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# "You Sound Like a Good Program Manager": An Analysis of Gender in Women's Computing Life Histories

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## ABSTRACT

Through the eyes of professional women in computing, we can better understand the impact of workplace structures, higher education pathways, and the particular closed nature of the tech industry. This study of women's life histories contributes to the work of in-depth qualitative examinations of CS learning contexts and psychological studies investigating phenomena such stereotype threat which contextualize the experience of women in computing environments. Drawing inspiration from Margolis and Fisher's work drawing the "blueprints" of the "boy's clubhouse" of computing education [20], as well as McDermott and Webber's analysis of when math learning occurs [22], we ask when, where, and how is gender being invoked and created, as a way to unpack the places, events, and interactions that shape women's participation in the Silicon Valley workforce. This qualitative analysis of 13 life history interviews with professional women in computing shows that gender becomes salient for women in public settings, particularly in early adulthood when women enter male-dominated classrooms, teams, and workplaces that foster "brogramming" culture. CS educators, hiring managers, and recruiters all need to be aware that the effects of gender go beyond just including more women in classrooms and on teams. The learning environment, incentives for participation, and the goal of diversity all need to be better aligned in order to foster an equitable workforce.

## CCS CONCEPTS

• **Social and professional topics → Computing education**.

## KEYWORDS

gender, life history, women in computing, workplace, higher education, equity, belonging

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## 1 INTRODUCTION

Representation and equity in computing have been a concern for many years [20]. The stereotype of a computer scientist is a middle-class white man who is often geeky and anti-social [12]. While stereotypes are not necessarily representative of the general population, they do impact the perception of who belongs in the field and can act as exclusionary forces for people who do not fit the stereotype [6, 26]. The numbers too clearly show computing to be dominated by men. As of 2016, in the United States only 18% of bachelor's degrees in computer and information sciences were awarded to women [15]. Even as the field grows, the proportion of women in computing has dropped in recent decades, from 35% in 1990 to 25% in 2016 and has held steady since [15], and women also leave computing at higher rates than their male peers [3, 7]. This gender gap raises several concerns, including: a perceived computing labor shortage, implications about the status of women in a supposedly gender-equal work world [20], and the risk of failing to design technologies that meet the needs of people not involved in the design process [25].

The underrepresentation of women in computing today results from a variety of social, cultural, and economic factors, and has been studied from historical, psychological, educational, anthropological, and gender-studies perspectives [1, 6, 8, 12, 18, 20, 21]. These studies nuance the picture and emphasize a different rationale for the need to study the underrepresentation of women. For example, large scale studies in computing education typically focus on Advanced Placement Computer Science (AP CS) courses and computer science (CS) degree completion rates, trying to figure out what factors best predict persistence and retention for women [30]. On the other hand, historical and sociological approaches have accounted for the social and structural factors that shape participation, such as gendered expectations for workers' career advancement and the countercultural influences on personal computing [16, 29].

The everyday experiences of professional women in computing bring another perspective. The goal of the following analysis is to zoom down to an underlying layer of meaning in women's stories about their experiences in the tech world, and through their eyes we can understand about the broader structures of computing.

### 1.1 Research questions

This paper reports select findings from a qualitative analysis of life history interviews with 13 women working in computing in Silicon Valley. The following questions guided the analysis:

- When in student life histories does gender appear as salient?

- Where does gender appear? In what spaces, formal and informal, do the participants become gendered?
- How does gender appear? Who is involved in marking the participants' gender? What gendered cultural, social, historical aspects can we see through the voices of these women?

## 2 LITERATURE REVIEW

Depending on the research questions and disciplines in which the researchers are situated, scholars have employed qualitative and quantitative research methods, as well as some mixed methods analyses, to understand different aspects of women's experience of computing. To contextualize the analysis presented in this paper, the following paragraphs provide a brief historical overview of how women have appeared in computing through the years to highlight some of the institutionalized structural barriers that were established due to gender norms, discuss psychological factors at play when women enter tech today, and touch on the types of analysis studies that have been conducted about gender and tech.

