Gender Disparities in Science & Engineering

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In January 2005 Lawrence Summers, then president of Harvard University, gave a speech on the under representation of women in the sciences and on science faculties of top universities. He essentially argued that the cause of this phenomenon is due to differences in men and women's inherent nature, and, not surprisingly, his comments unleashed a torrent of outrage: 100 Harvard faculty members endorsed a letter of censure to Summers, a member of the board resigned in protest, and the Arts and Sciences faculty passed a no confidence vote. Summers followed with a formal written apology, a personal apology to a group of female faculty, and the creation of a program to attract more women to the study of science and engineering at Harvard. Nonetheless, nothing he said or did could erase what for all intents and purposes was an argument for intrinsic female inferiority. Summers eventually resigned under pressure.

Summers' speech and the reactions it provoked were covered widely by the media. The issue of women in the sciences was thrust into the public sphere. The controversy over Summers' speech underscored the contentious nature of the debate about the under representation of women in science and engineering. Summers pointed to "three hypotheses about the sources of the very substantial disparities...with respect to the presence of women in high-end scientific professions." (Summers) These hypotheses -namely, that women inherently have less mathematical and scientific aptitude, less drive and ambition, and a fervent commitment to family instead of career - account for the unequal pay, slower promotion rate and lack of representation in high-powered positions that women experience. (Summers).

In response to Summers' speech and the ideas he posited, The National Academies, comprised of four organizations including the Nation Academy of Sciences, under the oversight of the Committee on Science, Engineering and Public Policy, created the Committee on Maximizing the Potential of Women in Academic Science and Engineering (MPWASE). Donna Shalala, former head of the Department of Health and Human Services and current president of the University of Miami, headed the committee. They looked at the issues concerning women, and in particular those concerning women in high-power academic positions in the top research universities. They assessed commonly held beliefs including: women are not as good in math, women are wired differently than men and have

less aptitude in math and science, women prefer careers outside of science and math, and women are not as competitive. (Shalala, et al, 1-1) The MPWASE committee held a conference to hear from experts on all sides of the issue. They reviewed the research on brain structure and function, hormonal modulation of performance, human cognitive development, human evolution, and bias and discrimination. (Shalala, et al, S-1) After a year of review, The MPWASE committee came to the conclusion that bias and discrimination, not biology, are the root cause of the gender gap in science and engineering. They found "no significant biological differences between men and women in performing science and mathematics that can account for the lower representation of women in academic faculty and scientific leadership positions in these fields." (Shalala, et al, S-1)

Summers' expressed goal was to "think systematically and clinically about the reasons for under representation." (Summers) In other words, he wished to think scientifically about each of his three theories. In the excellent book on scientific theory, Muddling Through, the authors point out that society tends to believe "Theories in the sciences are like lenses, which enable us to focus on the real world or on truth, without distortion. Like light, the real and the true pass directly to our eyes via scientific theories." (Fortun & Bernstein, 37) What is found both in Summers' speech, and in the scientific research upon which his ideas are at least indirectly based, is exactly what Fortun and Bernstein refer to as theory articulation: "..theorizing is never simply a matter of induction from empirical facts, but is a more elusive and less perfectly rational process that might even involve the imagination". (Fortun & Bernstein, 37) Summers and others propounding the biology theory are doing much more than creating a transparent lens through which to see the issues of gender disparity. They have created a framework and selectively reported data that fills it in. This is evident when the hypotheses presented by Summers and others- namely biology, aptitude, taste differences and ambition - are examined in light of the findings by The MPWASE committee and the total body of research available.

1 The Biology, Aptitude Hypothesis

Cognitive sex differences account for the differential success of men and women in science and engineering.

Kingsley R. Browne, author of Biology at Work: Rethinking Sexual Equality, a well-known expert cited in numerous other works on the topic, articulates his theory in terms of cognitive sex differences. He attempts to prove throughout the book that men have a cognitive advantage over women. His hypothesis falls flat however, because the research he includes is selected and framed to show male superiority. For instance, in the section

entitled “Mathematical Ability”, he cites boys’ out-performance of girls on the mathematical concepts portion of the SAT to support his theory that boys have more natural aptitude in math. (Browne, 29) It’s interesting to note that he uses the term “math ability” when what he is referring to is performance on the math concepts portion of the SAT. Or put another way, general “math ability” gets defined in terms of one group’s performance on one portion of one test in one country.

Furthermore, Browne claims, although he does not give supporting evidence, that the Educational Testing Service is purposely changing the SAT in favor of girls. (Browne, 29) He can find no other reason to explain the shrinking gender gap in math concept scores. He continues with a brief description of girls’ out-performance of boys on the verbal portion of the SAT. However, he quickly counters that “Focus on a single dimension of cognitive ability may result in an underestimation of the practical effect of sex differences”. (Browne, 31) He doesn’t want to focus on a single ability in girls but doesn’t have a problem doing it for boys, as he continually does throughout the section.

