UCSF
University of California
San Francisco

Ingredients for Broadening Participation in STEM

Measuring psycho-social stability and integration

Mica Estrada
Department of Social and Behavioral Sciences
& Institute of Health and Aging, UCSF

Paper given at OXIDE, Washington DC. April 2017

Funded by

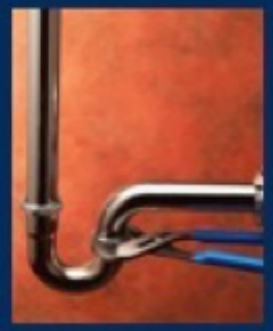
NIGMS

hhmi
Howard Hughes Medical Institute

…in diversity there is beauty and there is strength.

Maya Angelou

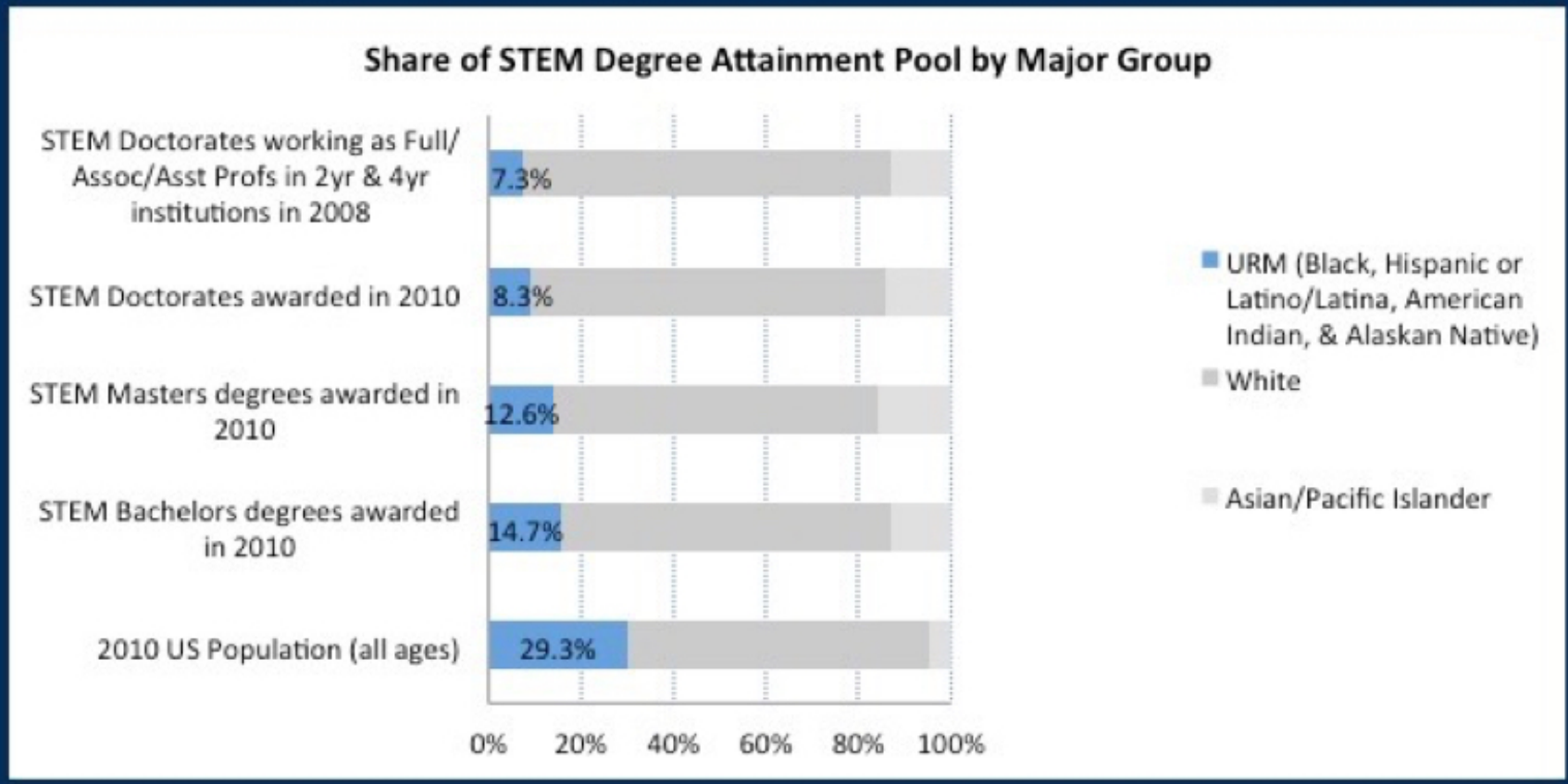
THE RESEARCH SCIENCE PIPELIE…



- BA/BS
- Masters
- Ph.D.
- Post Doctoral Fellow (optional)
- Contributing Scientist/Academic

UCSF

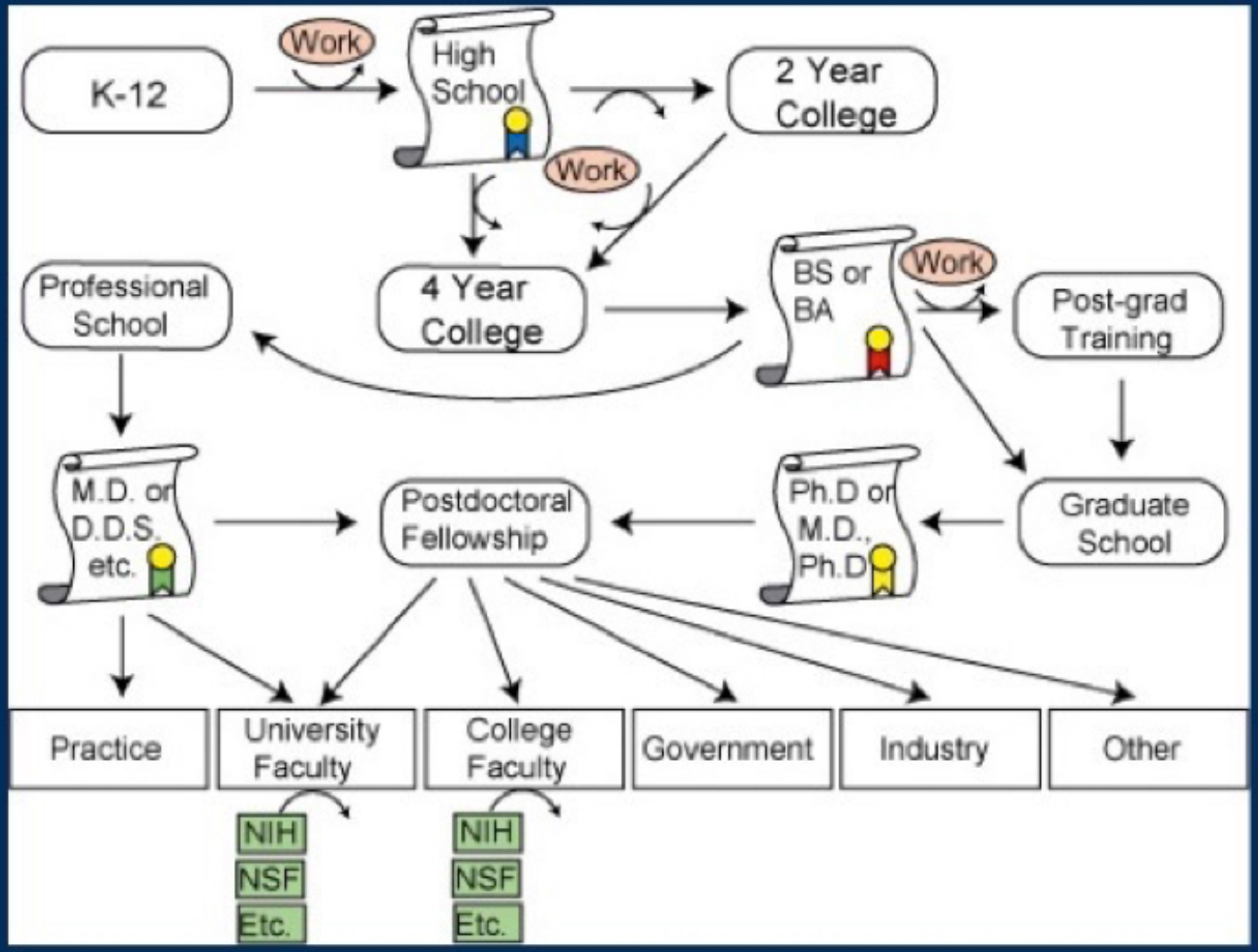
Disparity that grows…



Sources:
2010 http://www.nsf.gov/statistics
2008 Info http://www.nsf.gov/statistics

UCSF

Where do we go?

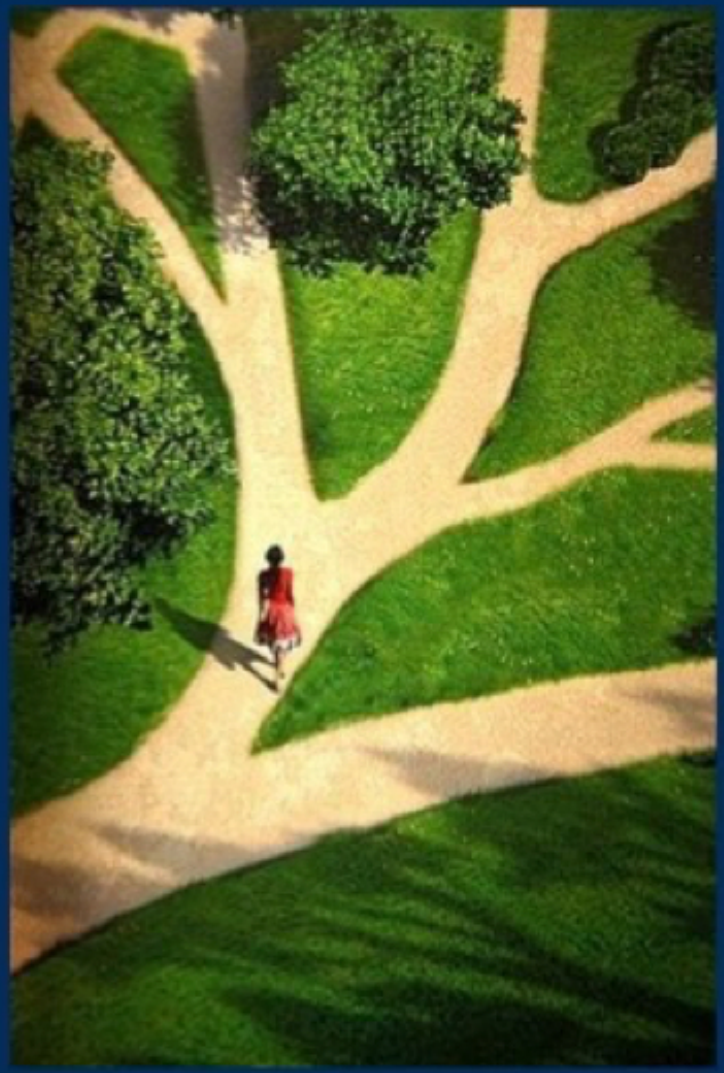


Work

Family

Other

Pipeline or Pathways?



