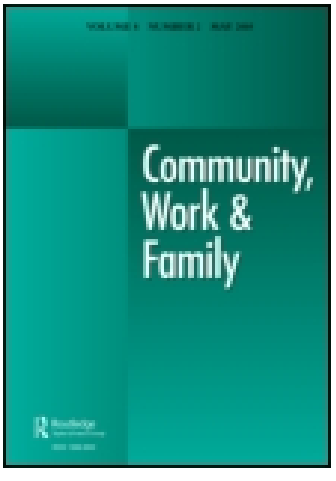

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Gendered institutional research cultures in science: the post-doc transition for women scientists

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Gendered institutional research cultures in science: the post-doc transition for women scientists

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This study examines perceptions of post-doctoral women bench scientists working across fourteen major US research universities, and how both individual and institutional experiences influenced their desired futures. Findings reveal three distinct career paths (research, teaching, and industry). This study provides insight into individual career decision processes involving as to how gender is experienced in male-centric cultures, how experiences of barriers are reframed, and how obstacles influence choices. These women emphasized strong desires to contribute to their respective fields and to collaborate with others, a key relational aspect missing in their current work. All participants indicated aspirations to have both a career and a full life beyond the lab. Findings further suggest a post-doctoral environment laden with gender and family biases including subtle discrimination and challenges specific to women working in male-centric cultures. A strong relationship between experiences of gender and family biases suggests that additional burdens are placed on women's career paths and their evolving identity. This study identifies the postdoctoral journey as a unique transition zone marked by a period of adaptation and selection as they make sense of their experience and decide on how best to achieve success and fulfillment as women and as scientists.

Keywords: postdoctoral experience; gendered cultures of science; work-in-life integration; work-family bias; women scientists; career development; identity

Este estudio examina las percepciones de mujeres científicas pos-doctorales trabajando en 14 importantes universidades de investigación en USA, y cómo las experiencias individuales e institucionales influyen en sus planes de futuro. Los resultados revelan tres distintos tipos de carrera (investigación, enseñanza e industria). Este trabajo ayuda a entender los procesos de decisión individuales teniendo en cuenta cómo el género influye en culturas dominados por hombres, cómo las barreras son reformuladas, y cómo los obstáculos afectan a las elecciones. Estas mujeres señalaron deseos fuertes de contribuir a sus campos respectivos y a colaborar con otros, un aspecto clave actualmente ausente en su trabajo. Todas las participantes señalaron su aspiración de tener tanto una carrera como una vida plena más allá del laboratorio. Los resultados también sugieren un ambiente pos-doctoral cargado de sesgos de género y familia, incluyendo discriminación sutil y desafíos específicos para las mujeres trabajando en culturas dominados por hombres. Una fuerte relación entre las experiencias de sesgos de género y familia ponen de relieve la existencia de cargas adicionales en las carreras de mujeres y la evolución de sus identidades. Este estudio identifica el periodo posdoctoral como una zona de transición única caracterizada por un

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período de adaptación y selección, en el que las mujeres tratan de comprender sus experiencias y decidir la mejor manera de lograr éxito y satisfacción como mujeres, y como científicas.

Palabras claves: experiencia postdoctoral; culturas de género de la ciencia; integración del trabajo en la vida; sesgo entre trabajo y familia; mujeres científicas; desarrollo profesional; identidad

Introduction

Much research on women in organizations focuses on factors hindering and helping them throughout their careers. Ongoing dissatisfaction about equity and opportunity is pervasive along with necessary professional development and institutional change. Prior investigations indicate that women working in male-centric environments (where men have power, privilege, and are in the majority) are often subject to disparate treatment and gender-specific barriers negatively affecting their ability to reach professional goals. In the last decade minimal progress has been made in recruiting and retaining women in the sciences. Those who are 'successful' persevere, often experiencing frustrations and dilemmas affecting the quality of their careers and lives beyond the lab. These women make enormous personal sacrifices, having to work harder than their male counterparts to be considered just as good (MacLachlan, 2006; Rosser, 2006).

There is a need to understand the interplay of individual and institutional dynamics affecting women's career choices, job satisfaction, and retention in areas like academic bench sciences, where they continue to leave in record numbers or continue to be underrepresented. What problems do the women who persevere, experience? What barriers continue to thwart progress toward full participation in science?

Prior research in the sciences reveals a high attrition rate for women during the postdoctoral experience, commonly referred to as the leaky pipeline. Studies identify this postdoctoral phase as a key period toward academic careers, but one where the numbers of women decrease dramatically (Goulden, Frasch, & Mason, 2009). Fifty-two percent of women in the STEM workforce quit their jobs, with most leaving during their mid- to late-thirties (Hewlett et al., 2008). Until recently, research emphasized women's perceptions, expectations, and choices with a focus on helping women fit into existing science departments. Women were construed as 'the problem' in need of change, an inappropriate approach for increasing the number of women in science (Bilimoria & Liang, 2012; Burke & Mattis, 2007; Stewart, Malley, & LaVaque-Manty, 2007).

High-level administrators from the most prestigious US universities acknowledge organizational resistance to change. Persistence of systemic barriers for women will necessitate significant changes in institutional policies and practices, as well as within the fields of science for women's full participation (Burke & Mattis, 2007; Ely & Rhode, 2010; Rosser, 2006). The ADVANCE program, initiated by NSF in 2001, was established to encourage institutional solutions to increase women's participation in science, technology, engineering, and management (Bilimoria & Liang, 2012).

This study focuses on women in the postdoctoral phase of their careers in biological bench sciences. It extends existing studies in three ways: (1) involves participants in transition zones; (2) incorporates individuals who are not accepted as

full-time, regular members of organizations; and (3) focuses on work-in-life integration.

Women represented 42% of all postdocs in this area of science in 2008 (NPA Advance, 2011). It is a critical stage in the academic pipeline. Unfortunately, postdocs are more likely to quit academic science just before their transition to principle investigator (PI) as a scientist (Martinez et al., 2007, NPA Advance, 2011). The postdoctoral experience provides a unique vantage point for understanding barriers within organizational cultures and work practices, and the interplay of individual choices informed by identity, gender, family situation, and definitions of success. In our study we examine postdoctoral bench scientists to understand the individual and institutional factors impacting their ability to create the future they desire.

