

Commentary

Lessons from the Stories of Women in Neuroscience

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Women have been contributing to the field of neuroscience since its inception, but their accomplishments are often overlooked. Lack of recognition, among other issues, has led to progressively fewer women at each academic stage; although half of neuroscience graduate students are women, women comprise less than one-third of neuroscience faculty, and even fewer full professors. Those who reach this level continue to struggle to get their work recognized. Women from historically excluded backgrounds are even more starkly underrepresented and face added challenges related to racial, ethnic, and other biases. To increase the visibility of women in neuroscience, promote their voices, and learn about their career journeys, we created Stories of Women in Neuroscience (Stories of WiN). Stories of WiN shares the scientific and personal stories of women neuroscientists with diverse backgrounds, identities, research interests, and at various career stages. From >70 women highlighted thus far, a major theme has emerged: there is not a single archetype of a woman neuroscientist, nor a single path to “success.” Yet, through these diverse experiences run common threads, such as the importance of positive early research experiences, managing imposter syndrome, the necessity of work–life balance, and the challenges of fitting into—or resisting—the “scientist mold” within a patriarchal, racialized academic system. These commonalities reveal important considerations for supporting women neuroscientists. Through the lens of women highlighted by Stories of WiN, we explore the similarities among their journeys and detail specific actionable items to help encourage, support, and sustain women in neuroscience.

Introduction

Storytelling is an undeniably powerful tool in communication. In the context of science communication, storytelling can underscore scientific motivation, build understanding of scientific career paths, and celebrate scientists in a personal way. In creating our project, Stories of Women in Neuroscience (Stories of WiN), we hoped to leverage the power of storytelling with a twofold mission: to bring visibility to women in neuroscience and to inspire the next generation of women to follow in their footsteps.

Although >50% of neuroscience PhD students are women, women comprise <14% of tenured neuroscience faculty (Society for Neuroscience, 2017; McDermott et al., 2018). Further, women are less cited than their male counterparts (Dworkin et al., 2020), diminishing their impact and creating ripple effects on other metrics of academic success and visibility. Women from historically excluded racial and ethnic groups and sexual and gender identities

face additional biases and even more stark underrepresentation (Freeman, 2020; Ullrich et al., 2021). Efforts to increase the representation of women in STEM have too often ignored women of color, and the term “women” has too often failed to be queer and trans inclusive (Turner, 2002; Serano, 2013). In giving women neuroscientists from all backgrounds and identities a platform to tell their stories, we hoped to identify how the field can recruit, retain, and support talented women.

From the stories of over 70 women interviewed thus far, it is obvious that there is no singular archetype of a woman neuroscientist, nor is there one path to “success.” Yet, through these diverse experiences run common threads. Four observations stand out: (1) the importance of positive early research experiences; (2) managing feelings of self-doubt; (3) finding a sustainable work–life balance; and (4) struggling to fit into—or resisting—the “scientist mold” within a patriarchal, racialized academic system. Here we describe these observations in more detail, with anecdotes and examples from Stories of WiN profiles. Based on the women’s shared experiences (Fig. 1), we propose specific action items to recruit and support women in neuroscience.

Observations

Observation 1: the importance of positive early research experiences

What drives women to pursue scientific research careers? Throughout our conversations for Stories of WiN, we found that

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a remarkable number of women initially wanted to pursue careers in other professions, including medicine, philosophy, art, engineering, and education. Then an early, positive experience in a laboratory sparked their passion for research. For some, this experience was largely unexpected. Dr. Bianca Jones Marlin—now an Assistant Professor at Zuckerman Institute of Columbia University—saw a flier advertising a paid laboratory research opportunity and considered it as she might consider any other job. However, through that initial and subsequent predoctoral research programs, she fell in love with research and learned about the trajectory of an academic science career. Indeed, we heard from many women, especially those from historically excluded backgrounds or who were the first in their families to pursue advanced degrees, that they entered their first research experiences not knowing that research could be a career. Thus, early research opportunities can be transformative experiences that inspire women to pursue neuroscience, including many women who otherwise would not have.

We also found that positive mentors were highly formative for our interviewees and often played a direct, momentous role in launching their neuroscience research careers. Noted attributes of influential mentors included cultivating scientific curiosity, acting as career-long advocates, and offering encouragement and concrete opportunities. For instance, Dr. Brenda Bloodgood—an Associate Professor at University of California, San Diego—credits her undergraduate mentor, Dr. Ed Callaway, with changing the course of her life. After initially hiring her to wash glassware in his laboratory, Callaway recognized her innate curiosity and genuine excitement for science. He offered her a paid technician position, although she had never even held a pipette. Later, when Bloodgood was feeling that graduate school might be beyond her reach, Callaway convinced her that she was an excellent candidate for any of her dream schools. This vote of confidence from a respected mentor was exactly what Bloodgood needed, and she applied (and was accepted) to top graduate programs. Overall, our interviews highlighted that early research experiences—both the science itself and the mentors—play a crucial role in a young student's career path.