### 2.1 Historical position of women in computing

The professionalization of computing was promoted by men in the mid-twentieth century as a way to legitimize programming, which until that point had been considered feminine labor. Professionalization thus required distancing computing from women and establishing higher education degrees, management hierarchies, and professional associations which were either closed to women or very difficult to obtain [12, 16].

By the 1960s, computer science was a relatively young professional and academic field, but was gaining popular recognition, and personal computing became more prevalent. The United States counterculture movement turned to computing as a tool for personal and collective transformation and brought with it unquestioned traditional gender norms [29]. At this point, computers were also being marketed to men and boys, and college enrollments saw a decline in women enrolling in CS courses when personal computers entered homes [27]. A decade later at the Massachusetts Institute of Technology (MIT), the Hacker mentality was reified as the self-adopted image of the "anti-social programmer, wearing sandals and a beard," (p. 239) [12] and gender was ignored in the "bogus criteria" listed "to be discarded" in the supposedly meritocratic Hacker Ethic [19].

Today, "brogrammer culture" acts as shorthand for pointing to sexism in the tech industry. The term, "brogrammer," began as a satirical term to refer to a man who can code and succeeds with the behaviors of a stereotypical "frat-boy" and ambition to become rich fast [18]. By definition, women are excluded from this group and often objectified and pushed out of workplaces because of the fraternity-like environments created as a result of brogrammers being in the space. Women who do succeed in these types of environments may also face difficulties due to their gender, as being better than men can be seen as threatening. In addition, the way in which women perceive being gendered in male-dominated spaces indicates how they relate their experience to gender. Women's beliefs about the reason for the lack of women at high levels in companies, for example, influence whether they are motivated to fight structural barriers for other women or if they reify glass ceilings [4]. Within brogrammer culture, there are often so few women that those who are there become accustomed to the environment.

### 2.2 A "chilly" environment and stereotype threat impact women's sense of belonging

Recent social psychology studies of computing have shown that a "chilly" environment in higher education [1] and stereotype threat contributes to women's underrepresentation in computing, because the stereotype of a computer science student is a nerdy white male, which excludes women by default [9, 21]. For some women, in particular women of color who are doubly and sometimes triply excluded because of their skin color and language practices, the discourse on gender may itself be harmful [8]. However, there are women who enter and stay in computing despite the apparent odds documented in the literature. Having well-developed interests [24] and strong social support systems [9, 23], for example, are thought to offset the threat of negative stereotypes and foster identification with the community. Understanding the characteristics of these women and the confluence of factors in their lives that have supported them to continue in computing may help influence the structures of the infamous tech pipeline to become more flexible and supportive.

### 2.3 Benefits of small-n research

Large scale studies of women's persistence in computing rely on statistical measures to isolate variables that predict retention in computing education programs and the workforce [5, 17, 30]. While useful in mapping the prevalence of certain psychological responses and patterns of behaviors, the relatively removed stance of the researcher limits the depth of detail and understanding of everyday context that is possible to capture. Ethnographic and discourse-based analyses can bring us closer by carefully unpacking the participants' narratives for what is and what is not said about the whys and hows of gender in everyday life [1, 8, 31].

## 3 METHODS

The interviews conducted for this study were semi-structured to capture a full picture of the participants' experiences with computing across their life times. The criteria for participation were to (a) identify as a woman, (b) identify as a computer scientist, and (c) work as a computing professional. All names are pseudonyms and all identifying company and university information has been obscured to protect participant privacy. During the recruiting process, all participants were informed that the goal of the study was to understand how women came to be computer scientists. The participants were not explicitly asked about the role their gender played in their life histories during the interviews unless it was salient to the conversation in order to not artificially invoke gender where the women themselves did not see it as an important aspect of their experience. Each interview ranged in length from 40-75 minutes. All interviews were audio recorded and transcribed. The transcripts were then de-identified and pseudonyms created to refer to the participants.

### 3.1 Participants

At the time of their interviews, the women in the study ranged in age from 22 - 45 and worked in the Silicon Valley tech industry at a variety of companies and one school. All participants are listed below with their respective ages and job titles.

