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ACADEMIC WOMEN IN STEM FACULTY

Views beyond a decade after POWRE

Sue V. Rosser

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For the women of POWRE

Contents

List of Figures

List of Tables

CHAPTER 1

Who Are the NSF POWRE Awardees: Why are their Experiences Significant for Academic Women Scientists?

Abstract Professional Opportunities for Women in Research and Education (POWRE), the National Science Foundation (NSF) initiative designed to facilitate the careers of individual women scientists was conceived in the wake of the November, 1994 Republican sweep of Congress. With a thought of keeping the money for the gender-based program more secure, POWRE became a cross-directorate program funded by the research directorates. The complete four-year cohort of all POWRE awardees (1997–2000) responded to questions regarding career opportunities and challenges and laboratory climate. 389 of the population of 598 POWRE awardees (65 percent) responded to the e-mail, with the respondents being representative of the awardees with regard to discipline. The relatively large sample size and response rates coupled with lack of disciplinary bias suggested that these data might be generalized to the broader population of women scientists and engineers. Knowing and understanding the perceptions and experiences of these successful women faculty and the context available from their qualitative comments provided significant information that administrators and faculty used to develop institutional transformation strategies.

Keywords POWRE awardees · Academic women scientists · NSF · Institutional transformation strategies

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From 1997 to 2000, the National Science Foundation (NSF) awarded Professional Opportunities for Women in Research and Education (POWRE) grants to almost 600 women scientists and engineers at U.S. universities to facilitate their careers. During that time, two-thirds of the POWRE awardees from all disciplines responded to a survey regarding career opportunities and challenges and laboratory climate. Successful academic women STEM faculty were surveyed in 1997–2000 and again in 2012 about their career challenges and opportunities, perceptions of laboratory climate, and the differing experiences of junior and senior women. Despite the major changes in higher education and in scientific technology during the last fifteen years, gender issues have persisted, even in disciplines with increasing numbers and percentages of women. Because little research has focused directly on the effect of the changes on women scientists who have remained in the professoriate, the POWRE awardees, a group who represent successful academic women scientists, provide insights into their perceptions of these effects. This volume compares and contrasts the results of the earlier surveys with the 2012 survey from these successful women. Consensus has coalesced around policies and practices to remove obstacles and barriers that inhibit career advancement for junior women. No such consensus about policies to facilitate careers for senior women appears to have evolved. The results of the data from the 2012 survey suggest additional policies and practices that institutions might pursue, especially for women at the senior level.

The last two decades have brought dramatic change in higher education, especially public higher education. Massive budget cuts caused by decreases in funding from State legislatures and cuts in federal grants triggered by sequestration due to the Great Recession beginning in 2008 have brought changing expectations and financial realities affecting both the research laboratory and teaching classroom at United States universities. Rapid advances in technology have enabled amazing breakthroughs in science such as genome sequencing of many species and in classroom pedagogy such as MOOCs, flipped classrooms, and collaborative document sharing for on-line groups. Despite the extreme changes in higher education and in scientific technology during these last twenty years, gender issues have persisted.

A few recent examples indicate that despite the increasing numbers of women in most science, technology, engineering, mathematics, and technology (STEM) disciplines, gender issues exist at all levels of STEM. A nationwide sample of 127 male and female science professors picked a man over a woman when asked to choose between two undergraduates with

the same qualifications to manage their lab (Moss-Racusin et al. 2012). A study conducted at the University of Washington of a large introductory biology class revealed that male students chronically overestimate the knowledge of their male peers and underestimate the knowledge of their female peers (Grunspan et al. 2016). When students of varying sex and ethnicity asked for mentorship via e-mail requests to 6,500 tenure-track professors at top research universities, those sent by researchers posing as white men were more likely to receive yes responses (Chugh et al. 2014). A study of 85,000 published scientific papers revealed that men and women perform different roles in the labs producing scientific research. Women perform the experimental work involved in pipetting, centrifuging, and sequencing, while men analyze data, conceive the experiments, contribute resources or write up the study (Macaluso et al. 2016). In short, gender inequality and disparity in science persist.

Media attention has focused on the dearth of women in science in general, and in the technology sector in particular, despite its rapid expansion and lucrative salaries; women remain especially limited in the management and executive levels of the technology sector. Only 3 percent of Silicon Valley tech startups have at least one female founder (Sposato 2015). It takes women longer to raise seed money (9 months for $1–$5 M) than it does their male counterparts (3 months for $1–$5 M) (Sposato 2015); perhaps this is because investors who heard pitches by entrepreneurs preferred pitches by a man over identical pitches from a woman (68 to 32 percent) (Brooks et al. 2014). Gender, rather than race/ethnicity, appears to be the main deterrent since one study documented the lower salaries and fewer chances of promotion of white and Asian-American women but not Asian women in the U.S. computer industry (Tao 2010).

Women's Degree Attainment

One possible reason for gender inequity in science, technology, engineering and mathematics (STEM) may result from a history smaller numbers of women obtaining STEM degrees compared to their male counterparts. Some science and engineering disciplines such as biology, chemistry, geosciences and even mathematics and physics have seen increasing numbers and percentages of women over the time period. In the United States, women currently earn more of the bachelors and masters degrees than men (Table 1.1). In 2012, women earned 57.4 percent of the bachelors degrees in all fields (NSF 2015, Table 5.1) and 60.1 percent of all masters degrees

Table 1.1 Women as a percentage of degree recipients in 1996 and 2012 by major discipline and group

	All fields		*All science and engineering*		*Psychology*		*Social sciences*		*Biology*		*Physical sciences*		*Geosciences*		*Math/ Statistics*		*Engineering*		*Computer science*	
	1996	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*	*1996*	*2012*
Percentage of Bachelors degrees received by women	55.2	57.4	47.1	50.5	73.0	76.7	50.8	54.7	50.2	59.3	37.0	40.6	33.3	39.1	–	43.1	17.9	19.2	–	18.2
Percentage of MS degrees received by women	55.9	60.1	39.3	45.6	71.9	79.1	50.2	55.9	49.0	57.5	33.2	35.9	29.3	42.7	–	40.6	17.1	22.9	–	27.8
Percentage of Ph.D. degrees received by women	40.0	49.6	31.8	41.1	66.7	72.6	36.5	48.7	39.9	53.1	21.9	31.5	21.7	43.3	–	28.2	12.3	22.6	–	21.4

Source: Calculated by author from data in NSF 2015, Women, minorities, and persons with disabilities; Table 5.1 for Bachelors, Table 6.2 for Masters, Table 7.2 for Ph.D. for 2012 data

Calculated by author from data in NSF 2000, Women, minorities, and persons with disabilities; Table 2.6 for Bachelors, Table 4.3 for Masters, Table 4.11 for Ph.D. for 1996 data

(National Science Foundation 2015, Table 6.2). Beginning in 2000, women also earned more of the bachelors degrees in science and engineering (S&E), although they earned only 45.6 percent of the masters degrees in science and engineering in 2012. In 2012, women earned 61.8 percent of the Ph.D.s in non-science and engineering fields, but only 41.1 percent of the Ph.D.s in science and engineering received by U.S. citizens and permanent residents (National Science Foundation 2015, Table 7.2).

The aggregated data mask the wide variance of women's participation among fields in STEM (Table 1.1). Major differences occur in distribution of gender across the disciplines. Overall, at the bachelors level, women earn the majority of the degrees in the non-science and engineering fields, such as humanities, education, and fine arts, and in the science fields of psychology, the social sciences, and biological sciences. Men earn most of the degrees in the physical sciences, earth, atmospheric, and ocean sciences, mathematics and statistics, and especially in computer sciences and engineering (National Science Foundation 2015). Unfortunately the percentage of women earning bachelors degrees in computer science and engineering has actually decreased from a decade earlier, in contrast to all other science and engineering fields where the percentage of women bachelors degree earners has increased. For computer science, this continues a downward trend from 1984 when women earned 37 percent of the degrees in the field (NSF/SRS 1997).

At the level of the masters degree, women earned the majority of degrees in 2012 not only in non-science and engineering fields, but also in biological sciences, psychology, and the social sciences (Table 1.1). Women earned less than half of the masters degrees in earth, atmospheric, and ocean sciences, mathematics and statistics, physical sciences, computer sciences and engineering (National Science Foundation 2015), although in all fields, with the exception of computer science, the percentage of women masters degree recipients has increased compared to a decade ago. Despite the percentage of women at the masters level remaining low in engineering (22.9 percent), in computer science the percentage decreased to 27.8 percent over the decade, although not as markedly as the percentage of those receiving bachelors degrees decreased.

Women still earned less than half of the science and engineering Ph.D. degrees in 2012 (Table 1.1) in all fields except psychology, biology and a few social sciences, such as anthropology, linguistics, and sociology (National Science Foundation 2015, Table 7.2). Women earned 53.1 percent of the Ph.D.s in biological sciences (Table 1.1). Although the percentage of women earning Ph.D.s in 2012 in computer science (21.4 percent) and

engineering (22.6 percent) remains relatively low, the percentage has increased over the decade.

In short, in many of the social sciences and the life sciences, women have reached parity in the percentages of degrees received (Table 1.1). In other areas, such as the geosciences as well as mathematics and physical sciences, the percentages of women continue to increase, although they have not approached parity. In contrast, in engineering and computer sciences, the percentages of women have dropped during the past decade at the bachelors level and also at the masters level in computer science.

Many studies have examined the failure of women to obtain science, technology, engineering and mathematics (STEM) degrees, enter STEM careers, or progress and remain in them. Fewer have explored successful women in STEM, especially in academia. Studying such academic women might provide clues as to policies and practices that institutions have adopted to facilitate career success.

A group representative of these successful women scientists, particularly in public higher education, is the NSF POWRE awardees. POWRE represented a competitive award initiated in 1997 by the National Science Foundation to facilitate the careers of individual women scientists; it was conceived in the wake of the November, 1994 Republican sweep of Congress. This resulted in cuts in federal spending, with programs that had gender or race as their central focus under particular scrutiny. Although the court challenges to NSF initiatives at that time focused on minority programs, programs targeted exclusively for women principal investigators were thought to be in jeopardy. With an aim of keeping the money for the gender-based program more secure, POWRE became a cross-directorate program funded by the research directorates at NSF. Having 100 percent of the time and support going for research of individual women investigators as POWRE did, went against a growing sentiment at the Foundation that support for institutional and systemic approaches, rather than for individual women scientists, would be required to increase the percentage of women at all levels in science and engineering.

History of Women's Programs at NSF

A brief history of women's programs at NSF provides a context for understanding POWRE. This history documents the shift in NSF policies over time from a focus on funding individual investigators to do

their research to institutional and systemic approaches to increase numbers and percentages of women and under-represented minorities.

Level 1: Women's Programs at NSF Focused on Individuals (1980s)

Although not implemented exactly as he envisioned, Dr. Vannevar Bush's 1945 report—"Science: The Endless Frontier"—became the blueprint for the long-term U.S. national investment in scientific research and education through research universities, industry, and government that led to the establishment of the National Science Foundation. Almost four decades later, the Science and Technology Equal Opportunities Act of 1980 mandated that NSF collect and analyze data and report the status of women and minorities in the science and engineering professions to Congress on a biennial basis. In 1982, NSF published the first congressionally mandated reports documenting trends in the participation of women and minorities in science and engineering. These biennial reports on Women and Minorities in Science and Engineering, to which persons with disabilities were added in 1984 (NSF 2000, xii), provided data documenting that science and engineering have lower representations of men of color and of women compared to their respective proportions in the U.S. population overall.

These reports laid the statistical foundation for NSF officials to plan initiatives to address these under-representations. Programs such as Research Opportunities for Women and Visiting Professorships for Women (VPW) exemplify these initiatives. As Mary Clutter, then assistant director of the NSF in charge of biological sciences, recounted in the evaluation of POWRE in 1998, the director of NSF established a Task Force on Programs for Women in the spring of 1989 with the charge of ascertaining the barriers to women's full participation in science and engineering and recommending changes in the Foundation's existing programs to promote full participation (Clutter 1998, Appendix B).

The task force concluded the following:

1. Significant progress has been made in increasing the representation of women in the sciences.
2. Serious problems remain, preventing the recruitment, retention, and advancement of women in science and engineering.

3. These problems are more severe in some fields than in others, although advancement to senior ranks is a problem in all fields. (Clutter 1998, Appendix B)

The task force also made several specific recommendations, including expanding the level of effort in some existing programs at intervention points along the pipeline and establishing two new programs: one designed to enhance the graduate environment in academic institutions; the second designed to recognize and advance outstanding women faculty to the senior ranks (Clutter 1998, Appendix B).

NSF funded several initiatives targeting various segments of the science and engineering pipeline. Graduate fellowships for women provided an incentive for women graduate students to remain in graduate school and complete their PhD. These fellowships provided support for individual women and their research in science and engineering.

Career Advancement Awards (CAA), initiated in 1986, were superseded by Professional Opportunities for Women in Research and Education (POWRE) in fiscal year 1998. As the CAA name suggests, the award focused on advancing the careers of individual women by providing them funds to pursue their own research agenda. By targeting junior women, CAA used a combination of release from teaching and recognition of potential to make a significant research contribution, to place these women on a fast track to academic success in science or engineering research.

The task force also recommended that the NSF "incorporate the existing Research Opportunities for Women programs into Division-level strategic plans, but retain the Visiting Professorship as a Foundation-wide program" (Clutter 1998, Appendix B). Many of the divisions used a segment of the Research Planning Grant funds as discretionary add-ons, often called Research Planning Grants for Women. These grants targeted women scientists or engineers who had never held an NSF grant or who sought reentry after a career interruption.

Visiting Professorships for Women (VPW), established in late 1982, stood as the primary, foundation-wide initiative for women until POWRE succeeded it in 1997. VPW sought to retain women who already had faculty appointments in science and engineering by providing them with new equipment and supporting them at different, generally more prestigious institutions, where they had an opportunity to develop new research methodologies and collaborations. A 1994 evaluation of VPW documented the success of VPW, stating that a VPW award often came "at a critical time for

keeping the recipient active in research as opposed to other academic, non-research responsibilities" (SRI International 1994, 13).

Although support of research of individual women scientists and engineers served as the predominant focus for the VPW during most of its fourteen-year history, each VPW recipient was required to spend approximately 30 percent of her time and effort to attract and retain women scientists and engineers at the institutions she was visiting (SRI International 1994). As part of her "interactive activities that involve teaching, mentoring, and other student contacts" (SRI International 1994, 1), each awardee engaged in activities such as forming a Society of Women Engineers (SWE) chapter, establishing mentor networks among women graduate students, and teaching women in science courses jointly with women's studies programs. This division of 70 percent support for individual research and 30 percent to improve institutional infrastructure to attract and retain women in science and engineering signaled recognition that support of individual research alone might not be sufficient to increase the numbers of women scientists and engineers. The 30 percent underlined the dawning realization that steps needed to be taken at the institutional, as well as individual, level.

Level 2: Women's Programs in the Early 1990s

As Table 1.2 shows, although Faculty Awards for Women (FAW) held only one program solicitation, in 1990, FAW attempted to address a systemic problem that the Task Force Report had identified—the dearth of women scientists and engineers in senior positions. The initiative used the traditional approach of supporting the research projects of individual women faculty for a period of five years at the level of $50,000 per year, in its attempt to solve the systemic problem. Almost all of the 100 awardees achieved the primary stated goal of the program of achieving tenure. The controversy within the peer review panel surrounding the criteria for selection of the FAW awardees (reviewers could not come to consensus over whether individuals who showed potential, but appeared to need a boost, or those whose records indicated they were very likely to receive tenure even without the award, should receive higher priority) contributed to the termination of the program after one year. It was difficult to judge the efficacy of this program of support for research of individual investigators as an approach to systemic change, given that there was only one cohort of awardees.

Table 1.2 Timeline of initiatives for women at NSF

1945:	Vannevar Bush's Report: *Science: The Endless Frontier*
1950:	NSF established
1980:	Women in Science and Technology Equal Opportunity Act mandates that NSF collect and analyze data on the status of women and minorities in the engineering professions
1982:	First publication of *Women and Minorities in Science and Engineering* (beginning in 1984, *Persons with Disabilities* were included)
1982–1997:	Visiting Professorships for Women (VPW)
1986–1998:	Career Advancement Awards (CAA)
1990:	Faculty Awards for Women (FAW)
1993–1998:	Program for Women and Girls (PWG)
1997–2000:	Professional Opportunities for Women in Research and Education (POWRE)
1998–2006:	Program for Gender Equity in Science, Mathematics, Engineering, & Technology
2001–Present	ADVANCE
2003–2010:	Gender Diversity in Science, Technology, Engineering & Mathematics Education (GDSE)
2010–2013:	Research on Gender in Science and Engineering

Recognizing that a focus on efforts to target individuals in groups such as minorities and white women would not work as long as the system remained unchanged, the Directorate of Education and Human Resources at NSF began to focus on systemic initiatives. In addition to Statewide Systemic Initiatives (SSI), Urban Systemic Initiatives (USI), and Rural Systemic Initiatives (RSI), NSF established the Program for Women and Girls (PWG) in 1993 to explore comprehensive factors and climate issues that may systematically deter women from science and engineering. In addition to Dissemination Projects, PWG included two other initiatives for women and girls: Model Projects for Women and Girls (MPWG) encouraged "the design, implementation, evaluation and dissemination of innovative, short-term highly focused activities which will improve the access to and/or retention of females in SEM (science, engineering, and mathematics) education and careers" (NSF 1993, 7). Experimental Projects for Women and Girls (EPWG) encompassed large-scale projects requiring a consortial effort with multiple target populations. They aimed "to create positive and permanent changes in academic, social, and scientific climates (for classrooms, laboratories, departments, institutions/organizations) in order to allow the interest and aptitude women and girls display in SEM to flourish; and to add to the knowledge base

about interactions between gender and the infrastructure of SEM which can provide direction for future efforts" (National Science Foundation 1993, 7). The only individual research projects supported under the Program for Women and Girls were those where the research and evaluation of a curricular change, co-curricular program, or faculty development initiative fit the individual researcher's agenda. Although K-12 always constituted the centrepiece of PWG, undergraduates, graduate students, and even faculty served as primary targets of several projects at the beginning of PWG. After 1995–1996, and particularly after VPW was incorporated into PWG in late 1995, eventually to be succeeded by the cross-directorate POWRE, PWG centered on K-16 exclusively. Transitioning through reincarnations as the Program for Gender Equity in Science, Mathematics, Engineering and Technology (PGE), and Gender Diversity in STEM Education (GDSE), by 2005 the program was called Research on Gender in Science and Engineering (GSE). GSE "seeks to broaden the participation of girls and women in all fields of science, technology, engineering, and mathematics (STEM) education by supporting research, dissemination of research, and extension services in education that will lead to a larger and more diverse domestic science and engineering workforce" (accessed June 23, 2005 from http://www.nsf.gov/funding/pgm/ehr).

Temporary Return to Level 1: Initiatives in the Late 1990s: Origins of POWRE

After the 1996 VPW solicitation, NSF replaced VPW with Professional Opportunities for Women in Research and Education (POWRE), giving the first POWRE awards in fiscal year 1997. POWRE was conceived in the wake of the November 1994 Republican take-over of Congress where 62 percent of white males voted Republican (Edsall 1995). The resulting cuts in federal spending targeted programs that had gender or race as their central focus.

In response to statements made by Senate Majority Leader Robert Dole on NBC's *Meet the Press* on February 5, 1995, suggesting that Republican lawmakers were studying whether federal affirmative action requirements should be dropped on the grounds that they discriminate against white men, President Clinton initiated his own review of affirmative action programs (Swoboda 1995, A1). In June 1995, the U.S. Supreme Court ruled in the *Adarand Constructors, Inc. v Pena* decision that "federal affirmative action programs that use racial and ethnic criteria as a basis for decision making are subject to

strict judicial scrutiny" (in Kole 1995, 1). On July 19, after holding a press conference to reaffirm his commitment to affirmative action, President Clinton issued a memorandum for heads of executive departments and agencies to bring them in line with the Supreme Court decision. On July 20, 1995, the University of California Board of Regents voted to end special admissions programs; that decision was confirmed a year later by a citizen referendum.

In 1996, a Texas circuit court ruling banned affirmative action in admissions and financial awards. In 1998, in a referendum, the citizens of the State of Washington prohibited any "preferential treatment on the basis of race, gender, national origin, or ethnicity." In July 2000, an administrative judge upheld Governor Jeb Bush's plan to end the consideration of race and gender in admissions in state colleges in Florida (Lauer 2000).

Although the NSF initiatives challenged in court focused on minority programs, specifically the Summer Science Camps and the Graduate Minority Fellowships, programs targeted exclusively for women principal investigators such as VPW, FAW, and CAA were thought to be in jeopardy. Since the MPWG and EPWG had some men as principal investigators and did not exclude boys and men from projects, while targeting girls and women, PWG was considered safe, with the exception of VPW. Since VPW had moved to PWG only in 1995, POWRE replaced it after the 1996 solicitation; CAA and RPG were subsumed by POWRE in fiscal year 1998. Rather than being housed in Education and Human Resources where PWG, VPW, FAW, and CAA had been housed, POWRE became a cross-directorate program, with objectives of providing visibility for, encouraging, and providing opportunities for further career advancement, professional growth, and increased prominence of women in engineering and in the disciplines of science supported by NSF (NSF 1997, 1). Despite threats against affirmative action, the approach to achieving these objectives came through individual research grants to support science and engineering research of individual women researchers. POWRE did not retain from VPW the concept of committing 30 percent of time devoted to infrastructure to attract and retain women in science and engineering.

NSF became aware of several factors that might mitigate against POWRE and its effectiveness almost immediately:

1. The request for proposals for POWRE had been put together very rapidly.
2. POWRE had been removed from the former site of VPW (EHR and HRD) because PWG was focusing increasingly on K-12; this meant

that program officers from the research directorates, rather than from the Program for Women and Girls, were overseeing POWRE, enabling varying commitments depending upon the directorate.

3. Moving POWRE to the research directorates, coupled with having 100 percent of the time and support going to the science and engineering research of individual investigators, went against a growing sentiment that support for institutional and systemic approaches, rather than support of the research of individual women scientists, would be required to increase the percentage of women at all levels in science and engineering. As was anticipated, POWRE was replaced by ADVANCE in 2001 and continues today.

In sum, the NSF women's programs have moved over time from support for the individual woman scientist and her research to support for institutional transformations. This transition from the support for the individual to support for institutions and systems was deemed necessary to increase both the numbers and percentages of women in STEM disciplines.

A Profile of a Typical POWRE Awardee

Pat Pearson (name has been changed to preserve anonymity) grew up in a traditional family, with a physician father and a mother who worked as his receptionist. Her divorced aunt, a Ph.D. recipient from a prestigious technical institution, works as a consultant in the Northeast and serves as her role model.

Although Pat entered a private Southern institution with an equal interest in art history and engineering, she pursued engineering because of the scholarship she received. The small classes allowed her to receive significant attention from mentors who encouraged her and invited her to pursue research while an undergraduate. She particularly credits one professor, an MIT Ph.D., who encouraged her to compete in graduate school. In graduate school at the large public Research I on the West Coast, her interest in design led her to specialize in concrete technology, realizing that design influences people's behavior.

She followed the wishes of her husband, who was two years behind her in the program because he had worked for a while in industry, and took a faculty position in a very good place so that they could maximize their opportunities as a couple. Although she might have preferred a smaller liberal arts college or less prestigious institution, she took the position in civil engineering at a Research I public institution in the South. This opened the door for her husband to take a faculty positon there in the department rated number one in the country in his field. Sometimes she wishes for a less high-pressure situation, particularly since

now, at age 30 and in her third year on the faculty, they are considering starting a family.

The POWRE grant provided Pat with the opportunity to get started on her research. She used it as a springboard for other funding. She also supported one male and three female students with the grant.

Although Pat views balancing career and family as the greatest obstacle for women engineers, she recognizes other issues surrounding access to facilities and recruitment of students. She also notes the visibility of women in a field in which they are an extreme minority. This can be advantageous, since if they do well they will be remembered. However, mistakes are equally evident and memorable. (Rosser 2004, 20–21).

In 2012, Pat Pearson remains at the Research I public institution in the South, where she has advanced to the rank of full professor with tenure. Author of more than 100 technical publications and two patents, she has received numerous awards and honors. She also served as the ADVANCE Professor and as the associate dean for faculty development and scholarship. She and her husband now have two daughters.

Earlier Research on POWRE Awardees

From 1997 to 2000, approximately 400 NSF POWRE awardees responded to e-mail questionnaires asking about some of the major issues and opportunities academic women scientists and engineers faced and the impact of laboratory climate on their careers (Rosser 2001, 2004; Rosser and Lane 2002a). The relatively large sample size and high response rates coupled with lack of disciplinary bias suggested that these data might be generalized to the broader population of women scientists and engineers. All of the POWRE awardees were successful women scientists. The overwhelming majority had achieved tenure-track positions at universities, mostly at what were then called Research I (now Carnegie R1 doctoral universities—highest research activity) public institutions, but some at private or liberal arts colleges. All had received at least this major very competitive peer-reviewed grant from the prestigious National Science Foundation. Conducting follow-up interviews with a subsample of 40 questionnaire respondents helped to better understand the qualitative context for the problems and potential solutions. The results of this prior research were published in journal articles (Rosser 2001; Rosser and Daniels 2004; Rosser and Lane 2002a, 2002b; Rosser and Zieseniss 2000) and two books (Rosser 2004, 2012) and have been useful,

particularly to institutions with NSF ADVANCE grants, in identifying potential changes to remove barriers. Knowing and understanding the perceptions and experiences of these successful women faculty and the context available from their qualitative comments provided significant information that administrators and faculty used to develop institutional transformation strategies incorporated into ADVANCE grants (the successor to POWRE) and into other initiatives to attract, promote and retain women faculty.

While many reasons, including sexual harassment (Clery 2015; Jahren 2016; Shipman 2015) exist for why women leave science and engineering, some of the difficulties of balancing career and children and the problem of finding satisfactory dual career positions become particular issues for women scientists and engineers (Rosser 2004, 2012). The dual career situation especially is an issue for academic women scientists since a majority of them are married to, or partnered with, another scientist or engineer, often in the same field (Schiebinger et al. 2008). In contrast, most men in academic science are not married to, or partnered with, another scientist or engineer. A 2001 survey of American science, technology, engineering and mathematics (STEM) Ph.D.s found that single men and single women participate about equally in the STEM workforce. In contrast, a married female Ph.D. is 13 percent less likely to be employed than a married male Ph.D. If the woman is married with young children, then she is 30 percent less likely than a single male to be employed (Long 2001). Such losses ultimately result in very few women in senior and leadership positions in the STEM workforce.

Aggregated data also fail to adequately reveal women's attrition at every phase of the educational and career STEM pipeline. Similarly, academia reflects this decrease of women at each rung of the career ladder, with women in U.S. academic four-year institutions reported by NSF in 2015 making up 42.8 percent of assistant professors, 34.0 percent of associate professors, and 20.8 percent of full professors in science and engineering (Table 1.3). These percentages represent increases at all ranks compared to a decade ago, although R1 doctoral universities—highest research activity institutions (formerly, Research I institutions) have fewer women professors.

