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Climate Control: Gender and Racial Bias in Engineering?

Su Li

Roberta Rincon

Joan C. Williams

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Dr. Su Li, U. C. Hastings, College of the Law

Su Li is the Director of Research on Organization Bias at the Center for WorkLife Law. Su is a quantitative sociologist with a background in using quantitative research methods in empirical legal studies research. Her research interests include quantitative methods, the legal profession, law and society, and gender and social inequality. She has published collaboratively in law review journals (such as Stanford Law Review, California Law Review, and Arizona Law Review) and peer review journals (such as Law and Social Inquiry, Sociology of Education, and Gender and Society) on topics including the legal profession, intellectual property, and constitutional law.

Dr. Roberta Rincon, Society of Women Engineers

Dr. Rincon joined the Society of Women Engineers in February 2016 as the Manager of Research, where she oversees the organization's research activities around female engineers from elementary through college and into the workforce. With over 15 years of experience in higher education administration, including as a Senior Research and Policy Analyst for The University of Texas System, her focus has been on understanding the factors that impact student success and influencing the policies that support students from high school through college completion. Her responsibilities have included managing various award and faculty recruitment programs, analyzing the impact of state legislative actions, coordinating efforts to increase resilience among college students, and preparing white papers on topics ranging from classroom utilization to student success. Dr. Rincon received her B.S. in Civil Engineering from The University of Texas at Austin, an MBA and an M.S. in Information Management from Arizona State University, and a Ph.D. in Educational Policy and Planning from The University of Texas at Austin.

Prof. joan Chalmers Williams, University of California, Hastings College of the Law

Joan C. Williams is Distinguished Professor of Law, Hastings Foundation Chair, and Founding Director of the Center for WorkLife Law at the University of California, Hastings College of the Law. She has written extensively on gender bias and women in STEM, with work published in sociology, psychology and law journals.

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Abstract

The concept of implicit bias is typically studied by behavioral and cognitive psychologists who seek to gain information on brain patterns versus how those patterns show up in the workplace. Thirty years of social science research have documented that although explicit bias against women and other under-represented groups is far less common today, subtle (or implicit) bias remains rampant. There have not been many studies systematically measuring implicit bias in daily interactions (categorized in this paper into four types of bias: Prove-It-Again, Tightrope, Tug of War, and Maternal Wall) and at different stages for workplace process (eg. Hiring, performance evaluations, etc.)

In this research, we reached out to thousands of engineers in the U.S. with a Workplace Experiences Survey focusing on implicit bias. The survey includes 38 Likert scale questions asking respondents to rate their agreement level of statements describing experience with implicit bias in the workplace. Over 3000 respondents with at least of two years of work experience completed the survey. Nearly one-third of them left comments describing related experience at their workplace. We also interviewed a number of senior female engineers who shared their experiences with implicit bias during their career. We conducted statistical analysis (ANOVA, regression analysis) and text analysis of the quantitative and qualitative data. Findings from both data sources showed that women and people of color experienced more implicit bias at work than white men.

Regression analyses showed that, after controlling for age, education, workplace seniority, and academic status, women still reported more Prove-It-Again, Tightrope, and Maternal Wall bias, and Asian and African-American engineers reported more Prove-It-Again and Tightrope bias, than their white male counterparts. Regression analysis showed that, after controlling for the above-mentioned variables, women reported experiencing higher levels of bias in hiring, networking/sponsorship, and promotion than their male counterparts. Regression analysis showed that, after controlling for above-mentioned variables, African-American engineers reported higher levels of bias in networking, promotion, and mentoring/sponsorship than their white counterparts. Asian-American engineers reported more bias in performance evaluations than their white counterparts.

Introduction

The concept of implicit bias[1] is typically studied by behavioral and cognitive psychologists who seek to gain information on brain patterns versus how those patterns show up in the workplace. Thirty years of social science research have documented that although explicit bias against women and other under-represented groups is far less common today, subtle (or implicit) bias remains rampant. Such studies typically ask subjects to rate identical resumes with a man's or woman's name or names associated with different racial groups. These studies have documented the same patterns of racial and gender bias over and over again.

Women and people of color are rated unfavorably by potential employers even if they have identical resumes with their male or white counterparts. For instance, Moss-Racusin et al. (2012) asked professors in STEM (Science, Technology, Engineering and Mathematics) to rate the resumes for a job as a lab manager and found that both male and female STEM professors rated male applicants more competent and hirable than their female counterparts. Similarly, Reuben et al. (2014) found that both males and females were twice likely to hire a man as a woman for a job that required math. In 2004, Bertrand & Mullainathan found that resumes of candidates with African-American-sounding names needed eight additional years of experience to get the same number of job callbacks as did white candidates with identical resumes—the higher the quality of the resume, the higher the racial gap. In a newly released Canadian study (2016), researchers found that resumes with Asian-sounding names received a lower rate of calling back for interviews even after counting for the educational credentials the candidates have. It also found that small and medium sized organizations were more likely to discriminate against Asians than larger ones.

Implicit bias against women and people of color were also found after successfully landing a job, in performance evaluations, promotions and the daily interactions in the workplace. For instance, earlier studies found that African-Americans were held to stricter standards of competence than whites (Biernat & Kobrynowicz, 1997) and that the black managers' achievements were less likely to be attributed to skill and more likely to be attributed to outside help (Greenhaus & Parasuraman, 1993).

While the social psychology studies provide objective measures of bias, most take place in social psychology labs with college students, leaving open the question of whether the bias they document occurs in actual workplaces. Professor Joan C. Williams in her 2014 Harvard Business Review article entitled "Hacking Tech's Diversity Problem" and her book with Rachel Dempsey "What Works for Women at Work" summarized the implicit bias women and people of color

[1] Please see here for the definition of implicit bias: https://plato.stanford.edu/entries/implicit-bias/

encountered in daily interactions at workplace. She created a four-type categorization system describing workplace implicit bias: the Prove-It-Again bias, Tightrope bias, Maternal Wall bias and Tug of War bias.

