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2

The Advancement of Women in Science and Engineering

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Women are conspicuous by their absence at the most prominent levels of science, mathematics, engineering, and technology. Women scientists are sparsely represented on the editorial boards of leading journals, on the steering committees of professional organizations, and in groups like the National Academy of Sciences, as data presented in this session by Professor Margaret Rossiter demonstrated. Women are thinly represented among full professors at major research universities. Even young women (under age 35) lag behind their male peers in institutional rank and tenure.

Women in the professions are more highly represented at lower-ranked than higher-ranked institutions, spend more time in rank than men do, and make less money. In addition, women at prominent research universities have lower ranks than do women at lower-ranked institutions (with the exception of biology[1]). That such phenomena are widespread is documented in my book, *Why So Slow? The Advancement of Women,*[2] which reviews men's and women's status in the professions and academia.

Recent data from the National Science Foundation (NSF), taken together with data from other studies and other disciplines, show (1) that there is a problem, (2) that the problem is now primarily found not at entry-level positions but at later points in people's careers, and (3) that it is general across disciplines and professions—business, medicine, law, the humanities.

In 1997 (the most recent date for which data are available), women made up 25 percent of doctoral scientists and engineers at universities and 4-year colleges. That figure includes scientists who are tenured, tenure track, not in track, or in positions for which tenure is not applicable, such as postdoctoral or other appointments. Women ranged from being 6.5 percent of faculty in engineering to 59 percent of faculty in health sciences.[3] Across all disciplines, 56 percent of women were tenured or tenure track,

[1]Sonnert, G., and Holton, G. (1996). Gender Differences in Science Careers: The Project Access Study. New Brunswick, NJ: Rutgers University Press.

[2]Valian, V. (1998). Why So Slow? The Advancement of Women. Cambridge, MA: MIT Press.

[3]National Science Foundation, Division of Science Resources Studies (1999). Characteristics of Doctoral Scientists and Engineers in the United States: 1997, NSF 00-308, Project Officer, Kelly H. Kang. Arlington, VA: NSF.

compared to 72 percent of men (calculated from data in footnote 3). There was no improvement compared to 1993, when 60 percent of women in science and engineering were in tenure or tenure-track positions, compared to 77 percent of men.[4]

If the category for which tenure is not applicable is excluded, 88 percent of men overall, compared to 77 percent of women, were tenured or tenure track. The sex disparity is similar from field to field and independent of women's representation. In psychology in 1997, women were 43 percent of the faculty in universities and 4-year colleges; 89 percent of men psychologists were tenured or tenure track, compared to 75 percent of women. In the biological and agricultural sciences, women were 28 percent of the faculty; 84 percent of men were tenured or tenure track, compared to 70 percent of women. In engineering, women were 6.5 percent of faculty; 90 percent of male engineers were on the academic ladder, compared to 83 percent of women. (All calculations are from data in footnote 3.)

In 1995 (the most recent date for which age cohort data are available), sex disparities in tenure and rank are evident even for scientists younger than 35.[5] Looking just at the categories of tenure, tenure-track, and not on track, we see that 3 percent of young women, compared to 6 percent of young men, are tenured; conversely, 36 percent of young women, compared to 20 percent of young men, are neither tenured nor tenure track. As with tenure, so with rank: 4 percent of young women, compared to 10 percent of young men, are associate professors.[6] Since early career differences are limited by standard lengths of time to stay in rank, and since men and women tend not to differ in interruptions of service early in their career, the presence of small differences within the first 5 years of a scientist's career is notable.

For scientists between 35 and 44, the situation is worse: 35 percent of women are tenured compared to 49 percent of men; conversely, 20 percent of women are not on track compared to 13 percent of men. With respect to rank, only 8 percent of the women are full professors, compared to 15 percent of the men. Women even lag behind at the associate professor level, where only 34 percent of them have achieved that rank compared to 44 percent of the men. A portion of these differences may be attributed to greater interruptions in women's service. But it should be kept in mind that these figures are for full-time faculty at universities and 4-year colleges; thus, it is likely that parental leave accounts for at most 2 years of interruption. As of 1995, there were only small sex differences in number of years between B.A. and Ph.D.,[7] so that age of doctorate achievement is unlikely to play a major role in the observed tenure and rank disparities.

For women age 45 and older, the situation is grim. Of scientists aged 45 to 54 in 1995, only 40 percent of women were full professors compared to 61 percent of men; 22 percent of older women were still assistant professors, compared to 7 percent of older men. For scientists aged 55 or older in 1995, 57 percent of the women compared to 84 percent of the men were full professors; 9 percent of the women were still assistant professors compared to 2 percent of the men.