UCSF

UCSF

Problems with Existing Data in 2005

1. Programs can "cherry pick" students who are likely to succeed

   - These students are likely to succeed *without* the program (growing new talent versus harvesting abilities)

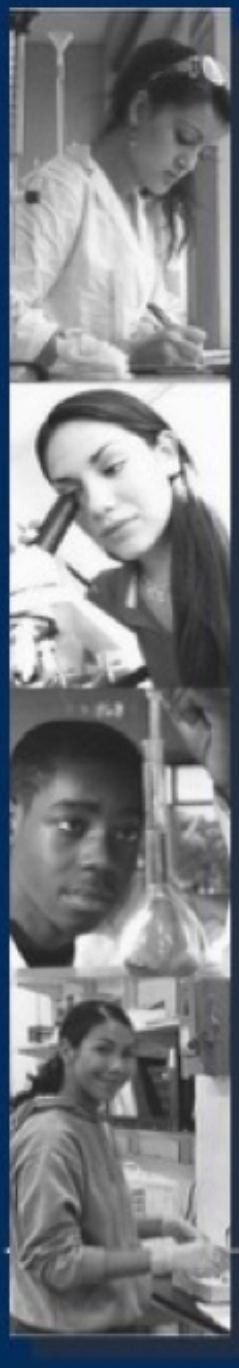
2. No control or comparison group

3. Long-term evaluations outside of funding scope

4. No way to examine the "mechanisms" of success

5. Retrospective accounts can be biased

UCSF



The Science Study

- Longitudinal study of underrepresented minority science students who had a strong interest in pursuing a biomedical research career

UCSF

TheScienceStudy Research Team

- Wesley Schultz (PI)
- Mica Estrada (Co-PI)

- Anna Woodcock
- Paul Hernandez
- Richard Serpe
- Victor Rocha

UCSF

Overview: The Science Study

From 50 campuses nationwide, 25 of these had RISE programs in 2005 (when study began)

Overview: The Science Study

Matched control group

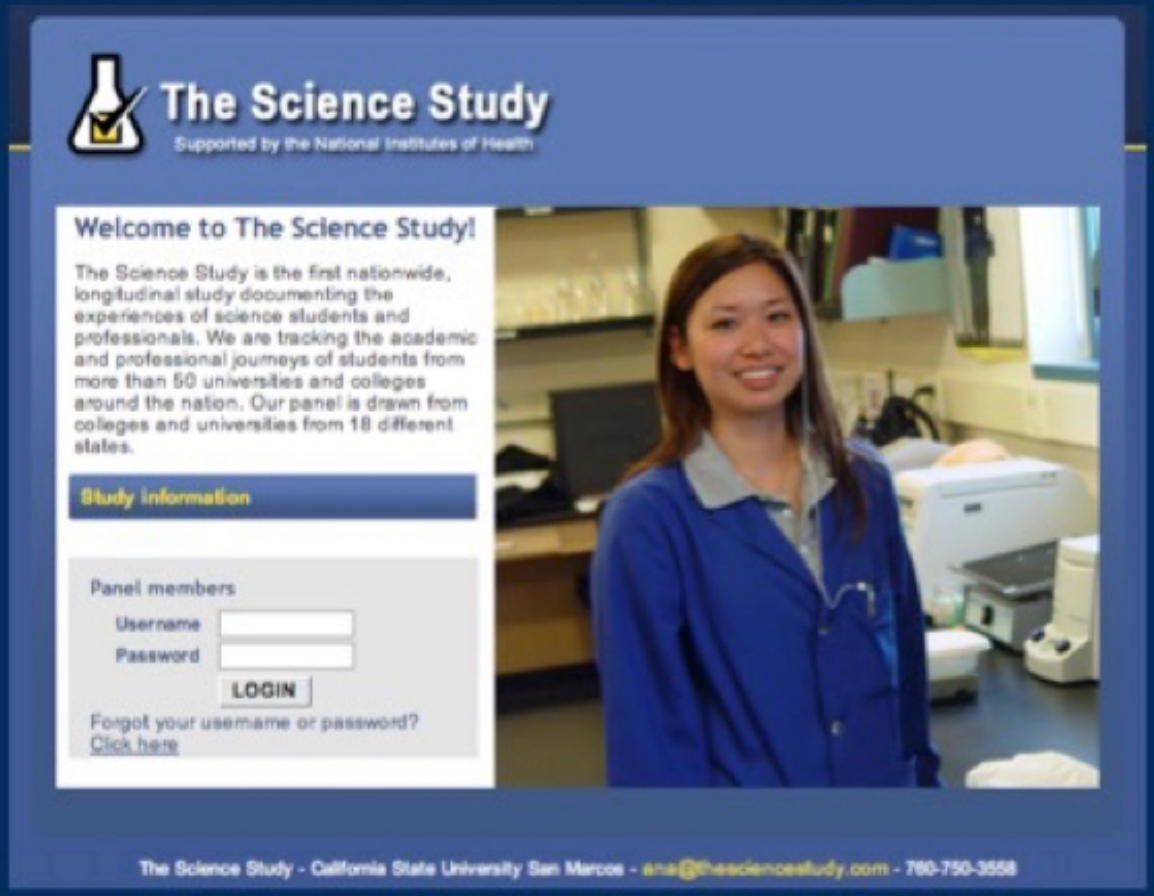
- For each R.I.S.E. or MARC student, we found a similar student who does not go through the program

- Matching variables: ethnicity, gender, major, GPA, intention to become a scientist, enrollment level (LD, UD, Grad)
- Secondary matching: age, parental education, community college transfer, English as first language

UCSF

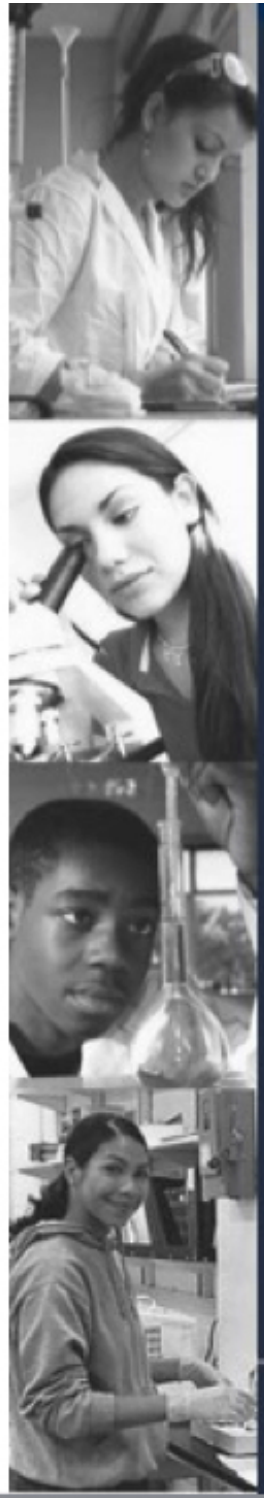
Survey Data Collection

- Data collected twice yearly from students through a secure web interface
- 11 years



www.TheScienceStudy.com

UCSF



Longitudinal Panel

- 72% Female
- Ethnicity/Race:
  - 49% African American
  - 39% Hispanic/Latino(a)
  - 1% Native American
- Major (when began):
  - 63% Biological Sciences
  - 21% Natural Sciences
  - 12% Behavioral & Social Sciences
  - 4% Mathematics & Engineering

UCSF

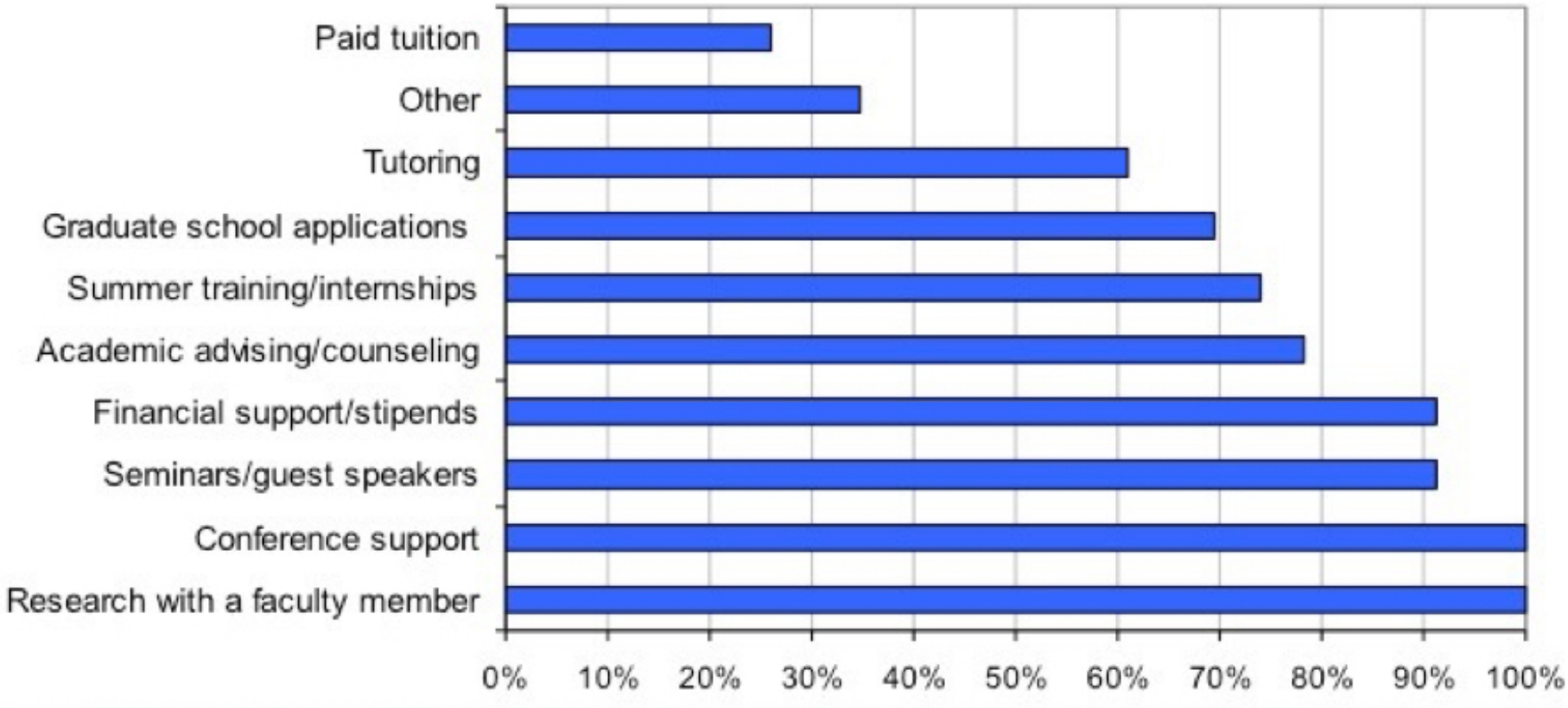
RETENTION: Tailored Panel Management

- Response rates at each wave range from 86% to 70% (71% in most recent, Spring 2015)
- Data augmented with degree attainment from the National Student Clearinghouse
- Remain in contact with 97% of panel

Protocol summarized in Estrada, Woodcock & Schultz, 2014

UCSF

Minority Training Programs: NIH RISE Program Elements



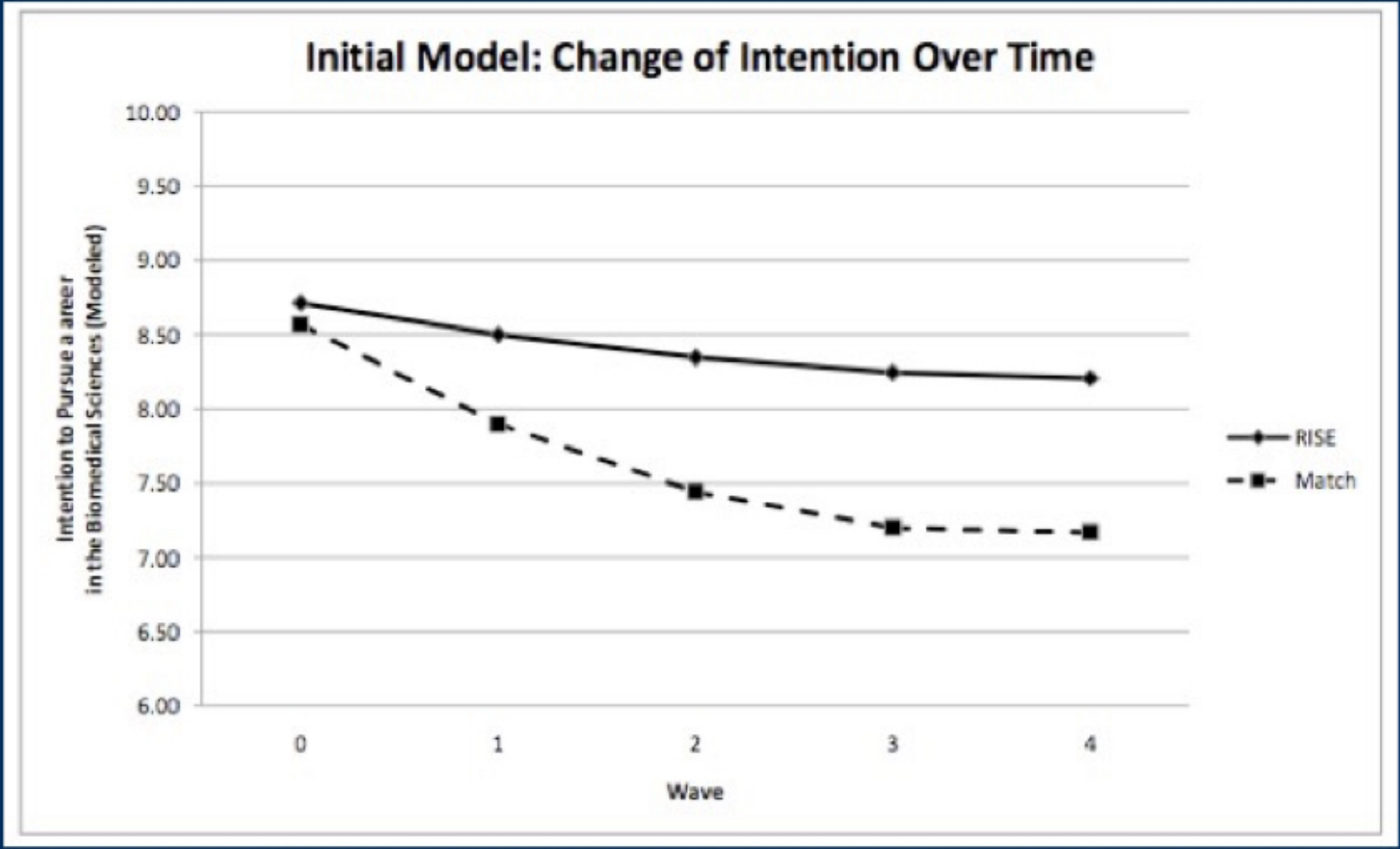
Note: Results based on survey responses from 25 RISE directors.

