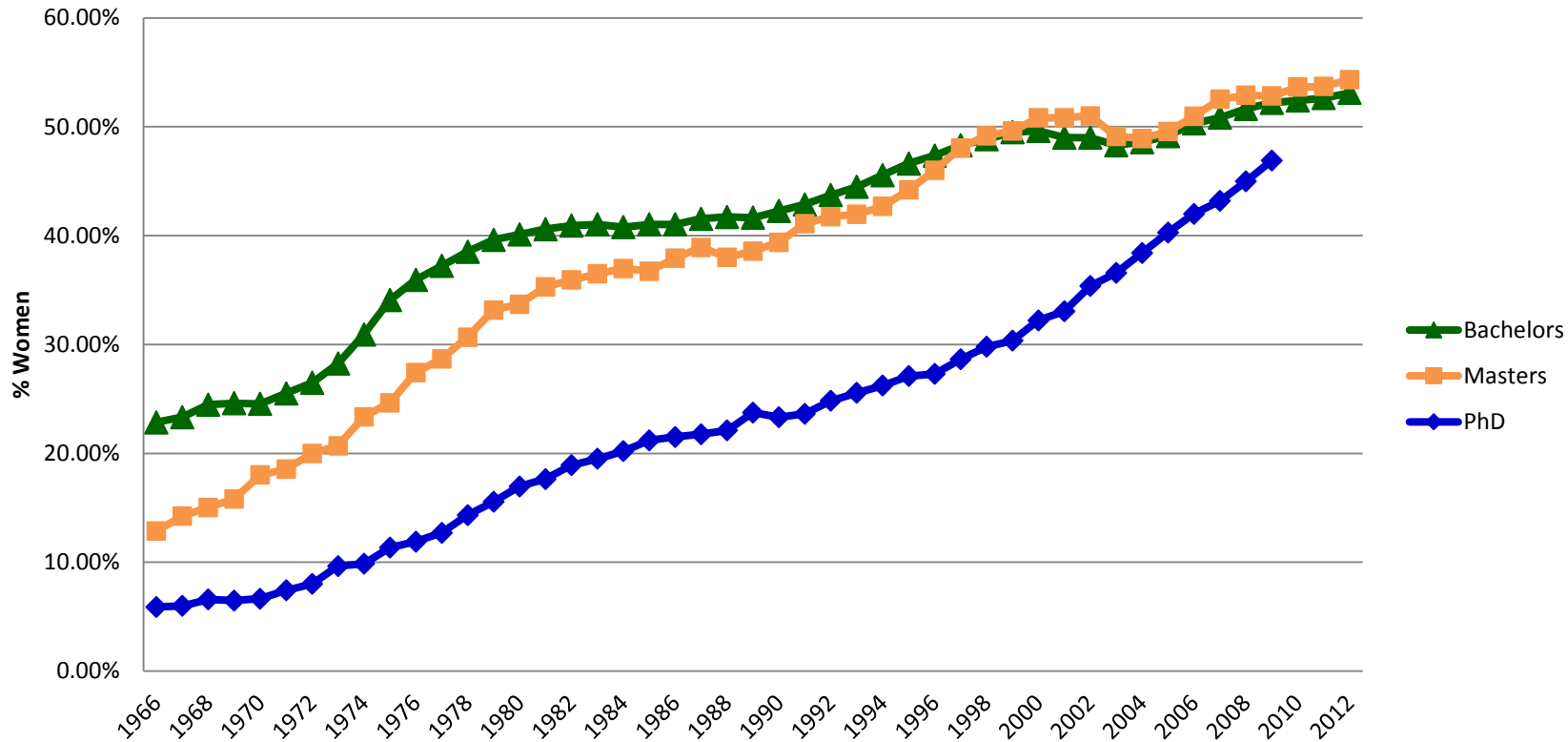# Women in STEM:
Understanding and Minimizing
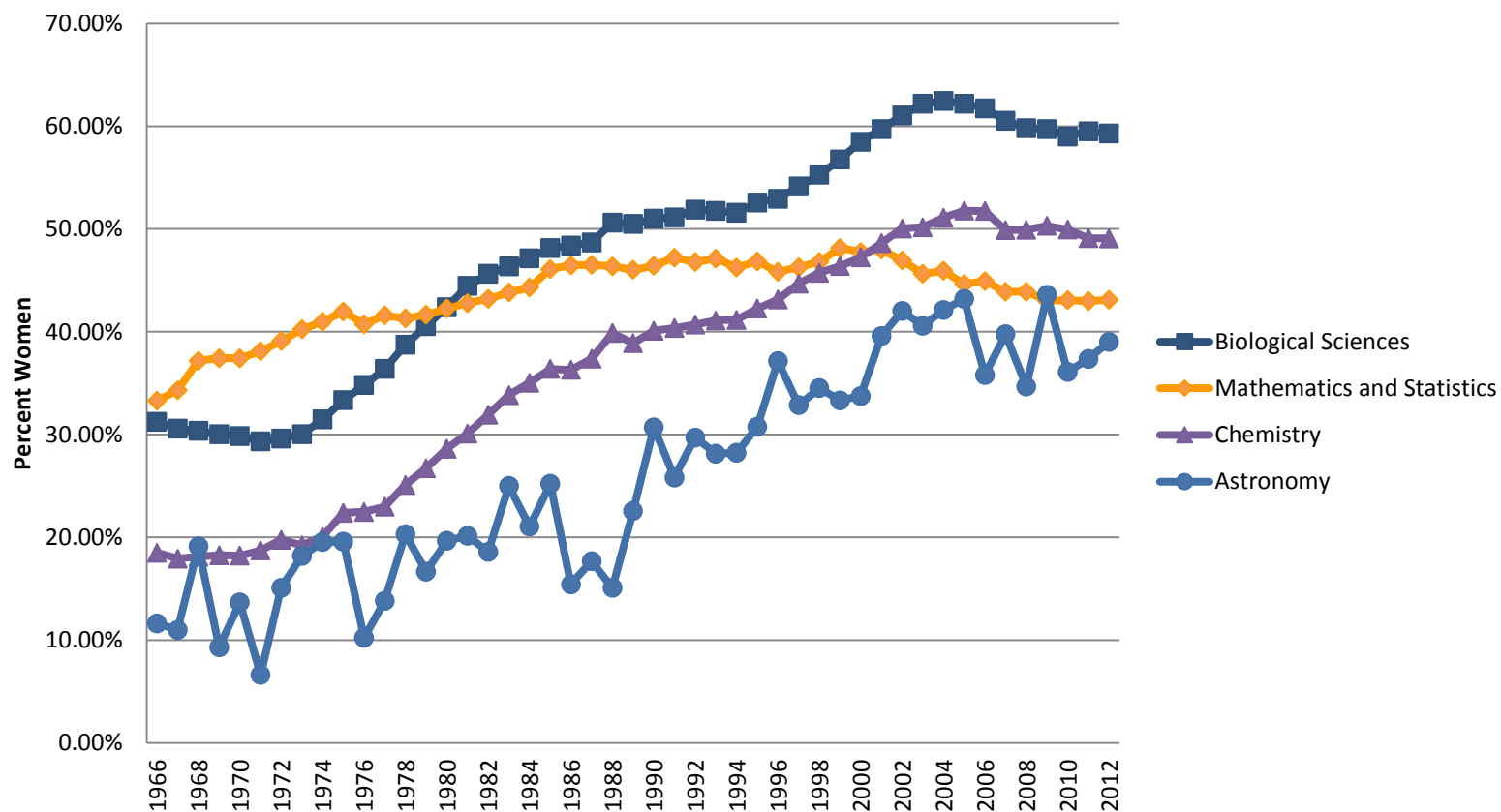## The Role of Implicit Bias