All of this is in spite of the fact that numerous other studies show that boys and girls perform equally well on tests that measure math ability. In his article, Ben A. Barres, professor of neurobiology at Stanford Medical School, shows standardized test scores in math for children ages 4-18 across the U.S. (Barres, 134) There is no distinguishable difference in performance between boys and girls. A study reported in the New York Times, conducted by the Organization for Economic Cooperation and Development, looked at 250,000 15-year-olds in 41 countries. Average math scores were wide-ranging; depending on what category of math was looked at. (Seward & Seward, 42) In some nations boys did better in math. In others, there were no discernible differences between boys and girls. Japanese girls outperform boys in many other nations and even out-performed boys in the United States. Furthermore, the MPWASE committee reported that female performance in high school mathematics now matches that of males. (Shalala, et al, Table S-1)

It appears that the cognitive sex difference in math ability, as it’s articulated in the work of Browne, varies according to time and place and to the research that one is willing to consider. Browne defines “math ability” in terms of the research he chose to cite, from one portion of a particular test he felt was most significant, from the country he felt to be most representative of typical men and women. Browne is not unique in his focus on specific data, citing the sources that support his arguments, leaving out the rest. The MPWASE committee looked at the large body of research available, confirming my own observations when reading this research, and found three flaws in the sex difference theory:

> First, the discussion has drawn on research in a highly selective way, emphasizing a small number of measures that show sex differences and de-emphasizing both the overlap between men and women on the

> measures and the large number of measures by which sex differences are small or nonexistent.
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> Second, most studies of sex differences in average abilities for mathematics and science focus on measures that were designed to predict academic success in high school or college mathematics or science, such as the quantitative portion of the Scholastic Assessment Test (SAT-M). Because the academic success of girls now equals or exceeds that of boys at the high school and college levels, however, there is no longer a gender gap for the studies to explain.
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> Third, most studies of cognitive sex differences at the highest levels of mathematical and scientific ability also focus on measures that predict success in high school and college. These measures, however, have not proved to be predictive of success in later science careers. Thus, we cannot look to cognitive sex differences to explain the differential success of men and women scientists and engineers. (Shalala et al, 2-1)

The conclusion then, is that the "scientific" studies purporting cognitive differences used a selective sample of research to support their theories. The studies were focused on the SAT, which was designed to predict academic success. Girls are now equally successful academically, which renders these studies obsolete. Finally, measures of the highest level of math and science ability have not been proven to predict success in science careers. Therefore, we cannot use these measures to explain the differential success of men and women in science and engineering.

2 The Taste Difference Hypothesis

Women choose careers outside of science and engineering because of their occupational interests or career preferences.

In Summers' second hypothesis he states "there is reasonably strong evidence of taste differences between little girls and little boys that are not easy to attribute to socialization." (Summers) This idea, that the issue is one of nature as opposed to nurture, is echoed by David C. Geary, author of Male, Female: The Evolution of Human Sex Differences. He attributes the wage and status gap in the workplace to taste differences, or as he terms it occupational interests: "sex differences in occupational interest and achievement...

contribute greatly to the difference in wage and social status advantage that men enjoy." (Geary, 326)

In his research Geary frames the issue in terms of the gender schema: men are reasoning, women are verbal. This harkens back to the simplistic analysis of scores on the math and verbal portions of the SAT by Browne. Geary claims that this gender schema is the cause of men entering math and science careers more frequently and women entering language-oriented careers more frequently. Furthermore, in math intensive careers the salaries are higher. In language intensive careers, the salaries are lower. He posits that a combination of innate occupational interest, and the associated salaries, is the cause of different status and different pay.

In the same vein, Browne states, "A full understanding of occupational patterns requires a consideration of the intersection of cognitive abilities and occupational interests". (Browne, 50) Further, the "...male advantage in spatial, mathematical and mechanical pursuits..." (which is only supported with a simplistic comparison of math-concept scores on the SAT) "...makes them more suited to certain jobs such as those in math and science, while verbal skills and social orientation make women more suited to jobs in the humanities". (Browne, 50, 52)

The research of the committee strikes down the taste difference hypothesis. Women are choosing careers in science and engineering more and more, showing a very strong occupational interest, especially now that barriers for women are being torn down. The MPWASE committee reports that "over the last 40 years, the number of women studying science and engineering has increased dramatically. Women now earn 51% of the bachelors degrees and 37% of the PhDs [in these areas]". (Shalala et al, *ix*) Exclusion, bias and social influences, not a lack of some biologically predetermined ability or interest, have kept women out of science.

For example, many studies point to exclusion of girls and preferential treatment of boys by teachers as a cause. In the ACM journal issue entitled "Women in Computing", one article cites a study that shows how "student, teacher and parental attitudes discourage girls from pursuing science and math." (Klawe, Leveson, 30) The article reports the research of Jacquelynne Eccles at the University of Colorado, who videotaped a large number of math classes in which teachers gave preferential treatment to boys. Other studies show that math teachers call on boys more frequently than girls. Teachers are also more likely to follow up on an answer given by a boy to make sure his reasoning was correct. (Hemenway, 56) These studies show that negative social factors, not a lack of innate interest, discourage girls from considering careers in math and science.

