How representation, relationships, and community act as 'social vaccines' for underrepresented students in STEM

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Presentation at the National Academies Summit on Diversity, Equity, Inclusion & Anti-Racism in 21st Century STEMM Organizations, 30 June 2021

Core social motives drive human behavior

- Humans are a social species that rely on relationships to survive and thrive. A few social motivations drive cognition, emotion, and behavior.

- **Need to belong**: We gravitate toward social environments where we feel we belong and away from others where we feel like misfits.

- **Need to feel competent and worthy**: We pursue activities that make us feel confident and worthy and move away from others that make us doubt our competence and worthiness.

- **Need for meaning or purpose:** We pursue and persist on paths that are personally and socially meaningful.

Impact of social motives on choosing STEM (or not) is often underestimated

- We assume that talent and ability is all that is needed for persistence and success in STEM.
- We assume high performance in STEM disciplines is the best predictor of persistence and success.
- We assume that young people who leave STEM pathways must be low performers.

Contrary to assumptions, research shows…

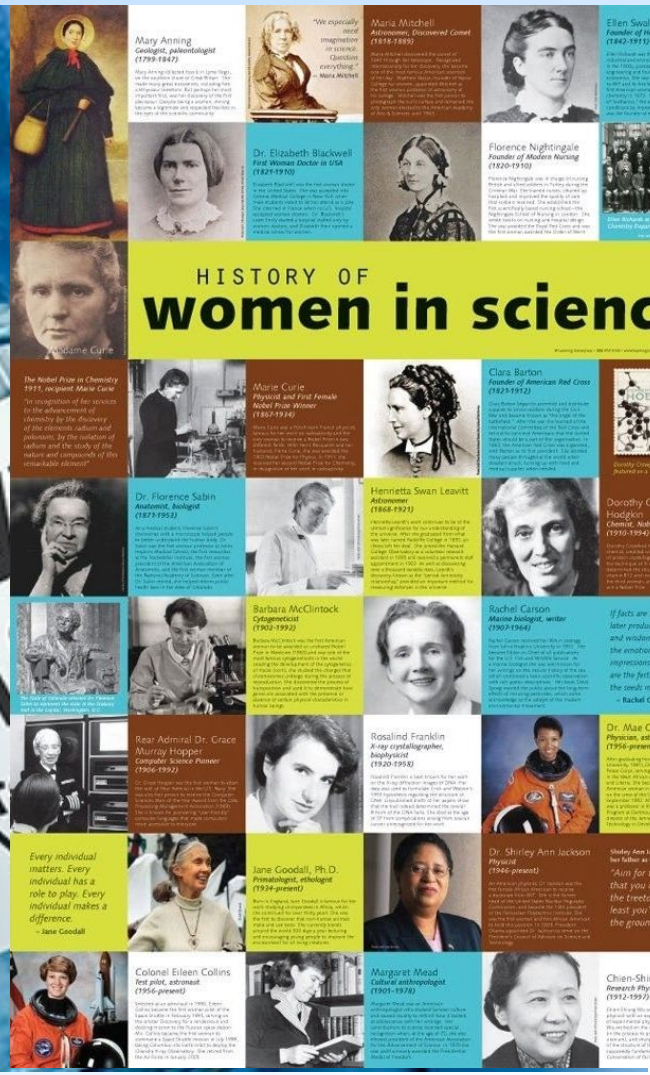
- People who are talented in STEM may initially approach STEM activities, but persistence depends on whether the learning environment satisfies core social motives.
- High performance is not sufficient for persistence if students' need to belong, feel competent, and need for personal meaning are not satisfied.
- For people underrepresented in STEM, approaching STEM spaces activates negative stereotypes. Stereotype activation plus scarcity of similar others threatens core social needs.
- Faced with belonging threat, worries about competence, and doubts about the meaningfulness of STEM, young people move away from STEM pathways.

Stereotype inoculation model and ‘social vaccines’

Dasgupta (2011), *Psychological Inquiry*

Stout, Dasgupta, Hunsinger, & McManus (2011), *Journal of Personality and Social Psychology*

Stereotype inoculation model and ‘social vaccines’



Dasgupta (2011), *Psychological Inquiry*

Stout, Dasgupta, Hunsinger, & McManus (2011), *Journal of Personality and Social Psychology*

Roadmap for today

Evidence-based solutions that leverage 3 features of STEM environments, satisfy social motives, and enhance persistence

- Representation of own-group experts and peers in STEM
- Mentoring relationships with own-group peers in STEM
- Building a learning community based on common identity
- [Emphasis on the social meaning of STEM]

Common themes

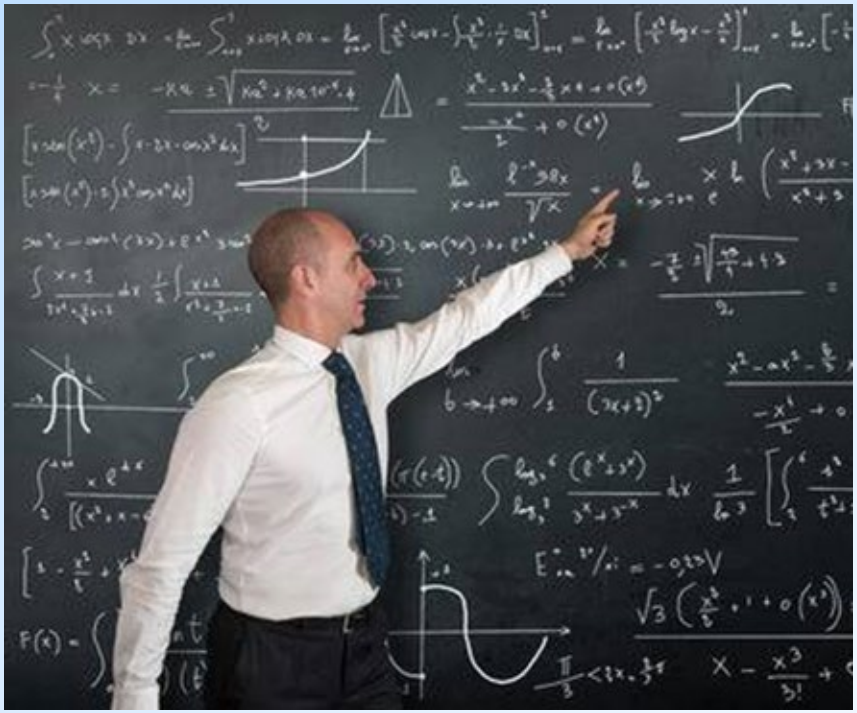
- Longitudinal studies conducted in naturally existing field settings
- Focus on multiple identity groups: gender, race, social class
- Solutions implemented in transition periods of human development
- Fix STEM learning environments, not 'fixing students'