Eve Fine, Ph.D.
Researcher
Women in Science & Engineering Leadership Institute

% Women receiving science and engineering degrees, 1966-2010

Source: National Science Foundation S&E Degrees
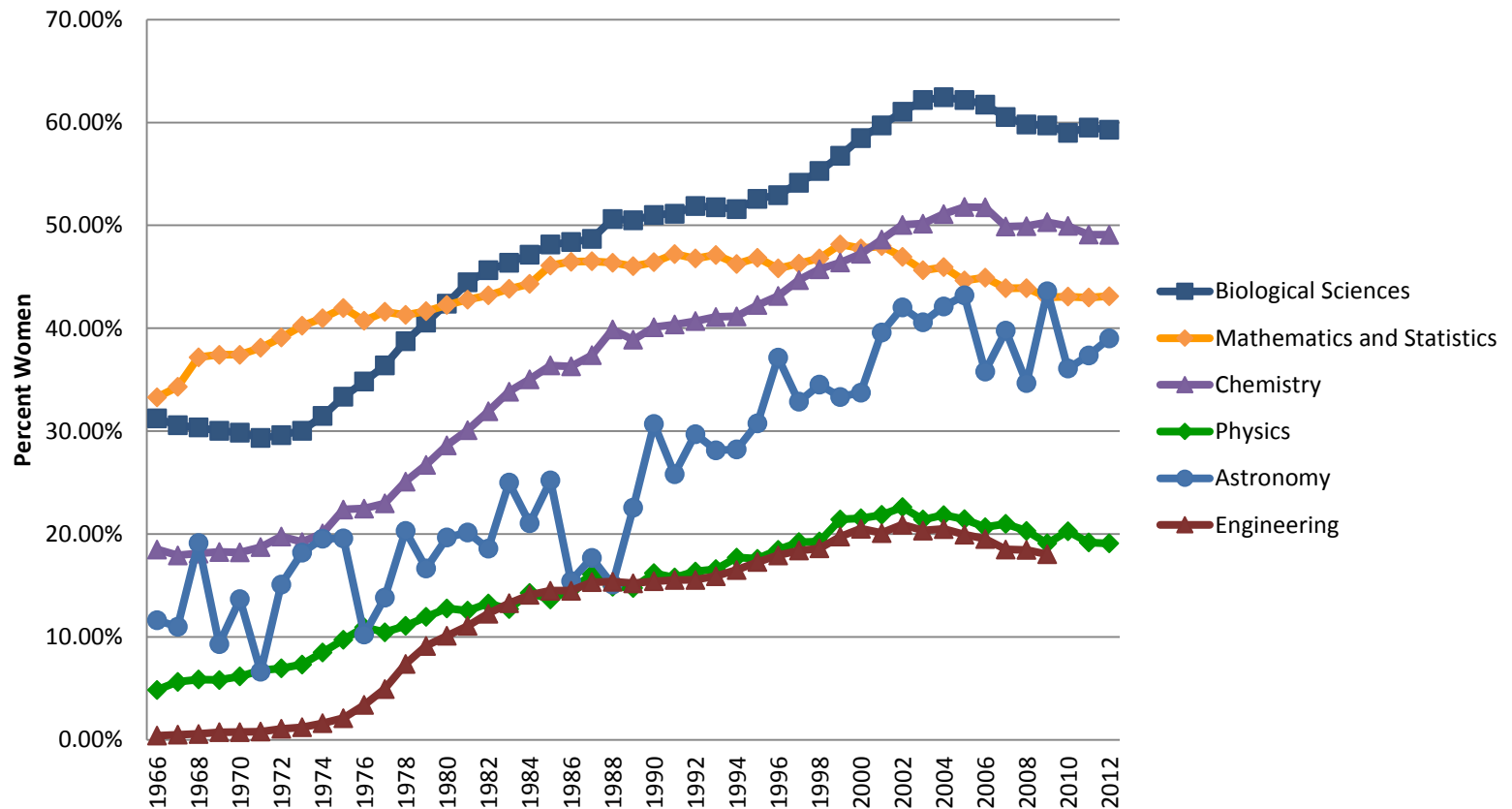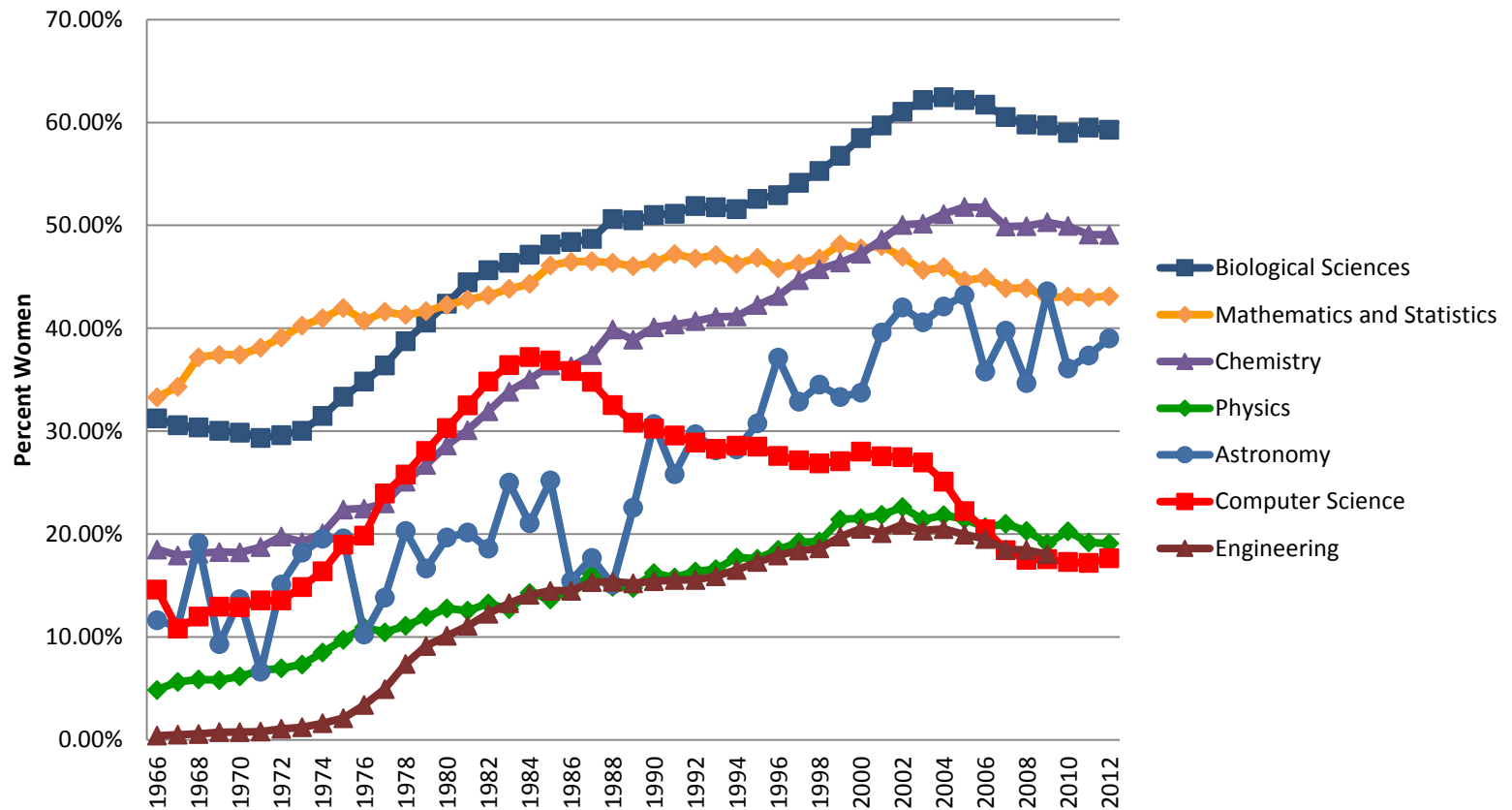
Percent Women - Bachelor's degrees