Several studies (Nelson 2005; Rosser et al. 2006) have drawn attention to the failure of the elite research institutions to hire women faculty in general, and women science and engineering faculty in particular, at rates comparable to the Ph.D. production of women from the science and engineering departments of those institutions. Many have sought to explain the small number of women in tenured positions relative to the

Table 1.3 Percentage of women doctoral scientists and engineers in academic institutions by field and rank in 1997 and 2013

	All science and engineering		*Psychology*		*Social sciences*		*Biology/Life sciences*		*Physical sciences*		*Engineering*		*Math and statistics*		*Computer science*	
	1997	*2013*	*1997*	*2013*	*1997*	*2013*	*1997*	*2013*	*1997*	*2013*	*1997*	*2013*	*1997**	*2013*	*1997*	*2013*
Assistant Professor	36.9	42.8	61.0	68.5	39.6	49.5	36.7	46.0	26.1	32.1	13.7	22.8	24.1	38.5	——	21.0
Associate Professor	25.7	34.0	44.3	57.6	32.4	46.7	22.9	31.3	13.5	25.3	6.3	19.0	14.3	22.2	——	25.0
Full Professor	11.6	20.8	22.5	41.2	14.9	26.6	13.1	23.4	4.2	15.2	1.4	7.5	6.7	16.2	——	12.5
Total (includes Instructor/Lecturer)	25.1	33.5	43.1	58.3	28.3	40.5	27.8	37.6	13.3	23.9	6.5	15.5	14.2	26.6	——	16.5

(a) First column on left for each discipline calculated by author from Commission on Professionals in Science and Technology (CPST), 2000, Table 5.1.
(b) Second column on right for each discipline calculated by author from data in National Science Foundation 2015. Women, minorities, and persons with disabilities, Table 9.25
*1997 data for Math and Statistics includes Computer Science

percentage of qualified women with Ph.D.s and the reasons for their relatively larger percentages in industry (Catalyst 1999; Etzkowitz et al. 1994), small liberal arts colleges (Rosser 2004; Schneider 2000), or in non-tenure track positions, such as research scientist or lecturer in research institutions (Arenson 2005; Mason et al. 2009, 2013). Although some disciplines, such as physics and astronomy, appear to be hiring women into tenure-track positions at R1 doctoral universities—highest research activity institutions at approximately the same percentages at which they receive their Ph.D.s (Ivie and Nies Ray 2005), other disciplines, such as chemistry (Nelson 2005), hired an exceptionally low percentage of women into tenure-track positions relative to the percentage of women Ph.D's produced by those same institutions. For example at the top 50 Ph.D.-granting institutions in chemistry, women accounted for 21 percent of assistant professors, 22 percent of associate professors, and only 10 percent of full professors (Marasco 2006).

In academic science and engineering, even in disciplines with increasing numbers and percentages of women, gender issues remain (Voosen 2016). Some evidence suggests that the budget cuts and increasing reliance on technology that have impacted higher education recently have exacerbated the gender issues, but little research has focused directly on the effects of the changes on successful women scientists who have remained in the professoriate. Having remained in academia and achieved seniority provides the POWRE awardee women with an interesting, unique perspective on this time period. Examining the persisting and changing perspectives of these women scientists who have been successful and stayed in academia during the last two decades constitutes the focus and contribution of this volume.

Re-administering the questionnaire in 2012 to the original 1997–2000 POWRE awardee respondents allows analyses of this unique data set to understand better their perceptions of these issues for academic women scientists some ten to fifteen years after their initial responses and yield insights about senior, compared to junior, women scientists. A re-survey of POWRE awardees in 2012 contributes to the variety of institutional, psychological, and social studies exploring the failure of the elite research institutions to hire women faculty in general, and women STEM faculty in particular, at rates comparable to the Ph.D. production of women from the STEM departments of those institutions.

Because the overwhelming majority of the POWRE awardees in 1997–2000 were untenured assistant professors, the barriers they originally identified are particularly problematic for younger women STEM faculty at

earlier stages of their academic careers. The quantitative results, and particularly the qualitative responses, to the re-administered survey provide insights into how this same group of individuals perceives career issues and laboratory climate fifteen years later, corresponding with a period of overall increasing numbers and percentages of women in STEM and a time of national and institutional focus on women STEM faculty.

This rare longitudinal study provides insights into what has changed and remained constant over fifteen years. In contrast to the many studies focused on why women leave STEM in general and academia in particular, this study centers on successful women. Since the POWRE awardees have remained in science and in academia, the quantitative results and qualitative comments of the survey provide indicators of conditions necessary for success over the long term.

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CHAPTER 2

Revisiting POWRE Awardees After a Decade: Continuing Issues for Successful Academic Women Scientists and Engineers

Abstract Changes occurred during the fifteen year period from 1997 to 2012 in both higher education and STEM. Although numbers and percentages of women increased overall in STEM fields, aggregated data mask vast differences among fields and women's attrition at every phase of the educational and career STEM pipeline. The quantitative results, and particularly the qualitative responses, to the re-administered POWRE survey provide insights into how this same group of individuals perceives career issues and laboratory climate ten to fifteen years later. Analyses from 2012 suggest that although tight funding and budget constraints present increased challenges, the issues from ten to fifteen years ago persist; balancing work with family responsibilities continues as the predominant challenge. Although the responses about laboratory climate reflect less consensus, the largest number of respondents did suggest that to some degree, their gender led to their being perceived as a problem, anomaly, or deviant in the laboratory or work environment.

Keywords STEM · Balancing work and family · Laboratory climate

> The climate has become more competitive. Faculty are expected to bring in more research dollars, yet the grant sources (such as NSF) are experiencing reduced funding and increased interference from Congress in scientific affairs. Thus, it becomes more difficult for all scientists and engineers, male and female alike to make progress in their careers. It is also true that

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> the financial rewards in academia are not what they should be and are shrinking. Unless one is able to find a position within industry, one is not going to have the financial reward that one should have for advanced education. Because universities are increasing teaching loads at the same time they are putting more pressure on faculty to produce research, it makes academia less and less family friendly. This will no doubt negatively impact the number of females within these professions. (2012 respondent from the 1997 POWRE cohort, Rosser 2013)

Ten to fifteen years after the initial administration of the e-mail questionnaire to the POWRE awardees, the first two questions of the initial questionnaire were re-administered to the original POWRE awardee respondents. Their responses should reveal issues that persist throughout careers or new issues, since the overwhelming majority of the POWRE professors were untenured assistant professors, when the questionnaire was first administered in 1997–2000. The barriers they identified at that time were particularly problematic for younger women scientists and engineers at early stages of their academic careers.

Re-administration of the Questionnaire

Each of the POWRE awardees for whom a valid e-mail address could be found was sent the following e-mail, with the date particularized for her POWRE awardee cohort of 1997, 1998, 1999, or 2000:

Dear Dr. xxx,

In 1998 you were kind enough to respond to an e-mail questionnaire about issues significant for attracting and retaining women faculty in science, technology, engineering or mathematics (STEM) in academia and your experiences as a POWRE awardee. As you may know, the responses you and other POWRE awardees gave became part of the results I published in a series of papers and two books that helped, along with the work of many others, to inform NSF's ADVANCE and the national conversations to improve the climate for STEM women faculty.

Now, more than a dozen years later, I would be most grateful if you would be willing to respond to the questions below. Because I'm interested in knowing whether your responses have changed over time, you'll note that two of the questions are the same ones you responded to more than a decade ago. Instead of including questions about the POWRE award, this questionnaire asks about institutional barriers and differences

between junior and senior women scientists and engineers. [Please note that the responses to the latter two questions are not analyzed or discussed in this chapter but will be discussed in Chapters 4, 5, and 6**].

All responses will be kept private. If information and quotations from your responses to the questionnaire are published, you will be identified by number only and the information will be written in a way that maintains your confidentiality and prevents recognition of you individually.

Thank you for responding to the questions below. Please do not hesitate to be in contact, if you have questions before or after you respond.

Sincerely,

Sue V. Rosser

**Through the manuscript [**] indicates that the material in [] was added by Rosser.

The first two e-mail questions were as follows:

1. What are the most significant issues/challenges/opportunities facing women scientists and engineers today as they plan their careers.
2. How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists and engineers.

Recipients responded in their own words to these open-ended questions, usually in sentences, but sometimes in phrases or paragraphs, since no Likert Scale, multiple choice, or rank order options were given. This chapter focuses on the results provided during the 2011–12 academic year from the original respondents to the first two questions to understand better their perceptions of the issues for academic women scientists some ten to fifteen years after their initial responses.

Response Rate

The questionnaire was e-mailed to all of the awardees who responded to the initial (1997–2000) questionnaire for whom a valid e-mail could be found; this included a total of 329 individuals. The questionnaires were first sent out between October, 2011 and January, 2012, with the first cohort receiving the questionnaire in October, 2011 and the final follow-up e-mail sent to the last cohort in March, 2012. Some initial respondents had died, according to information found on the Internet; for others, a valid e-mail address could not be found. Table 2.1 shows the number and

Table 2.1 Numbers and disciplinary distribution of respondents to questionnaire

Directorate or office[a]	*Total FY 1997 grants*[b]	*1997 Responded to email questions*	*2012 Email addresses*	*2012 Responded to email questions*	*Total FY 1998 grants*[b]	*1998 Responded to email questions*	*2012 Email addresses*	*2012 Responded to email questions*	*Total FY 1999 grants*	*1999 Responded to email questions*	*2012 Email addresses*	*2012 Responded to email questions*	*Total FY 2000 grants*	*2000 Responded to email questions*	*2012 Email addresses*	*2012 Responded to email questions*
BIO	17	10	9	8	43	27	23	14	36	25	22	11	41	22	20	10
CISE	10	10	7	5	19	11	7	6	10	6	6	3	11	8	8	2
EHR	3	3	2	1	7	1	1	1	7	5	3	2	6	3	2	2
ENG	19	15	11	5	28	23	19	12	30	18	17	9	26	13	12	4
GEO	10	8	7	5	15	10	5	2	12	8	6	3	17	12	11	6
MPS	18	9	8	7	34	22	20	6	43	25	23	10	44	28	27	17
SBE	19	12	10	3	27	22	19	9	21	11	8	5	25	18	16	7
Unknown	n/a	–	–	–	n/a	3[c]	–	–	n/a	–	–	–	n/a	1[c]	–	–
Totals[d]	96	67	54	34	173	119[e]	94	50	159	98[f]	85	43	170	105	96	48

Note: FY, fiscal year

N/A = not applicable (i.e., total grants awarded are known for each year of FY 1997–2000)

– = 0 percent or 0

[a]The National Science Foundation directorates represented in this study included Biological Sciences (BIO); Computer and Information Science and Engineering (CISE); Education and Human Resources (EHR); Engineering (ENG); Geosciences (GEO); Mathematical and Physical Sciences (MPS); and Social, Behavioral, and Economic Sciences (SBE)

[b]Some directorates included supplemental grants in their total grants awarded

[c]For three FY 1998 respondents and one FY 2000 respondent, the directorate was not evident from the email address

[d]This analysis does not include three respondents from the Office of Polar Programs (OPP) directorate for FYs 1997 and 1998 because the total number of respondents was too small to provide meaningful information. Therefore, the totals in this table for each award year do not include the OPP awards

[e]Three unknown directorates and five late respondents, not included in previous analyses (see Rosser 2001), were included in this analysis

[f]One additional respondent, not available in a prior study (Rosser 2001), was added to the FY 1999 data for this analysis

percentage of POWRE awardees that responded, grouped by the NSF disciplinary directorate, from cohorts from 1997, 1998, 1999, and 2000, and the number and percentage who responded to the re-administered questionnaire. From those for whom valid e-mail addresses could be found, of the total 175 who responded, the response rates were as follows: 63.0 percent of the 1997 awardees, 53.2 percent of the 1998 awardees, 50.6 percent of the 1999 awardees and 50.0 percent of the 2000 awardees. Ironically, the highest response rate came from the earliest, the 1997, cohort; they also had the highest response rate originally.

As was the case with the sample responding to the initial survey, as Table 2.1 shows, the sample responding to the 2011–2012 e-mail questionnaire in all four cohorts appeared to be representative with regard to discipline of the population of awardees, and the non-respondents did not appear to cluster in a particular discipline. The limited data available from the e-mail responses revealed no other respondent or non-respondent bias. Since the application for POWRE required a statement of "applicant's career objectives and relevance of the proposed activities to these objectives" and "impact of a POWRE award on the applicant's academic advancement and/or leadership roles," (NSF, National Science Foundation 1997), the women scientists and engineers receiving POWRE awards might have given some thought to issues surrounding gender, career, and science as they applied for the awards themselves.

Responses to Question 1: What Are the Most Significant Issues/Challenges/Opportunities Facing Women Scientists Today as They Plan their Careers?

Table 2.2 lists the 16 categories into which the data for the 1997–2000 responses to Question 1 were originally divided. These same categories were used so that the 2011–2012 data could be compared to the earlier data for each cohort. The original categories emerged from the coding of the textual replies. One original coauthor (Rosser and Zieseniss 2000) developed the categories and categorized each response; the other coauthor independently categorized the responses using the 16 divisions. Table 2.2 summarizes the results as pairs of columns. The first column of each pair presents data from the original cohort (e.g., 1997). The second column that appears to the right after each cohort (e.g., 2012) represents the percentage (and number in parentheses) from that

Table 2.2 Total responses to question 1[a]

Category		*1997*		*2012*		*1998*		*2012*		*1999*	
		Percent of responses		*Percent of responses*		*Percent of responses*		*Percent of responses*		*Percent of responses*	
1	Balancing work with family responsibilities (children, elderly relatives, etc.)	62.7	(42/67)	64.7	(22/34)	72.3	(86/119)	72.0	(36/50)	77.6	(76/98)
2	Time management/ balancing committee responsibilities with research and teaching	22.4	(15/67)	17.6	(6/34)	10.1	(12/119)	12.0	(6/50)	13.3	(13/98)
3	Low numbers of women, isolation, and lack of camaraderie/ mentoring	23.9	(16/67)	23.5	(8/34)	18.5	(22/119)	8.0	(4/50)	18.4	(18/98)
4	Gaining credibility/ respectability from peers and administrators	22.4	(15/67)	11.8	(4/34)	17.6	(21/119)	20.0	(10/50)	19.4	(19/98)
5	"Two-career" problem (balance with spouse's career)	23.9	(16/67)	32.4	(11/34)	10.9	(13/119)	10.0	(5/50)	20.4	(20/98)
6	Lack of funding/ inability to get funding	7.5	(5/67)	14.7	(5/34)	4.2	(5/119)	26.0	(13/50)	10.2	(10/98)

7	Job restrictions (location, salaries, etc.)	9.0	(6/67)	–	–	9.2	(11/119)	2.0	(1/50)	7.1	(7/98)
8	Networking	6.0	(4/67)	2.9	(1/34)	<1.0	(1/119)	12.0	(6/50)	–	–
9	Affirmative action backlash/discrimination	6.0	(4/67)	14.7	(5/34)	15.1	(18/119)	8.0	(4/50)	14.3	(14/98)
10	Positive: active recruitment of women/ more opportunities	6.0	(4/67)	–	–	10.1	(12/119)	10.0	(5/50)	9.2	(9/98)
11	Establishing independence	3.0	(2/67)	–	–	–	–	4.0	(2/50)	6.0	(6/98)
12	Negative social images	3.0	(2/67)	11.8	(14/34)	3.4	(4/119)	10.0	(5/50)	2.0	(2/98)
13	Trouble gaining access to nonacademic positions	1.5	(1/67)	–	–	1.7	(2/119)	2.0	(1/50)	1.0	(1/98)
14	Sexual harassment	1.5	(1/67)	–	–	<1.0	(1/119)	–	–	2.0	(2/98)
15	No answer	–	–	–	–	<1.0	(1/119)	–	–	1.0	(1/98)
16	Cutthroat competition	–	–	2.9	(1/34)	–	–	–	–	1.0	(1/98)

(continued)

Table 2.2 (continued)

Category	*2012*		*2000*		*2012*		*Overall*		*Overall*	
	Percent of responses		*Percent of responses*		*Percent of responses*		*Percent*	*1997–2000*	*Percent*	*2012*
1 Balancing work with family responsibilities (children, elderly relatives, etc.)	74.4	(32/43)	71.4	(75/105)	64.6	(31/48)	71.7	(279/389)	69.1	(121/175)
2 Time management/balancing committee responsibilities with research and teaching	11.6	(5/43)	13.3	(14/105)	18.8	(9/48)	13.9	(54/389)	14.8	(26/175)
3 Low numbers of women, isolation, and lack of camaraderie/mentoring	7.0	(3/43)	30.5	(33/105)	25.0	(12/48)	22.9	(89/389)	15.4	(27/175)
4 Gaining credibility/respectability from peers and administrators	16.3	(7/43)	21.9	(23/105)	6.3	(3/48)	20.0	(78/389)	13.7	(24/175)
5 "Two-career" problem (balance with spouse's career)	18.6	(8/43)	20.0	(21/105)	25.0	(12/48)	20.6	(80/389)	20.6	(36/175)
6 Lack of funding/inability to get funding	18.6	(8/43)	8.6	(9/105)	25.0	(12/48)	7.4	(29/389)	21.7	(38/175)
7 Job restrictions (location, salaries, etc.)	2.3	(1/43)	5.7	(6/105)	6.3	(3/48)	7.7	(30/389)	2.9	(5/175)
8 Networking	–	–	4.8	(5/105)	2.1	(1/48)	2.6	(10/389)	4.6	(8/175)
9 Affirmative action backlash/discrimination	9.3	(4/43)	12.4	(13/105)	20.8	(10/48)	12.6	(49/389)	13.7	(24/175)
10 Positive: active recruitment of women/more opportunities	4.6	(2/43)	14.3	(15/105)	12.5	(6/48)	10.3	(40/389)	7.4	(13/175)
11 Establishing independence	4.6	(2/43)	2.9	(3/105)	–	–	2.8	(11/389)	2.3	(4/175)
12 Negative social images	–	–	<1.0	(1/105)	4.2	(2/48)	2.3	(9/389)	12.0	(21/175)
13 Trouble gaining access to nonacademic positions	2.3	(1/43)	1.9	(2/105)	2.1	(1/48)	1.5	(6/389)	1.7	(3/175)
14 Sexual harassment	–	–	1.9	(2/105)	–	–	1.5	(6/389)	–	–
15 No answer	–	–	1.9	(2/105)	–	–	1.0	(4/389)	–	–
16 Cutthroat competition	2.3	(1/43)	1.9	(2/105)	–	–	0.8	(31/389)	1.1	(2/175)

– = 0% *or 0*

[a]*Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers

particular cohort giving that response in 2011–2012. Although most respondents replied with more than one answer, in some years, at least one awardee gave no answer to the question. Differences in responses across award years and across directorates clearly emerge when response frequencies are examined.

Just as in the initial surveys, an overwhelming number of respondents across all four years found "balancing work with family responsibilities" to be the most significant challenge facing female scientists and engineers in 2012. Although the other four of the top five responses from the initial survey continued to be frequent responses in 2011–2012, some issues such as the "low numbers of women, isolation, and lack of camaraderie/mentoring" decreased in frequency of response in 2011–2012. Most likely a reflection of the very difficult fiscal constraints, "lack of funding/inability to get funding" became the second most frequent response in 2011–2012 for all cohorts except the 1997 cohort.

Chart 2.1 focuses on the number of aggregated responses to Question 1 from 1997 to 2000 compared to 2012; the arrows show whether a particular response has moved up or down in ranking. As Chart 2.1 shows, in addition to "lack of funding/inability to get funding", that moved up from position nine, when the data from all original cohorts are aggregated, to position two in 2012, "negative social images" increased in 2012, moving up in frequency by three positions. No other response moved up or down by more than three positions, if at all.

Table 2.3 shows the responses to Question 1 when the data from all four years are pooled and the responses are categorized by the NSF directorate of the awardee; this categorization assumes that the NSF directorate granting the POWRE award serves as an indicator of the discipline or field of the awardee. (Note that for data interpretation, Education and Human Resources [EHR] is removed because the numbers are smaller and all awardees come from disciplinary backgrounds included in other NSF directorates.) Perhaps the most striking finding is the overall similarity among the directorates. "Balancing work with family responsibilities" stands out overwhelmingly as the major issue for women from all directorates, just as it did some fifteen years ago. The top six responses were fairly consistent across all directorates, with few exceptions. "Lack of funding", received a much higher response in 2012 from all directorates than it had in 1997–2000. As discussed earlier, this response probably reflects the very tight current fiscal funding situation.

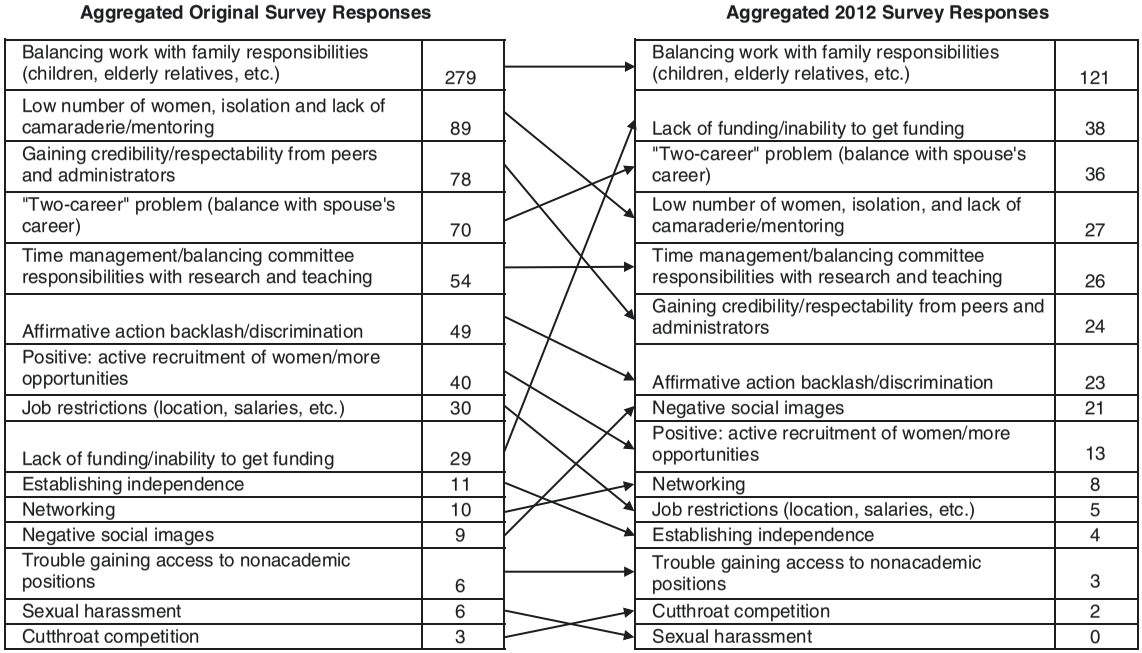

Chart. 2.1 Number of Aggregated Responses to Question 1 from 1997–2000 Compared to 2012

Table 2.3 Responses to question 1[a] according to directorate across all four years

Category		*SBE*				*MPS*				*ENG*			
		1997–2000 Percent of responses		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*	
1	Balancing work with family responsibilities (children, elderly relatives, etc.)	60.3	(38/63)	66.7	(16/24)	77.4	(65/84)	60.0	(24/40)	65.2	(45/69)	86.7	(26/30)
2	Time management/ balancing committee responsibilities with research and teaching	15.7	(10/63)	20.8	(5/24)	13.1	(11/84)	15.0	(6/40)	11.6	(8/69)	11.6	(3/30)
3	Low numbers of women, isolation, and lack of camaraderie/ mentoring	23.8	(15/63)	16.7	(4/24)	11.9	(10/84)	15.0	(6/40)	21.7	(15/69)	16.7	(5/30)
4	Gaining credibility/ respectability from peers and administrators	17.5	(11/63)	20.8	(5/24)	20.2	(17/84)	7.5	(3/40)	24.6	(17/69)	20.0	(6/30)

(*continued*)

Table 2.3 (continued)

Category		SBE				MPS				ENG			
		1997–2000 Percent of responses		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*	
5	"Two-career" problem (balance with spouse's career)	14.3	(9/63)	8.3	(2/24)	28.6	(24/84)	30.0	(12/40)	13.0	(9/69)	11.6	(3/30)
6	Lack of funding/ inability to get funding	4.8	(3/63)	20.8	(5/24)	7.1	(6/84)	12.5	(5/40)	8.7	(6/69)	26.7	(8/30)
7	Job restrictions (location, salaries, etc.)	3.3	(2/63)	4.2	(1/24)	7.1	(6/84)	–	–	5.8	(4/69)	–	–
8	Networking	1.6	(1/63)	8.3	(2/24)	1.2	(1/84)	2.5	(1/40)	–	–	3.3	(1/30)
9	Affirmative action backlash/ discrimination	7.9	(5/63)	12.5	(3/24)	6.0	(5/84)	12.5	(5/40)	15.9	(11/69)	6.6	(2/30)
10	Positive: active recruitment of women/more opportunities	7.9	(5/63)	8.3	(2/24)	15.5	(13/84)	10.0	(4/40)	13.0	(9/69)	3.3	(1/30)
11	Establishing independence	3.3	(2/63)	4.2	(1/24)	4.8	(4/84)	2.5	(1/40)	1.4	(1/69)	3.3	(1/30)
12	Negative social images	1.6	(1/63)	4.2	(1/24)	2.4	(2/84)	5.0	(2/40)	2.9	(2/69)	11.6	(3/30)
13	Trouble gaining access to nonacademic positions	1.6	(1/63)	–	–	2.4	(2/84)	–	–	–	–	3.3	(1/30)
14	Sexual harassment	3.3	(2/63)	–	–	1.2	(1/84)	–	–	–	–	–	–
15	No answer	4.8	(3/63)	–	–	–	–	–	–	1.4	(1/69)	–	–
16	Cutthroat competition	–	–	–	–	–	–	–	–	–	–	–	–

Table 2.3 (continued)

Category		*EHR*[b]				*CISE*				*BIO*				*GEO*			
		1997–2000 Percent of responses		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*	
1	Balancing work with family responsibilities (children, elderly relatives, etc.)	91.7	(11/12)	66.7	(4/6)	60.0	(21/35)	68.8	(11/16)	82.4	(70/85)	74.4	(32/43)	73.7	(28/38)	75.0	(12/16)
2	Time management/ balancing committee responsibilities with research and teaching	–	–	33.3	(2/6)	17.1	(6/35)	12.5	(2/16)	12.9	(11/85)	14.0	(6/43)	21.1	(8/38)	–	–
3	Low numbers of women, isolation, and lack of camaraderie/mentoring	33.3	(4/12)	33.3	(2/6)	31.4	(11/35)	12.5	(2/16)	20.0	(17/85)	11.6	(5/43)	39.5	(15/38)	6.2	(1/16)
4	Gaining credibility/ respectability from peers and administrators	25.0	(3/12)	–	–	31.4	(11/35)	–	–	16.5	(14/85)	18.6	(8/43)	13.2	(5/38)	18.8	(3/16)
5	"Two-career" problem (balance with spouse's career)	16.7	(2/12)	16.7	(1/6)	22.9	(8/35)	18.8	(3/16)	11.8	(10/85)	20.9	(9/43)	21.1	(8/38)	37.6	(6/16)
6	Lack of funding/ inability to get funding	–	–	33.3	(2/6)	5.7	(2/35)	12.5	(2/16)	8.2	(7/85)	30.2	(13/43)	10.5	(4/38)	25.0	(4/16)
7	Job restrictions (location, salaries, etc.)	8.3	(1/12)	–	–	5.7	(2/35)	–	–	11.8	(10/85)	4.6	(2/43)	10.5	(4/38)	6.2	(1/16)

(*continued*)

Table 2.3 (continued)

Category		EHR[b]				CISE				BIO				GEO			
		1997–2000 Percent of responses		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*		*1997–2000 Percent of responses*		*2012 Percent of responses*	
8	Networking	8.3	(1/12)	–	–	5.7	(2/35)	6.2	(1/16)	2.4	(2/85)	9.3	(4/43)	5.3	(2/38)	–	–
9	Affirmative action backlash/discrimination	8.3	(1/12)	16.7	(1/6)	20.0	(7/35)	18.8	(3/16)	11.8	(10/85)	14.0	(6/43)	23.7	(9/38)	18.8	(3/16)
10	Positive: active recruitment of women/more opportunities	8.3	(1/12)	16.7	(1/6)	8.6	(3/35)	6.2	(1/16)	3.5	(3/85)	7.0	(3/43)	15.8	(6/38)	–	–
11	Establishing independence	–	–	–	–	2.9	(1/35)	–	–	3.5	(3/85)	2.3	(1/43)	–	–	–	–
12	Negative social images	–	–	–	–	5.7	(2/35)	12.5	(2/16)	2.4	(2/85)	7.0	(3/43)	–	–	6.2	(1/16)
13	Trouble gaining access to nonacademic positions	–	–	33.3	(2/6)	5.7	(2/35)	–	–	1.2	(1/85)	2.3	(1/43)	–	–	–	–
14	Sexual harassment	–	–	–	(0/6)	5.7	(2/35)	–	–	–	–	–	–	2.6	(1/38)	–	–
15	No answer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16	Cutthroat competition	–	–	16.7	(1/6)	2.9	(1/35)	–	–	1.2	(1/85)	2.3	(1/43)	2.6	(1/38)	–	–

– = 0% or 0

[a]*Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers? SBE, Social Behavioral, and Economic Sciences; MPS, Mathematical and Physical Sciences; ENG, Engineering; EHR, Education and Human Resources; CISE, Computer and Information Science and Engineering; BIO, Biological Sciences; GEO, Geosciences

[b]Because of the low numbers of awardees, the EHR directorate should be carefully interpreted here. Many of the women representing this directorate have other disciplinary training and could be classified in other directorates. We have chosen not to interpret the EHR responses as a result

Table 2.4 presents the frequency of the first response for each category for Question 1 for each awardee cohort by year. Most respondents gave more than one answer to each question and each answer was categorized separately. This typically resulted in more than one answer per respondent for each question. Because of the multiple responses, the first response to each question was also analyzed separately. The data in Table 2.4 again reinforce that the first six responses represent the most frequent response. "Low numbers of women, isolation, and lack of camaraderie/mentoring" appeared to be less of a problem for 2012 respondents than for any of the 1997–2000 cohorts; this held for women in engineering and even in computer science, in contrast to what might be suggested by the NSF data showing continuing low percentages of women faculty in those disciplines (Table 1.3). Perhaps this reflects the growing numbers of women in STEM overall or that as women become senior they develop more national and international connections who serve as colleagues.

