

# The plan

- 20 minutes (John)



**Science faculty's subtle gender biases favor male students**

Corinne A. Moss-Racusin<sup>a,b</sup>, John F. Dovidio<sup>b</sup>, Victoria L. Brescoll<sup>c</sup>, Mark J. Graham<sup>a,d</sup>, and Jo Handelsman<sup>a,1</sup>

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Edited\* by Shirley Tilghman, Princeton University, Princeton, NJ, and approved August 21, 2012 (received for review July 2, 2012)

Despite efforts to recruit and retain more women, a stark gender gender disparity in science (9–11), and that it “is not caused

- 20 minutes (Sandro)



LETTERS

PUBLISHED: 26 MAY 2017 | VOLUME: 1 | ARTICLE NUMBER: 0141

**Quantitative evaluation of gender bias in astronomical publications from citation counts**

Neven Caplar<sup>\*</sup>, Sandro Tacchella<sup>\*</sup> and Simon Birrer

Numerous studies across different research fields have shown that both male and female referees consistently give higher scores to work done by men than to identical work done by number of references), we have to be careful when interpreting the quoted difference in the number of citations. We attempt to separate the gender bias effect from the effect caused by non-gender-specific

- 20 minutes (small groups + broad discussion)

# Underrepresentation of women in Science and Engineering

Figure 2-14  
**Women's share of S&E bachelor's degrees, by field: 2000-09**

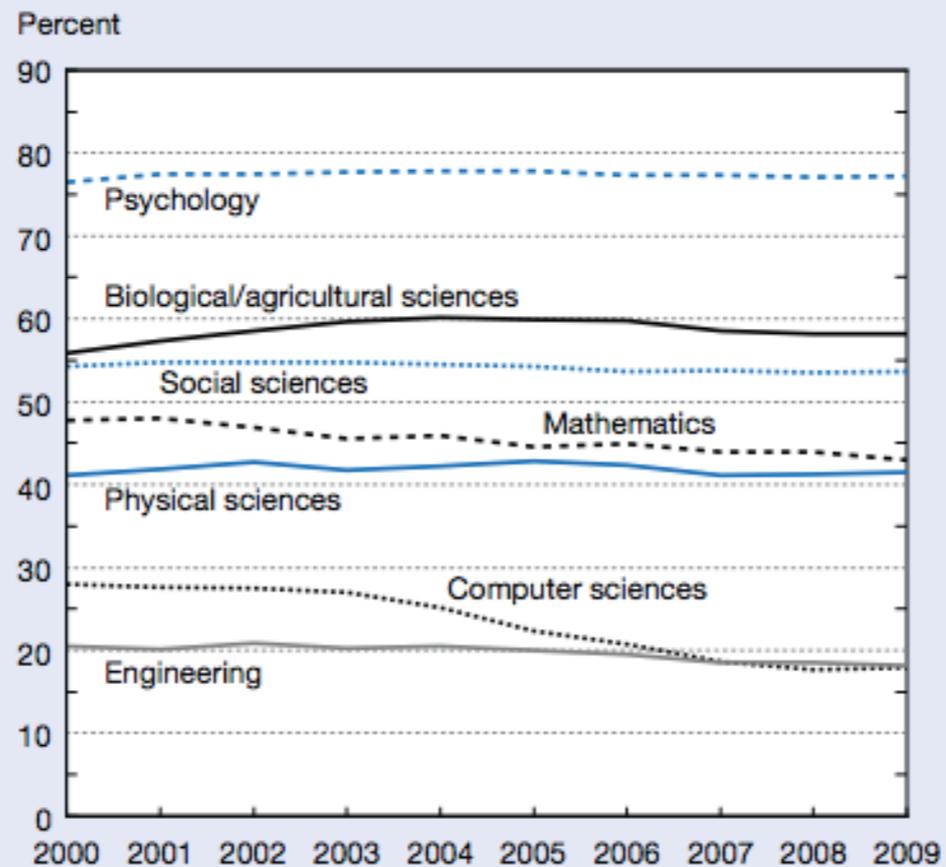
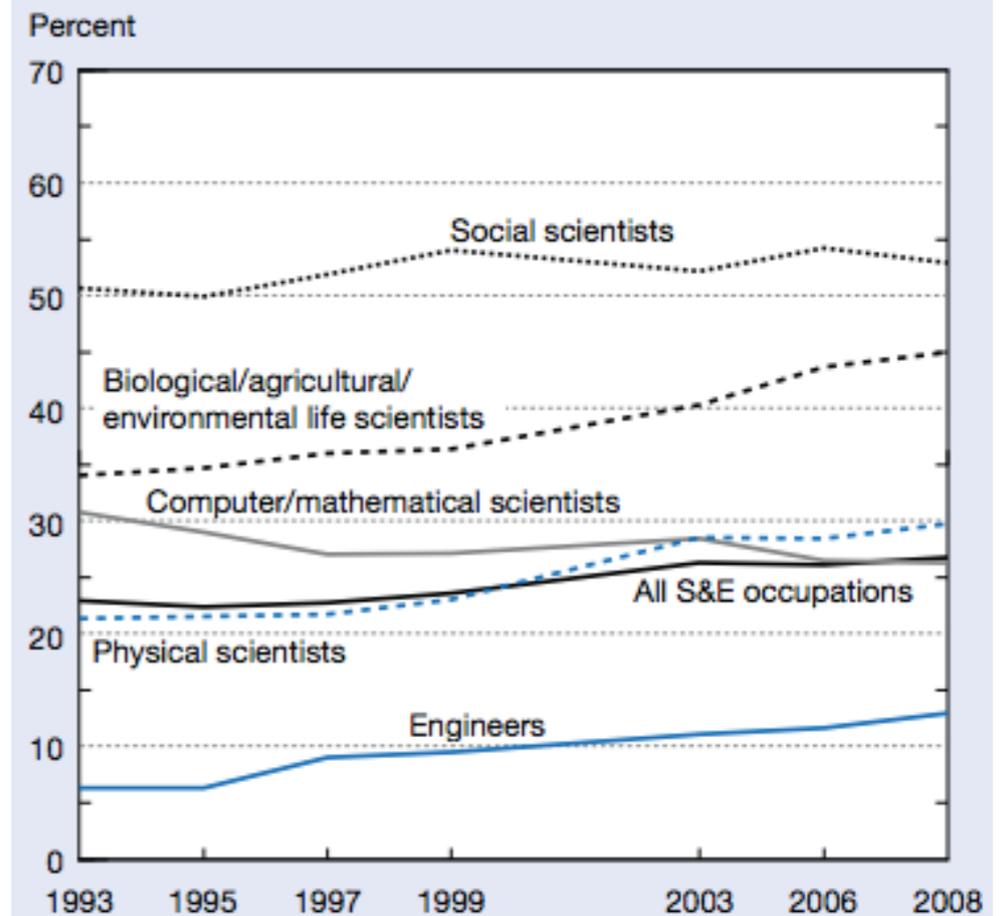