Source: National Science Foundation S&E Degrees

Percent Women - Bachelor's degrees

Source: National Science Foundation S&E Degrees
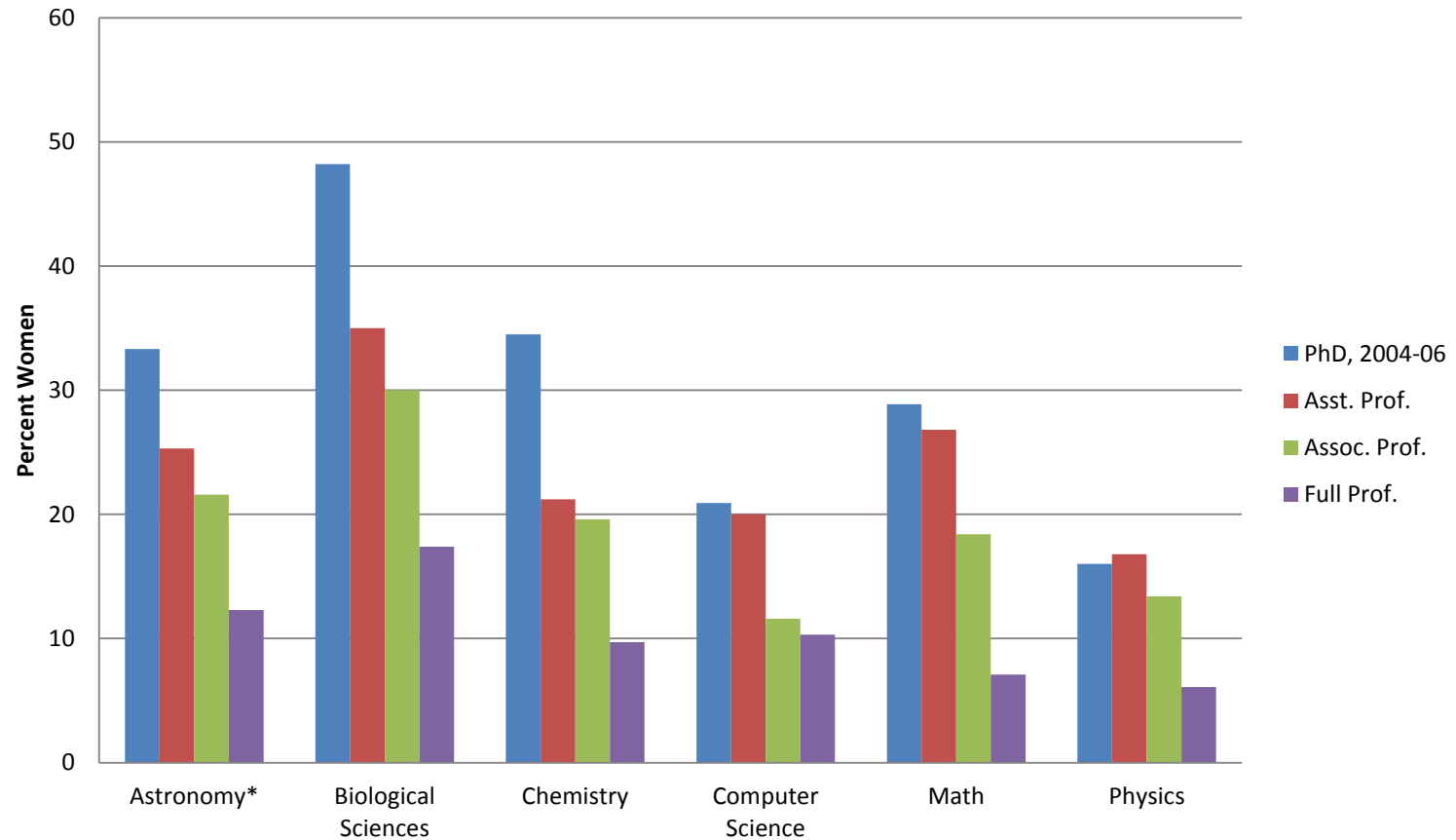
Percent Women - Bachelor's degrees

Source: National Science Foundation S&E Degrees

Percent Women PhDs and Faculty, 2007

Source: Faculty Data – Nelson Diversity Surveys, 2007; PhD data – National Science Foundation S&E Degrees
*For all disciplines except Astronomy, the faculty data are for the top 100 departments in each discipline as ranked by NSF on research spending. NSF only ranks 40 Astronomy departments

Why do you think it is important to have a diverse faculty and student body in science and engineering; to have better representation of women and minorities in science?

Why Diversity?

- Diverse working groups are more productive, creative, and innovative than homogeneous groups

- Diverse groups engage in a higher level of critical analysis than do homogeneous groups

- Diverse scholars and professionals can invigorate and expand disciplines and fields

- Mentors and role models for all

- Fairness and equity

Why do you think
women and minorities
are underrepresented
in many STEM disciplines –
especially in faculty ranks?

Why the Lack of Representation?

- Bias/discrimination
- Lack of encouragement for women and URM in STEM
- Lack of role models/mentors
- Microaggressions – and/or Negative/chilly climate women and minorities experience as students/faculty
- Societal factors including K-12 schooling, social expectations, career advice
- Women: Difficulty balancing work and family life

Why the Lack of Representation?

What's not on the list:

- Innate/biological differences in intellectual ability

- Lack of interest in science

What is Implicit Bias?

- A substantial body of evidence demonstrates that most of us routinely rely on unconscious assumptions even though we intend to be fair and believe that we are fair.

- Depending on the discipline, unconscious biases can also be referred to as:

  - Schemas
  - Stereotypes
  - Mental models
  - Cognitive shortcuts

  - Statistical discrimination
  - Implicit associations
  - Spontaneous trait inference
  - System 1 thinking

The tendency of our minds to apply characteristics of groups (real or imagined) to our judgments about individual group members.

What is Implicit Bias?

- Human brain works by categorizing people, objects and events around us -- this allows us to quickly and efficiently organize and retrieve information.

- These ordinary, necessary mental operations usually serve us well … but they are subject to error and can fail our intentions.

- When evaluating people we can be led astray by our tendency to categorize people – and we tend to do so on the following dimensions:
    - Race/Ethnicity, Sex, and Age.

