A Longitudinal Study of the Biology Scholars Program: Maintaining Student Integration and Intention to Persist in Science Career Pathways

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Abstract

The Biology Scholars Program (BSP) for undergraduate students has repeatedly demonstrated the retention and persistence of BSP scholars is on par with rates of "lower risk" scholars (Matsui et al., 2003). But an outstanding question regarding this consistent effect remains: Why do these "higher risk" scholars persist and consistently beat the odds? To address this question, the "Gift it Forward" study began in 2014 to collect data from 68 BSP scholars across four time points, to assess the growth, decline or maintenance of student integration into the scientific community and test hypotheses derived from the Tripartite Integration Model of Social Influence (TIMSI) (Estrada et al., 2011; Estrada et al., 2018). Results from a repeated measure analysis of variance (ANOVA) show that in spite of scholars being engaged in many entry-level "weeder" classes, which typically leads to high attrition of "at-risk" scholars, BSP scholars persist in maintaining science efficacy, identity and endorsement of science community values — all measures of integration into the scientific community. Cross-sectional analyses, comparing BSP scholars with non-BSP science students enrolled in entry level biology and chemistry courses, were also conducted. The results show that BSP student integration into the scientific community remains similar to those non-BSP science students with high intentions to pursue a scientific career, and significantly higher than lower intentioned non-BSP science students. At the same time, BSP scholars experience higher frequency of stereotype threat than other non-BSP science students. And, regardless of level of intention to pursue a science career or participation in BSP, all students in the study report similar levels of life satisfaction and stress.

Introduction

Over the past 40 years there has been a multitude of undergraduate co-curricular programs established to support and promote the retention of historically underrepresented (HU) ethnic and economically disadvantaged scholars in the United States (National Academies of Sciences Engineering and Medicine, 2016). Some of these programs have been able to consistently show that the persistence of their scholars exceeds the rate of retention for other scholars with similar demographic predictors (e.g., high school GPA, socioeconomic status, SAT scores, etc.) in their or other institutions. Those programs that have shown a consistent result of having scholars "beat the odds," have been held up as examples of success (see Estrada et al. (2016) for a sample list of such programs).

At the same time, the US' inability to achieve STEM (science, technology, engineering, and mathematics) workforce goals has persisted (President's Council of Advisors on Science and Technology, or PCAST, 2012). Specifically, while there have been some gains, national data show that the disparity in STEM degree attainment for HU scholars — African American, Hispanic or Latinx, American Indian/Native American, and Alaska Native— compared with majority scholars increases at each degree level (Estrada et al., 2016; National Academy of Science, 2016). The disparity, and motivation to understanding why it is so persistent, has led researchers to ask, "does this science training program work?" and to advance the science of inclusion, "for whom does it work?" and "why does it work?" To answer these latter questions, the National Academy of Sciences' recent report on "Undergraduate Research Experiences for STEM Students" recommended using applied social science methods to test theoretical models to improve understanding of why programs and interventions lead to student persistence in science (National Academies of Sciences and Medicine, 2017).

Biology Scholars Program

This paper seeks to explore more deeply "why" a successful program works by reporting on a longitudinal study that measured the psychosocial experiences of students involved in the historically successful program – The Biology Scholars Program (BSP) at UC Berkeley. The

BSP was founded in 1992 to promote academic and career success among undergraduate scholars from historically underrepresented (HU) groups in science, which included having economic, ethnic, gender or cultural experiences different from majority students in their discipline. Since then, over 3,500 UC Berkeley undergraduates have participated in BSP. The program is administered through the Department of Integrative Biology and provides academic and personal advising, mentorship, a career seminar series, access to paid research opportunities, academic support for lower-division biology major courses, and socializing opportunities. There is wrap-around support and advising as well to address issues that occur beyond the classroom including family, financial, and personal issues. Through these activities, BSP creates a community of scholars for whom there are “high expectation and high academic support” (Matsui et al., 2003, p. 118).

All UC Berkeley undergraduates are eligible to apply to this program. Low income and/or first-generation scholars and ethnically underrepresented group members are identified through on campus programs and encouraged to apply. Written applications and personal interviews are utilized in the selection process. Analysis of six years of BSP enrollment [2007 to 2012] shows that BSP selects scholars who are most at risk, with 80% being first-to college/low-income. BSP scholars are statistically identified as less prepared than the typical UC Berkeley biology student, with lower Standard Aptitude Test (SAT) scores and high school GPAs than their intended biological science freshman entrant peers (Matsui, 2018). Yet, in spite of statistically identified “deficits,” UC Berkeley institutional data reveals that BSP scholars are more likely to declare biomedical science majors, attain a biomedical degree, and maintain a high GPA relative to those HU students who are not in BSP. Further, their level of degree attainment is statistically similar to majority biomedical non-BSP science students at Berkeley that enter with much lower “risk” factors and with similar intention to pursue a biomedical degree (see Matsui, 2018). These outcomes are achieved economically, with the typical cost being about $2000 per scholar per year (including staff salaries), in comparison to other programs who focus on high achieving students and report costs of $20,000- $40,000 per student per year (J. Matsui,

personal communication, March 3, 2018). While there is strong evidence of the success of this program and the results have been well recognized nationally, this paper provides a description of students' psychosocial states as they progress through their first year with the program — providing a new lens through which to view the program.

