AWIS
ASSOCIATION FOR WOMEN IN SCIENCE

Critical Theoretical & Methodological Approaches to Broaden Participation in Science, Technology, Engineering, & Mathematics

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Critical Theory

- Originated in the 1920s
- Builds on Marxist critiques of capitalism
- Emancipatory and social-transformative goals
- Reads through and disrupts ideology
- Language, knowledge, power, oppression, and their reproduction
- Relationship between concepts and subjects
- Intersectionality

Aims to reveal hidden power arrangements, oppressive practices, and ways of thinking for the purpose of changing society to make it more just

Feminist Science Studies

- Applies critical theory to science as a socio-cultural text
- What is the "feminism" of FST?
- History of hierarchy, oppression, exclusion within STEM
- Questions:
  - Bias, knowledge construction in STEM scholarship
  - Notion of "objectivity"
  - Gendered, classed, sexualized, racialized assumptions
  - STEM's connection to:
    - Militarism
    - Environmental destruction
    - Global capitalism
    - Research used to "prove" inferiority of women & people of color

Critical Methodologies

Useful for qualitative *and* quantitative research

- Allow for reflection upon the ways in which we:
  - Collect
  - Measure
  - Interpret
  - Analyze
- Have transformative ability
- Must be understood within context

Applying Critical Mixed Methodologies: Study 1 – STEM Pathways

- Critical discourse and regression analyses
- (Leaky) Pipeline model of recruitment and retention
  - 1970s, lingering Cold War fears paired with technological & global competition
  - NSF model to quantify and predict number of scientists and engineers needed

$$Q1 + \sum fi - \sum fo = Q2$$

Where Q1 = the number of people in stock at the beginning of period, ∑fi = the sum of flows into the stock, ∑fo = the sum of flows out of the stock, and Q2 = the number of people in stock at end of period

Disrupting the Pipeline

- Pipeline model survived despite much criticism
  - Flawed predictions
  - Supply-side focus
  - Poor measurements
  - Linearity and inability to account for varied career paths
  - Tendency to homogenize people, fields, sectors, stages
  - Discursive view of people as passive “flow”
  - Lack of focus on systemic change and power relations

2006 SESTAT Surveys

- NSF Scientists and Engineers Statistical Data System (SESTAT)
  - National Survey of College Graduates
  - National Survey of Recent College Graduates
  - Survey of Doctorate Recipients
- STEM Measures
  - "scientist or engineer"
  - "S&E fields"
  - "S&E degrees"
- Demographic Measures
  - "gender" (sex)
  - "race"
  - "ethnicity"
- Retention Measures
  - pipeline
  - relatedness

Non-science and Engineering Degrees	*Non-science and Engineering Occupations*
Business administration, business and managerial economics	Managers and administrators
Health fields, bachelor's and master's level	Health-related occupations (doctors and other health practitioners, nurses, pharmacists, therapists, health technologists, and technicians)
Education fields	Precollege teachers; postsecondary teachers in non-S&E fields
Social services and related fields (social work, philosophy, religion, and theology)	Social services occupations (clergy, counselors and social workers)
Technologies fields (computer programming, data processing, and engineering)	Technologists and technicians (computer programmers and technicians in S&E fields)
Sales and market fields	Sales and marketing occupations
Art and humanities fields	Artists and other humanities occupations (artists, editors, writers, and non-S&T historians)

Source: National Science Foundation (2008).

Critical Regression Analyses

- Binary Logistic Regression: Traditional Pipeline Model
  - Retention: Degree in STEM, Job in STEM
  - Demographics:
    - Aggregated, mutually exclusive categories
    - Disaggregated, mutually exclusive categories
    - Disaggregated, interacted categories

Table 7.2. Binary Logistic Regression-Dependent Variable: Highest Degree/Occupation Leak

Explanatory Variables	*(1) Traditional Pipeline Exp(B)*	*(2) Disaggregated Model Exp(B)*	*(3) Interaction Model—Males Exp(B)*	*(4) Interaction Model—Females Exp(B)*
Female	1.377*	1.41*	–	–
Minority	1.280*	–	–	–
American Indian/Alaska Native, non-Hispanic only[a]	–	1.201	1.188	1.242
Asian, non-Hispanic only[a]	–	0.883*	0.896**	0.902***
Black, non-Hispanic only[a]	–	1.525*	1.705*	1.389*
Native Hawaiian/Pacific Islander, non-Hispanic only[a]	–	0.932	1.315*	1.291*
Hispanic, any race[a]	–	1.304*	1.144	0.694
Multiracial, non-Hispanic only[a]	–	1.176***	1.133	1.195

Notes: Odds ratio terms are reported and an intercept term is included in each model. *, **, and *** indicate statistically significant at the .001, .01, and .05 levels, respectively. $n = 105{,}064$.
[a]Race/ethnicity categories presented are in comparison to the category "White, non-Hispanic only."