Barriers to women in science

The major barriers to women in science include a lack of fit between how women see themselves as both women and scientists and their organizational culture; the male-centric nature of organizations; and a male model of science requiring total commitment. This creates further work–family integration issues for women. Extensive literature on these issues is too broad to be reviewed comprehensively here. The limited space available allows selective review of several themes from the literature to reserve as much space as possible to present the findings of this qualitative investigation.[1]

Juxtaposing a relational orientation with socialized demands of woman as 'caretaker,' and a desire to develop a professional identity within a workplace culture 'aligned with traditional images of masculinity such as autonomy, assertiveness, competition, and heroic action' (Rapoport, Bailyn, Fletcher, & Pruitt, 2002, p. 28) helps us recognize that women working in male-centric domains experience daily battles as competing desires collide. The impact of this environment on women's lives can be observed in 'organizational cultures that glorify employees who work as if they had no personal-life needs or responsibilities, silence personal concerns and make it difficult to recognize or admit the costs of overwork' (Rapoport et al., 2002, p. 31). Such gender biases affect capacities for developing an identity as a woman and scientist. Women's underrepresentation is partly attributable to such traditional gender expectations and practices (Eagly & Carli, 2007).

Different structures of opportunity and power block many women's access and advancement in organizations (Kanter, 1977; Ridgeway, 1993). Some persevere and succeed, because their level of commitment keeps them working through the challenges (Preston, 2004). But barriers experienced through routine practices of how science is done continue to shape experiences and subsequent development. Research shows women working in male-centric cultures experience additional deterrents to success, solely based on gender including tokenism (Kanter, 1977; National Academy of Sciences, 2006), gender stereotyping in workplace interactions (Williams, 2010), and sex-role spillover (Gutek & Cohen, 1987). Women scientists are often the only woman in a lab or one of few in their field. Tokenism leads to predictable problems including social isolation, minimal feedback, and extreme visibility. Stereotypical roles get exacerbated in such contexts.

The practices through which postdocs are recruited, processed, and deemed successful are advantageous to men. Small, consistent differences in evaluation, often caused by gender bias, substantially impact careers (National Academy of Sciences, 2007). Successful women scientists not only need be competent in their knowledge and skills, but also behave consistently with masculine organizational norms (Burke, 2007). Women drop out of these fields more frequently than their male counterparts. Among those persevering, many experience ongoing obstacles during this post-doctoral period.

Gender stereotypes are not just descriptive of how women are, but prescriptively demand particular ways for women to behave. Women behaving out of role are punished (Brescoll, 2012; Heilman, Wallen, Fuchs, & Tamkins, 2004). Those who stay in such unwelcoming science environments, where men more naturally fit, are left to navigate treacherous waters without guidance from mentors or role models. They also frequently shoulder additional burdens of both work and family. For some, passion still burns, but they continually need to focus on issues involving exclusionary scientific workplaces (Preston, 2004).

Even tenured women scientists at MIT found themselves invisible and marginalized within their departments, excluded from significant decision-making. They thought gender discrimination was a problem of previous generations, and surprised that the playing field was not level for them either. A sense of marginalization grew as their careers advanced (Bailyn, 2006).

Virginia Valian uses the term 'gender schemas' to refer to 'a set of implicit or unconscious hypotheses about sex differences affecting our expectations of men and women, our evaluations of their work, and their performance as professionals' (Valian, 1999, p. 2). In organizations with few women in powerful positions, gender saliently determines what is expected, socially permitted, and valued about men and women in particular contexts. This creates a double standard and classic double bind: too aggressive, not tough enough; assertiveness in a man appears abrasive in a woman (Brescoll, 2012; Case, 1994, 1995). Gender stereotypes subject aspiring female scientists to higher standards, needing more output to be rated as competent as men (Burke, 2007; Williams, 2010).

In studies involving women scientists, many recall the times they have felt disrespected or treated inappropriately because of their gender. This led to fewer connections to mentors, less interesting assignments, isolation, lack of camaraderie, difficulty gaining credibility, access to networks, and opportunities (Bilimoria & Liang, 2012; Burke & Mattis, 2007; Rosser, 2006; Stewart et al., 2007). Social isolation is one of the reasons that even single women without children, who are in the bench sciences, consider leaving the academia (Mason & Goulden, 2002). Women in traditionally male-dominated settings have a difficult time breaking into the 'old boys' loop of advice and professional development opportunities (Ragins, 1998).

Strong cultural barriers and rigid stereotypes of what constitutes a successful person in science continue. Assumptions about academic 'stars' govern recognition and evaluation systems, favoring publishing in elite journals above all other success criteria. Women postdocs occupy support positions enabling the 'individual' achievement of academic stars. Their contributions are unrecognized (Fletcher, 1999) as norms focus on 'exclusive devotion' and 'aggressive self-promotion' (Dean & Fleckenstein, 2007), not on collaboration.

These norms influence what the organizational culture accepts as life style, work style, and expected beliefs. Women entering these male spaces confront a culture and structures that many find bothersome, excluding or hostile. Exclusion is compounded by practices supporting men's experiences (Bailyn, 2006; Rapoport et al., 2002).

The norms of commitment and competence

The most gendered assumptions permeating science are linked to commitment and competence (Rapoport et al., 2002). The implicit male standard is devotion to scientific investigation to the exclusion of all other aspects of life (Burke, 2007; Preston, 2004). Excessive work hours are entrenched (Drago, 2007). The image of scientists in the lab at all hours of the night and weekend is not far from what is demanded (Dean & Fleckenstein, 2007). Commitment to work is manifested by singular devotion to work unencumbered with family responsibilities, designed around masculinity and men (Williams, 2010) producing extreme pressure in early career stages coinciding with women's childbearing years.

The factor most detrimental to career progression for women scientists is family status, with women particularly disadvantaged if they had children, with no similar pattern found for men (Ely & Rhode, 2010; National Academy of Sciences, 2006; Rosser, 2006; Williams, 2010). Powerful schemas about parenthood for women include perceptions of less competence and commitment (Correll, Benard, & Paik, 2007; Williams, 2010). Family formation (marriage and childbirth) accounts for the greatest exiting of academic research women scientists (Goulden et al., 2009; Hewlett et al., 2008; Rosser & Taylor, 2009), partly because of the separate spheres of assumption that the jobs of scientists are best suited to real scientists, not 'mothers' (Williams, 2010).