UCSF

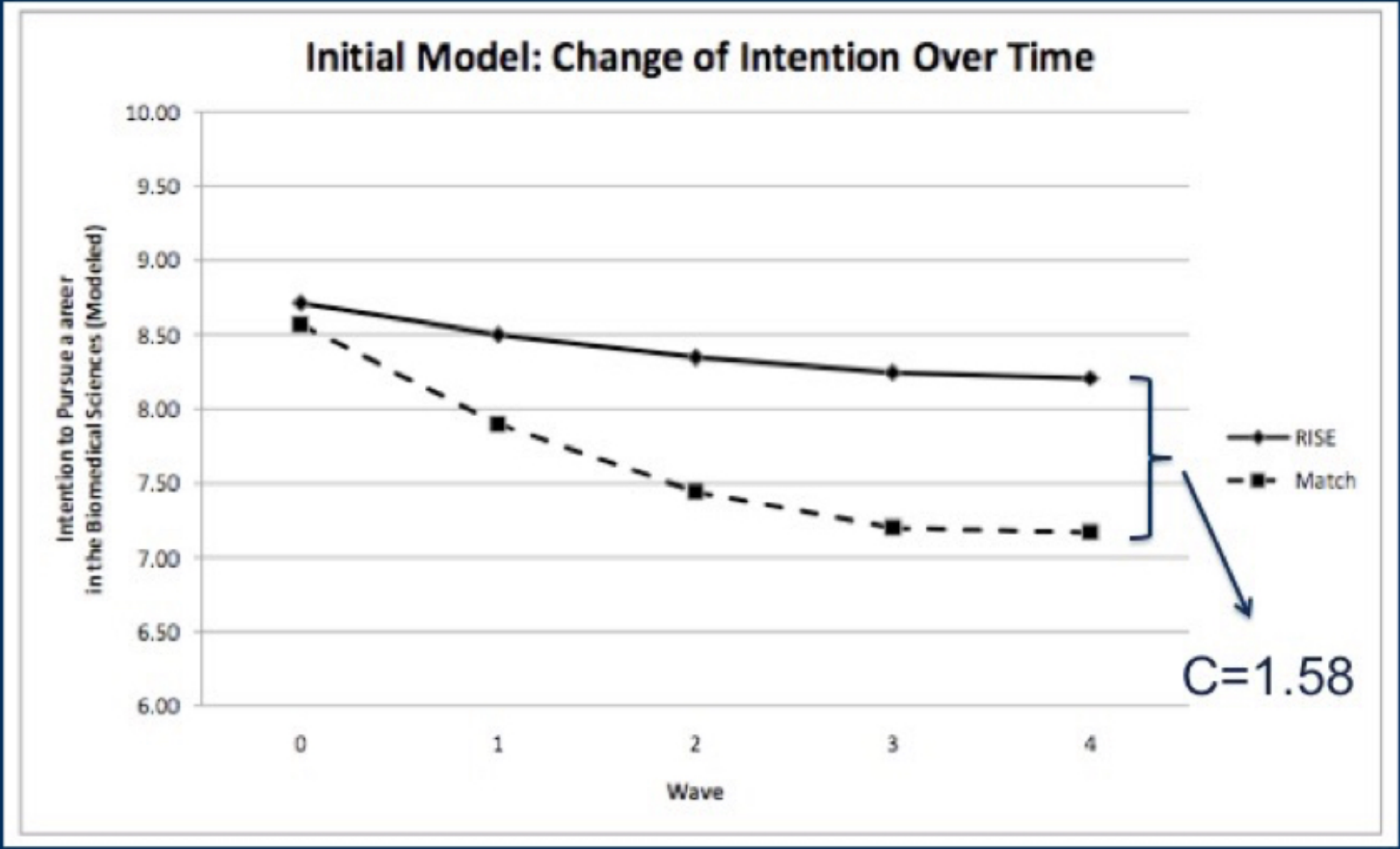
Overview of Results

1. Basic effects (summative outcome)
   - Persistence (Intention to become a scientist)
   - STEM career persistence
2. Program elements (mediators)
   - Research experience, faculty mentorship
3. Reasons for success (a process of integration)
   - Self-efficacy, identity, values

UCSF



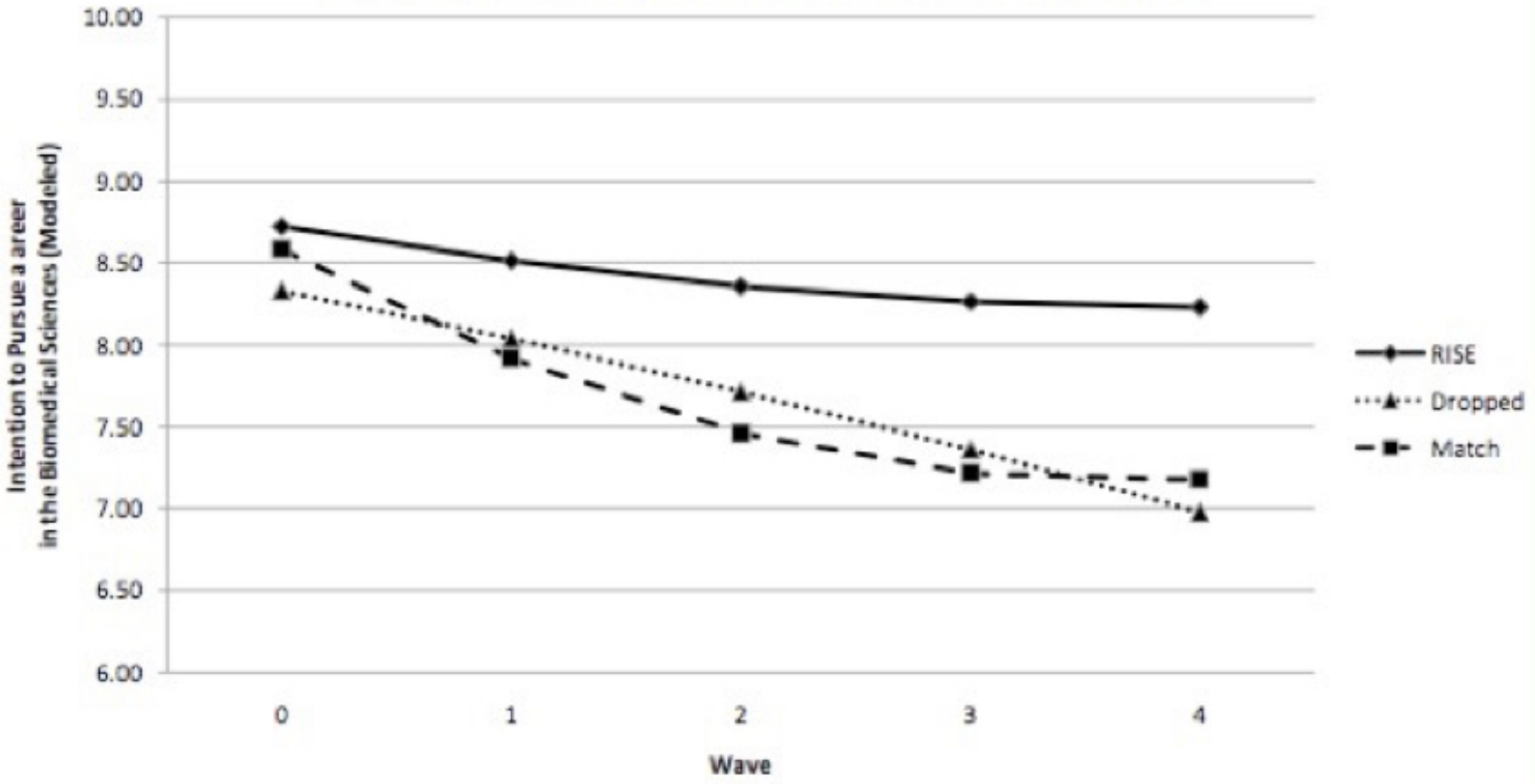
Q: To what extent do you intend to pursue a career as a biomedical scientist? (0 – 10)



Q: To what extent do you intend to pursue a career as a biomedical scientist? (0 – 10)