Figure 3-28  
**Women in S&E occupations: 1993-2008**



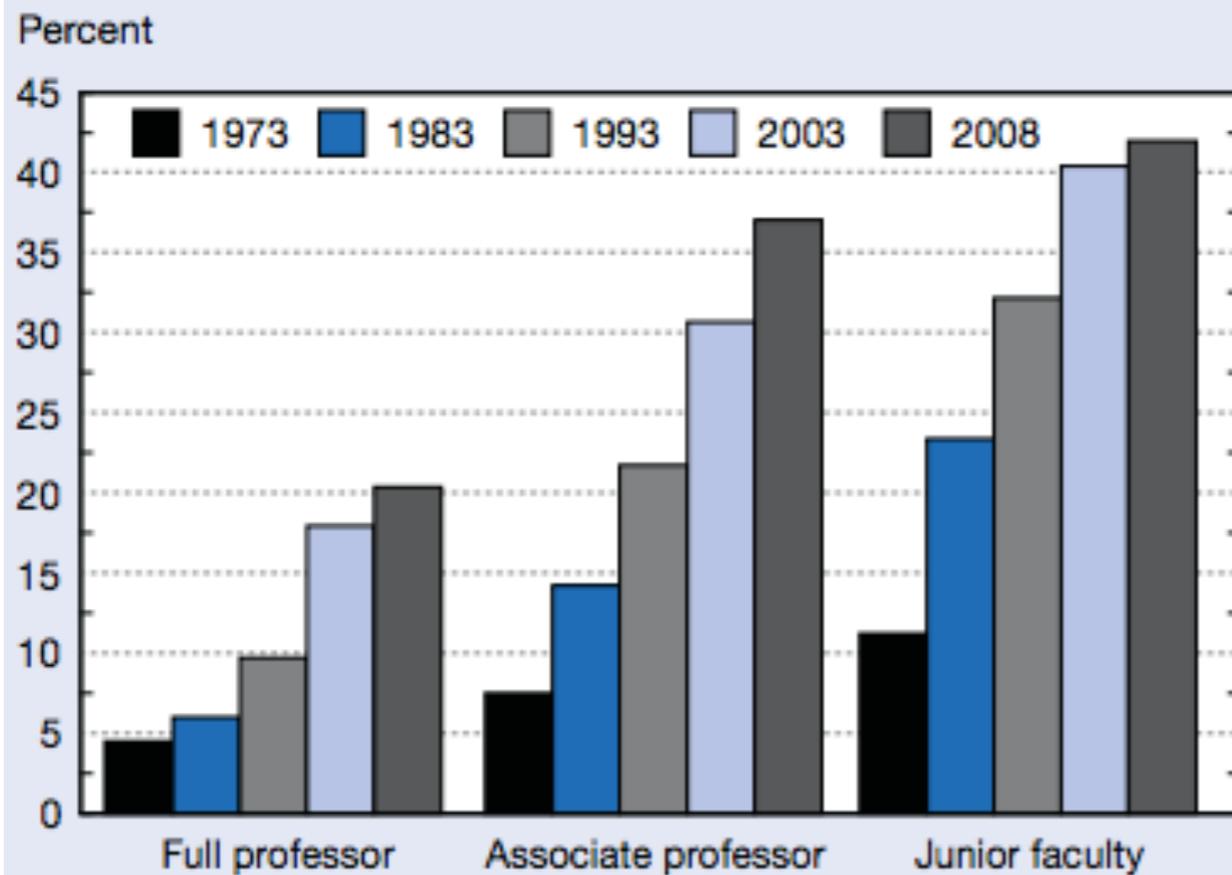
National Science Board

## SCIENCE AND ENGINEERING INDICATORS

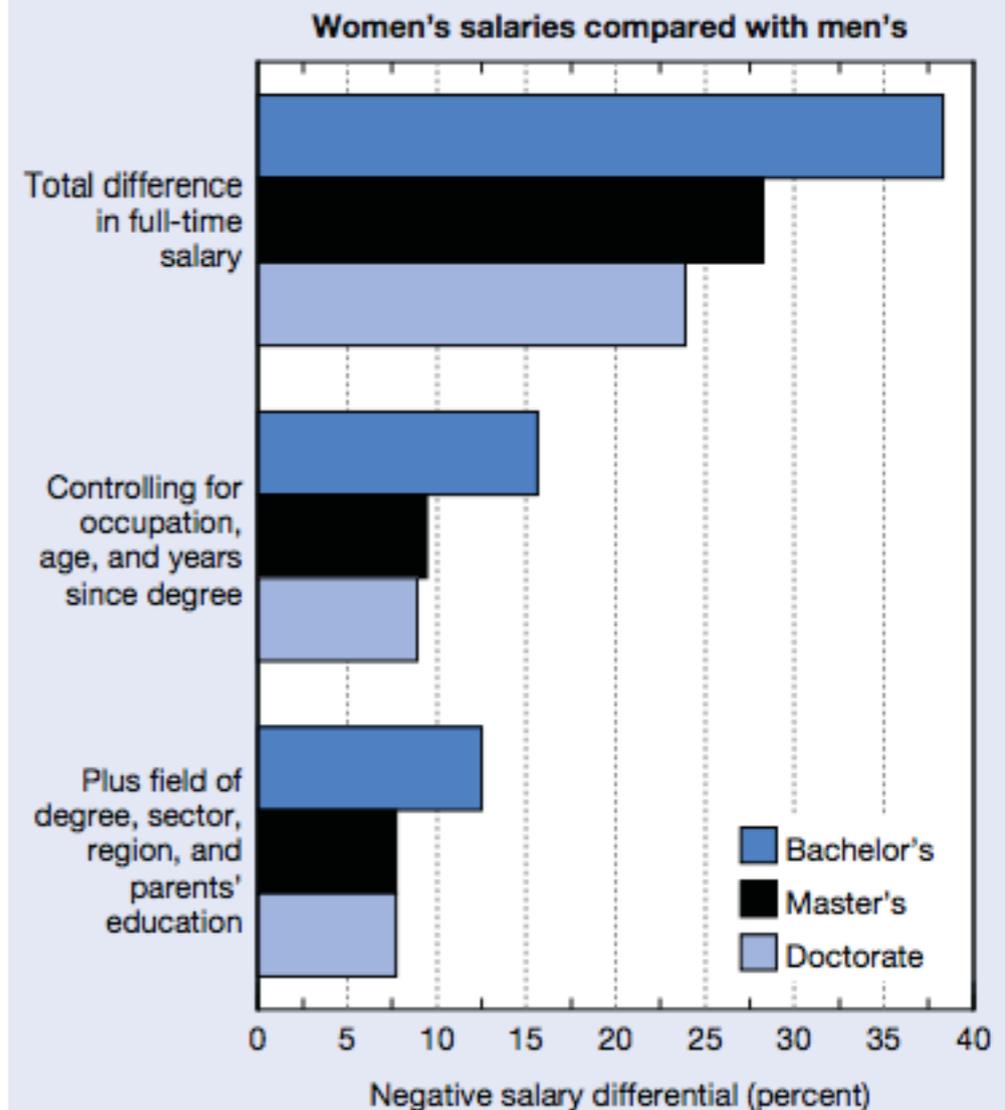


# Underrepresentation of women in Science and Engineering

**Figure 5-15**  
**Women as percentage of SEH doctorate holders with full-time employment in academia, by academic rank: Selected years, 1973–2008**



**Figure 3-32**  
**Estimated differences in full-time salary between women and men with highest degree in S&E, controlling for selected employment and other characteristics, by degree level: 2008**



# The paper

PNAS

## Science faculty's subtle gender biases favor male students

Corinne A. Moss-Racusin<sup>a,b</sup>, John F. Dovidio<sup>b</sup>, Victoria L. Brescoll<sup>c</sup>, Mark J. Graham<sup>a,d</sup>, and Jo Handelsman<sup>a,1</sup>

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Science faculty's subtle gender b

<https://www.ncbi.nlm.nih.gov/pubmed/229>

by CA Moss-Racusin - 2012 - Cited by 1112 -

# Why the gender imbalance?

- “evidence [suggests] biological sex differences in inherent aptitude for math and science are small or nonexistent”
- Claims by some that “women’s preference for nonscience disciplines and their tendency to take on a disproportionate amount of child- and family-care are the primary causes of the gender disparity”, but these studies are correlational
- Moss-Racusin et al’s approach: do an experiment to directly test for gender **bias**

# Procedure

- 3 “geographically diverse” regions in the U.S.
- 1 private & 1 public school from each
- Schools matched in size and prestige at undergrad & grad level
- Identify physics, chemistry, biology depts. (23 total)
- Select tenure-track non-emeritus faculty
- Request their participation in a [fake] study



# The cover story

*To study this question, we have compiled and summarized information from **actual applications of students who have recently applied to be lab managers at universities across the country.***

# The cover story

*To study this question, we have compiled and summarized information from **actual applications of students who have recently applied to be lab managers at universities across the country.***

*Today, we will be assigning you to read the applicant profile of one randomly-selected student from the nationwide database. Please imagine that you are actually evaluating this student's application to work **in your own lab.** After reading the applicant profile, you will be asked to provide your opinions of the student, and offer them feedback as they make decisions about moving forward with their career.*

# The identical application everyone received

## DEMOGRAPHICS

**Participant ID #:** 149

**Name:** Jennifer [REDACTED]

**Gender:** Female

**Ethnic Background:** Caucasian

**Age:** 22

**Degree:** Bachelors of Science, obtained May 2011 from [REDACTED] University

## BACKGROUND

**GPA:** 3.2

**GRE score:** 650 verbal, 780 quant

**Awards/honors:** President's Service Award, Rotary Club College Scholarship

**Previous research experience:** 2 years as a research assistant working with 2 different faculty mentors

**Academic standing:** appears from Jennifer's transcript that she was in good standing upon graduation, but withdrew from 1 class prior to final

**Letters of recommendation:** 3 (2 from former faculty research supervisors, 1 from an intro science course professor), all supportive

**Future plans:** apply to doctoral programs

**Extracurricular activities:** student government, college learning center tutor

**Position sought:** Lab Manager

**Position duration:** 2 years, with possibility of renewal pending satisfactory performance

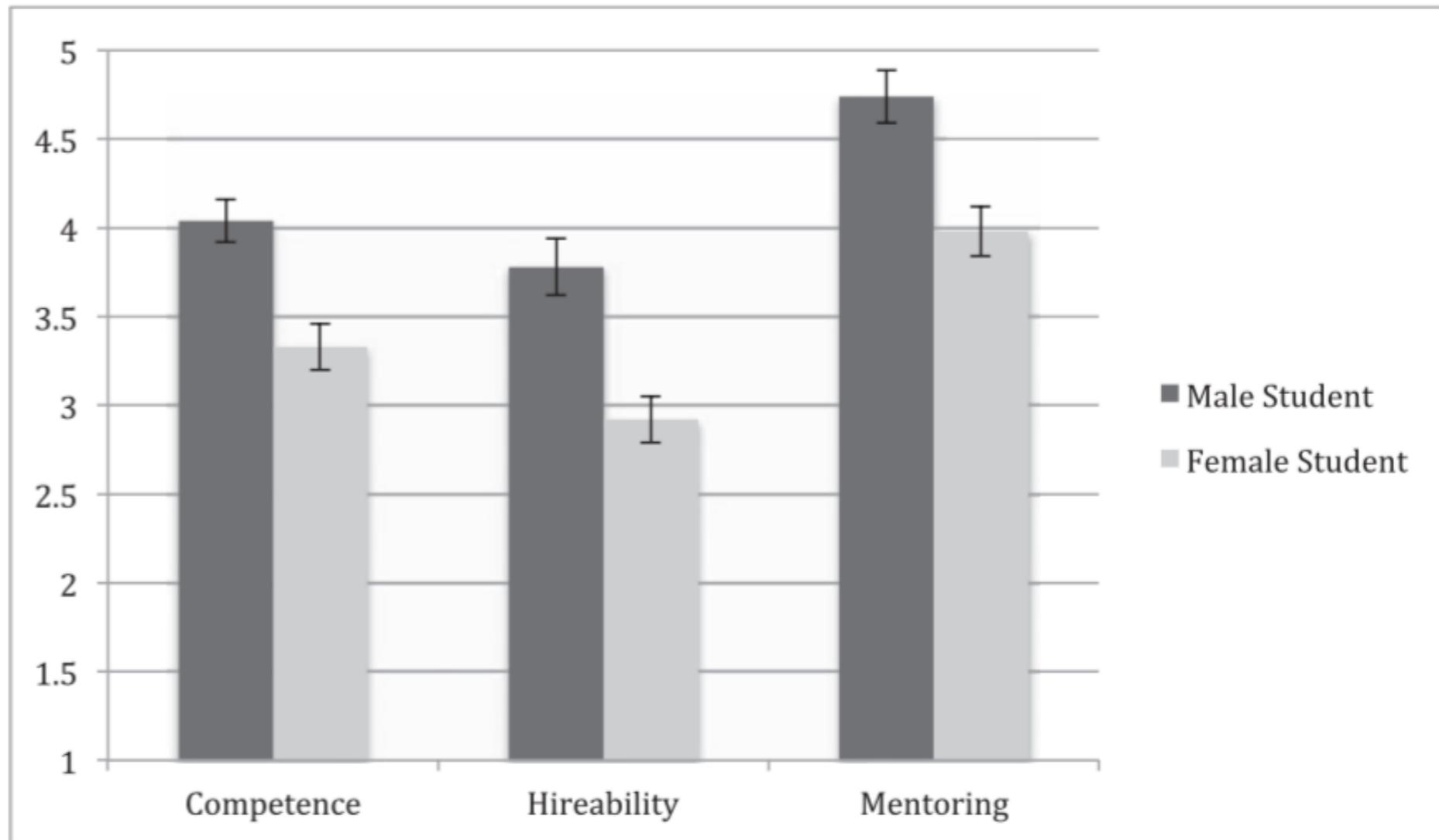
Designed to “reflect slightly ambiguous competence”