In Rosser's (2006) study, to understand the most significant issues and challenges facing 450 women scientists in their careers, she found balancing career with family to be the most significant barrier, mentioned by almost 88% of them including the issues of dual careers, as well as children. Eighty-three percent of women scientists with doctorates have academic partners who are also scientists, compared with only 54% of male peers (Schiebinger, Henderson, & Gilmartin, 2008), creating further work-life difficulties.

Barriers to work-life integration

Repeated studies indicate marriage and family is the major barrier to women in science. There is a continual struggle over timing and rearing of children, with an expectation of a substantial career penalty when and if they have children (Burke, 2007). Motherhood was identified as the factor most likely to preclude advancing in an academic career (Xie & Shauman, 2003). The difficulty in balancing postdoctoral demands and motherhood results in many women who leave (Preston, 2004). Discrimination is triggered by family responsibilities, once women scientists become mothers (Crosby, Williams, & Biernat, 2004; Williams & Segal, 2003).

Joan Williams (2010) uses the 'maternal wall' metaphor to show particular patterns impacting women, in what is now described in law, as family responsibilities discrimination (Williams & Bornstein, 2008). Marriage and the presence of young children spur the career advancement of men, but slow it for women (Drago, 2007; NPA Advance, 2011). Women on highly competitive academic career tracks, beginning in the

postdoc experience, marry at lower rates than men, are childless at higher rates, report having fewer children than they would like, and are more likely to divorce. Family commitments that interfere with career progress are minimized (Drago, 2007; June, 2012; Williams, 2010). In this study, we turn to the experience of women postdoctoral bench scientists in order to understand the factors they experience that impact their ability to create their desired futures. Our central question is, 'What are the individual and institutional forces experienced by women working in a male-centric environment?' The second question, embedded in the first, asks, 'How do these experiences influence the projected desired futures of these women?'

Sample and methods

Our study is based on feminist semi-structured interviews allowing the researchers to engage with the participants conversationally about their experiences, answering questions out of order, digressing, adding questions, and speaking spontaneously as long as they wanted (DeVault & Gross, 2012). This approach helped get to realities hidden and previously unarticulated by these women. It enabled the researchers to more fully understand the diversity of these women's lived experiences (Hesse-Biber & Leavy, 2007) both in the context of their work and life and how they made sense of it. The study design intended to elicit stories about participants' sense of what they experienced in their research environment and how these experiences impacted future career choice. Participants were free to draw and reflect upon past and present events.

Potential participants were identified at a major Midwestern research university using the online directory and search phrases 'research associate' and 'post doctoral fellowship.' This provided information on 462 postdoctoral researchers on campus including those employed at an affiliate university hospital. Based on our research criteria (gender, degree field, citizenship and physical location) a list of potential participants was completed. Eliminating men, foreign students and women not doing research in basic sciences, 46 women scientists remained. Women postdoctoral researchers are typically between 24 and 34 years of age. Controlling for this particular age group resulted in a sample size of ten from the population, all of whom agreed to participate.

Because of the limited number of women at the initial site, another major Midwestern hospital was contacted, with three more participants engaged. To further increase the sample size of thirteen, a 'call for participants' was made via an online professional association related to the sciences. Seventy-two women across the country responded to the request. From this group, fourteen women meeting our criteria, working at major research institutions across the United States, were selected to participate. The final sample included 24 participants, after three who began dropped out. The demographic characteristics of the study participants follow: fourteen of the 24 were married (59%), two were engaged (9%), and seven (30%) had children from newborn to age 6. Participants were 28–35 years, with time in postdoctoral positions from 8–78 months, averaging 37 months. At the time of the study, the projected career paths, initially beginning with a desire to be academic research scientists, were research (46%), academic teaching (33%), and industry (21%). Participants were interviewed from twelve different top tier research institutions across the United States within the bench sciences including fields of genetics, neuroscience, pharmacology, immunology, biochemistry, infectious diseases, oncology, and biology (cancer, molecular, developmental, and reproductive).

Face-to face interviews were conducted with 11 participants. Thirteen were done by phone. Each was tape-recorded, lasting 1½ to 2 hours. Rapport was easily established, even in phone interviews. No apparent differences appeared in the quality or length of interviews.

Analysis process

All interviews were transcribed. Thematic analysis was used, generating codes uniformly applied to the data, maximizing differentiation between subsamples (Boyatzis, 1998). Each question was a unit of coding with probes part of the question. To avoid double coding, codes were counted once in a question. Since the study was designed to capture differences and commonalities in the postdoctoral sample, the codes helped determine shared themes across groups.

Three interviews were randomly selected from each of the projected career paths (research, teaching, and industry) forming a subsample to develop themes, clusters and codes. The data from these nine interviews were then reduced, highlighting only relevant information, and further reduced, reconfirming that all data fitted the syntax and context stated by the participants. Reliability with an independent coder was established at an IRR of 89.9%, which exceeded the 80% requirement. After establishing reliability, the codes were applied to the remaining interviews.

Findings

The postdoctoral experience is marked by three key interconnecting dynamics experienced within the postdoctoral transition: (1) Self-Awareness, (2) Contextual Engagement and (3) Future Orientation (see Figure 1).

These form the basis of three main clusters emerging from data analysis and subsequent development of a data structure with themes, codes, and clusters (see Figure 2).

A discussion of findings within each cluster follows.

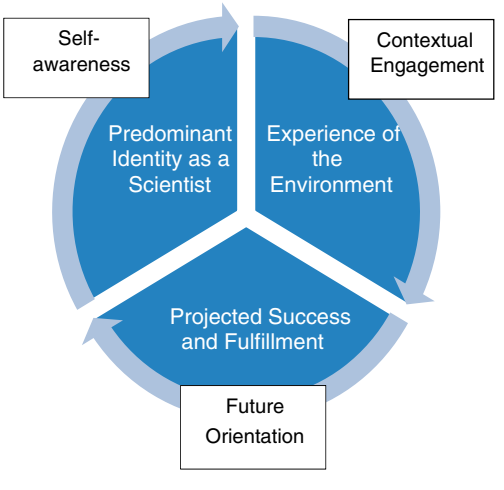

Figure 1. Key interconnecting events.