To more clearly examine general themes, all responses in Question 1 were grouped into four categories. Table 2.5 shows the groupings of all responses to Question 1. The four categories in Table 2.5 represent groupings of more similar responses that emerged from a discussion of the 16 categories and data at a national conference by 30 social scientists, scientists, and engineers whose work focuses on women and science (Rosser 1999). Category A. Pressures women face in balancing career and family; Category B. Problems faced by both men and women scientists and engineers in the current environment of tight resources which may pose particular difficulties for women; Category C. Issues faced by women because of their low numbers and stereotypes held by others regarding gender; Category D. More overt discrimination and harassment. The means of the percentage of responses for each of the four 1997 to 2000 cohorts is compared with the 2012 mean percentage response for that cohort. Finally, the overall aggregate mean percentage of earlier responses for all four cohorts for the category is compared with the aggregate 2012 percentage response. Adding restrictions because of spousal situations (Responses 5 and 7) to "balancing work with family responsibilities" (Response 1) suggests that Category A, pressures women face in balancing career and family, continues as the most significant barrier a decade or more after the initial survey, identified by female scientists and engineers regardless of directorate or year of initial award.

Table 2.4 First responses to question 1[a] by year of professional opportunities for women in research and education award

Category		*1997*		*2012*		*1998*		*2012*		*1999*	
		Percent of responses		*Percent of responses*		*Percent of responses*		*Percent of responses*		*Percent of responses*	
1	Balancing work with family responsibilities (children, elderly relatives, etc.)	46.3	(31/67)	35.3	(12/34)	60.5	(2/119)	48.0	(24/50)	54.1	(53/98)
2	Time management/ balancing committee responsibilities with research and teaching	9.0	(6/67)	–	–	4.2	(5/119)	4.0	(2/50)	6.1	(6/98)
3	Low numbers of women, isolation, and lack of camaraderie/ mentoring	7.5	(5/67)	5.9	(2/34)	8.4	(10/119)	2.0	(1/50)	9.2	(3/98)
4	Gaining credibility/ respectability from peers and administrators	7.5	(5/67)	5.9	(2/34)	5.9	(7/119)	12.0	(6/50)	3.1	(8/98)
5	"Two-career" problem (balance with spouse's career)	7.5	(5/67)	17.6	(6/34)	2.5	(3/119)	–	–	8.2	(4/98)

6	Lack of funding/ inability to get funding	7.5	(5/67)	11.8	(4/34)	1.7	(2/119)	20.0	(10/50)	4.1	(2/98)
7	Job restrictions (location, salaries, etc.)	1.5	(1/67)	–	–	5.0	(6/119)	–	–	2.0	(2/98)
8	Networking	3.0	(2/67)	2.9	(1/34)	<1.0	(1/119)	–	–	–	–
9	Affirmative action backlash/discrimination	1.5	(1/67)	5.9	(2/34)	6.7	(8/119)	4.0	(2/50)	7.1	(1/98)
10	Positive: active recruitment of women/ more opportunities	1.5	(1/67)	–	–	1.0	(1/119)	2.0	(1/50)	1.0	(3/98)
11	Establishing independence	1.5	(1/67)	–	–	–	–	2.0	(1/50)	3.1	(1/98)
12	Negative social images	3.0	(2/67)	2.9	(1/34)	1.7	(2/119)	4.0	(2/50)	1.0	(1/98)
13	Trouble gaining access to nonacademic positions	1.5	(1/67)	–	–	<1.0	(1/119)	–	–	–	–
14	Sexual harassment	1.5	(1/67)	–	–	–	–	–	–	–	–
15	No answer	–	–	–	–	<1.0	(1/119)	–	–	1.0	(1/98)
16	Cutthroat competition	–	–	2.9	(1/34)	–	–	–	–	1.0	(1/98)

(continued)

Table 2.4 (continued)

Category	*2012*		*2000*		*2012*		*Overall*			
	Percent of responses		*Percent of responses*		*Percent of responses*		*Percent 1997–2000*		*Percent 2012*	
1 Balancing work with family responsibilities (children, elderly relatives, etc.)	60.0	(26/43)	91.7	(11/12)	52.0	(25/48)	52.7	(205/389)	53.1	(93/175)
2 Time management/balancing committee responsibilities with research and teaching	2.3	(1/43)	–	–	6.2	(3/48)	4.4	(17/389)	3.4	(6/175)
3 Low number of women, isolation, and lack of camaraderie/mentoring	4.6	(2/43)	33.3	(4/12)	6.2	(3/48)	5.6	(22/389)	4.6	(8/175)
4 Gaining credibility/respectability from peers and administrators	9.3	(4/43)	25.0	(3/12)	2.1	(1/48)	5.9	(23/389)	7.4	(3/175)
5 "Two-career" problem (balance with spouse's career)	4.6	(2/43)	16.7	(2/12)	2.1	(1/48)	3.6	(14/389)	5.1	(9/175)
6 Lack of funding/inability to get funding	7.0	(3/43)	–	–	14.6	(7/48)	2.3	(9/389)	13.7	(24/175)
7 Job restrictions (location, salaries, etc.)	–	–	8.3	(1/12)	2.1	(1/48)	2.1	(8/389)	<1.0	(1/175)
8 Networking	–	–	8.3	(1/12)	2.1	(1/48)	1.0	(4/389)	1.1	(2/175)
9 Affirmative action backlash/discrimination	7.0	(3/43)	8.3	(1/12)	8.3	(4/48)	2.8	(11/389)	6.3	(11/175)
10 Positive: active recruitment of women/more opportunities	–	–	8.3	(1/12)	2.1	(1/48)	1.5	(6/389)	1.1	(2/175)
11 Establishing independence	–	–	–	–	–	–	<1.0	(2/389)	<1.0	(1/175)
12 Negative social images	–	–	–	–	–	–	1.0	(4/389)	1.7	(3/175)
13 Trouble gaining access to nonacademic positions	2.3	(1/43)	–	–	2.1	(1/48)	<1.0	(2/389)	1.1	(2/175)
14 Sexual harassment	–	–	–	–	–	–	–	(1/389)	–	–
15 No answer	–	–	–	–	–	–	<1.0	(2/389)	–	–
16 Cutthroat competition	2.3	(1/43)	–	–	–	–	–	(1/389)	1.1	(2/175)

– = 0% or 0

[a] *Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers?

The second grouping, Category B (Responses 3, 4, 8, 10 and 12) resulting from the low numbers of female scientists and engineers and consequent stereotypes surrounding expectations about their performance, appears to have decreased in frequency slightly in 2012 compared to the original survey cohort, with one exception (1998 cohort shows an increase in 2012, Table 2.5). Table 2.6 shows the groupings of first responses only to Question 1 into the four categories, across years of award for each of the original four first cohort responses compared with the first responses for 2012; the last two columns on the right show the overall aggregate mean of earlier first responses for all four cohorts for that category. Analyses of the first responses (Table 2.6) in Category B indicate decreases in responses in 2012 in all cohorts, including the 1998 cohort. "Isolation and lack of mentoring", as well as "gaining credibility and respectability from peers and administrators", typify Category B.

In contrast to Category B, Category C (Responses 2, 6, and 16) has increased in frequency in 2012. Category C includes issues faced by both male and female scientists and engineers. "Time management/balancing committee responsibilities with research and teaching" continues to be a problem for women because female faculty members are often asked to serve on more committees to meet gender diversity needs, even while they are still junior and to advise more students, either formally or informally (Burroughs Wellcome Fund & Howard Hughes Medical Institute 2004). The increase in frequency response in Category C appears to come from a higher "lack of funding/inability to get funding" response in 2012 compared to more than a decade ago (Tables 2.5 and 2.6). As indicated by first responses (Table 2.4), this response in 2012 increased across all cohorts, the extreme case being going from 0 percent in 2000 to 14.6 percent in 2012.

Table 2.7 shows the categorization of first response to Question 1 across directorates, and 2.8 shows the categorization of all responses to Question 1 across directorates. Note that when all responses are aggregated across directorates, the percentages are roughly proportional to the mean category responses across award year. When only first responses are categorized by directorate, in 2012, CISE parallels the other directorates, having higher responses in Category A and lower in Category B. This may suggest that women in computer science, despite the lower numbers of women receiving degrees at the bachelors and masters level (Table 1.1), may no longer perceive problems of low numbers to be of higher priority

Table 2.5 Categorization of question 1[a] across year of award

Category	*Response numbers*[b]	*Means of responses*								*Overall*	
		1997 (%)	*2012 (%)*	*1998 (%)*	*2012 (%)*	*1999 (%)*	*2012 (%)*	*2000 (%)*	*2012 (%)*	*1997–2000 (%)*	*2012 (%)*
A Pressures women face in balancing career and family	1, 5, 7	31.9	32.4	30.8	28.0	35.0	31.8	32.4	32.0	32.5	31.0
B[c] Problems faced by women because of their low numbers and stereotypes held by others regarding gender	3, 4, 8, 10, 12	12.3	10.0	10.1	12.4	9.8	5.5	14.5	10.0	11.7	9.5
C Issues faced by both male and female scientists and engineers in the current environment of tight resources, which may pose particular difficulties for women	2, 6, 16	10.0	11.7	4.8	12.7	8.2	10.8	7.9	14.6	7.7	12.4
D More overt discrimination and harassment	9, 11, 13, 14	3.0	3.9	4.4	3.5	5.8	8.0	4.8	5.7	4.5	5.3

[a] *Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers?

[b] Given the responses from all 4 years, after receiving faculty comments at various presentations of this research and after working with the data, we exchanged two questions from both Categories B and D to better reflect the response groupings. Specifically, Responses 10 and 12 (considered in Category D in Rosser and Zieseniss 2000) were moved to Category B. Similarly, Responses 11 and 13 (included in Category B in Rosser and Zieseniss 2000) were placed into Category D

[c] The alphabetic designations for Categories B and C have been exchanged, compared with earlier articles (Rosser and Zieseniss 2000), to present descending response percentages

Table 2.6 Categorization of first responses to question 1[a] across year of award

Category	*Response numbers*[b]	*Means of responses*								*Aggregated Means*	
		1997 (%)	*2012 (%)*	*1998 (%)*	*2012 (%)*	*1999 (%)*	*2012 (%)*	*2000 (%)*	*2012 (%)*	*1997–2000 (%)*	*2012 (%)*
A Pressures women face in balancing career and family	1, 5, 7	18.4	17.6	22.7	16.0	21.4	21.5	18.1	18.7	20.2	18.4
B[c] Problems faced by women because of their low numbers and stereotypes held by others regarding gender	3, 4, 8, 10, 12	4.5	3.5	4.5	4.0	2.9	2.8	4.9	2.5	4.2	3.2
C Issues faced by both male and female scientists and engineers in the current environment of tight resources, which may pose particular difficulties for women	2, 6, 16	5.5	6.9	5.5	8.0	3.7	3.9	3.2	6.9	4.5	6.4
D More overt discrimination and harassment	9, 11, 13, 14	1.5	1.5	1.5	1.5	2.6	2.3	2.4	2.6	2.0	2.0

[a]*Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers?

[b]Given the responses from all four years, after receiving faculty comments at various presentations of this research and after working with the data, we exchanged two questions from both Categories B and D to better reflect the response groupings. Specifically, Responses 10 and 12 (considered in Category D in Rosser and Zieseniss 2000) were moved to Category B. Similarly, Responses 11 and 13 (included in Category B in Rosser and Zieseniss 2000) were placed into Category D

[c]The alphabetic designations for Categories B and C have been exchanged, compared with earlier articles (Rosser and Zieseniss 2000), to present descending response percentages

Table 2.7 Categorization of first responses to question 1[a] across directorates

Category	Response numbers[b]	Means of responses													
		SBE		MPS		ENG		EHR		CISE		BIO		GEO	
		1997–2000 (%)	2012	1997–2000 (%)	2012	1997–2000 (%)	2012	1997–2000 (%)	2012	1997–2000 (%)	2012	1997–2000 (%)	2012	1997–2000 (%)	2012 (%)
A Pressures women face in balancing career and family	1, 5, 7	19.1	20.8	23.8	17.5	20.3	20.0	22.2	16.7	12.4	20.8	21.2	17.1	20.0	16.7
B[c] Problems faced by women because of their low numbers and stereotypes held by others regarding gender	3, 4, 8, 10, 12	3.5	4.2	3.6	3.5	4.3	4.7	6.7	0.0	7.4	1.2	2.6	1.8	3.1	3.8
C[c] Issues faced by both male and female scientists and engineers in the current environment of	2, 6, 16	3.7	2.8	2.4	5.0	2.4	6.7	–	11.1	2.9	4.1	4.3	10.1	5.3	6.3
D More overt discrimination and harassment	9, 11, 13, 14	2.4	1.0	0.9	1.2	2.2	0.8	–	4.2	4.3	4.7	2.7	1.7	2.0	1.6

– = 0% or 0

[a] *Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers? SBE, Social, Behavioral, and Economic Sciences; MPS, Mathematical and Physical Sciences; ENG, Engineering; EHR, Education and Human Resources; CISE, Computer and Information Science and Engineering; BIO, Biological Sciences; GEO, Geosciences

[b] Given the responses from all four years, after receiving faculty comments at various presentations of this research and after working on the data, we exchanged two questions from both Categories B and D to better reflect the response groupings. Specifically, Responses 10 and 12 (considered in Category D in Rosser and Zieseniss 2000) were moved to Category B. Similarly, Responses 11 and 13 (included in Category B in Rosser and Zieseniss 2000) were placed into Category D

[c] The alphabetic designations for Categories B and C have been exchanged, compared with earlier articles (Rosser and Zieseniss 2000), to present descending response percentages

than pressure to balance career and family, as they did in 1997–2000. Engineers have a slightly higher response rate in Category B in 2012.

Category D (Responses 9, 11, 13, and 14) identifies barriers of overt harassment and discrimination faced by female scientists and engineers. After the 2005 remarks by then Harvard President Larry Summers regarding women's aptitudes for science and unwillingness to put in long hours (Summers 2005), few people doubt these more overt barriers, although the percentages responding to Category D remained relatively stable over the decade, with the exception of EHR, where small numbers can contribute to large percentage increase (Table 2.8). The study by Jahren (2016) and the controversy about the failure of elite institutions such as University of California at Berkeley to adequately discipline and remove known sexual harassers such as Geoff Marcy because of his prominence in astronomy (Clery 2015), document continuing issues of harassment and discrimination.

Table 2.9 presents the frequency of the first response to Question 1 by directorate of awardee, pooled over four years. Again, for most directorates, the first six responses plus "affirmative action/backlash discrimination" for MPS, BIO, and GEO are the most frequent. Women in ENG and CISE in 2012 gave higher responses to "balancing career and family" and "lack of funding" and lower first responses to "low numbers of women, isolation, and lack of camaraderie" and "mentoring" than their earlier cohorts had. Perhaps this reflects increased percentages of women faculty in those disciplines, despite the small percentage of women students (Table 1.1).

The following example quotations from the respondents in 2012 drawn from all four initial cohorts provide the qualitative context for the categories. 2012 respondents express the continuing barriers, the perceived changes, or new faces for the issues.

Category A: Pressures Women Face in Balancing Career and Family

> There continue to be many issues around negotiating marriage/relationship/family and career (and those issues seem more pronounced for women than for men*). The shrinking base of tenure-track positions contributes vastly to the problem by limiting the options one has for making job responsibilities work with relationships. A surprising number of my younger female colleagues (compared to my younger male colleagues*) are not married or are living apart from marriage partners and significant others because finding two jobs together wasn't feasible. Two of my younger female colleagues who

Table 2.8 Categorization of all responses to question 1[a] across directorates

Category	*Response numbers*[b]	*Means of responses*													
		SBE		*MPS*		*ENG*		*EHR*		*CISE*		*BIO*		*GEO*	
		1997–2000 (%)	*2012 (%)*	*1997–2000 (%)*	*2012*	*1997–2000 (%)*	*2012*	*1997–2000 (%)*	*2012*	*1997–2000 (%)*	*2012*	*1997–2000 (%)*	*2012*	*1997–2000 (%)*	*2012*
A Pressures women face in balancing career	1, 5, 7	26.0	26.4	37.7	30.0	28.0	32.8	88.9	27.8	29.5	29.2	35.3	33.3	35.1	39.6
B[c] Problems faced by women because of their 3, 4, 8, 10, 12 low numbers and stereotypes held by others regarding gender	3, 4, 8, 10, 12	10.5	11.7	10.2	8.0	12.4	11.0	15.0	10.0	16.6	7.5	9.0	10.7	14.8	6.2
C[c] Issues faced by both male and female scientists and engineers in the current	2, 6, 16	6.8	13.9	6.7	9.2	6.8	12.8	–	27.8	8.6	8.3	7.4	15.5	11.4	8.3
D More overt discrimination and harassment	9, 11, 13, 14	4.0	4.2	3.6	3.8	4.3	3.3	2.1	12.5	8.6	4.7	4.1	4.6	6.6	4.7

– = 0% or 0

[a] *Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers?

[b] Given the responses from all four years, after receiving faculty comments at various presentations of this research and after working on the data, we exchanged two equestions from both Categories B and D to better reflect the response groupings. Specifically, Responses 10 and 12 (considered in Category D in Rosser and Zieseniss 2000) were moved to Category B. Similarly, Responses 11 and 13 (included in Category B in Rosser and Zieseniss 2000) were placed into Category D

[c] The alphabetic designations for Categories B and C have been exchanged, compared with earlier articles (Rosser and Zieseniss 2000), to present descending response percentages

Table 2.9 First response to question 1[a] according to directorate across all four years

Category	*SBE*				*MPS*				*ENG*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
1 Balancing work with family responsibilities (children, elderly relatives, etc.)	50.8	(32/63)	62.5	(15/24)	60.7	(51/84)	45.0	(18/40)	50.7	(35/69)	60.0	(18/30)
2 Time management/ balancing committee responsibilities with research and teaching	6.3	(4/63)	4.2	(1/24)	4.8	(4/84)	2.5	(1/40)	4.3	(3/69)	–	–
3 Low numbers of women, isolation, and lack of camaraderie/ mentoring	11.1	(7/63)	4.2	(1/24)	2.4	(2/84)	10.0	(4/40)	11.6	(8/69)	3.3	(1/30)
4 Gaining credibility/ respectability from peers and administrators	3.2	(2/63)	8.4	(2/24)	9.2	(8/84)	2.5	(1/40)	7.2	(5/69)	16.7	(5/30)
5 "Two-career" problem (balance with spouse's career)	4.8	(3/63)	–	–	10.7	(9/84)	7.5	(3/40)	7.2	(5/69)	–	–

(*continued*)

Table 2.9 (continued)

Category	*SBE*				*MPS*				*ENG*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
6 Lack of funding/ inability to get funding	4.8	(3/63)	4.2	(1/24)	2.4	(2/84)	12.5	(5/40)	2.9	(2/69)	20.0	(6/30)
7 Job restrictions (location, salaries, etc.)	1.6	(1/63)	–	–	–	–	–	–	2.9	(2/69)	–	–
8 Networking	1.6	(1/63)	–	–	1.2	(1/84)	2.5	(1/40)	–	–	–	–
9 Affirmative action backlash/ discrimination	4.8	(3/63)	–	–	–	–	5.0	(2/40)	8.7	(6/69)	3.3	(1/30)
10 Positive: active recruitment of women/more opportunities	–	–	4.2	(1/24)	3.6	(3/84)	2.5	(1/40)	–	–	–	–
11 Establishing independence	3.2	(2/63)	4.2	(1/24)	1.2	(1/84)	–	–	–	–	–	–
12 Negative social images	1.6	(1/63)	4.2	(1/24)	1.2	(1/84)	–	–	2.9	(2/69)	3.3	(1/30)
13 Trouble gaining access to nonacademic positions	1.6	(1/63)	–	–	12	(1/84)	–	–	–	–	–	–
14 Sexual harassment	–	–	–	–	1.2	(1/84)	–	–	–	–	–	–
15 No answer	4.8	(3/63)	–	–	–	–	–	–	–	–	–	–
16 Cutthroat competition	–	–	–	–	–	–	–	–	–	–	–	–

Table 2.9 (continued)

Category	*EHR*[b]				*CISE*				*BIO*				*GEO*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
1 Balancing work with family responsibilities (children, elderly relatives, etc.)	58.3	(7/12)	50.0	(3/6)	31.4	(11/35)	50.0	(8/16)	57.6	(49/85)	41.9	(18/43)	50.0	(19/38)	43.8	(7/16)
2 Time management/ balancing committee responsibilities with research and teaching	0.0	(0/12)	33.3	(2/6)	5.7	(2/35)	–	–	7.1	(6/85)	4.6	(2/43)	10.5	(4/38)	–	–
3 Low numbers of women, isolation, and lack of camaraderie/ mentoring	16.7	(1/6)	–	–	17.1	(6/35)	–	–	7.1	(6/85)	4.6	(2/43)	10.5	(4/38)	6.25	(1/16)
4 Gaining credibility/ respectability from peers and administrators	8.3	(1/12)	–	–	14.3	(5/35)	–	–	3.5	(3/85)	4.6	(2/43)	2.6	(1/38)	12.5	(2/16)
5 "Two-career" problem (balance with spouse's career)	8.3	(1/12)	–	–	5.7	(2/35)	12.5	(2/16)	1.2	(1/85)	7.0	(3/43)	7.9	(3/38)	6.25	(1/16)
6 Lack of funding/ inability to get funding	–	–	–	–	2.9	(1/35)	6.2	(1/16)	5.9	(5/85)	23.3	(10/43)	5.3	(2/38)	18.8	(3/16)
7 Job restrictions (location, salaries, etc.)	–	–	–	–	–	–	–	–	4.7	(4/85)	2.3	(1/43)	2.6	(1/38)	–	–

(*continued*)

Table 2.9 (continued)

Category	*EHR*[b]				*CISE*				*BIO*				*GEO*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
8 Networking	–	–	–	–	2.9	(1/35)	18.8	(3/16)	–	–	–	–	2.6	(1/38)	–	–
9 Affirmative action backlash/ discrimination	–	–	–	–	14.3	(5/35)	0.0	(0/16)	8.2	(7/85)	4.6	(2/43)	7.9	(3/38)	6.25	(1/16)
10 Positive: active recruitment of women/more opportunities	8.3	(1/12)	–	–	2.9	(1/35)	–	–	1.2	(1/85)	–	–	–	–	–	–
11 Establishing independence	–	–	–	–	2.9	(1/35)	6.2	(1/16)	1.2	(1/85)	–	–	–	–	–	–
12 Negative social images	–	–	–	–	–	–	–	–	1.2	(1/85)	–	–	–	–	–	–
13 Trouble gaining access to nonacademic positions	–	–	16.7	(1/6)	–	–	–	–	1.2	(1/85)	2.3	(1/43)	–	–	–	–
14 Sexual harassment	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
15 No answer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
16 Cutthroat competition	–	–	–	–	–	–	6.2	(1/16)	–	–	2.3	(1/43)	–	–	–	–

– 0% or 0

[a]*Question 1*: What are the most significant issues/challenges/opportunities facing women scientists today as they plan their careers? SBE, Social Behavioral, and Economic Sciences; MPS, Mathematical and Physical Sciences; ENG, Engineering; EHR, Education and Human Resources; CISE, Computer and Information Science and Engineering; BIO, Biological Sciences; GEO, Geosciences

[b]Because of the low numbers of awardees, the EHR directorage should be carefully interpreted here. Many of the women representing the directorate have other disciplinary training and could be classified in other directorates. We have chosen not to interpret the EHR responses as a result

are married and employed by the university live in different cities from their husbands. There are few options for a "trailing spouse," and men seem less amenable than women to play the trailing partner role, with the result that happily combining work and family is more problematic for women with academic careers. (2012 respondent from 1997 cohort)

*Note that all () within the quotations were placed there by the respondents in the texts of their e-mails.

Family issues still seem to rest disproportionately on women. Meaning the women do all the research and teaching and service that the men do and THEN all the care giving, particularly noticeable for faculty with elderly parents. I have not seen any progress on this issue/challenge yet. (2012 respondent from 1998 cohort)

The usual: balancing work and family needs. I think the economic slowdown has been particularly hard on female scientists as they still tend to partner up with other scientists, so they suffer from the two-body problem more than men. (2012 respondent from 2000 cohort)

Family responsibilities are assumed by women, and until the expectations change so that men see families as their responsibility, things won't improve for women. And academic responsibilities do interfere with family life. The travel schedule is punishing. Academic life was invented by men, especially in CS, where there are conferences year round, and you are expected to appear at them to build a reputation. (2012 respondent from 2000 cohort)

Category B: Problems Faced by Women Because of their Low Numbers and Stereotypes Held by Others Regarding Gender

The major challenge I see is that the cutting edge science and engineering remain out of reach of the vast majority if not all women. While presence of women in science and engineering has become more or less accepted, I think that most often less significant scientific tasks are delegated to women. Men remain in the driving seat, especially in cutting edge science and areas that have been traditionally considered "to belong" to them. (2012 respondent from 1998 cohort).