The overall picture in academia is that women start out slightly behind men in rank and tenure and

[4]National Science Foundation (1996). Characteristics of Doctoral Scientists and Engineers in the United States: 1993, NSF 96-302. Arlington, VA: NSF.

[5]National Science Foundation (1999). Women, Minorities, and Persons With Disabilities in Science and Engineering: 1998, NSF 99-338. Arlington, VA, Appendix Table 5-10.

[6]National Science Foundation (1999). Women, Minorities, and Persons With Disabilities in Science and Engineering: 1998, NSF 99-338. Arlington, VA, Appendix Table 5-9.

[7]National Science Foundation (1999).Women, Minorities, and Persons With Disabilities in Science and Engineering: 1998, NSF 99-338. Arlington, VA, Table 4-46.

become increasingly disadvantaged as they age. Put another way, universities and 4-year colleges are wasting the talents of their female scientists and engineers.

In industry, women scientists and engineers have fewer subordinates than do men. Women under age 35 in 1995 supervised 7.1 employees, while their male peers supervised 8.5. Between the ages of 35 and 44, women supervised 8.9, and men, 10.8. Between the ages of 45 and 54, women supervised 7.0, and men, 16.5.

It is important for everyone concerned with gender equity to know the relevant statistics. Most people are unaware of the data. Many believe that gender equity is a problem that will take care of itself as more women enter science. A full understanding of the data will help to dispel those misconceptions.

We also need to understand the irrelevance of exceptions. Everyone can think of women who are exceptions to the overall position of women; everyone can think of some very successful women. But an exception is just that—an atypical event. The fact that there are a few successful women should not distract us from the main body of evidence, which shows that—overall—women are not as successful as men, even when they have the same credentials.

Knowing the data is not enough. We need to go behind the data to an explanation. We need to understand the social cognitive processes that disadvantage women and advantage men, even in situations where the participants sincerely espouse meritocratic and egalitarian beliefs.

ANALYSIS OF THE PROBLEM: GENDER SCHEMAS

Broadly speaking, women's abilities, accomplishments, and contributions appear to be worth less than men's even when they have the same credentials (or differences in credentials are controlled for). The explanation I offer uses two key concepts: gender schemas and the accumulation of advantage. The application of gender schemas makes it more difficult for women to accumulate advantage. Schemas are hypotheses that people use to interpret social events. Schemas are similar to stereotypes, but the term "schema" is more inclusive and more neutral. The term is preferable because schemas are a necessary conceptual framework for understanding and predicting the social world and for knowing how to behave within it. Schemas are protoscientific hypotheses about social groups. We need schemas because we cannot treat every piece of data as if it is brand new and is independent of previous data. Schemas allow us to move more efficiently. They allow us to make predictions. We cannot get rid of them. At the same time, like all hypotheses they are susceptible to error. Once entrenched, they are difficult to dislodge just via disconfirmatory data. It is hard for people to revise a cherished theory, especially if it is not conscious.

Gender schemas are hypotheses about what it means to be male or female, hypotheses that we all share, male and female alike. Gender schemas are the beliefs people hold in common—whether they want to or not—about the genders. Schemas assign different psychological traits to males and females. Males are seen as capable of independent action (agentic), task oriented, and instrumental; females are seen as nurturant, expressive, and communal.[8, 9, 10, 11] In brief: men act, women feel and express their feelings.

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[8]Bakan, D. (1966). The Duality of Human Existence. Chicago, IL: Rand McNally.

[9]Martin, C. L., and Halverson, C. (1987). The roles of cognition in sex role acquisition. In D.B. Carter (ed.), Current Conceptions of Sex Roles and Sex Typing: Theory and Research (pp. 123-137). New York: Praeger.

[10]Spence, J.T., and Helmreich, R.L. (1978). Masculinity and Femininity: Their Psychological Dimensions, Correlates, and Antecedents. Austin, TX: University of Texas Press.

[11]Spence, J.T., and Sawin, L.L. (1985). Images of masculinity and femininity: A reconceptualization. In V.E. Oleary, R.K. Unger and B.S. Wallston (eds.), Sex, Gender and Social Psychology (pp. 35-66). Hillsdale, NJ: Erlbaum.

The main answer to the question why there aren't more women at the top is that our gender schemas skew our perceptions and evaluations of men and women, causing us to overrate men and underrate women. The small daily events in which men get a slight advantage add up over the long haul to put them at a large advantage relative to women. There are, of course, situations in which women are actively discriminated against and harassed. But in many professional contexts, nothing overtly seems wrong. Gender schemas explain what is wrong when the problem is invisible or appears trivial; they operate on a minute-to-minute basis throughout the workday.