Critical Regression Analyses

- Ordered Logistic Regression
  - Retention: Degree-occupation Relatedness
  - Demographics:
    - Aggregated, mutually exclusive categories
    - Disaggregated, interacted categories

Table 7.3. Ordered Logistic Regression-Dependent Variable: Degree-Occupation Relatedness

Explanatory Variables	*(1) Basic Pipeline Identity Measures Exp(B)*	*(2) Expanded Identity Measures Exp(B)*
Sex	1.032***	0.973
Minority	0.953**	–
American Indian/Alaska Native, non-Hispanic only[a]	–	1.206***
Asian, non-Hispanic only[a]	–	0.903*
Black, non-Hispanic only[a]	–	0.938***
Native Hawaiian/Pacific Islander, non-Hispanic only[a]	–	0.856
Hispanic, any race[a]	–	1.04
Multiracial, non-Hispanic only[a]	–	0.804*

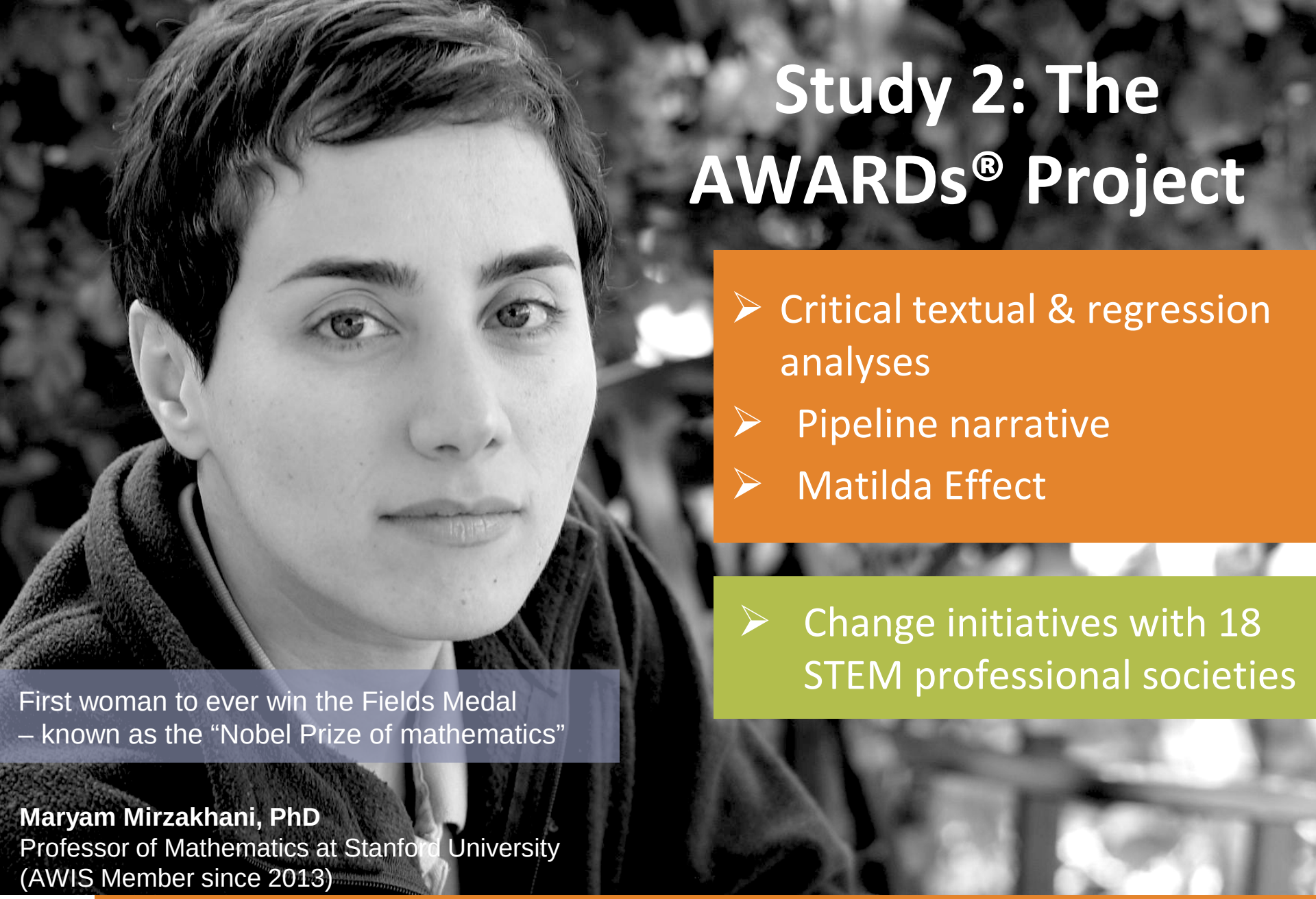
Notes: For models 1 and 2, odds ratio terms are reported and an intercept term is included in each model. *, **, and *** indicate statistically significant at the .001, .01, and .05 levels, respectively. $n = 90{,}711$.