RELATIONSHIPS

Exposure to female professors teaching gateway STEM courses

Calculus study

Stout, Dasgupta, Hunsinger, & McManus (2011), *JPSP*



Tracked female and male students from beginning to end of semester

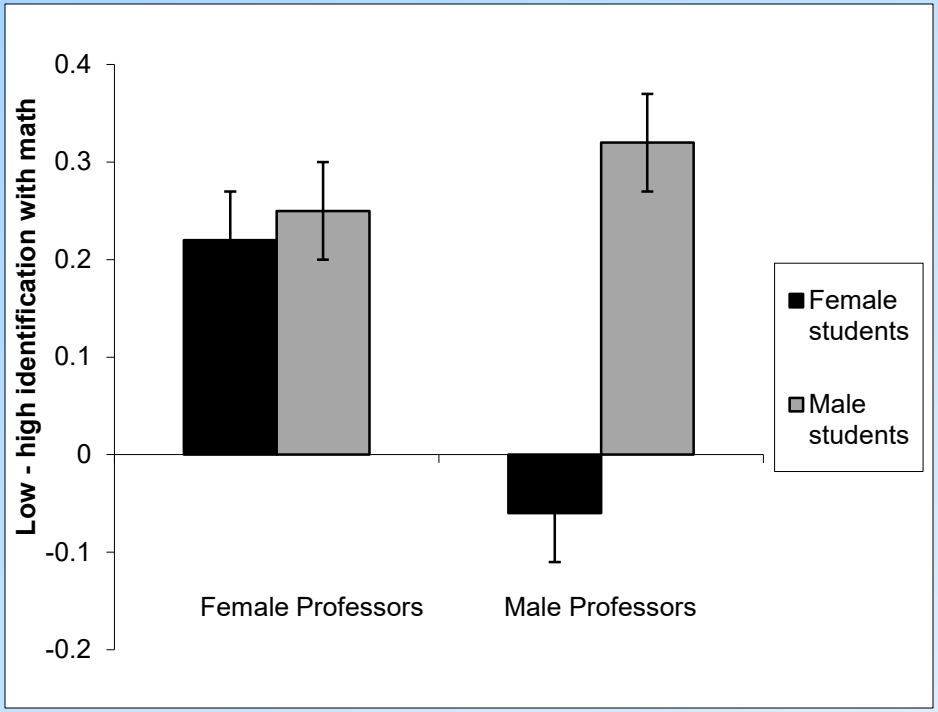
Multiple sections taught by female or male professors

Same syllabus, same exams, de-identified grading

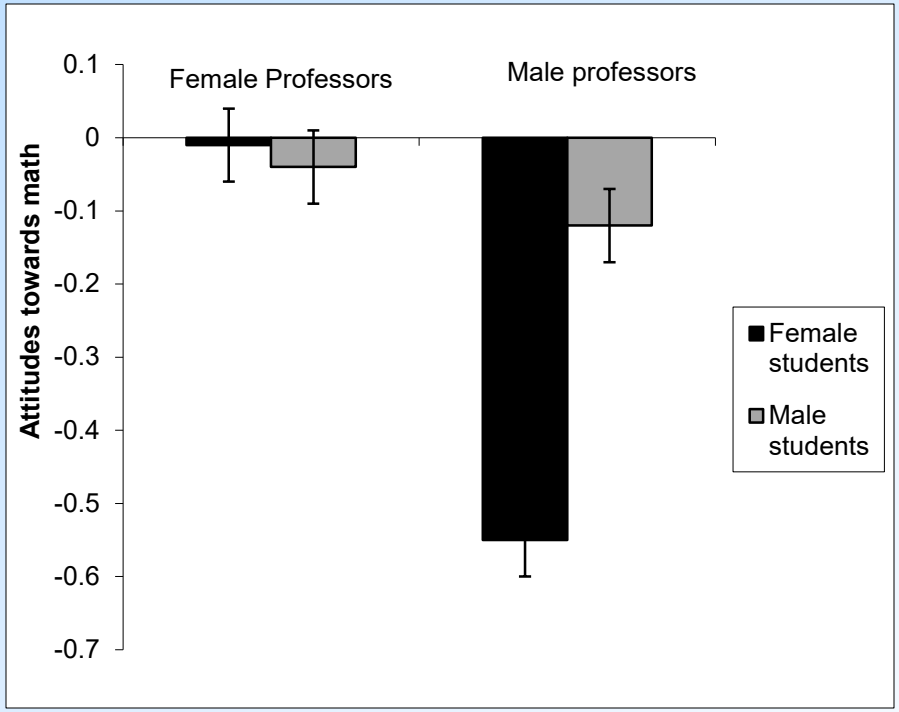
Professors and students were blind to hypotheses

Implicit identification and attitudes toward math

Implicit identification with math



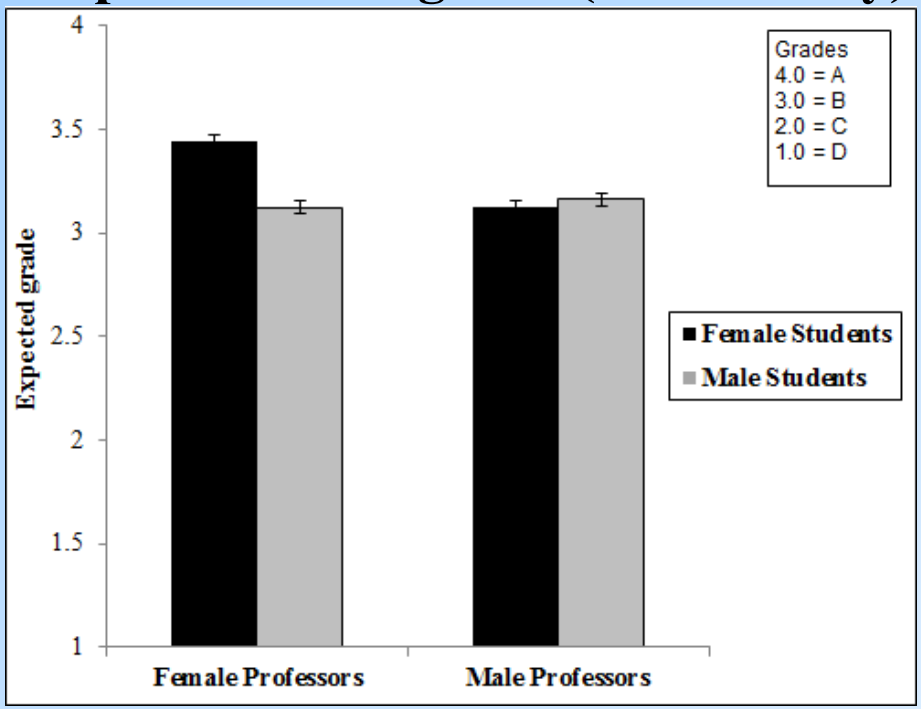
Implicit attitudes toward math



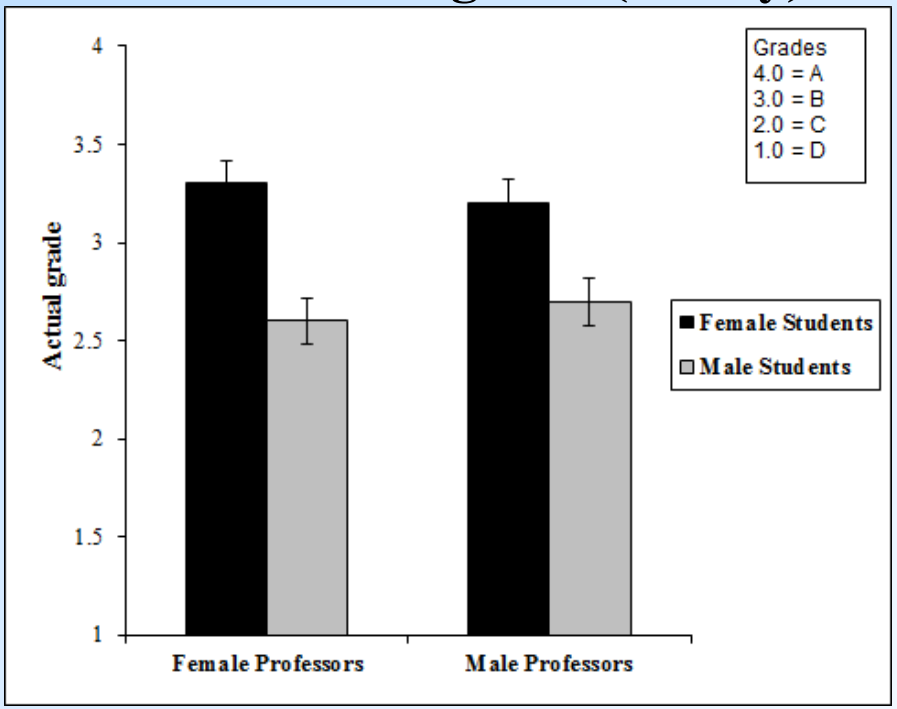
Stout, Dasgupta, Hunsinger, & McManus (2011), *Journal of Personality and Social Psychology*