Observation 2: managing feelings of self-doubt

“Imposter syndrome” was first described by clinical psychologists in the 1970s as a unique affliction among highly accomplished women wherein they believe that they are not as smart or capable as others perceive them (Clance and Imes, 1978). While we now know that this phenomenon is not unique to women, imposter syndrome is most common among women and those from backgrounds or identities historically excluded from their respective fields (Chrousos and Mentis, 2020).

Thus, it is no surprise that many Stories of WiN interviewees—women with successful, impactful careers—reported experiencing imposter syndrome and other forms of doubt and insecurity. From their stories, several lessons emerged. First, experiencing imposter syndrome is common and should not be considered a sign of weakness. Take, for instance, Dr. Kay Tye, a Wylie Vale Chair Professor and Howard Hughes Medical Institute Investigator at the Salk



Figure 1. Women featured in this perspective. While this perspective is inspired by all of the women who have shared their stories with Stories of WiN, we bring specific examples from the women depicted here: Drs. Bianca Jones Marlin, Sana Suri, Millie Rincón-Cortés, Brenda Bloodgood, Nanthia Suthana, Denise Cai, Letisha Wyatt, Alison Barth, Kay Tye, and Erin Calipari.

Institute, who felt such severe imposter syndrome during her PhD that she almost dropped out. For Tye, a major turning point was presenting her work and receiving positive feedback from her colleagues—she began to regain confidence in herself and her place in academia.

Other external factors, such as positive mentors and structured systems of support, also played key mitigating roles for the women of Stories of WiN. As a new PhD student without a neuroscience background, Dr. Millie Rincón-Cortés—now an Assistant Professor at the University of Texas at Dallas—was struggling with the challenge of changing fields as well as culture shock after moving to the mainland United States from Puerto Rico. Her grades were suffering, which threatened her spot in the program. However, the dean assisted her in getting free tutoring, ensuring Rincón-Cortés that he believed she could succeed. His support helped her turn her grades around and gave her the boost of self-assurance she needed.

While these and other external factors can help manage imposter syndrome, it is difficult to eradicate these feelings entirely. Thus, another common theme among our interviewees was learning how to internally manage doubt so that it is not self-limiting. Dr. Nanthia Suthana—an Assistant Professor at UCLA working at the intersection of neuroscience and engineering—describes learning to “sit with the discomfort” that she experiences among colleagues who have more expertise in certain areas than she does. Being able to set aside feelings of insecurity has proved to be essential for her interdisciplinary work. Overall, it is clear that imposter syndrome is extremely common among women in

neuroscience across career stages. However, external and internal mitigating factors can help temper those feelings, preventing them from becoming barriers to scientific advancement.

Observation 3: finding sustainable work–life balance

Overwhelmingly, there is a real and perceived expectation for academics to devote their time to scientific work over personal life (Lewis and Humbert, 2010; Cannizzo et al., 2019). In its extreme, work–life imbalance can negatively affect the health of individuals and their relationships and can contribute to scientists, especially women, leaving academia (Heijstra and Rafnsdottir, 2010; Gill, 2014; Cannizzo et al., 2019). Dr. Sana Suri—now an independent investigator at the University of Oxford—navigates this pressure by remembering advice she received early in her career: “Your job is what you do. It is not who you are.” She elaborates that in academia, “where the ups and successes can be so few and far between, you cannot let your achievements or knockdowns define you.” Suri is very particular about not working on weekends to preserve her time with family and life outside of the laboratory. While creating this boundary takes discipline, Suri explains that taking weekends off keeps her “coming back quite refreshed on Mondays.” She passes down this wisdom to all her laboratory members, encouraging students to take breaks and go on true “unplugged” holidays.

While all scientists struggle to find work–life balance, there remains an incompatibility between parenthood and the academic career trajectory, an issue that disproportionately impacts women. Based on the National Science Foundation, the average age of individuals at the time of PhD completion (now 31 years of age; National Science Foundation, 2018) results in biological pressure to start a family at an early academic career stage. Balancing motherhood and postdoctoral training challenges many women, including Dr. Alison Barth—currently a Professor at Carnegie Mellon University. After a difficult pregnancy accompanied by debilitating sickness and exhaustion during her postdoc, Barth was struck by financial instability—the astronomical cost of childcare can be nearly impossible on a postdoc salary. While Barth ultimately accepted a faculty position, she seriously considered leaving academia during that time and even applied to other jobs in parallel with her faculty search. Whether mothers or not, many of our interviewees found that maintaining clear boundaries between work and home life has been necessary for preserving their health and stamina as they advanced through the academic system.