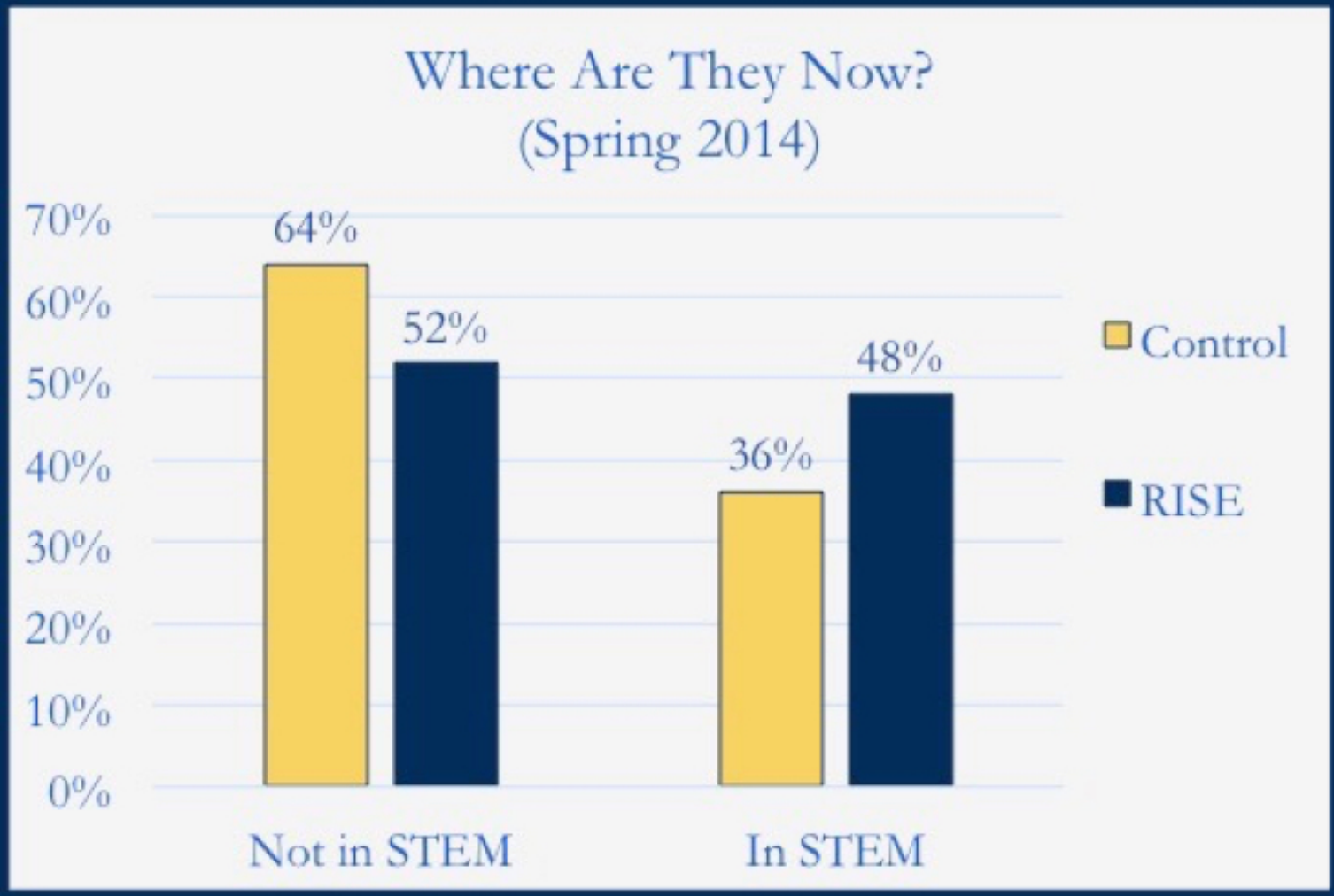
UCSF

Initial Model: Change of Intention Over Time



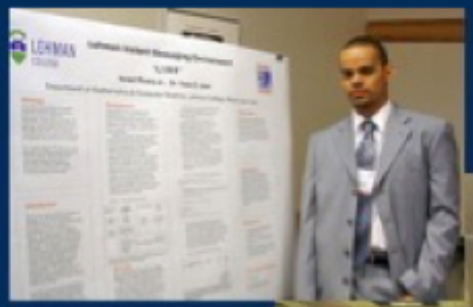
UCSF

Chance students is now in a STEM Career: RISE EFFECT



UCSF

2. Program Elements (Mediators)



Invited Speakers & Workshops

Tutoring

Paid Tuition & Stipends

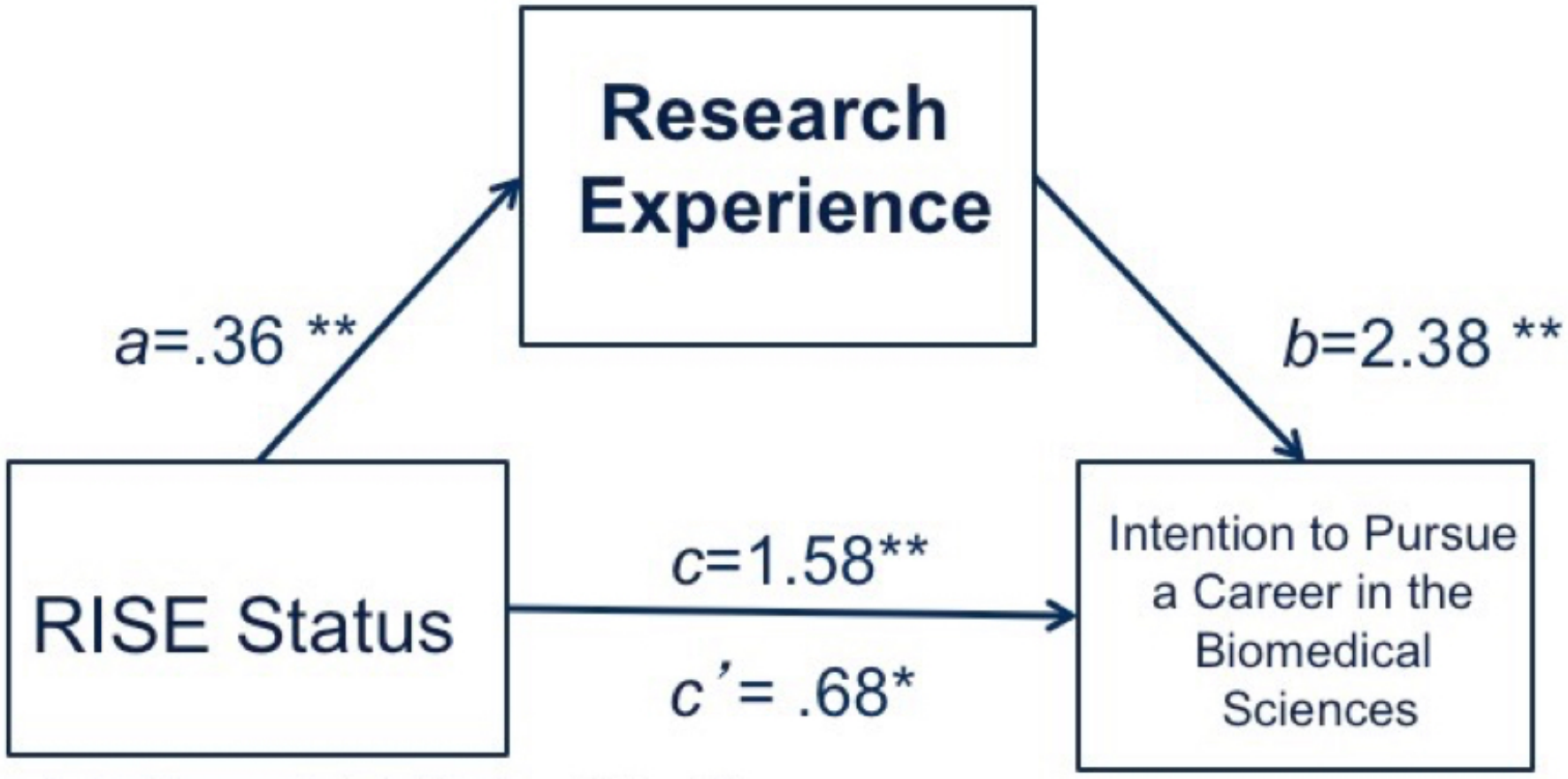
Support to attend professional conferences

Research Experience

Faculty Mentorship

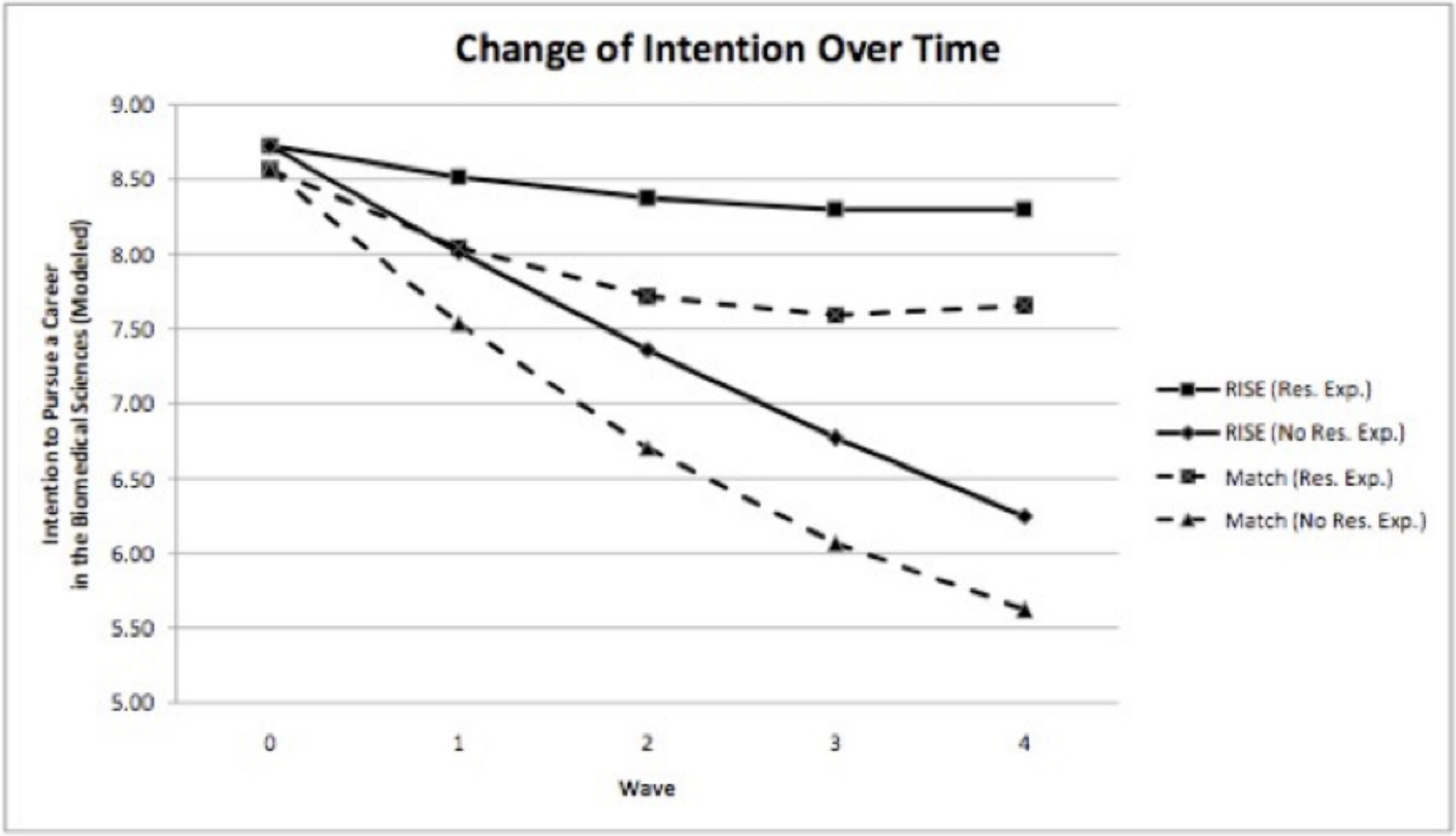
UCSF

Mediation: Research Experience



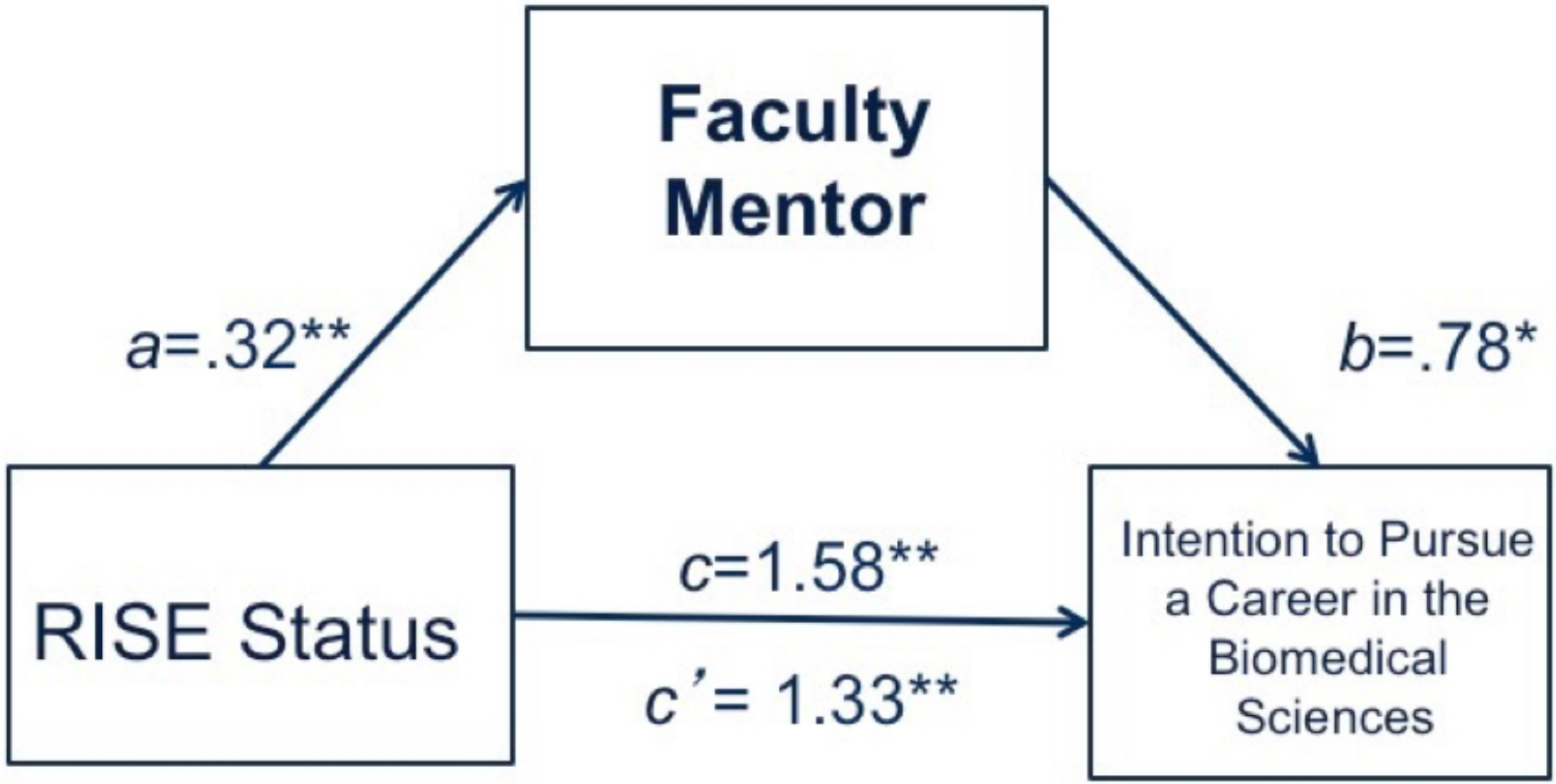
*Note: a, b and c path's are unstandardized coefficients. * p < .05, ** p < .001*
Bootstrapped Indirect Effect: Mean = 0.68, $CI_{99\%}$ = 1.31 to 0.45
Sobel: Z = 4.67, p < .001

UCSF



Note: Change over time analyses conducted as a hierarchical linear model, with both linear and quadratic terms. Analyses are based on students who were undergraduates (jr. or sr.) at W0. Propensity score (W0) used as time invariant covariate. RISE = students continuously funded, and MATCH = students never funded by any program and enrolled on a RISE campus. Research is *any* research experience ever during undergraduate education. Intention to pursue career as biomedical scientist.

Mediation: Faculty Mentor



*Note: a, b and c path's are unstandardized coefficients. * $p < .05$, ** $p < .001$*
Sobel: $Z = 2.08$, $p < .05$

Why does research experience have such a large impact?

Diversity involves integration…

And it is a two way street…community provides opportunity, inclusion, values…but students are not blank slates…

UCSF

Building on Kelman's social influence theory….

Who integrates into the scientific community?

