Mind the Gap

A Statistical Approach to Understanding Gender Inequality in the Physical Sciences

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18, January 2014

West Coast Conference for Undergraduate Women in Physics
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Based on Jessica Hanzlik’s “Feminist Physics” at 2010 Midwest CUWiP
Outline

1. The Gender Gap: What is it?
2. The Gender Gap: Possible Explanations & Contributing Factors
3. Why It Matters
4. Solutions
The Gender Gap

Women are underrepresented in the physical sciences.

Percent of PhDs earned by women in selected fields, 1958-2003

National Science Foundation. Compiled by AIP Statistical Research Center.
1837 - Oberlin becomes first US co-ed institution.

1880 - Cornell becomes first American woman PhD to US co-ed institution.

1930's - 40% undergrads are women (still gender segregated).


1980 - Men and women enrolled in equal numbers.

References:
http://beatl.barnard.columbia.edu/learn/timelines/women.htm

National Science Foundation. Compiled by AIP Statist...
1880 - Cornell. 1st PhD to American woman
1930's - 40% undergrads are women (still gender segregated)
1969 - Yale, Princeton accept first women undergrads
1980 - Men and women enrolled in equal numbers
1837 - Oberlin becomes first US co-ed institution
1862 - Oberlin grants first bachelors degree to black American woman
1880 - Oberlin becomes first American woman
1921 - U Penn, U Chicago grant first PhDs to black women
1954 - Brown v. Board of Ed

References:
http://beatl.barnard.columbia.edu/learn/timelines/women.htm
http://www.jbhe.com/chronology/
The Gender Gap

Women are underrepresented in the physical sciences.

Percent of PhDs earned by women in selected fields, 1958-2003

National Science Foundation. Compiled by AIP Statistical Research Center.
The Gender Gap

Women are underrepresented in the physical sciences.

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Why so few?
Another Gender Gap

“Leaky Pipeline” - women disproportionately leave the physical sciences despite equal enrollment at the beginning of college.

Actual and expected percentage of women and men in physics in the US
Another Gender Gap

“Leaky Pipeline” - women disproportionately leave the physical sciences despite equal enrollment at the beginning of college.

Actual and expected percentage of women and men in physics in the US
Possible [wrong] Explanations for the Gender Gap(s)

1. Lower aptitude
2. Higher variance in males
Lower aptitude?

References:
Ben Barres. Does Gender Matter?
Lower aptitude?

References:
Ben Barres. Does Gender Matter?
Lower aptitude?

References:
Ben Barres. Does Gender Matter?
Lower aptitude?

![Cartoon of two stick figures. One says, "Wow, you suck at math." The other says, "Wow, girls suck at math." To the right is a graph showing standardized math test scores by age when tested, with lines for boys and girls.](http://xkcd.com/385)

References:

*Ben Barres*. Does Gender Matter?
Higher Variance?

Larry Summers, President of Harvard (2005)

The under-representation of women in the top levels of academia is due to a "different availability of aptitude at the high end."
Higher Variance?

PISA = standardized math test

VR = male variance : female variance

US variance ratio from PISA: VR = 1.19

(Statistically significant)

References:
JS Hyde and JE Mertz. Gender, culture, and mathematics performance.
VR = male variance : female variance
Let VR = 1.19

Only high performers can become engineers.

References:
JS Hyde and JE Mertz. Gender, culture, and mathematics performance.
Higher Variance?

VR = male variance : female variance
Let VR = 1.19

High-performance tail:

@99.9th percentile - theoretically 32% women
Reality in engineering - 18% women

To accommodate reality with this model, would require all engineers to be >4-sigma (1/20,000) from average on math tests.

In reality, 145/20,000 are engineers.

References:
JS Hyde and JE Mertz. Gender, culture, and mathematics performance.
Higher Variance? No!

Recap: “Higher Variance Theory” = males have biologically higher variance, which is responsible for low number of women in STEM.

Last few slides => conclusion: VR does not explain low numbers of female engineers.

Additionally, VR varies by country and ethnicity.

Conclusion: males do not have a biologically higher variance.

References:
JS Hyde and JE Mertz. Gender, culture, and mathematics performance.
More Likely Explanations for the Gender Gap

Socio-Cultural Influences:

1. Stereotype threat
2. Cultural Representations of Scientists
3. Implicit bias
Stereotype Threat

- Term coined in 1999 paper by Spencer, Steele, and Quinn.
- Describes anxiety & impaired performance that occurs when a person has the potential to confirm a negative stereotype about their social group.