As a woman of color who is a first generation Ph.D. in higher education, I have found that not having a someone such as a mentor to help with understanding the tenure process is a major impediment to tenure and promotion. (2012 respondent from 2000 cohort)

Science is becoming increasingly interactive and multidisciplinary. Successful scientists are those who have not only strong disciplinary skills, but also the ability to communicate well and maintain strong networks. I believe that it can be harder for women sometimes to develop and maintain strong networks in the same way as men can. This is especially true when

women are in the minority. Getting ahead still sometimes requires getting access to the "old boys club". In my opinion, it is often not that men are deliberately trying to exclude women, it's just that it sometimes feels a little awkward to know how to include them. Some of the standard ways of engaging with fellow male colleagues might need to be adapted to allow women scientists to be part of the community. In my experience, being successful requires a strong level of personal drive and desire to achieve. While these characteristics are perceived as positives in men, in women there is still sometimes a slight negative. (2012 respondent from 2000 cohort)

I often hear people say that "women don't apply for leadership positions because they actually don't want them since they have families and they prefer positions of less responsibility . . .", or that "actually out of twenty names that came up in the nominating committee, hers never did . . ." (this even though she is a professor at the number one school in the country and that is exactly her expertise . . .*) There is generally a problem of invisibility or the assumption that women should be less ambitious and expect less. (2012 respondent from 1997 cohort)

There is a presumption that women are not interested in having a career in physics and therefore, women are overlooked in recruitment and promotion. (2012 respondent from 1997 cohort)

The extra work a woman needs to put in to convince colleagues (men and women alike*) that she is as good as an equivalently good man. Even when asking things from a secretary, a female professor needs to put some extra effort to get the same response as a male professor. The same is true for speaking up in a meeting, managing not to be interrupted, supporting an idea, etc. Everything seems to require just a tad of extra effort (a differential we would say using math language*). Cumulatively over a career, these "tads" make up for a large extra effort. (2012 respondent from 1999 cohort)

Respect from colleagues (I notice that's what the MIT follow up highlighted as being still a major problem for women faculty there too*). (2012 respondent from 1998 cohort)

Category C: Issues Faced by both Male and Female Scientists and Engineers in the Current Environment of Tight Resources, which may Pose Particular Difficulties for Women

Funding sources are drying up; very discouraging. For academic scientists, move to adjunct teaching, online teaching will decrease the number of positions available, especially tenure track positions. Sexism is still a problem, coupled with the assumption that all women are "motherly" and want to take on lots and lots of "helpful" projects. (2012 respondent from 1999 cohort)

The tendency of women to be nice and agreeable and not to stand up for issues like pay and promotion equality; the tendency of men to either not notice or not care that women are being paid less and promoted less often; and the willingness of management (men and women alike*) to go along with the convenience of paying lower salaries and not working to help women get promotions. (2012 respondent from 1997 cohort)

Rising expectations for tenure-track faculty combined with year to year uncertainty in funding availability exacerbates the lack of flexibility in career trajectory for women who wish to start a family or who need to provide care for elderly family members. (2012 respondent from cohort 1999)

Category D: More Overt Discrimination and/or Harassment

The Good-Old-Boy network is still very strong. Faculty positions are often given to "known" people—former students, collaborators, etc. Often faculty positions are intentionally narrowly defined to a particular research area, for example, to narrow the pool to make it easier to justify hiring the pre-selected candidates. Many faculty at my institution had "connections" before coming here, and were "helped" to get their job. Even though searches are supposedly "open" and there are "search committees", and the University has an "affirmative action" office who signs off on each hire, the process is often circumvented via how or when the job is advertised, or simply by senior faculty bullying junior faculty into selecting their target candidates. Sometimes the Good-Old-Boy happens to be a female, but more likely not, so it is biased against women, and the Good-Old-Gal who does get hired is not necessarily the best female available, just the one with the connections. (2012 respondent from 2000 cohort)

Other challenges include unconscious bias (which also affects funding rates*), often accompanied by a distrust/dislike of successful women that have an opinion. (2012 respondent from 1997 cohort)

Sexism. (2012 respondent from 1998 cohort)

The good old boy system is still alive and well and serves as a barrier to advancement and funding. (2012 respondent from 2000 cohort)

Responses to Question 2: How does the Laboratory Climate (or its Equivalent in Your Subdiscipline) Impact upon the Careers of Women Scientists?

Question 2 of the e-mail survey attempted to explore women's perceptions of their work environments. Across all award years, "balancing career and family time away from home" remained a frequent response in 2012,

but not the answer given by more respondents than any other, as it had been in 1997–2000. As Table 2.10 documents, the responses given to this question reflect less consensus. Awardees from all years, but particularly 1999 cohort awardees responding in 2012, had some difficulty understanding the question. Although many women did not mention problems in either their laboratory or work environment related to gender issues (Responses 3, 4, and 9), the largest number of responses did suggest that to some degree, their gender led to their being perceived as a problem, anomaly, or deviant in the laboratory or work environment.

In all cohort years, the 2012 respondents ranked "hostile or intimidating environment" higher than the 1997–2000 awardees did (Table 2.10); in fact, the 2012 respondents from the 1999–2000 cohorts ranked it higher than "balancing career and family/time away from home". All 2012 respondents ranked "lack of funding" higher than the 1997–2000 cohorts; this replicates the finding in responses to Question 1 about increasing concerns of tight funding and decreasing support for research.

Chart 2.2 focuses on the number of aggregated responses given to Question 2 from 1997 to 2000 compared to the aggregated responses for 2012. The arrows show differences in ranking or whether a particular response moved up or down in position or stayed approximately the same. In contrast to Question 1, where most of the responses retained relatively similar ranking over the decade (Chart 2.1), for Question 2, many of the responses moved four or more positions up or down. This provides further evidence that responses to Question 2 reflect less consensus as well as less stability over the decade.

Table 2.11 shows the responses to Question 2 when the data from all four years are pooled and categorized by the NSF directorate of the awardee. As with Question 1, the most striking finding is the similarity of responses among the awardees from different directorates. The 2012 responses in every directorate indicate a higher frequency of response to "hostile environment/intimidating/lack of authority", suggesting this constitutes a growing problem in all disciplines or women's growing awareness of the concept of hostile environment. Other issues such as "lack of funding" that had increased in the 2012 response when differences are considered by cohort, but not directorate, demonstrate disciplinary differences when broken out by directorate. Neither CISE nor GEO respondents in 2012 indicated "lack of funding" as a response, while respondents from all other directorates in 2012 gave "lack of funding" as a more frequent response compared to earlier years.

Table 2.10 Total responses to question 2[a]

Category	*1997 % of responses*		*2012 % of responses*		*1998 % of responses*		*2012 % of responses*	
1 Don't know/question unclear	16.4	(11/67)	8.8	(3/34)	4.2	(5/119)	2.0	(1/50)
2 Balancing career and family/time away from home	13.4	(9/67)	23.5	(8/34)	19.3	(23/119)	18.0	(9/50)
3 Have not experienced problems	11.9	(8/67)	11.8	(4/34)	16.8	(20/119)	18.0	(9/50)
4 Not in lab atmosphere/can't answer	11.9	(8/67)	5.9	(2/34)	5.9	(7/119)	4.0	(2/50)
5 Lack of camaraderie/communications and isolation	9.0	(6/67)	11.8	(4/34)	11.8	(14/119)	6.0	(3/50)
6 "Boys club" atmosphere	9.0	(6/67)	8.8	(3/34)	9.2	(11/119)	16.0	(8/50)
7 Hostile environment/intimidating/lack of authority	9.0	(6/67)	11.8	(4/34)	14.3	(17/119)	16.0	(8/50)
8 Establishing respectability/credibility	9.0	(6/67)	5.9	(2/34)	10.9	(13/119)	8.0	(4/50)
9 No answer	7.5	(5/67)	2.9	(1/34)	6.7	(8/119)	–	–
10 Positive impact	6.0	(4/67)	–	–	10.1	(12/119)	–	–
11 Lack of numbers/networking	4.5	(3/67)	2.9	(1/34)	6.7	8/119)	4.0	(2/50)
12 General problem with time management	4.5	(3/67)	2.9	(1/34)	1.7	(2/119)	–	–
13 Safety concerns/presence of toxic substances (health concerns)	3.0	(2/67)	5.9	(2/34)	–	–	2.0	(1/50)
14 Benefit by working with peers	3.0	(2/67)	2.9	(1/34)	2.5	(3/119)	2.0	(1/50)
15 Problem of wanting research independence	3.0	(2/67)	–	–	0.0	(0/119)	–	–
16 Lack of funding	1.5	(1/67)	2.9	(1/34)	<1.0	(1/119)	4.0	(2/50)
17 Benefit from time flexibility/determine own lab	3.0	(2/67)	2.9	(1/34)	1.7	(2/119)	8.0	(4/50)
18 Did not answer	–	–	–	–	–	–	–	–

(continued)

Table 2.10 (continued)

Category	*1999 % of responses*		*2012 % of responses*		*2000 % of responses*		*2012 % of responses*		*Overall*			
									%	*1997–2000*	*%*	*2012*
1 Don't know/question unclear	7.1	(7/98)	16.3	(7/43)	5.7	(6/105)	2.1	(1/48)	7.5	(29/389)	6.8	(12/175)
2 Balancing career and family/time away from home	16.3	(16/98)	9.3	(4/43)	13.3	(14/105)	16.7	(8/48)	15.9	(62/389)	38.7	(29/175)
3 Have not experienced problems	10.2	(10/98)	11.6	(5/43)	9.5	(10/105)	2.1	(1/48)	12.3	(48/389)	10.8	(19/175)
4 Not in lab atmosphere/can't answer	1.0	(1/98)	7.0	(3/43)	8.6	(9/105)	4.2	(2/48)	6.4	(25/389)	5.1	(9/175)
5 Lack of camaraderie/ communications and isolation	9.2	(9/98)	4.6	(2/43)	14.3	(15/105)	12.5	(6/48)	11.3	(44/389)	8.6	(15/175)
6 "Boys club" atmosphere	18.4	(18/98)	4.6	(2/43)	9.5	(10/105)	6.2	(3/48)	11.6	(45/389)	9.1	(16/175)
7 Hostile environment/intimidating/ lack of authority	15.3	(15/98)	23.2	(10/43)	8.6	(9/105)	29.2	14/48)	12.1	(47/389)	20.6	(36/175)
8 Establishing respectability/credibility	10.2	(10/98)	4.6	(2/43)	3.8	(4/105)	6.2	(3/48)	8.5	(33/389)	6.3	(11/175)
9 No answer	5.1	(5/98)	2.3	(1/43)	<1.0	(1/105)	–	–	4.9	(19/389)	2.7	(2/175)
10 Positive impact	6.1	(6/98)	4.6	(2/43)	11.4	(12/105)	25.0	12/48)	8.7	(34/389)	10.9	(19/175)
11 Lack of numbers/networking	12.2	(12/98)	4.6	(2/43)	4.8	(5/105)	2.1	(1/48)	7.2	(28/389)	3.4	(6/175)
12 General problem with time management	5.1	(5/98)	7.0	(3/43)	3.8	(4/105)	4.2	(2/48)	3.4	(14/389)	3.4	(6/175)
13 Safety concerns/presence of toxic substances (health concerns)	4.1	(4/98)	–	–	1.9	(2/105)	–	–	2.1	(8/389)	1.7	(3/175)
14 Benefit by working with peers	3.1	(3/98)	4.6	(2/43)	5.7	(6/105)	10.4	(5/48)	3.4	(14/389)	5.1	(9/175)
15 Problem of wanting research independence	1.0	(1/98)	–	–	<1.0	(1/105)	–	–	1.0	(4/389)	–	–
16 Lack of funding	5.1	(5/98)	9.3	(4/43)	<1.0	(1/105)	4.2	(2/48)	2.1	(8/389)	5.1	(9/175)
17 Benefit from time flexibility/ determine own lab	3.1	(3/98)	4.6	(2/43)	1.9	(2/105)	2.1	(1/48)	2.3	(9/389)	4.6	(8/275)
18 Did not answer	3.1	(3/98)	–	–	–	–	–	–	0.8	(3/389)	–	–

– = 0% or 0

[a] *Question 2*: How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists?

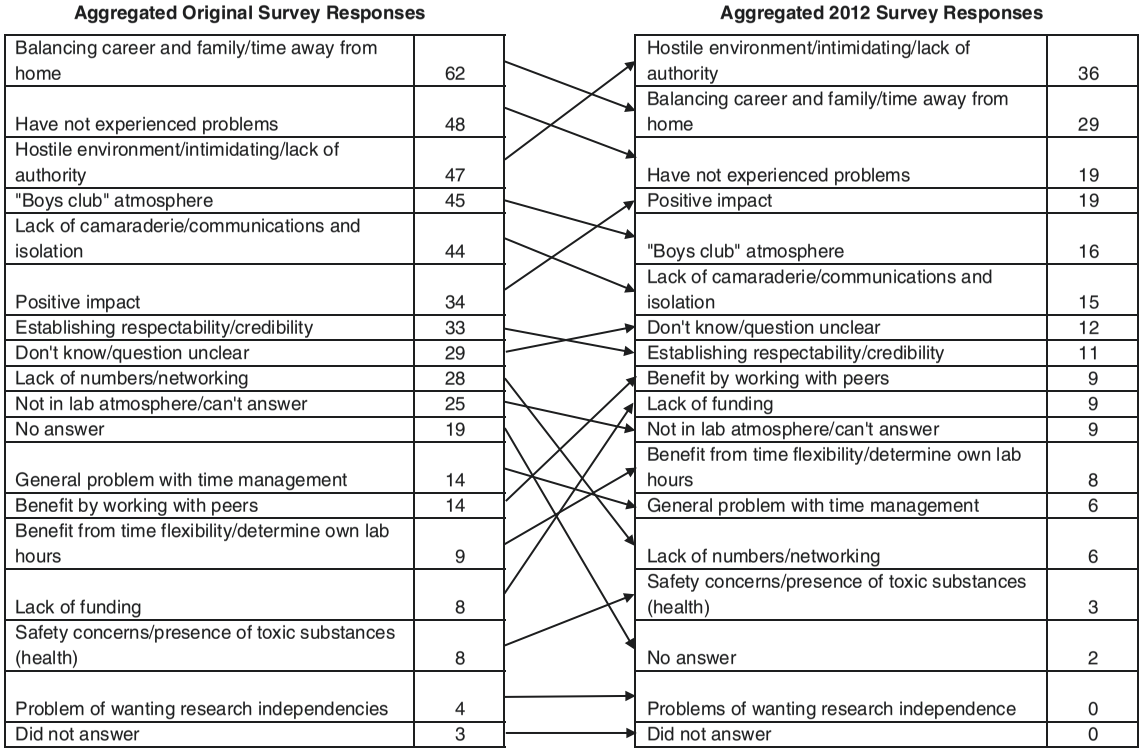

Chart. 2.2 Number of Aggregated Responses to Question 2 from 1997–2000 Compared to 2012

Table 2.11 Response to question 2[a] according to directorate across all four years

Category	*SBE*				*MPS*				*ENG*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
1 Don't know/question unclear	9.5	(6/63)	4.2	(1/24)	6.0	(5/84)	2.5	(1/40)	10.1	(7/69)	–	–
2 Balancing career and family/time away from home	11.1	(7/63)	12.5	(3/24)	14.3	(12/84)	12.5	(5/40)	10.1	(7/69)	16.7	(5/30)
3 Have not experienced problems	14.3	(9/63)	12.5	(3/24)	7.1	(6/84)	12.5	(5/40)	18.8	(13/69)	6.7	(2/30)
4 Not in lab atmosphere/ can't answer	19.0	(12/63)	12.5	(3/24)	4.8	(4/84)	10.0	(4/40)	1.4	(1/69)	3.3	(1/30)
5 Lack of camaraderie/ communications and isolation	4.8	(3/63)	–	–	20.2	(17/84)	7.5	(3/40)	11.6	(8/69)	26.7	(8/30)
6 "Boys club" atmosphere	7.9	(5/63)	4.2	(1/24)	14.3	(12/84)	5.0	(2/40)	10.1	(7/69)	16.7	(5/30)
7 Hostile environment/ intimidating/lack of authority	4.8	(3/63)	8.3	(2/24)	16.7	(14/84)	27.5	(11/40)	18.8	(13/69)	33.3	(10/30)
8 Establishing respectability/ credibility	9.5	(6/63)	–	–	9.5	(8/84)	5.0	(2/40)	7.2	(5/69)	10.0	(3/30)
9 No answer	11.1	(7/63)	4.2	(1/24)	3.6	(3/84)	–	–	4.3	(3/69)	–	–
10 Positive impact	3.2	(2/63)	8.3	(2/24)	6.0	(5/84)	10.0	(4/40)	7.2	(5/69)	6.7	(2/30)

11	Lack of numbers/ networking	7.9	(5/63)	–	–	11.9	(10/84)	5.0	(2/40)	5.8	(4/69)	3.3	(1/30)
12	General problem with time management	1.6	(1/63)	8.3	(2/24)	3.6	(3/84)	–	–	2.9	(2/69)	6.7	(2/30)
13	Safety concerns/ presence of toxic substances (health concerns)	1.6	(1/63)	–	–	3.6	(3/84)	2.5	(1/40)	2.9	(2/69)	3.3	(1/30)
14	Benefit by working with peers	4.8	(3/63)	–	–	1.2	(1/84)	5.0	(2/40)	2.9	(2/69)	–	–
15	Problem of wanting research independence	1.6	(1/63)	–	–	–	–	–	–	1.4	(1/69)	–	–
16	Lack of funding	–	–	12.5	(3/24)	1.2	(1/84)	2.5	(1/40)	–	–	10.0	(3/30)
17	Benefit from time flexibility/determine own lab	3.2	(2/63)	8.3	(2/24)	1.2	(1/84)	–	–	1.4	(1/69)	6.7	(2/30)
18	Did not answer	–	–	–	–	2.4	(2/84)	–	–	1.4	(1/69)	–	–

(continued)

Table 2.11 (continued)

Category	*EHR*[b]				*CISE*				*BIO*				*GEO*			
	1997–2000 % of responses		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*		*1997–2000 % of responses*		*2012 % of responses*	
1 Don't know/ question unclear	8.3	(1/12)	–	–	5.7	(2/35)	6.2	(1/16)	7.1	(6/85)	14.0	(6/43)	5.3	(2/38)	18.8	(3/16)
2 Balancing career and family/time away from home	16.7	(2/12)	–	–	8.6	(3/35)	6.2	(1/16)	28.2	(24/85)	20.9	(9/43)	18.4	(7/38)	18.8	(3/16)
3 Have not experienced problems	8.3	(1/12)	–	–	11.4	(4/35)	12.5	(2/16)	8.2	(7/85)	11.6	(5/43)	18.4	(7/38)	25.0	(4/16)
4 Not in lab atmosphere/can't answer	8.3	(1/12)	16.7	(1/6)	17.1	(6/35)	6.2	(1/16)	–	–	–	–	2.6	(1/38)	12.5	(2/16)
5 Lack of camaraderie/ communications and isolation	33.3	(4/12)	–	–	5.7	(2/35)	–	–	9.4	(8/85)	4.6	(2/43)	5.3	(2/38)	12.5	(2/16)
6 "Boys club" atmosphere	25.0	(3/12)	–	–	8.6	(3/35)	12.5	(2/16)	12.9	(11/85)	7.0	(3/43)	10.5	(4/38)	12.5	(2/16)
7 Hostile environment/ intimidating/lack of authority	–	–	16.7	(1/6)	14.3	(5/35)	31.2	(5/16)	11.8	(10/85)	20.9	(9/43)	5.3	(2/38)	12.5	(2/16)
8 Establishing respectability/ credibility	8.3	(1/12)	16.7	(1/6)	8.6	(3/35)	12.5	(2/16)	8.2	(7/85)	4.6	(2/43)	5.3	(2/38)	–	–
9 No answer	8.3	(1/12)	–	–	11.4	(4/35)	6.2	(1/16)	1.2	(1/85)	–	–	–	–	–	–
10 Positive impact	16.7	(2/12)	–	–	2.9	(1/35)	18.8	(3/16)	12.9	(11/85)	7.0	(3/43)	21.1	(8/38)	–	–

11	Lack of numbers/ networking	8.3	(1/12)	–	–	2.9	(1/35)	–	–	7.1	(6/85)	2.3	(1/43)	–	–	6.2	(1/16)
12	General problem with time management	–	–	–	–	5.7	(2/35)	–	–	5.9	(5/85)	4.0	(2/43)	2.6	(1/38)	–	–
13	Safety concerns/ presence of toxic substances (health concerns)	–	–	–	–	–	–	–	–	2.4	(2/85)	2.3	(1/43)	–	–	–	–
14	Benefit by working with peers	–	–	16.7	(1/6)	2.9	(1/35)	12.5	(2/16)	4.7	(4/85)	7.0	(3/43)	7.9	(3/38)	6.2	(1/16)
15	Problem of wanting research independence	–	–	–	–	–	–	–	–	1.2	(1/85)	–	–	2.6	(1/38)	–	–
16	Lack of funding	–	–	–	–	–	–	–	–	3.5	(3/85)	7.0	(3/43)	10.5	(4/38)	–	–
17	Benefit from time flexibility/ determine own lab	–	–	–	–	–	–	18.8	(3/16)	3.5	(3/85)	7.0	(3/43)	5.3	(2/38)	–	–
18	Did not answer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

– = 0% or 0

[a] *Question 2*: How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists? SBE, Social Behavioral, and Economic Sciences; MPS, Mathematical and Physical Sciences; ENG, Engineering; EHR, Education and Human Resources; CISE, Computer and Information Science and Engineering; BIO, Biological Sciences; GEO, Geosciences

[b] Because of the low numbers of awardees, the EHR directorate should be carefully interpreted here. Many of the women representing the directorate have other disciplinary training and could be classified in other directorates. We have chosen not to interpret the EHR responses as a result

Table 2.12 presents the frequency of the first response for each category for Question 2. Overall, the responses are more evenly distributed among the first twelve categories during all four years than they were for Question 1. The increased frequency of 2012 for "hostile environment/intimidating/lack of authority" as a first response for each cohort except 1997 underlines the importance of this as a current problem. Ironically, "have not experienced problems" is the second most frequent first response in 2012; it ranked as the most frequent response a decade earlier.

Table 2.13, which sorts the frequency of first responses by the directorate of awardee and pools them over the four years, reveals more variation in responses to some categories by directorate. Not surprisingly, the results in Table 2.13 mirror those in Table 2.11, although for "hostile environment" in SBE and ENG, the 2012 responses were lower than those of earlier cohorts, indicating that although they were mentioned, it was not frequently the first response (Table 2.13). Oddly, first responses in ENG and CISE did not parallel each other, as one might expect, given that both are fields where women hold less than 18 percent of faculty positions overall (Table 1.3). Although in ENG, "lack of camaraderie/communications and isolation" increased in 2012, none in CISE gave this as a first response. "Lack of funding" was given as a first response only in SBE, ENG and BIO in 2012, but never by more than three individuals.

An issue that appeared repeatedly in 2012 responses but not mentioned in the earlier 1997–2000 cohorts was the difficulty of fieldwork, as opposed to laboratory work. As the quotations below suggest, fieldwork exacerbates balancing career and family in particular.

> Field work for me means being in the field for a month in the summer. I can take kids but had a hard time finding childcare. More like impossible most years. Now that my children are older, that aspect is easier. However, I have chosen to limit my field visits to a month because my children have their own lives at home—it isn't fair to them to be stuck in the field their entire summer—so again, competing time demands. (2012 respondent from 1999 cohort)
>
> Demands of fieldwork or methods updating while juggling family and career can lead women to make decisions with short term gains but long term costs. (2012 respondent from 1997 cohort)

Table 2.12 First response to question 2[a] by year of professional opportunities for women in research and education award

Category	*1997*		*2012*		*1998*		*2012*	
	% of responses		*responses*		*% of responses*		*responses*	
1 Don't know/question unclear	16.4	(11/67)	5.9	(2/34)	4.2	(5/119)	4.0	(2/50)
2 Balancing career and family/time away from home	9.0	(6/67)	11.8	(4/34)	11.8	(14/119)	8.0	(4/50)
3 Have not experienced problems	11.9	(8/67)	14.7	(5/34)	16.8	(20/119)	14.0	(7/50)
4 Not in lab atmosphere/can't answer	11.9	(8/67)	5.9	(2/34)	5.9	(7/119)	4.0	(2/50)
5 Lack of camaraderie/communications and isolation	4.5	(3/67)	8.8	(3/34)	10.1	(12/119)	4.0	(2/50)
6 "Boys club" atmosphere	7.5	(5/67)	2.9	(1/34)	9.2	(11/119)	4.0	(2/50)
7 Hostile environment/intimidating/lack of authority	6.0	(4/67)	2.9	(1/34)	11.8	(14/119)	14.0	(7/50)
8 Establishing respectability/credibility	9.0	(6/67)	5.9	(2/34)	6.7	(8/119)	6.0	(3/50)
9 No answer	7.5	(5/67)	2.9	(1/34)	6.7	(8/119)	–	–
10 Positive impact	4.5	(3/67)	–	–	6.7	(8/119)	–	–
11 Lack of numbers/networking	1.5	(1/67)	–	–	4.2	(5/119)	4.0	(2/50)
12 General problem with time management	1.5	(1/67)	–	–	1.7	(2/119)	–	–
13 Safety concerns/presence of toxic substances (health concerns)	3.0	(2/67)	2.9	(1/34)	–	–	2.0	(1/50)
14 Benefit by working with peers	1.5	(1/67)	2.9	(1/34)	1.7	(2/119)	2.0	(1/50)
15 Problem of wanting research independence	1.5	(1/67)	–	–	–	–	–	–
16 Lack of funding	–	–	2.9	(1/34)	<1.0	(1/119)	4.0	(2/50)
17 Benefit from time flexibility/determine own lab hours	1.5	(1/67)	2.9	(1/34)	1.7	(2/119)	6.0	(3/50)
18 Did not answer	–	–	–	–	–	–	–	–

(continued)

Table 2.12 (continued)

Category	*1999*		*2012*		*2000*		*2012*		*Overall*			
	% of responses		*responses*		*% of responses*		*% of responses*		*%*	*1997–2000*	*%*	*2012*
1 Don't know/question unclear	6.1	(6/98)	9.3	(4/43)	5.7	(6/105)	4.2	(2/48)	7.2	(28/389)	5.7	(10/175)
2 Balancing career and family/time away from home	10.2	(10/98)	9.3	(4/43)	11.4	(12/105)	8.4	(4/48)	10.8	(42/389)	9.1	(16/175)
3 Have not experienced problems	10.2	(10/98)	11.6	(5/43)	9.5	(10/105)	2.1	(1/48)	12.3	(48/389)	10.3	(18/175)
4 Not in lab atmosphere/can't answer	1.0	(1/98)	4.6	(2/43)	8.6	(9/105)	4.2	(2/48)	6.4	(25/389)	4.6	(8/175)
5 Lack of camaraderie/communications and isolation	7.1	(7/98)	2.3	(1/43)	13.3	(14/105)	6.2	(3/48)	9.2	(36/389)	5.1	(9/175)
6 "Boys club" atmosphere	13.3	(13/98)	4.6	(2/43)	6.7	(7/105)	6.2	(3/48)	9.2	(36/389)	4.6	(8/175)
7 Hostile environment/intimidating/lack of authority	13.3	(13/98)	18.6	(8/43)	7.6	(8/105)	16.8	(8/48)	10.0	(39/389)	13.7	(24/175)
8 Establishing respectability/credibility	5.1	(5/98)	4.6	(2/43)	1.9	(2/105)	6.2	(3/48)	5.4	(21/389)	5.7	(10/175)
9 No answer	5.1	(5/98)	–	–	<1.0	(1/105)	–	–	4.9	(19/389)	0.6	(1/175)
10 Positive impact	6.1	(6/98)	4.6	(2/43)	10.5	(11/105)	22.9	(11/48)	7.2	(28/389)	7.4	(13/175)
11 Lack of numbers/networking	6.1	(6/98)	4.6	(2/43)	4.8	(5/105)	2.1	(1/48)	4.4	(17/389)	2.8	(5/175)
12 General problem with time management	4.1	(4/98)	2.3	(1/43)	3.8	(4/105)	4.2	(2/48)	2.8	(11/389)	1.7	(3/175)
13 Safety concerns/presence of toxic substances (health concerns)	3.1	(3/98)	–	–	1.9	(2/105)	–	–	1.8	(7/389)	1.1	(2/175)
14 Benefit by working with peers	1.0	(1/98)	–	–	4.8	(5/105)	6.2	(3/48)	2.3	(9/389)	4.0	(7/175)
15 Problem of wanting research independence	1.0	(1/98)	–	–	–	–	–	–	0.5	(2/389)	–	–
16 Lack of funding	2.0	(2/98)	7.0	(3/43)	<1.0	(1/105)	–	–	1.0	(4/389)	3.4	(6/175)
17 Benefit from time flexibility/determine own lab hours	2.0	(2/98)	4.6	(2/43)	1.9	(2/105)	2.1	(1/48)	1.8	(7/389)	4.0	(7/175)
18 Did not answer	3.1	(3/98)	–	–	–	–	–	–	0.8	(3/389)	–	–

– = 0% or 0

[a] *Question 2*: How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists?