TIMSI and Complex Social Influence Context

Programs that contribute towards the training of new scientists, such as the BSP, can potentially provide a context in which scholars with interest in science career pathways maintain or increase integration into the scientific community. A complex combination of interactions can occur while students participate in science training programs, providing social influences where a student "…changes his or her behavior as a result of induction by some other person or group – the influencing agent" (Kelman and Hamilton, 1989, p. 78). Viewed this way, advisors, mentors, and program staff of science training programs are influencing agents. Additional influencing agents can be representatives from the academic community (such as instructors, staff, or fellow scholars) as well as contextual variables (such as posters on a wall or program information pamphlets), which can influence a person's sense of belonging and intentions to participate in academic community activities (Murphy et al., 2007). We draw from a rich literature showing how learning environments matter.

Specifically, Kelman (1956, 1974, 2006) describes social influence as a reciprocal relationship between an individual and influencing agents, that results in the individual complying with the norms, requests, or even orders of the influencing agent. His research shows that the target of influence, in this case this case the student, can orient to the influencing agent in three different ways: (1) efficaciously following the rule of the group to avoid sanctions or gather rewards, (2) identifying with the role of being a part of that group, and (3) internalizing the values of the group. Kelman did not measure rule, role, and value orientation in the context of academia, thus Estrada and colleagues drew on a wide array of research to develop measures and hypotheses for each orientation that were published in 2011 and named Kelman's theory The Tripartite Integration Model of Social Influence (TIMSI) (Estrada et al.,

2011). Longitudinal research showed that these three orientations — *efficacy* (confidence in their ability to perform science-related tasks and skills), *identity* (seeing self as belonging to the community), and *values* (endorsement of the community's core values) — measured in the final year of undergraduate education, predicted intention to pursue a science career one-year later (Estrada et al., 2011) and actual career choice four-years later (Estrada et al., 2018). These measures of science efficacy, identity, and values collectively measure student integration into the scientific community and compliance with the norm of that community, to persist in a science career pathway.

The findings regarding TIMSI are consistent with classic Social Cognitive Career Theory (SCCT) research showing that scholars higher in science efficacy are more likely to continue to pursue a scientific career (Chemers et al., 2011; Lent, 2007) and show higher academic achievement (Hackett et al., 1992; Lent et al., 1989). Yet, feeling they can do scientific work does not automatically mean scholars identify as scientists, or feel they belong to a community of scientists; nor does it suggest the skills they have acquired are valuable. According to TIMSI, scholars integrate into their discipline community when they also *identify with and internalize the values* of the community.

Longitudinal quasi-experimental research testing hypotheses derived from the TIMSI model have confirmed this hypothesis. Demonstrating that while science efficacy may be a necessary component for historically underrepresented (HU) scholars integrating into the community of scientists, it is not a unique predictor of persistence when science identity and values are also part of the model (Estrada et al., 2018). Other research measuring STEM identification shows that science or engineering identity is a strong, direct predictor of persistence in STEM (Chemers et al., 2011; Graham et al., 2013). Thus, disciplinary or professional identity now is regarded as a relevant proximal measure for scholars being socially connected to their academic communities and results in persistence.

Together, the previous research on TIMSI suggests that maintaining efficacy, identity, and values is important to integrating scholars into the science community, resulting in

sustained intentions to persist among scholars who begin their undergraduate academic career with interest in science careers. Thus, for students who enter university feeling connected to the scientific community and holding high intentions to pursue a career in science, the goal is not necessarily to grow their intention, but to maintain it. While this may seem the natural course of things for a student, there is strong evidence that early courses, such as entry level biology and chemistry courses, result in a disproportionate number of low income and HU students abandoning their pursuit of a science degree (Benderly, 2012; Chen and Soldner, 2013; Crisp et al., 2009). Many co-curricular and curriculum change activities aim to arrest this phenomenon, including the Biology Scholars Program.

Beyond persistence to wellness.

In addition to wanting scholars to persist in science careers, there is the added hope for most science co-curricular programs that scholars will thrive in the science community in which they are integrating. For undergraduate scholars, thriving may consist of having increased life satisfaction, less stress, and reduced experiences of stereotype threat, or at the very least, stability in these factors. Measurement of life satisfaction and stress among undergraduate HU science scholars has not garnered research attention, though programs that demonstrate impacts on retention note how having a “holistic” approach to scholars is an important component of their program (Toven-Lindsey et al., 2015). Studies that utilize valid and reliable measures of life satisfaction and stress levels among science program scholars across time, however, are not easily found in the literature. In contrast, there is some evidence to suggest that those scholars who experience chronic stereotype threat gradually disidentify as scientists (Woodcock et al., 2012) and are less likely to persist.