Observation 4: the patriarchal, racialized “mold” of a scientist

The stories we hear in our interviews often implicitly or explicitly reveal pervasive biases against women in STEM. Dr. Denise Cai—Assistant Professor of Neuroscience at Mount Sinai—uses her white, male husband, who had similar training and started his laboratory at the same time, as her “wild-type littermate control.” Cai shared examples of the stark differences in how she and her husband are assessed, particularly their perceived “expertise” in grant reviews. Indeed, an analysis of National Institutes of Health (NIH) funding of first-time principal investigators (PIs) across all grant types and institutions found that new women PIs received approximately \$40,000 less funding than men despite no difference in baseline performance measures (Oliveira et al., 2019). In a system in which NIH grants are crucial for the success of a laboratory, these biases are extraordinarily detrimental.

The damaging effects of biases against women are compounded for women who also face racial, ethnic, and/or gender identity prejudices. Microaggressions, overt racism, transphobia, and other stressors add a significant mental toll on top of the daily tribulations

of experiments. Additionally, many interviewees emphasized that, for those historically excluded from the field, it is difficult to find a sense of belonging in the neuroscience community. As a Black woman and scientist, Dr. Letisha Wyatt—Assistant Professor and Director of Diversity in Research at Oregon Health & Science University—confirms, “I do a lot of equity work out of necessity for my own sense of belonging...building communities that I need to persist.” A system that was built for and continues to cater to a particular “mold” of a scientist will always demand more of those who deviate from that norm. But each time a woman—especially a queer woman or woman of color—persists in the field, a new crack appears in the “mold” of the white, cis male neuroscientist. Addressing the implicit biases and systemic barriers within academia is essential to empower and retain women and thus reshape the mold.

Action items

Based on observations from speaking with over 70 women in neuroscience, we propose specific action items for recruiting, supporting, and retaining women in the field.

Action item 1: increase accessibility to entry

Neuroscience doctoral programs, like many others, use previous research experience as an admission criterion. Many of the women we interviewed emphasized the importance of early, paid research opportunities for their career success. About half of full-time undergraduate students in the United States hold a part-time job during college (Snyder and Dillow, 2014), and many do not have the financial luxury of doing unpaid volunteer work in a laboratory. To increase access to academia and help increase gender parity and diversity in neuroscience, we propose the following: (1) fund young scientists: increase funding allocation for organizations that provide paid undergraduate or postbaccalaureate opportunities, especially those that focus on women and other historically excluded groups; and (2) denormalize unpaid labor: PIs with adequate resources can help denormalize unpaid scientific labor by paying all undergraduate technicians, whether full time or part time.

Additionally, mentors should make a concerted effort to educate young students on the hidden curricula of academia, for instance by guiding students in their graduate school application and interview process.

Action item 2: incentivize good mentorship

Across our interviews, it was clear that having supportive, inspiring mentors was critical to the success of WiN scientists. Unfortunately, scientists rarely receive formal mentorship training despite the critical role of mentoring in career development (Estrada et al., 2018; Lambert et al., 2020). We propose the following steps to incentivize good mentorship in academia. (1) Include mentorship scores in tenure decisions. Currently, promotion processes for tenure require faculty to demonstrate scholarship and leadership through publications, teaching, and service. Given these criteria to measure “success,” there is no pressing incentive to strive for exceptional mentorship. If letters from trainees and/or faculty describing the applicant’s mentorship ability were part of the tenure package, PIs would be incentivized to devote time and energy to developing mentorship skills. (2) Require mentorship training for grant recipients. Postdoctoral recipients of transitional awards (e.g., NIH K Awards) should be required to take mentorship courses as part of their fellowship training (analogous to the currently required ethics courses). This would better

prepare new PIs to be positive, supportive mentors to their first trainees rather than developing mentorship skills via trial and error. (3) Institute zero-tolerance policies for harassment and abuse.