# Professors then answered the following

*Most of these questions are answered on a scale of 1 to 7.*

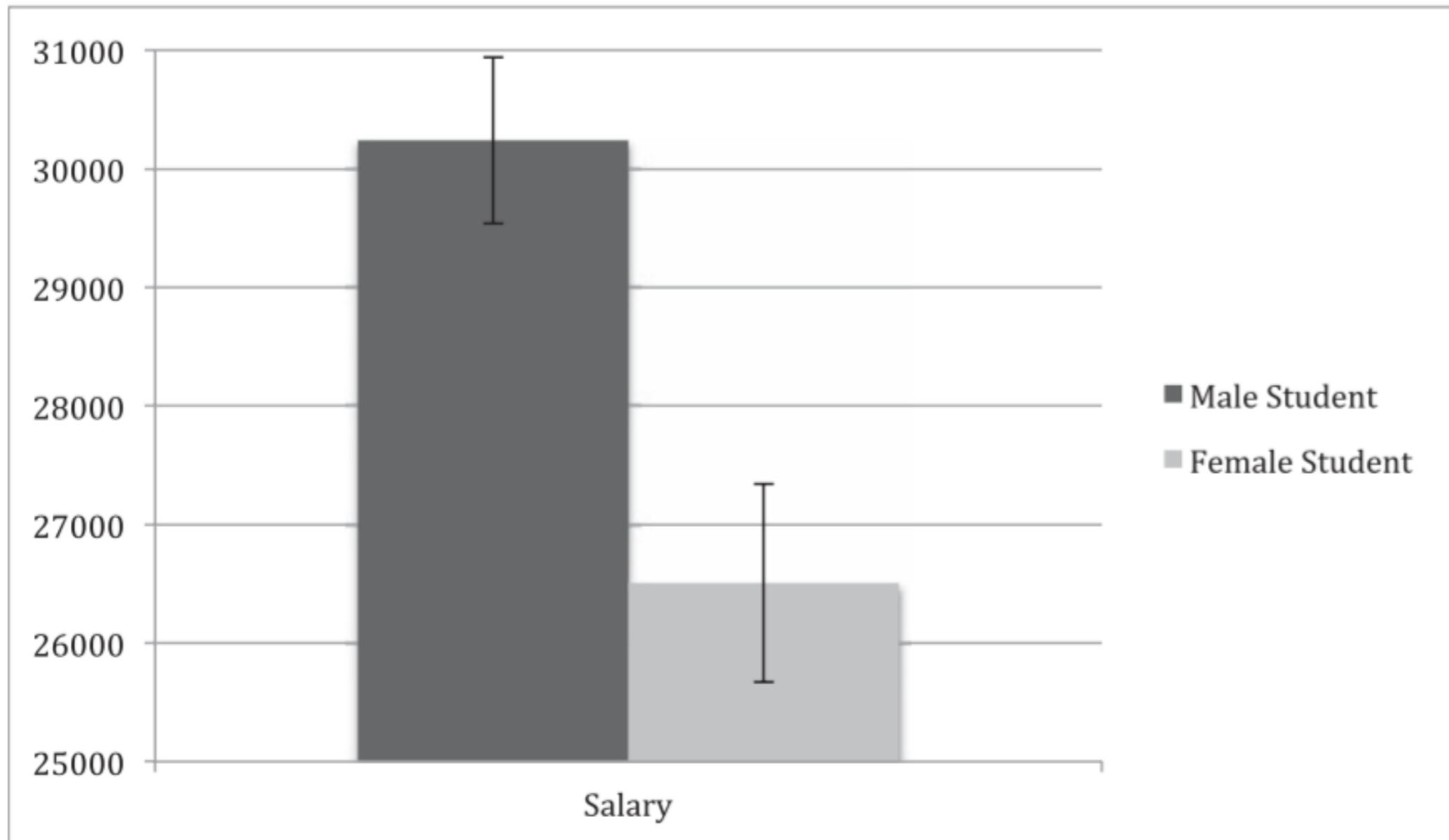
- Student **competence**
  - e.g. “How qualified do you think the applicant is?”
- Student **hireability**
  - e.g. “How likely would you be to hire the applicant?”
- **Salary** Conferral
  - “If you had to choose one of the following starting salaries for the applicant, what would it be?” \$15k, \$20k, \$25k, \$30k, \$35k, \$40k, \$45k, \$50k
- **Mentoring**
  - e.g. “If you encountered this student at your institution, how likely would you be to encourage the applicant to stay in the field if he/she were considering changing majors?”
- **Subtle Gender Bias**
  - e.g. on a scale of 1-7, how strongly do you agree “Discrimination against women is no longer a problem in the United States”
- **Likability**
  - e.g. “Would the applicant fit in well with other lab members?”

# Results: I



**Fig. 1.** Competence, hireability, and mentoring by student gender condition (collapsed across faculty gender). All student gender differences are significant

# Results: II



**Fig. 2.** Salary conferral by student gender condition (collapsed across faculty gender). The student gender difference is significant ( $P < 0.01$ ). The scale

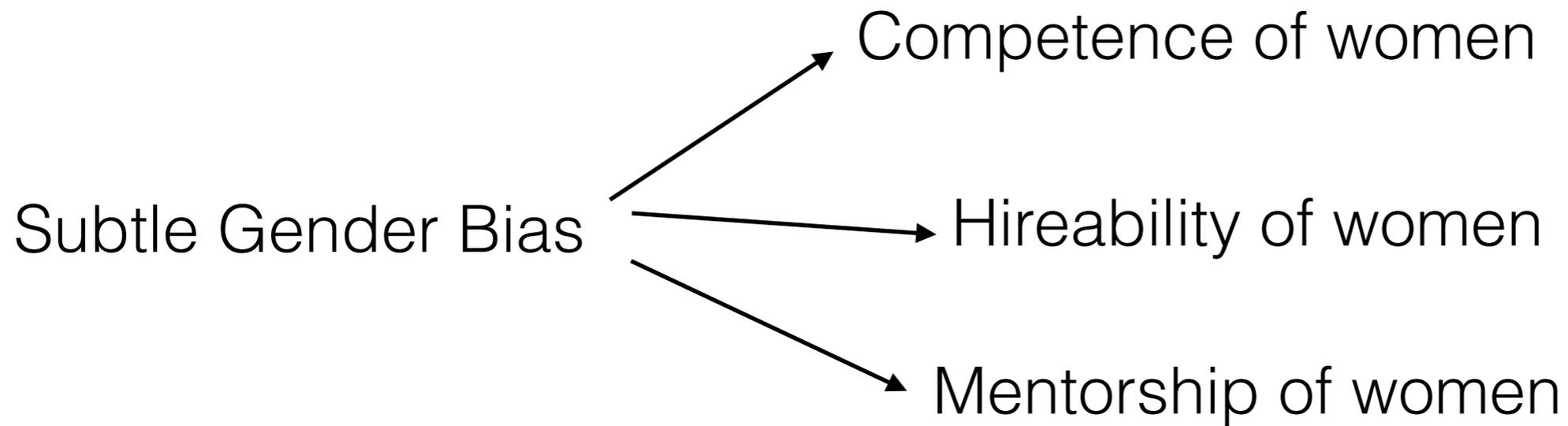
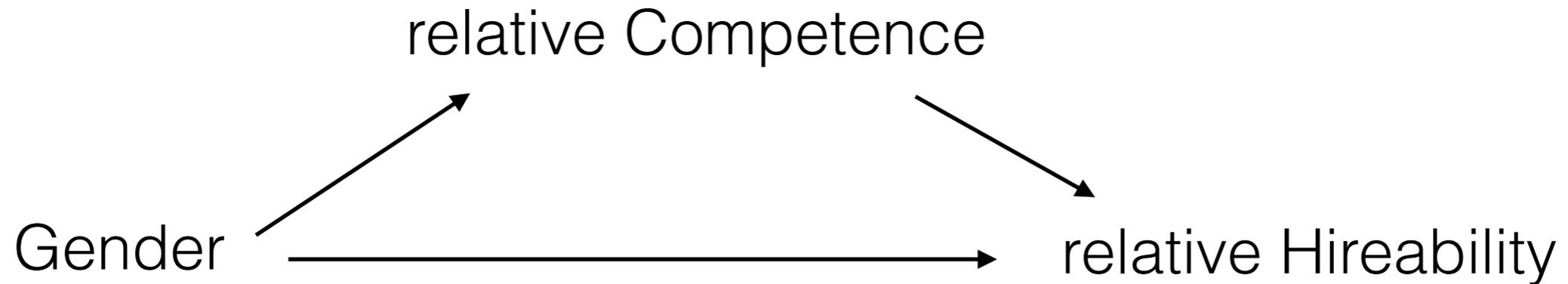
# Results: III