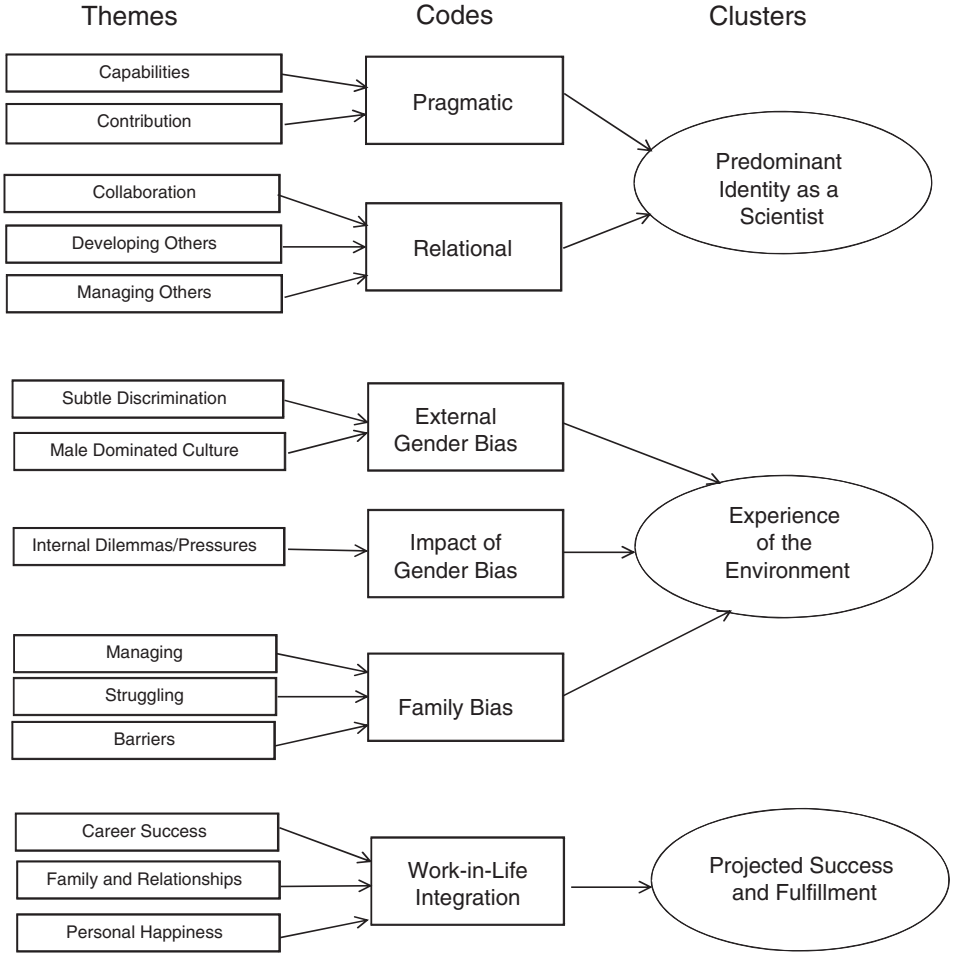

Figure 2. Data structure.

Self-awareness and predominant identity as a scientist

Self-awareness is the ability to perceive and interpret aspects of personality, behavior, emotions, motivation, and thought processes during the postdoctoral experience. It was a process characterized by conscious attention to aspects of their institutional environment and lived experience that gave the most meaning to their identity as a scientist. Participants articulated how certain skills, roles, and experiences became more salient over time leading to assessments of what they most liked or disliked. This ongoing process of thought and interpretation provided critical data helping to shape images of life in the future after the postdoctoral experience. The mindful process enhanced clarity in selecting a career track as an academic researcher, teacher or moving into industry. This choice developed from interplays of their predominant identity as a scientist, experience of their environment and desired future. Participants' responses reflected individual preferences, coded as pragmatic and relational orientation that fit personal notions of success as a scientist.

Pragmatic

A pragmatic orientation focuses on skills, abilities, and desires to contribute to the field by publishing in top-tier journals, presenting at conferences, and gaining respect of peers. This profile resembles traditional markers of academic success. This orientation is supported by two related themes: (1) Capabilities and (2) Contribution. Capabilities is coded as emphasizing a focus on developing good writing skills, clear communication, business acumen, patience, persistence, and attention to detail. Contribution signifies focusing on publishing in reputable journals, quantity of publications, overall quality of research and desires to achieve a reputation as respected scientist. Below are representative quotes from the data indicating a pragmatic orientation:

> 'You have to be really good at communicating your results to people, either putting them into a graph, or displaying them in some way. You have to be able to quickly and concisely communicate your experiences to other people [and] to be good at networking.'

> 'I would say that being a successful scientist would mean publishing in high-profile, peer reviewed journals, having more than one NIH grant or other sources of funding, having several people working in your lab, having an exciting research environment in your lab, of which you are the head . . . and being well respected by your peers. Therefore you'd be recognized as being that by being on editorial boards of different scientific journals or other kinds of boards for the NIH, doing peer review and grants. And for my own personal measure of success I would hold myself to similar standards.'

Relational

A relational orientation demonstrates a desire to be in connection with others. This happens through teaching, mentoring, collaborating as part of a team, and through being a role model. A relational focus was also expressed as a wish to supervise or manage others in the work environment. Three themes supported this code: (1) Collaboration, (2) Developing Others, and (3) Managing Others. Collaboration is defined as desire to work with others, best described as a team approach to science. Developing Others places high value on teaching and mentoring, especially students, and providing a nurturing and supportive environment conducive to learning. Managing Others involves positions requiring supervising or directing work in a lab setting. Participants indicating a relational orientation reflect the importance of connection to others as key to their identity as a successful scientist across all three themes.

> I would broaden that definition [of success] to go beyond just productivity measured in publications or measured in lab work. I would include other things like your commitment to teaching people, and also working with your colleagues, if you can mentor another person. And you could even extend it even more than that, with interaction with family or community.

> I would very much enjoy working with graduate students and I would make it a high priority to be mentoring people, and teaching them how to write papers, and how to write grants.