Action item 3: make academia more family friendly

In our interviews, one of the top career challenges women discussed was that of balancing motherhood and research. Compared with men or with women faculty without children, women faculty with children face more obstacles in academic careers (Carr et al., 1998). While not all gender disparities in research careers are linked to motherhood (Mason et al., 2013; Morgan et al., 2021), academia could retain more women by instituting the following family-friendly policies. (1) More paid family leave. Universities should create paid maternity and paternity leave policies for graduate students, postdocs, and faculty. If institutions do not have clear policies, PIs can help normalize paid leave by providing this option to their trainees and advocating for explicit institutional policy. (2) Increasing access to childcare. Universities should provide or subsidize childcare options that make it feasible on a graduate student or postdoctoral stipend/salary. Additionally, universities should ensure easily accessible lactation rooms so new mothers returning to work can use their time efficiently.

Action item 4: recognize women

Reaching gender parity will require us to expand how both we and future generations of scientists picture the “quintessential academic.” This will require broad-sweeping changes in the demographics of positions of power and recognition within academia. We suggest the following. (1) Cite and invite women. Women are often underrepresented in citation lists and conference speaker lineups (Schrouff et al., 2019; Dworkin et al., 2020). The neuroscience community has already begun to address this, with sites like “BIASWATCHNEURO,” which monitors gender ratios of neuroscience conference speakers. Further progress will require us to actively seek out citations of women’s work and women speakers. Resources and tools available for monitoring gender parity are summarized and linked in the study by Llorens et al., 2021. (2) Put women in positions of power. Women disproportionately take on more service work in academia (Carrigan et al., 2011; Guarino and Borden, 2017; Jimenez et al., 2019). This partially stems from biases fueled by gender norms, but well intentioned attempts for gender parity on, for example, committees and panels can also result in a greater service burden on women compared with men, due to the smaller pool of women faculty. We propose that, until there is a higher percentage of women faculty, gender parity should be prioritized among groups with gatekeeping power—such as committees with the authority to hire, promote, or select for awards—over other service positions. Relatedly, leadership positions, such as department chairs and institute directors, are still overwhelmingly occupied by men (McCullough, 2020). We propose that those choosing leadership positions should adopt demographic benchmarks or equity advocates to shift this power balance [see Faculty Pipeline Benchmark Data, Office for Faculty Equity & Welfare, University of California, Berkeley (<https://ofew.berkeley.edu/faculty-pipeline-benchmark-data>); Cahn et al., 2022].

Conclusion

In her interview, Assistant Professor Dr. Erin Calipari at Vanderbilt University describes a pattern she often sees in

academia: “We’ve identified there’s a problem: there aren’t enough women [or] URM’s... [but] we want them to come into the system and be just like everyone else.” This is a common sentiment expressed by the women we have interviewed. The structure of academia was built not just by men, but also for men. These systems were simply not originally designed to promote or be desirable to women.

Advocacy work, such as that of Stories of WiN, lends a new perspective through which to understand the academic system. This collection of interviews has provided us the opportunity to recognize not only the blind spots and biases of an imperfect academic system, but, uniquely, how women have managed to overcome these barriers to become leaders in the field. Through these stories, we have curated a collective imagining of what a more equitable system of science could look like. The women we have interviewed emphasized that academia, at its best, fosters a sense of belonging, equal opportunity, and shared purpose—the pursuit of knowledge for public good. We argue that these qualities emerge when opportunities to enter the field are plentiful and accessible; systems of support help individuals manage self-doubt; work–life balance is protected and encouraged; and the unique challenges facing women and other minoritized identities are acknowledged and addressed.

Throughout the last couple years, we have seen the fissures in academia widen under the stress of the pandemic, with the pre-existing issues discussed in this article becoming more severe. Increased feelings of isolation (Leal Filho et al., 2021), the erasure of lines between work and life (especially for women; Matulevicius et al., 2021), lost opportunities for undergraduate research, and increased barriers for those with intersectional identities have made academia a less desirable path for many women. However, systems and institutions are at their most flexible when they have recently experienced a stressor and need to be rebuilt. So, too, can the typical mold of a scientist be stretched and reshaped, and the systems that have reinforced that mold can be reimaged and reformed.

Limitations and potential biases

The observations and action items proposed herein should be understood within the context of our own limitations as authors. As a group, we do not represent all racially minoritized and other marginalized identities that we have aimed to include in our discussion of women in neuroscience. Given the privilege to offer this commentary based on the stories that many women have generously shared with us, we must recognize the potential for bias and other shortcomings in our perspectives.

We also acknowledge that the project, in highlighting women in academia, does not tell the stories of the countless women who may have desired and thrived in an academic career but were pushed out because of abuse, harassment, sexism, racism, homophobia or transphobia, ableism, financial hardship, lack of family-oriented policies, etc. We acknowledge the struggles of women who were forced out of the academic system, and we encourage continuous, purposeful action against the forces that erased their stories from the academic narrative.

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