Tripartite Integration Model of Social Influence (TIMSI)

Scientific self-efficacy	• I can do what scientists do
Scientific identity	• I am a scientist
Internalization of scientific values	• I agree with the values of the scientific community.

\+ \+ \+

Integration (persistence)

Estrada et al., 2011

UCSF

Example of Science Efficacy Questions

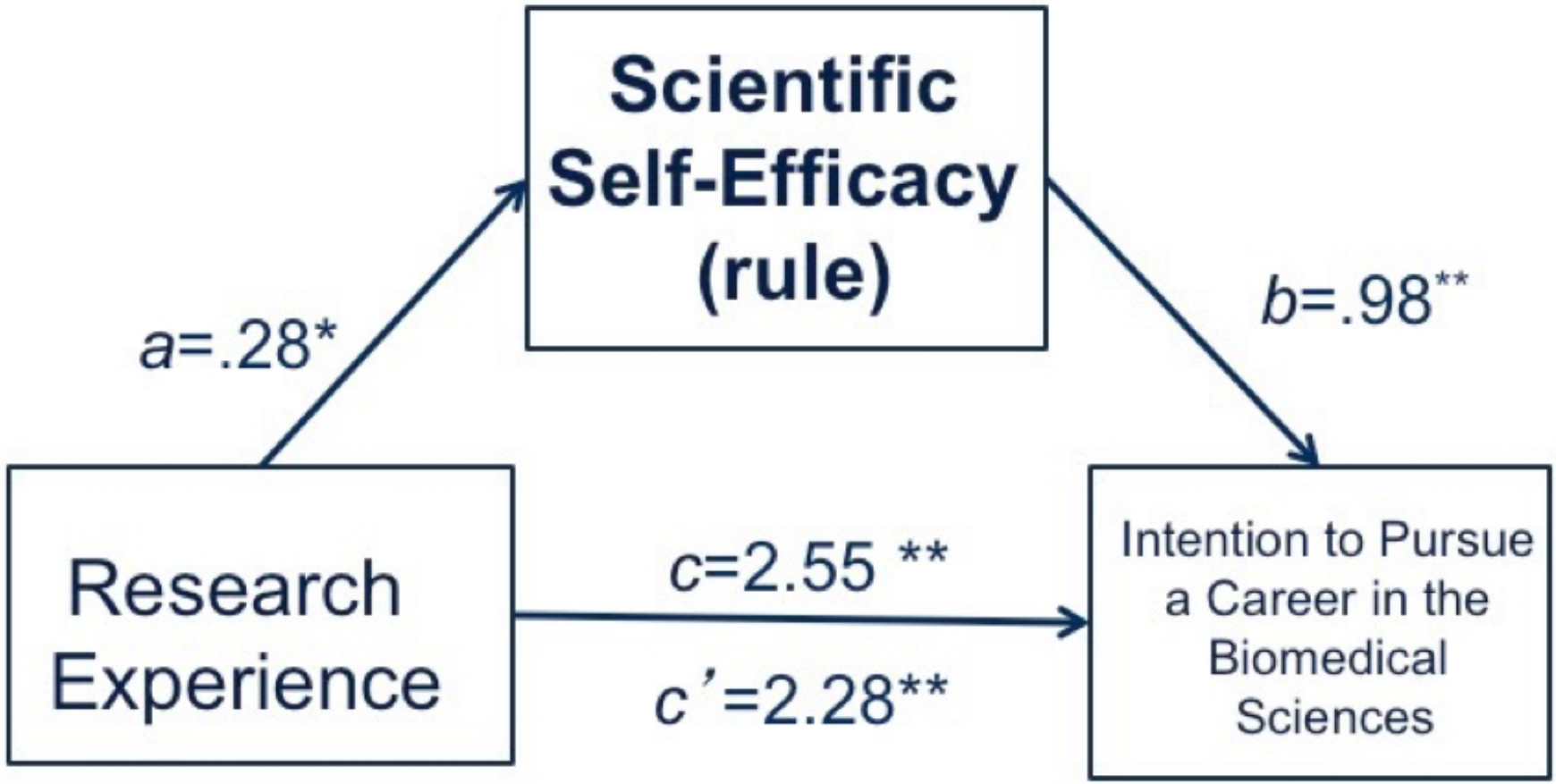
Extent to which you are confident you can successfully complete the following tasks…

- Use scientific language and terminology.
- Figure out/analyze what data/observations mean.
- Use scientific literature and/or reports to guide research.
- Use technical science skills (use of tools, instruments, and/or techniques).
- Report research results in a written paper.

Chemers, et. al. (2010).

UCSF

3. Reasons for Success (process)

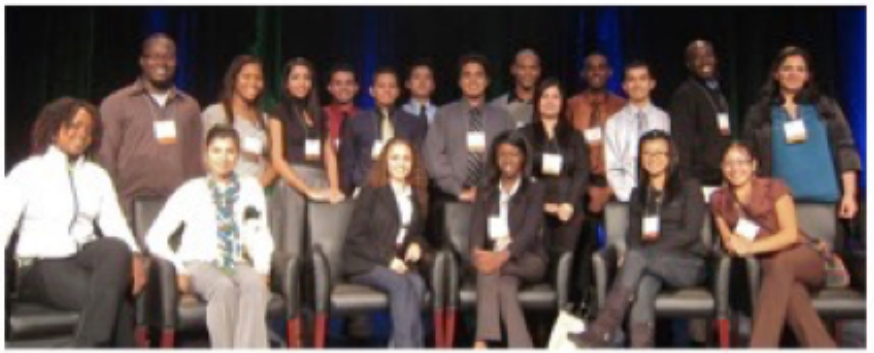


*Note: a, b and c path's are unstandardized coefficients. * p < .05, ** p < .01*
Bootstrapped indirect effect: mean = .27, $CI_{99\%}$ .06 to .56

Example of Science Identity Questions

Level of agreement with each statement…

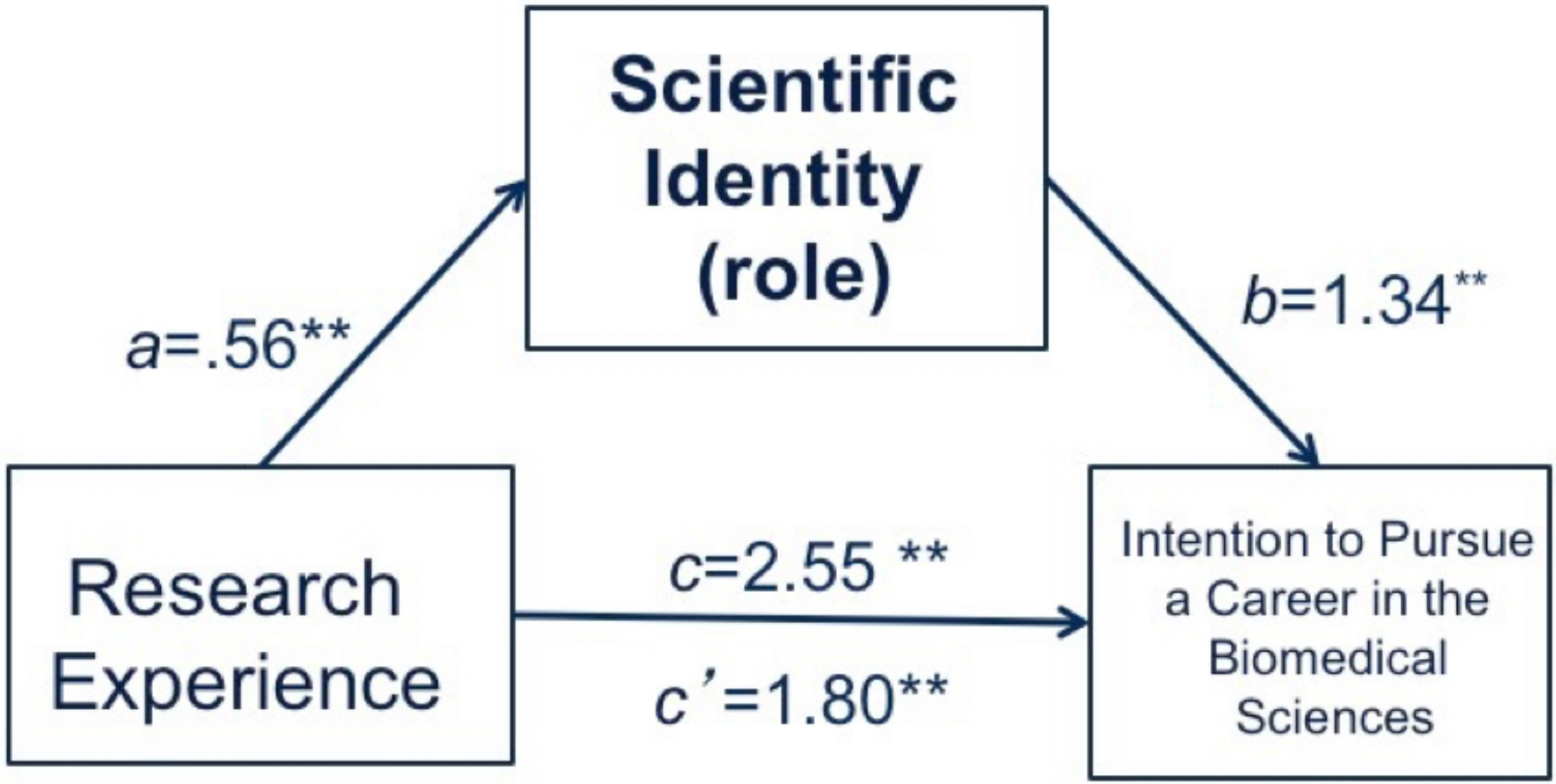
- In general, being a scientist is an important part of my self-image.
- I am a scientist.
- I have a strong sense of belonging to the community of scientists.
- Being a scientist is an important reflection of who I am.



Modification of Chemers, et. al. (2010).

UCSF

4. Reasons for Success (process)



Note: a, b and c path's are unstandardized coefficients. * p < .05, ** p < .01

Bootstrapped indirect effect: mean = .75, CI = .33 to 1.23

Sobel: Z = 4.35, p<.001

Example of Science Value Questions

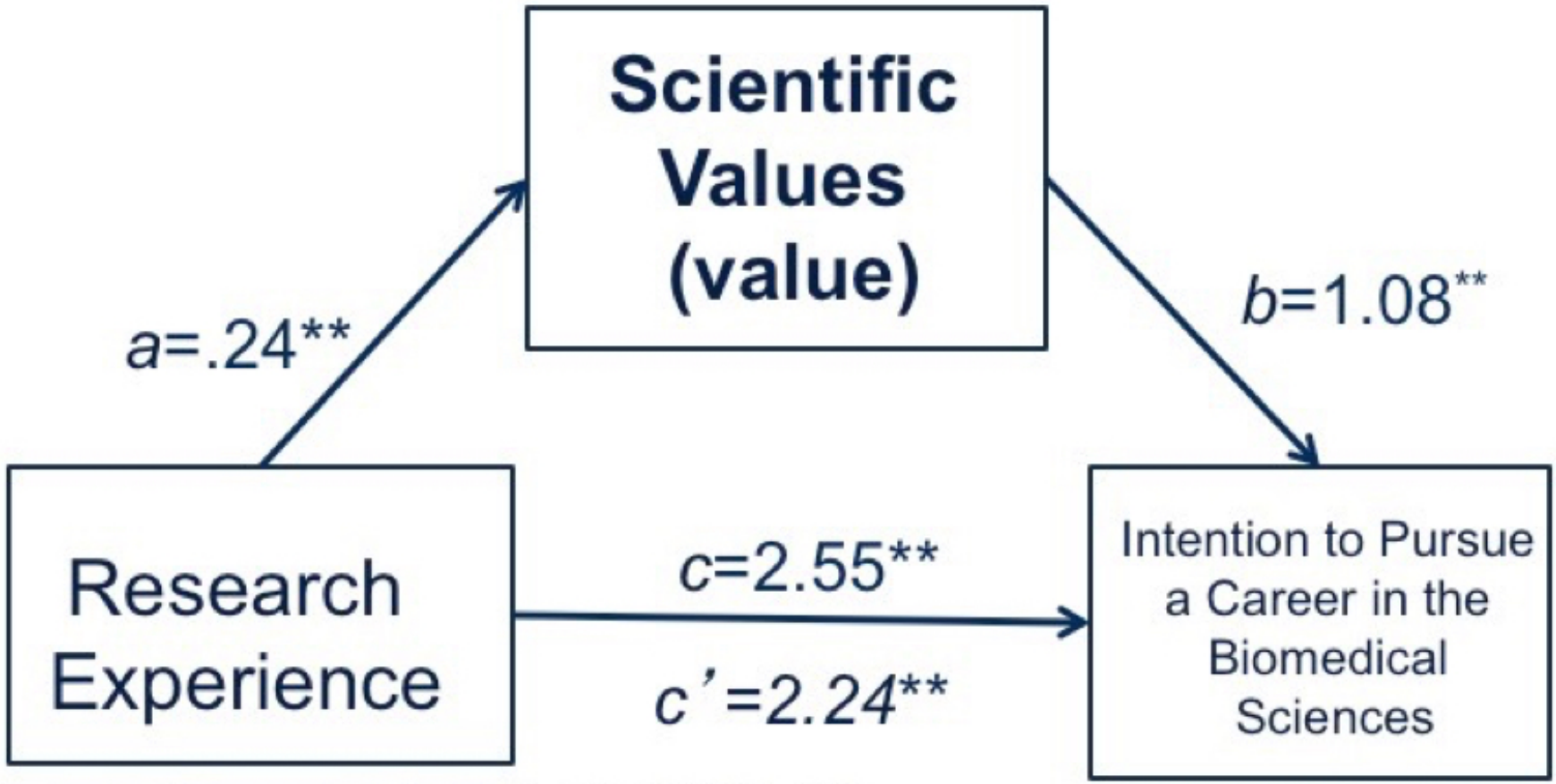
How much is this person like you?