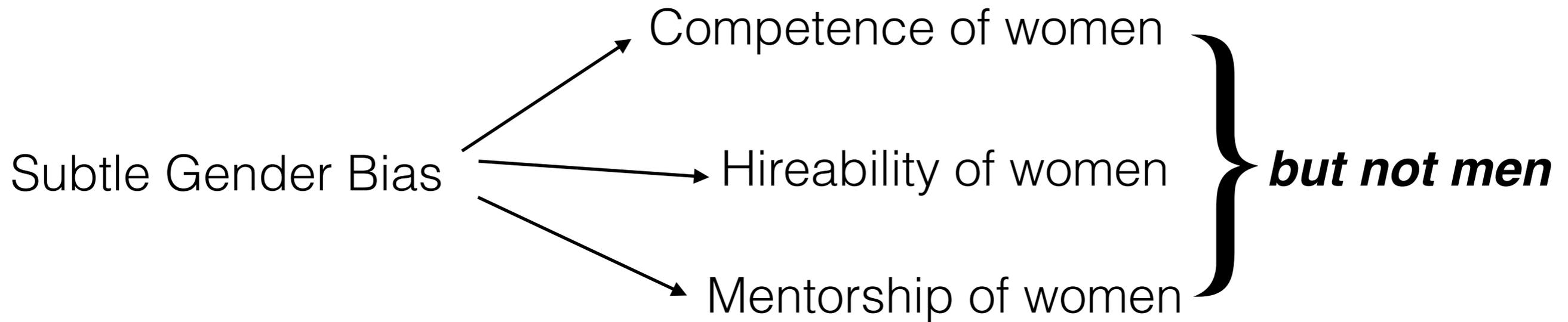
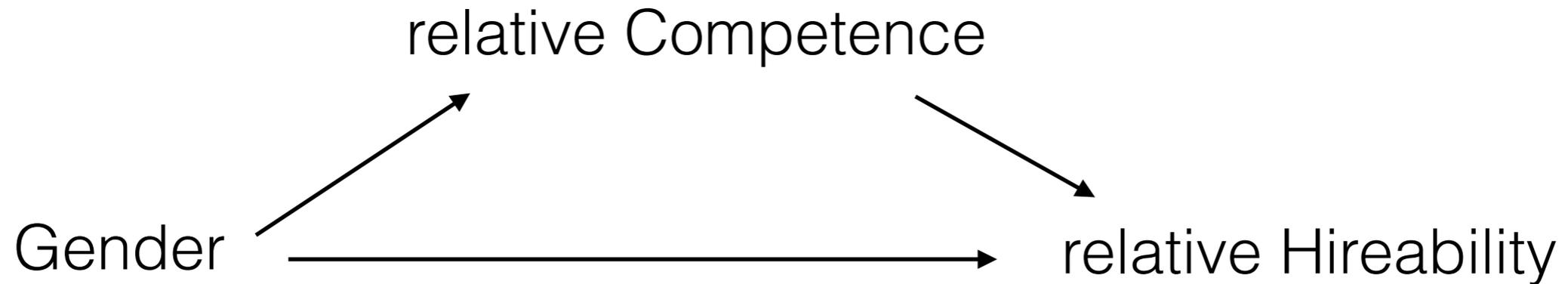
# Results: III



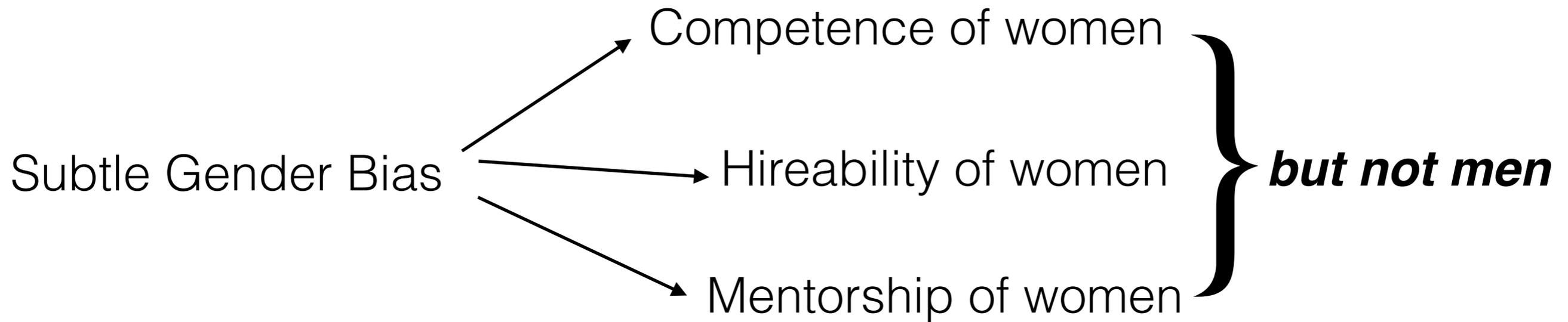
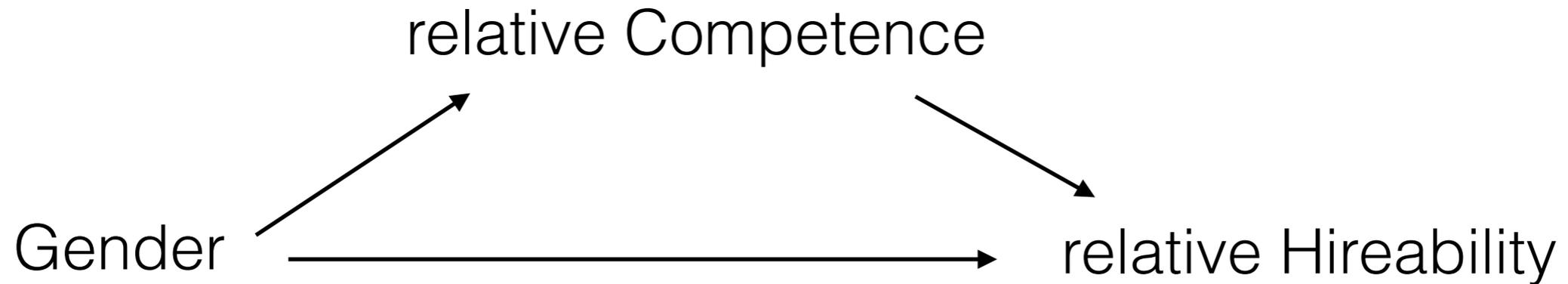
# Results: III



# Results: III



# Results: III



# The story

- Profs considered female students less **hirable**
- ... because they considered the female students less **competent**
- ... because of **subtle gender bias**
- Female and male profs were equally subject to this bias

# Suggestions for action

- “Our results suggest that academic policies and mentoring interventions targeting undergraduate advisors could contribute to reducing the gender disparity”
  - “educating faculty and students about the existence and impact of bias within academia”
  - “establishing objective, transparent student evaluation and admissions criteria”