Research questions

Building on previous research of the TIMSI and to advance the understanding of interventions that increase persistence of students in science, we sought to answer three research questions:

(1) *How do BSP scholars' science self-efficacy, scientific identity, and valuing the objectives of science (measures of student integration into the scientific community) change across the first year of their enrollment in BSP?* We hypothesize that BSP students will remain integrated across this time period, as opposed to declining in integration. And consistent with previous studies on students who persist (Schultz et al., 2010), BSP students' intentions to persists will show no decline.

(2) *To what extent do BSP scholars emotionally thrive across the first year of enrollment in BSP?* We hypothesize that BSP scholars will show no decline in their ability to thrive, measured as maintaining life satisfaction and not showing spikes in stress across the year of their participation. We have no hypothesis about the how stereotype threat levels will be maintained or vary across the year.

(3) How do BSP students compare to low and high intentioned non-BSP science students at UCB at the end of nine months in the program? We hypothesize, based on the history of success for BSP, that BSP scholars, like non-BSP science students with high intentions to pursue a career in science, will show signs of significantly stronger integrations into the science community than non-BSP science students with low intentions to continue. We also hypothesize that their intentions to persist will be significantly higher than the low intentioned non-BSP science students (and not significantly different from high intentioned non-BSP science students). Regarding indicators of thriving, we hypothesize that non-BSP high intentioned science students will show stronger indicators of thriving (measured as higher life satisfaction, lower stress, and lower stereotype threat) than low intentioned non-BSP science students. This latter hypothesis is based on the idea that students enrolled in science classes, while not wanting to pursue a science career, may be less inclined to thrive than those who are committed to that career path.

Data to answer these questions were collected through a longitudinal study of the BSP scholars across nine months and through a cross-sectional study that included UC Berkeley introductory biology and chemistry course students to derive low and high intentioned non-BSP science

student comparison groups.

Method

Data collection included two cohorts of scholars. The first longitudinal panel included scholars selected for the BSP and included data collection at four time points across nine months. The second cohort included cross-sectional data from entry level Biology and Chemistry courses at the same institution taken around the same time as the nine months data for BSP fellows. All data was collected through Qualtrics and the protocol had IRB approval through UC San Francisco.

Participants and Procedure

Longitudinal BSP panel. Participants in the longitudinal panel included 68 BSP scholars, who were surveyed four times from late summer 2014 to spring 2015. Participants included 74.3% females and self-identified as 44.3% Hispanic/Latinx, 8.6% African American, and 4.3% Native American/Alaska Native. Of the BSP scholars, 75% of the participants were first generation college students, and reported their class status as 44% first year, 32% second year, 16% third year, 3% 4th year, and 5% were in their 5th year of undergraduate or more.

BSP scholars were selected through a two-stage process that involved students submitting an application and then participating in an interview process with BSP staff and faculty. Participants are selected based on the following: 1) ‘distance travelled’ (i.e., barriers and challenges they have negotiated), 2) passion for science, and 3) demonstrated commitment to service. Further, BSP uses SATs and GPAs not as a threshold to include or exclude students but as a starting point to discuss an applicant’s life circumstances. Measures of strength may include assessing a candidate’s resilience, persistence, authenticity, willingness to seek and give help, and ability to re-strategize and re-group in the face of failure.

A tailored panel management (TPM) approach to data collection was utilized to collect online longitudinal data (Estrada et al., 2014). The TPM protocol involves increasing participant commitment to the study through building credibility, having multiple approaches to

communication, and implementing the approach consistently. In keeping with this approach, the study was named “Gift it Forward” and scholars were invited to participate in the study when they received the BSP program welcome materials. Having given consent, the participants then received email solicitations to complete each round of surveys. Non-responders, after two weeks, were given reminder calls to confirm they received the survey and as an opportunity to ask any questions. Response rates were as followed: Baseline n=68, 100%; three months n=49, 72%; six months n=57, 84; nine months n=63, 93%. After giving consent, BSP scholars voluntarily completed the survey in compliance with the approved human subjects protocol and were not compensated for their participation. Of the 68 BSP scholars, 41 completed the surveys at all four time points.

Cross-sectional non-BSP science student sample. The comparison group, a cross-sectional non-BSP science student sample, was drawn from science courses in which BSP scholars typically enrolled. Specifically, we drew from introductory biology (Biology 1A and 1B) and chemistry courses (Chemistry 1A (General), 3A (Organic), and 3B (Organic)) at the end of the spring semester, 441 non-BSP science students consented to complete a survey and provide data as a comparison group (a 38% response rate). The course coordinators solicited their participation on behalf of the *Gift It Forward* study. Participation was voluntary for extra credit and represented all sections of those courses offered at that time. The sample consisted of 66.6% female undergraduates with 77% of them in their first year of college, 17% in their second year, 5% in their third year, 1% in their fourth year, and 0% as other. Of the non-BSP science students, 11.1% of the participants were Hispanic/Latinx, 28.1% White, 65.6% were Asian, 2.3% African American, .7% Native American/ Alaska Native, and 5.2% self-categorized as “other.” All BSP students enrolled in these courses were omitted from the cross-sectional class sample.