Examples of how ordinary, necessary mental operations can be subject to error
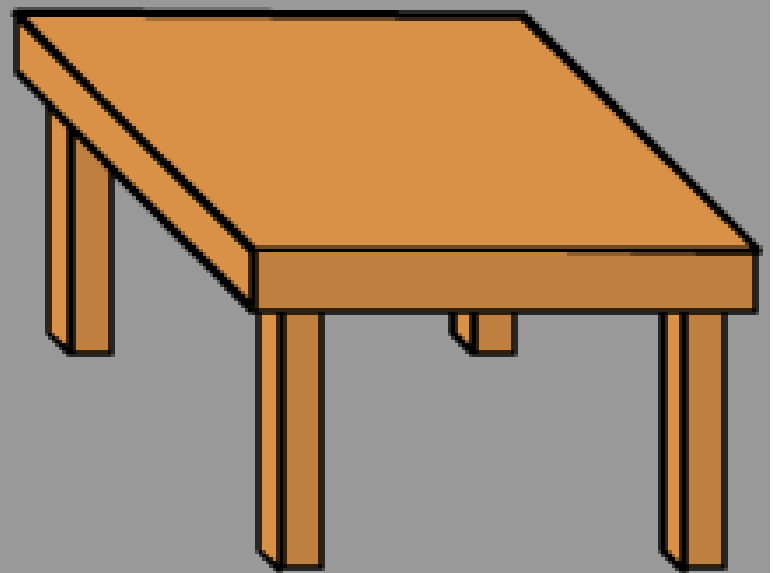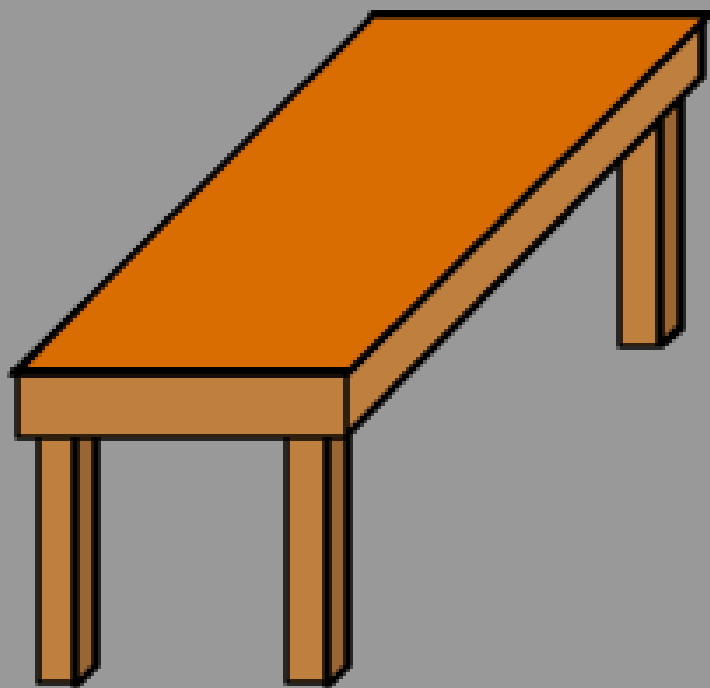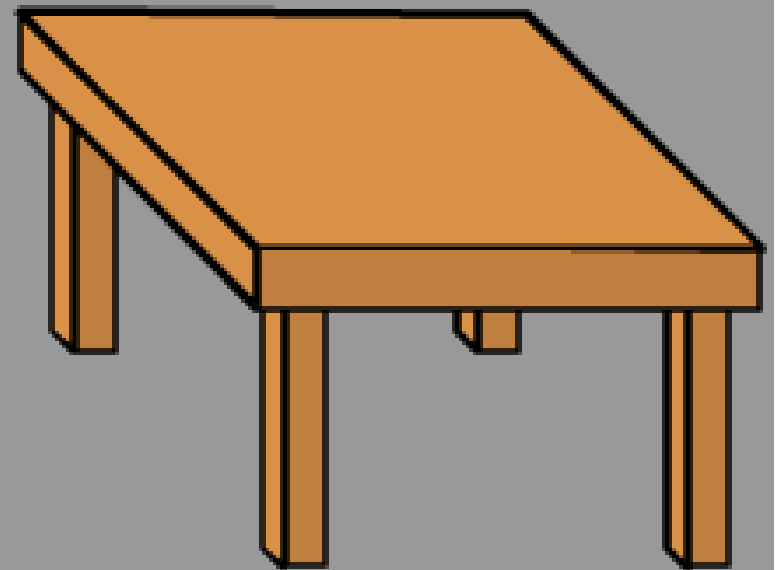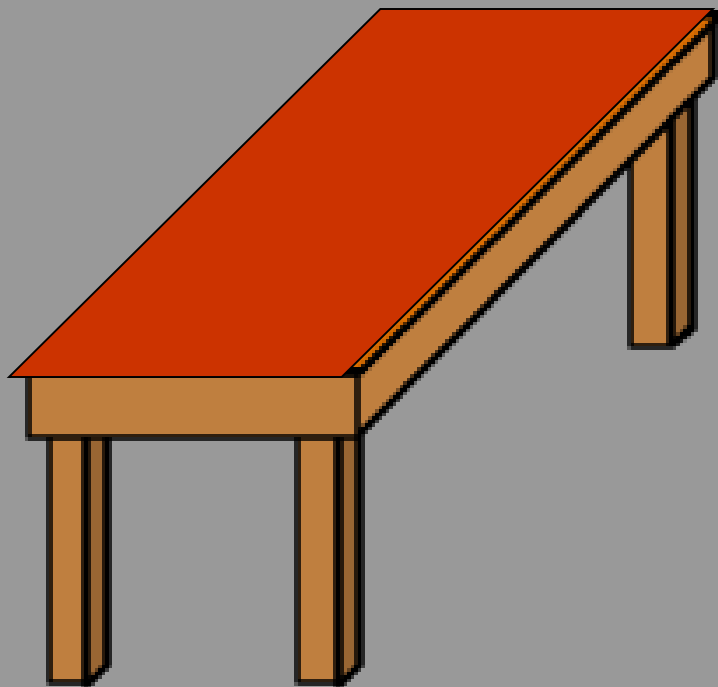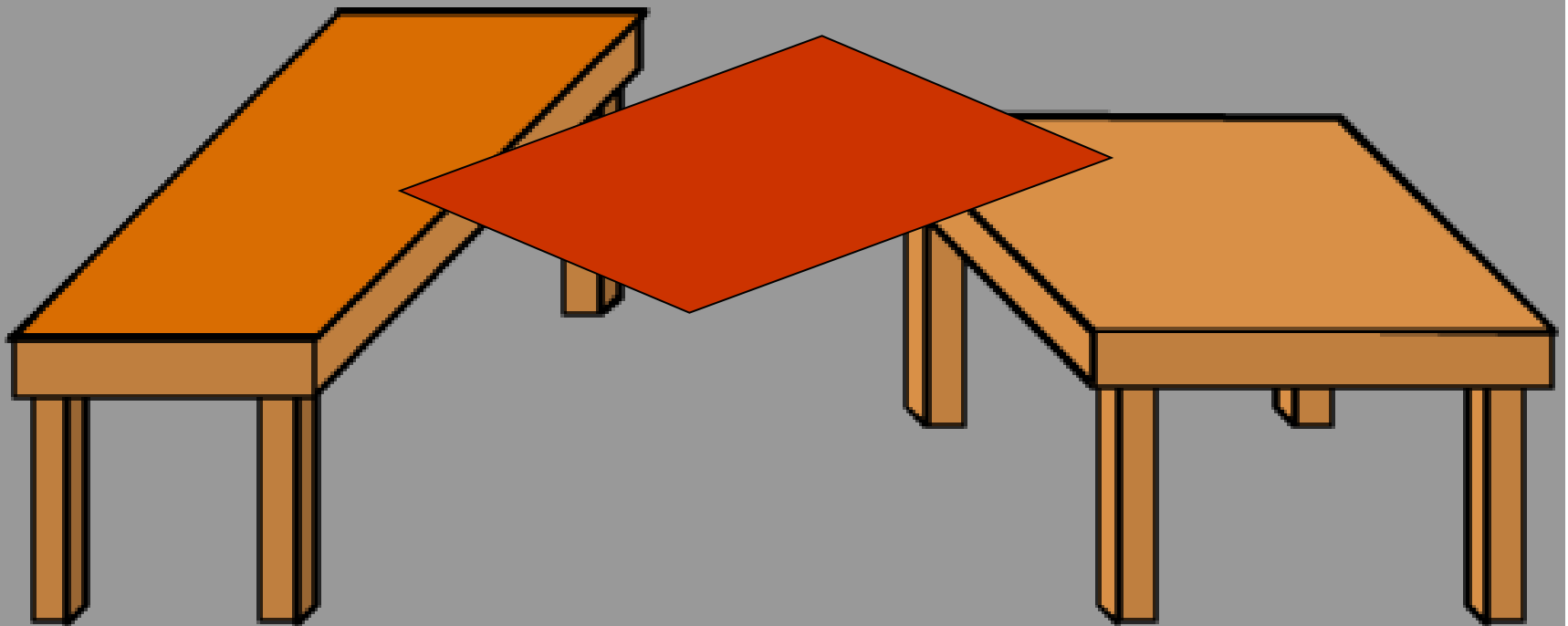
©2005 M.Bach
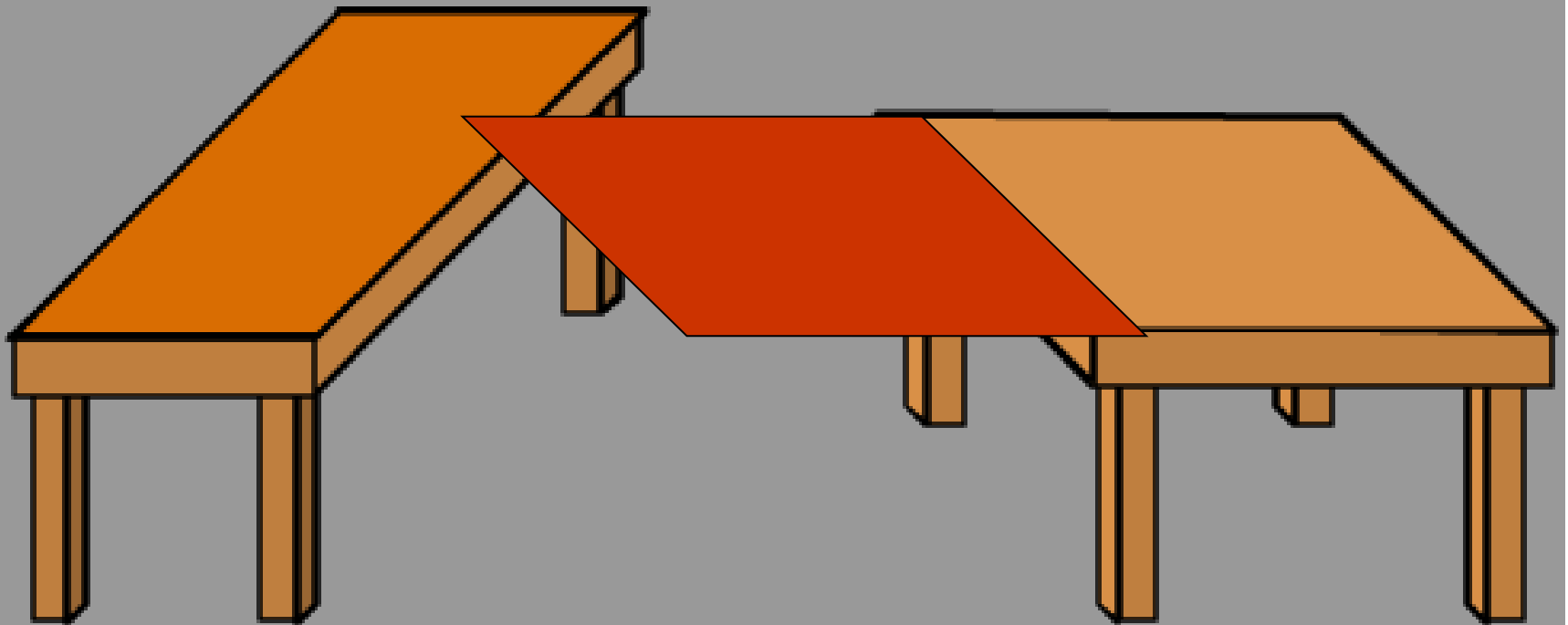
Stereotypes about men?