Experimental data demonstrate that observers do not see people simply as people, but as males or females.[12] Once gender schemas are invoked they work to disadvantage women by directing and skewing perception, even in the case of objective characteristics like height. In one example,[13] the experimenters exploited the fact that our schemas include the information that men are on average taller than women. In this experiment, college students saw photographs of other students and estimated their height in feet and inches. The photos always contained a reference item, such as a desk or a doorway, so that height could be accurately estimated.

Unbeknownst to the participants, the experimenters had matched the photographs so that for every photograph of a male student of a given height there was a female student of the same height. The question was how accurate the judges could be when faced with a sample that violated the population tendencies.

The evaluators were affected by their knowledge that men are on average taller than women; they judged the women as shorter than they really were and the men as taller. In this experiment, as is typically the case, there were no differences in how male and female observers perceived the others. That is, both male and female observers rated males as taller than females. The data from this experiment are typical: men and women make the same judgments to the same degree.

In the case of professional competence, perceptions are similarly prone to error. People are likely to overvalue men and undervalue women. One can expect gender schemas to play a role in evaluations whenever (1) schemas make a clear differentiation between males and females, and they do for professional competence as much as for height, and (2) evidence is ambiguous and open to interpretation, as is the case with professional competence. We are all tempted to think of scientific excellence as straightforward and objective, and we have difficulty seeing how much interpretation is required of the data in front of us.

A real-life demonstration of the importance of schemas comes from a study of the Swedish Medical Research Council's awarding of postdoctoral fellowships in 1995.[14] Although women were 46 percent of the applicants, they received only 20 percent of the fellowships. An analysis of the judgments made by the senior scientists on the panels showed that women received lower "scientific competence" scores than men did. To determine what contributed to scientific competence, the investigators developed a model called "total impact points," using a combination of productivity and prestige of the journal in which the young scientists had published. This model predicted scientific competence scores well for the young male applicants. But women had to receive 100 or more impact points in order to get the same rating from the judges that a man with 40 or fewer impact points got.

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[12]Valian, V. (1998). Why So Slow? The Advancement of Women. Cambridge, MA: MIT Press.

[13]Biernat, M., Manis, M., and Nelson, T. (1991). Stereotypes and standards of judgment. Journal of Personality and Social Psychology, 66, 5-20.

[14]Wenneras, C., and Wold, A. (1997). Nepotism and sexism in peer-review. Nature, 387, 341-343.

The judges undoubtedly did not intend to discriminate against the female applicants. Nevertheless, they saw a male's qualifications as worth more than a female's. The same data were interpreted differently depending on the sex of the applicant.

Not only do schemas affect perceptions of competence, they also make it difficult for women to reap the benefits of their achievements and be perceived as leaders.[15] College students were shown slides displaying five people seated around a table. The group was described as working together on a project. Two people sat at each side and one person sat at the head of the table. Sometimes the group members were the same sex, sometimes of different sex.

The observers were asked to identify the leader of the group. In same-sex groups, the person sitting at the head of the table was reliably identified as the leader. In mixed-sex groups, a man at the head of the table was reliably identified as the leader. But in mixed-sex groups when a woman was at the head, observers sometimes labeled her as the leader and about equally often labeled a man seated elsewhere at the table as the leader. There were no differences between male and female observers. There was no intention to discriminate. The implication of this experiment is that the symbolic position of leadership carries less weight for a woman than a man. Women are less likely to obtain the automatic deference that marks of leadership confer for men. Women are objectively hurt in situations of that sort, even though observers intend no harm.

For women aspiring to scientific leadership, then, the road will be rougher than it will be for men. It will be more difficult for women to be rated as competent (as the Swedish Medical Research Council data suggest) and more difficult for them to be perceived as leaders, even when they are potentially in a leadership position.

It should be emphasized that the claim here is about tendencies. Not every woman will experience problems. Even women who do experience problems will not experience them at every point in their career. Rather, on average, women will have more difficulty than men do.

Senior members of a field, gender schemas in place, take men more seriously than women. (As it happens, most of those senior members are male, but, according to the gender schema analysis, senior women are as likely as senior men to undervalue women relative to men.) Senior members are thus more likely to pass on important information to young men than to young women (seeing them as likely to benefit from the information) and are more likely to intervene helpfully in the careers of young men compared to young women (seeing them as likely to excel). Young men are more likely than young women to be identified as rising stars and to be groomed for success.

When women do actively adopt an assertive leadership style, they are perceived more negatively than men. A laboratory study measured people's facial reactions to people trained to act as a leader.[16] The study demonstrates that both women and men—unconsciously but visibly—react negatively to women in a situation that is aimed at finding a group solution to a problem. People respond especially negatively to women's attempts to be assertive.