Measures

For the BSP panel, basic demographic information regarding age, gender, and ethnicity were collected only at baseline and all other measures were collected at all four time periods

(baseline, three months, six months, nine months) across the first academic year of student participation in BSP. The cross-sectional non-BSP science student sample received the survey once towards the end the spring semester. The reported reliability ratings for each of the measures was calculated by combining the BSP panel baseline data with the cross-sectional non-BSP science student one time data (thus using baseline data from all samples). All administered surveys included the following measures relevant to answering the proposed research questions.

Scientific Self-Efficacy. A six-item scientific self-efficacy scale used in previous research (Estrada et al., 2011) assessed scholars' belief in their ability to perform science related tasks. Participants were asked to indicate on a scale from 1(not at all confident) to 5(absolutely confident) to what extent they believed they could complete tasks such as "Use technical skills (use of tools, instruments, and/or techniques of your field of study," (α =.90).

Scientific Identity. The five-item Science Identity Scale (Estrada et al., 2011) assessed scholars' science identity by asking them to indicate on a scale from 1(strongly disagree) to 7(strongly agree) to what extent a statement was true (e.g. "I have come to think of myself as a scientist"), (α = .89).

Science Community Value. A four-item values scale used in prior research (Estrada et al., 2011) asked scholars to read descriptions of a person (e.g., "a person who feels discovering something new in the sciences is thrilling") and rate "how much the person in the description is like you". Response options included "1=not like me at all," "2=not like me," "3=a little like me," "4=somewhat like me," "5=like me", and "6=very much like me," α= .87.

Life Satisfaction. The five-item life satisfaction scale (Diener et al., 1985) used a seven point scale, 1(strongly disagreed) to 7(strongly agree). Scholars were asked to rate their level of agreement with each statement (e.g. "In most ways my life is close to my ideal"), with a reliability of α= .84.

Stress. A four-item short version of the Perceived Stress Scale (Cohen et al., 1983) measured students' stress. The measure asked scholars to indicate how often they experienced

certain stressful situations (e.g., “Felt difficulties were piling up so high that you could not overcome them”). Responses options included 1=never, 2=almost never, 3=sometimes, 4=fairly often, and 5=often. Two items in the scale were reverse coded, with the lower score indicating lower stress levels, (α= .78).

Stereotype Threat. The four-item stereotype threat scale measured the level of negative perception the scholars experienced within the campus and their courses based on their ethnicity. On a scale from 1(never) to 5(almost always), the scholars were directed to rate “How often do you feel that because of your ethnicity a) Some people believe that you have lower ability than other students, b) People assume that you are not good enough, even if you are similar to other students, c) If you do poorly on a test, people act like that is normal, and d) Your intelligence is not fairly evaluated. This scale was adapted for this study from an eight-item scale used in (Woodcock et al., 2012), and had a reliability score of α= .86.

Intention to Persist: A seven-item scale measured students’ intention to remain in STEM, which extended the intention measure Schultz et al. (Schultz et al., 2011) and Estrada et. al. (Estrada et al., 2011) used, while maintaining the same response options. The scale required participants to rate from 0(definitely will not) to 10(definitely will) their level of intentions to pursue a certain science themed activity. Items included: a) To what extent do you intend to pursue a science related career?, b) How likely is it that you will pursue a Master’s degree in a science field?, c) How likely is it that you will pursue a Doctoral degree in a science field?, d) To what extent do you intend to pursue a career in which you will conduct research?, e) How likely is it that you will pursue a career in which you share research findings with other people?, f) How likely is it that you will pursue a career in which you present academic papers at conferences?, and g) How likely is it that you will pursue a career in which you publish academic papers in reviewed academic journals? This scale had strong reliability at α= .81.

Data Analysis Plan

To address the question of how BSP scholars’ level of integration changed or remained stable across the first year of their program participation, we planned to conduct repeated-

measures analysis of variance (ANOVA). Because we do not have a comparison group across time, there was no between subject variable. These analyses aim to describe if there were significant changes, including any linear or quadratic trends for the cohort and test the hypothesis that BSP students will remain integrated across this time period and not decline in their science efficacy, identity, values or their overall intentions to pursue a scientific career. To answer the second research question regarding the stability or fluctuation in indicators of thriving (i.e., Life Satisfaction and Stress), similar repeated-measures analyses of variance are planned.