# **Quantitative Evaluation of Gender Bias in Astronomical Publications from Citation Counts**

Neven Caplar, Sandro Tacchella & Simon Birrer



# Women in Science – Why so Few?

Meg Urry  
 Department of Physics, Yale University



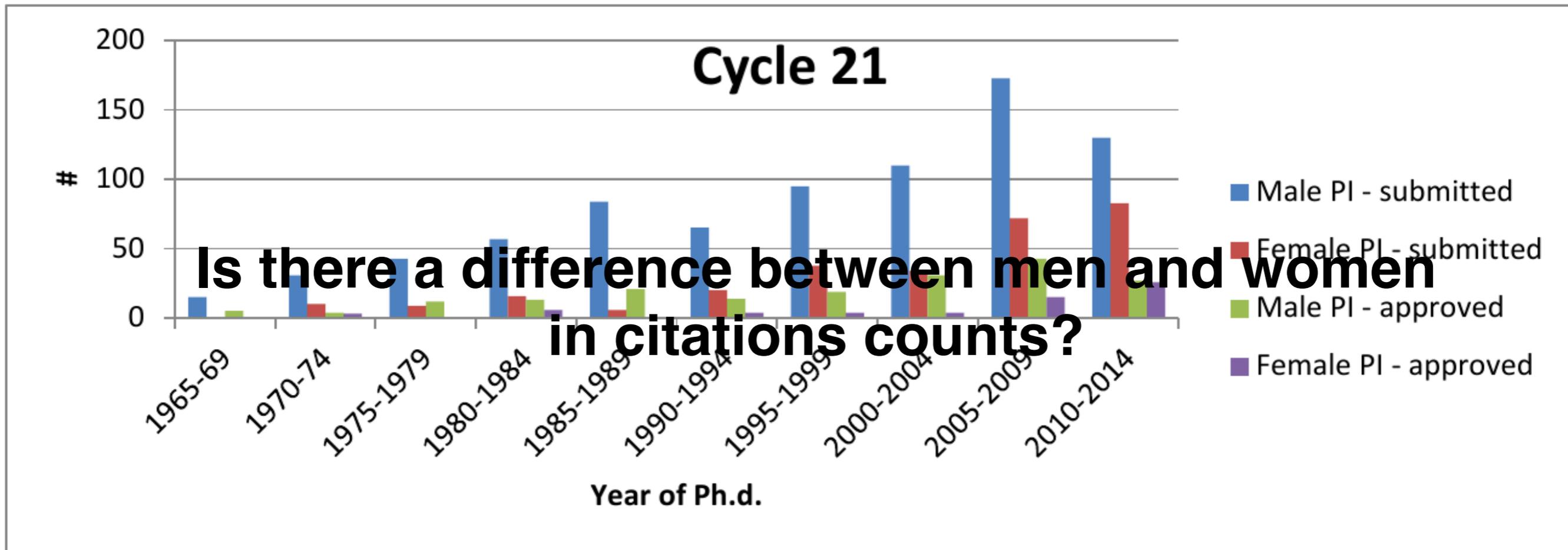
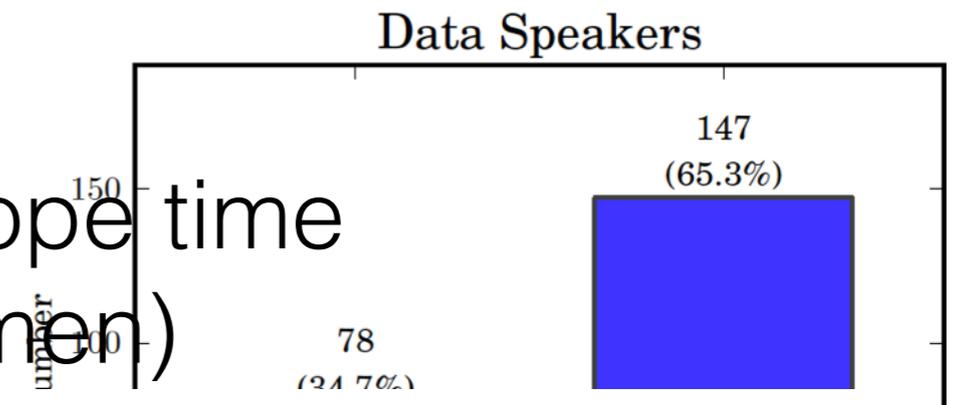
# Gender difference in astronomy

Davenport+14:

women ask less questions at conferences

Reid+14:

women are less likely to get telescope time  
(seems even more so for older women)



# Method

- gathering data
  - every paper in ADS database “astronomy” and published in Science, Nature, APJ, A&A, MNRAS from 1950 to 2015
  - all the information gathered in single effort in June 2016
  - if paper is available on arXiv, also record the subfield of the paper and download the source \*.tex file
- adding paper information
  - \*.tex file used to establish length of papers
  - subfield determined from abstract for papers where subfield is not recorded

# Method

- adding information about authors
  - Country of origin from affiliation
  - Seniority = time since the first paper in our database
  - Gender
    - We run the name through 3 different databases
      - \* SexMachine (40,000 names, done by native speakers)
      - \* Data from USA Social Security Administration and UK Office of National Statistics (highly complete but geographically limited)
      - \* Gender API (commercial service)
    - Agreement between databases around 98.5%

**Table 1A**  
Example of the data available (first 8 columns)

Bibcode	First Author <sup>1</sup>	First name	Gender	first publication year <sup>2</sup>	# citations	# references	# authors
1978ApJ...222..745C	Condon, J. J.	James	male	1973	19	22	2
1988ApJ...333..611W	Wilson, Christine D.	Christine	female	-99	18	14	5
1990MNRAS.246..565A	Aspin, C.	Colin	male	1981	19	26	4
1990Natur.345...49T	Torbett, Michael V.	Michael	male	1980	48	11	2
1992ApJ...392..760B	Burrows, Christopher J.	Christopher	male	1991	37	7	3
1993A&A...277..677M	Meier, R.	Roland	male	1993	97	77	4
1996A&A...309..171S	Shibanov, Y. A.	Yurii	male	1992	42	18	2
1997A&A...324L...5C	Cambresy, L.	Laurent	male	1997	58	12	8
2002A&A...381L..25M	Meynet, G.	Georges	male	1985	82	31	2
2002MNRAS.329L..67B	Ballantyne, D. R.	David	male	2000	31	29	3
2010ApJ...711.1310K	Khatri, Rishi	Rishi	male	2010	3	37	2
2014ApJ...780..111H	Heitmann, Katrin	Katrin	female	2006	63	57	5
...							

<sup>1</sup> Name of the first author as specified in the paper

<sup>2</sup> Year in which the leading author of the paper in question published their first paper

**Table 1B**  
Example of the data available (continued, last 9 columns)

Region	Year	Journal	# field <sup>3</sup>	# floats <sup>4,5</sup>	# equations	# math inline	# words	# Bibcode of first publication
NAMERICA	1978	APJ	3	-99	-99	-99	-99	1973ApJ...183.1075C
NAMERICA	1988	APJ	4	-99	-99	-99	-99	-99
OTHER	1990	MNRAS	4	-99	-99	-99	-99	1981MNRAS.194..283A
NAMERICA	1990	NAT	1	-99	-99	-99	-99	1980Natur.286..237T
NAMERICA	1992	APJ	6	-99	-99	-99	-99	1991ApJ...369L..21B
OTHER	1993	AA	4	-99	-99	-99	-99	1993A&A...277..677M
OTHER	1996	AA	2	-99	-99	-99	-99	1992A&A...266..313S
OTHER	1997	AA	4	-99	-99	-99	-99	1997A&A...324L...5C
EUROPE	2002	AA	2	-99	-99	-99	-99	1985A&A...150..163M
EUROPE	2002	MNRAS	5	-99	-99	-99	-99	2000ApJ...536..773B
NAMERICA	2010	APJ	3	8	10	160	2709	2010ApJ...711.1310K
NAMERICA	2014	APJ	3	17	14	502	11456	2006ApJ...642L..85H
...								

<sup>3</sup> 1=“Earth and Planetary Astrophysics”, 2=“Solar and Stellar Astrophysics”, 3=“Astrophysics of galaxies”, 4=“Cosmology and Extragalactic Astrophysics”, 5=“High Energy Astrophysical Phenomena”, 6=“Instrumentation and Method for Astrophysics”

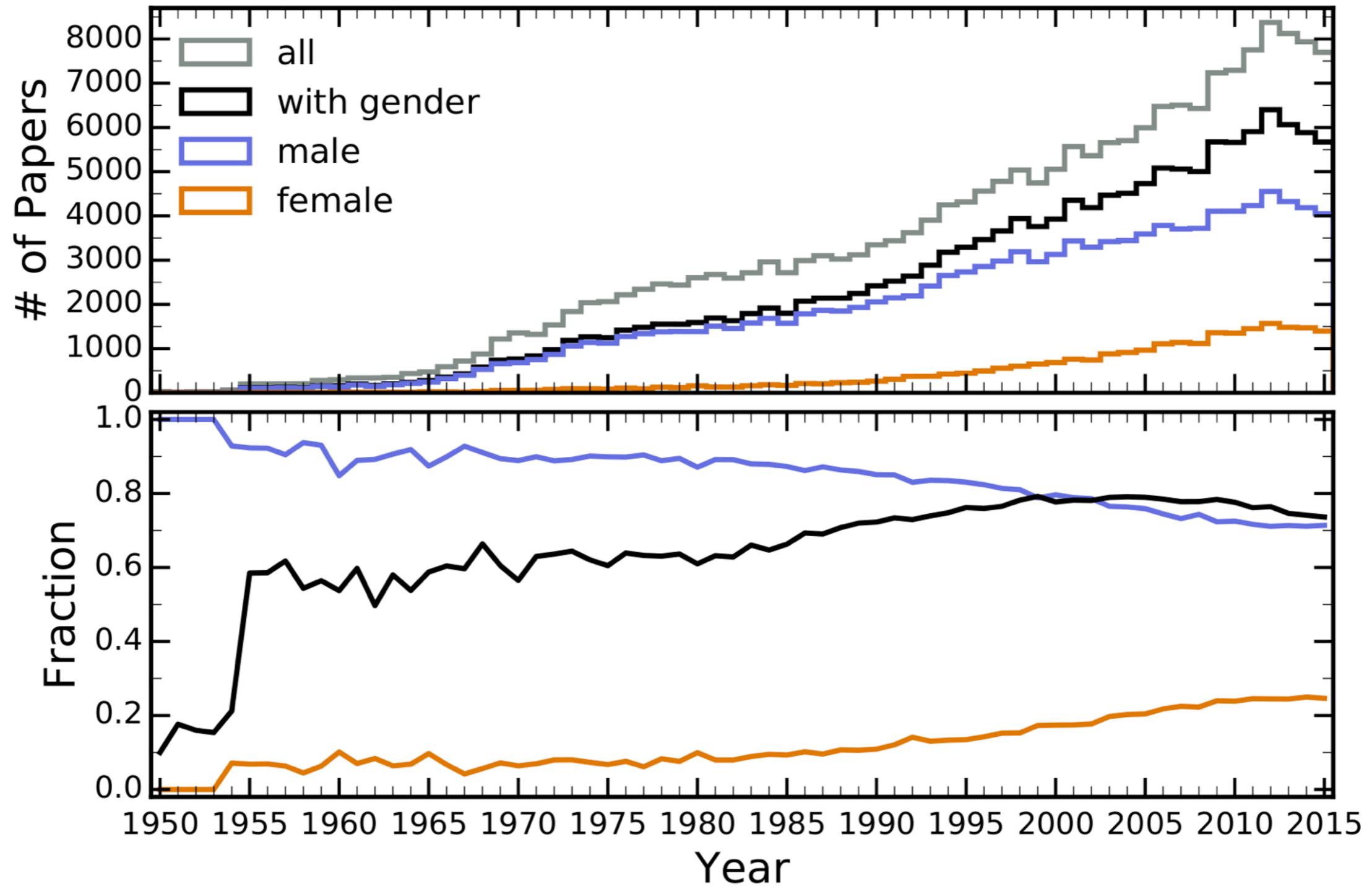
<sup>4</sup> floats include both figures and tables