- Amy, 22, Web developer for an established company
- Briana, 23, Software engineer for an early-stage start-up
- Carol, 37, Software engineer at a late-state start-up
- Diana, 25, Web application developer for an established company
- Emily, 30, Product Manager (Director) at an established company
- Fiona, 23, Program Manager at an established company
- Georgia, 23, Software engineer at a late-stage start-up
- Heidi, 25, Front-end developer at an established company
- Jackie, 24, Full stack software engineer at an early-stage start-up
- Laura, 31, Senior software engineer at an early-stage start-up
- Molly, 45, Senior Software Developer for a university
- Naomi, 33, Software Developer for a university
- Pearl, 28, Computer science teacher

### 3.2 Analytic Approach

The analytic approach was an iterative process that borrows from James Gee's [14] conception of "big D" Discourse to explore the language the participants use to describe their experiences as professional women, and how this language illuminates the behaviors, ways of thinking, values, and perspectives that dominate the tech industry and position women within it relative to men. Given the infamous glass ceiling that women in the workplace encounter in different ways [4] and the numerous revelations of sexual harassment that were brought to light in the #MeToo movement, it was hypothesized that it was highly likely the participants would have experienced being gendered while participating in tech in some way. However, they may not express such experiences as "gendered" either due to their own ideologies or lack of formal work experience. Using a discourse analysis-like approach by looking for both instances of when gender is marked and when it is implied can help draw out the effects of gender at an underlying level.

To develop a codebook to guide the analysis, two researchers independently open coded four transcripts for gender being marked explicitly, being implied despite gender neutral language, or being implied through the context of the conversation ("when," "where," and "how" from the research questions). From the open coding, they developed a set of inductive codes for the types of settings, people, and events that were implicitly and explicitly marked (e.g. mentor, internship, academics). Next, they identified deductive codes to pull out factors known to be salient to gender from social, historical, and psychological studies of gender in computing, such as job titles, college degrees, and self-identification with CS. The researchers then separately applied the codebook to three transcripts and discussed their results. Together, they iteratively coded a representative sample of the transcripts and revised the codebook until they agreed that it included codes that were broad enough to capture the spaces and interactions where gender was being enacted but narrow enough for comparison across transcripts [11]. Using the final codebook, they separately coded a new 10% subsample of transcripts and calculated interrater reliability to be 77.5% using Cohen's Kappa. All differences in codes were discussed and 100% of disagreement in codes was reconciled.

## 4 FINDINGS

As heard through the voices of the participants, gender becomes salient in public and often in early adulthood when the women enter male-dominated classrooms, teams, and workplaces, in particular ones that cater to "brogrammers." At home and among friends, the interviewees' gender is rarely noted. The majority of women (8 of 13) do not report explicit stories of being discriminated against. However, some describe behaviors that are known to be implicitly feminine that can be a barrier to advancement, such as withdrawing from asserting themselves as the expert in the room. Within the workplace, there is an acknowledgement of the hierarchy of technical jobs (e.g., software engineers being at the top of the technical ladder and program managers at the bottom), and explicit assignments of female gender to the less technical jobs, which Naomi, Jackie, and Carol describe. The assignment of female gender to less technical jobs also indicates how the default gender associated with technical work is male.

The women who entered tech before the most recent boom reflect on how the industry has changed since the rapid development in the 90s. However, in their narratives there is not much reflection beyond when they themselves were active in tech. Two women of color, Pearl and Emily, allude to a more complex historical picture when they comment on the role of race and culture, respectively. Though not within the scope of this analysis, it is worth noting that both Pearl and Emily expect to encounter differences based on their backgrounds. For example, Pearl is used to being the "only" in the room, whether it be the only woman or the only Black person or the only Black woman. Though she does not explicitly reflect on the historical precedent for her position as the "only," she also does not express surprise, unlike some of the other women who are surprised to encounter their gender setting them apart from their male peers such as Georgia, a young, white, software engineer.