Study 0: “...[Replicates] the pattern found in the literature—that women underperform in comparison to men on difficult tests, but perform equally with men on easy tests—in a sample of highly qualified equally prepared men and women.”

![Graph showing test performance]

References:
SJ Spencer, CM Steele, and DM Quinn. Stereotype threat and women’s math performance.
Stereotype Threat

Study 1: Half the test subjects are told test shows no gender difference, the other half are told that women score lower.

<table>
<thead>
<tr>
<th>Test Characterization</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-Gender-Difference</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender-Difference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hard math test = GRE subject level

Study 1 Results:
Explicitly eliminating stereotype = equal scores.
Reinforcing stereotype = women underperformed.

References:
SJ Spencer, CM Steele, and DM Quinn. Stereotype threat and women’s math performance.
Stereotype Threat

Study II: Half the test subjects are told test shows no gender difference, no mention of gender to other half.

Study II Results:
Explicitly removing stereotype = equal scores
Stereotype not even mentioned = women underperformed

Not mentioning stereotype gives same results as reinforcing it!

References:
SJ Spencer, CM Steele, and DM Quinn. Stereotype threat and women’s math performance.
Cultural Representations of the Scientist

Who is the Scientist?

Seventh graders describe scientists before and after a visit to Fermilab

BEFORE
“I think of a scientist as very dedicated to his work. He is kind of crazy, talking always quickly. He is constantly getting new ideas. He is always asking questions and can be annoying. He listens to others’ ideas and questions them.”

AFTER
“I know scientists are just normal people with not so normal job.... Scientists lead a normal life outside of being a scientist. They are interested in dancing, pottery, jogging, and even racquetball. Being a scientist is just another job which can be much more exciting.”

-Amy

References:
Gendered Advertising: Yesterday

1953

You mean a woman can open it?

1970

The Mini Automatic. For simple driving.

1970

THIS IS A COMPUTER?

1970

YOU BET YOUR SWEET TELEX OPERATOR IT IS!

1970

You mean a woman can open it?
Gendered Advertising: Today

2012 Land’s End Catalog

super light, superhero tough

FeatherLights reduce their school load by trimming weight off the pack. But what makes them really amazing is they do it without sacrificing durability, thanks to strategically placed 420D and 600D pack cloth, lighter weight. Same awesome durability. Guaranteed. Period.

light as a feather, tough as long division

FeatherLights reduce their school load by trimming weight off the pack. But what makes them really amazing is they do it without sacrificing durability thanks to strategically placed 420D and 600D pack cloth, lighter weight. Same awesome durability. Guaranteed. Period.

Take it your own! Add a monogram, embroidery or both! See p. 20

Matthew

Chloe
Gendered Advertising: Today

2009 Toys ‘R Us Catalog
Gendered Advertising: Today
Gendered Advertising: Today

2013 AP Exams

Cracking the AP ENGLISH LITERATURE & COMPOSITION EXAM 2013
Proven techniques for a higher score.
- 2 full-length practice tests with detailed explanations
- In-depth, engaging review of important literary movements
- Updated strategies that reflect the AP test scoring change

Cracking the AP U.S. HISTORY EXAM 2013
Proven techniques for a higher score.
- 2 full-length practice tests with detailed explanations
- Thorough review of economic, social, and political trends from the 17th through 21st centuries

Cracking the AP CALCULUS AB & BC EXAMS 2013
Proven techniques for a higher score.
- 8 full-length practice tests with detailed explanations (3 for AB and 2 for BC)
- Comprehensive review of topics, from derivatives to logarithmic functions
- Cheat sheet of key formulas
- Updated strategies that reflect the AP test scoring change

Cracking the AP PHYSICS C EXAM 2013
Proven techniques for a higher score.
- 2 full-length practice tests with detailed explanations
- Coverage of vectors, kinematics, Newton's Laws, linear momentum, gravitation, electromagnetic induction, and much more
- Updated strategies that reflect the AP test scoring change
Implicit Biases

“...individuals are not necessarily withholding their "true" attitudes and beliefs but rather that they are unable to know the contents of their mind.”


Some Results from the IAT (Implicit Association Test):
75% of men and women do not associate ‘female’ with ‘career’ as easily as with ‘family’.

75% of whites (and 50% of blacks) show anti-black bias.