Men

- Strong
- Decisive
- Independent
- Logical/Rational
- Lack emotions
- Good at math

Stereotypes about women?

Men

- Strong
- Decisive
- Independent
- Logical/Rational
- Lack emotions
- Good at math

Women

- Nurturing
- Nice
- Supportive/Helpful
- Emotional
- Sympathetic
- Verbal

Stereotypes about scientists?
Stereotypes about engineers?

Men

- Strong
- Decisive
- Independent
- Logical/Rational
- Lack emotions
- Good at math

"Scientist"
?
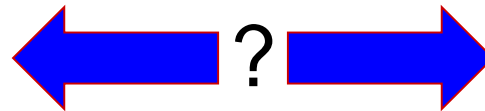
Women

- Nurturing
- Nice
- Supportive/Helpful
- Emotional
- Sympathetic
- Verbal

Men

- Strong
- Decisive
- Independent
- Logical/Rational
- Lack emotions
- Good at math
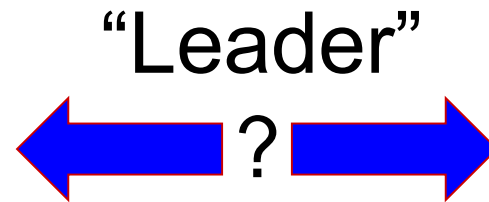
Women

- Nurturing
- Nice
- Supportive/Helpful
- Emotional
- Sympathetic
- Verbal

"Engineer"

?

Men

- Strong
- Decisive
- Independent
- Logical/Rational
- Lack emotions
- Good at math

Women

- Nurturing
- Nice
- Supportive/Helpful
- Emotional
- Sympathetic
- Verbal

"Leader"
?

Measuring Unconscious Bias: Gender-and-Leadership IAT Gender-and-Science IAT

Logic of the IAT

- IAT provides a measure of the strength of associations between mental categories such as "male or female" and attributes such as "leader or supporter," and "science or humanities" disciplines

- Strength of association between each category and attribute is reflected in the time it takes to respond to the stimuli while trying to respond rapidly

- Trial Types

Congruent Trials

Say "LEFT" for

Leader

OR

Men

Say "RIGHT" for

Supporter

OR

Women

Congruent Trials

Say "LEFT" for   **Say "RIGHT" for**

Science   **Humanities**

OR   OR

Men   **Women**

Incongruent Trials

Say "LEFT" for

Leader

OR

Women

Say "RIGHT" for

Supporter

OR

Men

Incongruent Trials

Say "LEFT" for   **Say "RIGHT" for**

Science   **Humanities**
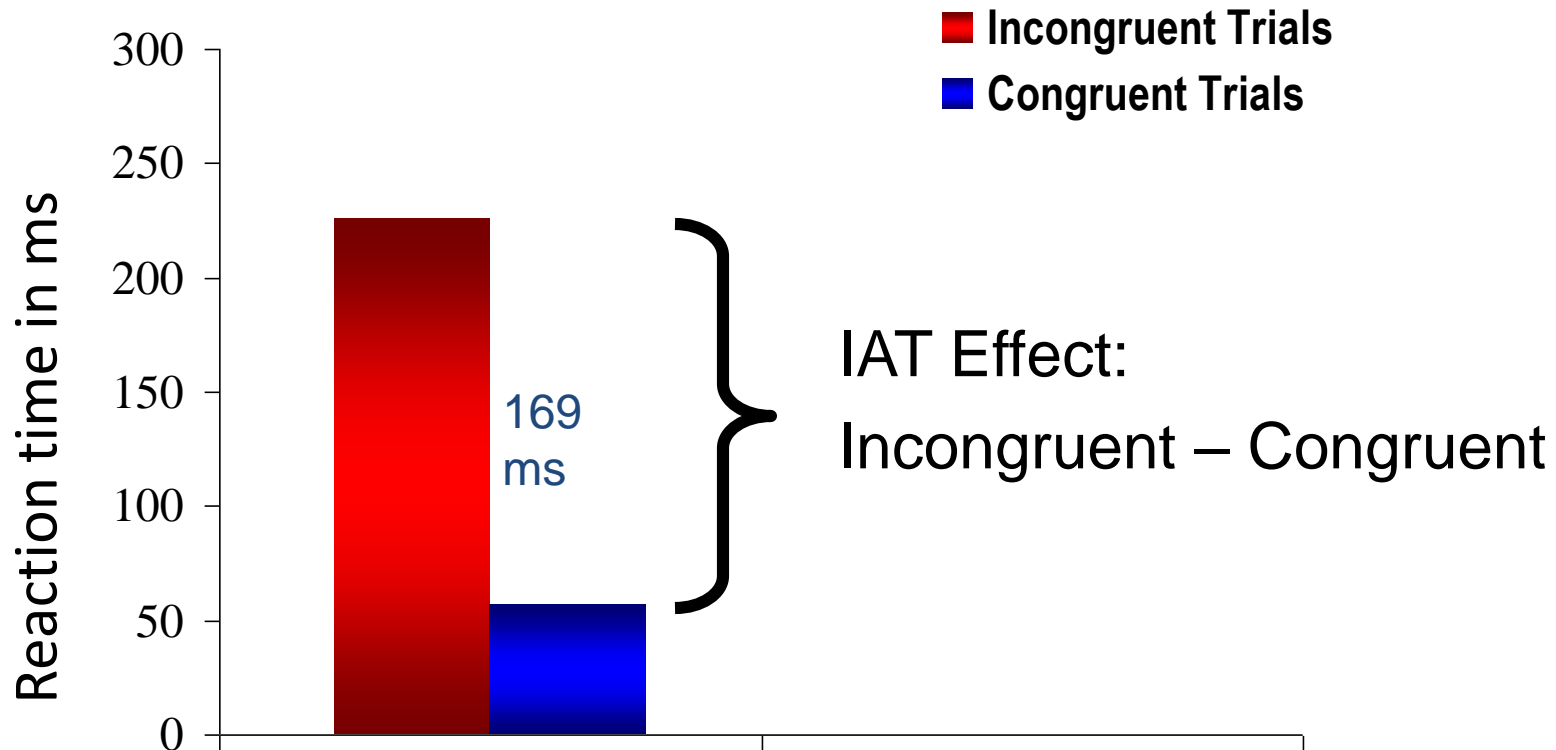
OR   OR

Women   **Men**

IAT Effect

The larger the difference, the greater the bias in associating men with leaders/science and women with supporters/humanities