In this research, we focused on the engineering field and asked engineers what they have personally experienced in their careers. We compared the answers of women, men, white engineers and engineers of color. This research is one of the first efforts systematically measuring implicit bias in daily interactions in engineering. The self-reported experience by engineers tells us there is still a long way to go before achieving gender and racial equality among engineers.

Theoretical Framework and Literature Review

According to Joan C. Williams, there are four basic patterns of implicit bias against women and people of color. The first two (the Prove-It-Again bias and the Tightrope bias) are patterns of both racial and gender bias. The last two (the Maternal Wall bias and the Tug of War bias) concern gender. Other disadvantaged groups such as people with disability and the LGBT group, suffer from similar Prove-It-Again bias as women and people of color. People with elder care responsibilities may experience similar bias as people with childcare responsibilities (the Maternal Wall bias).

Prove-It-Again: stereotypes and in-group favoritism

Nearly 40 years of studies have documented that women and people of color often need to be more competent than white men in order to be seen as equally competent (Knobloch-Westerwick, Glynn, & Huge, 2013; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; Heilman, 2012; Heilman & Chen, 2005; Roth, Purvis, & Bobko, 2012; Biernat, Fuegen & Kobrynowicz, 2010; Bowles & Gelfand, 2010; Fiske, Cuddy, Glick, & Xu, 2002; Bauer & Baltes, 2002; Davison & Burke, 2000; Foschi, 2000; Biernat & Kobrynowicz, 1997; Foschi, 1996; Steele & Aronson, 1995; Heilman, Block, & Martell, 1995; Landau, 1995; Scherer, Owen, & Brodzinski, 1991; Heilman, 1983, 1984; Berger, Fisek, Norman, & Zelditch, 1977).

Imagine a brilliant engineer. What jumps into most people's heads is a man (Glick, 1995). Women and people of color do not seem as good a fit (Fiske & Taylor, 2013; Heilman, 1983, 1984, 2012; Steele & Aronson, 1995), which is why they often need to provide more evidence of competence than men in order to be seen as equally competent. Women and people of color literally have to prove it again and again. Stereotypes of the elderly as warm but less competent can also trigger Prove-It-Again bias (Cuddy, Norton, & Fiske, 2005). It is unclear how stereotypes of the elderly play out in workplaces.

Many studies have shown that both women and people of color often are held to higher standards. Double standards have been documented for decades through blind resume studies and other types of studies that provide an objective measure of their existence (Knobloch-Westerwick, Glynn, & Huge, 2013; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; Roth, Purvis, & Bobko, 2012; Davison & Burke, 2000; Biernat & Kobrynowicz, 1997; Foschi, 1996, 2000). Studies have shown that women post-docs needed to be twice as productive to receive the same competency rating as men (DesRoches & Zinner et al.., 2010) and that a female scientist needed 64 more impact points than an identical male scientist to be seen as equally competent—which translates into three extra papers in *Nature* or *Science* or 20 in less prestigious journals (Wenneras & Wold, 1997).

A second mechanism that fuels Prove-It-Again bias is in-group favoritism: in-groups, but not out-groups, tend to get the benefit of the doubt (Brewer, 1999; Brewer & Gardner, 1996; Hewstone, 1990). The Prove-It-Again phenomenon also reflects stereotype expectancy (Hamilton & Rose, 1980), aka confirmation bias (Mahoney, 1977): we see what we expect to see. Because low-competence stereotypes set expectations low, more evidence will be required of out-groups, as compared with in-groups, to persuade observers to change their assumptions of lower competence. This is the first comprehensive survey, to our knowledge, to document what social psychology has observed in labs for decades: that women and people of color experience a double standard in the workplace.

Prove-It-Again bias is triggered not only by gender and race, but also by disability (Ameri, Schur, Adya, Bentley, McKay, & Kruse, 2015) and LGBTQ status (Tilcsik, 2011).

Tightrope: pressure to behave in feminine ways and backlash when women behave in masculine ways.

Over 40 years of studies have documented that a narrower range of behavior often is accepted from women than from men (Haselhuhn & Kray, 2012; Rudman, Moss-Racusin, Phelan, & Nauts, 2012; Bowles, Babcock, & McGinn, 2005; Heilman & Chen, 2005; Brescoll & Uhlmann, 2008; Rudman & Fairchild, 2004; Prentice & Carranza, 2002; Glick & Fiske, 2001; Rudman & Glick, 2001; Heilman, Wallen, Fuchs, & Tamkins, 1995; Heilman & Taylor, 1981). As a result, women often walk a tightrope between being seen as "too masculine," and thus respected but not liked, or "too feminine," and thus liked but not respected. Tightrope bias has been less studied in the racial than the gender context, but a few studies suggest that a narrower range of behavior is accepted from African-Americans (Livingston & Pearce, 2009) and Asian-Americans (Cuddy, Fiske, & Glick, 2008; Fiske, Xu, Cuddy, & Glick, 1999) than from white men.

The Tightrope consists of two sets of pressures that are analytically distinct: pressure to behave in feminine ways and backlash when women behave in masculine ways. The end result is that a broader range of behavior often is accepted from men than from women.

Pressure to behave in feminine ways, to be helpful rather than ambitious, nice rather than direct, can leave women in dead-end roles (Williams & Dempsey, 2014; Allen, 2006; Heilman & Chen, 2005; Kanter, 1977). The backlash against women who behave in masculine ways, combined with a workplace that rewards those behaviors, can create much trickier office politics for women than for men. Thus, behaviors that are seen as admirably assertive in a man may be seen as inappropriately abrasive or aggressive in a woman (Cuddy, Fiske, & Glick, 2008; Fiske, Cuddy, & Glick, 2007; Glick & Fiske, 2001; Rudman & Glick, 1999, 2001). Men tend to interrupt to show they are competitive and ambitious—men to be reckoned with—whereas a woman who interrupts may be seen as rude or a prima donna because she is violating expectations that she should be modest and nice (Ridgeway & Smith-Lovin, 1999; Smith-Lovin & Brody, 1989; Mulac, Wiemann, Widenmann, & Gibson, 1988; Wagner, Ford, & Ford, 1986; Lockneed, 1985; Pugh & Wahrman, 1983; Zimmerman & West, 1975). Several studies show that expressing anger tends to increase the perceived status of a man but decrease that of a woman (Judge, Livingston, & Hurst, 2012; Brescoll & Uhlmann, 2008; Brescoll & Uhlmann, 2005; Rudman & Fairchild, 2004). Self-promotion, too, may be accepted in men but seen as inappropriate in women (Phelan, Moss-Racusin, & Rudman, 2008; Rudman, 1998; Rudman & Glick, 1999, 2001; Heatherington et al.., 1993; Daubman, Heatherington, & Ahn, 1992; Gould & Slone, 1982).