Table 2.13 First response to question 2[a] according to directorate acoss all four years

Category	SBE				MPS				ENG			
	1997–2000		2012		1997–2000		2012		1997–2000		2012	
1 Don't know/question unclear	9.5	(6/63)	4.2	(1/24)	6.0	(5/84)	5.0	(2/40)	8.7	(6/69)	–	–
2 Balancing career and family/time away from home	9.5	(6/63)	4.2	(1/24)	7.1	(6/84)	7.5	(3/40)	8.7	(6/69)	13.3	(4/30)
3 Have not experienced problems	14.3	(9/63)	12.5	(3/24)	7.1	(6/84)	12.5	(5/40)	18.8	(13/69)	6.7	(2/30)
4 Not in lab atmosphere/ can't answer	19.0	(12/63)	12.5	(3/24)	4.8	(4/84)	5.0	(2/40)	1.4	(1/69)	3.3	(1/30)
5 Lack of camaraderie/ communications and isolation	1.6	(1/63)	–	–	16.7	(14/84)	7.5	(3/40)	11.6	(8/69)	16.7	(5/30)
6 "Boys club" atmosphere	7.9	(5/63)	4.2	(1/24)	10.7	(9/84)	5.0	(2/40)	7.2	(5/69)	6.7	(2/30)
7 Hostile environment/ intimidating/lack of authority	4.8	(3/63)	4.2	(1/24)	11.9	(10/84)	20.0	(8/40)	14.5	(10/69)	10.0	(3/30)

(*continued*)

Table 2.13 (continued)

Category	SBE				MPS				ENG			
	1997–2000		2012		1997–2000		2012		1997–2000		2012	
8 Establishing respectability/ credibility	3.2	(2/63)	–	–	7.1	(6/84)	7.5	(3/40)	7.2	(5/69)	10.0	(3/30)
9 No answer	11.1	(7/63)	8.3	(2/24)	3.6	(3/84)	2.5	(1/40)	4.3	(3/69)	–	–
10 Positive impact	3.2	(2/63)	8.3	(2/24)	4.8	(4/84)	7.5	(3/40)	4.3	(3/69)	6.7	(2/30)
11 Lack of numbers/ networking	7.9	(5/63)	–	–	6.0	(5/84)	2.5	(1/40)	2.9	(2/69)	3.3	(1/30)
12 General problem with time management	–	–	8.3	(2/24)	2.4	(2/84)	–	–	1.4	(1/69)	–	–
13 Safety concerns/ presence of toxic substances (health concerns)	–	–	–	–	3.6	(3/84)	2.5	(1/40)	2.9	(2/69)	–	–
14 Benefit by working with peers	4.8	(3/63)	–	–	1.2	(1/84)	5.0	(2/40)	1.4	(1/69)	–	–
15 Problem of wanting research independence	–	–	–	–	–	–	–	–	1.4	(1/69)	–	–
16 Lack of funding	–	–	4.2	(1/24)	–	–	–	–	–	–	6.7	(2/30)
17 Benefit from time flexibility/determine own lab hours	1.6	(1/63)	4.2	(1/24)	1.2	(1/84)	–	–	1.4	(1/69)	3.3	(1/30)
18 Did not answer	–	–	–	–	2.1	(2/84)	–	–	1.4	(1/69)	–	–

Table 2.13 (continued)

Category	*EHR*[b]				*CISE*				*BIO*				*GEO*			
	1997–2000		*2012*		*1997–2000*		*2012*		*1997–2000*		*2012*		*1997–2000*		*2012*	
1 Don't know/question unclear	8.3	(1/12)	–	–	5.7	(2/35)	6.2	(1/16)	7.1	(6/85)	7.0	(3/43)	5.3	(2/38)	6.2	(1/16)
2 Balancing career and family/time away from home	16.7	(2/12)	–	–	8.6	(3/35)	6.2	(1/16)	17.6	(15/85)	16.3	(7/43)	10.5	(4/38)	6.2	(1/16)
3 Have not experienced problems	8.3	1/12)	–	–	11.4	(4/35)	12.5	(2/16)	8.2	(7/85)	11.6	(5/43)	18.4	(7/38)	12.5	(2/16)
4 Not in lab atmosphere/ can't answer	8.3	(1/12)	16.7	(1/6)	17.1	(6/35)	6.2	(1/16)	–	–	–	–	2.6	(1/38)	6.2	(1/16)
5 Lack of camaraderie/ communications and isolation	25.0	(3/12)	–	–	5.7	(2/35)	–	–	7.1	(6/85)	–	–	5.3	(2/38)	6.2	(1/16)
6 "Boys club" atmosphere	16.7	(2/12)	–	–	8.6	(3/35)	–	–	10.6	(9/85)	2.3	(1/43)	7.9	(3/38)	–	–
7 Hostile environment/ intimidating/lack of authority	–	–	16.7	(1/6)	11.4	(4/35)	18.8	(3/16)	10.6	(9/85)	16.3	(7/43)	5.3	(2/38)	6.2	(1/16)

(*continued*)

Table 2.13 (continued)

Category	*EHR*[b]				*CISE*				*BIO*				*GEO*			
	1997–2000		*2012*		*1997–2000*		*2012*		*1997–2000*		*2012*		*1997–2000*		*2012*	
8 Establishing respectability/ credibility	–	–	16.7	(1/6)	2.9	(1/35)	12.5	(2/16)	5.9	(5/85)	2.3	(1/43)	2.6	(1/38)	–	–
9 No answer	8.3	(1/12)	–	–	11.4	(4/35)	6.2	(1/16)	1.2	(1/85)	–	–	–	–	–	–
10 Positive impact	–	–	–	–	2.9	(1/35)	18.8	(3/16)	11.8	(10/85)	7.0	(3/43)	21.1	(8/38)	–	–
11 Lack of numbers/ networking	8.3	(1/12)	16.7	(0/6)	2.9	(1/35)	–	–	3.5	(3/85)	2.3	(1/43)	–	–	6.2	(1/16)
12 General problem with time management	–	–	–	–	5.7	(2/35)	–	–	5.9	(5/85)	2.3	(1/43)	2.6	(1/38)	–	–
13 Safety concerns/presence of toxic substances (health concerns)	–	–	–	–	–	–	–	–	2.4	(2/85)	2.3	(1/43)	–	–	–	–
14 Benefit by working with peers	–	–	16.7	(1/6)	2.9	(1/35)	–	–	1.2	(1/85)	2.3	(1/43)	5.3	(2/38)	6.2	(1/16)
15 Problem of wanting research independence	–	–	–	–	–	–	–	–	–	–	–	–	2.6	(1/38)	–	–
16 Lack of funding	–	–	–	–	–	–	–	–	3.5	(3/85)	7.0	(3/43)	2.6	(1/38)	–	–
17 Benefit from time flexibility/determine own lab hours	–	–	–	–	–	–	6.2	(1/16)	2.4	(2/85)	7.0	(3/43)	5.3	(2/38)	–	–
18 Did not answer	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

— = 0% or 0

[a]*Question 2*: How does the laboratory climate (or its equivalent in your subdiscipline) impact upon the careers of women scientists? SBE, Social Behavioral, and Economic Sciences; MPS, Mathematical and Physical Sciences; ENG, Engineering; EHR, Education and Human Resources; CISE, Computer and Information Science and Engineering; BIO, Biological Sciences; GEO, Geosciences

[b]Because of the low numbers of awardees, the EHR directorate should be carefully interpreted here. Many of the women representing the directorate have other disciplinary training and could be classified in other directorates. We have chosen not to interpret the EHR responses as a result

> Fieldwork is common in my field. Again, family demands can make it difficult to be away for an extended period. That continues to be a problem. (2012 respondent from 1997 cohort).

Other quotations taken from the responses of the 2012 female scientists and engineers explain the context and provide specific illustrations of problems and difficulties in daily laboratory life:

> The laboratory climate is meant for single people who can be at the lab for hours on end and partners who have someone else taking care of the daily activities of running a household. I would say that in cognitive neuroscience there is less of an overt gender bias and more of an inability for women with families to devote as much time in the lab as their male counterparts. (2012 respondent from 1998 cohort)
>
> Laboratory climate generally works against women faculty. Students (especially foreigners*) simply don't respect women. My students and post docs often refuse my direction, for instance to calibrate an experiment before running it. They simply don't hear when I tell them to do things, and I often have to back up my oral directions in writing to ensure they understand I'm serious. If I don't ask 3 times, it doesn't get done. (2012 respondent from 1999 cohort)
>
> Often existing lab environments have the atmosphere of a locker room (X-rated screenshots, etc.*). It's very hard for women to combat that unless they are very assertive and force changes. This gives them the "bitch" label. (note: I actually found a large stash of Playboy/Penthouse type magazines in a government lab and was crazy enough to force the "guys" to get rid of them*). (2012 respondent from 1998 cohort)
>
> Another climate issue can arise in settings where there are cross-cultural interactions. The intersecting issues of gender, race/ethnicity, class, and cultural expectations can impact the laboratory climate. The result may be a hostile environment or potentially one where women are less welcome in the informal interactions that aid in science and engineering research. LGBTQ [lesbian, gay, bisexual, transgender, queer**] issues in science and engineering disciplines do not seem as pronounced as in the humanities and social sciences (at least on my campus*) but could certainly be a laboratory climate issue if there are challenges for inclusiveness. (2012 respondent from 2000 cohort)

Some women see their particular discipline as presenting unique challenges, including safety concerns:

> The achievement of success in the laboratory requires long hours with little flexibility in scheduling and work environment. There has been improvement

in some areas, but overall challenges still exist. The issue of laboratory safety (e.g., exposure to hazardous chemicals*), particularly during childbearing years, is still a factor. These issues need to be openly discussed so that faculty (both male and female*) know what options exist. (2012 respondent from 1997 cohort)

I do field research so the main thing is that women are treated as less competent on the technical side, dealing with equipment and troubleshooting problems. We are the only women that even navigate and launch boats anywhere near our site. This sometimes makes it difficult for women to get certified (coxswains, etc.*) or be able to get their fieldwork done without male assistance. I work in the remote outback of Australia, so this kind of sexism is common there, but it's pretty common elsewhere too according to my female colleagues. (2012 respondent from 1997 cohort)

I am in Civil Engineering which has the lowest numbers of women entering the profession. Construction still rules and women are still an anomaly on a construction site or an Industry Advisory Board. (2012 respondent from 1998 cohort).

I work in a subfield of biomedical engineering, so there are a few more women in my subdiscipline than in others. The pipeline is still extremely leaky, though—there are reasonably large numbers of women undergrads and masters students at conferences, but very few women faculty members or industry leaders. I received my Ph.D. in the late 1990s, but I'm already considered a "senior woman" when organizers look for panel speakers or female representation on committees. As few women as there are on the academic side of things, there are even fewer in the specialized consulting business where I do most of my work. I'm routinely the only woman on a team of clients and technicians on job sites. I haven't had any female mentors in the companies where I've worked and there are very few women at my senior level who I would consider to be peers. Even in the biomedical world, women who want to advance still have to consider themselves pioneers and develop a lot of diplomatic skills in order to survive in a male environment while still proving themselves technically (2012 respondent from 1999 cohort).

Women may experience situations of harassment that threaten to derail their careers:

It can have a major impact. I nearly lost my career (and essentially seven years of productive life*) due to a sexual harassment situation that the university tried to make go away. I was initially not the complainant, a university freshman was. I had witnessed some of her interaction with the male professor in question and the university forced me to testify. It was traumatic, because that professor had harassed and raped me when he was

my department chair—seeing how many young women he had hurt, I decided to come forward. He spent several years terrorizing me and my young son—breaking into my home, vandalizing my back yard and pool on numerous occasions, filing false charges against me with the police, false charges claiming I misused funds, and then actually sued ME for "sexual harassment". My immediate supervisors (chairman and dean*) were not sympathetic, and essentially treated me like the perpetrator (despite official complaints by six very different women*), even threatening to fire me if I bothered that professor. I could have dealt with that individual, but the actions of my superiors and the university literally made me ill. I had to take a year off, but my research and lab went down the tubes. I am still trying to recover in terms of research and still have seriously lingering health issues that resulted from all of this. And that faculty member is still here and still harassing women. (2012 respondent from 2000 cohort)

Most women view competition for space and resources or a competitive environment, in general, as negative:

There is an expectation in my field that scientists and engineers will devote their lives to their careers. Not everyone adopts this mantra, but the truly successful have. These individuals (now in their mid and late careers*) are effectively single without children. This model has been deemed unattractive to most of the women in the field. Consequently, none of the superstars are female. (2012 respondent from 1998 cohort)

I believe that women are more affected by the lab climate than men. I believe that competitive lab environments bring out the lack of self confidence in women. Some seem intimidated by the competition, when it isn't really a competition but everyone trying to succeed. (2012 respondent from 1998 cohort).

I've worked now in five different labs for extended periods of time, plus run my own small lab. At the very, very top labs, the climate can be gruesome for everyone, but women tend to feel dehumanizing expectations more acutely, in my opinion. Women's tendencies to want to please others and to feel social bonds with co-workers makes the most competitive labs very uncomfortable places to work—in fact, I would argue the very competitive atmosphere does not bring out the best work in women scientists. (2012 respondent from 2000 cohort)

There are still fights for space, or funds for lab modernization, new instrumentation, etc. I think men are more successful at negotiating for space and money. It's not clear to me if it is because they are more comfortable asking for space/money/equipment and better at negotiating from a position of power, or because they intrinsically are more valued and

> therefore more likely to get what they want. The two-body problem has some effect here: the way you get more resources is frequently through getting counteroffers, and these are harder to manage if there are two careers involved. (2012 respondent from 1997 cohort).
>
> Laboratory space is in prime demand for women—and they are often either given less or less prominent space for laboratories! (2012 respondent from 2000 cohort).
>
> Impact tends to be measured quantitatively . . . resource allocation goes also based on quantitative measures, so time spent not bringing in grants and pumping out papers is considered not the most efficient use of time. Women tend to spread their efforts across more areas, especially teaching and service, and we find ourselves at a disadvantage. (2012 respondent to 1999 cohort)
>
> I will admit that I struggled initially to "gain footing" or respect in a shared laboratory environment in my academic career. However, over time, this has been less of an issue. What remains an issue, for me, is the fact that my research laboratory space is shared with an undergraduate course. I literally have 100+ undergraduate students in my research lab nearly every week. This certainly impacts our productivity on the research side. I think it's a situation that few men would tolerate. I've tried to work with my Chair to fix this situation, but the funding and space to do so never seem to be available. (2012 respondent from 2000 cohort)

In contrast, often women articulated an improved situation in 2012 compared to respondents in 1997–2000, partially due to the presence of computers:

> There is not a significant laboratory component in Astronomy. Even going to observatories to obtain data is less common now, as a lot of astronomical data is available through large survey databases and archives. I believe that Astronomy is much more individual investigator oriented, and has less hierarchical laboratory structure than other disciplines. It is true that some very large survey projects tend to be dominated by older male scientists, and that can make it difficult for women to participate. This is not true for all large projects however. (2012 respondent from 1999 cohort)
>
> In Computer Science, I think the climate is positive for women. Soft skills are very important, and most women easily outperform men in that area. Work can be done in teams or independently, and often remotely (for example, from home*). This flexibility can be helpful to women through various changes and phases in our careers. (2012 respondent from 2000 cohort)

> With regard to equipment, in some ways the "laboratory climate" in CS (computer science*) is very advantageous compared to some other science and engineering disciplines. As computing power has increased, cost and size have decreased; it is ever easier for faculty to own home machines that are powerful enough to support serious research. And high speed Internet connections also facilitate the ability to connect to institutional computers from home, and to connect to more powerful research computers (super computers, etc.*) at other institutions. Therefore there is less need to 1) be on campus to do research and 2) travel to other institutions to do research. So this simplifies the home-work issues. Basically, you can work a 9–5 day on campus, head home for dinner with the family, and then do some quality work without schlepping back to the lab. (2012 respondent from 1999 cohort).

Many women saw the laboratory as a site of empowerment because it becomes a place where a woman can control the climate if she heads the laboratory:

> By this, do you mean how does the climate of having a lab or do you mean the specific climate of the lab that I experience? If the question is the former, I think that having a lab is potentially beneficial because you can create your own climate in your lab. (2012 respondent from 1997 cohort).
>
> If the woman is in charge of her own laboratory, then she controls the climate. However If she has to share or work in someone's space, then she does not control the climate. The expectations are high—two NSF grants before tenure—she has to have a working environment (climate*) that is encouraging and supporting. (2012 respondent from 1998 cohort)
>
> I think that women tend to prefer a more cooperative and constructive environment. We can certainly be as competitive as anyone, but I suspect that women are much more productive in a constructive environment. This could affect career choices, and may well affect letters of recommendation. (2012 respondent from 1998 cohort)

Analyses of the 2012 responses by the 1997, 1998, 1999 and 2000 POWRE awardee cohorts suggest that overall, the same issues remain twelve to fifteen years later. Despite programs such as NSF's POWRE and ADVANCE, the Clare Booth Luce Professorships, the Office of Women's Health Research at National Institutes of Health (NIH) and considerable media attention to work-life balance, issues women face in

balancing career with family, including dual career issues, remain as the overwhelming problem identified by women scientists and engineers. Issues faced by women because of their low numbers and stereotypes held by others regarding gender have decreased slightly in frequency of response, perhaps due to increasing numbers and percentages of academic women scientists (Table 1.3), although the pipeline of undergraduate women in CISE and ENG remains less than 20 percent (Table 1.1). More overt discrimination and harassment has remained about the same as earlier, although the relatively low percentages should be measured against the goal of tolerance that institutions and departments must have in this area. Sexual harassment and its impacts on derailing careers and causing women to leave STEM entirely have become more openly discussed and documented recently (Clery 2015; Jahren 2016; Shipman 2015). Issues faced by both male and female scientists and engineers in the current environment of tight resources, which may pose particular difficulties for women, show increased responses in 2012. The 2012 data document that the increased percentages come primarily from responses focused on lack of funding.

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CHAPTER 3

Consistency in Responses over Time

Abstract Aggregated responses of the POWRE awardees remained quite consistent over the time between the two surveys, especially for question one about significant issues women face as they plan their careers. By comparing the written qualitative answers given by an individual in 2012 to the responses she gave more than a decade ago, a particular woman's responses can be examined for consistency across time. Balancing work with family responsibilities remains the major issue as it was a decade earlier. Responses to question two surrounding perception of the impact of laboratory climate appeared less consistent over time. Both qualitative and quantitative results suggest that as academic women scientists progress in their careers, perceptions of career challenges and opportunities remain more consistent than do perceptions of laboratory climate.

Keywords Consistency of responses over time · Qualitative results · Quantitative results

> The most significant issue/challenge for me is balancing family/career responsibilities with the demands of my tenure-track position. As the main wage-earner in my family (my husband earns less than half of what I earn), job security is a huge issue, so I am hesitant to start my family before tenure. A challenge facing all scientists regardless of gender is the difficulty in obtaining long term (greater than one year at a time!) research funding. This has a spillover effect into my family planning decisions, as I might be less hesitant to start my family

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> with one or more of my projects funded for a natural duration of three to four years, rather than the current situation where I have to continually seek funding from multiple sources. (Engineer POWRE respondent in 1999)
>
> *Rising expectations for tenure-track faculty combined with year to year uncertainty in funding availability. (2) The lack of flexibility in career trajectory for women who wish to start a family or who need to provide care for elderly family members.* (2012 response from same engineer from 1999 POWRE cohort)

The preceding chapter documented that the aggregated responses of the POWRE awardees remained quite consistent over the ten to fifteen years between the two surveys, especially for question one: What are the most significant issues/challenges/opportunities facing women scientists and engineers as they plan their careers? Such aggregated data provide one way to examine consensus and consistency over more than a decade for the questions of career issues and opportunities, as well as laboratory climate.

This chapter explores another way to examine changing perceptions. By comparing the written qualitative answers given by an individual in 2012 to the responses she gave more than a decade ago, a particular woman's responses can be examined for consistency across time, as the quotation above from the same woman engineer POWRE awardee illustrates. Comparisons of responses by each individual to see if they are similar or different constitute the focus of this chapter.

Recent research has renewed interest and critique in academic and popular circles as to whether the situation for women in STEM has really improved, remained static or deteriorated. 2015 began with an uptick in the burgeoning scholarship and interest in gender and science, technology, engineering and mathematics (STEM). Articles in the January 16, 2015 issue of *Science* focused on "Gender Inequality in Science" (Penner 2015) and "Expectations of Brilliance Underlie Gender Distributions across Academic Disciplines" (Leslie et al. 2015). The United States popular media have also devoted considerable attention to the gender gap, particularly the gender and racial gap in the tech industry, as well as questions about why women (and men of color) with PhDs in STEM do not go into academia. In contrast, research such as "National Hiring Experiments Reveal 2:1 Faculty Preference for Women on STEM Tenure Track" published in the *Proceedings of the National Academy of Sciences* (Williams and Ceci 2015) suggested that in the U.S. perhaps women have reached not only parity, but receive preference, in hiring in academia. This evoked significant conversation and critique in

both academic and popular circles, as did the international study "Gender-Science Stereotypes Persist Across the World" released in May, 2015 (Miller et al. 2015) about whether the situation for women in STEM has really improved, stayed the same, or deteriorated in recent years.

Some insight into whether and how the situation for STEM academic women has changed over time can be gleaned from the responses of the POWRE awardees. The answers given in 2012 by a respondent to question 1 will be compared with the answer that same individual gave to the same question in the initial survey more than a decade earlier.

Question 1. What are the Most Significant Issues/Challenges/Opportunities Facing Women Scientists and Engineers Today as They Plan their Careers?

The 2012 responses of each individual were compared with the response she had given initially, using the same 16 categories for question one. Each individual's 2012 response was rated compared to her earlier response as similar, mostly similar, mostly different, or different. Table 3.1 shows the results for the question for the four cohorts, grouping similar and mostly similar together for comparison, with different and mostly different grouped together.

Most respondents gave a similar or mostly similar response to question one in 2012 as they had earlier. When all cohorts were aggregated, well over twice as many respondents (125 out of 177) gave consistent answers from one decade to the next. Although in three cohorts, over twice as many gave similar or mostly similar responses, for the 1997 cohort, only 21 out of 33 gave consistent responses, with 12 out of 33 giving different or mostly different responses.

Table 3.1 Consistency of responses to question 1 by earlier Cohort year

Year	*Similar*	*Mostly similar*	*Total #*	*%*	*Mostly different*	*Different*	*Total #*	*%*
1997	8	13	21	63.6	7	5	12	31.4
1998	8	29	37	71.2	7	8	15	28.8
1999	10	23	33	75.0	4	7	11	25.0
2000	10	24	34	70.8	4	10	14	29.2
Total	36	89	125		22	30	52	

Table 3.2 Consistency of responses to question 1 by discipline

Discipline	*Similar and mostly similar*						*Different and mostly different*					
	1997	*1998*	*1999*	*2000*	*Total #*	*%*	*1997*	*1998*	*1999*	*2000*	*Total #*	*%*
BIO	6	10	7	6	29	63.0	3	4	4	6	17	37.0
CISE	3	6	3	3	15	88.2	2	0	0	0	2	11.8
EHR	0	0	2	2	4	66.7	1	1	0	0	2	33.3
ENG	4	11	6	0	21	75.0	1	1	3	2	7	25.0
GEO	1	1	2	4	8	53.3	3	2	1	1	7	46.7
MPS	4	4	8	14	30	76.9	3	2	2	2	9	23.1
SBE	4	5	4	3	16	64.0	0	4	2	3	9	36.0

BIO biological sciences, *CISE* computer and information sciences, *EHR* education and human resources, *ENG* engineering, *GEO* geosciences, *MPS* mathematics and physical science, *SBE* social, behavioral and economic scienes

As Table 3.2 shows, the responses for question one for the majority of scientists in all disciplines remained consistently similar or mostly similar. However, the data show considerable disciplinary differences in consistency. For example, five times the number (15 out of 17) CISE women gave consistent responses, while barely more than half (8 out of 15) of the women in GEO did.

Example quotations from individual respondents in 2012 compared to their response earlier illustrate the demarcations used to distinguish among the categories of similar, mostly similar, mostly different, and different. For each pair of quotations, the first represents the earlier response; the second response comes from the same individual in 2012. These quotations from individuals from different cohorts and from different disciplines reinforce the consistency across more than a decade (twelve to fifteen years) of responses to question one.