[a]Race/ethnicity categories presented are in comparison to the category "White, non-Hispanic only."

Study 2: The AWARDs® Project

- Critical textual & regression analyses
- Pipeline narrative
- Matilda Effect

- Change initiatives with 18 STEM professional societies

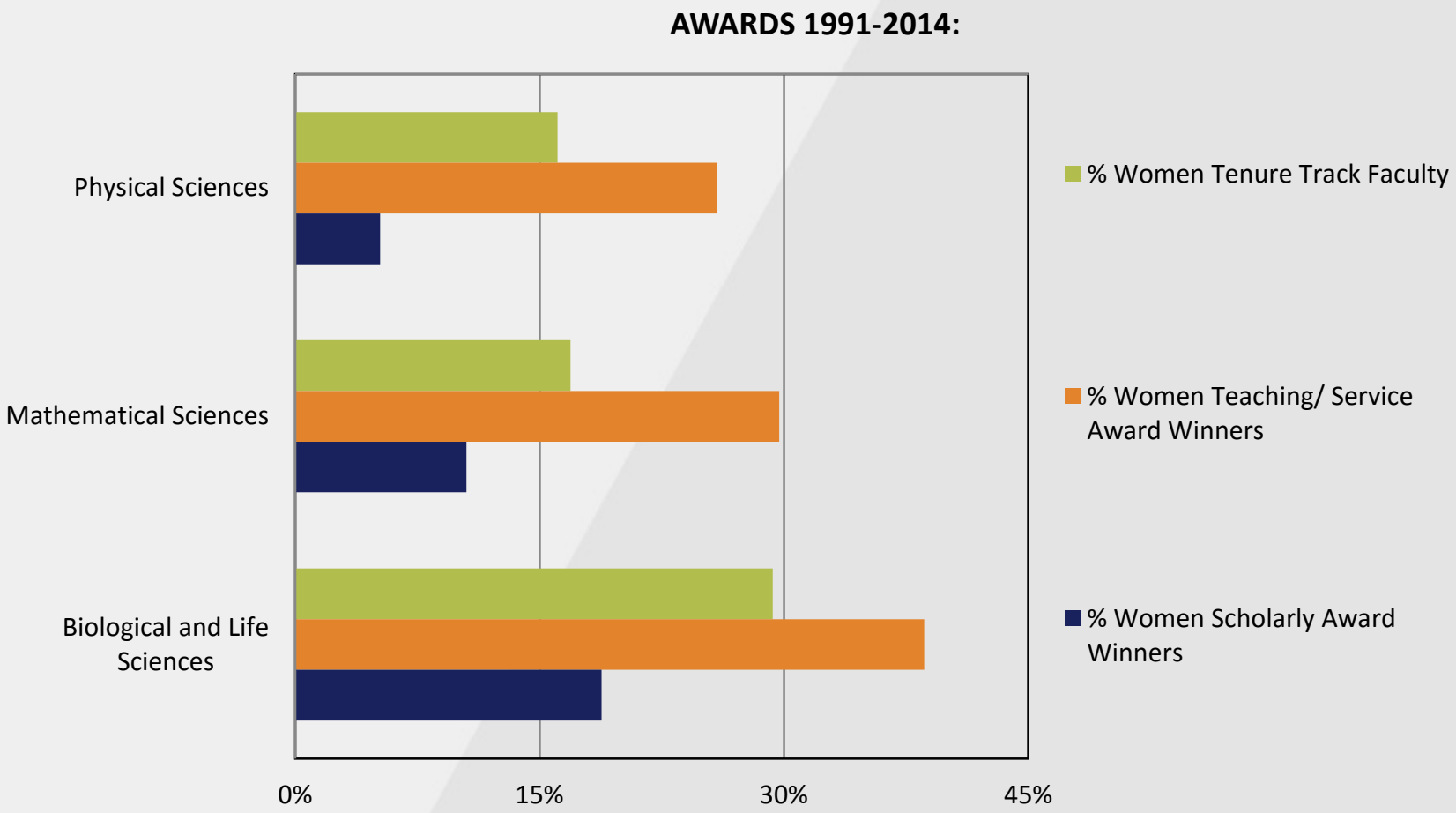


First woman to ever win the Fields Medal – known as the "Nobel Prize of mathematics"