Existing studies on prescriptive bias focus almost exclusively on gender. Two studies focus on African-Americans: one of African-American men (Livingston & Pearce, 2009) and one of African-American women (Rosette & Livingston, 2012). In addition, the leadership literature shows the Asian-American stereotype that Asians are good at technical tasks but lack leadership ability (Sy & Shore et al.., 2010; Cuddy, Fiske, & Glick, 2008; Fiske, Xu, Cuddy, & Glick, 1999).

Maternal Wall: motherhood penalty and flexibility stigma

Over 20 years of studies have documented that motherhood triggers strong negative competence and commitment assumptions (Heilman & Okimoto, 2008; Crosby, Williams, & Biernat, 2004; Correll, Benard, & Paik, 2007; Hebl & King et al.., 2007; Cuddy, Fiske, & Glick, 2004; Fuegen, Biernat, Haines, & Deaux, 2004; Halpert, Wilson, & Hickman, 1993). In addition, mothers who are indisputably competent and committed tend to be considered less warm, less likeable, and more interpersonally hostile (Correll & Benard, 2010).

Another aspect of Maternal Wall bias is the "flexibility stigma." For women, taking family leave or requesting a reduced schedule can trigger Maternal Wall bias (Crosby, Williams, & Biernat, 2004; Epstein, 1983; Stone & Hernandez, 2013.) For men, doing the same thing may lead to career detriments because it signals that men are not living up to the idealized male breadwinner role (Rudman & Mescher, 2013; Vandello, Hettinger, Bosson, & Siddiqi, 2013). One study found career detriments for men who disclosed that they had caregiving responsibilities (Berdahl & Moon, 2013).

Tug of War: strategic distancing and fighting for women slots

Sometimes gender bias against women fuels conflicts among women. Research also documents "strategic distancing"—women may distance themselves from other women because they sense that being seen as a woman is a disadvantage (Van Laar, Bleeker, Ellemers, & Meijer, 2014; Derks, Van Laar, Ellemers, & de Groot, 2011; Ellemers & Van den Heuvel et al.., 2004). Women also may be divided by differing strategies for assimilating into masculine work cultures (Duguid, Lloyd, & Tolbert, 2012; Duguid, 2011; Ely, 1994; Kanter, 1977). In addition, women may be motivated to penalize other women to protect their own self-identities (Parks-Stamm, Heilman, & Hearns, 2012).

Sometimes, however, gender bias against women fuels conflict among women. If women perceive that there is just one, or a few, women's slots for prized positions, then naturally they end up competing for that position. Research documents that women who have experienced discrimination in heavily male environments early in their careers often distance themselves from other women (Derks, Van Laar, Ellemers, & de Groot, 2011).Women also may find themselves divided against each other by their different strategies with respect to assimilating into the male-dominated environment. Some women respond by assimilating as much as possible into the boys' club (Duguid, 2011; Duguid, Loyd, & Tolbert, 2012). Tugs of War result when women fault each other for assimilating too much or too little.

Data and Methods

Between February and May 2016, Professor Joan Williams at the Center for WorkLife Law (CWLL), UC Hastings College of the Law, conducted the Workplace Experiences Survey on behalf of the Society of Women Engineers (SWE). SWE reached out to its membership and the membership of five other organizations for survey respondents. A total of 3,093 professionals in science, technology, and engineering completed the survey online. Respondents included women and men, aged 18 to 65 and up, with at least two years of experience as an engineer, from multiple sectors (academia, corporate, government, military, and nonprofit). The survey data was weighted to be representative of the gender and race distribution of engineers in the U.S. using

the 2015 Current Population Survey[2] (see Appendix A for details about the weights of the data). The weighted data was used in regression analyses but not bivariate and univariate analyses (see explanation of both terms below). Appendix B lists the demographic distribution of the survey respondents (unweighted data). Please note that in the charts, percentages may not always add up to 100 because of computer rounding or the acceptance of multiple response answers from respondents.

Apart from questions about the respondents' demographic information and their industries and positions, the main part of the Workplace Experiences Survey consists of 39 Likert scale questions asking respondents to choose an answer on a scale from one to six, from strongly disagree to strongly agree,[3] for each of the 39 statements. (One item was excluded from the analysis. See Appendix C for details.) We conducted univariate, bivariate, and multivariate analyses on the survey data.

For the univariate analysis, we dichotomized the Likert scale variables (e.g., combined strongly agree, agree, and somewhat agree into the "agree" category) and calculated the percentage of respondents who agreed with each statement.

For the bivariate analysis, we compared the percentages of respondents who agreed with each statement by gender and race, specifically between people of different gender and race. We conducted Chi-square tests and two sample t-tests on the comparisons and considered differences statistically significant when the p values were smaller than .05. Results ae presented in Tables 1-4.

For the multivariate analysis, we conducted regression analyses predicting variations of bias experienced while controlling for gender, race, age, education, workplace seniority, dependent children, and academic status (whether the respondent worked in an academic environment or not). Regression analysis results are presented in Table 5A and 5 B of the report. The outcome variables of the regression analysis are Prove-It-Again scale, Tightrope scale and questions measuring the Maternal Wall bias, the Tug of War bias, and various workplace processes bias. We created scale using factor analysis, which is described in details below.

Factor analysis

[2] http://www.bls.gov/cps/cpsaat11.htm

[3] This is the six-point scale: strongly disagree, disagree, somewhat disagree, somewhat agree, agree, and strongly agree

We designed the survey to tease out possible biases that exist in workplaces, based on the vast amount of social science research conducted in the past 30 years. On the basis of previous literature, we classified the survey items into the four major categories (Prove-It-Again, Tightrope, Tug of War, and Maternal Wall). The breadth of the survey instruments made it difficult to create scales for each category, as the items are not heavily overlapped, especially for the Tug of War and Maternal Wall questions.