Responses Classified as Similar

Many of the responses classified as similar focused on balancing career and family:

> I am now in the second year of my tenure-track position and reaching an age where starting a family is urgent. I spoke to other women at the university. Several of them waited to have children after they had tenure but by then they either had so many complications with their pregnancy that they were not able to have children or they had complications with the birth so that they gave up their position to care for their child full-time. It seems a difficult choice to make: to sacrifice their scientific interests to fulfill their desire to have children or vice versa. (ENG respondent from 2000 cohort)
>
> Integrating career with having a family is a difficult challenge. The timing is challenging as tenure-track years are the child-bearing years. In addition, women faculty are posed with uncomfortable decisions to make on what to sacrifice. This is still a significant challenge and opportunity for institutions who want to recruit and retain women faculty. (2012 same ENG respondent from 2000 cohort)
>
> How to balance career and family (ENG respondent from 1998 cohort)
>
> Need for flexible work hours for women with children.
>
> Need for availability and affordability of high-quality child care.
>
> Need to travel can make family responsibilities challenging.
>
> I think that fewer women would leave the workforce if there were more opportunities for meaningful part-time work. (2012 same ENG respondent from 1998 cohort)

The dual career aspect of balancing career and family remained consistent over the decade:

> Finding a geographically compatible job for professional spouses (especially if the spouse is also an academic scientist). (MPS respondent from 1997 cohort)
>
> Dual career couples are the most significant problem that I see. Women physicists are much more likely to be married to other professionals who also have limited job choices. (2012 same MPS respondent from 1997 cohort)

For some, the consistent issue focused on the image of women scientists and whether women do cutting-edge science compared to that of their male colleagues:

> Having to continually challenge the idea of women scientists to the male, and sometimes even female audience (colleagues and students). The main reason for this is probably lack of the image of female professor and researcher. Compared to very strong and traditional presence of the image of male professor, scientist, and researcher, especially in male dominated disciplines such as natural sciences and engineering the image of female scientist is practically non-existent. (ENG respondent from 1998 cohort).
>
> I feel that I can speak only for myself as a woman. The major challenge I see is that the cutting edge science and engineering remain out of reach of the vast majority, if not all, women. While presence of women in science and engineering has become more or less accepted, I think that most often less significant scientific tasks are delegated to women. Men remain in the driving seat, especially in cutting edge science and areas that have been traditionally considered "to belong" to them . . . I would say that the main challenge is that women still remain on the margins of cutting edge science. (2012 same ENG respondent from 1998 cohort)

Responses Classified as Different

In contrast to the large percentage of women academic scientists showing consistency in responses over the decade, a much smaller number (30 out of 177) gave a quite different response in 2012 compared to what they had twelve to fifteen years earlier. For some, it seemed that a particular event, such as birth of a child, led them to give a very different response in 2012 than they had given earlier. For others, the reason for the difference was unclear.

2-body problem

Very restricted choice of job location, temporary nature of employment, low salaries and the impact of these three things on the quality of life. Overlap of child-bearing years with most demanding years of research. Coming to terms with expectations (career + family) and the reality of a 24-hour day. (GEO respondent from 1997 cohort)

Loneliness, isolation, lack of community/connectivity. Politics and non-technical issues that impede the technical work, plus funding hardships within federally-sponsored programs (gender neutral concerns). There are still incentive hires and funding for early-career women and minorities. Less for mid-level women, unfortunately. (2012 same GEO respondent from 1997 cohort)

A few indicated they thought they had responded in a similar fashion more than a decade earlier, although their response was coded as different from the one given earlier by the same individual:

There continue to be few female role models in tenured positions in engineering. In my field (concrete technology), women are so poorly represented that being female certainly creates more notice for you and your work, particularly when presenting at conferences. This can be beneficial, as recognition of your research by your peers is important for gaining tenure; it can also add to the already large amount of pressure on new faculty. (ENG respondent from 2000 cohort)

I think work/life balance issues remain an ongoing challenge for many, but perhaps especially for women. However, if one is able to strike the right balance, certain STEM careers (like being in academia) do offer some flexibility that makes this balance a bit easier. (2012 same ENG respondent from 2000 cohort)

As seen in many of the 2012 responses, the tight fiscal situation leads to funding issues dominating responses compared to those given a decade earlier:

This is a bit hard for me to answer as I am single and have no interest in children and my guess is the most significant challenge facing female scientists is balancing family/children with a career that obviously is not a 9–5 proposition. I know my institution is pretty good about adding things like maternity leave to the time until one goes up for promotion, but I don't know if all institutions are good about this. (BIO respondent from 1998 cohort)

Same as men, the fiscal climate for research funding is very poor (2012 same BIO respondent from 1998 cohort)

Issues: still lower pay as evidenced from C&E News salary survey; still fewer women in upper level jobs (full professor, administration, etc.); husband's job still seems to take precedence (moving to a new location for husband with lateral or demotion for wife, child care arrangements); many positions expect 50–70 hours/week, family/home/career, career interruptions.

Opportunities: many. (MPS 1997 cohort)

To me, the most significant issue facing women scientists is the reduction in funding levels and lower funding rates for basic research. The success of a career and future opportunities are limited by one's pattern of funding and hence their publication rate.

Other challenges include unconscious bias (which also affects funding rates), often accompanied by a distrust/dislike of successful women that have an opinion. (2012 same MPS respondent from 1997 cohort)

Responses Classified as Mostly Similar

For determination of consistency, distinguishing similar responses made by individuals over the decade from those that differed proved relatively easy. A larger fraction (111 of 177) of individuals gave responses that were neither very similar nor very different from those they gave more than a decade earlier. 89/177 ranked as mostly similar, while 22/177 ranked as mostly different. Although for determining consistency "mostly similar" was lumped with "similar" and "mostly different" with "different", the following examples illustrate how "mostly similar" differed from "mostly different" as well as "similar".

Several continued to mention work-life balance, but interspersed it with different issues more than a decade later:

Equal pay for equal positions, respect of older male peers in the discipline, family (to have or have not).

Opportunities are that women are good mentors, see problems from different perspectives, and can bring some human-ness to science. (BIO respondent from 1999 cohort)

Funding for research, home-work balance, and stress are major issues/challenges. Major opportunities are the ability to mentor more women as they start to outnumber men in college, grad school. (2012 same BIO respondent from 1999 cohort)

Dual career issues or even more so two academic couples. Who gives up/takes a back seat to the other's career. (SBE respondent from 1999 cohort)

Balancing work and family. (2012 same SBE respondent from 1999 cohort)

Interactions with colleagues remained significant:

> As for all scientists, the working climate is important for the women scientists. Often times, subtle interactions amongst players can be quite important. (GEO respondent from 2000 cohort)
>
> The glass ceiling still exists! Women are more prone to be stuck in middle management. Very few rise to lead! Women are more prone to rise to the top when a majority of group members are women; however, in a mixed group, they are more often than not second-in-command. (2012 same GEO respondent from 2000 cohort)

Responses Classified as Mostly Different

In some cases, distinguishing mostly different from different became difficult; ultimately it came down to a judgment call. As was the case with the responses categorized as different, many of the responses reflected one issue such as balancing career and family in one decade; another issue became the primary thrust of the response in the next decade, with the earlier issue mentioned in passing in the later comment.

> For whatever reason, often women scientists are still not taken seriously and are treated differently than their male counterparts by management. In an academic setting, the female faculty are seen as "moms" and students feel more comfortable asking them for help, asking them for reference letters, crying on their shoulder, etc. This is a time consuming part of the job that is never factored into any equation anywhere and thus credit is not given where it should be given. (ENG respondent from 1998 cohort)
>
> Women are not effective at negotiating (if they negotiate at all) when transitioning from trainee to independent scientist. This often leads to lower salaries and less institutional support for their labs than what men negotiate for themselves. There are great resources available for women to learn how to negotiate on their own behalf, and I can tell you from personal experience that it works. More women need to learn this important skill, and to use it throughout their career. (2012 same ENG respondent from 1998 cohort)
>
> Cons: Credibility issues, lack of leadership opportunities, glass ceilings, poor climate, too many time demands.
>
> Pros: Great visibility, great NSF programs, great NSF panel opportunities. (MPS respondent from 1997 cohort)
>
> In the physical sciences and engineering in the US, women are still in a minority. Therefore all the issues associated with this hinders women at all

> career levels. They have to work harder to achieve the same recognition, and also have heavier service roles. Thus, family and career balance is challenging.
>
> Women in the physical sciences and engineering are not well-represented globally, so this also causes problems since science is global. (2012 same MPS respondent from 1997 cohort)

Just as funding issues in 2012 placed a group of respondents in the "different" category, funding issues in the 2012 response also caused some to be categorized as "mostly different".

> Obtaining good jobs, research funding, and, for many women, figuring out when/whether to have children. On the bright side, now there are biotech possibilities that never used to be there; however, it is easy for women to be marginalized at these places. (BIO respondent from 1998 cohort)
>
> Funding sources are drying up; very discouraging. For academic scientists, move to adjunct teaching, online teaching will decrease the number of positions available, especially tenure-track positions. Sexism is still a problem, coupled with the assumption that all women are "motherly" and want to take on lots and lots of "helpful" projects. (2012 same BIO respondent from 1998 cohort)

Question 2. How does the Laboratory Climate (or its Equivalent in Your Subdiscipline) Impact upon the Careers of Women Scientists and Engineers?

As Table 3.3 indicates, for question two, only slightly more individuals expressed similar or mostly similar issues about laboratory climate than those who expressed different or mostly different issues; all cohorts showed lack of consistency. These responses to question two contrast with those to question one where the overwhelming majority of individuals gave similar or mostly similar responses to those given a decade earlier.

Not surprisingly, the individuals from different disciplines also did not show consistent responses to question two over the two decade stretch. As Table 3.4 documents, no particular discipline was consistent in its responses to question two.

The following quotations pair the 2012 response with the response ten to fifteen years earlier given by the same individual to question two. The first quotation of the pair represents the response given between 1997 and 2000; the second quotation is the response given by the same individual in 2012. These pairings illustrate responses ranked as "similar":

Table 3.3 Consistency of responses to question 2 by earlier Cohort year

Year	*Similar*	*Mostly similar*	*Total #*	*%*	*Mostly different*	*Different*	*Total #*	*%*
1997	7	6	13	14.8	5	14	19	22.6
1998	5	25	30	34.1	13	8	21	25.0
1999	3	11	14	15.9	16	12	28	33.3
2000	13	18	31	35.2	9	7	16	19.0
Total	28	60	88		43	41	84	

Responses Categorized as Similar

Many saw the laboratory climate as critical for success:

> The laboratory climate has everything to do with the success of women scientists. She cannot function if the climate is not conducive to getting quality research done. The laboratory climate where I work is very conducive to getting a great deal of research done. The people with whom I work are all very supportive. However, I know that this is not always the case. It is extremely important for anyone, male or female, to work in a climate that is both supportive and encouraging. (BIO respondent from 2000 cohort)
>
> The climate in the biology laboratories in which I have worked as a student and as a faculty member has always been equally supportive of men and women scientists.
>
> It goes without saying that the climate of any laboratory has a significant impact on the productivity of everyone in that lab and could be either beneficial or detrimental to one's career. (2012 same BIO respondent from 2000 cohort)

Some saw the climate as individual or neutral:

> In my field the climate is positive towards women as much as men; there is quite a fixation on status within the field but it is more dependent on one's rank/title than one's gender. (Not necessarily ideal either but a different problem.*) (MPS respondent from 2000 cohort)
>
> One of the places I work is pretty much insiders and outsiders, so it is more how well one is "cool" within the culture, rather than whether one is male or female. (2012 same MPS respondent from 2000 cohort)

Table 3.4 Consistency of responses to question 2 by discipline

Discipline	*Similar and mostly similar*						*Different and mostly different*					
	1997	*1998*	*1999*	*2000*	*Total #*	*%*	*1997*	*1998*	*1999*	*2000*	*Total #*	*%*
BIO	3	7	2	8	20	22.7	4	6	9	2	21	25.0
CISE	2	4	1	1	8	9.1	3	2	2	2	9	10.7
EHR	0	1	2	2	5	5.7	2	1	0	0	3	3.6
ENG	1	7	3	0	11	12.5	3	5	5	4	17	20.2
GEO	2	1	1	4	8	9.1	1	2	2	2	7	8.3
MPS	3	4	4	11	22	25.0	4	2	6	5	17	20.2
SBE	2	6	1	5	14	15.9	2	3	4	1	10	11.9

BIO biological sciences, *CISE* computer and information sciences, *EHR* education and human resources, *ENG* engineering, *GEO* geosciences, *MPS* mathematics and physical sciences, *SBE* social, behavioral and economic sciences

Others defined climate by a particular aspect such as safety or field work that differentially impacts women:

> Most of my work is done in the field, and this requires time away from family. Even with a supportive partner, I find my ability to get into the field for any length of time is severely constrained because of children. I do not regret that, but only mention it as a fact of life. Once in the field, I find the work runs smoothly, with nothing to constrain my work. (SBE respondent from 1997 cohort)
>
> Field work is common in my field. Again, family demands can make it difficult to be away for an extended period. That continues to be a problem. (2012 same SBE respondent from 1997 cohort)

Responses Categorized as Different

In contrast to the consistently similar responses over more than a decade to question one, almost half of respondents gave a different response to question two in 2012 than they did a decade earlier. Several individuals from each cohort gave very different responses in 2012, in some cases almost diametrically opposed, to those they had to the same question earlier. The following quotations, pairing the earlier response with the 2012 response from the same individual, illustrate responses ranked as "different".

Some who initially indicated the laboratory climate had no effect or that they didn't understand the question gave very different responses a decade later:

> In my job, there is not really a lab climate that I deal with. Instead, much of my work is on computer connected to the internet. The ability to have a laptop and cable internet connection at home allows me to get a lot of work done on my schedule. I think this really helps women scientists, who sometimes have stranger schedules than many men scientists. (GEO respondent from 2000 cohort)
>
> Many women in my field are frustrated or even demoralized by the lack of junior and senior leadership in research labs and universities who are women, or even in the lack of women with whom they can collaborate with on research. (2012 same GEO respondent from 2000 cohort)
>
> Not any different from male scientists. (ENG respondent from 1998 cohort)
>
> There is an expectation in my field that scientists and engineers will devote their lives to their careers. Not everyone adopts this mantra, but the truly successful have. These individuals (now in their mid and late

careers) are effectively single without children. This model has been deemed unattractive to most of the women in the field. Consequently, none of the superstars are female. (2012 same ENG respondent from 1998 cohort)

In some cases, women who saw laboratory climate as a positive initially now see it as quite negative more than a decade later:

In my subdiscipline, women are well-represented at all levels (although perhaps not yet at the very top—National Academy/department chair/etc.). Thus, the laboratory climate has a positive impact. (BIO respondent from 1997 cohort)

Impacts negatively! I have been an academic scientist for 24+ years. It has been a constant battle for resources—from delays (nearly 1 year) in getting a laboratory at the time of hire while tenure clock is ticking, threats of having my space re-assigned to a less productive male colleague, being banned at one point from using the coldrooms in my department, and now to what will be nearly a year delay in assigning additional space to accommodate new hires (in response to new grants). One could go on! But the point is that the work environment is very stressful. My women co-workers feel that too, but the men don't. So, the question is—is it perception or is it real? Either way, it needs to be understood and the problem solved. (2012 same BIO respondent from 1997 cohort)

I prove theorems—so this does not impact me. (CISE respondent from 1997 cohort)

Juggling kids and tenure is complicated. Increasingly the younger women do have a spouse who shares that set of responsibilities. But few women have "wives"—partners who take full, or almost full, responsibility, for family life. Many male scientists do, which goes some way to explaining the imbalance. (2012 same CISE respondent from 1997 cohort)

In contrast, some switched from a negative view of laboratory climate to a more positive view after a decade:

With a field that is dominated 90 % by men, laboratories tend to be very "male culture" oriented. This can be a very alienating climate for women to the point where they find themselves moving out of the scientist career path they originally sought in order to work in an environment they feel more comfortable with. (CISE respondent from 1998 cohort)

I believe being in the computer discipline makes things a little easier for me since there is no "wet-lab" that needs to be personally monitored at all hours (evenings and weekends included). This gives me more flexibility in how and where I work (i.e., I am not tied down to physically

working in my lab), which I think is especially important for women scientists. (2012 same CISE respondent from 1998 cohort)

Responses Categorized as Mostly Similar

The 2012 responses, when compared to the earlier responses of the same individual, were relatively easy to categorize in the clear-cut examples above when the responses overlapped very substantially (similar) or contained little, if any, overlap (different). In contrast, all cohorts included many individuals who gave answers in 2012 that had considerable overlap but some differences from their earlier responses. The paired quotations below illustrate the responses of these individuals, labelled as "mostly similar":

I have heard rumors that there are women astronomers who have left the field because of sexual harassment/discrimination. I haven't known any of those women personally, and I have generally felt welcome and respected in observatories and other institutes. The only thing I have noticed is that men (particularly the older ones) don't really appreciate how hard it is for a mother to be a good mother and also work 60 hours a week (or whatever they expect you to be doing). (MPS respondent from 2000 cohort)

I don't perceive significant differences. Well, to be specific: the issues do probably differ in detail, depending on whether you're already on the tenure ladder or not, but the overall theme is the same. In both cases the women have to tackle some subtle or passive discrimination. On the bright side, as I get older the "imposter syndrome" is disappearing. (2012 same MPS respondent from 2000 cohort)

Field work presents particular challenges, as also indicated in the responses to question one:

Laboratory (or field team) climate is a microcosm of the larger sciences, with students experiencing their "position" and "working relationships" with respect to the authority (prof) and coworkers. Generally these experiences guide the views and expectations of young scientists through much of the early postgraduate years . . . for better or worse. (GEO respondent from 2000 cohort)

Lab climate impacts all students in terms of role modeling, standards and practices. Cooperative environments benefit everyone; competitive environments disfavor women. The attitude of the boss/mentor sets the tone and it is their mentality that can pervade the sense students have of the career

expectations. Women have more options in choosing mentors that suit them and mechanisms to get out of negative mentorships. Guys benefit from these newer options as well. (2012 same GEO respondent from 2000 cohort)

Some noted the difficulties involved with distinguishing climate in a particular or individual lab from the overall climate of the discipline:

The lab environment does intimidate the women in computer science. There are a lot of male hackers who know the in's and out's of how to use a computer and they can be very condescending to people who lack the background, but have the same or more ability to succeed. There are too many egos that drive this attitude, rather than cooperative attitudes. I hear this concern from women just beginning grad school and or undergrad computer science, regularly. (CISE respondent from 1998 cohort)

I believe that women are more affected by the lab climate than men. I believe that competitive lab environments bring out the lack of self-confidence in the women. Some seem intimidated by the competition, when it isn't really a competition but everyone trying to succeed. (2012 same respondent from 1998 cohort)

Responses Categorized as Mostly Different

Those responses categorized in 2012 as "mostly different" had a small amount of overlap but considerable difference from the response given by that same individual more than a decade earlier. Although the line between "mostly similar" and "mostly different" rested upon a judgment call, the following paired quotations exemplified those categorized as "mostly different":

As for all scientists, the working climate is important for the women scientists. Often times, subtle interactions amongst players can be quite important. (GEO respondent from 2000 cohort)

Laboratory space is prime demand for women—and they are often either given less or less prominent space for laboratories! (2012 same GEO respondent from 2000 cohort)

I have not seen any blatant or offensive sexism in my almost 10 years as a professor. I feel very fortunate. However, I certainly can sense that students have different expectations for women professors than they do for men. I have seen examples of pregnant women getting terrible teaching ratings that they likely did not deserve. (CISE respondent from 1999 cohort)

Lack of recognition; hostile work environment. (2012 same CISE respondent from 1999 cohort)

Several underlined the importance of mentors for improving climate:

> Very negative—too easy for women to be isolated. Men are not used to working with women in physics and engineering—women are too often seen as a threat. (MPS respondent from 1997 cohort)
>
> Unless you have a power mentor/network in physical sciences/engineering, it is challenging for women to achieve their full potential. (2012 same MPS respondent from 1997 cohort)

Reflections on Consistency of Responses to Questions Over Time

Comparing the qualitative comments of respondents from 2012 with those they made twelve to fifteen years earlier provides more granular evidence of how the responses of an individual remain similar, mostly similar, or change considerably over a decade. As documented previously with this population of POWRE awardees (Rosser 2004, 2006, 2012, 2013) and other studies using other populations (Mason and Ekman 2007; Mason et al. 2013; Monosson 2008), balancing career with family responsibilities remains the predominant career opportunity/challenge for academic women scientists and engineers. Although respondents answered question one with an eye to issues for women scientists in general, some of the specific contextual details reflected their own age/career stage. For example, earlier responses focused on whether and when to have children, while 2012 responses described the struggle of dealing with children over the summer, during field work, or when undertaking required travel. Dual career situations, another major work-life balance issue, continued to challenge the many women scientists partnered with other scientists.

The less than one-third of individuals who gave different or mostly different responses in 2012 than they had a decade earlier to question one, typically gave a response that differed for her individually, but not a response that focused on a new issue that others had not mentioned. For example, a woman who described struggles with daycare and whether to have a second child in 1998 might underline the difficulty of obtaining the same level of respect and credibility accorded her male colleagues at the same senior rank as she.

Problems about funding, coupled with concerns about the future for academic scientific research, stood out as the different response to question one brought up significantly more in 2012. Since the questionnaire

and responses occurred well before the sequestration and its effects, a further increase in responses about tight funding might have been likely if the questionnaire had been sent in 2013 or 2014 instead of 2012.

In 2012, women scientists also more frequently emphasized the struggle to succeed to obtain credibility and respectability. Although seniority represents a likely reason for this increase in the response, the tight funding situation, leading to constant need to write grant proposals, face rejection, and worry about maintenance of the lab and personnel to carry out research, possibly confound the increase in this response. Since the 2012 responses came from the same individuals who responded earlier, this different response to question one likely correlates with the age and increased rank of the respondents and their recognition of different measures of success at senior levels compared to focus on achieving tenure at the junior level.

In short, responses to question one reflected considerable consistency or slight improvement over time with one primary exception; most found the future for academic research deteriorating, particularly as exemplified by the difficulty of obtaining funding.

The tight funding situation was also reflected strongly in responses to question two about laboratory climate. As the results indicate, individuals demonstrated less consistency in their responses to question two over the ten to fifteen years than they did in their responses to question one.

With a few exceptions, gender differences in laboratory climate in science (Traweek 1988; Latour 1987; Rosser 2004) and engineering (McIlwee and Robinson 1992; Fouad and Singh 2014; Tao 2016) have not been studied extensively. Although most agree that the work climate in general, and laboratory climate in particular, aid in productivity and career success, studies of work climates have shown that employee perceptions of the same environment vary considerably, with race, gender, status, and other factors leading to differences in perception.

Two scientists sharing the same office or laboratory may have entirely different perceptions. Some studies (Britton 1997; Wright and Saylor 1992) suggest that women like their workplace when they have effective supervisors, and men like it when they have other colleagues "like themselves." Institutional setting variations such as research university compared to liberal arts college, may offer different constraints and opportunities for one gender compared to the other (Fox 1991). In several of the climate studies conducted at universities under their NSF ADVANCE grant initiatives (Herbers and Desai 2012; University of Michigan ADVANCE 2014), women

scientists and engineers reported different perceptions from their male peers of their departmental and institutional climate. In their study of why women leave engineering, Fouad and Singh (2014) found that women leave because of climate issues such as undermining behaviors by supervisors, lack of managerial support and sensitivity toward family responsibilities, and lack of advancement opportunities. In sum, studies suggest that perceptions of the workplace vary among individuals, with gender as one of the many factors affecting the perception. Since women gave much less consistent results over the decade to question two than they did to question one, the question two response results suggest that in addition to gender, variation in time or career stage may constitute another factor influencing perception of laboratory climate.

Although most agree that laboratory climate influences productivity, the exact mechanism by which it exerts influence remains less clear, as does the metric by which to measure productivity. Publications and grant funding become proxies for productivity.

The *Nature* article, "Global gender disparities in science" (Lariviere et al. 2013) documented that fewer than 6 % of countries represented in the Web of Science achieve gender parity in terms of papers published. The study showed that women have fewer authorships (30 %) than men (70 %), have almost half as many first authorships as men, have fewer international collaborations than men and that women's papers receive fewer citations than those of their male colleagues. Although this *Nature* article presented new data, analyzing 5.4 million peer-reviewed globally published articles written by 27.3 million people between 2008 and 2012, the finding of the publication gap was not news. The "productivity puzzle" between men and women in STEM has been studied for several decades (Cole 1979; Cole and Zuckerman 1984; Fox 1985; Long 1992; Zuckerman et al. 1991), with findings that although the gap differs in size among fields, women publish less on average than men. The widening of the gap in areas where research is expensive (Duch et al. 2012), as well as the discrepancy in research funding between women and men (Ley and Hamilton 2008) that results in women having smaller labs with fewer people, remain as suggested contributors to the lower publication rates of women.

The results of this survey suggest that as academic women scientists progress in their careers, their perceptions of career challenges and opportunities remain more consistent over time than their perceptions of laboratory climate. The reasons for the differences in consistency in response of the group as a whole (Rosser 2013) and within the same individual

become difficult to discern. Life events such as children, dual career issues, and relationships with mentors emerge as factors that appear to influence consistency of responses for some individuals. More systemic factors such as the current tight fiscal climate, difficult job market, relatively low pay of academics compared to professionals in other sectors, and negative public image of higher education may influence the individual responses, as well as the overall aggregate response.

On January 14, 2005, I was an invited speaker at the National Bureau of Economic Research at Harvard University where President Larry Summers delivered his now infamous speech. Summers drew on anecdotes and popular outdated or pseudo-science to make three points explaining the paucity of women scientists and engineers: (1) women are unwilling or unable to work the 80-hour weeks required for success in science at top-flight academic institutions; (2) innate or biological factors, rather than socialization, probably account for sex differences in mathematical aptitude and also for adult preferences for choice of academic study and occupational field; (3) discrimination, which he defined as a "taste" for hiring people like oneself, does not exist in academia because that would be eliminated through market forces by lesser institutions hiring highly qualified women and minorities, thereby gaining a competitive advantage.

Now, more than a decade later it appears that we are still debating these same issues as reasons for the gender disparity in certain disciplines and how to achieve better gender balance in academia. The Leslie et al. article (2015) basically took each of his points as a hypothesis to prove or disprove with their survey data. Other studies have addressed these same issues. After all the debates, one of the positive points of the controversy over Summers' remarks is that it brought attention and focus to issues of women and science in academia. Those who do research on gender, serve on faculty hiring committees, or facilitate the implementation of policies to balance equity in the capacity of administrators, must strive to keep these issues in central focus.

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CHAPTER 4

Senior Compared to Junior Women Academic Scientists: Similar or Different Needs?

Abstract In 2012, two additional questions not in the initial survey sought also to probe differences between junior and senior women. The 2012 written responses from all four cohorts of POWRE awardees overwhelmingly affirm that they believe junior and senior women face different issues from those faced by the senior women colleagues. Most discussed a number of changes in institutional policies and practices that they believe would be most useful for facilitating careers and laboratory climates for junior women. Although they acknowledged that issues differed for junior and senior women, overall, relatively few respondents had ideas about how to improve the situation for senior STEM academic women compared to their junior colleagues.

Keywords Junior women STEM faculty · Senior women STEM faculty · Institutional policies and practices

> Very different. Issues for junior women are about harnessing respect from senior male colleagues within whatever social expectations of "feminine" behavior they have while asserting their personalities and their scientific identities, visibility (unless one has an exceptional mentor, which some do), and graduate student access. The climate issues for senior women are about equitable access to resources financial and otherwise, access to critical budget information, space allocation, access to prestigious positions, access to leadership positions that involve making budget and resource allocation decisions,

S.V. Rosser, *Academic Women in STEM Faculty*,
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> access to large research grants/facilities, support for large initiatives. My experience suggests life is easier if husbands/partners work in academia. People's behavior and attitudes tend to reflect whether they need to worry about the "other" or not. (2012 respondent from 1997 POWRE cohort)

Consistency over time and career progress raise issues of whether junior and senior women face different challenges and opportunities in their careers in general, and in the laboratory, in particular. Because the overwhelming majority of the POWRE awardees were untenured assistant professors, the barriers they wrote about in 1997–2000 were particularly problematic for women scientists and engineers at the early stages of their academic careers.

Many of the early twenty-first century institutional changes heralded as significant for attracting and retaining women in science and adopted by both prestigious private institutions (Bartlett 2005; Fogg 2005; Pope 2005) and institutions funded through the NSF ADVANCE program (Stewart et al. 2007) focus on issues that are particularly significant for junior women. On one level, this focus on junior women remains critical, particularly in light of the study conducted at Penn State documenting the significant difference in the percentage of women faculty (48 percent) achieving tenure at 10 top research institutions relative to their male peers (56 percent) (Wilson 2006). If institutions do not evolve policies to attract and retain women, especially in STEM, there will be no issues for senior women, because there will be few or no senior women.