The researchers duplicated in the laboratory a common everyday situation in which a small group of people, in this case four people, must arrive at a decision. In the experiment the group's task was to rank, after 10 minutes of discussion, how important nine items (such as a first aid kit and a map) would be if one crash-landed on the moon.

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[15]Porter, N., and Geis, F.L. (1981). Women and nonverbal leadership cues: When seeing is not believing. In C. Mayo and N. Henley (eds.), Gender and Nonverbal Behavior. New York: Springer-Verlag.

[16]Butler, D., and Geis, F.L. (1990). Nonverbal affect responses to males and female leaders: Implications for leadership evaluation. Journal of Personality and Social Psychology, 58, 48-59.

In order to investigate differences in facial reactions to men and women leaders, the investigators put together groups of four people. Two members of each group—one male and one female—were naive participants, undergraduate college students, who were videotaped. The other two members—also one male and one female—were upper-level undergraduates whom the experimenters had trained to be leaders, using a friendly, cooperative, and pleasantly assertive style.

The experimenters' main interest was the subtle reactions of the naive participants to females and males who were making the same suggestions in the same way. Facial reactions, because they are less under a person's direct control than oral comments, are a good, subtle measure of how someone is reacting to another person. Both male and female leaders received a certain amount of negative facial reactions; observers may harbor some resentment toward leaders. But males, unlike females, received more positive than negative reactions. Women ended up with a net loss. The male and female naive subjects did not differ in their reactions. Both sexes saw the male leader more positively than the female leader.

Thus, when women attempt to be leaders they lose, relative to men. They lose in three steps. First, they are attended to less. Women have more difficulty than men in gaining and keeping the floor. Second, when women do speak and behave in a leaderly way, they get negative reactions from those around them, even when the content and manner of their presentations is identical to men's. Men are encouraged to be leaders by the reactions of those around them. Women, conversely, are discouraged from acting in a leaderly way by the reactions of those around them. Third, otherwise neutral observers are also affected by negative reactions and tend to go along with the group judgment.

ANALYSIS OF THE PROBLEM: ACCUMULATION OF ADVANTAGE

Many of the cases in which a woman is underrated, does not receive information, does not get public notice, or is not perceived as a leader, are of small scale. It is difficult for people to appreciate the long-term consequences of small differences in treatment. Women who react to such differences may be told by well-intentioned colleagues not to make a mountain out of a molehill. That is where the notion of accumulation of advantage comes in.[17, 18, 19, 20, 21] It tells us that, piled one on top of the other, molehills *are* mountains.

Like interest on capital, advantages accrue; like interest on debt, disadvantages accrue. Very small differences in treatment can, as they accumulate, have major consequences in salary, promotion, and professional prominence.

A computer simulation of promotion practices at a hypothetical corporation provides a convincing demonstration of the cumulative effects of small-scale bias.[22] The simulation modeled an organization with an 8-level pyramidal hierarchy, in which each level was staffed with equal numbers of men and

[17]Cole, J., and Singer, B. (1991). A theory of limited differences: Explaining the productivity puzzle in science. In H. Zuckerman, J.R. Cole, and J.T. Bruer (eds.), The Outer Circle: Women in the Scientific Community (pp. 277- 310). New York: W.W. Norton.

[18]Fox, M.F. (1981). Sex, salary, and achievement: Reward-dualism in academia. Sociology of Education, 54, 71-84.

[19]Fox, M.F. (1985). Publication, performance, and reward in science and scholarship. In J. Smart (ed.), Higher Education: Handbook of Theory and Research (pp. 255-282). New York: Agathon.

[20]Long, J.S. (1990). The origins of sex differences in science. Social Forces, 68, 1927-1315.

[21]Merton, R.K. (1968). The Matthew effect in science. Science, 159, 56-63.

[22]Martell, R.F., Lane, D.M., and Emrich, C. (1996). Male-female differences: A computer simulation. American Psychologist, 51, 157-158.

women. The simulation assumed a certain percentage of incumbents would be promoted from one level to the next. Finally, it assumed a tiny bias in favor of promoting men, a bias that accounted only for 1 percent of the variance. Such a bias would typically be considered inconsequential. After repeated iterations until there was complete turnover, the highest level in the hierarchy ended up being 65 percent male. This simulation demonstrates that operating at a minute disadvantage can have substantial long-term effects.

This is the condition of ambitious women in science. They operate at a small disadvantage in a variety of areas. Those multiple small disadvantages accumulate over time to result in underrepresentation at the top.

THE ANSWER IN A NUTSHELL AND SOME REMEDIES

The basic social cognitive answer to women's slow advancement is that women's credentials do not buy them the same positive evaluations that men's credentials buy them.