To answer the third research question and assess how BSP scholars were similar to or different from non-BSP UCB students in introductory biology and chemistry courses, the plan of analyses included two steps. First, the non-BSP science students will be divided into two groups — High and Low Intentioned Science Students to pursue a science career — using a scale score split. By using the scale score rather than the mean as the point of the split, we group together people who report low intentions relative to the scale options rather than each other. An ANCOVA will then be run for each variable to assess if BSP scholars, high intentioned and low intentioned groups show significant differences, when controlling for the effects of year in school among the groups. If the omnibus test is found to be significant, a follow-up planned contrast analysis will be conducted to test the hypothesis if BSP scholars and High Intentioned non-BSP science students show significantly higher measures of integration and thriving than the Low Intentioned non-BSP Science Students for each of the variables (using the weights +1 for BSP and High Intentioned non-BSP Science Students and -2 for Low Intentioned non-BSP Science Students) (Abdi and Williams, 2010). No additional contrasts analyses were planned.

Results

BSP scholars across nine months of program participation

Measures of integration. To answer our first research question and assess how BSP scholars' science efficacy, identity, and science community values (measures of integration),

change or remain stable across a year, we conducted a one-way repeated measures ANOVA across four time points in a nine month's time span. Results showed a remarkable level of stability for scholars (see Table 1) on all three measures. No significant differences were found across time for any of the TIMSI variables (Efficacy, Wilks' Lamdba = .923, $F(3,43) = 1.783$, p= ns; Identity, Wilks' Lamdba = .984, $F(3,43) = .35$, p= ns; Values, Wilks' Lamdba = .876, $F(3,43) = 3.037$, p=.06). Further, there was no significant change in Intention to pursue a scientific career, (Wilks' Lamdba = .842. $F(3,38) = 2.376$; p= ns). Given the attrition and loss of persistence typical of HU and first-generation scholars during this time period, the sustained interest and measures of integration for BSP scholars were consistent with program objectives.

Measures of Stress, Life Satisfaction and Stereotype Threat. To assess wellness of scholars, we also examined changes in levels of life satisfaction, stress, and experiences of stereotype threat. Results showed great stability for the BSP students (Stress, Wilks' Lamdba = .925. $F(3,38) = 1.032$; p= ns; Life Satisfaction, Wilks' Lamdba = .959. $F(3,38) = .537$; p= ns; Stereotype Threat, Wilks' Lamdba = .985. $F(2,37) = .182$; p= ns) (see Table 1). Across the first year, there was no significant variability in these measures.

Cross sectional analyses of BSP Scholars compared with non-BSP High and Low Intentioned Non-BSP Science Students

Correlational results. Before proceeding to conduct the planned analyses, we correlated all variables with each other to assess if the relationships among the variables were overall consistent with previous research showing that Efficacy, Identity and Values were significantly related to Intentions to Persist. In addition, we wanted to assess if measures of Life Satisfaction, Stress, and experiences of Stereotype Threat might also be related to Intentions to Persist. Given that the sample is cross sectional, we conducted these analyses as a way to describe the data rather than wrongly inferring causation. Overall, we found that the expected relationships existed, with Efficacy ($r=0.33$; $p<.01$), Identity ($r=0.61$; $p<.001$), and Values ($r=0.46$; $p<.01$) being significantly related to Intentions to Persist. While Life Satisfaction, Stress and Stereotype Threat did not show significant relationships with Intentions to Persist (see Table 2).

Measures of integration. In order to assess how BSP scholars compared with students in common classes, non-BSP science students from general chemistry and biology courses were grouped into High (n= 342) and Low Intentioned (n= 73) Science Student cohorts using a scale score split (on a scale from 0-10, 0-5.0=low, 5.1-10=high). We chose to use the scale score split because it better reflected lower intention overall to pursue a science than a mean split score, which would reflect lower intention relative to other students in the class, but still with high intentions relative to the scale options (M=6.70, SD 1.91). High and Low Intentioned Science Students were similar in terms of gender (High, 66% and Low, 69% female), age (High mean age 18.3 years; Low mean age 18.2 years) and ethnicity (High 13% and Low 18% from HU groups). BSP scholars (utilizing only the nine months data collected and the non-BSP science student data) were then compared with High and Low Intentioned non-BSP Science Scholars regarding their levels of science Efficacy, Identity, Values, Life Satisfaction, Stress and experience of Stereotype Threat. A one-way ANCOVA was conducted to compare BSP scholars and non-BSP High and Low Intentioned Science Students on all variable of interest, whilst controlling for year in school. Levene's test and normality checks were conducted and assumptions were met. Table 1 provides the estimated means (M) and standard deviations (SD) for all variables. The omnibus ANCOVA results provided evidence that there were significant differences among these three groups on all TIMSI variables (Efficacy, $F(2, 470) = 6.74$, $p=.001$; Identity, $F(2, 472) = 48.73$, $p <.001$, and Values, $F(2, 467) = 21.15$, $p <.001$ (see Figure 1)).