### 4.1 Gender becomes relevant in adult, public settings

Gender is visible in middle school, high school, college, adulthood, and motherhood, however less is said about middle and early high school than college and beyond in the participants accounts. Three of the participants, Diana, Fiona, Heidi, attended an all girls middle school where their gender did not set them apart from their peers in their early interest in STEM and computing. Another two participants, Jackie and Laura, discussed having their gender noticed in high school. Jackie felt marked by her gender in technology-focused high school track: "When I was in this class, I think there were two girls in my engineering class out of 40 students in the program. I don't know, I definitely felt really out of place." Laura described hearing teachers comment on her presence as the only woman in an electronics class.

College, specifically college classes, homework sessions, and exams, made gender visible in ways that it might not have been

before, depending on the participants' experience until then. Georgia, for example, confided, "Honestly, I – the concept that it would be harder to be a woman in computing, it – I didn't even really notice until after I came – left [elite college]." Yet she also describes how she counted the number of men and women present at her midterms "just for fun" and noted that approximately 8% of the students were women.

Interestingly, the many of participants' descriptions of what they would consider a "typical" path to computing revolve around a modern masculine stereotype: men engaging in computing early and moving through a formal schooling path to industry. For example, Emily commented that it would be easier to describe a man's path to computing than a woman's. Fiona admitted that she saw people like Steve Jobs and Bill Gates as the ones who are typical, not women (despite the fact that Steve Jobs is famous for not taking the formal schooling path to industry). No women were described as taking "typical" paths. Comments like these locate gender along the entire pathway of a woman in computing because of the masculine norm. However, looking for jobs, workplace social events, becoming mothers, and facing ageism were all times along the participants' journeys that highlighted the ways in which distinctions are made between men's and women's paths.

## 4.2 Selection bias in recruiting

A contested and consequential space where gender is legally not supposed to appear, but does appear in the actions of recruiters and hiring managers, is the technical job market. Especially for the younger women, gender is more visible as a factor in hiring than for the rest of the participants. Georgia, Jackie, and Briana all mention that they had been told women have an easier time being hired because of their gender now that companies in Silicon Valley are feeling pressure to diversify their employee base. Recruiters can be both barriers and catalysts to finding tech jobs. They appear when participants are first entering the tech workforce and also make appearances later in the arc of the participants' careers, for example when the participants are being recruited to change jobs. Gatekeeping happens implicitly, such as when Diana was immediately directed to retail jobs at a high tech company by a male recruiter as she approached his booth at a career fair, and explicitly, for example when Fiona was offered an interview by a female recruiter just because she was a woman. Sometimes situations are ambiguous. Jackie was typecast by a male recruiter to be a program manager when she had little expertise in that domain (an implicitly female, semi-technical role according to technical hierarchy) rather than recruited as a software engineer for an internship she applied for at a high tech company. She recounts:

> "My junior year, I got an internship at [high tech company] as a program manager. At that time, I didn't really know what that was but I talked to a recruiter. I was working at the virtual reality lab and I was talking about the work that I was doing there. He started asking me what I did and what I liked about it. He was like, 'You sound like a good program manager.' I was like, 'Okay, sure.' Then, he wrote it down on my resume and I got an email from [high tech company] later asking me if I wanted to continue through the interview process."

Taking the program manager internship opened the door for Jackie to get a full-time position after graduating from college and also influenced her identity as a computer scientist. She remembers thinking, "Maybe programming is not for me. It's not what I want to do" even though her passion for computer science is what kept her in the major in college. Program managers are considered to be the least technical of the technical roles at a tech company, and Jackie encountered this bias first hand at a high tech company. She recalled, "There's also this stigma of like, 'Yeah, all the women are program managers because that's what they're good at.' This was really annoying in my opinion and I really didn't like it." Two years later a recruiter recognized her technical competence and Jackie was hired for a software engineering position at a different company.

## 4.3 Experiences with "Brogrammer" culture

Aspects of "brogrammer" culture are frequently mentioned in the interviews as the women described the environments of their current and former workplaces. Heidi talks about beer refrigerators and forced happy hours at the first company she worked for being a "turn-off" now when she hears them being used as selling points by other companies. For Georgia, the posturing of male interns in her internship cohort at a high tech company and an unwelcoming male host discouraged her from taking a job there, even though she'd been offered a full time position. Amy describes seeing brogrammer behaviors and having been intimidated by them before, not because of harassment issues, but because of their focus on technology: "I've seen males who have, I just feel intimidated by some of them. They just have this attitude that they've been working on this for a long time, and they do these side projects at home, and I wonder am I as dedicated as them if I don't do things at home?" For Amy, the technical challenge is important, but she also cares about the mission of the company. Even at social impact start-ups, technical concerns can still dominate.