Women's lower valuation is seen on a daily basis, in meetings where their suggestions are not attended to. It is seen more importantly when people look at a woman's vita and say, "I notice she published a lot of work with her mentor. Perhaps her mentor is the real mover behind this work."

The myriad ways in which we underrate women and overrate men add up over the long haul to produce women's disadvantage relative to men's. This can happen with the best will in the world, with the best intentions, with the most sincere desire to have equality between men and women in an organization.

With a firmer understanding of the social cognitive basis of gender inequity in hand, it is possible to map out some of the on-the-job consequences of gender schemas for women and men and to work out solutions. A few examples of how to approach the problem are given here.

- *Consequence and solution: Women's inadequate access to information and public notice.* As a result of gender schemas that portray women as less professionally competent and ambitious than men, women end up with less information and less public notice than do men. Compared to men, women have less access to informal routes of information and are less likely to be given opportunities by their superiors to receive public notice. For example, a recent study of the Johns Hopkins University Department of Medicine within the School of Medicine demonstrated that senior faculty were six times as likely to suggest names of junior male faculty rather than female faculty to chair conference sessions. Qualified junior women were also less likely to be identified as candidates for promotion compared with qualified junior men.[23] Thus, women are not as likely to be identified as star material, and as their careers continue they become less and less likely to be perceived as important scientific contributors to their field.

Women can press for and leaders can provide information about the criteria for success within their organization and within their discipline. Women can press for and leaders can provide opportunities for women to shine.

- *Consequence and solution: Cognitive unavailability of women's names.* When academics are choosing contributors to invite to colloquia and conferences or nominate candidates for awards, they do

[23]Fried, L.P., et al. (1996). Career development for women in academic medicine: Multiple interventions in a department of medicine. Journal of the American Medical Association, 276, 898-905.

not use a systematic search procedure. Nor, typically, are they concerned about overlooking members of any particular social group. They choose names that are cognitively available and accessible. Many cognitive and social factors contribute to determining whose names are cognitively available—recentness of mention, frequency of mention, prestige of setting in which mention occurred, recentness of last acquaintance, frequency of acquaintance, degree of acquaintance, prestige of setting in which acquaintance occurred, impression based on acquaintance, prestige of institutional affiliation, and status within the institution.

Women are disadvantaged compared to men in many of those factors. Since women do not publish as much as men, for example, their frequency and recentness of mention is lower than men's. For another example, women are overrepresented at less prominent institutions and tend to have lower ranks at more prominent ones. That, too, will contribute to their lower cognitive availability in others' minds. The factors that contribute to males' higher visibility in science also contribute to their greater cognitive availability. The effects of women's invisibility are evident in experimental psychology, where women are numerous. The June 2000 national annual meeting of a major psychology organization, for example, had 23 invited speakers, 20 male. Of a special set of 5 interdisciplinary symposia, 4 consisted only of male chairs and presenters. Here, too, no overt discrimination was intended. The organization has been in existence for 12 years, has had 6 female presidents, and had a female president when the program was developed.

Women and men can work actively to nominate women for important positions and awards. Institutional leaders can address the problem of cognitive unavailability by ensuring women's representation as invitees and awardees at rates proportional to their representation in the discipline.

• *Consequence and solution: Need to legitimate female leaders.* Leaders legitimate other leaders. In a study of person evaluation, undergraduate evaluators watched a videotape in which five graduate students had a group discussion.[24] On the tape, a male faculty member introduced one of the students as the leader. In one version of the tape the faculty member vouched for the student's expertise, mentioning the student's theoretical knowledge and performance ability; in another version the faculty member simply said the student would be the leader. The two videotapes were otherwise identical. After watching the video, the evaluators judged the student leader on a number of dimensions, including how much leadership the leader showed, how good the leader's contributions were, how desirable it would be to hire the leader, and how much salary the leader deserved.

In the tape where the faculty member had vouched for the student's expertise, the leader scored higher on all measures. The same effect occurred whether the student leader was male or female, and there was no difference in how positively male and female leaders were rated. There was also no difference in how male and female evaluators responded. A credible authority figure can successfully legitimize females as well as males. What appears to happen in such a situation is that evaluators interpret the direct information they get about a potential leader in the light of any earlier information that they have. If the prior information legitimizes the leader, the leader's behavior is seen as an example of being a good leader. If the prior information is not legitimizing, judges do not see a leader in as positive a light.