Little is known about the needs of senior women scientists. A few liberal arts institutions garnered an ADVANCE grant to collaborate on "Horizontal Mentoring Alliances to Enhance the Academic Careers of Senior Women Chemists at Liberal Arts Institutions" (Karukstis et al. 2011), an initiative clearly focused on senior women. An important aspect of the ADVANCE Institutional Transformation (IT) grant at the University of Wisconsin—Madison centered on "discovery interviews" with senior women faculty in the physical and biological sciences to inform the policies and transformations that would be most useful for them on campus and to increase the networks of senior women, thereby reducing their isolation and improving their workplace climate (Sheridan et al. 2006). Although other ADVANCE initiatives had advancing women to senior and leadership positions as their ultimate goal, their primary activities tended to focus on recruitment, retention, climate, and tenure for junior women in order to build a critical mass of women in STEM and facilitate their preparation eventually to assume leadership positions after they had become full professors.

In 2006, an e-mail questionnaire that had previously been administered to more than 450 women scientists and engineers, composed primarily of untenured assistant professors, either POWRE awardees (Rosser 2001; Rosser and Lane 2002) or Clare Booth Luce Professorship awardees (Rosser and Daniels 2004) was given to the population of Association for Women in Science (AWIS) Fellows. The results of the questionnaire helped to elucidate the issues of senior women scientists in contrast to those of junior women scientists. The results also shed light on what institutional practices might facilitate attracting and retaining of both groups.

The results of that study (Rosser 2006) revealed little overlap between the issues AWIS Fellows considered important for junior compared to senior women scientists. Responses of AWIS Fellows to the question of the most significant issues/challenges/opportunities facing "junior" women scientists today as they plan their careers, overlapped substantially with those given by POWRE and CBL awardees to that same question without the word "junior". In contrast, the AWIS Fellows did not give the same responses when the word "senior" was exchanged for "junior".

The questionnaire given to AWIS Fellows in 2006 also explored laboratory climate. Again, almost no overlap occurred between what AWIS Fellows thought were the issues surrounding the impact that laboratory climate has on the careers of junior compared to senior women scientists, although the AWIS Fellows gave similar responses to the POWRE and CBL awardees about what the impacts are for "junior" women scientists and engineers.

For neither question were the terms "junior" and "senior" defined for the respondents. Because respondents decided on these terms themselves, individuals may have interpreted what "junior" and "senior" meant in different ways than others interpreted these same words.

The responses of AWIS Fellows suggested they believed that more information from senior women scientists would help in understanding both the issues they face and the institutional policies and practices that might facilitate resolution of those issues. As one woman wrote:

> I think we need to know more about what senior women scientists feel is important. Is it lab space, release time, more post-docs, higher salary, a chance for an administrative assignment, etc. Do we know this? (Rosser 2006: 289)

Because the vast majority of the POWRE and CBL professors were untenured assistant professors, the barriers they identified in 1997–2000 were particularly problematic for women scientists and engineers at early

stages of their academic careers (Rosser 2001; Rosser and Lane 2002; Rosser and Daniels 2004). Now ten to fifteen years after the initial administration of the e-mail questionnaire to the POWRE awardees, as shown in Chapters 2 and 3, re-administering the first two questions of the initial questionnaire to the original POWRE awardee respondents yields some insights about senior, compared to junior, women scientists. In addition, two questions from the questionnaire given to the Association for Women in Science Fellows in 2006 that focused specifically on issues for senior women scientists were added to the 2011–2012 survey:

3. Do you think that the issues and/or climate differ for junior compared to senior women? If so, how?
4. In your opinion, what changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the junior level? Would these be the same for women at the senior level?

Chapter 2 explored the responses to questions one and two; Chapter 6 will explore the responses to question four. This chapter focuses on responses to question three.

Responses

The 2011–2012 responses from all four cohorts of POWRE awardees to question 3 overwhelmingly affirm that they believe that junior and senior women face different issues/challenges/opportunities from those faced by their senior women colleagues (see Table 4.1). Just as with the earlier study of AWIS Fellows, the POWRE awardees in the 2012 re-survey did not have the terms defined for them.

How much the four cohorts thought the issues differed for the two groups varied considerably in 2011–2012. While in the 2000 cohort three and one-half times as many respondents thought the issues differed compared to those who thought they remained the same, in the 1997 cohort more than eight times as many felt they differed.

Table 4.2 shows the responses separated by directorate of awardee. Respondents from all directorates in all cohorts believed issues faced by senior and junior women differed, suggesting that the idea that issues are more different than similar between the more senior and junior groups is not unique to particular discipline(s).

Table 4.1 Responses to whether issues and/or climate differ for junior vs. senior women according to POWRE Cohort

	Year Cohort									
	1997		*1998*		*1999*		*2000*			
	Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Total*	*Percentage*
Different	26	79	41	82	37	82	35	71	139	78
Same	3	9	6	12	6	13	10	20	25	48
Don't Know	4	12	3	6	2	4	4	8	13	8

Similar

A minority (14.1 percent) of respondents indicated that they felt the issues remained similar. Although some just said, "no difference", others spelled out why they thought the issues remained the same:

> I do not think that the issues or climate differs that much for junior compared to senior women. The perception and potential negative impacts of the issues and climate may change some after one obtains tenure but the issues are pretty much the same. (2012 respondent from 2000 cohort)
>
> Good question! I know so few senior women in my field, that this is a hard answer. If I go on the basis that I'm more senior than I was 10 years ago, I would say that the issues are the same, but that it gets easier to manage with time. (2012 respondent from 1998 cohort)

Individuals from all disciplines, as shown in Table 4.2, thought that the issues differed for junior compared to senior women. Some pointed out that departmental or institutional climate made more difference with regard to gender issues than junior compared to senior rank:

> I guess the question is are things getting better for the younger, female scientists. Really, could things have gotten much worse? I would say that whether things have gotten better is department-specific and leadership-specific. Enlightened men of any age have always been supportive of women. Certainly throughout my career, I was helped by enlightened men. We can only hope that there are now more enlightened men than before. However, there is (sic) still some hidden biases that need to be rooted out. For instance, why are men considered caring when they have to leave early to pick up children, whereas women are considered not serious about their work when they leave early? Little biases like that will continue to hold women back. (2012 respondent from 1999 cohort).

Different

The overwhelming majority (78.5 percent) believe that senior and junior women face different challenges. In addition to the quotation at the beginning of this chapter, the following quotations suggest some of the differences respondents observe:

Table 4.2 Responses to whether issues and/or climate differ for junior vs. senior women according to NSF directorate

	SBE		*ENG*		*EHR*		*MPS*		*GEO*		*BIO*		*CISE*	
	Number	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*	*Number*	*Percentage*
Different	17	68	26	76	4	80	33	87	15	88	30	75	10	71
Same	5	20	4	12	1	20	3	8	1	6	8	20	3	21
Don't know	3	12	4	12	0	0	2	5	1	6	2	5	1	7
Total	25	100	34	100	5	100	38	100	17	100	40	100	14	99

NSF directorate names:
SBE social behavioral and economic sciences, *ENG* engineering, *EHR* education and human resources, *MPS* math and physical sciences, *GEO* geosciences, *BIO* biology, *CISE* Computer and Information Sciences

> Yes, I think junior women are still tightly connected to their former mentors' networks. With time, they need to form their own but that doesn't work for all women. Some women in science end up pretty isolated except for students and former students. Junior women also are good at ignoring slights and acting like there is no problem. Sometimes older men are very lenient with attractive young women compared to how they will treat them when they are a bit older. Junior women get invited to speak much more, as best I can tell, and are nominated for awards, because of their network connections. (2012 respondent from 1998 cohort)

> I think senior women are more likely to stand up for themselves. I think junior faculty (male and female) are reluctant to stand up to senior faculty (male or female) out of fear of what might sway a vote about tenure. It might be better if the department faculty did NOT get to vote on tenure in their home department, but that faculty in the College did. Then day-to-day interactions could move forward and tenure votes would not always be in the back of junior faculty minds. (2012 respondent from 1998 cohort)

Although many thought that the differences made it more difficult for junior women, compared to their senior colleagues, many also thought that senior women have a more difficult time than their junior women scientists and engineers:

> Per the statement above, for senior women, the stakes are higher, the competition greater, and the challenges from men more serious. The "old boys" club is still strong at the senior level. There is also fatigue about gender issues. Once you get to the senior levels of faculty or administration you have spent so much time fitting in, getting along, etc. that you can lose sight of your identity. (2012 respondent from 1999 cohort)

> Yes, senior women are nearing or at the "glass ceiling". Thus the impact of the "good ol' boys" committees, etc. has more impact. (2012 respondent from 2000 cohort)

> The issues are harder for senior women than for young faculty. The reason is that people is (sic) usually more receptive and welcoming to young colleagues; later you have to demonstrate really excellent work to be able to compete. (2012 respondent from 1997 cohort)

> Ironically, I think that the climate for junior female scientists is better than for senior. Junior male scientists are less biased against their female counterparts than are more senior scientists. (2012 respondent from 1998 cohort)

As the quotations above suggest, the 2012 written responses from all four cohorts of POWRE awardees to question three overwhelmingly affirm that they believe that junior and senior women face different issues/challenges/opportunities from those faced by the senior women colleagues. Although some examples mentioned might be particular to a discipline, respondents from all directorates in all cohorts believed the issues faced by senior and junior women differed. This suggests that issues are more different than similar between the more senior and junior groups and that this perception is not unique to particular discipline(s).

Causes for these perceived differences will be explored in the next chapter. The practices and policies to remove obstacles for both junior and senior women will be examined in the concluding chapter. National initiatives coupled with institutional and departmental priorities emphasize mentoring and retention of junior faculty. This appears to translate into more policies and practices to facilitate careers of junior women faculty. Less attention has been given to senior faculty, especially senior women STEM faculty.

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CHAPTER 5

Are Perceived Differences for Junior and Senior Women Because of Struggle to Balance Career and Family?

Abstract Because career stage is highly correlated with chronological age, junior women are more likely to face childbearing and caring issues and/or may be more likely to be trying to establish a satisfactory dual career situation in conjunction with their partner/spouse than are their senior colleagues. This chapter focuses on whether balancing career and family explains the perceived differences for junior and senior women. A quick interpretation of the responses might suggest that differences for junior and senior women scientists center on career-family balance. Closer examination reveals a more complex situation. Qualitative comments add the necessary dimension to understand that while balancing career and family contributes significantly to the perceived differences between junior and senior women, those are not the only issues that account for the differences.

Keywords Childbearing and childcaring · Dual career issues · Similar vs. different

> Junior women are still working out their identity and (often) their own goals and still building their self-confidence. So, climate has a larger molding effect. Senior women have either "made it" or are struggling to keep up or re-enter after having a lower profile during the family years. Their issues are different. Soon I'll be caring for aging parents rather than kids—that might be even more time-consuming, I don't yet know. As family sizes have shrunk, parental care falls on the shoulders of fewer grown children. (2012 respondent from 2000 POWRE cohort)

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As the last chapter documented, most women scientists and engineers believe that junior and senior academic women face different challenges and opportunities. Women scientists who are junior in their career typically are younger in age than their colleagues who are more senior in their profession. Because career stage is highly correlated with chronological age, junior women are more likely to face childbearing and caring issues and/or may be more likely to be trying to establish a satisfactory dual career situation in conjunction with their partner/spouse than are their senior colleagues.

Some senior women also express issues raised by constraints on time or travel due to child-rearing or caring for elderly parents or inhibitions about switching institutions because of the difficulties of finding suitable positions for both members of a senior dual career couple. A possible interpretation of the results from chapter two, demonstrating that balancing career and family remains as the overwhelming issue for academic women scientists, and the results from chapter four, showing that the challenges differ for junior and senior women, is to draw the conclusion that the differences for junior and senior women emanate from efforts to balance career and family.

Different Issues for Junior and Senior Women

This chapter focuses on whether balancing career and family explains the perceived differences for junior and senior women. In order to explore this, the written responses categorized as "balancing career and family" (responses 1, 5) to question one from each individual were compared with her responses to question three to determine whether she saw the issues as the same or different for junior and senior women. As Table 5.1 documents, 100 of the 175 individuals who listed "balancing career with family responsibilities" (response 1) and/or "two career problem" (response 5) to question one also responded that issues and/or climate differ for junior compared to senior women in answer to question three. Since these were comparisons of an individual's response to question one with her response to question three, this meant that 100 individuals gave response 1 and/or 5 to question one **and** the response that issues differed for junior and senior women to question three.

Looking at the quantitative data quickly, the conclusion might be drawn that most women scientists think that the issues for junior and senior women differ because of childbearing and child caring and/or maybe because of the difficulties associated with dual career couples

Table 5.1 Comparison of questions 1 and 3

	Response to question 1[b]			
Response to question 3[c]	*#1. Balancing with family*	*#5. Dual career*	*Both #1 and #5*	*Neither #1 nor #5*
Differ 131	67	5	28	31
Same 41	23	0	7	11
Total[a] 172				

[a]Note that 3/175 individuals were not included because they did not provide a response to question 1 or to question 3

[b]Question 1. What are the most significant issues/challenges facing women scientists and engineers today as they plan their careers?

[c]Question 3. Do you think that the issues and/or climate differ for junior compared to senior women? If so, how?

becoming established with first positions that are satisfactory for both and within reasonable geographic proximity. Closer examination of the 100 responses reveals that most (67/100) gave a response of "balancing career and family" (response 1) along with their response of difference to question three. Few (5/100) indicated "two career problem" (response 5) along with the response of difference to question three, while a substantial number (28/100) gave a reply that was categorized both as "balancing career and family" and "two career problem" (both responses 1 and 5) along with the response of difference to question three.

Respondents Who See Issues as Different and Due to Balancing Career and Family

The qualitative comments of the respondents who see issues as different and due to balancing career and family illustrate types of the 67 responses categorized as "balancing career and family" (response 1) to question one and response of difference to question three:

> In the academy, I think the issue of generating enough published research to get tenure, right at the point in time when people want to have kids, is still hard. I think there is a lot more recognition of the issues, and many schools have taken steps to address it. And there are places that say that men also

should spend time with their kids, and let men and women both stop the tenure clock when they have a kid. But we don't really know that those accommodations are equally useful across the board. (2012 response from 1999 CISE POWRE awardee to question 1)

Yes, I think the issues are different. Within the academy, junior women are all about getting tenure. What do they need to do in order to satisfy all the criteria, while still maintaining some semblance of a life, etc. Within that, they have to quickly learn an institution which is new, get up to speed on the personalities and politics in their department, figure out who can be a mentor, who will make life difficult, who will be neutral. (2012 response from same 1999 CISE POWRE awardee to question 3)

Getting the same opportunities as male counterparts without exceptional measures. All discrimination, including positive discrimination, sets women apart and reduces the perception of their achievement. Famous quote: "you got that position because you are a woman" is very detrimental. This is especially challenging for women who also want to become mothers. This leads to an undeniable inequality between men and women and can cause women to either leave their careers or not have kids. (2012 response of 2000 MPS POWRE awardee to question 1)

I think there is a big difference between junior women who are starting their career AND family, and older women who have established themselves in both roles. After the childbearing age, these biological differences are no longer an argument and men and women can function on the same level. So yes, I think there is a difference. (2012 response from same 2000 MPS POWRE awardee to question 3)

Overall, stress management seems to be one of the greatest challenges, particularly in relation to: 1) securing the next position as a woman moves through the ranks in academia (i.e. grad student, post-doc, faculty member), and 2) securing research funding. Even after attaining tenure and job security, the uncertainty of research funding remains extremely stressful. Additional challenges for women scientists are the potential trade-offs between family and career including children and care-giving to other family members. (2012 response from 1998 BIO POWRE awardee to question 1)

The stress related to family versus career trade-offs does seem to differ for junior and senior women scientists. Junior women anticipate that a choice between family and career is eminent, that they may not have the opportunity to pursue both, regardless of whether that situation is ever realized. In contrast, senior women seem more likely to have reconciled this source of stress regardless of whether or not they have had children. (2012 response from same 1998 BIO POWRE awardee to question 3)

Balancing career and family priorities. It seems, all too often, a woman is forced to choose one or the other. And if she choses to have a family, she

must have a partner who is willing to become the "nurturer" so that the female academic can succeed. (2012 response from 2000 BIO awardee to question 1)

The issues differ, because senior level women are at a fundamentally different stage. Junior women can be struggling with very new/young families in combination with the stresses of teaching courses for the first time, managing a lab, etc. (all the "normal" stresses associated with being a new professor). Senior women may have more official responsibilities. However, in my experience, the issues might require less URGENT compromises (e.g. for junior women, a screaming baby needs immediate care and work must stop). My impression is that senior women have more stability (their courses are set, they know the "ropes" of their institution) and flexibility (kids are in school, more time to focus on expectations of the workplace). (2012 response from same 2000 BIO awardee to question 3)

Juggling career and family responsibilities. And it's not a female factor only. Personally, I felt more resentment coming from women without children/family than from men who were in a situation similar to mine. (2012 response from 2000 CISE POWRE awardee to question 1).

Definitely. Family issues are mostly gone. On the other hand, work is no longer a refuge from house routine. There are no more internal excuses "if I had more time", "if only I did not have to think about kids and family, and could totally concentrate on my work". (2012 response from same 2000 CISE POWRE awardee to question 3).

Respondents Who See Issues as Different and Due to Both Dual Career and Balancing Career and Family

The qualitative comments below demonstrate the examples from among the 28 responses categorized both as "balancing career and family" (response 1) and "two career problem" (response 5) to question one, along with the response of difference to question three:

At this point, I think there are two main issues: 1) jobs where spouses/partners can also find a job as many female academics have academic partners and 2) support by the department and university that lives need to be a balance of work and family. (2012 response from 1997 GEO awardee to question 1)

Raising a young family and/or having children while pre-tenure seems to be the main hurdle for junior women. And of course all the other non-gender

specific obligations of junior faculty. Too much teaching, too much demand on time, demands for publications, etc. (2012 response from same 1997 GEO awardee to question 3)

Family issues in all their manifestations: the 2-body problem (or n-body when children come*); maternity leave just at the time you need to be working 80 hour weeks; responsibility for the "executive care"" of the family—everything from identifying summer camps, contacting, baby sitters, baking cookies for birthday parties, planning birthday parties dealing with family holiday celebrations; planning on and executing elder care; planning family nutrition; supervising housekeepers and staying home when repair people arrive, etc. All this work and executive thought is so exhausting that even women who "do it all" tend to do research that focuses more on "quick and dirty" results rather than on the far-reaching profound problems that move the field. (2012 response from 2000 MPS awardee to question 1)

The situation is very different for junior and senior women. In a sort of perverse Darwinian scenario, the climate issues and crushing workload at home and in the lab (did I mention the huge amount of travel involved?*) discourage all but the most resolute women. Thus, the senior women (the few*) are the most resilient, energetic, in-control, and assertive ("bitchy" as their detractors often say*). The pipeline continues to leak at the lower levels due to the two items in #1, but those who have made it are largely immune to the issues. But the final irony is the senior women "recognize" the issues, while the junior ones are oblivious at first. (2012 response from same 2000 MPS awardee to question 3)

I believe the most significant issues today are making decisions regarding family and professional career balance. I talk to many young women who seem to struggle with when to start a family and how to fit that into their career planning. They seem to be leaning more toward having children later because they don't think they can balance both at the start of their careers after school. Also, they face the challenge of both they (sic) and their spouse finding jobs that they like in the same location. (2012 response of 1998 CISE awardee to question 1)

I believe the climate in academia has changed over the past 10 years in general, more money-driven and grant-driven. This many not appeal to many women. But, it affects both junior and senior women. The issues are definitely different in terms of having young children versus grown children, so younger women have more life balance issues than senior women. (2012 response of same 1998 CISE awardee to question 3)

I think the most significant challenge is that women still do the majority of childcare work (including making the arrangements for outside childcare, dropping children off and picking up, finding backups, staying home with a sick child etc*). Because the years of having young children coincide with

> the years when scientists' careers should be accelerating (and when some of us need to travel for field work or to distant, child-unfriendly facilities*), this puts women in a bind. Especially since many women scientists are married to male scientists who are promoting their own careers, and time attending to family duties can be a zero-sum game. (2012 response of 1999 GEO awardee to question 1)
>
> It appears to me that junior women are working with a generation of men who are used to having female colleagues, and that this makes the climate more friendly. Senior women are still dealing with a generation of men used to a male-dominated system, especially in positions of leadership. I expect that this will change as the current generation of younger scientists advances into those positions. (2012 response of same 1999 GEO awardee to question 3)
>
> Two-body problem seems a major challenge for both men and women, but it seems more a problem for women because it is still less common for a husband to stay home than for a wife. Balancing work and raising a family can also be challenging for a two-career household. (2012 response from 1997 CISE awardee to question 1)
>
> There are more women scientists and engineers than before, and therefore there are more junior women than senior women, which is certainly the case in our institution. The institution seems more sensitive to women now with programs designed to help women faculty to advance their careers. (2012 response from same 1997 awardee to question 3)

Respondents Who See Difference Due to Dual Career Issues

The qualitative comment below comes from one of the 5 responses categorized only as "two career problem" (response 5) to question one and the response of difference to question three:

> Dual career couples are the most significant problem that I see. Women physicists are much more likely to be married to other professionals who also have limited job choices. (2012 response of 1997 MPS awardee to question 1)
>
> The junior women have it even tougher because they are in their child-bearing years. (2012 response of same 1997 MPS awardee to question 3)

In sum, a large majority (100/175) of respondents indicated that issues differed for junior and senior women in response to question three and balancing career and family and/or dual career to question one. In contrast,

a substantial group, (31/175) who thought the issues differed for junior and senior women, did not mention either balancing career with family or dual career issues in response to question one. Problems resulting from tight funding and struggles to obtain visibility and access to powerful networks feature prominently in the comments about difference.

Respondents Who Saw Difference but not Caused by Balancing Career and Family or Dual Career

The following quotations exemplify responses of individuals from this substantial group:

> The most significant issue/challenge facing women scientists currently is the same as that facing all scientists: funding. The current funding cut-offs are too low, resulting in many labs going without. Universities will close labs if they do not have funding. Yes funding is going to only a minority of the labs that need it. The cut-off at NIH is currently 8, meaning 92% of those that apply are turned away. Students just starting out see this and do not feel encouraged about going into science.
>
> But I think the question has the intent of identifying issues specific to women. I think that there is still a lot of prejudice against women, but it is far less overt than it used to be. That being said, I have still come across some faculty that are outright sexist, for example, by speaking against female faculty candidates in very sexist language. (2012 response of 2000 BIO POWRE awardee to question 1)
>
> Yes, of course, largely relating to having young children. Now that my children are older, it is much easier for me to juggle work and family obligations. Now I am facing issues regarding promotions. I do see that the men who are at my peer level seem favored for chairmanships of committees. This is a disadvantage to me, since those chairmanships allow for better visibility and additions to their CVs that help with promotions. The funny thing is, that my department chair is female, so having a woman at the top making the decisions is not always going to lead to equal treatment. My previous department head was male, and chose me far more often for these types of opportunities. (2012 response of same 2000 BIO POWRE awardee to question 3)
>
> Loneliness, isolation, lack of community/connectivity//politics and non-technical issues that impede the technical work, plus funding hardships within federally-sponsored programs (gender neutral concerns*)//there are still incentive hires and funding for early-career women and minorities. Less for mid-level women, unfortunately. (2012 response of 1997 GEO POWRE awardee to question 1)

I think the gender differences become more pronounced as I become older. I am more aware of the inequities. And I am more likely to be bothered by them and less tolerant of them. I see more women moving into EPO roles, or mid-level management roles (i.e., few achieve senior leadership roles*) or leaving, period. This saddens me though I understand why. (2012 response of same 1997 GEO awardee to question 3).

The good old boy system is still alive and well and serves as a barrier to advancement and funding. (2012 response of 1999 BIO POWRE awardee to question 1)

Hard to say since I am not junior anymore but I would say the climate is a LITTLE better for junior women. Seventeen years ago when I had my children, I didn't even think of taking time off as I was trying for tenure. Now there is both maternity and paternity leave which is a big improvement. (2012 response of same 1999 BIO POWRE awardee to question 3)

Science is becoming increasingly interactive and multidisciplinary. Successful scientists are those who have not only strong disciplinary skills, but also the ability to communicate well and maintain strong networks. I believe that it can be harder for women sometimes to develop and maintain strong networks in the same way as men can. This is especially true when women are in the minority. Getting ahead still sometimes requires getting access to the "old boys club". In my opinion, it is often not that men are deliberately trying to exclude women, it's just that it sometimes feels a little awkward to know how to include them. Some of the standard ways of engaging with fellow male colleagues might need to be adapted to allow women scientists to be part of the community. In my experience, being successful requires a strong level of personal drive and desire to achieve. While these characteristics are perceived as positives in men, in women there is still sometimes a slight negative. (2012 response of 2000 MPS POWRE awardee to question 1)

In some ways I wonder if things might be a little easier for younger women these days. Things get easier as there are more senior women around to act as role models. Younger women have also grown up in a more connected and collaborative world and I think this enhances their abilities to network and collaborate. (2012 response of same 2000 MPS POWRE awardee to question 3)

Similar Issues for Junior and Senior Women

To complicate the interpretation further, an equally substantial group (30/175) indicated in response to question three that they thought the issues were similar for junior and senior women and gave either response 1 of "balancing career and family" or response 5 "two career problem" to

question one. Since dual career couples might have issues that persist from the junior to the senior level, those responses (#5) were separated from those who discussed childrearing and bearing (response #1) to disentangle those responses. That separation revealed that none who thought issues for junior and senior women were similar in response to question three mentioned only dual career (response #5) to question one. Eleven indicated that the issues were the same but gave neither a response of 1 or 5 to question one.

Respondents Who Thought Issues were the Same but Caused by Balancing Career and Family

Most (23 of the 30) only indicated issues of balancing career and family (response #1). The following quotations typify these responses:

> Balancing careers and family. (2012 response of 1999 ENG POWRE awardee to question 1)

No difference. (2012 response of same 1999 ENG POWRE awardee to question 3)

> The current job market, economic uncertainty, and politically-motivated attacks on and defunding of science are broad issues that affect both men and women as they plan a technical career. Women still face additional challenges in timing of family vs. progression up the career ladder, the continued poor societal impression of bright and ambitious women in technical careers, and social and professional isolation in many tech fields. (2012 response of 1998 ENG POWRE awardee to question 1)
>
> In terms of percentages, there aren't any more women in engineering now than there were when I was a student. The attitudes of male students towards female peers and faculty might be changing though, since more of them have mothers who continued to work and pursue careers. More universities and companies now have things like written maternity leave and tenure clock policies, but until we get to the point where at least 30% of the people on project teams, committees, and corporate leadership teams/boards are women with scientific/tech backgrounds, critical mass won't be reached and the issue of feeling like the token woman on every assignment isn't going to change. (2012 response of same 1998 ENG POWRE awardee to question 3)

Challenges: women are still delaying having children because of the tenure clock, often leaving it too late. (2012 response of 2000 GEO POWRE awardee to question 1)

Not to my knowledge. I do think that junior female scientists have benefitted positively from the impact of current senior women in the field. (2012 response of same 2000 GEO POWRE awardee to question 3)

The biggest challenge for women is the same for men. This is the lack of funding for science research... The next biggest challenge is the struggle that women continue to bear the brunt of and that is having a family. It seems crazy to me that we would make it difficult for the most intelligent people in our society to bear children. It would seem far better to make it easier for the smartest people to have children as this will help society as a whole. (2012 response of 1997 BIO POWRE awardee to question 1)

Certainly junior women are more likely to have family struggles with young children. However, senior women can have just as many struggles with older children. While you can leave older children alone for longer periods of time, they need more things from you. This society continues to push children to overschedule their lives and as a result, parents must get them to all the many activities they are involved in. (2012 response of same 1997 BIO POWRE awardee to question 3)

Compatibility of academic careers with family life. Family responsibilities are assumed by women, and until the expectations change so that men see families as their responsibility, things won't improve for women. And academic responsibilities do interfere with family life. The travel schedule is punishing. Academic life was invented by men, especially in computer science, where there are conferences year round, and you are expected to appear at them to build a reputation. (2012 response of 2000 CISE POWRE awardee to question 1)

I cannot identify any issues. I am happy at my institution—I do not feel there are any systematic differences in how men and women, junior or senior, are treated. (2012 response of same 2000 CISE POWRE awardee to question 3)

Respondents Who Saw Issues as the Same, but Caused by Dual Career and Balancing Career and Family

Seven of the 30 who thought the issues were the same for junior and senior women indicated both balancing career and family and dual career issues in response to question one (both responses #1 and #5). The following quotations demonstrate the types of answers they expressed.