Expected final grade and actual final grade

Expected math grade (self-efficacy)



Actual math grade (ability)



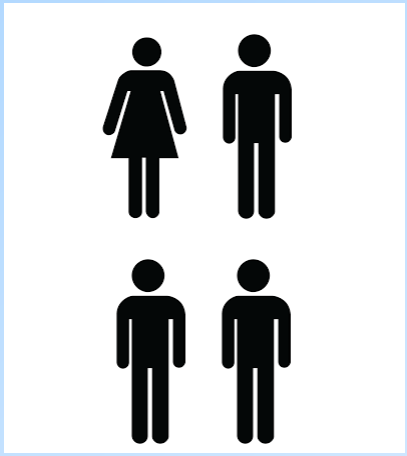
Stout, Dasgupta, Hunsinger, & McManus (2011), *JPSP*

RELATIONSHIPS

Exposure to a critical mass of female peers in project teams

Women's experiences in engineering teams is more positive if there is a critical mass of female peers

Dasgupta, Scircle, & Hunsinger (2015), *PNAS*



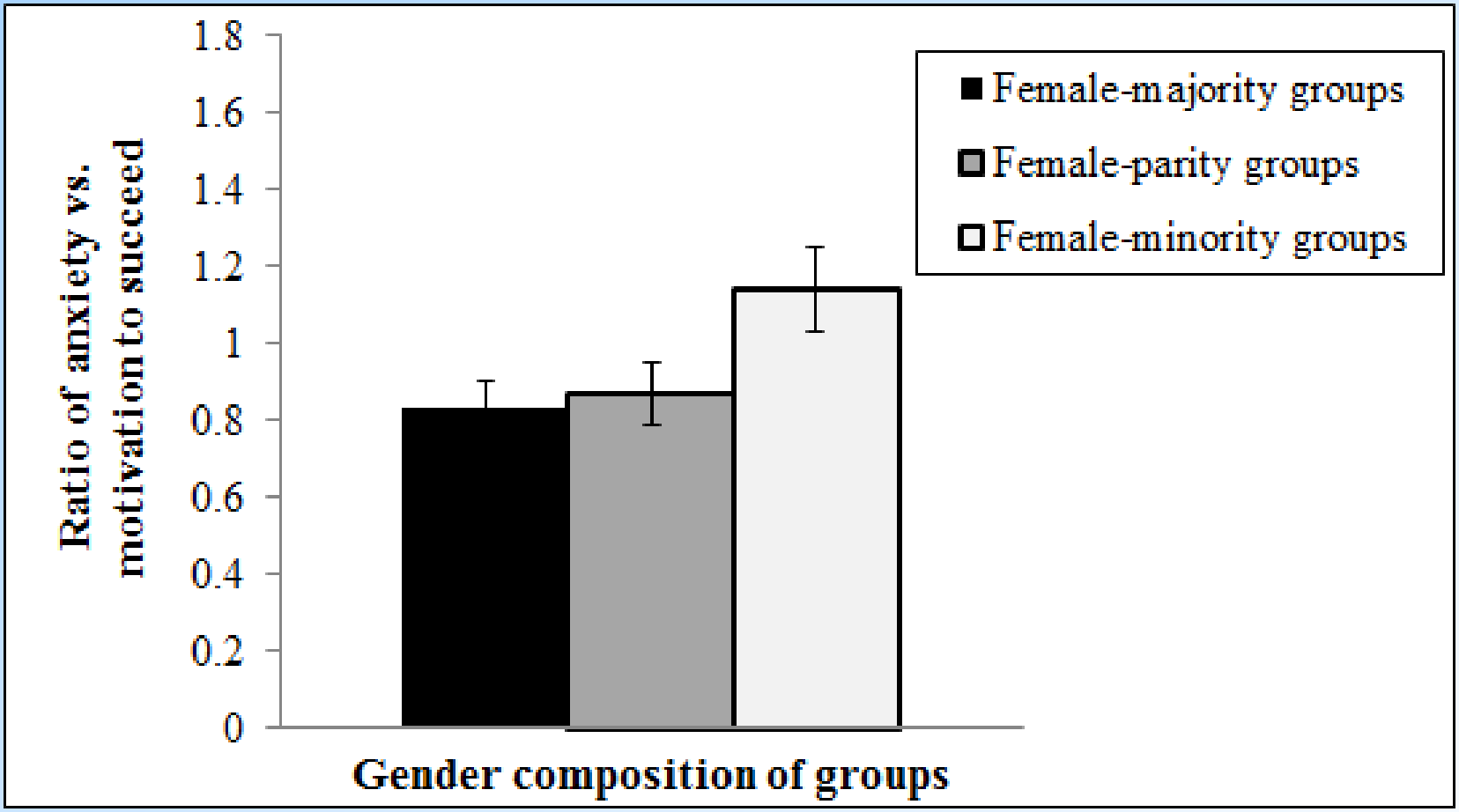
25% women

50% women

75% women

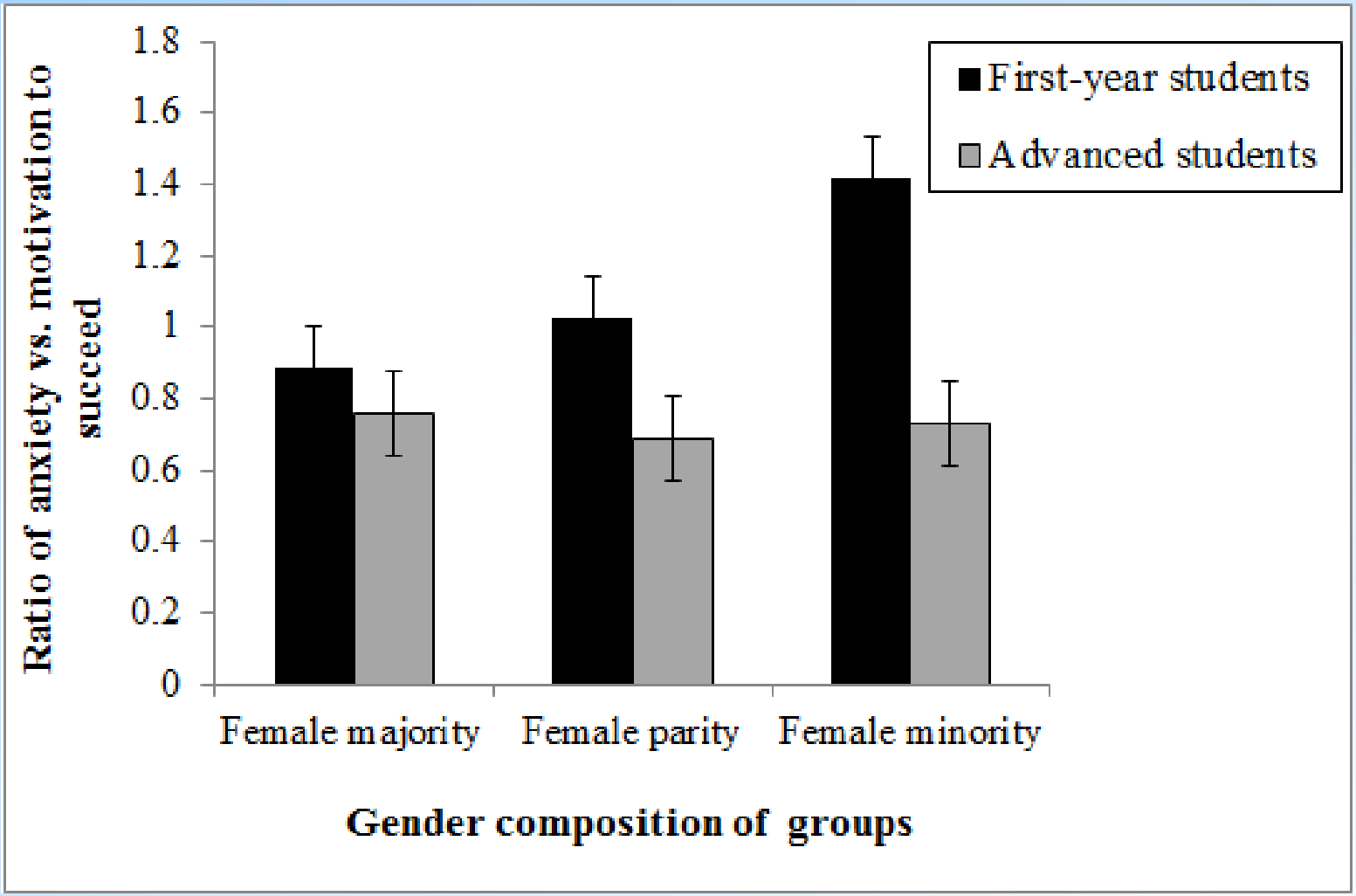
Measured anxiety, motivation, confidence, career aspirations while working in the team. Also measured speaking up during teamwork