A subsequent study showed that both male and female authority figures can legitimize other lead-

[24]Brown, V., and Geis, F.L. (1990). Nonverbal affect responses to male and female leaders: Implications for leadership evaluation. Journal of Personality and Social Psychology, 58, 48-59.

ers.[25] Using the same videotaped group discussion scenes, the experimenters had one version that included a prior endorsement by a male authority and one that included a prior endorsement by a female authority. Both were equally effective in establishing students as leaders.

Thus, both women and men in authority can help competent aspiring women by legitimizing them as leaders. Leaders can use their influence to vouch for women's and men's value as leaders equally.

• *Consequence and solution: Need to identify problems.* Because of our belief that we are operating within a meritocracy, we do not scrutinize our procedures for their possible disproportionate impact on males and females. We do not ensure, for example, that men and women are aware of institutional resources and have the same access to them. But a study of men and women in academic medicine reported that, even at the beginning of their careers, men had more resources than women.[26]

Women can press for and institutional leaders can provide the tools necessary to determine subtle inequalities within their organization that help men more than they help women.

In short, we can understand the causes of women's slow advancement and do something about them.

DISCUSSION

Pushpal Murthy, Michigan Technological University: That was a scary talk. It was an interesting talk as well. I was looking for a solution, what we can do, and I heard you say that we have to depend on leaders who are going to pick us out. I agree with that, but it means we are depending on somebody else to help us. I wondered if you could address any other things where we can define the function for ourselves?

Virginia Valian: Good point. I focused on leaders because a number of you are leaders in the field and can do more than you might realize. But certainly there are things that everybody can do. Women need to work together, as the people in this room are doing, much more actively on their own behalf and the behalf of women more generally.

Ambitious women often do not want to affiliate with other women, and there are many reasons why that should be the case, not least of which is that ambitious women know that women as a group are losers in the status hierarchy. Why would one want other people to see one as part of this group?

We need to get beyond that and to understand why we might feel that way and to actively work on behalf of women in both large and small ways.

Cecily C. Selby, Radcliffe Institute for Advanced Study, Harvard University: A comment and a question. The comment relates to MIT in the 1970s, when Jerry Wiesner and Howard Johnson as president and chairman of MIT did exactly what you described in terms of finding women on the faculty. They actively promoted them and moved them, and that is how Sheila Widnall got to be Secretary of the Air Force and Shirley Jackson head of the Atomic Energy Commission. Margaret MacVicar was advanced before her premature death, and of course we all know of the continuing advance of Millie Dresselhaus. Jerry and Howard are the best example I know of being really proactive.

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[25]Geis, F.L., Brown, V., and Wolfe, C. (1990). Legitimizing the leader: Endorsement by male versus female authority figures. Journal of Applied Social Psychology, 20, 943-970.

[26]Tesch, B.J., Wood, H.M., Helwig, A.L., and Nattinger, A.B. (1995). Promotion of women physicians in academic medicine: Glass ceiling or sticky floor? Journal of the American Medical Association, 273, 1022-1025.

Here's my question: Can you imagine what would to me be nirvana, a chemistry that would recognize and reflect both gender schemas? Could or would you hypothesize that the quality of chemistry would be improved by the participation of both gender schemas—and maybe some other schemas, too?

Virginia Valian: I would argue in favor of gender diversity. There is some evidence, not as strong as one would like, that innovations are more likely among a diverse group of people than among a homogeneous group of people. A more diverse workforce, diverse with respect to sex, race, class, and age (we are wasting the talents of older people) would increase the likelihood of innovative solutions to problems. The MIT example that you raised is an interesting one, because however successful MIT was at one, limited earlier time, it did not continue. We see that effort must be constant.

Cecily Selby: We learned that from Nancy Hopkins.

Virginia Valian: Right. Gender equity requires constant ongoing effort. There is no magic bullet. There is no one-time fix. We have to keep at it all the time. Unless we do, our schemas will reassert themselves and recreate the problem we thought we had solved.

Victoria Friedensen, National Academy of Engineering: I am the director of a project by the National Academy of Engineering, Diversity in the Engineering Workforce. We have done a couple of things to promote, and otherwise encourage, an expanded definition of who is an engineer in this country.

I also have an observation and a question. In a previous life I worked for NASA and did a lot of peer review management. One of the things we discovered, after a complaint was lodged, was that very few women PIs [principal investigators] were getting funded by NASA, and they were certainly submitting proposals to NASA. We took a look at the claim, and what we did was a language analysis of the committees at work. We found that in peer review committees of men and women—and this goes to your schemas—during proposal discussion, men were referred to by their titles and names: Dr. Johnson, Dr. Smith, Dr. Jones, and so on "from this institution" or "that institution." The committee member speaking of the proposal would review it and would generally use the PI's title and last name even if the reviewer knew him personally. Women would be referred to initially as Dr. Johnson and Dr. Smith; however, they were also referred to in the third person. For example, "she did" and "she is in his lab" and "she worked for him." There was a difference in language. When the reviewer brought the language assessment forward to the committee, the committee would very often go back again and reexamine the proposal. They sometimes, but not always successfully, revised their initial estimation based on their unexamined assumption and how they presented that individual. We found that the presenter might have every good intention in the world and yet was doing a disservice to the PI by using what I would call "petite" language.