We conducted both exploratory (using a randomly selected 50% of the sample) and confirmatory (using the other 50% of the sample) factor analysis on all items of the four major categories. We created scales (by averaging the items) for the Prove-It-Again and Tightrope bias. The scales did not include items with eigenvalues less than .5 in the confirmatory factor analysis. If an item had similar eigenvalue (say, around .4) in two factors, we placed the item in the category that fits our literature review and classifications. We also calculated Cronbach's alpha for the items used for creating scales and reported them.

The Tug of War and Maternal Wall items did not load well together in the factor analysis. So we chose to use two Tug of War items and run regression models separately on each item. We did the same for the Maternal Wall questions.

For the workplace processes questions, we calculated Cronbach's alpha to decide if we could create scales. There are two questions for each of the following processes: performance evaluations, mentoring/sponsorship, and compensation. We created scales for the latter two processes (alpha bigger than .7 for both processes) and chose to use one question, "My performance evaluations have been fair," for the performance evaluations process.

Table 5A and 5B list the questions that we used to create scales or that we used as dependent variables in the regression analyses for both the four types of bias and the workplace processes.

Findings

Four types of bias

Table 1A showed that white women reported more Prove-It-Again bias than women of color. For instance, 51% white women vs. 61% women of color agreed that they felt they were held to higher standards than their colleagues. 68% of black women agreed with this statement. The differences between white and non-white women, between white and African-American women are statistically significant on this question.

Asian-American women (65%) and Latina (64%) reported lower level of agreement to "My suggestions or ideas are respected as much as my colleagues" than white women (73%). The differences are statistically significant.

59% white women, 78% black women, and 70% Asian-American women reported that they agreed with the statement "I have to repeatedly prove myself to get the same level of respect and recognition as my colleagues." The differences between white women and other groups are statistically significant.

Latina women reported they were much more likely to be mistaken for administrative or custodial staff than white women (55% vs. 44%) and women of other racial groups. The differences are statistically significant.

African-American women were more likely than white women and women of other groups to agree with two statements "In meetings, other people get credit for ideas I originally offered." And "After moving from an engineering role to a project management/business role, people assume I do not have technical skills." The differences are statistically significant.

Table 1B reported the percentage agreement of men in different racial groups on the Prove-It-Again questions. As mentioned above, the majority of the sample is female (please see appendix C for gender and race breakdown of the sample.) Only 45 engineers took the survey self-identified as men of color. Due to the very small number of male engineers in the sample, we did not further breakdown non-white male engineers into more detailed racial groups. Men of color reported higher percentage of agreement than white men (55% vs. 40%) on the question "I feel I am held to higher standard than my colleagues." Men of color also reported higher percentage of agreement than white men (21% vs. 9%) on the question "I have been mistaken for administrative or custodial staff."

Table 2A and 2B presented the gender and racial differences on answers to the Tightrope questions. Women of color expressed higher level of Tightrope bias than white women. Women of color, compared to white women, reported higher percentage of agreement on statements saying that they were expected to be a 'worker bee' and they felt pressure to let others take the lead. They also reported lower percentage of agreement on statements such as people saw them as leaders, they felt free to express anger and they had the same access to desirable assignments and high profile tasks as their colleagues.

Table 2B showed that men of color reported higher level of Tightrope bias than white men. The gap between men of color and white men is larger than the gap between women of color and white women. For instance, men of color led white men by 13.2 percentage points on agreeing with the statement that "I feel free to express anger at work." The difference between women of color and white women on this question is 7 percentage points.

The Tug of war questions and the Maternal Wall questions were asked to capture gender differences mainly so we did not present the differences of percentage agreement by racial group. Table 3 showed the percentage agreement on the Maternal Wall questions by gender. Table 4 showed the percentage agreement on the Tug of War questions by gender. Table 3 and Table 4 showed that women suffered more Tug of War and Maternal Wall bias than men regardless of their racial background.

Regression analysis: Models 1 and 2 in Table 1A[4] show that women, African Americans and Asian Americans reported higher level of Prove-It-Again bias compared to their male or white counterparts while controlling for other demographic variables such as, age, education, seniority as engineers, and if working in the academia. Interestingly the difference on reporting Prove-It-Again and Tightrope bias is not statistically significant between Latino/Latina and their white counterparts. We suspect one of the explanations to this could be that Latino/Latina may not be perceived as people of color especially if the person is biracial (e.g. one of their parents is Anglo-American.)

Models 3 and 4 predicted two different questions measuring the Tug of War bias: "I am regularly competing with my female colleagues for the woman's slot" and "Some women engineers just do not understand the level of commitment it takes to be a successful engineer." The first question was asked to female respondents only. Regression results show that African American women reported higher level of agreement with this statement compared to their white counterparts. People with doctoral level education found them subject to less bias of this type. In other words, with a doctorate degree, more opportunities instead of the "women slots" would be opened up to women engineers. In the academia, however, women are still struggling with competing for limited designated slots. The second question, "Some women engineers just do not understand the level of commitment it takes to be a successful engineer." is especially designed to capture the women to women bias in the workplace. We found that women reported a much stronger level of agreement with this statement compare to their male counterparts regardless of their race, education and work seniority. Older women reported even stronger agreement to this statement compared to younger women. The results echoed well with the literature that it was often women in senior positions giving a harder time to junior women.

Models 5 and 6 predicted two different questions measuring the Maternal Wall bias: "Having children did not change my colleagues' perceptions of my work commitment of competence." And "Asking for family leave or flexible work arrangements would not hurt my career." The first question was asked to people with children only. Model 5 showed that women reported a much

[4] The dependent variables of model 1 and 2 are scales calculated by averaging a few items measuring similar concepts. Please see the footnote under Table 1A for more details.

higher level of agreement with this statement while holding other variables constant[5]. Model 6 also provided clear evidence that women engineers reported more Maternal wall bias than their male counterparts, i.e. people at work were more likely to assume that women's work commitment and competence would reduce after having children.