Gender-Leadership IAT Scores
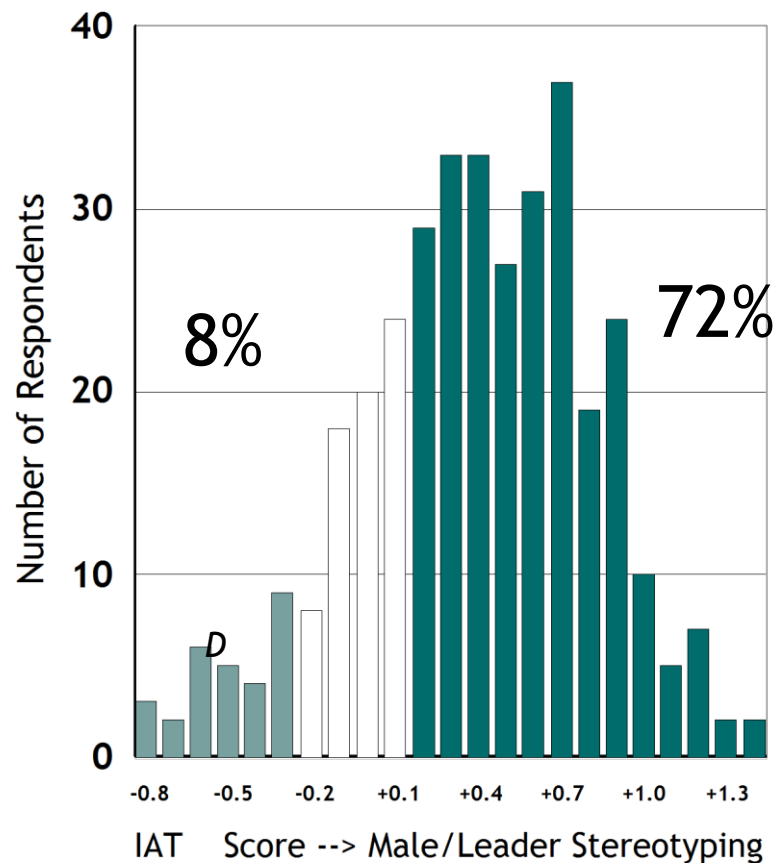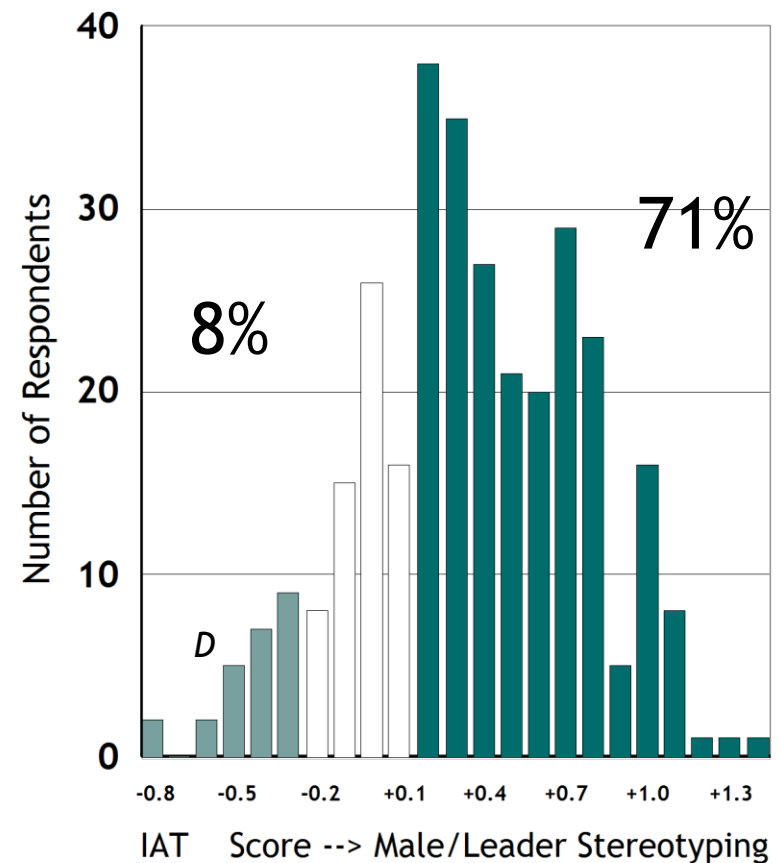
Gender-Science IAT Scores
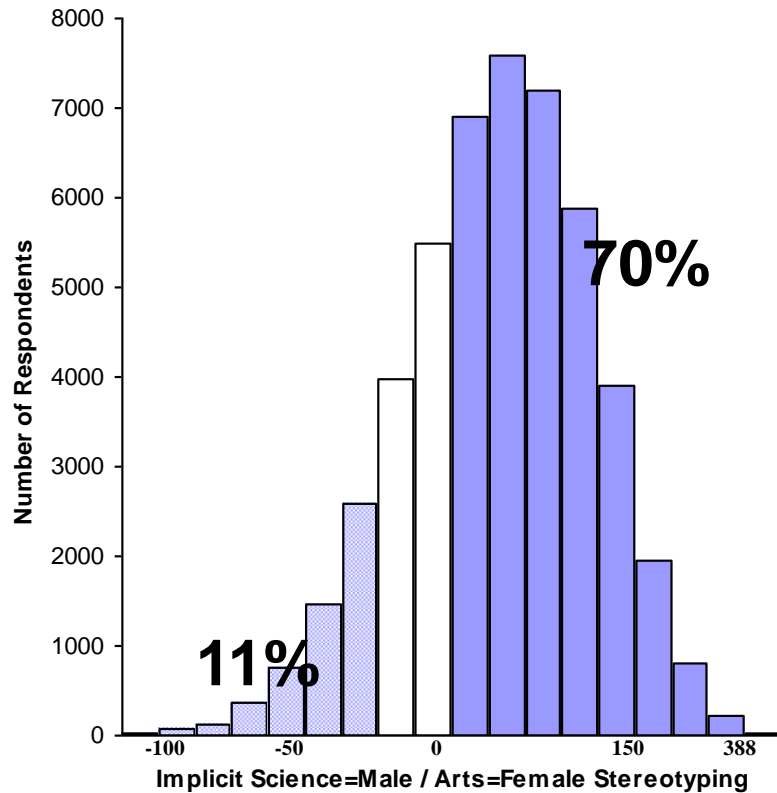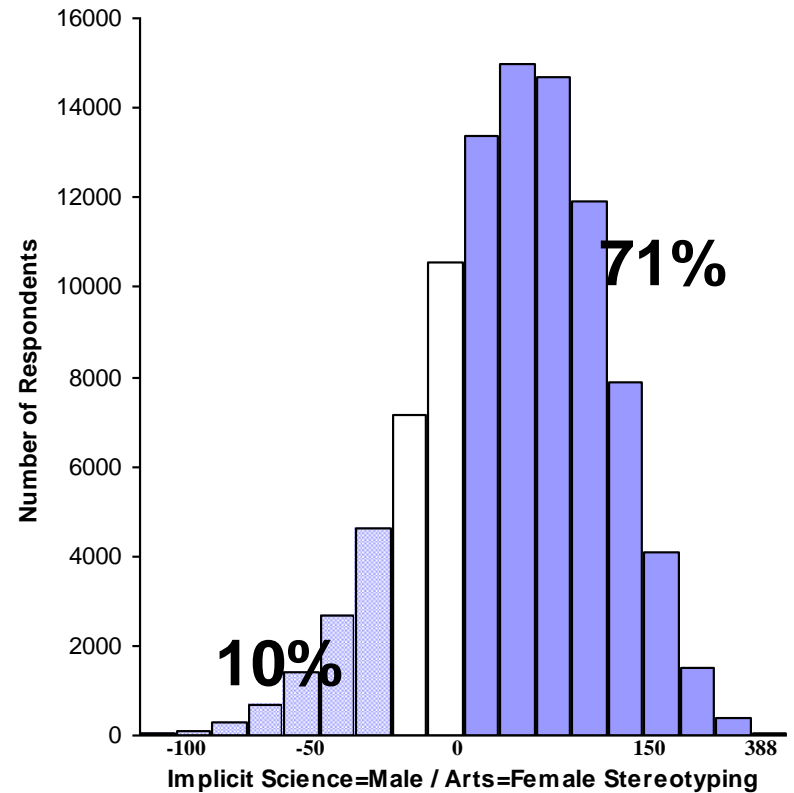
Influence of Implicit Bias on Women in STEMM

Implicit bias has consequences for "evaluators" and for individuals being evaluated.

Consequences for "evaluators"

- Parents/teachers/counselors provide help, mentoring, and advice based on *assumptions* of students' interests & abilities -- may steer women away from "male" or "intellectually challenging" fields or toward jobs more closely aligned with stereotypes.

- Evaluators view credentials in ways that conform to gender role expectations.

Implicit Bias: Hiring a Lab Manager

- 127 faculty from Physics, Chemistry and Biology departments
- Evaluated an application from an undergraduate science student for an entry-level Lab Manager.
  - Competence
  - Hireability
  - Likability
  - Starting Salary
  - Willingness to Provide Mentoring
- Application randomly assigned name "Jennifer" or "John"

C.A. Moss-Racusin, J.F. Dovidio, V.L. Brescoll, M.J. Graham & J. Handelsman. (2012). Science Faculty's Subtle Gender Biases Favor Male Students. *PNAS* 109 (41), 16474-16479.
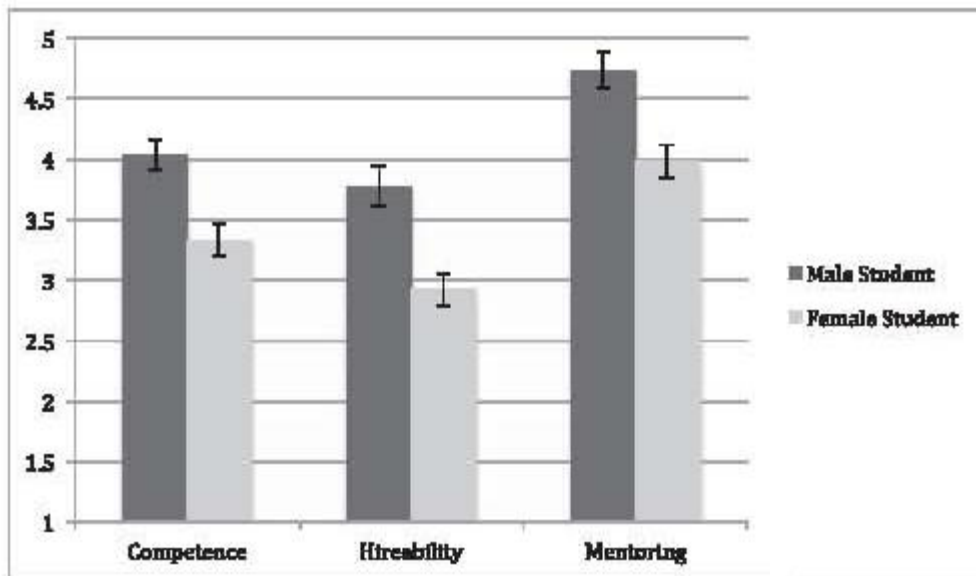
Fig. 1. Competence, hireability, and mentoring by student (collapsed across faculty gender). All student gender differenc (P < 0.001). Scales range from 1 to 7, with higher numbers re extent of each variable. Error bars represent SEs. $n_{\text{male stu}}$ $n_{\text{female student condition}} = 64$.