My question is this: Have there been any studies done in which researchers are tracking the activities of women who are in leadership positions? Are they making a difference, whether consciously or unconsciously, to the promotion of women as they come up through the organization? Is the presence of a woman manager, in other words, going to make a difference to the kinds of schemas in promotion activities that you mentioned?

Virginia Valian: The schema data suggest that having a few women in positions of leadership isn't

good enough. A woman who doesn't affiliate with other women and who doesn't know how evaluations are skewed by gender schemas is likely to make the same kinds of judgments that a man does.

That said, at workshops that I have given, I have found differences between men's and women's initial responses to a questionnaire that I give. Women are more aware of gender equity problems than men are, even if they themselves are not actively working to confront those problems and even if they do not see themselves as experiencing any gender-based problems. They are more aware than men are that problems exist, and they seem more receptive to the kinds of information that I present.

My hypothesis about what happens is that women have been tracking examples of gender inequity all along—while studiously not paying attention to them. When they acquire a framework within which to make sense of gender imbalance, all those examples get pulled in. They are then more convinced than men because men haven't been tracking those examples right along. Men don't have the same database that women do.

Women as a whole are thus likely to be a better source for changes in gender equity, as indeed the composition of this room would suggest. But we shouldn't think women are the solution and we shouldn't think men are the problem.

L. Shannon Davis, Solutia, Inc.: I have a question that builds on the previous one. We have talked much in rooms like this at other professional meetings about the impact of critical mass. At what point do you think critical mass will start to begin to impact your schemas?

Virginia Valian: That is a really good question. There actually are data on that. I will tell you an experiment that demonstrates the importance of having women in a candidate pool. Madeline Heilman conducted the experiment. She gave people a resume to evaluate along with 7 others. She varied the sex composition of the remaining seven.

The (fictitious) person you have to evaluate is always female. The other seven are either all males, six males, five males, four males, or zero males. (This is a between-subjects design.) The resumes stay the same. All Heilman varies is what the composition of the pool looks like with respect to the representation of women. Up to about 38 percent of women, women are evaluated more negatively than they are if there are 38 percent or more in the pool.

Women in business talk about the rule of three: you need to have three women in any group in order for it not to be too biased in the male direction with respect to looking at female candidates, for it to be receptive to issues that are of traditional concern to women, and for a women in a group to get a hearing for her ideas.

So the composition of the pool matters. If the pool is almost all male, it looks like a job for men. It also makes the woman look more feminine. Other work by Heilman has shown that the more feminine a woman appears, the less competent she appears to both males and females. If she is the only woman in the group, her femininity and her status as a woman are highlighted. She is seen as less competent than she would be seen if there were some other women around.

However, in those National Academy of Sciences data that Professor Rossiter showed I was particularly struck by the social science category, which had the tiniest sprinkling of women, despite the very large number of women who are getting, and have been getting, advanced degrees in the social sciences. These women are grossly underrepresented in the National Academy. Representation is not enough, but it helps.

Marylee Southard, University of Kansas: That is a good point for my question. The most disturbing statistic that you showed on your handout was on page 3 in the middle of the page. This is

academic tenure across all disciplines, at universities and 4-year colleges. It compares data that are 20 years apart. This is not just in the sciences and engineering. Is that correct?

Virginia Valian: That is right. That is, everybody mixed in together.

Marylee Southard: This suggests to me that this is not merely a chemical sciences problem and that we may actually be doing better than the system as a whole. There may be some things that have been borne out in other studies about academe showing that it is not friendly and not working for women. Could you comment on this?

Virginia Valian: It is an across-the-board phenomenon. I don't know data on advancement of women in chemistry, but the other data on that numbers sheet I handed out—for women in science and engineering—certainly do not show women doing well.

I should also mention that the same database is not being used from comparison to comparison, even within the NSF data. You cannot look at the exact numbers across these different comparisons because they don't have the same denominators. (All of the NSF data are available online, by the way, at the NSF Web site. You can just print out the particular tables that interest you.)

The tenure data and the rank data are not exactly the same. The numbers differ by several hundred, sometimes several thousand. It is really hard to make clear numerical comparisons. What we should focus on is the fact that wherever you look, women are not advancing. You can look anywhere: women are not advancing at the rates they should, and it cannot be explained by things like increasing numbers of women at lower positions, because you can subtract out those older men and women who are full professors and recalculate and you still see a problem.