<sup>5</sup> with -99 we denote that there is no data available for this quantity

# Method

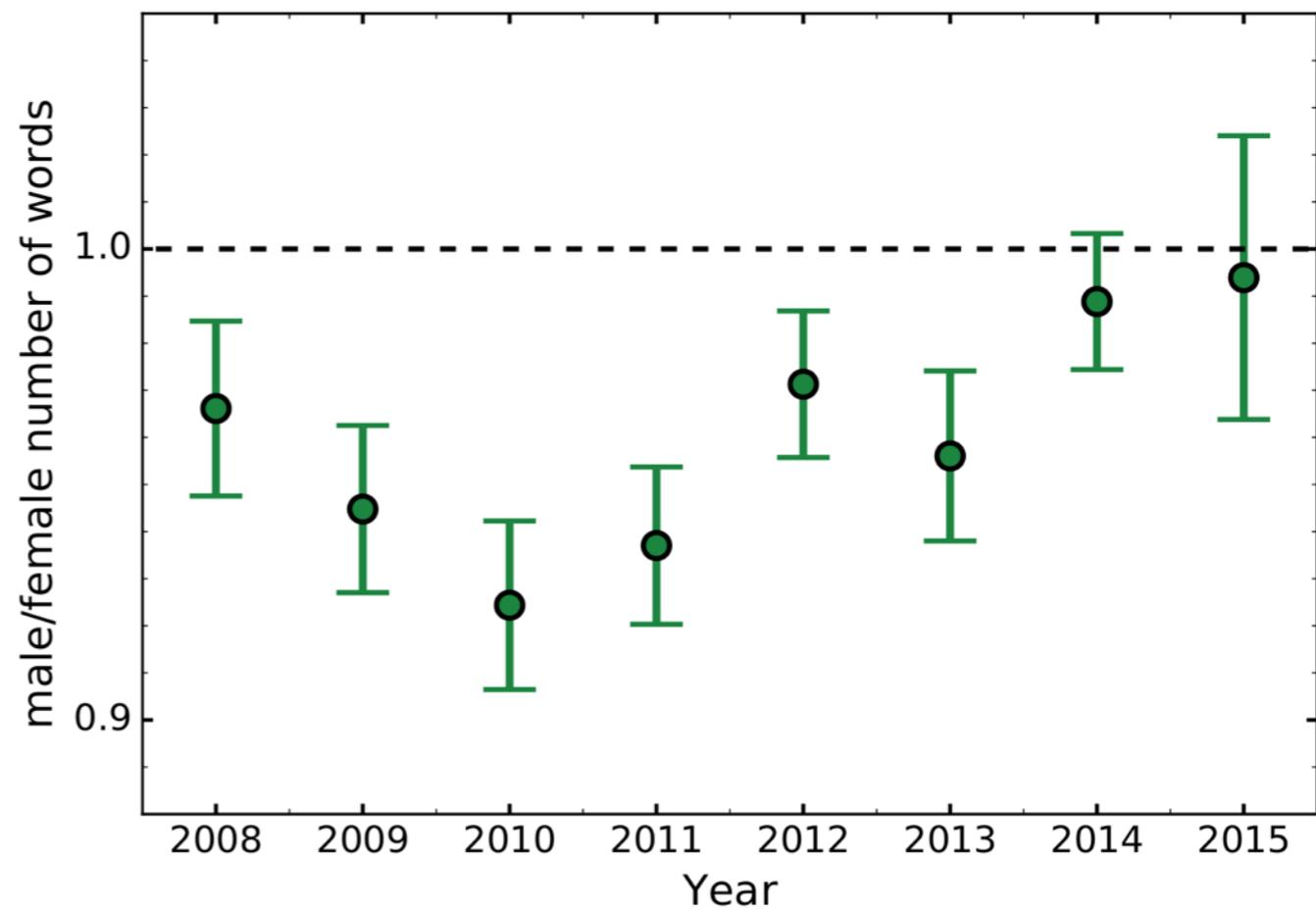
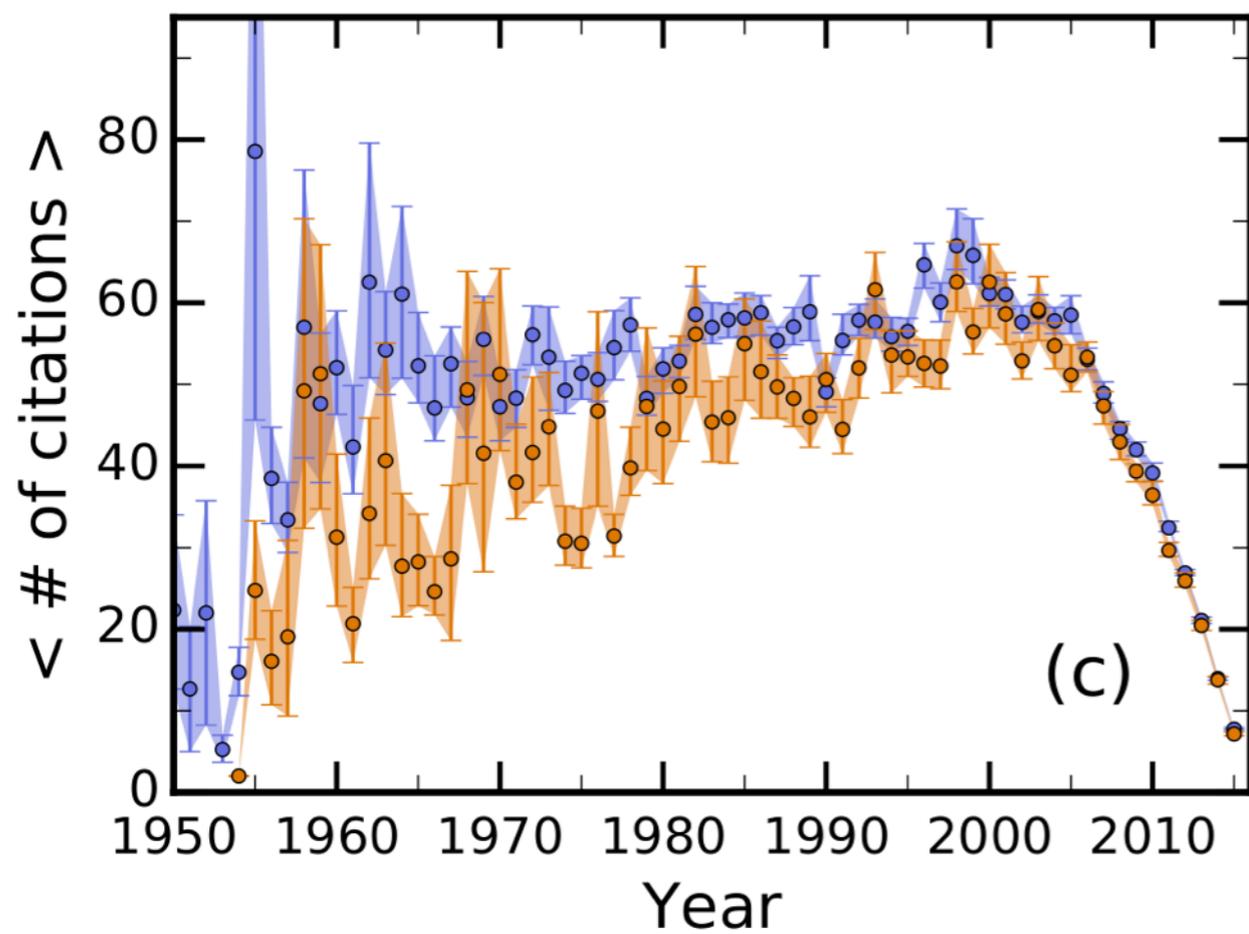
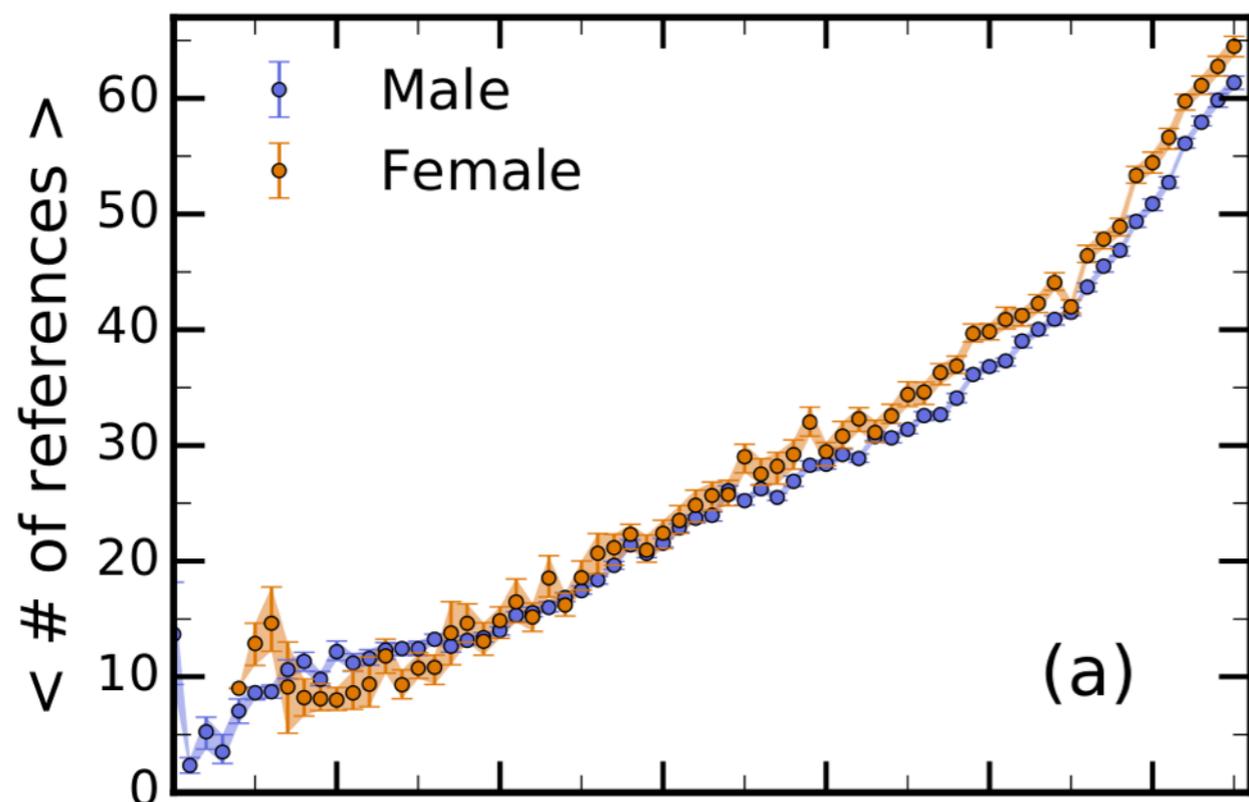
- Total: 208,577 entries
- Final dataset: 149,741 entries
- Cleaning data
  - entries with zero citations or zero references (4,417 ADS entries);
  - authors that have only published in Science and/or Nature (5,484 ADS entries);
  - entries with no authors specified (491 ADS entries);
  - entries with no first name for the first author (e.g. collaboration articles; 7,713 ADS entries);
  - entries for which first author only used initials for all publications available in the dataset (42,448 ADS entries)
  - entries for which the gender of the first name of first author could not be determined (2,260 ADS entries)