Women in female-parity and female-majority teams felt less anxious and more motivated



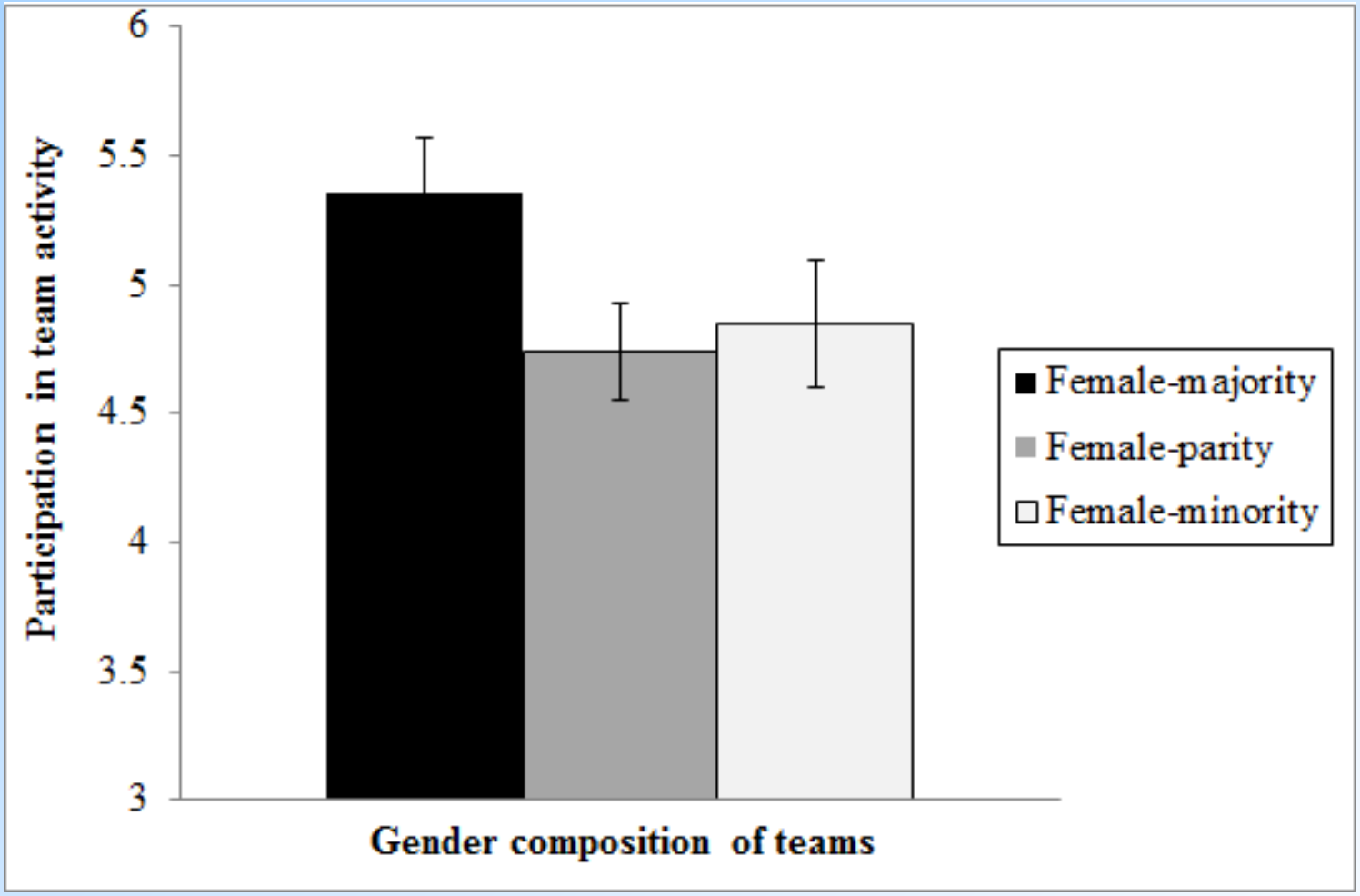
Dasgupta, Scircle, & Hunsinger (2015), *PNAS*

A critical mass of female peers matters most to first-year women students (novices)



Dasgupta, Scircle, & Hunsinger (2015), *PNAS*

Women engineering students were more verbally active in female-majority teams



Dasgupta, Scircle, & Hunsinger (2015), *PNAS*

RELATIONSHIPS

Same-sex peer mentors as social vaccines

Peer mentors in the transition to college

Longitudinal study with first-year women in engineering ($N = 150$).

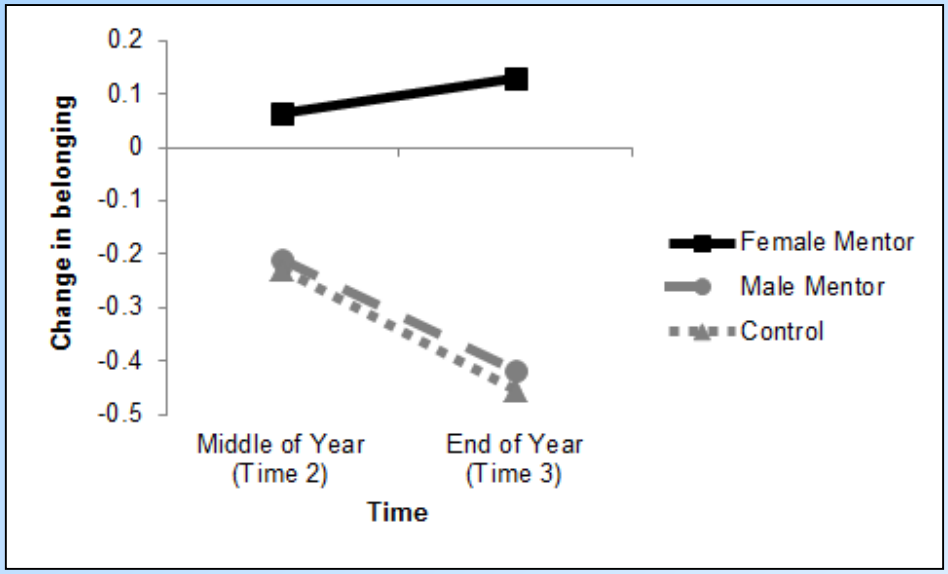
Random assignment to condition: female mentor, male mentor, or no mentor (control)

Mentor-mentees met for 1 year.