Pearl relates how on the engineering team of an ed tech start-up she worked at, the people on the team: "loved technology for its own sake. And so they like it if there were on the team because they wanted to solve the technical problems, and I was more interested in how the technical problems afforded this educational experience." At the time that Pearl came into the tech workforce, the contemporary start-up industry was just beginning and tech companies were making a splash with perks such as free meals, slides, and laundry services. For Pearl, this type of environment was not appealing: "I wanted to be an adult, and I didn't want someone to wash my clothes for me and someone to feed me all my meals and someone to hold my hands through all of my life and so I could just go nonstop and then otherwise play video games." These environments are also a barrier to entry for older women, like Naomi, who have children and need to maintain work-life balance. As she points out, "brogrammer culture is a real thing" in start ups and they "expect you to spend a lot of time there [at work]" which would not be a possibility for her.

In summary, the participants react negatively to different parts of the brogrammer stereotype. For example, Pearl does not want to be

treated like a child. Heidi is turned off by happy hours and beer pong. Jackie and Amy felt intimidated because there were no women engineers who looked like them. Diana objects to the machismo undertones that normalize sexual harassment as something that does not impact an engineer's character. Some of the women want to use CS for good (e.g., Pearl, Amy). Others are fine sticking with the technical aspects of their jobs and solving fun problems (e.g., Naomi, Diana). A few of the women fit the male stereotype more closely than others (e.g,. Carol, Molly), especially the younger women who had access to computers and were encouraged from a young age to pursue STEM careers (e.g., Georgia, Heidi, Fiona, Amy). But even they are positioned as outsiders, regardless of their personal ideologies of gender.

### 4.4 Gender or expertise?

For women, proving that they belong often means needing a credential to prove that they can do technical work, emphasizing that the industry is still biased against a "bricoleur" [28] approach to entering the industry which could be more welcoming to women. Carol states plainly:

> "Credentialing is a lot – is more important for people who aren't – the Mark Zuckerbergs for the world, let's put it that way. Those people definitely can make it, but, again, I think it's rarer than people like to admit. [...] I know more than a few women who went back and got a master's degree in CS, merely for the credential."

Yet sometimes credentialing is not enough to make the participants feel included in the expert circles. The stereotype of a person passionate about computing implies that one has been programming and hacking for years before college. For several of the women in the study, coming "late" to CS or not majoring in CS is perceived as more of a barrier than gender because it is harder to be part of the CS crowd without knowing the jargon, habits, etc. even when they have been involved with STEM fields before finding computing (e.g. Georgia, Amy, Heidi, Carol). These discussions in their narratives place the focus on the "typical" pathway that they associate with men - early interest and experience with computing - that they set themselves apart from regardless of their actual paths to computing. "I mean, the thing that I think may be a little atypical about my experience is that I really wasn't a computer person at all until I came to school – until I came to college, and even then I started kind of late" Georgia mused. Jackie started CS "late" in sophomore year, and Amy and Heidi did not actually major in CS. By that definition, however, Naomi started the latest by going back to school for a masters in CS before looking for jobs in the tech industry, but does not see that as much of a barrier to her career development as being a mother. And again, the expectations of the women for when, where, and how they will encounter gender dynamics in their lives influences how they interpret experiences. Heidi, for example, says that she does not always know what "to attribute to gender as opposed to like actual just age and experience. I think if you come back to me and ask me in 5 years from now, I'll be a little more confident in saying 'See? They treat me differently because of gender'", and then goes on to describe that when her ideas get revoiced by men, they are taken up by the team.

Sometimes the experience is gender marked, such as Briana's first high tech internship program that was designed to recruit cohorts of new software engineers from underrepresented backgrounds. But sometimes circumstances can be more ambiguous: Heidi and Diana had difficult job searches after college without CS degrees, even though they had relevant experience and high interest. Given the stereotype of the self-taught genius hacker, or the fraternity networks of a brogrammer, one wonders if not having a degree but showing interest and experience with computing would have held a male candidate back.

