantaged in career productivity, once they attain positions in doctoral-granting programs. These successful and productive women can provide a core group of mentors for women scientists of the next professional generation. Studying experiences of scientists with women mentors was impossible with these data, but perhaps will be possible in a few years as the first students and postdoctoral associates working with women physicists and astronomers begin their careers. In other disciplines, most notably sociology, where there now are about 30 percent women faculty in doctoral-granting U.S. departments, the highest effectiveness ratings are assigned in woman mentor/woman protege teams. These groups also have the highest collaboration rates. Such dyads should become increasingly common in physics and astronomy in the next professional generation.

Finally, women scientists in universities recognize mentoring as important but have doubts about the extent to which this is rewarded in hiring, tenure, and promotion decisions, relative to other activities. Intervention is possible in this regard, and universities and academic departments can alter evaluation criteria to provide greater rewards for men and women who are effective mentors, especially of under-represented groups.

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ENDNOTES

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