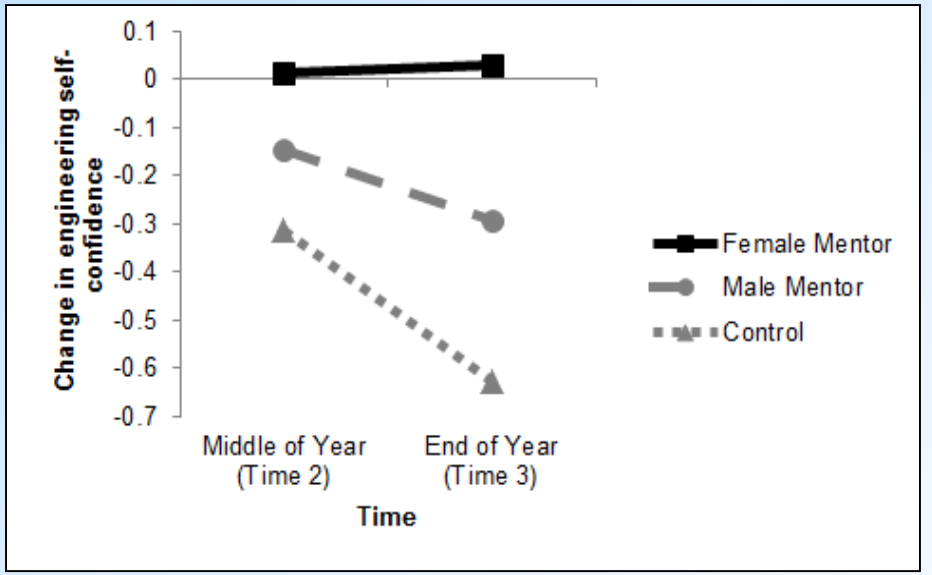
Tracked mentees' progress from 1st year through graduation long after mentoring had ended.