## 5 REACTIONS TO BEING GENDERED

The participants reacted in three distinct ways to being gendered in their computing experiences. First, some spoke clearly to gender through their own experiences dealing with the effects of brogrammer culture and stereotypes (e.g. Jackie, Carol, Diana, Emily, Molly). "I don't know any woman who hasn't had something uncomfortable happen to her because she's female" claims Diana. Second, Briana stands out as speaking clearly to gender without prompting, even though she herself has not personally experienced discrimination based on her gender. She wants to prove that she is a good engineer beyond just being a woman and found validation in, "Getting into this smaller company, like a startup, and getting an engineering role kind of allows me to prove otherwise. Like prove that it's not because I'm a female." Thirdly, the rest of the participants do not speak specifically to gender until probed, and they have one of three reactions:

- Agree that it's a problem that women are underrepresented in tech (e.g. Amy, Pearl, Naomi, Georgia). For example, Naomi reflects that, "Here at [workplace] it's fine, but I do feel that it's much harder for me as a woman to try and work in a lot of other places."
- Express frustration with the focus on gender. In particular, Heidi and Fiona object to the way that gender is used to try to convince more girls to join. Heidi characterizes the discourse as, "almost harmful in and of itself just because of the boxes you have to check to be counted in that" and gets frustrated, "Sometimes it's like the talk will be like, 'You should be a computer science major because there aren't any women in computer science.' It's like, 'You should come to my party because there's no one else coming.'" Fiona calls out modifying toys to attract girls. "I loved Legos as a kid and I didn't care what colors they were, but I loved playing with dolls as a kid, and it didn't change who I became."
- Expressing ambivalence about the situation is Laura. When attending her company's women in engineering meet-ups, she wonders, " 'what are we trying to achieve here?' I don't feel like there's been any sort of discrimination against me [...] I don't feel like I've been treated differently than anyone else."

## 6 IMPLICATIONS FOR EQUITY, DIVERSITY, AND INCLUSION IN COMPUTER SCIENCE

The analysis above shows how gender works across the life of a woman in tech and is evoked most strongly in workplace interactions with male co-workers. CS educators, hiring managers, and

recruiters all need to be aware that the effects of gender go beyond just hiring women. The environment, incentives for participation, and the goal of diversity all need to be better aligned in order to foster a workforce that is actually equitable. However, these efforts also rely on the perceptions of the women who these efforts are designed to help, and so future research and design must also consider how women's personal reactions to being gendered shape the way they act. This finding aligns with Cech and Blair-Loy's [4] finding that if women believe in meritocracy, they are less likely to remove structural obstacles for other women. For example, Emily fits the description of someone who has shattered glass ceilings and ascended to the ranks of leadership, but it's unclear what she's doing to help other women from the way in which she brushes off gender as a factor in her narrative. Jackie, however, is actively engaging her workplace in conversations about gender and looking to create a supportive environment.

Research on the design of learning environments has shown that making modifications to learning environments to make them more friendly to women do not negatively impact men [10]. Cheryan and colleagues [6] advocate for a shift as well, recommending that "Efforts to increase women's participation in computer science, engineering, and physics may benefit from changing masculine cultures and providing students with early experiences that signal equally to both girls and boys that they belong and can succeed in these fields." This suggests that "feminizing" adjustments might just be better for all. The idea of "feminizing" computing is hotly debated as stereotypes command people's visions of what that might look like. Betz and Sekaquaptewa [2] conducted two social psychology studies investigating if showing "feminine" STEM role models is motivating to middle school girls who are not already interested in STEM. The feminine characteristics of these role models were that they were wearing pink, had their nails painted, and wore make-up. Results from the experiments showed that the girls were more dissuaded from STEM because it would be too hard for them to be like one of the women depicted who challenged the male scientist stereotype. Studies such as this, however, take a narrow view on what feminizing the workplace would mean. It does not necessarily mean wearing pink and getting manicures, though all employees should feel comfortable doing that should they wish. It refers more to workplace structures, such as recognizing achievements, ensuring that all voices in the room get a chance to be heard, and incorporating social-impact as a built in goal [13].