Fig. 2. Salary conferral by student gender condition (collapsed across faculty gender). The student gender difference is significant (P < 0.01). The scale ranges from $15,000 to $50,000. Error bars represent SEs. $n_{\text{male student condition}} = 63$, $n_{\text{female student condition}} = 64$.

Implicit Bias: Hiring a Lab Manager

Mentoring Questions – How likely are you to:

- Encourage the applicant to stay in the field if s/he was considering changing majors?

- Encourage the applicant to continue to focus on research if s/he was considering switching focus to teaching?

- Give the applicant extra help if s/he was having trouble mastering a difficult concept?

C.A. Moss-Racusin, J.F. Dovidio, V.L. Brescoll, M.J. Graham & J. Handelsman. (2012). Science Faculty's Subtle Gender Biases Favor Male Students. *PNAS* 109 (41), 16474-16479.

Minimizing Implicit Bias in Evaluation

- More information about individual applicants minimizes bias

- Individuation minimizes bias
  - Establish rapport and professional relationships with faculty
  - Work in a lab/seek out internships
  - Networking

Influence of Implicit Bias on Women in STEMM

Implicit bias has consequence for "evaluators" and for individuals being "evaluated."

Consequences for individuals being "evaluated"

- Stereotype Threat
- Individuals may "choose" jobs/fields of study that conform to the stereotypes of their group
- Individuals may drop out of fields they have chosen due to lack of encouragement/sense of not belonging
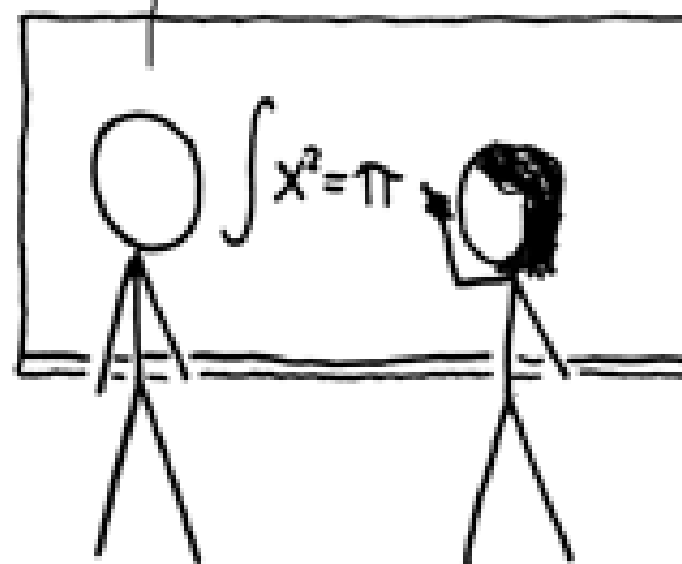
Stereotype Threat

Members of negatively stereotyped groups may underperform when reminded of their group membership
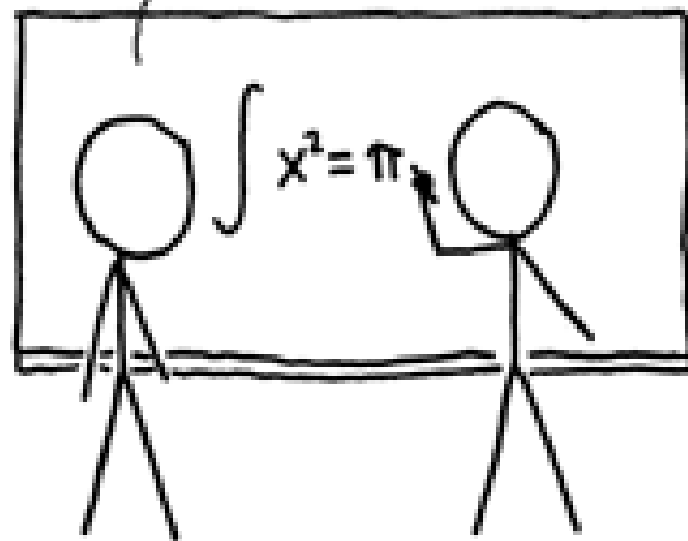
Multiple Studies of Stereotype Threat

- Black students' taking GRE Verbal – under two conditions: testing intellectual ability vs. testing psychological factors involved in solving verbal problems.
Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*(5), 797–811.

- Asian women taking a difficult mathematics test –primed to think about their ethnic identity vs. primed to think about their gender identify.
Shih, M., & Pittinsky, T. L. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science*, *10*(1), 80–83.

- White men students at Stanford U. with high scores on the math SAT took a challenging math test under two conditions – primed with information Asian students perform better than White students on tests of math ability vs. no priming.
 Aronson, J., & Lustina, M. J. (1999). When white men can't do math: Necessary and sufficient factors in stereotype threat. *Journal of Experimental Social Psychology*, *35*(1), 29–46.

Stereotype Threat: Images in science textbooks

- 81 9th- and 10th grade students (29 male, 52 female) – never taken a chemistry course

- Read a section of a chemistry text under 3 conditions:
  - Only male scientists pictured (stereotypic)
  - Only female scientists pictures (counter-stereotypic)
  - Both male and female scientists pictured
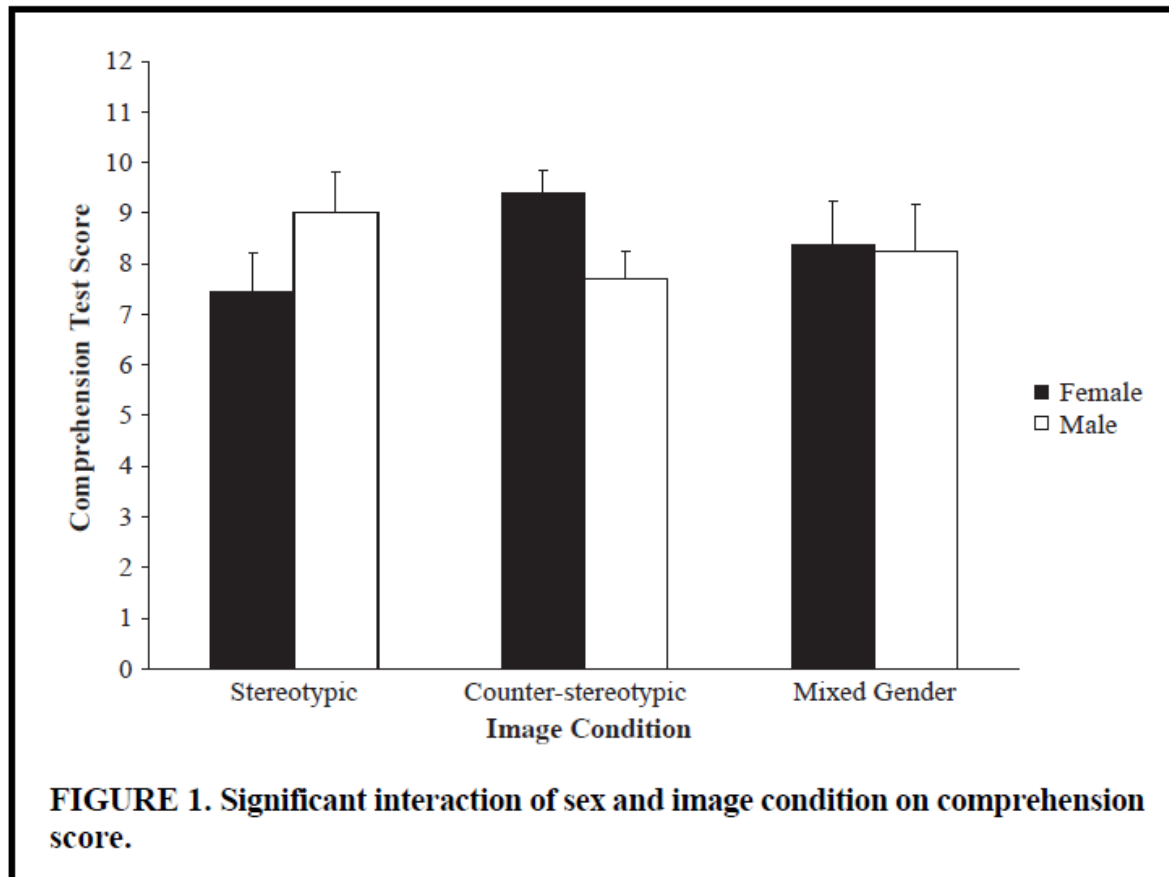
Good, J.J., J.A. Woodzicka, & L.C. Wingfield. (2010). The Effects of Gender Stereotypic and Counter-Stereotypic Textbook Images on Science Performance. *Journal of Social Psychology* 150(2), 132-147.