Belonging and confidence in engineering: 1st year of college

Belonging

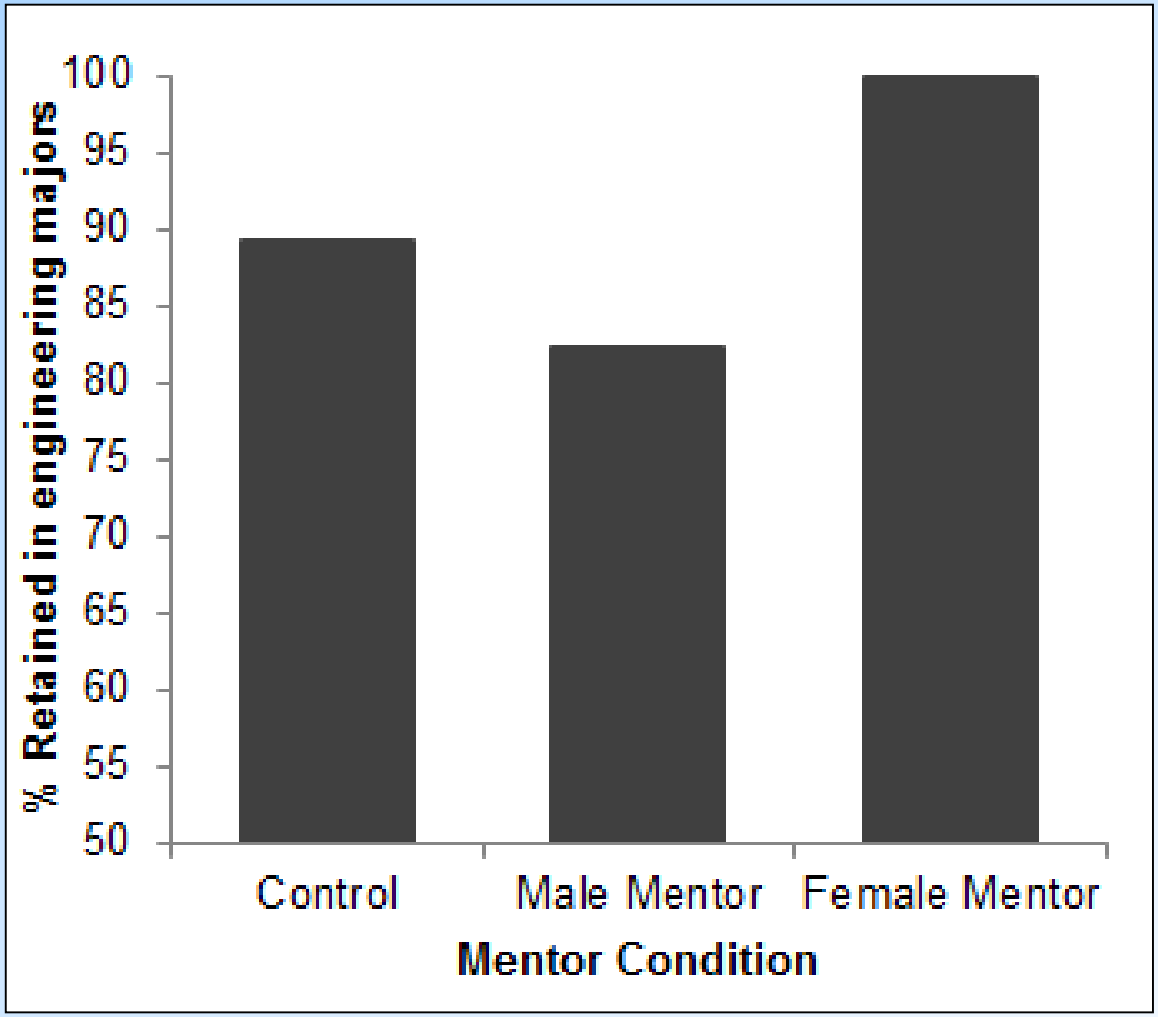


Confidence



Dennehy & Dasgupta (2017). *Proceedings of the National Academy of Sciences*

Women's retention in engineering majors: end of 1st year of college

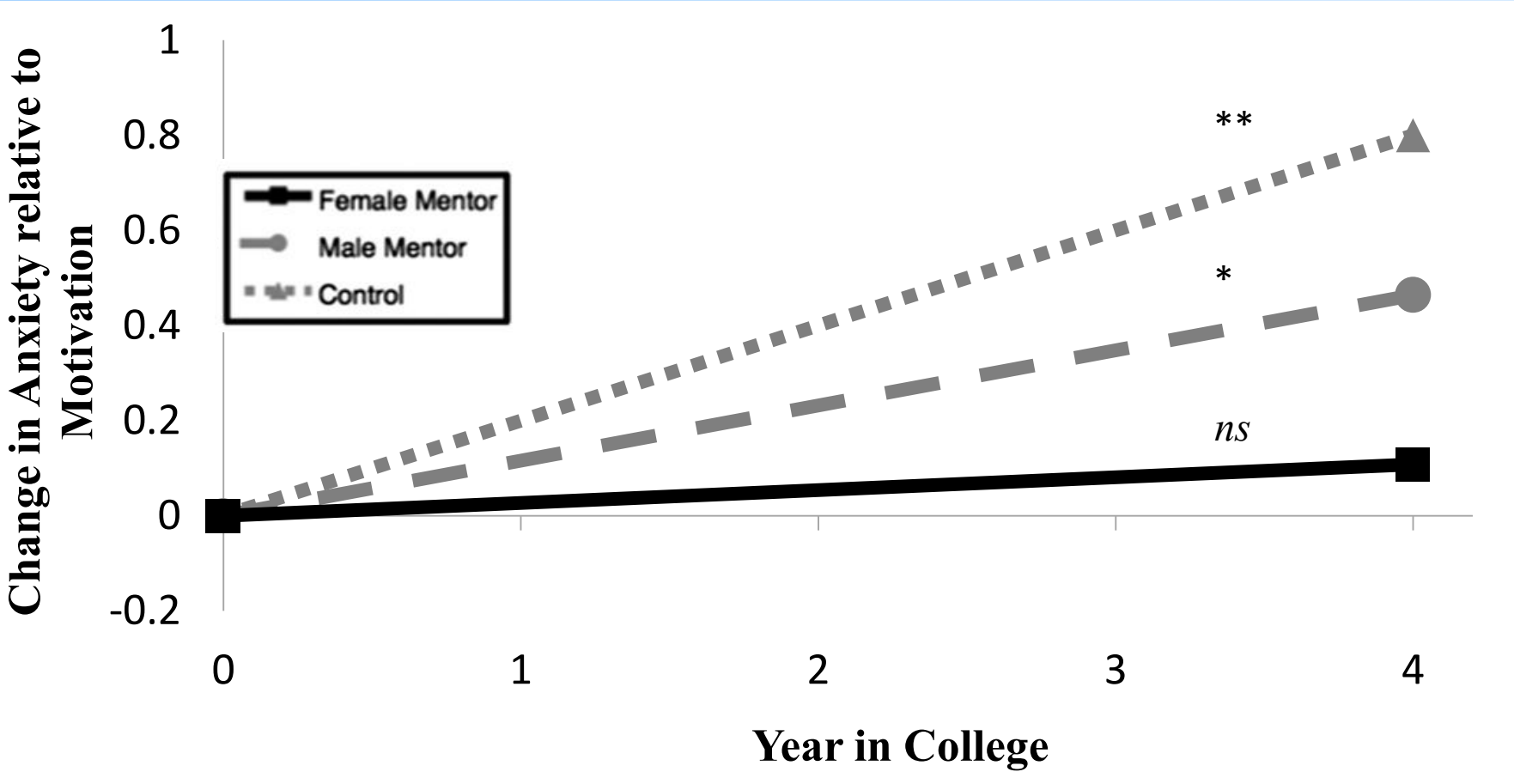


Dennehy & Dasgupta (2017). *PNAS*

Four years later at college graduation (Peer mentoring has long ended)

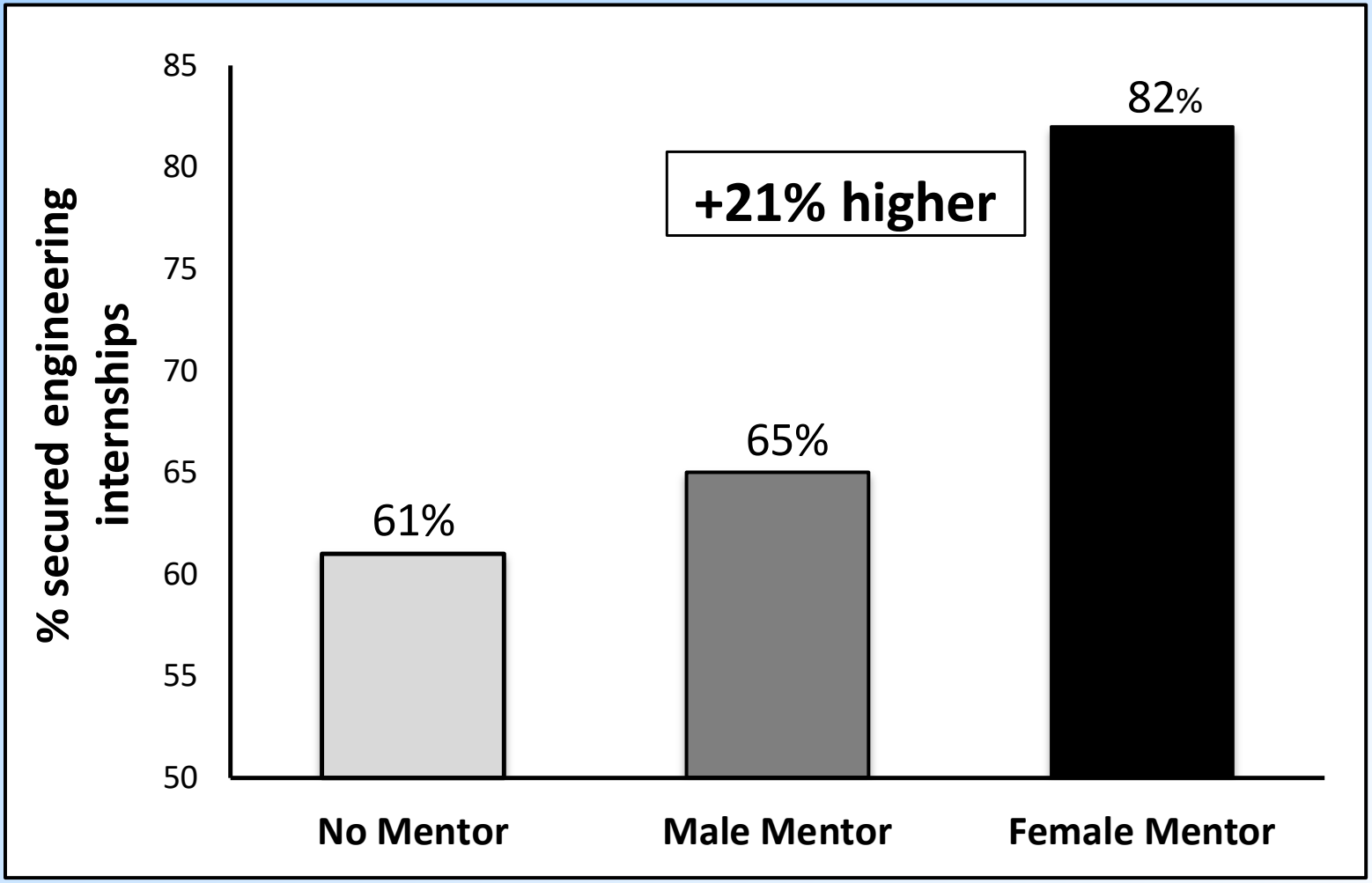
Wu, Thiem, & Dasgupta (2021)

Anxiety vs. motivation in engineering



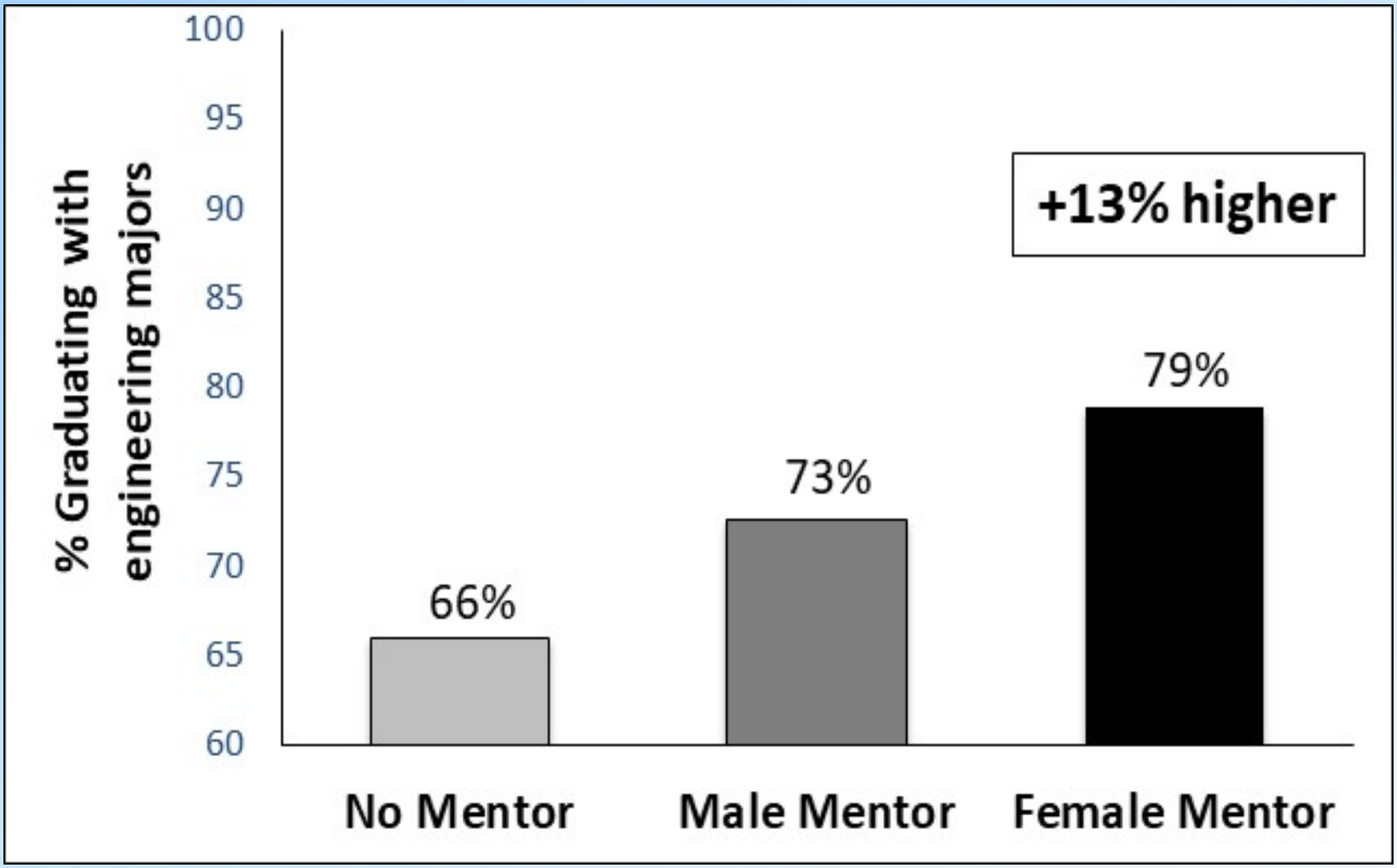
*$p < .05$, **$p < .01$. Wu, Thiem, & Dasgupta (in preparation)