I remember reading in Chemical and Engineering News a number of years ago that female scientists tend to marry male scientists relative to the population at large. A consequence of this is the "two-body problem" that complicates job searches and eventual employment options. My suspicion is that women probably compromise on their career choices at a higher rate on average than do men. While women scientists seem to be more adept than in my generation at navigating the issue of the "biological clock" by either giving birth to one or more children while still in grad school or by taking advantage of more flexibility in academia with respect to flexible tenure clocks based on parental leave or even shared positions. (2012 response of 2000 MPS POWRE awardee to question 1)

I don't perceive any substantive change in the academic gender climate with respect to the issues regarding tenure and promotion, but the greater flexibility noted above regarding shared appointments and flexible tenure clocks have, from my perspective, lessened the pressure on junior female faculty members. Ultimately, the extent to which research and publication is an expectation will always have some bearing in the professional challenges each faculty member faces. (2012 response of same 2000 MPS POWRE awardee to question 3)

Managing tenure clock and biological clock . . . Difficult to accept semester-long invitations at other institutions or resident fellowships during sabbatical because of husband's job constraints and family responsibilities. (2012 response of 2000 SBE POWRE awardee to question 1)

Probably not. Universities are working hard on improving diversity issues and instituting family-friendly policies. I think that I was more appreciated and treated with proper respect when I was a junior faculty (before tenure) because perhaps, I was still in a subordinate role to my male colleagues. After I became the first tenured female faculty in my department, I think that some male colleagues experienced difficulties to make adjustments as they realized that I might have become one of their peers. When I was promoted to the rank of full professor, male colleagues who were ahead of me but stayed in the associate rank, situations seemed to become much more difficult and at times felt abusive. (2012 response of 2000 same SBE POWRE awardee to question 3)

In my experience, the greatest issue and challenge is development of a win-win solution for both institutions and faculty couples with dual-careers in science. It could also present a significant opportunity in cases where the right solution is worked out. Some women might contend that children and raising a family are the biggest challenge. To me, what makes this challenge less insurmountable is that the impact on the career can be reduced by a good support network. Also, this issue is alleviated once the children grow up and leave home, whereas the

dual-career spouse issue remains constant, assuming the couple stays together. (2012 response of 1999 BIO POWRE awardee to question 1)

In a general way the main issue is the same, that there is a single ideal model for a scientist's work/life balance of activities. That model does not allow much flexibility for dealing with family issues, whether it be raising a family or caring for an elderly parent. For dual-career couples at my institution, the negative climate towards the trailing spouse does not seem very different for junior and senior women. (2012 response of same 1999 BIO POWRE awardee to question 3)

Respondents Who Saw Issues as the Same, but not Related to Family or Dual Career

Eleven thought the issues were the same for both junior and senior women in response to question three but did not mention either balancing career and family or dual career issues in response to question one. The types of issues that they raised included the following:

The professional/social interactions with male colleagues in seminars, committee work etc. can be difficult for many women due to the presence of some men with an aggressive way of interacting. A softer approach, say using a softer voice or a softer way of expressing ideas and opinions, can easily drown under such circumstances. (2012 response of 1999 SBE POWRE awardee to question 1)

The number of women at the junior level has increased in my field, and this makes the problem I have stated above less prominent. On the other hand, not much has changed with respect to the social structure such as family relations, and more men than women in academe are married to spouses that are forgiving of the long work hours that are implied by this job. (2012 response of same 1999 SBE POWRE awardee to question 3)

The main challenge is that it is MEN's world. They are the majority who are in the leadership role and decide who decide who will be in the leadership role, the promotions, salary increases and so on. Most women, including me, for many reasons do not want to fight. (2012 response of 1997 MPS POWRE awardee to question 1)

Same for junior, but for different issues, such as survivor instead of salary justice. (2012 response of same 1997 MPS POWRE awardee to question 3)

In conclusion it appears that balancing career and family and dual career issues only partially explain the differences for junior and senior women scientists that most perceive. The explanation that differences for junior

and senior women emanate from family and dual career issues proves too facile to cover the complexity of reasons for the differences. While family and dual career issues prove significant, other issues surface to explain why individuals perceive that senior women face different issues encountered less by their junior colleagues.

Junior women must strive to earn tenure, obtain their first major grant, and establish their career. Having surpassed these hurdles earlier in their careers, senior women face different obstacles. Senior men fear competition from the senior women. Senior women must also struggle for resources, and experience expectations that they will provide excessive mentoring and other service responsibilities.

In contrast, some who indicated their belief that junior and senior women face similar issues did so on the basis that balancing career and family continues throughout the career span. This occurs when junior women defer childbearing until they receive tenure or in the cases where women who have their children well before earning tenure may be dealing with eldercare for aging parents or other relatives.

In addition to childbearing and caretaking issues, the difficulty of pursuing careers in tandem with a partner or spouse can remain challenging throughout the career span. In the earlier years, obtaining two appropriate, satisfactory positions in geographic proximity may constitute the problem; in later years, one partner/spouse may wish to pursue opportunities for a better position or at a more prestigious institution that does not have an equally satisfactory situation for the other partner/spouse.

The next, concluding chapter explores policies and practices developed by some institutions to alleviate some of these difficulties. Most appear to apply to women at the junior stage of their career.

CHAPTER 6

Conclusion: What Can the Last Fifteen Years Tell Us about the Future of Academic Women in STEM

Abstract Despite the major changes in higher education and in scientific technology during the last fifteen years, gender issues have persisted. Even in disciplines with increasing numbers and percentages of women, gender issues remain. Because little research has focused directly on the effect of the changes on women scientists who have remained in the professoriate, the POWRE awardees, a group who represent successful academic women scientists, provide insight into their perceptions of these effects. Consensus seems to have coalesced around policies and practices to remove obstacles and barriers that inhibit career advancement for junior women. No such consensus about policies to facilitate careers for senior women appears to have evolved. The results of the data from this re-survey suggest additional policies and practices that institutions might pursue, especially for women at the senior level.

Keywords Persistence of gender issues · Policies to support junior women STEM faculty · Practices to support senior women STEM faculty

> One of the most far-reaching changes in institutional policies and practices would be to incorporate a comprehensive win-win solution that would benefit both the institution and all dual-career couples who requested consideration for appointments. This would include factoring into the institution's funding pool the frequency of hires who bring with them a talented spouse or significant other. (2012 respondent from 1997 POWRE cohort)

S.V. Rosser, *Academic Women in STEM Faculty*,
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Despite the major changes in higher education and in scientific technology during the last fifteen years, gender issues have persisted, even in disciplines with increasing numbers and percentages of women. Because little research has focused directly on the effect of the changes on women scientists who have remained in the professoriate, the POWRE awardees, a group who represent successful academic women scientists, provide insight into their perceptions of these effects. Comparison of the qualitative responses of the same group of women to the same questions to which they responded fifteen years earlier permits some understanding of how career issues and opportunities and laboratory climates have changed or remained the same over this time.

Both aggregated and individual responses demonstrate consistency. Responses at the two different time periods of 1997–2000 and 2012 that the e-mail questionnaire was administered can be compared for similarities and differences in the aggregate to the questions by cohort of award year and by discipline. Responses of each individual from the earlier time period can also be compared to her 2012 response to determine individual consistency or change over time. Despite some disciplinary differences, the vast majority of individuals gave consistent responses from one decade to the next.

What additional institutional changes are still needed? Asking women scientists themselves may provide some solutions. Two additional questions, not included in the questionnaire for POWRE awardees in 1997–2000, were included in a 2006 study of AWIS Fellows, that included a focus on institutional policies and practices to facilitate careers for junior compared to senior women scientists and engineers: (1) In your opinion, what changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the junior level? (2) Do you think that other changes in institutional policies and practices would be more useful for facilitating careers of senior academic women scientists and engineers? Because respondents decided on definitions of "junior" and "senior" themselves, individuals may have interpreted what "junior" and "senior" meant in different ways than others interpreted these same words.

The most frequent response "monitor equity in space, salaries, travel, graduate students, etc." given by 23.9 percent of respondents to the second question (Rosser 2006), echoed the findings of the 1999 MIT Report (Hopkins 1999). Disparities between men and women in these arenas continued to rank as major issues for senior women in 2006. The responses of AWIS Fellows to this question regarding changes in institutional policies

and practices that would be more useful for facilitating careers of senior academic women scientists underlined two of the reasons why I undertook a survey of issues for senior women in 2006. First, almost one third (15/46) of respondents indicated "they can't think of anything" or gave an inappropriate response or none, suggesting that issues for senior women were understudied or poorly understood. Second, relatively little overlap existed between the policies and practices suggested for senior and junior women; as documented by responses to other questions on the survey (Rosser 2006), the issues for the two groups appear not to overlap very much.

Additional information comes from question 4 of the 2012 e-mail survey of POWRE awardees which asked the following: In your opinion, what changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the junior level? Would these be the same for women at the senior level?

Policies

Tables 6.1 and 6.2 document the policies and practices respondents suggested would be useful for facilitating the careers of academic women scientists or engineers at the junior (Table 6.1) or senior (Table 6.2) level. The categories used to group the 2012 responses in these tables were the same categories as those used for grouping responses for policies for junior and senior women in the study of AWIS Fellows (Rosser 2012, Tables 4.3 and 4.4). Using these categories from the AWIS study meant that some categories had no responses in them from POWRE awardees in 2012.

Policies for Junior Women

Most respondents identified a number of changes in institutional policies and practices that they find most useful for facilitating careers and laboratory climates for junior women. As Table 6.1 shows, family friendly issues, when grouped together (responses 1, 2, 3, 4, and 21) could be seen as the highest priority for institutional policies for junior women.

> Family–friendly policies, such as scheduling departmental seminars at midday rather than late in the afternoon or in the evening. University-based child care for employees, which is still quite rare. More flexibility in hiring academic partners of recruited candidates; this is a major reason we lost our best attempted hires. (2012 respondent from 1997 cohort)

Table 6.1 Responses to question: In your opinion, what changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the junior level

Categories		*Year cohort*					
		1997[a]	*1998*[a]	*1999*[a]	*2000*[a]	*Total*	*Percentage*
1.	Family friendly policies	12/33	14/50	15/45	15/49	56/177	32
2.	Extension of tenure clock	10	14	13	12	49	28
3.	Mentoring for Junior faculty	5	517	10	13	45	28
4.	Daycare	2	15	7	1	25	14
5.	Transparency of expectations, especially for tenure and promotion	3	8	3	5	19	11
6.	Don't overload with excess of committee work	5	3	7	3	18	11
7.	Monitor infrastructure issues—start-up, salaries, space	3	5	4	5	17	10
8.	Career partner positions	4	2	7	4	17	10
9.	Train faculty and administrators for nondiscrimination	1	0	7	9	16	9
10.	Change 24/7 expectations for academics in science	3	5	3	5	16	9
11.	Leadership training	0	3	4	6	13	7
12.	Availability of Federal money	3	3	3	4	13	7
13.	Opt-out policies available to everyone	4	4	1	2	11	6
14.	Network/support group for women	2	5	1	3	11	6

Table 6.1 (continued)

Categories		*Year cohort*					
		1997[a]	*1998*[a]	*1999*[a]	*2000*[a]	*Total*	*Percentage*
15.	Hire more senior women	3	1	2	3	9	5
16.	Value service more	2	5	1	1	9	5
17.	Seed money for women	1	5	1	1	8	4
18.	Establish rainy day fund—unanticipated emergencies	1	2	0	3	6	3
19.	Incentives to value diversity	2	2	0	1	5	3
20.	Workshops on negotiation	1	1	1	1	4	2
21.	Sick daycare	0	0	1	2	3	2
22.	Woman president, provost	0	2	1	0	3	2
23.	Access to graduate students	1	1	1	0	3	2
24.	More women on search, admissions and tenure committees	1	1	0	0	2	1
25.	Rethink tenure	0	0	2	0	2	3
26.	Best practices in recruitment	0	0	0	1	1	1
27.	No response	0	0	0	0	0	0
28.	Train graduate students/post-docs in career management	0	0	0	0	0	0
29	Train promotion and tenure committees	0	0	0	0	0	0
30.	Encourage post-docs to aim high	0	0	0	0	0	0

[a] *Note*: Each respondent could give more than one response

Table 6.2 Responses to question: What changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the senior level

Categories		*Year cohort*					
		1997[a]	*1998*[a]	*1999*[a]	*2000*[a]	*Total*	*Percentage*
1.	Training for leadership	3/33	3/50	3/45	0/49	9/177	5
2.	Eldercare	1	2	1	1	5	3
3.	Bridge/seed funding	1	2	1	0	4	2
4.	Same as for junior	1	2	1	0	4	2
5.	Granting agencies need to hold institutions accountable for equity	1	1	1	0	3	2
6.	Making sure women are in key decision-making positions	1	1	1	0	3	2
7.	Provide male colleagues a safe way to discuss their gender biases and learn how to overcome them	1	1	0	0	2	1
8.	Have women in highest levels of power	2	0	0	0	2	1
9.	Awards and honors not based on old boys network	1	0	1	0	2	1
10.	Value human impact and impact on community	1	0	1	0	2	1
11.	Monitor equity in space, salaries, travel, students etc.	2	0	0	0	2	1
12.	No response or inappropriate	1	0	0	0	1	1
13.	Reward service	1	0	0	0	1	1
14.	Ways to overcome isolation such as networking	1	0	0	0	1	1

Table 6.2 (continued)

Categories		*Year cohort*					
		1997[a]	*1998*[a]	*1999*[a]	*2000*[a]	*Total*	*Percentage*
15.	Targeted recruitment for senior women	1	0	0	0	1	1
16.	Can't think of anything	0	0	0	0	0	0
17.	Commitment to women from top administration—not the Larry Summers approach	0	0	0	0	0	0
18.	Don't base salary on outside offers	0	0	0	0	0	0
19.	Transition to retirement roles	0	0	0	0	0	0
20.	Recognition that diversity improves creativity and research	0	0	0	0	0	0
21.	Get rid of all age limits	0	0	0	0	0	0
22.	Committee to examine situation of senior women	0	0	0	0	0	0
23.	Talent-scouting	0	0	0	0	0	0

[a] *Note*: Each respondent could give multiple responses

> Dedicated space in child-care on campus for the female faculty. Many universities don't even offer child-care and if they do the space is extremely limited. (2012 respondent from 1999 cohort)
>
> Extending a tenure clock if a woman has a child is a must. Acceptance of such extension by all members of a department is also a must. (2012 respondent from 2000 cohort)

Although family-friendly policies such as childcare or extension of the tenure clock at the time of childbirth are more likely to benefit junior women, other family-friendly policies such as eldercare might be more relevant for senior women. Others, such as reduction in time base to accommodate family and personal time needs or dual career hires, might be beneficial for either junior or senior women, as suggested by the

quotation at the beginning of this chapter. The exact wording as to whether policies are opt-in or opt-out and whether such policies extend to both men and women at the birth of a child become crucial. Some recent studies (Wolfers 2016) suggest that men may gain an advantage in terms of publication productivity from parental leave policies that are gender neutral compared to their women colleagues who actually give birth and have gone through pregnancy, childbirth, and nursing.

> The partner hire program would benefit women at any level. (2012 respondent from 1999 cohort)

Mentoring emerged as a very helpful practice that colleagues see as critical for junior faculty:

> Availability of and access to senior role models/mentors. (2012 respondent from 1997 cohort)

Although individual faculty can take it upon themselves informally to mentor their junior colleagues, many felt that a formal institutional college or departmental mentoring policy, overseen by administrators, proves most effective:

> Formal mentoring programs for junior faculty would help both men and women, but may be more important for women in fields where they are in the minority. (2012 respondent from 1999 cohort)

People did recognize the tie between situations of junior and senior faculty. Several individuals commented explicitly on the links between junior and senior women, especially because of mentoring:

> Junior women need mentoring in their career activities; senior women may be those mentors. (2012 respondent from 1997 cohort)

Policies such as required mentoring for junior faculty from senior faculty may result in positive effects for one group and negative impacts or more service work for the other. For example, requiring that all junior women have at least one senior woman on their mentoring committee in a department that included many junior women faculty would be likely to result in overloading a sole woman full professor with committee work that is not always highly valued.

> Starting women faculty really need mentors—both male and female. A series of policies that would bring together junior and senior women would be helpful. This needs to be formalized. (2012 respondent from 1998 cohort).

Again, overuse of senior women as mentors may benefit the junior women, while burdening the senior women faculty with service that may not be valued very much by their department or broader profession.

A whole set of issues might be described as practices/policies and directives for administrators: "Train faculty and administrators for non-discrimination" at various levels. Simultaneously, "training for leadership" also corresponds with the policy/practice cited most for senior women (Table 6.2).

> Leadership development for chairs, deans, etc. so that they know how to work with people (this is good for senior women and all men too*). (2012 respondent from 1999 cohort)

The importance of transparency and monitoring on a continuing basis were seen as crucial, especially around issues such as start up packages, salaries, and time to promotion. Respondents also cited the following as important: "Transparency of expectations, especially for tenure and promotion"; "network/support group for women"; "don't overload with excess committee work"; and "value service more".

> Transparency and codification of promotion criteria. In a department with no will, no institutional policy will help, however! (2012 respondent from 1998 cohort)
>
> Having clear written expectations regarding tenure & promotion (and annual evaluations) benefits women, since they otherwise may have less "informal" access to information about what is expected. (2012 respondent from 2000 cohort)

Senior women leaders who may themselves have suffered from fewer informal mentors and methods to obtain information may especially appreciate and foster transparency. Transparency becomes important not only in the initial tenure and promotion process, but most particularly in uncovering what is necessary for advancement to full professor.

> Transparency, how the decisions are made. (2012 respondent from 1997 cohort)
>
> Make departmental and university policies and practices transparent. Issues relating to teaching assignments, lab space allocation, assignments to important committees, allocation of departmental financial resources, the placement of graduate students with faculty advisors—can each have a tremendous impact on a faculty member's career. (2012 respondent from 1998 cohort)
>
> Another issue is finding ways to create fair evaluations and fair access to university support, awards, etc. (2012 respondent from 2000 cohort)

Undoubtedly a reflection of the current tight fiscal times, several individuals from each cohort cited the availability of federal money as critical for the success of junior colleagues:

> Granting agencies might be aware of the shrinking amount of time available to faculty, not only to conduct research, but to write it up. I'd like to see more "writing stipends," to allow junior faculty the time to put their research into publication. (2012 respondent from 1997 cohort)
>
> More funding opportunities for junior women will be really helpful. (2012 respondent from 1997 cohort)

Respondents recognized that reductions in federal funding and budget constraints also make it difficult for senior women to maintain their labs, re-compete for grants or consider taking on new potential high-risk, high yield projects:

> All women scientists need better funding opportunities! (2012 respondent from 1998 cohort)

Senior women understand they have a responsibility to mentor their junior colleagues in obtaining grants:

> During this time of difficult grant funding, I think that for any scientist, junior or senior, female or male, a scientist with experience on grant reviewing panels should help review drafts of grants before their submission. NIH only allows two submissions for any proposal, and NSF recently changed to only one submission/year for many directorates, so obviously, the best grant needs to be put forward. Junior faculty members don't know what a "fundable" grant is yet. I routinely give my funded grants to other faculty members as well as to the

> students in my lab. Many faculty members, however, are unwilling to share their grants (don't know why*). In addition, I routinely review grants for others, but again, many faculty are unwilling to take the time and give critical advice to others. Maybe NIH and NSF can set up a database so that we can see the complete grant, not just the abstracts. (2012 respondent from 1999 cohort)

Policies for Senior Women

In contrast to policies for junior women, as demonstrated in Table 6.2, respondents gave relatively few suggestions for senior women. Although the 177 awardees could provide more than one response, only 42 total responses were given to the question: What changes in institutional policies and practices are most useful for facilitating careers of academic women scientists or engineers at the senior level? This contrasted with the 236 responses given to the same question when the word "junior" replaced the word "senior" (Table 6.1). These results reinforce the findings from the earlier study (Rosser 2006) using the AWIS population, that little is known about the issues facing senior women or what policies institutions might use to facilitate careers for senior women. Eight responses (16–23 in Table 6.2) given by the earlier population of AWIS Fellows were not mentioned at all by POWRE awardees in 2012. Within this same population of POWRE awardees, only eight of the categories (7, 9, 11, 14, 15, 17, 22, and 24 in Table 6.1) overlapped between policies for junior women compared to policies for senior women scientists (1, 3, 6, 8, 11, 14, 15, and 17 in Table 6.2). These included training for leadership, non-discrimination, monitoring space, salaries, travel, networking, seed money, more women on important committees, women leaders, and hiring senior women. However, the response level was much higher for the same policy for junior rather than senior women. For example, 11 people responded "Network/support group for women" for junior women but only one responded "ways to overcome isolation such as networking" for senior women. Similarly, 17 responded "monitor infrastructure issues—start-up, salaries, space" for junior women, but only two responded "monitor equity in space, salaries, travel, students, etc." for senior women.

"Training for leadership" (#1) ranked as the most frequent response for policies for senior women, with nine responses as exemplified by the following quotations:

> Provide leadership opportunities and mentor women in leadership positions. Same for all—men and women! (2012 respondent from 2000 cohort)

> More leadership and entrepreneurial opportunities that are extended outside of the institution. (2012 respondent from 1998 cohort)

For junior women, 13 responded "leadership training".

Several underlined the importance in one response or another (6 and 8 in Table 6.2) for the policies for senior women of having women in key decision-making positions:

> I think that every tenure and promotion review committee should have senior women (who get it and are willing to speak up*) on them (even if the women have to come from other colleges and be paid for their efforts*). (2012 respondent from 1998 cohort)

More female administrators. (2012 respondent from 1999 cohort)

> The Dean at the College level has a lot to say about how women move through the system, how they are supported. We need more women to serve as Deans. (2012 respondent from 1998 cohort)
>
> Senior: having women in key administrative roles, such as President and/or Provost. (2012 respondent from 1999 cohort)

Again, the importance of hiring and having more senior women, particularly in influential positions (15, 22, 24 in Table 6.1) was emphasized for junior women. Financial issues continued to play a role in policies sought for senior women (3 in Table 6.2) with need for "bridge/seed funding" mentioned by four respondents. Again, fourteen respondents mentioned need for these policies for junior women (17, 18 Table 6.1).

Future Directions

Although they acknowledged that issues differed for junior and senior women, overall, relatively few respondents have ideas about how to improve the situation for senior STEM academic women compared to their junior colleagues. Since both junior women themselves (Rosser 2012) and senior women (Rosser 2006) seem to agree on what the issues are for junior women, it is not surprising that some consensus has also emerged about effective institutional policies and strategies to address those issues. Family friendly policies, dual-career hires, equitable start-up packages and space, and monitoring the data to ensure that women receive

tenure, promotion and awards at the same rates as their male colleagues constitute institutional practices and policies significant for success for junior women. People recognize the significance of mentoring in a variety of areas including the promotion and tenure process, grant writing, and providing advice for professional success. Many underline that a formal mentoring process, overseen and rewarded by administrators at the departmental, college or institutional level, translates into more equitable mentoring for both women and under-represented minorities. Administrators have key roles in communicating policies and implementing them equitably. Leadership of senior women can be crucial for junior women.

Attention also needs to be given to the environment for senior women. These women represent a group of successful scientists who have survived and thrived, despite obstacles and barriers that deterred others. They have made significant contributions to STEM, the institution, and the broader profession. Yet, as the MIT Report documented (Hopkins 1999), these very successful women scientists and engineers do not have the same access to space, awards, students, and perks as their male peers.

An initial impetus for ADVANCE also came from the recognition of a glass ceiling (Etzkowitz et al. 1994; Rosser and Zieseniss 2000) and problems for senior women (Handley 1994) even in the disciplines within the life sciences with a substantial percentage of women. In addition to the PAID grant for STEM women at small liberal arts colleges (Karukstis et al. 2011) and the discovery interview portion of the IT grant at University of Wisconsin—Madison aimed at senior women (Sheridan et al. 2006), some of the other ADVANCE initiatives included a small program for senior women. These encompassed shadowing programs for women considering moving into institutional leadership roles, named fellowships or chairs for senior women such as the ADVANCE professorships at Georgia Tech (Rosser and Chameau 2006), and informal networking events or groups for senior women, particularly those serving in the role of department chair. Most of the ADVANCE efforts either centered directly on junior women or included senior women as role models, mentors, and institutional leaders to facilitate the attraction and retention of junior women STEM faculty, rather than focusing on the needs of the senior women themselves.

Data such as the Fidelity Investments study of higher education faculty shows that 74 percent of professors aged 49–67 plan to delay retirement past age 65 or never retire (Flaherty 2013). These data and increasing number of programs to encourage retirement in the absence of a mandatory retirement age (Patel 2016), suggest that more academics, including

senior women, postpone retirement, remaining in their tenure-track positions, teaching in the classroom, and conducting research in their laboratories. They choose to delay retirement or not retire partially because of changing personal fiscal circumstances in light of the Great Recession that began in 2008 and because of the increasing life span statistics, but most particularly because of their commitment to their students, research and institution. Failure to recognize the issues facing these senior women scientists and to address them with appropriate policies and practices risks undercutting the productivity and professional contributions built over a life-time of these women, who earlier in their careers, overcame many obstacles to become successful.

NSF's ADVANCE has directed over $130 million in a national effort towards encouraging academic institutions to transform and to evolve policies and practices to facilitate careers, particularly for junior women scientists and engineers. NSF launched ADVANCE in 2001, with the first cohort of nine Institutional Transformation five-year awards being completed in 2006. This timing suggests that most POWRE awardees were not able to benefit from the institutional transformations and national emphasis upon removing barriers to attract, retain, and facilitate careers of women scientists while they were still junior in their own careers. Perhaps it is not surprising that POWRE awardees in 2012 perceive basically the same issues surrounding gender in career progression and in the laboratory as they did fifteen years earlier.

The results of the data from this re-survey suggest additional policies and practices that institutions might pursue, especially for women at the senior level. By 2015, more than one hundred institutions and STEM-related not-for-profit organizations had benefitted from ADVANCE grants. One hopes that the policies and practices now in place in academic STEM departments will mean that women scientists and engineers surveyed fifteen years from now will no longer perceive the same issues and barriers that they did in 1997–2000 and 2012.

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Index

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