- A person who thinks it is valuable to conduct research that builds the world's scientific knowledge.
- A person who believes writing up research results to be published in a leading scientific journal is a good use of time.
- A person who feels discovering something new in the sciences is thrilling.
- A person who thinks it is important work to identify truths using the scientific method.
- A person who thinks discussing new theories and ideas between scientists is important.

Estrada, et al. (2011).

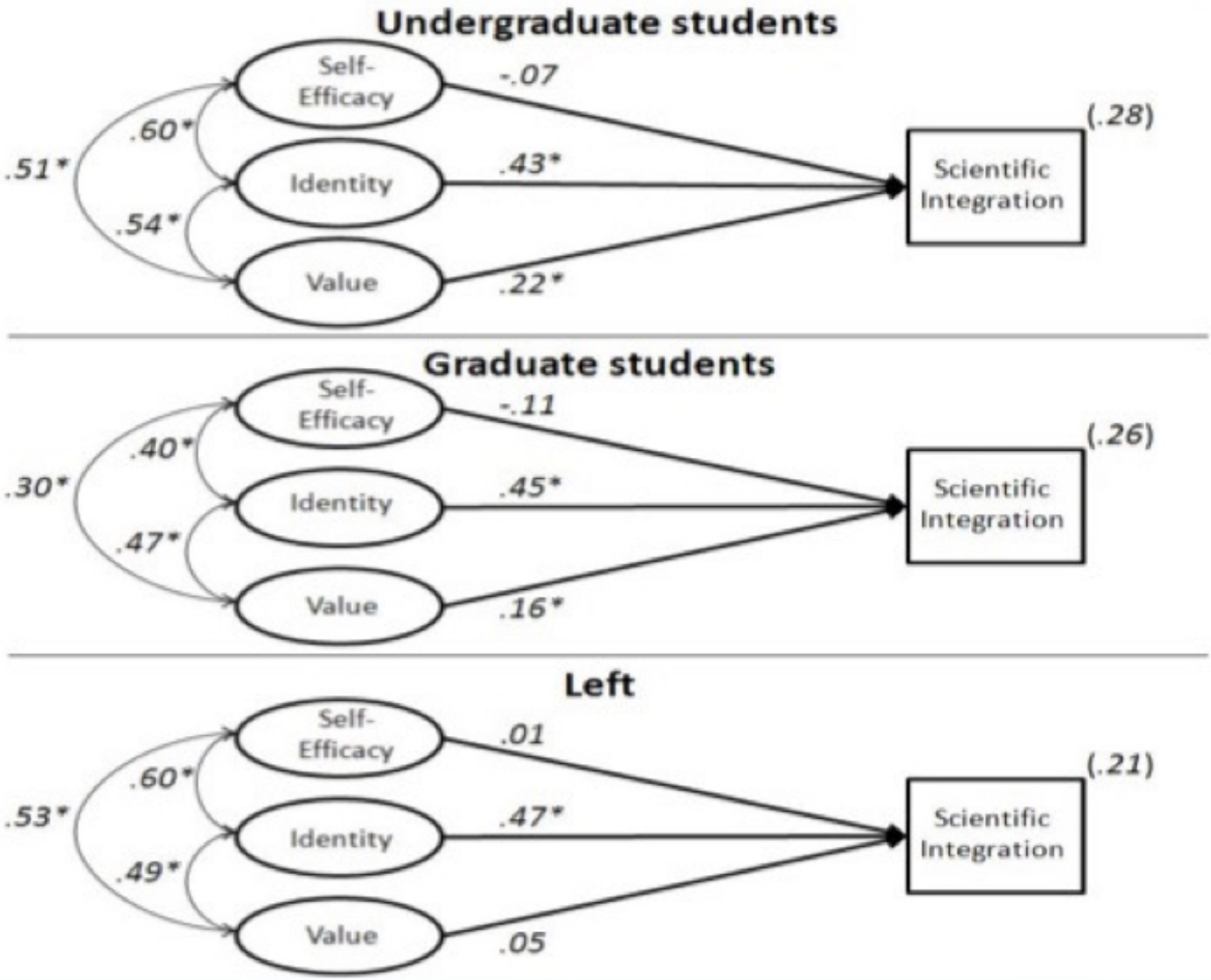
UCSF

4. Reasons for Success (process)



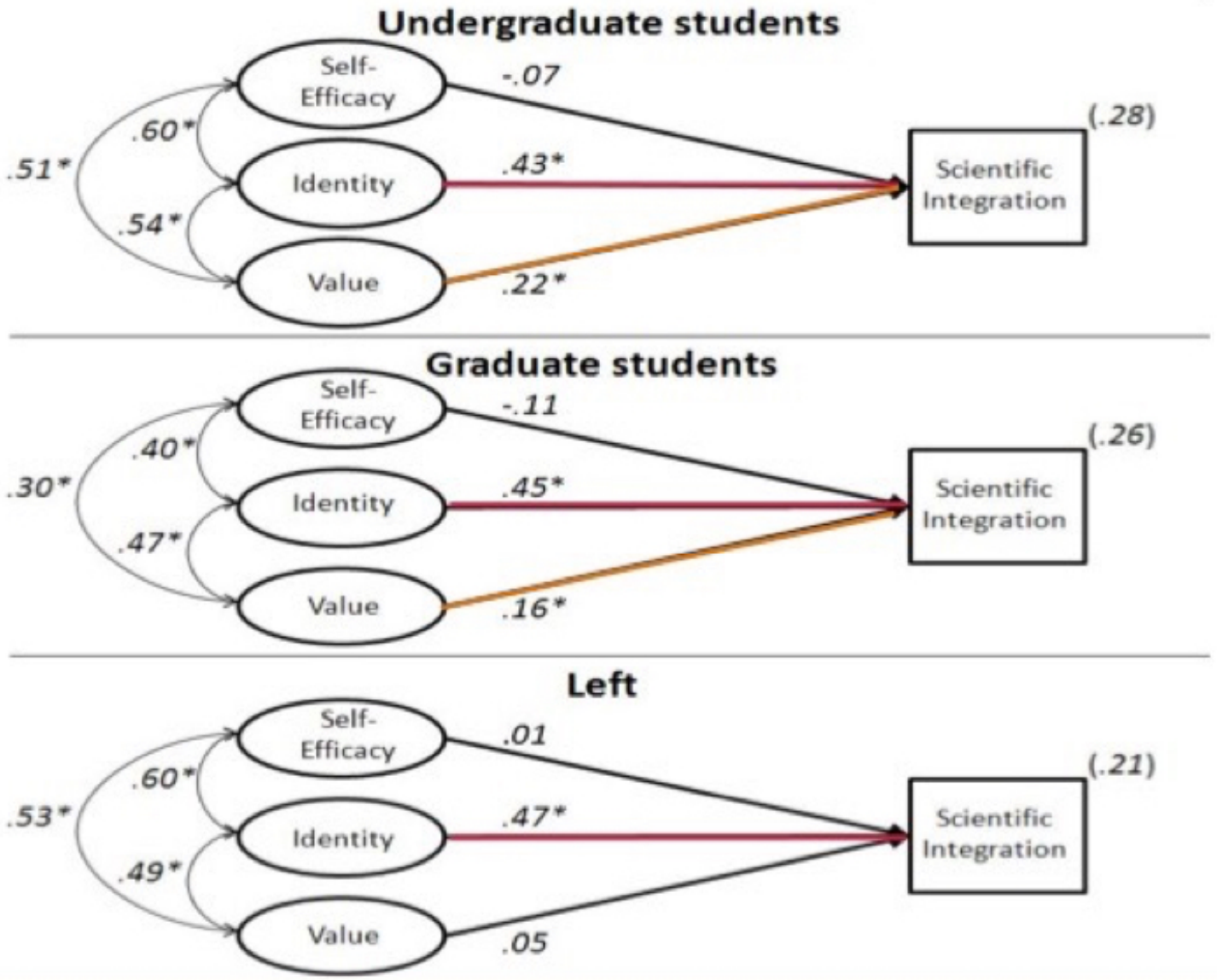
*Note: a, b and c path's are unstandardized coefficients. * p < .05, ** p < .01*
Bootstrapped indirect effect: mean = .27, $CI_{99\%}$ .01 to .60
Sobel: Z = 2.43, p<.01

Tripartite Integration Model of Social Influence (TIMSI)



Estrada et al. (2011)

Tripartite Integration Model of Social Influence (TIMSI)



Estrada et al. (2011)

UCSF

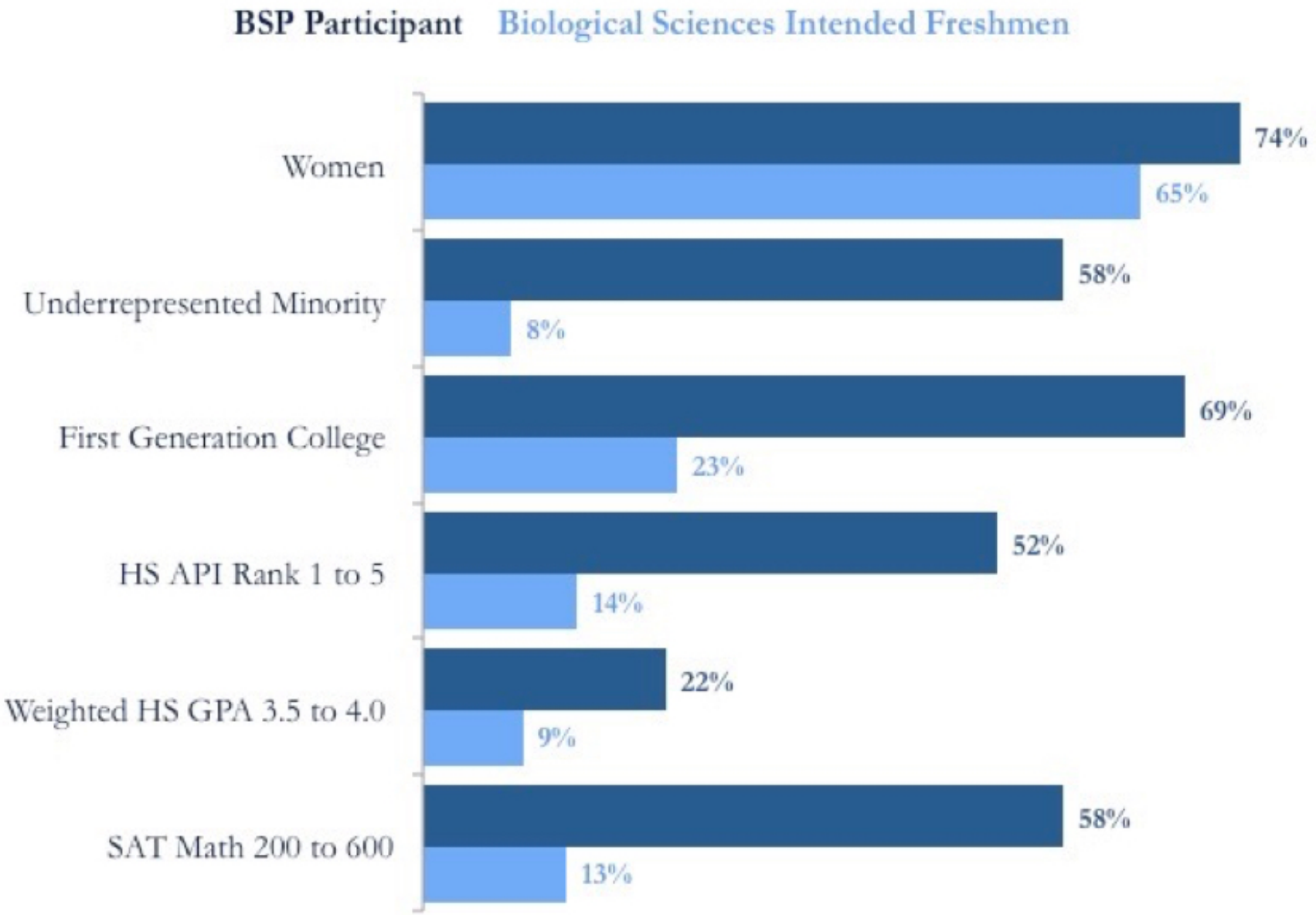
Gift it Forward Study: Researching UC Berkeley's Biology Scholars Program