However, given the structural mechanisms that have played a critical role in women's exclusion from computing, the educational implications of this history are more challenging than current efforts imply. As Hicks [16] cautions readers:

> "Despite the rhetoric of meritocracy, patterns like these will not be undone by the individual career choices of workers, especially if they belong to groups that lack the power to participate in the structures of dominance and control that created institutionalized discrimination in a given organization or industry in the first place." (p. 238)

It is not enough for educators to support the development of women's interest in computing. There is also a need to address entrenched social values and stereotypes at a systems change level. This will require rethinking how technical expertise is assessed (e.g. challenging the effectiveness of white board technical interviews) and expressed, and bridging the gap between entry level and leadership positions.

## 7 AREAS FOR FUTURE RESEARCH

The thirteen women who shared their life histories in these interviews together give a complex view of gender in the tech industry, calling attention to brogrammer culture through their own experiences and descriptions of the types of environments they have encountered through college and their professional lives. While not all of the women identified themselves as having been impacted because of their gender, having personal experience is not necessary to find elements of the gendered history of computing in their narratives. In fact, their responses to being gendered because of their participation in the tech industry reflect various perspectives on the debate of the importance of gender in tech and how women should navigate the space. Nevertheless, there is more to consider in future research on gender in computing including race, broadening the scope to include all genders, anchoring the interviews with contemporary issues facing minorities in the tech industry, and accounting for more entry points to computing (e.g., coding bootcamps).

An aspect of the women's identities that went largely unexplored in this study was brought up by Pearl - race. The intersection of race and gender will be important to take into account for the next round of this study because it allows us to examine multiple overlapping histories. For example, race stands out as just as salient to Pearl's identity as her gender as she recounts how in a Chicago education start-up she was the only Black person at the company. To make things harder for people of color, tech is not only a male space, it is specifically a white male space that carries privilege and power. While interventions exist that aim to address systemic inequalities and encourage more people of color (e.g., Streetcode), and in particular women of color (e.g., Black Girls Code), to learn to code and join the tech workforce, academic research has yet to critically understand what people who enter tech through these avenues encounter when they get to college and the workplace.

Related to the intersection of race and gender, the context of the study does not account for women from countries where the gender gap is not so great in computing who were trained and worked in those contexts before coming to the U.S. (except Emily, who by happenstance was from South Asia.) They may have interesting thoughts on the structure of computing in the U.S. since they have known another system. Language differences may also come into play.

Due to the scope and original purpose of the interview study from which these transcripts come, gender is only presented from one perspective - cisgender women. To gain a more complex understanding of how gender operates in tech work environments, we need to include the voices of men and gender non-conforming folks. It would be productive to break the gender binary to interview gender non-conforming computer professionals who may be more attuned to the assumptions and expectations held for them based on how others perceive their gender.

# REFERENCES


[1] Lecia J Barker and Kathy Garvin-Doxas. 2004. Making visible the behaviors that influence learning environment: A qualitative exploration of computer science classrooms. *Computer Science Education* 14, 2 (2004), 119–145.

[2] Diana E Betz and Denise Sekaquaptewa. 2012. My fair physicist? Feminine math and science role models demotivate young girls. *Social psychological and personality science* 3, 6 (2012), 738–746.

[3] Tracy Camp. 2002. The incredible shrinking pipeline. *ACM SIGCSE Bulletin* 34, 2 (2002), 129–134.

[4] Erin A Cech and Mary Blair-Loy. 2010. Perceiving glass ceilings? Meritocratic versus structural explanations of gender inequality among women in science and technology. *Social Problems* 57, 3 (2010), 371–397.

[5] Chen Chen, Stuart Jeckel, Gerhard Sonnert, and Philip M Sadler. 2019. " Cowboy" and" Cowgirl" Programming and Success in College Computer Science. *International Journal of Computer Science Education in Schools* 2, 4 (2019), n4.

[6] Sapna Cheryan, Sianna A Ziegler, Amanda K Montoya, and Lily Jiang. 2017. Why are some STEM fields more gender balanced than others? *Psychological bulletin* 143, 1 (2017), 1.