Bias at different workplace processes

We also run regression analysis predicting self-reported bias experienced at different workplace processes, such as hiring, performance evaluation, sponsorship etc. Table 1B presented 6 regression models focusing on different aspect of workplace processes.

We found than women reported higher level of agreement than men on experiencing bias in hiring, workplace networking and promotion, while holding other covariates constant. African Americans reported higher level of agreement than their white counterparts on experiencing bias in networking, promotion, and mentor/sponsorship. Older engineers reported, at higher rate than younger engineers, experiencing bias in performance evaluations, promotion and mentor/sponsorship. 45-54 years old seems to be the beginning of the dividing line between older and younger engineers. Engineers beyond 45 reported experiencing more bias in performance evaluation and mentor/sponsorship than engineers below 35. Engineers beyond 55 years old reported, at a higher rate, experiencing bias in promotion compared to engineers younger than 35.

We did not find consistent results on the correlation between seniority and workplace processes bias, probably because we asked overall seniority as an engineer instead of the seniority with an organization.

Overall, our data did find that women, people of color, and older engineers experiencing bias at various aspects of workplace processes.

Conclusion

Results from the survey found that precisely the same kinds of gender and racial bias that have been documented over and over again exist in engineering workplaces. Survey evidence also showed that both women engineers and engineers of color feel they are disadvantaged in pay, promotions, performance evaluations, and mentoring; women also reported that they believe it is harder to get hired as a woman. These findings perfectly align with results from lab and field experiments and provide a more tangible picture for the experience of implicit bias. Identifying the problem should not be the end of the exploration. Instead, finding solutions and making

[5] Since the Maternal Wall bias is focused on gender based bias, we would not elaborate on the regression coefficients of the race variables. Model 5 does show Latino/Latina reported lower level agreement with the statement. We do not have enough data in this study to offer an explanation to this result.

improvements are what researchers and practitioners should focus on next. Various attempts have been made or are in the making. For instance, a group of graduate students and faculty at the Purdue University Engineering Education program published a report with proposed solutions to improve African-American women's presence in engineering (Fletcher et al 2016). The Center for WorkLife law at U. C. Hastings are working on establishing metric-based solutions and tool kits helping companies and organization to reduce implicit bias at workplace[6].

An important point for both engineers and companies is that the climate differs dramatically in different companies. Many comments from this survey reflected that women who find a hostile climate leave to join organizations that treat women better. Further exploration of the qualitative data will shed lights on finding creative solutions to solve the problem of implicit bias in different organizations.

[6] http://biasinterrupters.org/

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Table 1A: Percentage agreement with Prove-It-Again questions: comparisons between white women, African-American women, Asian-American women, and Latina women engineers

Question	White Women (WW)	Women of Color (WC)	WW-WC Diff	African-American Women (BW)	WW-BW Diff	Asian-American Women (AW)	WW-AW Diff	Latina (L)	WW-L Diff
"I feel I am held to higher standards than my colleagues."	51%	61%	9.6% ***	68%	16.4% ***	57%	5.90%	59%	7.6%
"My suggestions or ideas are respected as much as my colleagues'."	73%	66%	-7.4% ***	70%	-3.1%	65%	-8.2% **	64%	-9.1% **
"In meetings, other people get credit for ideas I originally offered."	47%	47%	-0.60%	57%	9.8%*	41%	-6.1%	45%	-2.5%
"After moving from an engineering role to a project management/ business role, people assume I do not have technical skills."	61%	64%	2.70%	74%	12.6%*	62%	0.4%	59%	-2.3%
"I have to repeatedly prove myself to get the same level of respect and recognition as my colleagues."	59%	71%	12.3% ***	78%	18.8% ***	70%	10.8% ***	68%	8.9% *
"I have been mistaken for administrative or custodial staff."	44%	48%	3.9%	50%	5.8%	41%	-2.9%	55%	10.7 %**

Chi-square tests and two sample t-tests conducted for comparison. *p<0.01; **p<0.01; ***p<0.001

Table 1B: Percentage agreement with Prove-It-Again questions: comparisons between white men, African-American men, Asian-American men, and Latino male engineers

Question	White Men (WM)	Men of Color (MC)	WM-MC Diff
"I feel I am held to higher standards than my colleagues."	40%	55%	14.5%*
"My suggestions or ideas are respected as much as my colleagues'."	86%	77%	-8.2%
"In meetings, other people get credit for ideas I originally offered."	32%	41%	8.5%
"After moving from an engineering role to a project management/business role, people assume I do not have technical skills."	37%	43%	6.2%
"I have to repeatedly prove myself to get the same level of respect and recognition as my colleagues."	35%	39%	3.2%
"I have been mistaken for administrative or custodial staff."	9%	21%	11.1%**

Two sample t-tests conducted for comparison. ł No observations in this cell. *p<0.01; **p<0.01; ***p<0.001

Table 2A: Percentage agreement with Tightrope questions: comparisons between white women, African-American women, Asian-American women, and Latina women engineers

Question	White Women (WW)	Women of Color (WC)	WW-WC Diff	African-American Women (BW)	WW-BW Diff	Asian-American Women (AW)	WW-AW Diff	Latina (L)	WW-L Diff
"Being vocal about my work and accomplishments is rewarded."	62%	64%	1.6%	66%	3.7%	68%	6.0%	59%	-3.3%
"I am expected to be a 'worker bee', which means I should work hard, avoid confrontation, and not complain."	48%	59%	11.3% ***	65%	16.9% ***	56%	8.3%**	59%	10.8% **
"People at work see me as a leader."	82%	79%	-2.8%	83%	1.0%	72%	-9.7% ***	85%	2.8%
"I feel free to express anger at work when it's justified."	51%	44%	-7% **	42%	-9.4%*	42%	-9.7% **	49%	-2.2%
"As compared to my colleagues in a comparable role with comparable seniority and experience, I am more likely assigned to high-profile tasks or work teams."	51%	47%	-4.6%*	46%	-4.9%	46%	-4.8%	47%	-4.0%
"I seldom receive pushback when I behave assertively."	52%	48%	-3.6%	48%	-3.5%	52%	0%	46%	-6%
"I feel pressure to let others take the lead."	31%	40%	9.5% ***	32%	1.0%	43%	12.2% ***	42%	11%**
"I have had the same access to desirable assignments as my colleagues."	68%	53%	-15.5% ***	43%	-25.3% ***	56%	-12.4% ***	57%	-11.1% **
"I am interrupted at meetings more than my colleagues."	46%	47%	1.3%	39%	-6.8%	46%	0%	54%	8.1%*