Lilibeth Flores[1]. John Matsui[2]
University of California San Francisco[1] &
University of California Berkeley[2]

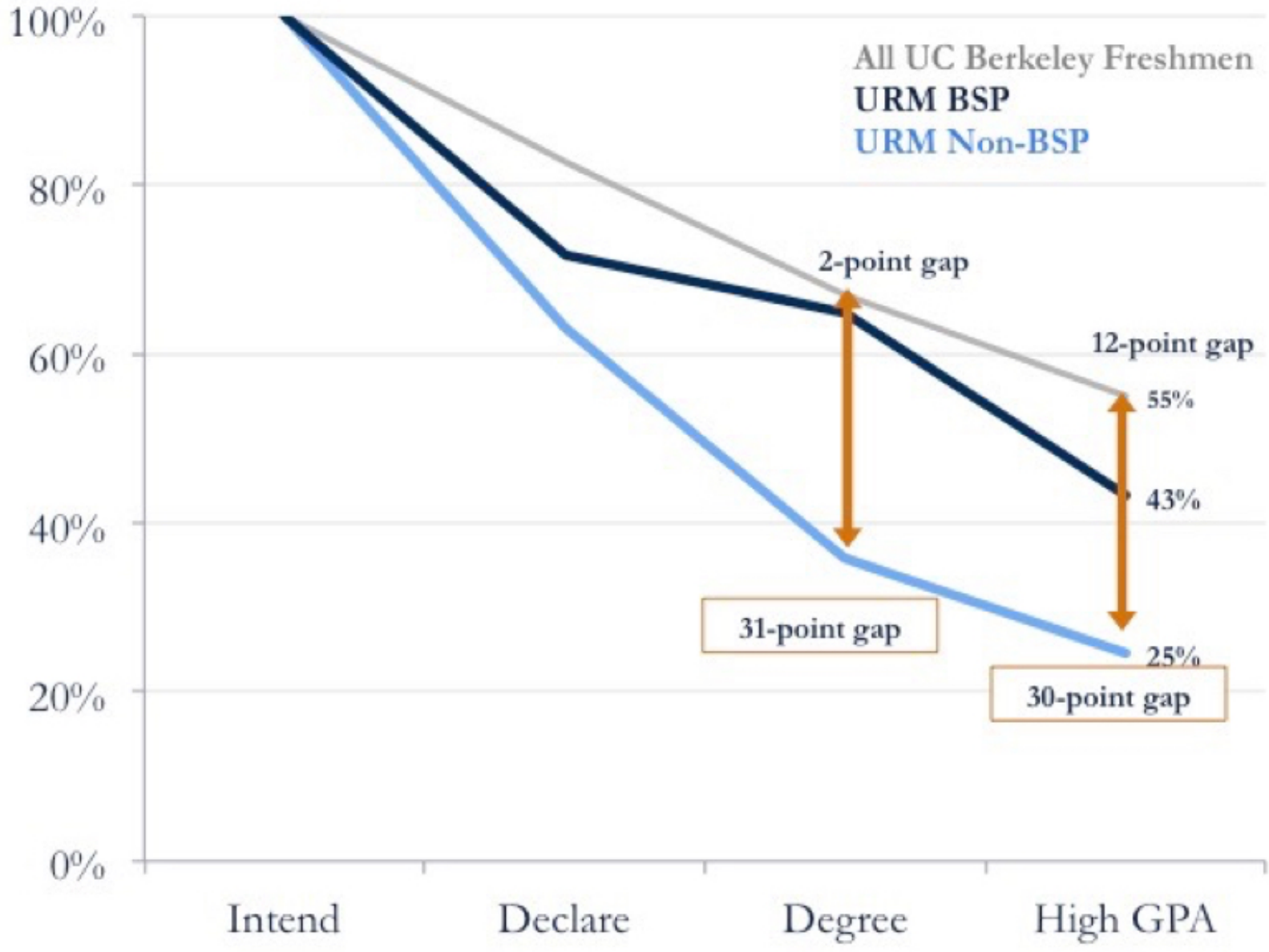
Biology Scholars Program (BSP)
UC Berkeley

- 23 year program
- Consistent "beating the odds" results
- Provides academic advising, social support, research opportunities, mentorship, seminars and workshops, community.
- National recognition for its success

BSP Demographics



Biological/Biomedical Sciences Persistence – URM



Note: 2002-2008 entering freshmen cohorts, intended biological and biomedical sciences majors

UCSF

Beyond outcomes…

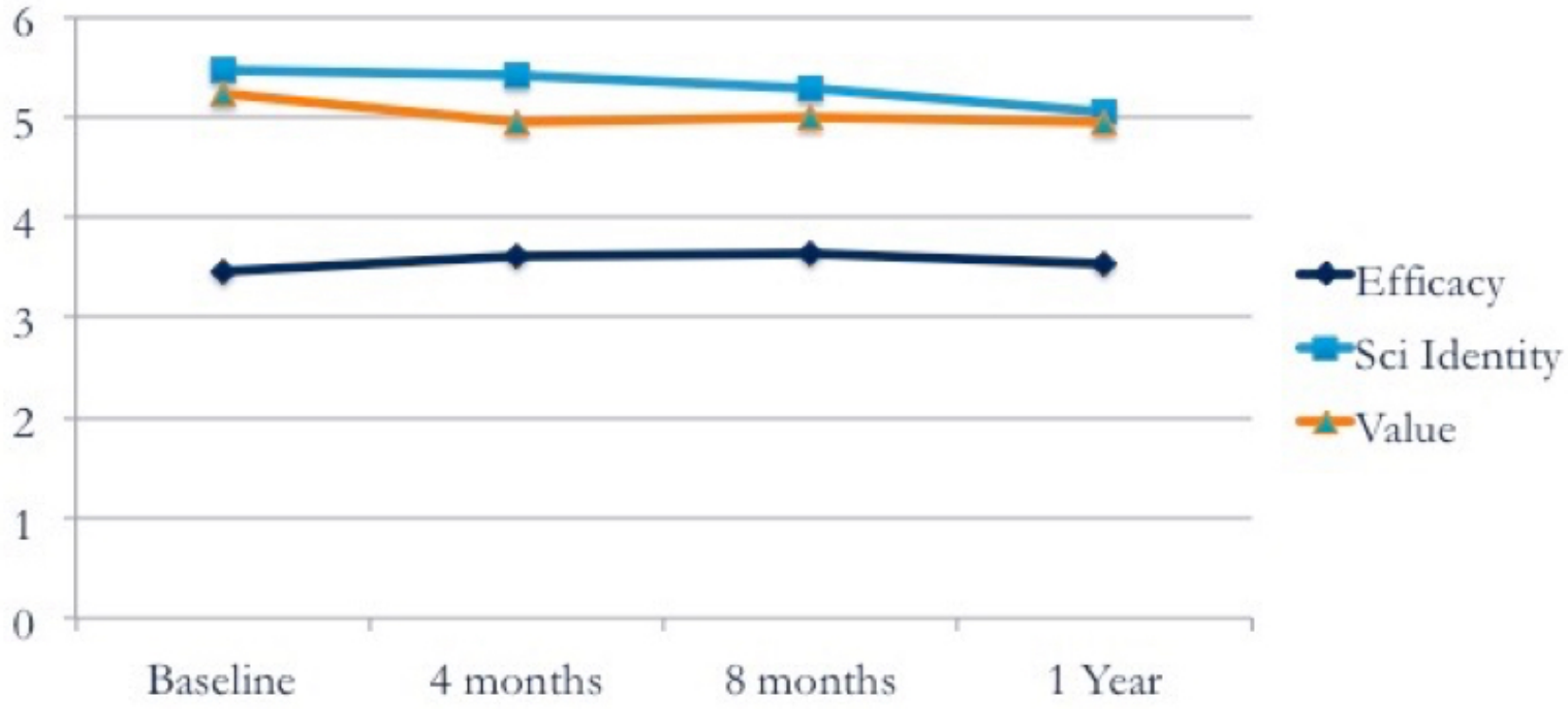
What is happening?

UCSF

BSP Gift It Forward Study

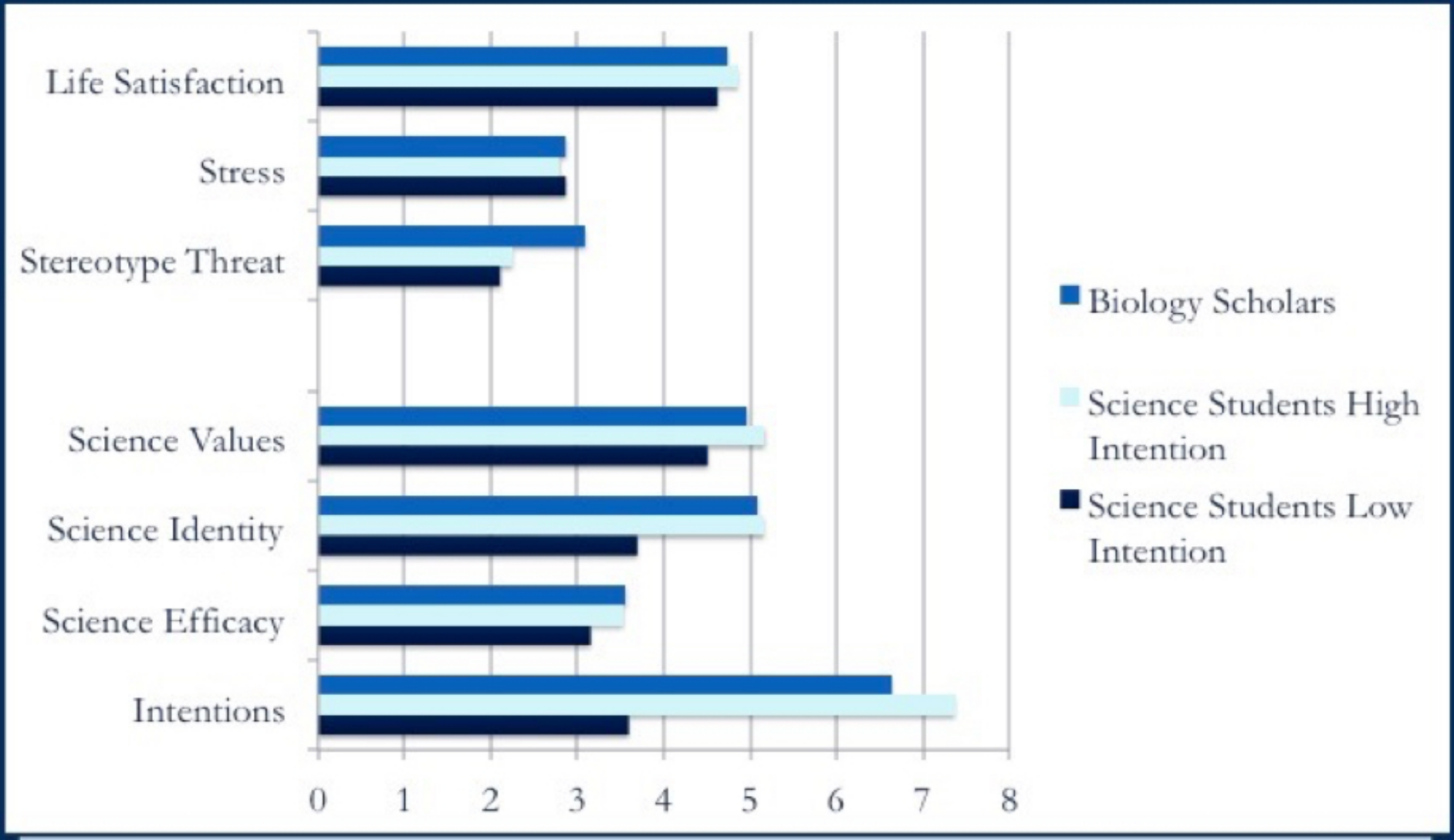
- Began in Fall 2014 (currently have 5 waves of data)
- 72 Participants (2014 cohort)
  - 74.3% females
  - 44.3% Hispanic/Latino/Chicano; 8.6% African American; 4.3% Native American/Alaskan Native.
  - 75% of the participants were first generation college students
  - 43.7% first year, 31% second year, 15.5% third year, 2.8% 4th year, and 4.2% 5th year or more at UCB