[7] Jacob Clark Blickenstaff*. 2005. Women and science careers: leaky pipeline or gender filter? *Gender and education* 17, 4 (2005), 369–386.

[8] Christina Convertino. 2020. Nuancing the discourse of underrepresentation: a feminist post-structural analysis of gender inequality in computer science education in the US. *Gender and Education* 32, 5 (2020), 594–607.

[9] Christianne Corbett and Catherine Hill. 2015. *Solving the Equation: The Variables for Women's Success in Engineering and Computing*. ERIC.

[10] Toni Nicole Dancu. 2010. Designing exhibits for gender equity. (2010).

[11] Jessica T DeCuir-Gunby, Patricia L Marshall, and Allison W McCulloch. 2011. Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field methods* 23, 2 (2011), 136–155.

[12] Nathan L Ensmenger. 2012. *The computer boys take over: Computers, programmers, and the politics of technical expertise*. Mit Press.

[13] Nadya A Fouad, Wen-Hsin Chang, Min Wan, and Romila Singh. 2017. Women's reasons for leaving the engineering field. *Frontiers in psychology* 8 (2017), 875.

[14] James Paul Gee. 2014. *An introduction to discourse analysis: Theory and method*. Routledge.

[15] Wendy DuBow J.J. Gonzalez. 2019. *NCWIT Scorecard: The status of women in computing*. Technical Report. National Center for Women Information Technology, Boulder, CO.

[16] Marie Hicks. 2017. *Programmed inequality: How Britain discarded women technologists and lost its edge in computing*. MIT Press.

[17] June Park John and Martin Carnoy. 2019. The case of computer science education, employment, gender, and race/ethnicity in Silicon Valley, 1980–2015. *Journal of Education and Work* 32, 5 (2019), 421–435.

[18] Deepak Kumar. 2014. Disrupting the cultural capital of brogrammers. *ACM Inroads* 5, 3 (2014), 28–29.

[19] Steven Levy. 1984. *Hackers: Heroes of the computer revolution*. Vol. 14. Anchor Press/Doubleday Garden City, NY.

[20] Jane Margolis and Allan Fisher. 2002. *Unlocking the clubhouse: Women in computing*. MIT press.

[21] Allison Master, Sapna Cheryan, and Andrew N Meltzoff. 2016. Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. *Journal of educational psychology* 108, 3 (2016), 424.

[22] Ray McDermott and Vicki Webber. 2013. When is math or science? In *Thinking practices in mathematics and science learning*. Routledge, 331–350.

[23] Katarina Pantic. 2020. Retention of Women in Computer Science: Why Women Persist in Their Computer Science Majors. (2020).

[24] K Ann Renninger and Suzanne Hidi. 2015. *The power of interest for motivation and engagement*. Routledge.

[25] Londa Schiebinger and Martina Schraudner. 2011. Interdisciplinary approaches to achieving gendered innovations in science, medicine, and engineering1. *Interdisciplinary Science Reviews* 36, 2 (2011), 154–167.

[26] Claude M Steele. 1997. A threat in the air: How stereotypes shape intellectual identity and performance. *American psychologist* 52, 6 (1997), 613.

[27] Steve Henn 2014. When women stopped coding. Planet Money, NPR.

[28] Sherry Turkle and Seymour Papert. 1990. Epistemological pluralism: Styles and voices within the computer culture. *Signs: Journal of women in culture and society* 16, 1 (1990), 128–157.

[29] Fred Turner. 2010. *From counterculture to cyberculture: Stewart Brand, the Whole Earth Network, and the rise of digital utopianism*. University of Chicago Press.

[30] Timothy J Weston, Wendy M Dubow, and Alexis Kaminsky. 2019. Predicting women's persistence in computer science-and technology-related majors from high school to college. *ACM Transactions on Computing Education (TOCE)* 20, 1 (2019), 1–16.

[31] Alison T Wynn and Shelley J Correll. 2018. Puncturing the pipeline: Do technology companies alienate women in recruiting sessions? *Social studies of science* 48, 1 (2018), 149–164.