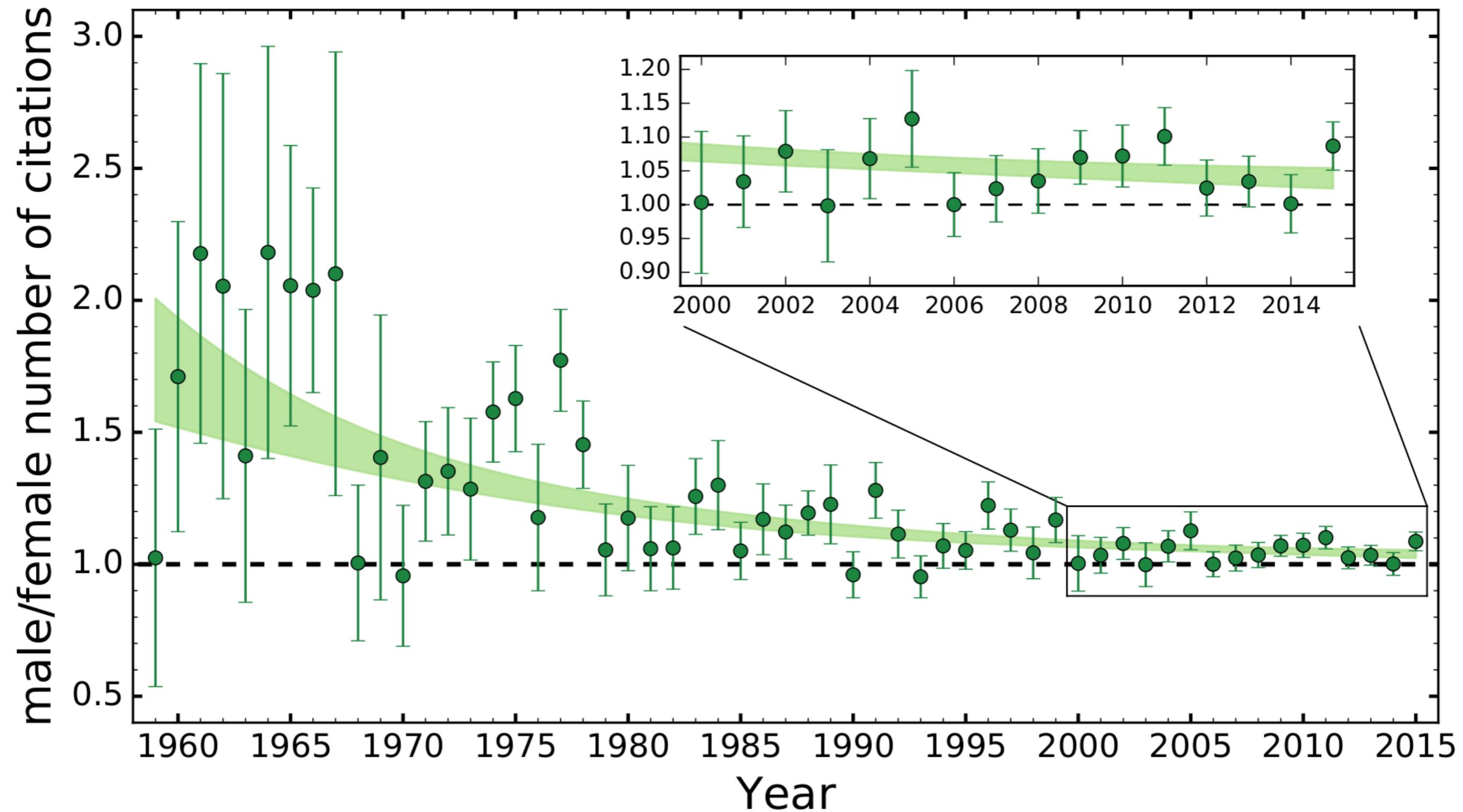
# Properties of the sample



Slow increase of the fraction of the papers written by women

# Properties of the sample





Gender difference: ratio of mean number of citation for papers written by men over mean number of citations for papers written by women  
 Constant fit to data since 1985: Men receive ~6% more citations

# How to control for difference in the properties of the sample?

## idea:

train random forest algorithm on the sample of papers written by men and use it on the sample of papers written by women

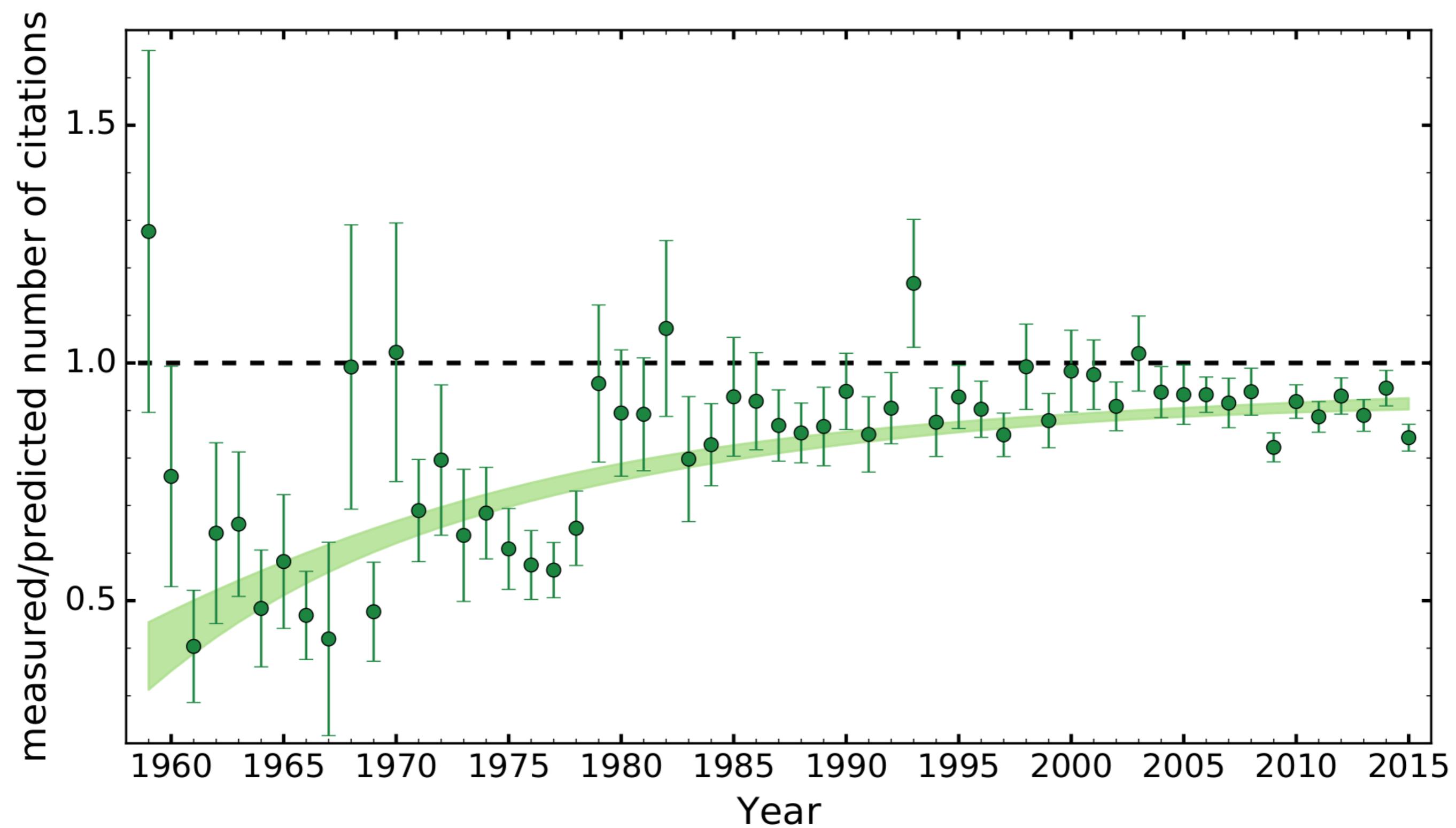
## non-gender-specific parameters:

- seniority of the first author
- number of references
- total number of authors
- year of publication
- journal of publication
- field of study
- geographical region of the first author's institution

## assumption:

men and women should receive the same number of citations for papers that have the same non-gender-specific properties

→ any difference in the citation counts between papers led by men and women with matched non-gender properties is labeled as “gender bias”



Gender bias: measured over predicted number of citations for papers authored by women

Constant fit to data since 1985: Women receive  $10.4 \pm 0.9\%$  less citations

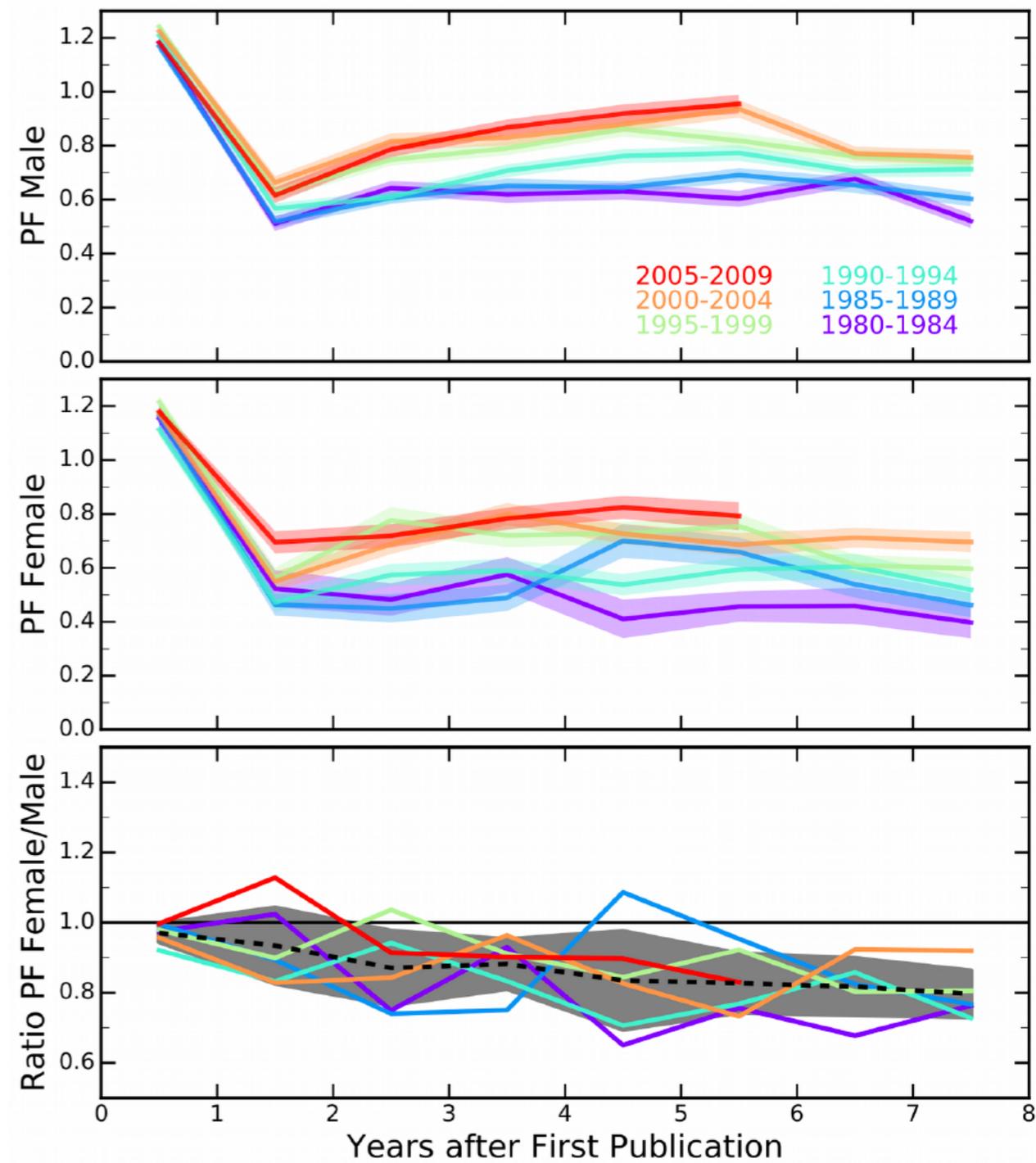
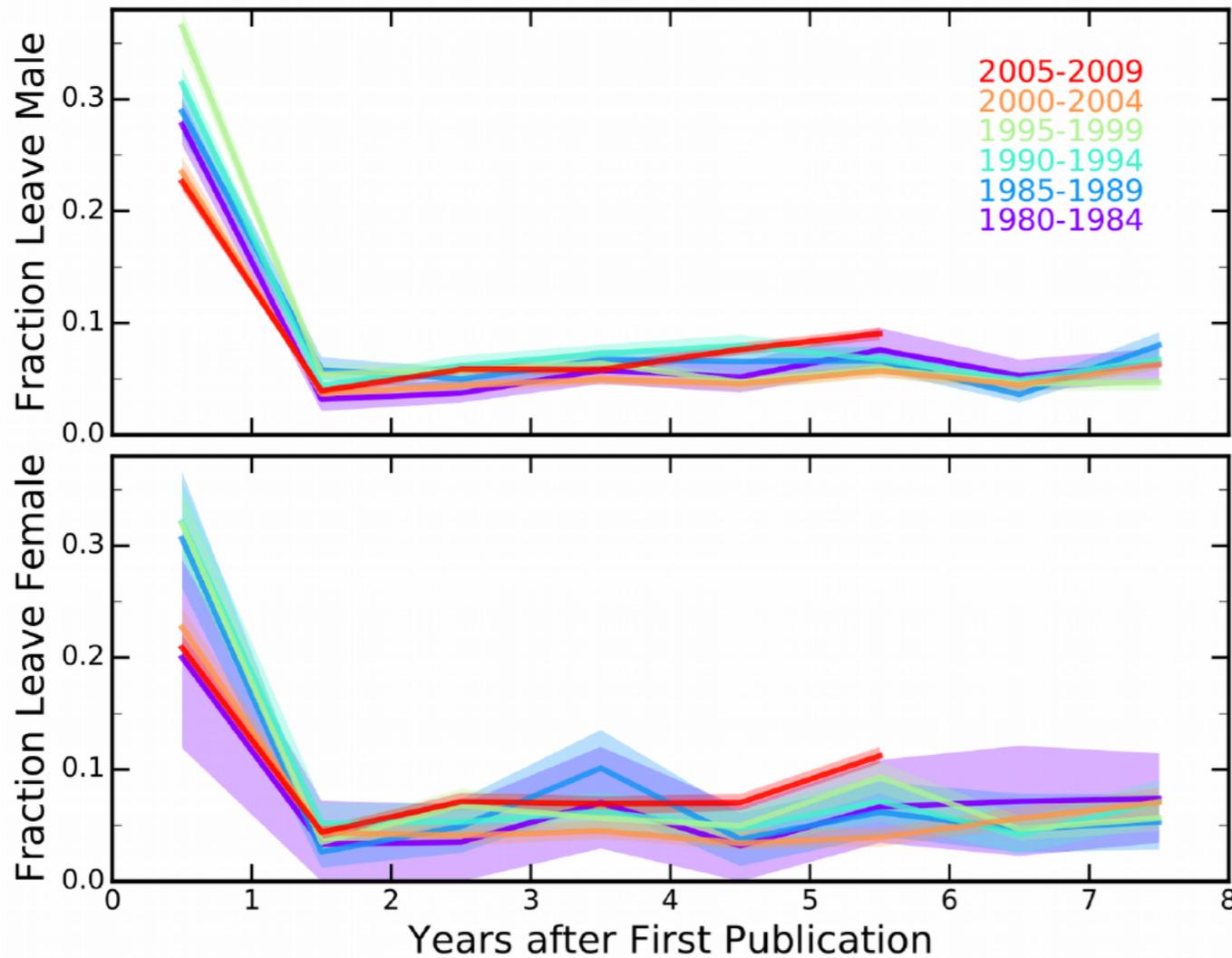
# Summary

- analysis of over 200,000 publications from astronomy
- gender difference of 6%
- but samples differ in their properties:  
we find that women receive  $10.4 \pm 0.9\%$  less citations than expected given the parameters of their papers,  
i.e., we expect that if there was no bias men should receive 4% fewer citations in the sample
- Most important parameters (Gini importance):  
1. number of references, 2. year of publication, 3. journal

# Suggested questions for discussion

1. Why is there a gender bias in the number of citation a paper gets?
2. What kind of numbers / studies would you like to see in order to address gender bias better?
3. What institutional procedures can we adopt at the CfA to help us avoid subtle gender bias? *Are transparent hiring standards feasible?*
4. What day-to-day practices can we adopt among ourselves to help us avoid subtle gender bias?

- Do women leave astronomy more often than men?
- We find no difference in fraction of authors who have left the field



- Women publish less than men in our sample