% Success securing engineering internships



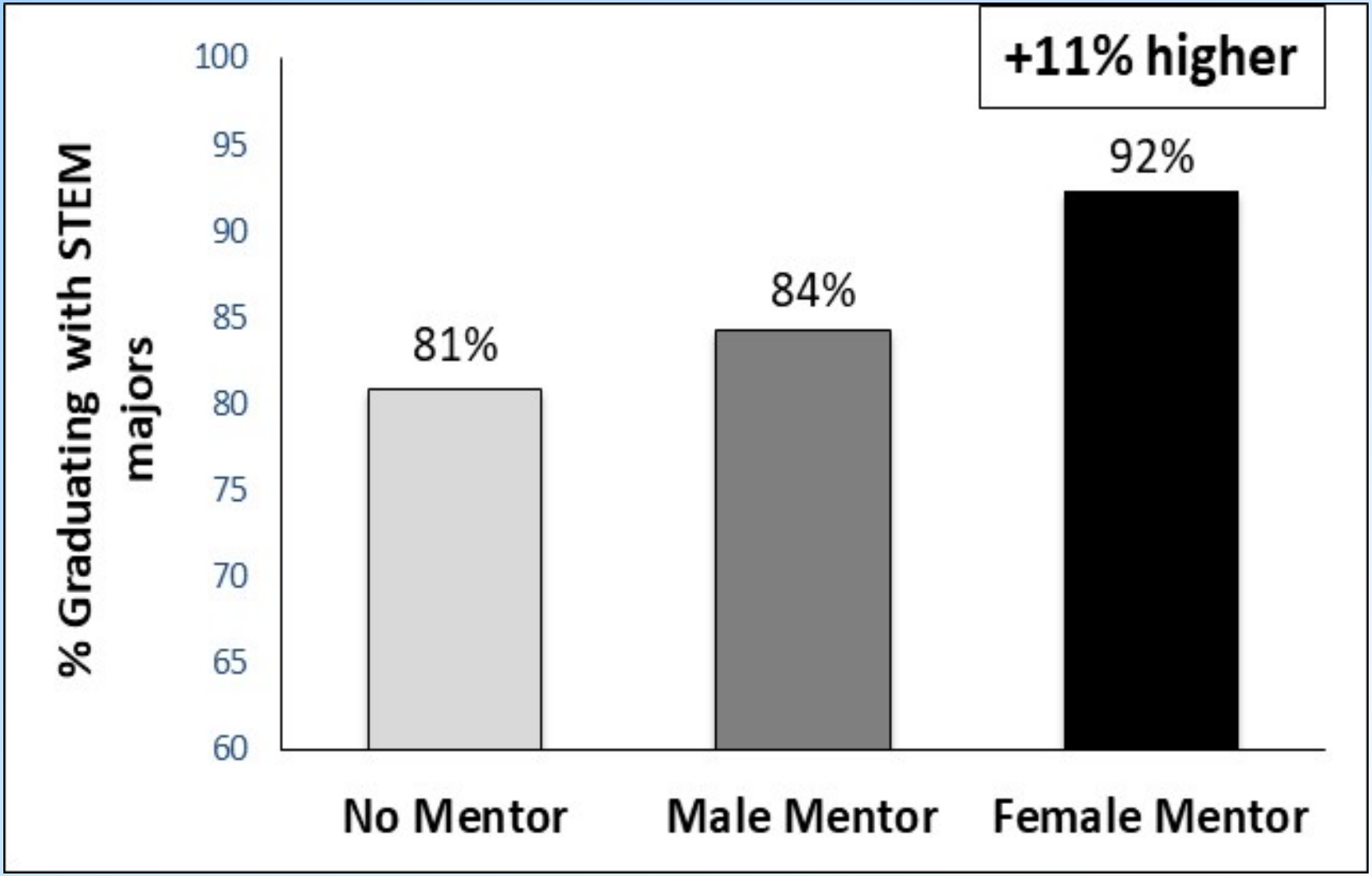
$\chi^2(1) = 4.79$, $p = .029$. Wu, Thiem, & Dasgupta (2021)

% Women graduating with engineering majors



Wu, Thiem, & Dasgupta (2021)

% Women graduating with STEM majors



Wu, Thiem, & Dasgupta (2021)

COMMUNITY

Living-learning community for first-generation students in STEM

Living learning community in biological sciences

N = 165 first-year first-generation college students.

Randomly assigned to living learning community vs. control condition

Race & ethnicity: 27% Black, 21% Asian, 12% Latinx, 36% White, 4% other race/ethnicity.

Sex: 69% female, 31% male.

Features of the living learning community

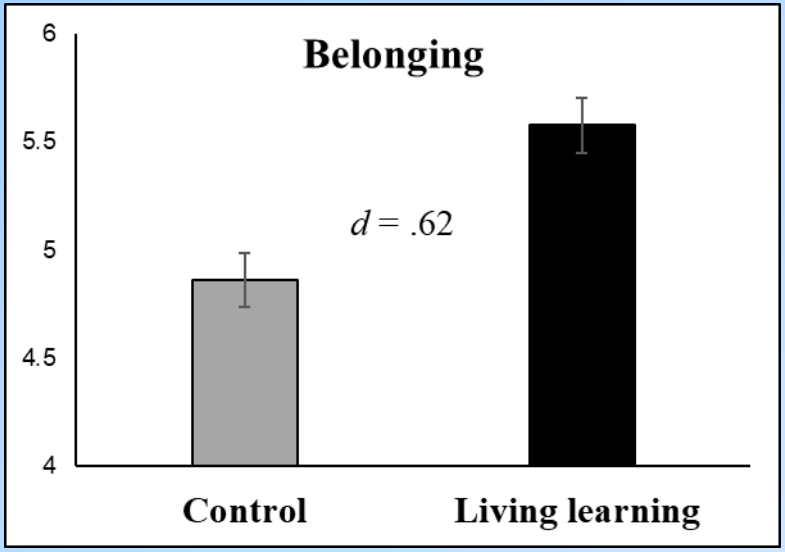
Intervention condition

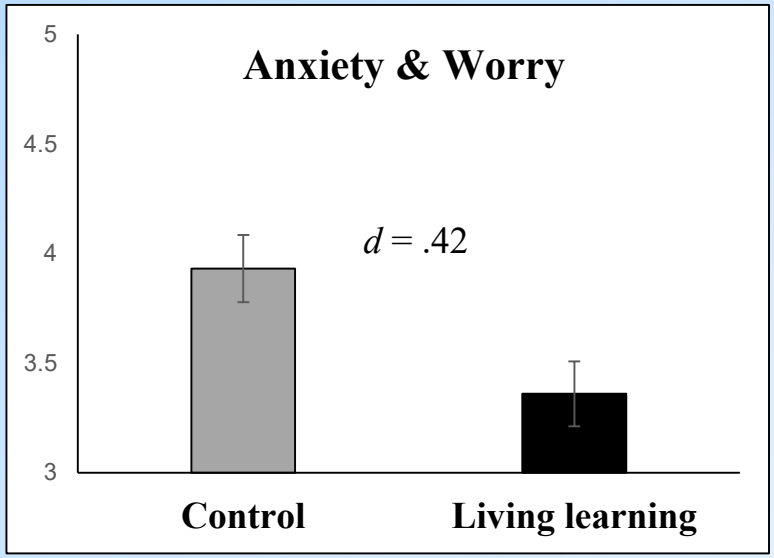
- Took introductory biology as a cohort.
- First-year seminar as a cohort
- First-gen student as peer mentor
- Students' roommate was also in the intervention condition
- Community building with first-gens once a semester