Women spend too long in rank, period.

W. Sue Shafer, University of California San Francisco: I recently read a fascinating book written by Susan B. Evans and Joan P. Avis, faculty at the University of San Francisco. Their book, *The Women Who Broke All the Rules: How the Choices of a Generation Changed Our Lives*, reports the interviews of 100 women in the baby boomer generation born between 1945 and 1955. Coming of age in a time of enormous social change affected both their initial career aspirations and their eventual careers. The book has a number of fascinating lessons in it, including the factors that made the difference for those women in terms of the careers they were able to achieve. One of the most significant lessons for me came toward the end of the book.

The authors asked each of these women if they were feminists, and many of them refused to accept that label. However, if you asked them if they believed that women and men ought to succeed equally they all, of course, agreed. Having avoided the label of feminist myself, it was an insight to me to understand that we have allowed that term to be taken away from us. It now carries negative connotations that we don't necessarily want to espouse. A basic concept of feminism is that all people succeed according to their ability. I think most of us would agree with that as a concept that we could support.

Janet G. Osteryoung: In the interests of keeping on time I will take the questions from the people who were standing, but please try to keep it brief.

Marion C. Thurnauer, Argonne National Laboratory: I have given a lot of thought to this issue of schema (without knowing this term). I have used different terms—socialization for one. We do get

beyond the schema at certain points in time, in specific situations. I have often wondered, however, As our society becomes more diverse and we have people coming from other cultures, can we move beyond the schema? How different are the gender schemas in different cultures and how does diversity ultimately affect the outcome?

Virginia Valian: I will address your last point first. Schemas are unlikely to differ enough from one culture to another to give us any hope that we will find a culture where there is no problem with gender equity. Certainly there are cultural and subcultural differences in exactly how gender schemas are constituted and how they play out. There are odd separations in terms of things like political representation, for example, in which this country—at least at the national level—has a very poor record compared with some other countries (in part because of different voting systems). But in terms of other measures we do somewhat better than other countries.

It is also not the case that every indicator tells exactly the same story, but there is enough commonality even globally with respect to how women and men see other women and men that we can take that as a given. The increasing diversity of the workplace could work in women's favor if they were positioned in such a way that they could take advantage of it. We could try to capitalize on that.

Geraldine V. Cox, Eurotech, Ltd.: I find it interesting that we really haven't touched on the issues of sexuality. Many would-be mentors fear that they will be unjustly accused of an improper relationship when they are working with a student and trying to help a career.

I have to admit that I was pretty oblivious to this when I was in graduate school. I was very goal directed—I wanted to do my work, get out, and get on with my career. I ran into my research adviser about 20 years later and he asked, "Do you know how many faculty asked me about my relationship with you?" I was shocked because it had never even crossed my mind that his mentoring would be questioned. I think there is a real concern here, especially with male-female relationships, that many male faculty are reluctant to mentor a woman for fear of being accused inappropriately of some sort of relationship that doesn't exist.

Virginia Valian: Yes, sex itself is a factor. It is something that we should turn our attention to so that it doesn't prevent effective mentoring. Too often fears of being accused of sexual harassment or inappropriate sexual behavior are used as an easy way out. We need to say, Okay, that is a problem. Now, let's figure out what we can do to solve it.

Marjam Behar, National Institutes of Health: I think this really goes back to the societal outlook on men and women many, many years ago and the different toys that girls and boys were given to play with. It was unheard of that girls would play with any toys that they had to think about how to use—it was always a doll or a dollhouse—and the boys had other, more interesting and challenging toys. The same was true about careers. Women were thought of as going into home economics or something similar, while the men were thought of for careers in science, and that, again, changes with cultures because it depends on personal values and attitude.

My father was a man who was three generations ahead of his time. He had two daughters and taught us that the most important thing in our lives was education, and that we would have plenty of time to get married—if we wanted to get married. It was our choice, but the most important thing was to get a career. I taught youngsters, and when I had a very bright female student and I would tell her parents that she was very bright and had promise, they would tell me not to encourage her too much, because all they were interested in was for her to get a good husband. That attitude has to change. It's the same about

calling a man a doctor: if a man is a doctor they usually don't call him mister; however, a woman doctor is usually called miss or missus. So, there is a general societal attitude also that we have to consider.

Virginia Valian: Sure, there are problems everywhere. But I don't want us to make the problem so big that we give up and say there's nothing we can do. It is important for us to specify particular areas where we see we can make a difference and make a difference in those areas. Everyone needs to work, in his or her own way, on making gender equity a professional reality.