"As compared to my colleagues in a comparable role with comparable seniority and experience, I more often do office housework – finding a time everyone can meet, taking notes at a meeting, planning office parties, etc."	56%	55%	-1.0%	56%	0.9%	51%	-4.3%	57%	1.8%

Chi-square tests and two sample t-tests were conducted for comparison. *p<0.01; **p<0.01; ***p<0.001

Table 2B: Percentage agreement with Tightrope questions: comparisons between white men and non-white men

Question	White Men (WM)	Men of Color (MC)	WM-MC Diff
"Being vocal about my work and accomplishments is rewarded."	63.8%	55.8%	-7.9%
"People at work see me as a leader."	84.6%	90.7%	6.1%
"I feel free to express anger at work when it's justified."	58.7%	45.5%	-13.2%*
"As compared to my colleagues in a comparable role with comparable seniority and experience, I am more likely assigned to high-profile tasks or work teams."	61.3%	46.5%	-14.8%*
"I am expected to be a "worker bee", which means I should work hard, avoid confrontation, and not complain."	47.8%	41.9%	-5.9%
"I seldom receive pushback when I behave assertively."	67.1%	59.1%	-8%
"I feel pressure to let others take the lead."	15.5%	29.5%	14%**
"I have had the same access to desirable assignments as my colleagues."	84.9%	69.8%	-15.2%**
"I am interrupted at meetings more than my colleagues."	16.2%	22.7%	6.5%
"As compared to my colleagues in a comparable role with comparable seniority and experience, I more often do office housework – finding a time everyone can meet, taking notes at a meeting, planning office parties, etc."	25.8%	27.9%	2.1%

Chi-square tests and two sample t-tests conducted for comparison. *p<0.01; **p<0.01; ***p<0.001

Table 3: Percentage agreement with Maternal Wall questions: comparisons between white women, women of color, white men and men of color

Question	White Women (WW)	Women of Color (WC)	WW-WC Diff	White Men (WM)	Men of Color (MOC)	MOC-WM Diff	WW-WM Diff	WC-MOC Diff
"I have to spend more time working to compensate for the schedules of my colleagues who have children."	20%	23%	-3.1%	21%	13.6%	7.6%	-1%	9.4%
"My colleagues have communicated to me that I should work fewer hours because I have children."	3%	11%	-7.5% ***	3%	15.8%	13.3% ***	0%	-4.8%
"My colleagues have communicated to me that I should work more hours because I have children."	98%	91%	6.5% ***	99%	84.2%	-14.3% ***	-1%	6.8%
"I feel pressured to work long hours to show my commitment, even when the workload does not really justify the overtime."	41%	43%	-2.0%	37%	40.9%	4.1%	4%	2.1%
"Asking for family leave or flexible work arrangements would not hurt my career."	51%	48%	2.5%	63%	50%	-1.3%	-12% ***	-2.0%
"Having children did not change my colleagues' perceptions of my work commitment or competence."	55%	54%	0.6%	78%	85%	6..8%	-23% ***	-31.0%

Chi-square tests and two sample t-tests were conducted for comparison. *p<0.01; **p<0.01; ***p<0.001

Table 4: Percentage agreement with Tug of War questions: comparisons between white women, women of color, white men and men of color

Question	White Women (WW)	Women of Color (WC)	WW-WC Diff	White Men (WM)	Men of Color (MOC)	MOC- WM Diff	WW-WM Diff
"Some women engineers just do not understand the level of commitment it takes to be a successful engineer."	22%	28%	5.5%**	11%	5%	6.6%	11%***
"I find it difficult to get administrative personnel to do the kinds of support work for me that they do for other engineers."	18%	24%	6.3%***	13%	25%	-11.6%**	5%**
"I feel I have a lot in common with engineers of my own gender."	81%	75%	-6.3%***	82%	66%	15.8%**	1%
"I am regularly competing with my female colleagues for the woman's slot."	20%	27%	7.2%***				

Table 5A: Regression Tables Predicting Four Types of Bias

	(1) Prove-It-Again	(2) Tightrope	(3) Tug of War I	(4) Tug of War II	(5) M-Wall I	(6) M-Wall II
Women	0.685***	0.204***		0.631***	1.114***	0.492***
	(0.0684)	(0.0603)		(0.0913)	(0.134)	(0.114)
With Dep. Child	0.0166	-0.0243	-0.0189	0.236		0.0180
	(0.106)	(0.0872)	(0.0800)	(0.121)		(0.174)
African-American	0.779**	0.784***	0.350*	-0.459	0.115	-0.0504
	(0.281)	(0.186)	(0.173)	(0.248)	(0.562)	(0.400)
Latino/Latina	0.204	-0.109	0.118	0.0412	-0.838***	-0.255
	(0.191)	(0.142)	(0.141)	(0.221)	(0.251)	(0.273)
Asian-American	0.560**	0.440*	0.189	-0.162	-0.491	0.294
	(0.180)	(0.205)	(0.129)	(0.262)	(0.278)	(0.374)
Other people of color	0.254	0.255	0.0929	-0.332	0.640	0.612
	(0.312)	(0.278)	(0.307)	(0.189)	(0.706)	(0.367)
35-44 (age)	-0.0527	0.0975	0.0577	0.361	-0.151	-0.0747
	(0.166)	(0.159)	(0.103)	(0.291)	(0.268)	(0.300)
45-54 (age)	0.201	0.0393	-0.00512	0.546**	-0.0962	0.247
	(0.146)	(0.134)	(0.119)	(0.173)	(0.253)	(0.246)
55-64 (age)	0.447**	0.00538	-0.0819	0.956***	-0.122	0.323
	(0.171)	(0.128)	(0.120)	(0.193)	(0.296)	(0.210)
65 & up (age)	0.279	0.0762	0.121	0.863**		
	(0.273)	(0.233)	(0.405)	(0.314)		
Master/Professional	-0.0951	-0.178	-0.0278	0.193	-0.279	0.137
	(0.0993)	(0.0939)	(0.0789)	(0.156)	(0.186)	(0.182)
Doctorate degree	-0.170	-0.158	-0.313*	-0.305	-0.00529	0.535
	(0.140)	(0.118)	(0.148)	(0.174)	(0.363)	(0.324)
2-5 years	0.0357	0.0435	0.0534	-0.234	0.300	0.0617
	(0.172)	(0.142)	(0.124)	(0.205)	(0.314)	(0.259)