> Having people in the lab that you can support and you can supply them with opportunities.

The Developing Others category was not exclusively coded for women focused on a teaching career. In our sample, women, irrespective of career choice, valued including mentoring, teaching, and interacting with students in their lives as scientists.

Contextual engagement and experience of the environment

Contextual Engagement describes the participants' direct and indirect experience and sense making of their environment as a woman in science. Experience of the Environment focuses on an individual in interaction with others within science, and considers the salience of gender, organizational culture, and family related issues. Our analysis revealed the impact of the behavior and actions of others involving gender and family related biases that had negative consequences on their lives and careers. These experiences included intentional and unintentional acts of discrimination against an individual and/or references to children, child rearing, or family issues suggesting a lack of commitment to science. Participants across each career path expressed an awareness of working in a culture disadvantaging women. When participants were asked to consider environmental barriers to success for women in science, three codes emerged: (1) External Gender Bias, (2) Impact of Gender Bias, and (3) Family Bias.

External Gender Bias

This code represents discriminatory acts toward a woman scientist by others in the environment. Two themes emerged that reveal gender bias: (1) Subtle Discrimination and (2) Male Dominated Culture. Subtle discrimination is defined as acts against women, intentional and unintentional; visible but often unnoticed; communicated both verbally and behaviorally; and is situational (Benokraitis & Feagin, 1986). Fifty-eight percent of the participants (a majority in each group) articulated acts of subtle discrimination revealing that even in early career stages, they were aware of disparate treatment of women in science.

> 'Okay, there is a slight undertone. Not everybody perceives a woman at first impression . . . capable of making it to the top.'

> 'Men basically saying, 'Women can't do this, women can't do that.' Some of it comes back to us to prove ourselves, which on some level is kind of annoying, proving yourself over and over again. I look around me and I see how much easier it is for men with less effort to basically be seen in a different way.'

> 'I personally haven't experienced it but I have seen it happen, where women aren't necessarily given tenure before a man is even though they've done more work and you see that all the time.'

Male Dominant Culture is defined as an environment, where men outnumber women and are primary owners of power and privilege. The behavior exhibited in the environment reflects often unconscious, preferential treatment toward males and those behaving in ways favoring the dominant culture. All eleven women projecting a research career described their environment as reflecting cultural norms and values favoring men; similar themes emerged among women on both the teaching and

industry tracks. Variations on the impact of the 'old boys network' was a continuous refrain throughout interviews:

> Traditionally there are a lot of men and there is an old boy's network and they help each other out. There's a lot of politics involved in science too and if you're in the old boy's network, or some network, of course you have an advantage [over] people who aren't.

> And the guy sitting next to me who doesn't really understand the applications of tools, and basically puts things together, he gets referred to as Dr. Such-and-Such, and I many times don't even get introduced to people.

> It's very much an old boy's club . . . an unwillingness to let other people be part of that club on some level.

Impact of Gender Bias

This code is defined as the impact of gender bias on participants' experiences. The theme is labeled Internal/Dilemmas/Pressures and represents negative outcomes resulting from external gender bias. These descriptions include how sense is made of the bias, how it is experienced as a woman within the environment, and different treatment/standards placed on her. This code also includes an expressed understanding that the salience of their gender results in 'extreme expectations' for job performance compared to what is required of men in similar positions:

> Confidence, determination, hard work . . . women might need more, I guess that, that's the only distinction I would make.

> I think that, unfortunately still in science, women I think need to work a little harder, need to portray confidence a little more. Not that they don't work hard enough but I think . . . that they might need to do more work to get the same recognition.

> The threshold for validity is maybe higher than for men. So you need to maybe publish fifteen papers instead of eight.

The Impact of Gender Bias was coded for a majority of women on each of the three career tracks. These findings demonstrate an awareness of the salience of gender bias, as well as the impact of this disparate treatment on daily work life making it more difficult for them to succeed. The data suggests participants experience additional burdens as scientists with being women 'affecting everything.' They had to continually 'live up to higher expectations' and were 'having to prove themselves more than men.'

Family Bias

Beyond Gender Bias, participants also reported Family Bias defined as how children and family impacted their careers and life in general. Three major themes emerged: (1) Managing, (2) Struggling, and (3) Barriers. Managing refers to needs for additional support from the institution to handle family responsibilities.

> 'Women who have children use more support . . . with pay, with full pay . . . they cannot remove your position for one year . . . so this is actually exceptionally supportive to a woman.'

> 'Because it is very demanding, and certainly at the early stages, you're not paid well enough to have other people do the things that you need to do. So you're not paid well enough to have a full-time nanny or a full-time housekeeper. People who work in other professions where they're expected to work incredibly hard, at least they have the financial resources to pay other people to get the other stuff done in their life.

Struggling highlights difficulties experienced within organizational environments concerning pregnancy, raising children, and tending to family life. Participants across all three career paths reported challenges or difficulties with each of these.

> Because I feel so restricted in being able to balance out the other areas of my life, it makes me more resentful of work, just in general. Which makes it more difficult for me to go to work on a daily basis and do what I need to do. Because I feel like it's sucking every ounce of my life out of me.

> Because I feel, when I look back now, I think that this is a terrible career choice for a family. On the other hand, I feel like if I hadn't pursued this I wouldn't be fulfilling my own personal goals. So I'm constantly wrestling with these two identities, one as a wife and mom, and one as a scientist as well.

> I've heard of examples from people who say that when they've told their advisor that they're pregnant, he's threatened to cut off their health insurance. I don't think that's true for men. I think they [men] automatically sort of see this [family] as a distraction from their [a women scientist's] research.

The third theme in the Family Bias code is Barriers. Barriers represent experiences within the work environment suggesting that family life creates obstacles to achieving career success.

> And you did not get pregnant in his lab, he made it clear.

> The barriers in terms of family – it becomes an excuse for why they [women] can't really be successful. 'Well we hired this female faculty, but now she wants to have a baby! We knew this wouldn't work.

> I do feel that it is not a field that makes it very easy for women. It is not very accommodating if they decide to have children or if they want to have a life outside of your work.

There was more variation in this code amongst the three groups of women. This theme was reflected in a majority of interviews for those planning research and teaching careers, but only a minority seeking careers in industry. Married women and those who already had children were extremely aware of family bias barriers to career advancement and success across the three groups. Some who were single also recognized the patterns, though some did not.