Further study indicated that implicit bias correlates with real-world behavior.
Implicit Biases

2012 study: “...[to] experimentally investigate whether science faculty exhibit a bias against female students that could contribute to the gender disparity in academic science.”

- Randomized double-blind study (n = 127), nation-wide science professors (bio, chem, & physics), research-intensive universities.

significance: \( p < 0.001 \)

Same CV - only name changes!

<table>
<thead>
<tr>
<th>Competence</th>
<th>Hireability</th>
<th>Mentoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male Student</td>
<td>Female Student</td>
<td></td>
</tr>
</tbody>
</table>

References:
Moss-Racusin, et al., Science faculty’s subtle gender biases favor male students.
Implicit Biases

Starting salary offered to applicant by gender.

All biases in this study were found to be independent of faculty’s age, gender, tenure status, & discipline.

Everyone — even young female faculty — harbor implicit bias against women.

References:
Moss-Racusin, et al., Science faculty’s subtle gender biases favor male students.
Why do we care?

For science!

As good scientists, we aim to control for bias. Not correcting for these biases = vastly smaller talent pool. **This is not** a “women’s issue” - this is a science issue. Doing nothing undermines academic/scientific meritocracy.

“Maintaining a strong workforce in the physical sciences is of critical importance to the national economy, health care, defense, and domestic security. Increasing the participation of women in these sciences can strengthen that workforce....”

-Gender Equity Report, 2007
What Can We Do?

What ‘The Academy’ Can Do:

Increase leadership diversity in academic and scientific institutions.

- Example: Companies that introduced diverse leadership have higher net profit margin for stretch of six years, when compared with other companies in years before/after new leadership.

Best practices for ‘judging.’

- Example: Double-blind peer review increased the acceptance rates of female first-author papers.

References:

Budden et al. Double-blind review favours increased representation of female authors.
What Can We Do?

What We (me and you!) Can Do:

Mentoring

- Mentors help navigate social norms.

- Women who participate in mentoring programs:
  - Publish more papers
  - Publish more papers in top journals
  - Earn more federal grant money

Organizing, Self-Advocating, & Outreach!

References:
Stalker. Athene in academe- women mentoring women in the academy.
Jaschik. Proof that Mentoring Matters.
Mentoring

Join an existing mentoring program:

- Look at your home institution, in your community, or even online to connect with physicists at different stages of their careers.

Build your own mentoring program:

- Ask the people around you at this conference about mentoring programs at their home institutions.

- The Gender Equity Collaborative offers a step-by-step list of how to build and market a mentoring program: www.genderequitycollaborative.org
Mentoring

Informal mentoring:

- TA/Grad student.

- Favorite professor or research adviser

- Ask your peers about which courses/summer programs/research advisers they’re interested in.
Mentoring

Informal mentoring:
- TA/Grad student.
- Favorite professor or research adviser
- Ask your peers about which courses/summer programs/research advisers they’re interested in.
- Mentor up, down, & laterally
- Form networks — that’s part of the reason you’re here!
Think Strategically About Gender Norms

References:
Crandall. Sex differences in expectancy of intellectual and academic reinforcement.
Greig. Propensity to Negotiate and Career Advancement: Evidence from an Investment Bank that Women are on a “Slow Elevator”
Think Strategically About Gender Norms

Women self-promote less than men.

- In cover letters, grad school apps make sure you don’t underrate your achievements.

- Men tend to apply for jobs they are under qualified for; women tend to think they need 70-100% of the qualifications to apply. So apply for positions you want even if you don’t fit all the requirements!

References:
Crandall. Sex differences in expectancy of intellectual and academic reinforcement.
Greig. Propensity to Negotiate and Career Advancement: Evidence from an Investment Bank that Women are on a “Slow Elevator”
Think Strategically About Gender Norms

Women negotiate less than men.

- Ask for a raise, a higher starting salary, a promotion, ability to work from home, flexible hours, etc.

- It is reasonable/common to negotiate for things you want.

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Crandall. Sex differences in expectancy of intellectual and academic reinforcement.
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Think Strategically About Gender Norms

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- It is reasonable/common to negotiate for things you want.

Find a supportive environment.

Seek out people, professionally and personally, men and women, who support your goals.

References:
Crandall. Sex differences in expectancy of intellectual and academic reinforcement.
Greig. Propensity to Negotiate and Career Advancement: Evidence from an Investment Bank that Women are on a “Slow Elevator”
Thanks for listening!