6-10 years	-0.0583	-0.0730	-0.0617	-0.377	0.283	0.0188
	(0.160)	(0.156)	(0.133)	(0.256)	(0.311)	(0.316)
11-20 years	-0.118	-0.210	0.0582	-0.233	0.364	-0.420
	(0.173)	(0.160)	(0.141)	(0.290)	(0.277)	(0.291)
21-30 years	-0.388*	-0.138	-0.0937	-0.509*	-0.103	-0.651*
	(0.190)	(0.187)	(0.166)	(0.239)	(0.333)	(0.266)
31 years & up	-0.533*	-0.426*	-0.0957	-0.412	-0.529	-0.351
	(0.208)	(0.201)	(0.250)	(0.281)	(0.369)	(0.327)
Academia	0.322*	0.108	0.389*	0.0635	-0.0262	-0.194
	(0.147)	(0.112)	(0.165)	(0.168)	(0.354)	(0.288)
Constant	2.657***	2.991***	2.489***	1.822***	2.333***	3.028***
	(0.113)	(0.131)	(0.111)	(0.151)	(0.311)	(0.237)
Observations	2361	2361	1857	2332	909	2350
R-squared	0.161	0.131	0.013	0.152	0.181	0.060

Standard errors in parentheses
*p<0.05; **p<0.01; ***p<0.001

All outcome variables are on the six-point scale: 1: “strongly disagree”; 2: “disagree”; 3: “somewhat disagree”; 4: “somewhat agree”; 5: “agree”; 6: “strongly agree.”

Prove-It-Again: scale of five items (average, six-point scale) (Cronbach’s alpha = 0.80)

- "I have to repeatedly prove myself to get the same level of respect and recognition as my colleagues."
- "I feel I am held to higher standards than my colleagues."
- "My suggestions or ideas are respected as much as my colleagues’." (reverse-coded)
- "In meetings, other people get credit for ideas I originally offered."
- "I have been mistaken for administrative or custodial staff."

Tightrope: scale of five items (average, six-point scale) (Cronbach’s alpha = 0.77)

- "I feel pressure to let others take the lead."
- "I am expected to be a ‘worker bee’, which means I should work hard, avoid confrontation, and not complain."

- "People at work see me as a leader." (reverse-coded)
- "I have had the same access to desirable assignments as my colleagues." (reverse-coded)
- "As compared to my colleagues in a comparable role with comparable seniority and experience, I am more likely assigned to high-profile tasks or work teams." (reverse-coded)

Tug of War I: "I am regularly competing with my female colleagues for the woman's slot." (six-point scale)

Tug of War II: "Some women engineers just do not understand the level of commitment it takes to be a successful engineer." (six-point scale)

Maternal Wall I: "Having children did not change my colleagues' perceptions of my work commitment or competence." (six-point scale) (reverse-coded)

Maternal Wall II: "Asking for family leave or flexible work arrangements would not hurt my career." (six-point scale) (reverse-coded)

Table 5B: Regression Tables Predicting Workplace Processes Bias

	(1) Hiring	(2) Performance Evaluation	(3) Networking	(4) Promotion	(5) Mentor/Sponsor	(6) Compensation
Women	0.558***	0.129	0.259**	0.276*	0.0319	0.0728
	(0.0977)	(0.114)	(0.0994)	(0.116)	(0.102)	(0.0475)
With Dep. Children	-0.0635	0.269	-0.226	0.0444	0.0167	-0.0561
	(0.140)	(0.158)	(0.158)	(0.169)	(0.148)	(0.0569)
African-American	0.516	0.562	0.774*	1.230**	0.862*	-0.159
	(0.309)	(0.298)	(0.379)	(0.381)	(0.365)	(0.0828)
Latino/Latina	0.250	0.432	0.0586	0.164	-0.184	0.0209
	(0.307)	(0.332)	(0.287)	(0.349)	(0.274)	(0.106)
Asian-American	0.00252	0.745*	0.384	0.476	0.339	-0.195
	(0.258)	(0.366)	(0.281)	(0.342)	(0.256)	(0.116)
Other People of Color	-0.397*	-0.0923	-0.101	-0.410	0.318	-0.0161
	(0.184)	(0.398)	(0.267)	(0.256)	(0.394)	(0.129)
35-44 (age)	-0.337	0.267	0.117	-0.216	0.240	-0.163
	(0.192)	(0.292)	(0.237)	(0.222)	(0.240)	(0.0874)
45-54 (age)	-0.246	0.636*	0.0346	0.319	0.741**	-0.0664
	(0.196)	(0.286)	(0.203)	(0.274)	(0.246)	(0.0819)
55-64 (age)	-0.0574	0.935***	0.283	0.665*	1.013***	-0.141
	(0.260)	(0.245)	(0.246)	(0.267)	(0.229)	(0.105)
65 up (age)	-0.158	1.230***	-0.0253	0.818*	1.007**	0.0197
	(0.318)	(0.372)	(0.360)	(0.413)	(0.353)	(0.147)
Master/Professional	0.0645	-0.0577	-0.102	-0.191	0.130	-0.0691
	(0.138)	(0.178)	(0.146)	(0.159)	(0.165)	(0.0705)