Biology Scholars
Integration into Science Community

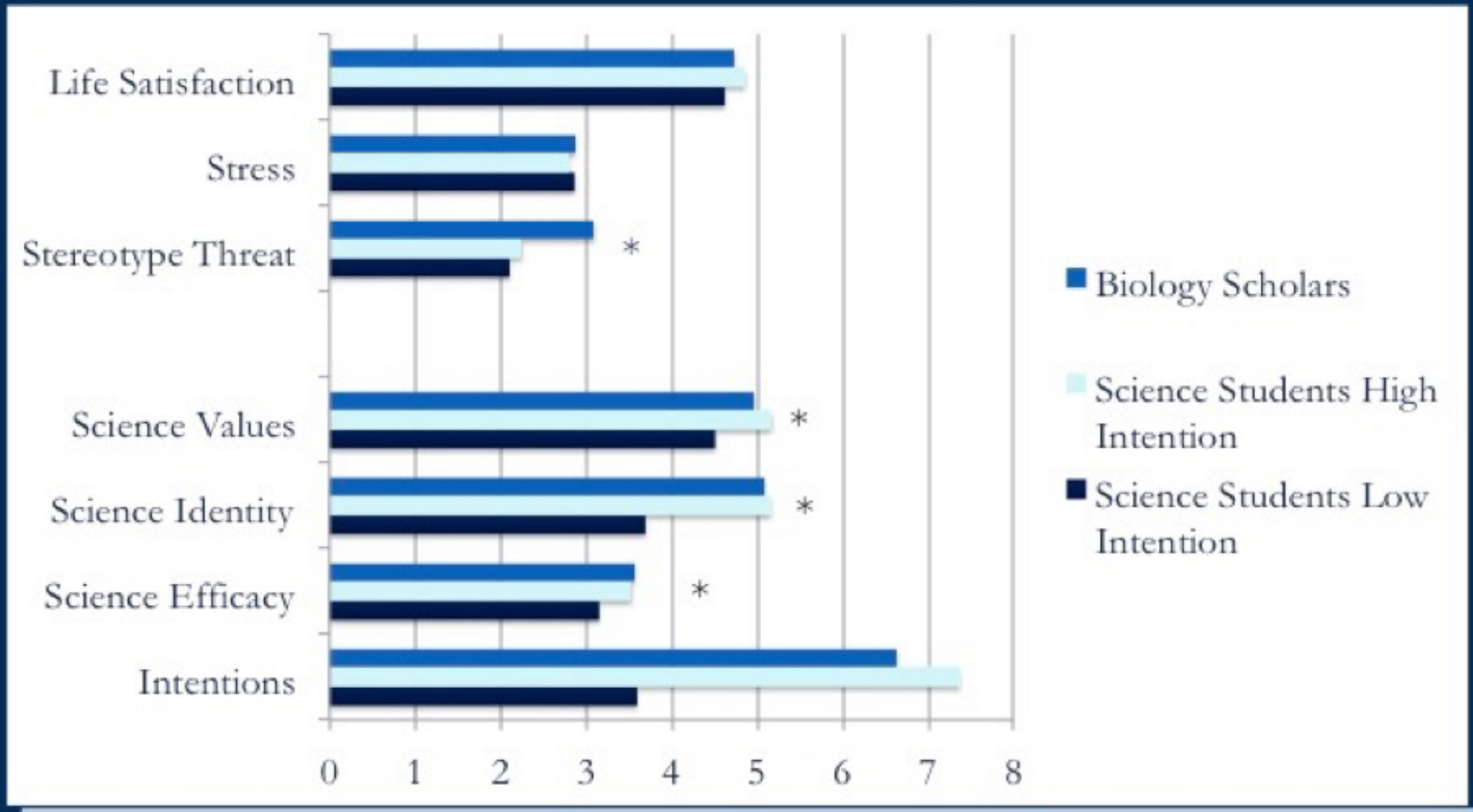


UCSF

Psychosocial and Outcome Variable:
BSP compared with Bio1A/Chem 1A Students (Fall 2015)

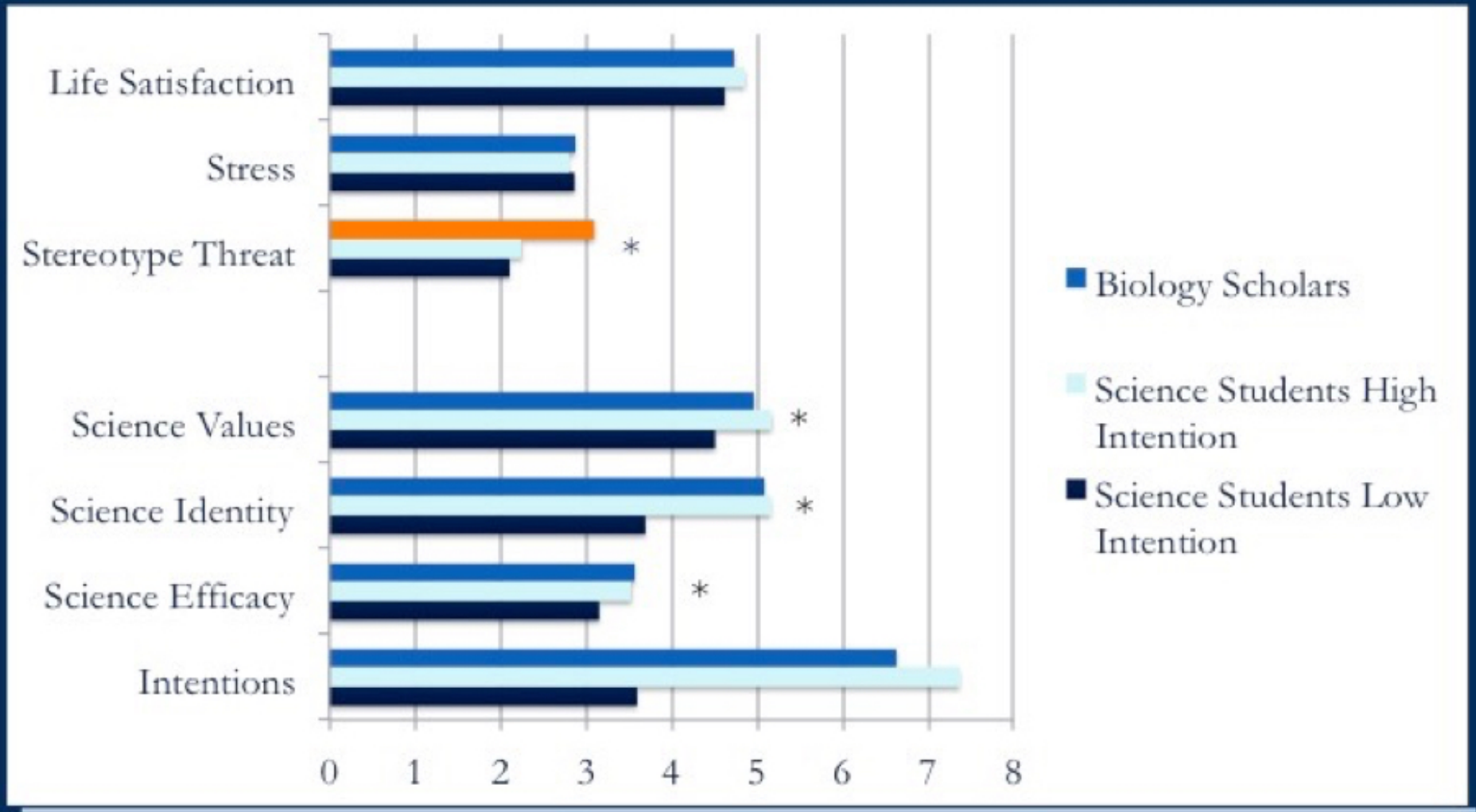


Psychosocial and Outcome Variable:
BSP compared with Bio1A/Chem 1A Students (Fall 2015)



Psychosocial and Outcome Variable:

BSP compared with Bio1A/Chem 1A Students (Fall 2015)



Example of Stereotype Threat Questions

How often do you feel that because of your ethnicity…

- Some people believe that you have lower ability than other students.
- People assume that you are not good enough, even if you are similar to other students.
- If you do poorly on a test, people act like that is normal.
- Your intelligence is not fairly evaluated.

UCSF

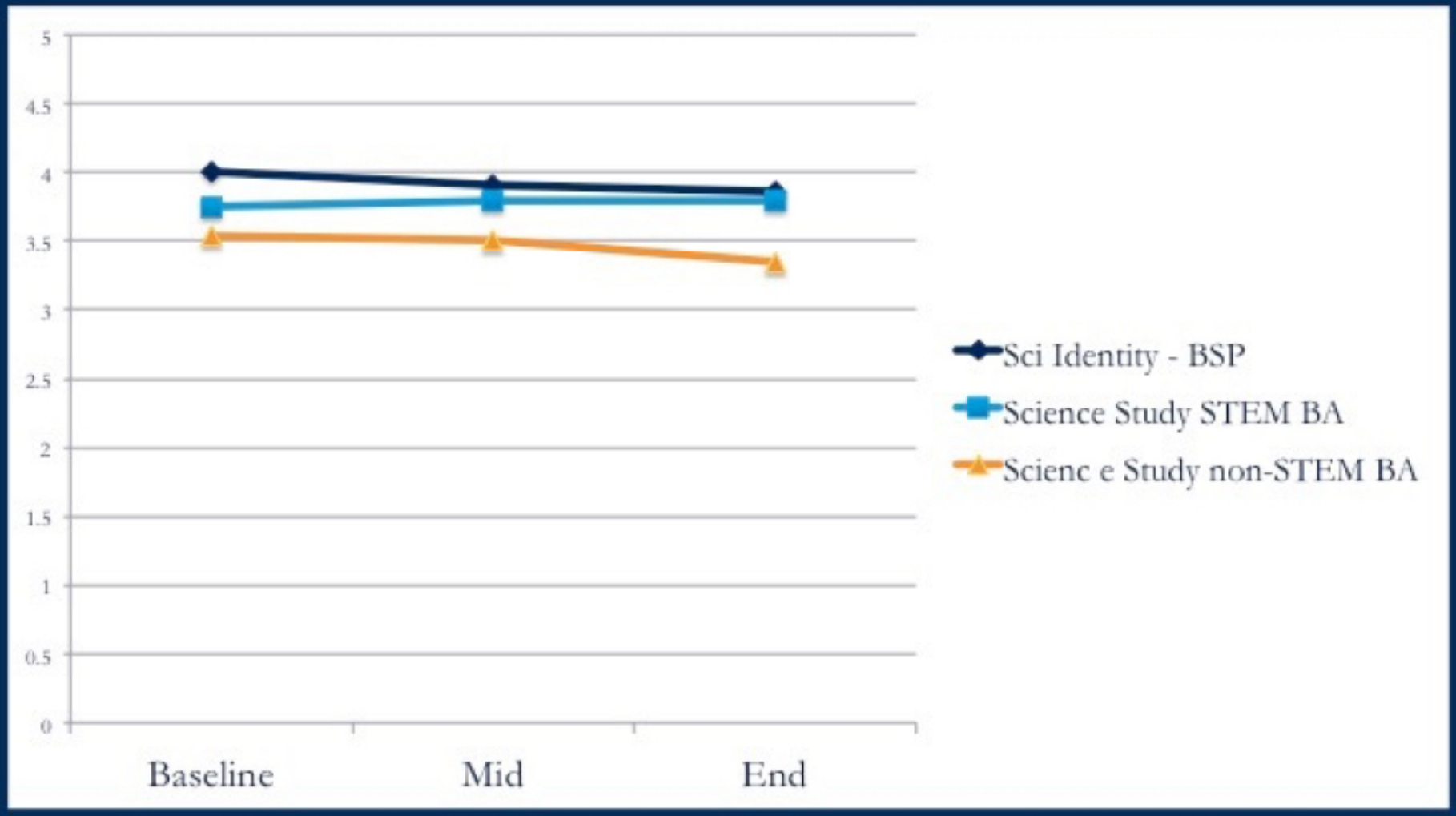
SCHOLARS
Gift It Forward Study

BSP 2015 Participation and Integration

Spring 2015	Science Efficacy	Science Identity	Science Values	Social Climate
Tutoring	-.27	-.16	-.05	-.11
BSP Participation	.21	.12	.13	.19
Events Attended	**.27***	**.29***	.01	**.36****
Appointments Attended	**.40****	.26	-.08	.20
Total Events Attended	**.40****	**.28***	.19	**.29***

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

BSP Integration into Science Community
(compared with TheScienceStudy)



UCSF

Key Points

1. There are ways to evaluate and conduct research to see if a programs are effective at increasing persistence

    Collect longitudinal data

    Prospective (as it happens)

    Have comparison groups when feasible

    Utilize institutional data to track short- and long- term impacts

2. There are ways to start to understand why programs work

    Measure psychosocial variables -- such as science efficacy, identity and values -- that are related to persistence.

    Looks at well-being, stereotype threat and stress as well.

UCSF

THANK YOU

To reach me…
Mica.estrada@ucsf.edu

UCSF