Maryam Mirzakhani, PhD
Professor of Mathematics at Stanford University
(AWIS Member since 2013)

The Advancing Ways of Awarding Recognition in Disciplinary Societies (AWARDS) Project is funded by the National Science Foundation ADVANCE program. Grant #0930073

Descriptive Findings

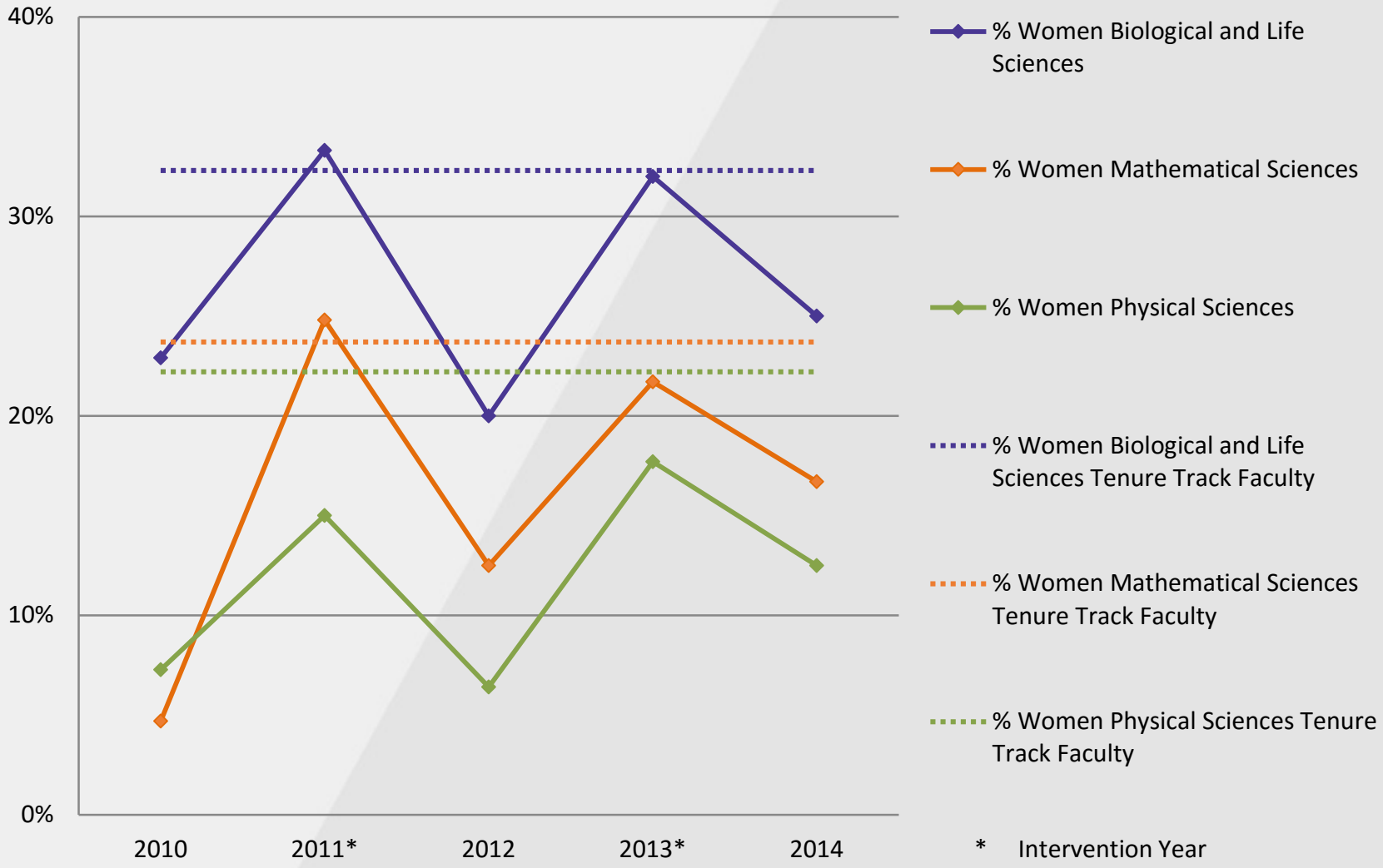


Regression Findings

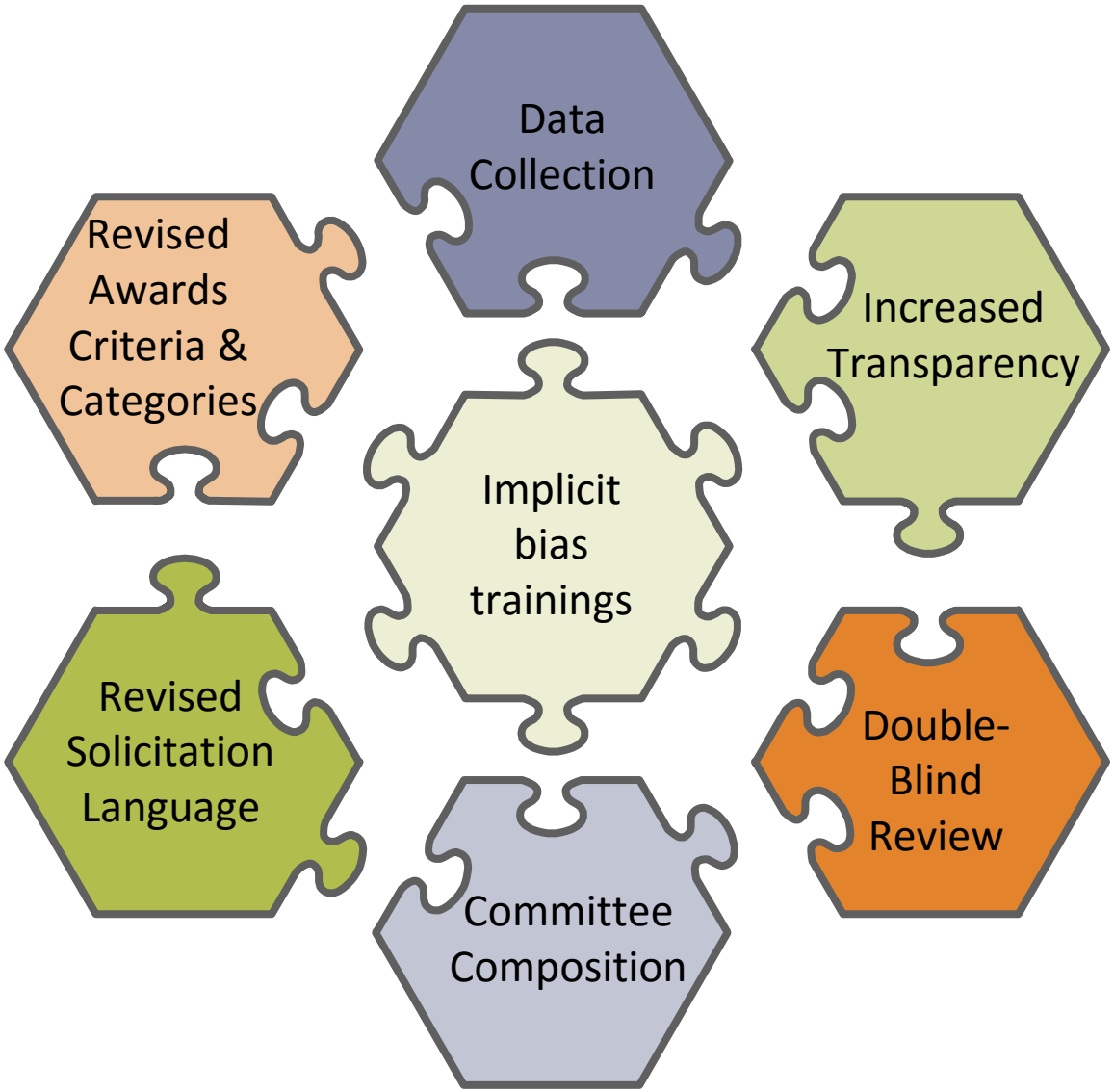
Women were recognized for:

Regardless of representation in nomination pool, men ***twice*** as likely to win research awards

Challenges in Sustainability



Proven Interventions



Conclusion

- Using critical methodologies can
  - Deepen our understanding of retention, recognition, & demographics
  - Generate a richer pool of resources for achieving, rather than undermining, equity-related goals
  - Help us see the subjective choices made in the construction and analysis of large-scale data sets
  - Provide context
  - Show us limitations and sustainability issues in our work

By calling into question our own and others' underlying assumptions, methods, models, and measures, broadening our thinking, and richly contextualizing our work, we step outside our comfort zones to open up the possibility of seeing our institutions and our worlds differently and changing them.

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