Doctorate Degree	0.0931	-0.240	-0.140	0.0954	0.107	-0.0500
	(0.205)	(0.360)	(0.184)	(0.316)	(0.271)	(0.0869)
2-5 years	0.622*	0.0690	0.0631	0.140	-0.121	-0.166
	(0.274)	(0.250)	(0.272)	(0.285)	(0.268)	(0.106)
6-10 years	0.449*	0.0255	-0.367	0.183	-0.0684	-0.0804
	(0.212)	(0.324)	(0.222)	(0.251)	(0.281)	(0.104)
11-20 years	0.398	-0.103	-0.314	-0.0832	-0.353	0.0684
	(0.239)	(0.310)	(0.243)	(0.247)	(0.281)	(0.101)
21-30 years	0.0536	-0.366	-0.163	-0.523	-0.446	-0.0482
	(0.261)	(0.307)	(0.273)	(0.312)	(0.287)	(0.128)
31 years & up	0.118	-0.669*	-0.412	-0.892*	-0.696	-0.0688
	(0.312)	(0.336)	(0.350)	(0.360)	(0.367)	(0.125)
Academia	0.109	-0.223	0.0434	-0.340	-0.169	0.0758
	(0.221)	(0.319)	(0.184)	(0.295)	(0.253)	(0.0839)
Constant	1.805***	2.153***	2.836***	2.876***	3.086***	3.647***
	(0.192)	(0.221)	(0.243)	(0.225)	(0.242)	(0.125)
Observations	2347	2348	2351	2347	2358	2330
R-squared	0.103	0.091	0.071	0.106	0.096	0.048

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

All outcome variables are on the 6-point scale: 1: “strongly disagree” 2: “disagree” 3: “somewhat disagree” 4: “somewhat agree” 5: “agree” 6: “strongly agree”.

Hiring: "It is harder to get hired at my workplace if you’re a woman." (six-point scale)
Performance Evaluations: "My performance evaluations have been fair." (six-point scale)

Networking: "I have had as much access to informal or formal networking opportunities as my colleagues." (six-point scale)
Promotion: "I have been given the advancement opportunities and promotions I deserve." (six-point scale)
Mentoring/sponsorship (average of two items, six-point scale) (Cronbach's alpha = 0.71)

- "I have had good mentors at my workplace." (reverse-coded)
- "I have a sponsor who is willing to use their influence and power to help advance my career." (reverse-coded)

Pay (average of two items, six-point scale) (Cronbach's alpha = 0.78)

- "My pay is comparable to my colleagues' with similar qualifications and experience." (reverse-coded)
- "As compared with my colleagues, I work more but get paid less."

Appendix A: Weights

According to the 2015 Current Population Survey (http://www.bls.gov/cps/cpsaat11.htm), the gender distribution of engineers in the U.S. is 82% men and 18% women. The racial/ethnic distribution of engineers is 67% white, 8% black or African-American, 7% Hispanic or Latino, 16% Asian-American, and 2% other people of color (estimated). We calculated the joint distribution of race and gender in the population and our sample (e.g., % white multiplied by % women is the proportion of white women. Between the two gender and five racial categories, we created 10 joint categories). We used the gender/race joint percentages in the population divided by the gender/race joint percentages in the sample to create a weight variable of 10 different values. Each value corresponds to a joint gender/race category. Underrepresented groups received weights greater than 1. Overrepresented groups in the sample received weights less than 1. The weight was applied in the regression analyses.

Gender	Race	Gender/race joint percentages (population)	Gender/race joint percentages (sample)	Weight
Woman	White	0.106	0.701	0.151
Woman	African-American	0.023	0.038	0.611
Woman	Asian-American	0.028	0.050	0.551
Woman	Latino	0.016	0.068	0.238
Woman	Other	0.004	0.006	0.553
Man	White	0.493	0.117	4.202
Man	African-American	0.109	0.003	38.776
Man	Asian-American	0.129	0.006	21.484
Man	Latino	0.076	0.005	14.576
Man	Other	0.016	0.004	4.115

Appendix B: Demographics and Summary Statistics of the Sample

Total Responses = 3,093

Demographic	Observations	Proportion of Responses
Women	2,587	84.93%
Men		
Transgender (Men)		
Have Dependent children	1,136	37.36%
White	2,040	81.89%
African-American	102	4.09%
Latino/Latina	140	5.62%
Asian-American	183	7.35%
Other People of Color	26	1.04%
18-25 years old	143	5.60%
26-34 years old	898	35.17%
35-44 years old	590	23.11%
45-54 years old	543	21.27%
55-64 years old	336	13.16%
65 years old and up	43	1.68%
Bachelor's degree or below	1,185	45.91%
Master's or professional degree	1,020	39.52%
Doctorate degree	376	14.57%
2-5 years of workplace seniorityŧ	338	13.23%
6-10 years of workplace seniorityŧ	756	29.59%
11-20 years of workplace seniorityŧ	544	21.29%
21-30 years of workplace seniorityŧ	539	21.10%
31 years and up of workplace seniorityŧ	262	10.25%
Academia	339	13.63%

ŧThe workplace seniority variables were measured by the question “How long have you been at your current employer/the employer you have spent the most time with in the past 5 years?”

Appendix C: Gender and Race breakdown of the sample

	Male	Female	Total
White	292	1,744	2,036
African American	7	95	102
Latino/Latina	15	125	140
Asian American	13	170	183
Other	10	16	26
Total	337	2150	2487

Appendix D: Number of Survey Questions for Each Type of Biasł

Type of Likert Scale Questions	**# of Likert scale questions**
Prove-It-Again	6
Tightrope	10
Tug of War	4
Maternal Wall	6
Workplace process: hiring	1
Workplace process: performance evaluation	2
Workplace process: promotion	1
Workplace process: mentoring/sponsorship	2
Workplace process: networking	1
Workplace process: compensation	2
LGBTQ & respect	3
Total	**38**

ł One Prove-It-Again question did not yield reliable statistics (i.e., the gender and racial differences were not statistically significant on this item, which was not consistent with the hypothesis constructed on the basis of previous research): "I would ask for a promotion only if I believe I have already met all the stated qualifications for that role." Therefore, only 38 questions were analyzed.