Having met the assumption of significance, and with all tests showing homogeneity of variance, we proceeded to conduct planned contrast analyses for each of the integration variables to test the hypotheses that BSP Scholars and High Intentioned non-BSP Science Students would be significantly more integrated than the Low Intentioned non-BSP Science Students. The weight of +1 was given to both the BSP and High Intentioned non-BSP Science Students and -2 was given to the Low Intentioned non-BSP Science Students. These planned comparisons were found to be significant for all three integration variables, showing that BSP

and High Intentioned non-BSP Science Students were significantly higher than the Low Intentioned non-BSP Science Students (Efficacy ($F(1,463) = 3.63$, $p<.001$); Identity ($F(1,463) = 9.16$, $p<.001$); Values ($F(1,463) = 5.09$, $p<.001$)).

Intentions to Persist. On a scale of 0 -10 with higher responses indicating higher intentions to persist and engage in science career activities, BSP students were 3.04 points higher than Low Intentioned non-BSP Science Students and 0.73 points lower than High Intentioned non-BSP Science Students when (see Table 1 for means). Two t-tests were conducted, which showed that BSP student Intentions to Pursue a science career pathway was significantly higher than Low Intentioned non-BSP Science Students ($t(135) = -11.12$, $p<.001$) and significantly lower than the High Intentioned non-BSP Science Students ($t(403) = 3.79$, $p<.001$).

Measures of Life satisfaction, Stress, and Stereotype Threat. The ANOVA results did not show significant differences in Life Satisfaction ($F(2, 463) = 1.49$, p = ns), or Stress ($F(2, 463) = 0.80$, p = ns), among the three groups. There was, however, a significant difference in BSP scholars compared to both High and Low Intentioned non-BSP Science Students in their self-reported experience of Stereotype Threat ($F(2, 463) = 19.34$, $p <.001$). To better understand this latter significant finding regarding Stereotype Threat, a non-planned contrast analysis was conducted to test if BSP scholars (+2) had significantly higher rates of stereotype threat than both the non-BSP High (-1) and Low (-1) Intentioned Science Students. Results showed this contrast analysis was significant ($F(1, 467) = 6.90$; $p<.001$), indicating that BSP students report significantly higher rates of Stereotype Threat than the non-BSP High and Low Intentioned Science Students.

In summary, these results show that BSP Scholars integration into the scientific community remains similar to those non-BSP science students with high intentions to pursue a scientific career. At the same time, BSP students experience higher frequency of stereotype threat, including lowered expectations of them regarding their abilities, intelligence, and

performance. And, regardless of level of intention to pursue a science career or participation in BSP, levels of life satisfaction and stress are stable and similar among all students.

Discussion

The overarching purpose of this paper was to utilize a social influence framework to better understand the experience of BSP Scholars as they navigate the first academic year of the program participation, by tracking their level of integration into the science community, their ability to thrive, and their level of persistence in science career pathways. This study occurs in the context of the students enrolled in UC Berkeley entry level biology and chemistry science courses, which are notorious for their high level of competition and their ability to "weed out" students not showing aptitude, with historically underrepresented students progressing far less often than majority students (Eppig and Wadhwani, 2018). The results of this nine month study show that BSP scholars show remarkable stability in their level of integration into the scientific community during this same time. Specifically, in spite of being in competitive "weeder courses" and continuing to adapt to an academic environment known for high expectations, these students maintain a strong sense of their own ability to do science (i.e., science efficacy), they continue to identify as a scientist, and their endorsement of scientific community values remains steady. Results from this study suggest that one of the reasons that BSP Scholars persist and maintain an intention to pursue a science related career is because they maintain their integration into the scientific community.

In addition to stability in their integration and intentions to persist, we also found that BSP scholars show sustained indicators of thriving, measured as life satisfaction and no spikes in levels of stress. Questions related to life satisfaction included feeling as if life is close to their ideal, excellent, or satisfactory, and has elements they would not want to change. While there is no evidence that these predict long term persistence in STEM, there are hopefully real-time benefits to maintaining life satisfaction, despite fluctuations in the demands of a degree program. Further, and perhaps more surprisingly, is that the level of stress did not significantly

vary across the year in spite of the survey being given at very different times of the academic calendar, including just as the terms began, during midterms, and at the conclusion of the year, when finals were eminent or just had concluded. These results are consistent with research showing that supportive group affiliations can help reduce stress even when demands increase (Baqutayan, 2011; Nicpon et al., 2006; Pfeiffer, 2001; Rayle and Chung, 2007). Lastly, experiences of stereotype threat did not significantly waver across the year.