A few interesting facts also contest the taste difference hypothesis proposed by Summers and others. In WWII many women were encouraged to enter the workforce because men were fighting the war. During this time nine women programmed the ENIAC,

the first large scale, electronic, digital computer. In fact, the very first computer programmers were mostly women. When given the chance, women showed a great occupational interest and high level of competence and ability. Also in 1965 Sister Mary Kenneth Keller became the first woman to earn a PhD in Computer Science in the US. (Gurer, 47) For part of her study she attended Dartmouth University, where they had a *men only* rule in the computer lab. Circumstances such as this were an obvious deterrent for women entering the field of Computer Science. Exclusion, bias and social influence have played a big role in keeping women out of science. When barriers are taken down for women they have an equal interest and equal aptitude.

3 The High-Powered Job Hypothesis

Men hold higher positions and earn better salaries in science and engineering careers because they more readily make the commitments required to advance their careers.

The next part of Summers' argument has to do with ambition and commitment to career or as he terms it, the "high-powered job hypothesis." (Summers) High-powered jobs such as those of managers, tenured professors at top universities, and CEOs, demand a huge time commitment that Summers' claims is more readily accepted by men. He anecdotally commented that a former female colleague, and graduate of Harvard Business School, said that only 3 women out of 22 in her first year section are working full time. He argues that women are less willing to make work the center of their lives, valuing children and family more and are correspondingly underrepresented in leadership positions.

Research confirms that bias and discrimination, not a lack of commitment and ambition, keep women out of high-powered positions, earning less. Studies that controlled for factors such as age, experience, quality of credential, proportion of women graduating at the relevant time, and current proportion of women in the industry still found that women are paid less and hold lower ranking positions. (Hemenway, 56) Virginia Valian, professor of psychology and linguistics at Hunter College and graduate studies at City University in New York, has conducted extensive research on sex differences in cognition. She recently published the book Why So Slow?, which addresses gender gaps in rank, pay and tenure in the workplace and universities. After due consideration of Valian's research and that of numerous others, The MPWASE committee found:

> A substantial body of research demonstrates that women are underrepresented at higher levels of business and academe because of

the influence of gender schemas and the accumulation of disadvantage that such schemas generate.

Valian gave a lecture at MIT on why so few women occupy positions of power in every field of science. In it she describes the influence of gender on the accumulation of disadvantage experienced by women. (Valian) Women with equal education and experience have to do more to get promoted, tenured and salaried. In the humanities and sciences, a couple years post PhD, men and women make equal salaries. But at almost all intervals subsequent, men make more money. This is even more true in science and engineering. She describes how gender schemas "add a plus to things that a man does and a minus to the things that a woman does". For instance, she cites a study in which 17 factors affecting men and women in international business occupations were looked at. The men and women studied were U.S. professionals in international occupations, and equally matched on the factors the researchers considered. She reports:

> Researchers looked at factors that could contribute to salary such as the type of degree held, years of experience, strategies for advancement and number of hours worked per week. The researchers found that most factors helped both men and women but they helped men more. A BA contributed $28,000 to a man's salary and $9,000 to a woman's salary. Having lived outside the US added $9200 to a man's salary and subtracted $7200 from a woman's. Having chosen international work added $5300 to a man's salary and subtracted $4200 from a woman's. Speaking another language added $2600 to a man's salary and subtracted $5100 from a woman's.
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> Two factors helped women more than they helped men. Negotiating for one's salary added $3500 for women and subtracted $5600 from men's. Traveling 10 days more than average per year added $6300 for women and $3200 for men.

Valian says that results like these are typical in the literature. "Women tend to benefit less from their qualifications, even when they have the same qualifications as men, than men do".

So we can see that the issue is not a willingness to make the necessary time commitment to high-powered jobs as Summers claims, or less ambition, aptitude, cognitive ability or suitableness to a math or science career. Sex differences in occupational interest and achievement do not contribute greatly to the difference in wage and social status as Geary claims. Research shows that women have to do more to get promoted, tenured, and

salaried. Women's credentials are worth less than men's. Girls are not treated equally in math and science classes. Women historically have been excluded from computer science and the sciences in general. Valian succinctly states, "we have to know what the issues are, and what they are not." The issues are bias, discrimination, a lack of encouragement, and a lack of opportunity. They are not a lack of ambition and commitment, different tastes, lower aptitude, or different abilities.

On an interesting note, Summers concluded his speech by saying "I've given you my best guesses after a fair amount of reading the literature and a lot of talking to people. They may be all wrong. I will have served my purpose if I have provoked thought on this question and provoked the marshalling of evidence to contradict what I have said." He added, "[these issue] are too important to sentimentalize rather than to think about in as rigorous and careful ways as we can." Thankfully, the work of The MPWASE committee showed that despite his reading and talking, Summers' best guesses were wrong. While his goal of provoking discussion on the issues provided a platform for the rigorous and careful research of The MPWASE committee, it is unfortunate that Summers and the research he draws from did not meet the same standards of inquiry. Ben A. Barres put my feelings into words by stating: "I'm suspicious when those who are at an advantage proclaim that a disadvantaged group of people is innately less able".

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