Women in industry without children expected companies would be more supportive toward work and family than academia. They were more likely than the other postdocs to cite children as reasons for choosing a nonacademic career path. Nonetheless, those who chose this path who had children expected their

environment to be similar in all career trajectories. Most of these women, no matter career trajectory, indicated they had not or would not ask for resource support concerning family life responsibilities from their institutions for fear of further jeopardizing the perception of them as 'real scientists.'

Projected success and fulfillment

Our inquiry included juxtaposing the participants' notion of success against how success is defined in the larger community of science. Our analysis found shared themes of a more inclusive notion of success involving concepts of relationship, personal satisfaction, and healthy work-in-life integration as part of what they envisioned as a fulfilling life. Because of our interest in the wholeness of their lives we asked the question, 'How do you define success in your own terms?'

Since participants are in the process of both postdoctoral experiences and simultaneously constructing their ideal future, the third cluster emerging from the data is Projected Success and Fulfillment coded as Work-in-Life Integration. The importance of Work-in-Life Integration became figural when asked, 'Are there other things that you need in order to have a life that feels fulfilled*?*' All participants, but one, stated the importance of work-life integration as critical to what they envisioned as a fulfilled life. Participants spoke of attending to feelings as a source of data to gauge success, rather than merely using external validation markers. This code is defined as desire to achieve both a successful and happy life. Three themes emerged: (1) Career Success, (2) Family and Relationships, and (3) Personal Happiness.

> A definition of success for me personally is a balance for me of various aspects of my life. And I think that some of the trick is finding how to achieve the right level of success in each area, so that you have enough of yourself to invest in the other areas.

> I would like to be in a job that I find fulfilling and one that makes me personally happy, that's stimulating and interesting. But that also allows me to have a life outside of just a career.

> Feeling happy with what I'm doing and still enjoying things. Then personally, that's more successful than if I'm just gritting my teeth and sucking it up and continuing on some path.

A model of the postdoctoral experience transition zone

The information garnered from participants' interviews with data organized as clusters, codes, and themes demonstrate the postdoctoral period as an interactive and recursive transition zone involving experiencing, sense making and deciding throughout. Three ongoing dynamics resulted from their experience: self-awareness as a woman scientist, contextual engagement and experience of their environment, and a future orientation involving success and fulfillment. This new dynamic conceptual model is represented in Figure 3.

Discussion

All 24 women in our study wanted to be contributing scientists and to continue careers in their respective fields. This study makes clear obstacles for women in

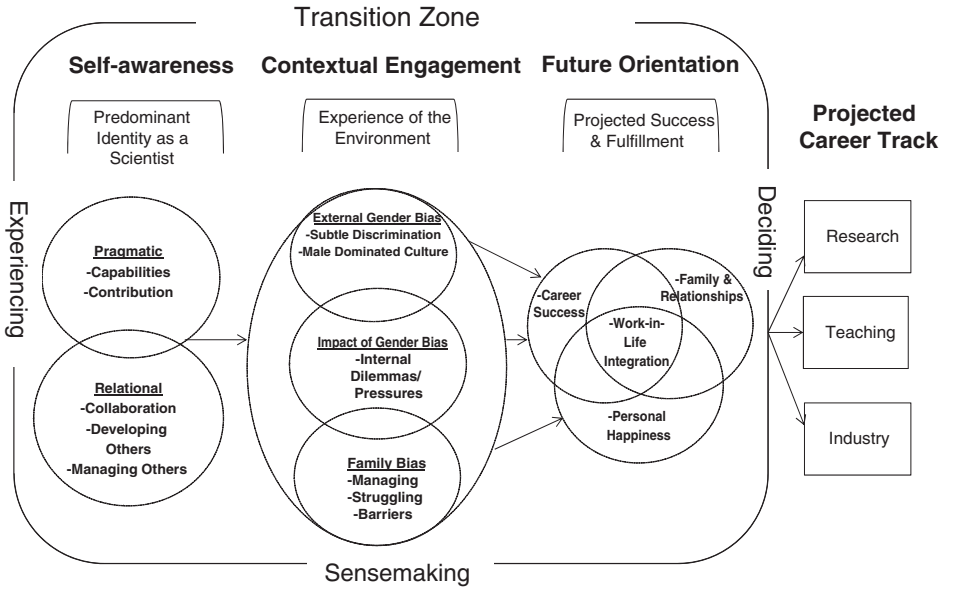

Figure 3. The postdoctoral experience transition zone.

science are embedded in how academic science is organized and practiced, with its rules and policies interacting with negative gender biases toward women. This socially constructed environment results in a different set of demands on women from those on men influencing their ability to achieve success both as a scientist and as a woman. All these women, across institutions, shared descriptions of living in what we have identified in our model as the postdoctoral transition zone, a major contribution of this study.

The transition zone

Our study reveals that even at this early stage of career development, before full membership has been obtained in an organization, these women experience barriers similar to those of women further along in academia. The biopsychosocial demands of childbirth and childrearing conflict with the timing of their ideal career. This period is one of pressure, stress, and vulnerability with difficulty reconciling demands of science with those of their private lives. Many felt that they did this poorly leading to 'not much of a private life.' They spoke of having to set priorities and making continual sacrifices. All acknowledged that what they were trying to do took incredible effort.

These postdoctoral researchers engaged in complex interactions: observation, word-of-mouth, lived experience, and anticipation of biases within this unique learning environment. These influenced career paths from the beginning of their post-doctoral experience until they ended up in an 'emerged' career fitting who they are as women and the type of gendered life they wanted to live. The women in our study provide insight into career experiences in a work environment transitional zone with its embedded signals, resources, reward schemas, and networks of communication.

These include appraisal processes, collegial interactions (or lack thereof), work climate, and collaborative opportunities. This environment does not operate uniformly, neutrally, or androgynously within the same setting. How women engage with such an environment needs deeper understanding, especially around its impact on future career paths.