Overall, these results describe the BSP Scholars as students who remain stable and consistent through their academic year. The cross-sectional comparison of BSP scholars and non-BSP science students enrolled in similar entry level biology and chemistry courses provides another layer of results showing that BSP Scholars remain inoculated from the typical loss of integration and persistence that "high risk" students experience. The data show instead a group of students who have similar levels of confidence in their scientific skills (i.e., efficacy), identification as a scientist, and endorsement of science community values as non-BSP science students with high intentions to persist, while having significantly higher rates of these characteristics than the low-intentioned students.

At the same time, the BSP scholars, and both the high and low intentioned non-BSP science students report nearly identical levels of life satisfaction and stress. This perhaps is particularly interesting given that BSP scholars report significantly higher rates of experiencing stereotype threat than both high and low intentioned non-BSP science students. Collectively, these data provide a description of a group of students who perceive their skills and intelligence are being judged more negatively because of their ethnicity, while at the same time not experiencing greater stress or less life satisfaction than their fellow students.

Overall, these results show that while BSP students are not having identical social experiences as their fellow non-BSP science students, they continue to report a pattern of responses that are nearly identical to students who continue to persist in STEM.

Caveats

While the results of this study support the utility of the TIMSI to describe how scholars, in a

successful science training program, maintain integration with the STEM community, there are several caveats that should be noted.

Causation. The results we present are intended to be primarily descriptive and not causal in the conclusions drawn. Students selected for BSP were not randomly selected, therefore we cannot disaggregate selection from program participation. Further, students who apply to BSP are highly motivated to pursue a science career, even before they start. But unlike some programs that focus on choosing the "most likely to succeed" students, BSP has a history of selecting students statistically at risk of leaving science, with the intention of growing talent and beating the odds (Matsui, 2018). We can speculate that the program components, which includes building a strong sense of community through advising, workshops, community space, mentorship, and two courses required of all members taught by the BSP Director, contribute towards students maintaining integration, even when temporary stressors, curriculum challenges or outright prejudice is experienced. A quasi-experimental, longitudinal study that tracks BSP scholars and a propensity score matched comparison group prospectively would allow for drawing causal conclusions, which these results suggest, but do not confirm.

Lack of growth versus stability. Many studies of persistence hypothesize that growth and development of intentions to persist are necessary for broadening participation in STEM, particularly in the K-12 literature (Dabney et al., 2012; Graham et al., 2013; Sithole et al., 2017). Less is known about how to maintain student science integration — measured as efficacy, identity and values — once a motivated and high intentioned science student comes to a university to fulfill science career aspirations. Previous research examining students who participated in the Research Initiative for Scientific Enhancement (RISE) showed that intentions remained high and were maintained across two years, whereas a propensity score matched comparison group, who held similar intentions to persist when recruited to the study, steadily declined across the two years (Schultz et al., 2011). The BSP results mirror those found in that study of the RISE program in that program participants maintain (rather than lose) intention. A recent study also showed that growth in science efficacy and identity did not predict persistence

to STEM fields four years after undergraduate degree attainment, while their overall levels did (Estrada et al., 2018). Does this mean that programs should not aim to grow efficacy, identity and values? The results of this study simply show that maintaining stability of these among students who begin with efficacy, identity and values already highly held, may be enough to support their persistence. However, the needs of those students who do not hold high initial intentions to pursue a science career may be very different. Further, tracking students across the tenure of this academic career from undergraduate into early faculty careers may reveal more peaks and valleys among students who persist. However, this is left for future research to discern.

Imperfect comparison group. In examining the demographic characteristics of the cross sectional non-BSP science student comparison group, it is clear that this group is not a perfect match to the BSP scholars. They are more likely to be in their first year of study than BSP students and more likely to be a majority group member. The selection of this sample for non-BSP science students was to take a pulse in the level of integration of science students-at-large at UC Berkeley and be able to compare them to BSP students enrolled in similar degree programs. The response rate from the science courses suggests that the student sample may not be representative of all students at UC Berkeley, and thus conclusions drawn must be considered with that knowledge. In recognition of the year in school differences between BSP and non-BSP groups, we controlled for the year at university effects using ANCOVA. Overall, the results show that in spite of their class level differences, high intentioned non-BSP science students were mostly statistically indistinguishable from the BSP scholars, suggesting that this is a relevant comparison group. Future research utilizing a propensity score matched sample that matches year of study and current level of science course progression may provide an even stronger comparison group to add additional knowledge to the results reported here.

Summary

Understanding why successful training programs work is important to identifying principles that can be applied to university departments, programs, and even at the institutional

level. The results presented here seek to make this sort of data-driven contribution by showing it is possible to create the conditions for students to remain integrated into the science community, even when they are pursuing competitive science degree programs and experiencing stereotype threat. The results reported here indicate that creating conditions within academia that support the maintenance of students' integration into their discipline communities, even among higher-risk student populations, is possible and related to their persistence in science career pathways.