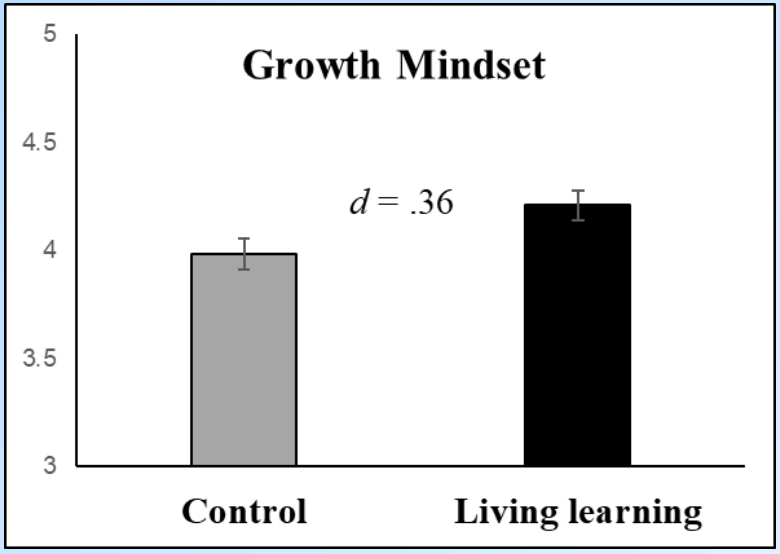
Control condition

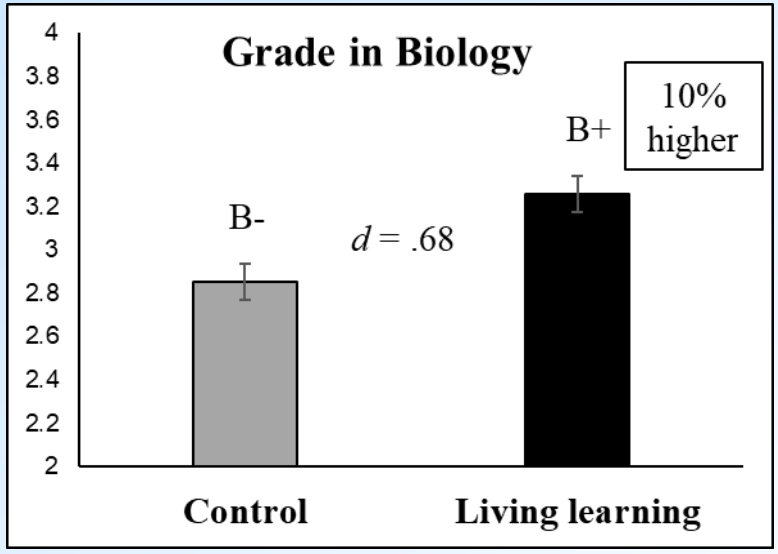
- Intro biology w/ non-first-gen students (same professor, syllabus, exams)
- First-year seminar with non-first-gen students
- No peer mentor
- Roommate not matched by major or first-gen status
- No first-generation specific community building

Belonging, anxiety, mindset, & grades



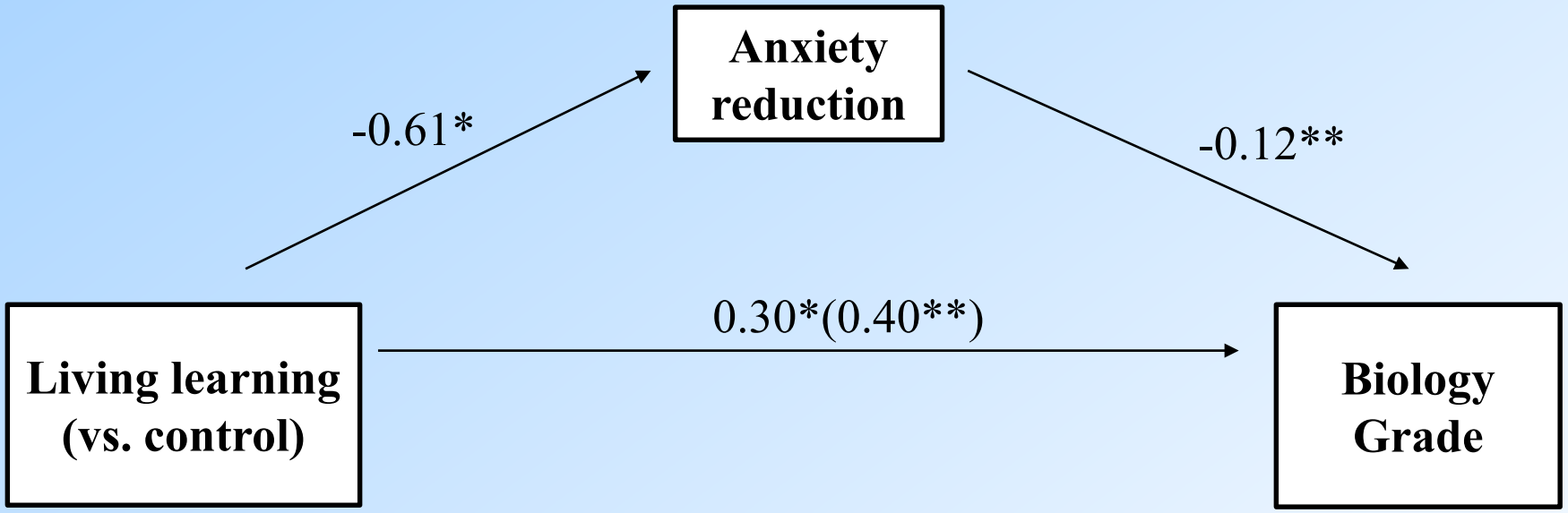






Wu, Gibson, & Dasgupta (2021).

Living learning community predicts better grades through reduced anxiety



*$p < .05$; **$p < .01$

Hayes' PROCESS Model 4 with 5,000 bootstrapping samples

Indirect effect: $B = 0.07$, $SE = 0.04$, 95% CI [.01, .18]

The take-away

- Representation, relationships, and community act as social vaccines to protect young people's resilience, persistence, and success in STEM.
- Focus on fixing learning environments, not fixing students.
- Representation: Mere exposure to own-group experts and peers are effective social vaccines for women students in STEM.
- Relationships: Short-term mentoring relationships with near peers from one's own identity group yields dividends years after end of mentoring.
- Community: Living learning programs have big positive impacts for first-generation students and students of color.
- Benefits accrue by satisfying students' need to belong and need to feel competent.
- Interventions are most effective when inserted into transition periods.

We not me

Graduate Students: Past & present
Jane Stout, Melissa Scircle, Matthew Hunsinger, Deborah Wu, Kelsey Thiem, Tara Dennehy

Colleagues in Mathematics, Engineering, and Biology
Dr. George Avrunin, Dr. Elizabeth Connor, Dr. Tracie Gibson, Dr. Randall Phillis, Dr. Paula Rees, Dr. Bernard Schleimann, Dr. Linda Zeigenbein

National Science Foundation
NSF CAREER BCS 0547967
NSF GSE 1132651
NSF HRD 1348789

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