Little is known about women during the transition zone period of their careers. This is a critical time, where formal membership in an organization is being considered and individuals engage in exploratory learning processes about the fit between themselves, their environment, and their desired future. The process is shaped by experiences encountered, how they make sense of them, and subsequent decisions based on accumulated experiences and their sense making in this transition zone. The decision whether to stay in research or go into teaching or industry is a decision of aligning passions as scientists to where they stand the greatest chance of success within their chosen field as a woman and a scientist. These women were not leaving science as the leaky pipeline metaphor suggests. They were looking for venues, where they could be successful and fulfilled women scientists.

The women in this study are 'free agents' who have not obtained or accepted full membership in an organization. This research provides insight into a time when the individual is engaged in an extended period of decision-making about a key life choice that is both adaptive and selective (Ibarra, 1992). We suggest this 'adapting-selecting' process is unique to transition zones. Our data suggests the transition zone involves persistent and ongoing struggles for many, as well as joy and fulfillment as they do science. Post-doctoral support is needed to lessen internal and external struggles. This transition period is critical for full time labor force participation, and one where more women postdocs, particularly in life sciences and physical sciences (NPA Advance, 2011), are lost from the academic science pipeline than men (Long, 2001).

This research adds documentation about how institutions both exclude and include women in science. The purpose was to understand institutional obstacles and barriers that forced choices and decisions leading many women to leave the system to fulfill their scientific research interests, and career and life goals, through other paths. The questions asked about success, fulfillment, projected career path and how gender is experienced in science enabled development of a more comprehensive picture of the participants' lives during this critical transition point in their career. We learned what is most important to them as scientists, as women, and in the totality of their lives.

Work-in-life integration

Even though women bear the brunt of challenges arising from working in male-dominated STEM fields, efforts to make the workplace more family-friendly will fall short, if women remain the face of work-life balance efforts. If the work of 'caring' (childcare and parent care) continues to be viewed as women's work rather than human work, there will be an ongoing cost to women, science, and society.

Although Valian (2006) argues that men appear more willing to forgo a 'balanced life' in order to have a scientific career than women, men are beginning to demand changes around work and family. Recent research found 40% of men unhappy with the way their work lives meshed with personal lives. This is in contrast to 50% of

women, who felt that way (June, 2012). Both men and women struggle with issues of family responsibility and its effects on scientific careers (Philipsen, 2008). The goal of work-in-life integration is more than just work and family integration. It includes maintaining ability to combine interests and responsibilities outside of work with productive work lives. The issue of meaningful and rewarding science as part of life recognizes individual priorities differ at different life and career stages. Men and women should be able to experience an integrated life throughout their careers.

Projected success and fulfillment

During the postdoc transition period, it was important for these women to find a path that led to their own definition of success, leading to fulfillment in the life they were creating. This had to fit the complex identity they had, with who they wanted to become. None of these women were rejecting work as scientists. Instead they were rejecting the 'all-or-nothing workplace' (Williams, 2010, p. 30). When sharing individual definitions of success, most of the women included the importance of relationships to them, as well as feeling personal satisfaction. Extensions to definitions of success support previous research concerning tensions women experience working in cultures defined by male notions of success (Rapoport et al., 2002). Women often include more 'relationship-oriented definitions' of achievement in their overall concepts of success, wanting to achieve in 'multiple arenas of their life' not just their career (Case & Thompson, 1995, p. 161).

As postdocs they became increasingly aware of difficulties integrating personal life and parenting with a career as scientist. We don't believe that women in science self-select out. Our findings show that these women struggle to feel both fulfilled and successful. Pregnancy will always be problematic when equated with lack of commitment. All our women were subjected to the accusation that they were not as serious about science as their male counterparts leading to sacrificing family commitments and forgoing outside interests.

More women entering the sciences today are unwilling to give up motherhood for scientific careers (June, 2012; NP Advance, 2011). They consider having both, essential to fulfillment and success. Yet they confront academic norms demanding total focus on science with extreme pressure in early career stages during their 20s and 30s, a time coinciding with child-bearing years. Our findings are consistent with these studies.

We should be asking more questions about constraints on excellence, especially structural and cultural barriers to recognition and demonstration of achievement in multiple arenas of life. Structural factors include workplace practices causing differential treatment of men and women even when they have the same qualifications and work orientations. In a previously mentioned survey by The Association of Women in Science, one-third of the researchers taking advantage of work-life initiatives believed that it hurt their careers (June, 2012).

Family-friendly policies are embedded in institutional workplace structures. However, women taking advantage of such policies accommodating family caregiving responsibilities are viewed less seriously and committed to science in contrast to male colleagues (National Academy of Sciences, 2006). Organizations need better ways to help women manage family life and have rewarding careers just as men can have. Bias against caregiving has led women to use bias avoidance strategies

including sacrificing having children and/or marriage and hiding family commitments to not damage their career. They want to achieve career success, avoiding career-damaging punishment. Not surprisingly, women are more likely to leave positions because of this (National Academy of Sciences, 2006; Williams, 2010).

In hierarchical systems, the closer one is to the top of organizations, the more subjectively, rewards are determined and the more informal systems accumulate power (Case, 1990). Preston (2004) found 80% of women scientists mentioned at least one lost career opportunity to accommodate a husband or children. Fifty percent of married women without children similarly mentioned sacrifices to accommodate their husband's career. None made conscious decisions to advance their career at the expense of family. Of those single and childless women scientists, most had not faced conflicting pulls from family and work except sacrificing relationships that could have led to marriage for career advancement.

The effects of gender, professional culture, and social expectations on men and women's evolving roles create problems for achieving integrated lives. Systemic changes in institutional priorities, actions, structures, and processes are needed. So is societal change affecting values, assumptions, attitudes, and beliefs people have about science and their organizations (Fox, 2008). Perceptions largely determine what is possible in different life spheres. They are embedded in established structures, relationships, and ways of doing things, exerting powerful influences over people's sense of identity and self-esteem (Rapoport et al., 2002). Women should not need changing to fit the traditional ways that science is done. Ways to create success that do not pose continual conflicts between work and the rest of life are needed for women (Wylie, Jakobsen, & Fosado, 2007). Gender assumptions and stereotypes based on separation of spheres constrain choices of women and men.