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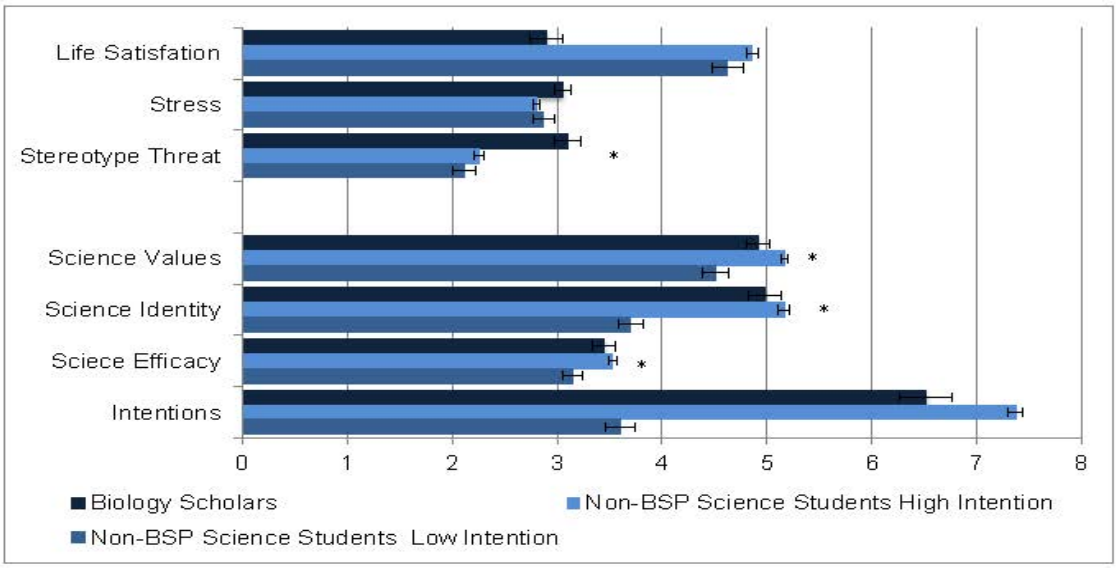
Figure 1

Bar chart of ANCOVA results for *Science Identity(1-7), Science Self-Efficacy(1-5), Scientific Community Values(1-6), Intention to Persist(0-10), Life Satisfaction(1-7), Stress(1-5), and Stereotype Threat(1-5) for BSP scholars at nine months(n=63) and the cross-sectional sample of low intentioned (n=73) and high intentioned (n=339) non-BSP science students.*



Note: These utilize estimated means, with year in college as a covariate. Asterisks denote significant differences.

Table 1.

Means and Standard Deviations for measures of Science Identity, Science Self-Efficacy, Scientific Community Values, Intention to Persist, Life Satisfaction, Stress, and Stereotype Threat in BSP scholars, low intentioned non-BSP science students, and high intentioned non-BSP science students from baseline to nine months.

	Baseline		3 Months		6 Months		9 Months		Low Int.*		High Int.*	
Scale	M	SD	M	SD	M	SD	M (*)	SD	M	SD	M	SD
Science Self-Efficacy	3.46	0.86	3.62	0.83	3.65	0.73	3.56 (3.45)	0.83	3.17	0.76	3.55	0.80
Science Identity	5.48	1.08	5.43	1.19	5.30	1.41	5.10 (4.98)	1.21	3.73	1.06	5.18	1.16
Science Community Values	5.24	0.64	4.95	0.87	4.99	0.80	4.97 (4.91)	0.87	4.51	0.98	5.18	0.75
Intention to Persist	7.59	1.28	7.24	1.67	6.92	1.85	6.64 (6.52)	1.98	3.61	1.16	7.40	1.27
Life Satisfaction	4.75	1.12	4.66	1.28	4.66	1.31	4.74 (4.69)	1.26	4.63	1.30	4.86	1.15
Stress	2.91	0.69	2.83	0.70	3.02	0.63	2.88 (2.90)	0.64	2.87	0.81	2.80	0.63
Stereotype Threat	3.19	1.03	3.01	1.06	3.08	1.10	3.10 (3.05)	1.02	2.11	0.90	2.25	0.92
N (sample size)	67		49		57		63		73		342	

*Estimated means with Year in School as a covariate.

Table 2

Correlations of key variables utilizing cross-sectional data from BSP scholars at nine months and all non-BSP science students.

Scale	1	2	3	4	5	6	7
1. Self-Efficacy	-	.53**	.42**	.33**	.19**	-.29**	.03
2. Science Identity	.53**	-	.55**	.61**	.14**	-.16**	-.01
3. Science Community Values	.46**	.55**	-	.46**	.17**	-.08	-.05
4. Intention to Persist	.33**	.61**	.46**	-	.07	-.07	.04
5. Life Satisfaction	.19**	.14**	.17**	.07	-	-.51**	-.12
6. Stress	-.28**	-.16**	-.08	-.07	-.51**	-	.23**
7. Stereotype Threat	.03	-.00	-.05	.04	-.12**	.23**	-

Note: p<.05*, p<.01**, P<.001***