Stereotype Threat:
Images in science textbooks

FIGURE 1. Significant interaction of sex and image condition on comprehension score.

Good, J.J., J.A. Woodzicka, & L.C. Wingfield. (2010). The Effects of Gender Stereotypic and Counter-Stereotypic Textbook Images on Science Performance. *Journal of Social Psychology* 150(2), 132-147.

Stereotype Threat
When Choosing a Major

- 39 undergraduate students, non-declared major

- Entered room in two conditions:
  - Stereotypical computer science objects
  - Non-stereotypical objects

- Filled out a career assessment questionnaire – included measuring level of interest in taking a course or majoring in computer science

Cheryan, S., V.C. Plaut, P. Davies, & C.M. Steele. (2009). Ambient Belonging: How Stereotypical Cues Impact Gender Participation in Computer Science. *Journal of Personality and Social Psychology* 97, 1045-1060.

Classroom Environments

Stereotypical room

Star Trek poster

Sci Fi books

Coke cans

Classroom Environments

Non-stereotypical room

Nature poster

Neutral books

Water bottles

Environment influences women's interest in CS

Interaction: $F_{(1, 35)} = 10.22, p < .01$

Chervan, Plaut, Davies & Steele. *Journal of Personality & Social Psychology.* 2009
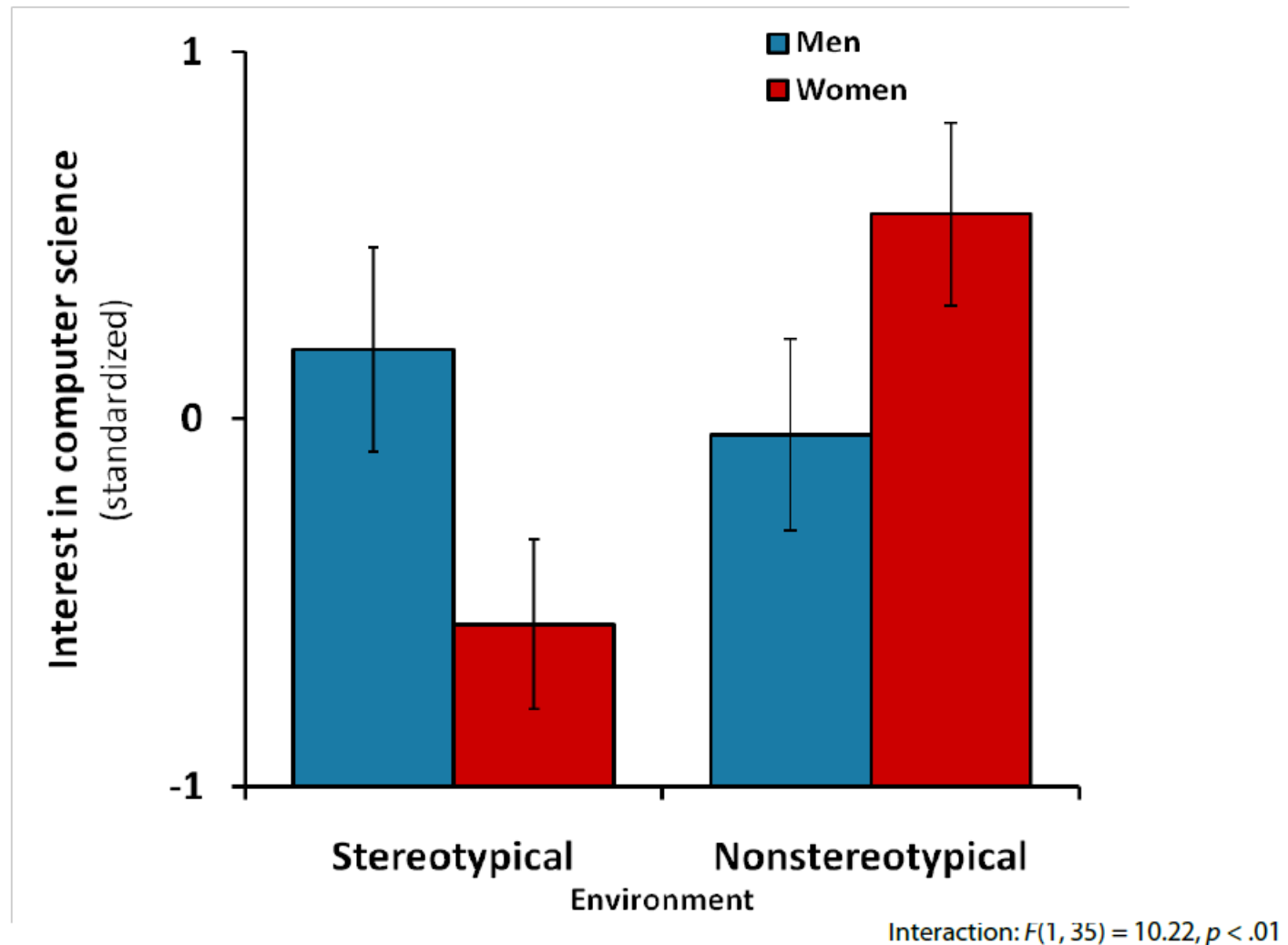
Strategies to Reduce the Influence of Implicit Bias/Stereotype Threat

- **Knowledge**
  Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance. *Psychological Science*, *16*(3), 175–179.

- **Growth Mindsets (vs. fixed mindsets)**
  http://mindsetonline.com

- **Sense of Belonging**
  - Microenvironments – small study groups with mostly female peers
    DasGupta, N., McManus Scircle, M., & Hunsinger, M. (2015) Female peers in small work groups enhance women's motivation, verbal participation, and career aspirations in engineering. PNAS, 112(10): 40888-4993.
  - Role models
  - Images/awareness of women scientists/engineers and their accomplishments
    Good, C., Rattan, A., & Dweck, C. S. (2012). Why Do Women Opt Out? Sense of Belonging and Women's Representation in Mathematics. *Journal of Personality & Social Psychology*, *102*(4), 700–717.

  http://www.reducingstereotypethreat.org/reduce.html

Strategies to Reduce the Influence of Implicit Bias/Stereotype Threat

Strategies to reduce stereotype threat (Cont.)

- Priming with positive counter-stereotypic images

- Values Affirmation

Cohen, G. L., Garcia, J., Apfel, N., & Master, A. (2006). Reducing the racial achievement gap: A social-psychological intervention. *Science*, *313*(5791), 1307–1310.

Harackiewicz, J. M., Canning, E. A., Tibbetts, Y., Giffen, C. J., Blair, S. S., Rouse, D. I., & Hyde, J. S. (2014). Closing the Social Class Achievement Gap for First-Generation Students in Undergraduate Biology. *Journal of Educational Psychology*, *106*(2), 375–389.

- Stereotype Replacement

McGlone, M. S., & Aronson, J. (2007). Forewarning and Forearming Stereotype-Threatened Students. *Communication Education*, *56*(2), 119–133.

Minimizing the influence of bias

- Not necessarily easy

- With effort (awareness, motivation, and a sustained commitment), bias can be reduced
  - Can expect that you may slip up
  - Stay committed

- Strategies we provided are powerful tools to combat implicit biases
  - Implicit responses can be brought into line with explicit beliefs and commitments