Experience of the environment

Our findings demonstrate the significant role gendered identity has on daily experiences of women in science affecting their lives professionally and personally. Cultural stereotypes about gender are widely held by men and women. Perceptions of quality and performance are affected by these gendered stereotypes, not only by employers, but also in ways men and women perceive themselves. Tokens are expected to work harder, be scrutinized more severely, behave as if they are not different from the majority, and their problems (which differ from the majority) are seen as insignificant or burdensome to the organization.

Being a woman is 'a better predictor of inequality than such variables as age, religion, intelligence, achievements, or socioeconomic status' (Benokraitis, 1997, pp. 6–7). Women who face 'family responsibilities discrimination' experience gender stereotyping in the ways jobs are defined, standards to which they are held, and assumptions made about competence and commitment. The forms of discrimination reported are often subtle, sometimes intentional, or unintentional, but with implications that negatively affects experience.

Yet, in spite of the challenges particular to women, our participants were committed to their chosen field of science. They were not opting out when they changed directions, but in many cases chose other venues like teaching or industry, where they could contribute their passion better for science and still blend work with their life. The pipeline theory focuses on increasing the number of women in science

without questioning why the pipeline works as it does, or the context in which it is situated (Hammonds & Subramaniam, 2003). The leaky pipeline is an institutionally imposed construction based on a linear male version of success in science. Its focus is on continual upward movement in a career done 'my way or no way,' with no ability for exiting and reentry.

The findings from our study suggest ongoing interplays between individual and institutional factors negatively affecting women's daily life and their desired futures as they work in male-centric science environments. Decision-making, an inherently political process, is influenced by distribution of power among groups with differing and often conflicting interests. Many 'micro inequities' look harmless (Benokraitis, 1997) yet these interfere with work, exacting costly tolls on self-confidence and relationships, expressed by women in our study.

Barriers today are subtle. Most faculty scientists intend to treat male and female post-doctoral students the same. But this seeming equality works against women. They are expected to behave contrary to socially constructed stereotypes and the preferences of many women for working cooperatively, having positive relational interactions, and sharing experiences with others, all part of their identity.

Academic female scientists including our sample are troubled over isolation experienced as scientists and voice this discontent more than men (Rosser, 2006). They want stronger social interaction for fulfillment (Eagly, 2004). Many want to help others and work with people, preferring careers like teaching to the research lab. Contrary to popular views of scientists spending countless hours alone in the lab, the practice of science actually involves teams of academics applying for grants and working together on research and publications. Despite this reality, many women are excluded from such collaborative efforts and departmental networks (Rosser, 2006).

Structural changes should lead to better work-in-life integration and retention of women as research scientists. But these changes alone will have little effect on subtle and largely unrecognized social psychological processes linked to gendered stereotypes about women's and men's roles and occupations (Benokraitis, 1997). Institutions must demonstrate through words and actions that scientists can combine high levels of professional achievement with family life. This study demonstrates that women are not leaving the sciences entirely, but instead finding other arenas, where their norms and expectations are more aligned with personal identities and desired futures. As one participant stated, '*I'm going to leave and I'm going to be successful where I know I can be successful.*'

Implications

We discovered that these women envisioned three different career paths: research, teaching, and industry. What we don't know is how their postdoctoral experience had already influenced their choice of career path and how this would carry over, influencing them in a new environment. It is clear that these post-doctoral women scientists navigate a societal and organizational terrain, different from their male counterparts, a terrain deeply rooted in cultural ambivalence, which emerges in organizational structures and practices, as well as individual attitudes. The double bind facing women shapes their experiences and identities as scientists. Women think about career in the context of their whole lives. Obstacles to career achievement that arise in their personal lives need addressing, as does maintaining focus on both work

and family life. Without this, choices become limited and women lose the capacity to exercise all their potential as scientists and human beings.

The pipeline analogy for increasing women in science is an inappropriate one presenting the perspective that women are leaving the field of science. It does not consider that rather than leaving science, they are moving into career tracks better aligned with their definitions of success and fulfillment. Instead, the pipeline analogy takes a linear view, with one entry point through education and one exit point, with no reentry possibilities. Career success means continuing along the pipeline, ending with recognition as a distinguished scientist. There are not varied entry and branch points like those that occur in actual pipeline systems. You enter at one point, and if you exit at any of the transition points, there is no way to reenter.

This study shows that women enter this pipeline. Their experience in this transition zone permits flexibility to branch off into better and more appealing areas. We counter the leaking pipeline metaphor with one of 'organic branching' allowing women to grow and thrive as scientists. We suggest this analogy be used in studies involving women in other industries or domains of work, believing it a more appropriate metaphor, better aligning with experience and engagement within dynamic environments, and a less linear framework.

Using this metaphor provides organizations with new ways to revisit policies that could allow for dynamic interactions and eliminate those that only support more male linear performance perspectives and male-centric concepts. We propose exploring new forms of engagement with women in the work environment, establishing the concept of branching and evolving, making these aligned with success and fulfillment and more human centric.

Women's experience along their science journey begins interactively during early educational experiences. Becoming a scientist, and remaining one is a process of individual experience, self-awareness and sense making, coupled with information and knowledge obtained through observing the organizational climate and treatment of women, through informal communication, and direct contact with the science 'grapevine' where women learn through other's stories of what is in store for them, the longer they remain in science.

The primary limitation of the study is its small sample size. In addition, further quantitative measures should be used on a larger sample following the preliminary analyses of this study. Our study uses retrospective data. It would be interesting to think about how the process unfolds over time. Are there stages experienced? The type of analysis we conducted assists in understanding how organizations perpetuate disparate treatment and the relationship between behavior and outcomes.

Conclusion

Collectively, the shared voices of the women in the study tell a powerful story about science environments and the impact of this on their careers and life. The stories and conversations emerging from this study align with those found by Nancy Hopkins from MIT concerning previously unrecognized inequities experienced by women science faculty. She said, 'Only when the women came together and shared their knowledge, only when the data were looked at through this knowledge and across departments, were the patterns irrefutable' (Hopkins, 1999, p. 11).

The women participants came together to join in this study hoping to make a difference to both present and future women scientists. They shared their experiences as women, as scientists working in renowned institutions across the country, and as individuals committed to making a difference. The data that emerged offers an intimate insight into what might otherwise be unknown, unseen, or unheard.

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Note

1. A longer version of this paper, available online at the Work and Family Commons, includes a more systematic review of the literature.

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